Amelco Data Book, Volume 1

Presented To

M. (Goose) Weintraub

By

R.E. Schuttenhelm

FET Product Manager (Sales)

To Find A Specific Data Sheet

If you know only the Device Number, look in the Numeric Index, page 6, for the page series number.

If you know only the Category of Device, look in the Category Index, page 10. Then refer to the Numeric Index for the specific type and page series number.

Notes On This First Edition

This first edition of the Amelco Data Book contains currently published data sheets. As new data sheets are published, they will be distributed for insertion in the appropriate sections of this basic Tightleaf® catalog.

This catalog replaces collections of loose data sheets. Many of the data sheets in this book have been revised, and therefore cancel and supersede earlier editions.

Please give your present collection to a co-worker who can make use of it; the largest part of the old data is still current.

Note that certain large blocks of page numbers have intentionally been omitted, to permit simplified numbering of insert pages.

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DEFINITION OF SYMBOLS AND TERMS

*	Contact local representative for latest information
NPN	Silicon Planar Transistor, N-Polarity
PNP	Silicon Planar Transistor, P-Polarity
DNPN	Dual NPN Transistor
DPNP	Dual PNP Transistor
PFET	Silicon Planar Junction Field Effect Transistor, P-Channel
NFET	Silicon Planar Junction Field Effect Transistor, N-Channel
DNFET	Dual N-Channel Field Effect Transistor
DPFET	Dual P-Channel Field Effect Transistor
MDNPN	Monolithic Dual NPN Transistor
MDDNPN	Monolithic Dual Darlington NPN Transistor
HNIL	High Noise Immunity Logic
TTL	Transistor-Transistor Logic
MEMA	Micro Electronic Modular Assembly

TRANSISTORS

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2N5019	PFET	General Purpose Switch	3503
2N5078	NFET	RF/IF Amplifier	3307
2N5079	NPN	Medium Power	1307
2N5080	NPN	Medium Power	1307
2N5277	NFET	High Voltage Amplifier	*
2N5278	NFET	High Voltage Amplifier	*
A1109	NPN	General Purpose	*
A1341	NPN	General Purpose	*
DL1009	DPNP	General Purpose	*
P1027	PFET	General Purpose	*
P1028	PFET	General Purpose	*
P1029	PFET	General Purpose	*
SA2206	DNPN	General Purpose	*
SA2253	DNPN	General Purpose	*
SA2664	MDDNPN	General Purpose	*
SU2078	DNFET	General Purpose	*
SU2079	DNFET	General Purpose	*
SU2080	DNFET	General Purpose	*
SU2081	DNFET	General Purpose	*
SU2098	DNFET	General Purpose	4101
SU2099	DNFET	General Purpose	4101
U1277	NFET	General Purpose	*
U1278	NFET	General Purpose	*
U1279	NFET	General Purpose	*
U1280	NFET	General Purpose	*
U1281	NFET	General Purpose	*
U1282	NFET	General Purpose	*
U1283	NFET	General Purpose	*
U1284	NFET	General Purpose	*
U1285	NFET	General Purpose	*
U1286	NFET	General Purpose	*
U1325	NFET	General Purpose	*
U1714	NFET	Low Leakage Amplifier	3301
U1715	NFET	High Voltage Amplifier	3302

LINEAR MICROCIRCUITS

709	Monolithic	Operational Amplifier	5001
710	Monolithic	Differential	5002
711	Monolithic	Dual Differential	5003
800	Monolithic	Operational Amplifier	5001
801	Monolithic	Operational Amplifier	5201
805	Monolithic	Operational Amplifier	5202
806	Monolithic	Operational Amplifier	5202
807	Monolithic	Operational Amplifier	5202
808	Monolithic	Operational Amplifier	5202
809	Monolithic	Operational Amplifier	5203
819	Monolithic	Operational Amplifier	5204
831	Monolithic	Differential Amplifier	5205
901	Monolithic	Video Amplifier	5401
903	Monolithic	VHF Amplifier	5402
911	Monolithic	RF/IF Amplifier	5403

Device Part No.	Type	Description	Sheet No.
508	TTL	Dual 4 Input Nand/Nor Gate	6506
509	TTL	JK Flip-Flop	6507
510	TTL	Dual 3 Input Gate	*
510	TTL	Dual 3 Input Gate	*
511	TTL	Dual 3 Input Gate	*
512	TTL	JK Flip-Flop	*
513	TTL	Dual 4 Input Gate	*
526	TTL	Dual 4 Input Gate	*
527	TTL	Dual 3 Input Gate	*
528	TTL	Dual 3 Input Gate	*
529	TTL	JK Flip-Flop	*
530	TTL	Dual 4 Input Gate	6503
531	TTL	Quad 2 Input Gate	6504
533	TTL	Triple 3 Input Gate	6505
534	TTL	Dual 4 Input Gate	6503
535	TTL	Quad 2 Input Gate	6504
537	TTL	Triple 3 Input Gate	6505
538	TTL	Dual 4 Input Nand/Nor Gate	6506
539	TTL	JK Flip-Flop	6507
540	TTL	Dual 4 Input Buffer	6508
541	TTL	Dual 4 Input Buffer	6508
543	TTL	Dual 4 Input Gate	6509
544	TTL	Dual 4 Input Gate	6509
547	TTL	Dual 4 Input Power Gate	6510
548	TTL	Dual 4 Input Power Gate	6510
570	TTL	Dual 4 Input Gate	6503
571	TTL	Quad 2 Input Gate	6504
573	TTL	Triple 3 Input Gate	6505
574	TTL	Dual 4 Input Gate	6503
575	TTL	Quad 2 Input Gate	6504
577	TTL	Triple 3 Input Gate	6505
578	TTL	Dual 4 Input Nand/Nor Gate	6506
579	TTL	JK Flip-Flop	6507
580	TTL	Dual 4 Input Buffer	6511
583	TTL	Dual 4 Input Gate	6509
584	TTL	Dual 4 Input Gate	6509
587	TTL	Dual 4 Input Buffer	6511

DIGITAL MICROCIRCUITS

Device Part No.	Type	Description	Sheet No.
301	HNIL	Dual 5 Input Buffer	6001
302	HNIL	Quad 2 Input Power Gate	6002
311	HNIL	RST-JK Flip-Flop	6003
312	HNIL	Dual JK Flip-Flop	6004
321	HNIL	Quad 2 Input Gate	6005
322	HNIL	Dual 5 Input Gate	6006
323	HNIL	Quad 2 Input Gate	6007
331	HNIL	Dual 5 Input Expander	6008
341	HNIL	Dual Exclusive-Or	6009
342	HNIL	Dual One Shot	6010
361	HNIL	Dual Input Interface	6011
362	HNIL	Dual Output Interface	6012
370	HNIL	Quad D Flip-Flop	6013
500	TTL	Dual 4 Input Gate	6503
501	TTL	Quad 2 Input Gate	6504
503	TTL	Triple 3 Input Gate	6505
504	TTL	Dual 4 Input Gate	6503
505	TTL	Quad 2 Input Gate	6504
507	TTL	Triple 3 Input Gate	6505

Device Part No.	Type	Description	Sheet No.

HYBRID MICROCIRCUITS

Device Part No.	Type	Description	Sheet No.
2001	Hybrid	High Voltage/Current Driver	7001
2107	Hybrid	SPST FET Analog Switch	7101
2110	Hybrid	SPST FET Analog Switch	7101
2114	Hybrid	SPDT FET Analog Switch	7102
2126	Hybrid	SPDT FET Analog Switch	7103
2128	Hybrid	Quad SPST FET Analog Sw.	7104
2404	Hybrid	Operational Amplifier	7401
2405	Hybrid	Operational Amplifier	7401
2709	Hybrid	Operational Amplifier	*
2802	Hybrid	Voltage Regulator	7801
2803	Hybrid	Voltage Regulator	7801
2809	Hybrid	Operational Amplifier	*

MICRO-ELECTRONIC MODULAR ASSEMBLY

Device Part No.	Type	Description	Sheet No.
5551	MEMA	20 Bit Shift Register	8101
5552	MEMA	16 Bit Shift Register	8101
5598	MEMA	16 Bit Ripple Counter	8102
5603	MEMA	Up/Down-BCD Decimal Counter	8401
5604	MEMA	Dual Decade Counter	*
5605	MEMA	16 Bit Ripple Counter	8102
5606	MEMA	Dual Decade Decoder	*
5608	MEMA	Dual 4 Bit Counter	*
5620	MEMA	Dual 12 Bit Shift Register	*
5621	MEMA	Dual 10 Bit Shift Register	*
5622	MEMA	Dual 8 Bit Shift Register	*
5623	MEMA	UP/Down-BCD Decimal Counter	8401
5624	MEMA	Dual Decade Counter	*
5625	MEMA	16 Bit Ripple Counter	8102
5626	MEMA	Dual Decade Decoder	*
5627	MEMA	Dual Decade Decoder	*
5628	MEMA	Dual 4 Bit Counter	*
5643	MEMA	UP/Down-BCD Decimal Counter	8401
5644	MEMA	Dual Decade Counter	*
5645	MEMA	16 Bit Ripple Counter	8102
5646	MEMA	Dual Decade Decoder	*
5647	MEMA	Dual Decade Decoder	*
5648	MEMA	Dual 4 Bit Counter	*
5660	MEMA	8 Channel Binary Multiplexer	*
5661	MEMA	8 Channel Binary Multiplexer	*
5662	MEMA	12 Channel Multiplexer	*
5663	MEMA	12 Channel Multiplexer	*
5670	MEMA	RF Power Amplifier	8402

CATEGORY INDEX

NPN GENERAL PURPOSE

TYPE NO.	V_{CER}* OR V_{CEO} V min	V_{CBO} V min	V_{EBO} V min	h_{fe}* @ 1KHz OR h_{FE} min	h_{fe}* @ 1KHz OR h_{FE} max	$V_{CE(sat)}$ V max	$V_{BE(sat)}$ V max	I_{EBO} nA max	I_{CBO} nA max	I_{CBO} 150°C μA max	C_{ob} pf max	C_{ib} pf max	f_T MHz min	NF db max	PACKAGE TYPE	BASE
2N718	*40	60	5	40	120	1.5	1.3		1.0K	100	35		50		TO-18	3L
2N718A	*50	75	7	40	120	1.5	1.3	10	10	10	25	80	70		TO-18	3L
2N720	*80	120	5	40	120	5.0	1.3		2.0K	200	20		50		TO-18	3L
2N760	45	45	8	*76	333	1.0	1.0		200	10	8		50		TO-18	3L
2N760A	60	60	8	*76	333	1.0	1.1		100	10	8		50		TO-18	3L
2N910	60	100	7	*80	200	0.4	0.8	25	25	15	15	85	60		TO-18	3L
2N911	60	100	7	*40	100	0.4	0.8	25	25	15	15	85	50		TO-18	3L
2N929	45		5	40	120	1.0		10			8		30	4	TO-18	3L
2N929A	45	60	6	40	120	0.5	0.9	2	2	2	6		45	4	TO-18	3L
2N930	45		5	100	300	1.0		10			8		30	4	TO-18	3L
2N930A	45	60	6	100	300	0.5	0.9	2	2	2	6		45	3	TO-18	3L
2N930B	45	60	6	100	300	0.5	0.9	2	2	2	6		45	3	TO-18	3L
2N1613	*50	75	7	40	120	1.5	1.3	10	10	10	25	80	60		TO-5	3L
2N1711	*50	75	7	100	300	1.5	1.3	5	10	10	25	80	70		TO-5	3L
2N2192	40	60	5	100		.35		50	10		20		50		TO-5	3L
2N2192A	40	60	5	100		.25		50	10		20		50		TO-5	3L
2N2192B	40	60	5	100		.18		50	10		20		50		TO-5	3L
2N2193	50	80	8	40		.35		50	10		20		50		TO-5	3L
2N2193A	50	80	8	40		.25		50	10		20		50		TO-5	3L
2N2193B	50	80	8	40		.18		50	10		20		50		TO-5	3L
2N2194	40	60	5	20		.35		50	10		20		50		TO-5	3L
2N2194A	40	60	5	20		.25		50	10		20		50		TO-5	3L
2N2194B	40	60	5	20		.18		50	10		20		50		TO-5	3L
2N2195	25	45	5	20		.35		100	100		20		50		TO-5	3L
2N2195A	25	45	5	20		.25		100	100		20		50		TO-5	3L
2N2195B	25	45	5	20		.18		100	100		20		50		TO-5	3L
2N2217	30	60	5	20		0.4		10	10		8		250		TO-5	3L
2N2218	30	60	5	40		0.4		10	10		8		250		TO-5	3L
2N2218A	40	75	6	40		0.3		10	10		8	25	250		TO-5	3L
2N2219	30	60	5	100		0.4		10	10		8		250		TO-5	3L
2N2219A	40	75	6	100		0.3		10	10		8	25	300		TO-5	3L
2N2220	30	60	5	20		0.4		10	10		8		250		TO-18	3L
2N2221	30	60	5	40		0.4		10	10		8		250		TO-18	3L
2N2221A	40	75	6	40		0.3		10	10		8	25	250		TO-18	3L
2N2222	30	60	5	100		0.4		10	10		8		250		TO-18	3L
2N2222A	40	75	6	100		0.3		10	10		8	25	300		TO-18	3L
2N2222B	40	75	6	100		0.2			10	10	8	25	300	4	TO-18	3L

NPN GENERAL PURPOSE (Cont.)

TYPE NO.	V_{CER}* OR V_{CEO} V min	V_{CBO} V min	V_{EBO} V min	h_{fe}* @ 1KHz OR h_{FE} min	h_{fe}* @ 1KHz OR h_{FE} max	$V_{CE(sat)}$ V max	$V_{BE(sat)}$ V max	I_{EBO} nA max	I_{CBO} nA max	I_{CBO} 150°C µA max	C_{ob} pf max	C_{ib} pf max	f_T MHz min	NF db max	PACKAGE TYPE	BASE
2N2243		120	7	40	120	0.35		50	10	15	15				TO-5	3L
2N2243A		120	7	40	120	0.25		50	10	15	15				TO-5	3L
2N2297	35	80	7	40	120		1.6	10	10	10	12		60		TO-5	3L
2N2483	60	60	6	40	120	0.35		10	10	10	6	6	60	4	TO-18	3L
2N2484	60	60	6	100	500	0.35		10	10	10	6	6	60	3	TO-18	3L
2N2484A	60	60	6	100	500	0.35	0.7	10	10	10	6	6	60	2	TO-18	3L
2N2509	80	125	7	25		1.0	0.9	2	5	10	6	10	45	7	TO-18	3L
2N2510	65	100	7	75		1.0	0.9	2	5	10	6	10	45	4	TO-18	3L
2N2511	50	80	7	120		1.0	0.9	2	5	10	6	10	45	4	TO-18	3L
2N2586	45	60	6	120	360	0.5	0.9	2	2		7		45	3	TO-18	3L
2N2865	13	25	3	20	200	0.4	1.0		10	1.0	2.5		600	4.5	TO-18	4L
2N3117	60	60	6	250	500	0.35		10	10	10	4.5	6	60	1.0	TO-18	3L
2N5079	30	60	5	100	300	0.2	1.0	10	10	10	7.0	30	400	4	TO-18	3L
2N5080	30	60	5	200	500	0.2	1.0	10	10	10	7.0	30	400	4	TO-18	3L
A1109		45	5	70		0.6	0.9		100		8.0		40		TO-18	3L
A1341		75	5	50		1.2	1.2		10		10		40		TO-5	3L

PNP GENERAL PURPOSE

TYPE NO.	V_{CER}* OR V_{CEO} V min	V_{CBO} V min	V_{EBO} V min	h_{fe}* @ 1KHz OR h_{FE} min	h_{fe}* @ 1KHz OR h_{FE} max	$V_{CE(sat)}$ V max	$V_{BE(sat)}$ V max	I_{EBO} nA max	I_{CBO} nA max	I_{CBO} 150°C µA max	C_{ob} pf max	C_{ib} pf max	f_T MHz min	NF db max	PACKAGE TYPE	BASE
2N869	18	25	5	20	120	1.0	1.0		10	25	9	11	100		TO-18	3L
2N995	15	20	4	35	140	0.2	0.95	10K	5.0	25	10	11	100		TO-18	3L
2N2601	60	60	6	12.5		0.5	0.9	5	25	25	6		20		TO-46	3L
2N2602	60	60	6	25		0.5	0.9	5	25	25	6		40		TO-46	3L
2N2603	60	60	6	50		0.7	0.9	5	25	25	6		60		TO-46	3L
2N2604	−45	−60	−6	40	120	0.5	0.9	−2	10		6		30	4	TO-46	3L
2N2605	−45	−60	−6	100	300	0.5	0.9	−2	10		6		30	3	TO-46	3L
2N2904	40	60	5	20		0.4	1.3		20	20	8	30	200		TO-5	3L
2N2904A	60	60	5	40		0.4	1.3		10	10	8	30	200		TO-5	3L
2N2905	40	60	5	35		0.4	1.3		20	20	8	30	200		TO-5	3L
2N2905A	60	60	5	75		0.4	1.3		10	10	8	30	200		TO-5	3L
2N2906	40	60	5	20		0.4	1.3		20	20	8	30	200		TO-18	3L
2N2906A	60	60	5	40		0.4	1.3		10	10	8	30	200		TO-18	3L
2N2907	40	60	5	35		0.4	1.3		20	20	8	30	200		TO-18	3L
2N2907A	60	60	5	75		0.4	1.3		10	10	8	30	200		TO-18	3L

NPN SWITCHING TRANSISTORS

TYPE NO.	V_{CEO} V min	V_{CBO} V min	V_{EBO} V min	h_{FE} min	$V_{CE(sat)}$ V max	I_{CBO} nA max	C_{ob} pf max	C_{ib} pf max	f_t MHz min	t_r nsec max	t_s nsec max	t_f nsec max	PACKAGE TYPE	BASE
2N2192	40	60	5.0	100	0.35	10	20		50	70	150	50	TO-5	3L
2N2192A	40	60	5.0	100	0.25	10	20		50	70	150	50	TO-5	3L
2N2192B	40	60	5.0	100	0.18	10	20		50	70	150	50	TO-5	3L
2N2193	50	80	8.0	40	0.35	10	20		50	70	150	50	TO-5	3L
2N2193A	50	80	8.0	40	0.25	10	20		50	70	150	50	TO-5	3L
2N2193B	50	80	8.0	40	0.18	10	20		50	70	150	50	TO-5	3L
2N2194	40	60	5.0	20	0.35	10	20		50	70	150	50	TO-5	3L
2N2194A	40	60	5.0	20	0.25	10	20		50	70	150	50	TO-5	3L
2N2194B	40	60	5.0	20	0.18	10	20		50	70	150	50	TO-5	3L
2N2218A	40	75	6.0	40	0.30	10	8.0	25	250	25	225	60	TO-5	3L
2N2219A	40	75	6.0	100	0.30	10	8.0	25	300	25	225	60	TO-5	3L
2N2221A	40	75	6.0	40	0.30	10	8.0	25	250	25	225	60	TO-5	3L
2N2222A	40	75	6.0	100	0.30	10	8.0	25	300	25	225	60	TO-5	3L
2N2222B	40	75	6.0	100	0.20	10	8.0	25	300	25	225	60	TO-5	3L
2N2368	15	40	4.5	20	0.25	400	4.0		400	12 t_{on}	10	15 t_{off}	TO-18	3L
2N2369	15	40	4.5	40	0.25		4.0		500	12 t_{on}	13	18 t_{off}	TO-18	3L
2N2369A	15	40	4.5	40	0.20		4.0		500	12 t_{on}	13	18 t_{off}	TO-18	3L

PNP SWITCHING TRANSISTORS

2N2904	40	60	5.0	20	0.40	20	8.0	30	200	40	80	30	TO-5	3L
2N2904A	60	60	5.0	40	0.40	10	8.0	30	200	40	80	30	TO-5	3L
2N2905	40	60	5.0	35	0.40	20	8.0	30	200	40	80	30	TO-5	3L
2N2905A	60	60	5.0	75	0.40	10	8.0	30	200	40	80	30	TO-5	3L
2N2906	40	60	5.0	20	0.40	20	8.0	30	200	40	80	30	TO-18	3L
2N2906A	60	60	5.0	40	0.40	10	8.0	30	200	40	80	30	TO-18	3L
2N2907	40	60	5.0	35	0.40	20	8.0	30	200	40	80	30	TO-18	3L
2N2907A	60	60	5.0	75	0.40	10	8.0	30	200	40	80	30	TO-18	3L

NPN MEDIUM POWER TRANSISTORS

TYPE NO.	V_{CEO} V min	V_{CBO} V min	V_{EBO} V min	h_{FE} min	$V_{CE(sat)}$ V max	I_{CBO} nA max	I_{EBO} nA max	C_{ob} pf max	C_{ib} pf max	h_{fe} 1 KHz min	h_{ie} Ω max	f_t MHz min	t_r nsec min	t_s nsec max	t_f nsec max	PACKAGE TYPE	BASE
2N2192	40	60	5	100	0.35	10	50	20				50	70	150	50	TO-5	3L
2N2192A	40	60	5	100	0.25	10	50	20				50	70	150	50	TO-5	3L
2N2192B	40	60	5	100	0.18	10	50	20				50	70	150	50	TO-5	3L
2N2193	50	80	8	40	0.35	10	50	20				50	70	150	50	TO-5	3L
2N2193A	50	80	8	40	0.25	10	50	20				50	70	150	50	TO-5	3L
2N2193B	50	80	8	40	0.18	10	50	20				50	70	150	50	TO-5	3L
2N2194	40	60	5	20	0.35	10	50	20				50	70	150	50	TO-5	3L
2N2194A	40	60	5	20	0.25	10	50	20				50	70	150	50	TO-5	3L
2N2194B	40	60	5	20	0.18	10	50	20				50	70	150	50	TO-5	3L
2N2195	25	45	5	20	0.35	100	100	20				50				TO-5	3L
2N2195A	25	45	5	20	0.25	100	100	20				50				TO-5	3L
2N2195B	25	45	5	20	0.18	100	100	20				50				TO-5	3L
2N2217	30	60	5	20	0.4	10	10	8			60	250				TO-5	3L
2N2218	30	60	5	40	0.4	10	10	8			60	250				TO-5	3L
2N2218A	40	75	6	30	0.3	10	10	8	25	50		250				TO-5	3L
2N2219	30	60	5	100	0.4	10	10	8			60	250				TO-5	3L
2N2219A	40	75	6	100	0.3	10	10	8	25	75		300				TO-5	3L
2N2220	30	60	5	20	0.4	10	10	8			60	250				TO-18	3L
2N2221	30	60	5	40	0.4	10	10	8			60	250				TO-18	3L
2N2221A	40	75	6	40	0.3	10	10	8	25	50		250				TO-18	3L
2N2222	30	60	5	100	0.4	10	10	8			60	250				TO-18	3L
2N2222A	40	75	6	100	0.3	10	10	8	25	75		300				TO-18	3L
2N2222B	40	75	6	100	0.2	10	10	8	25	75		300				TO-18	3L
2N2243		120	7	40	0.35	10	50	15		2.5						TO-5	3L
2N2243A		120	7	40	0.25	10	50	15		2.5		$T_b = 2.1$ nsec				TO-5	3L
2N2297	35	80	7	40		10	10	12				60				TO-5	3L
PNP MEDIUM POWER TRANSISTORS																	
2N2904	40	60	5	20	0.4	20		8	30			200	40	80	30	TO-5	3L
2N2904A	60	60	5	40	0.4	10		8	30			200	40	80	30	TO-5	3L
2N2905	40	60	5	35	0.4	20		8	30			200	40	80	30	TO-5	3L
2N2905A	60	60	5	75	0.4	10		8	30			200	40	80	30	TO-5	3L
2N2906	40	60	5	20	0.4	20		8	30			200	40	80	30	TO-18	3L
2N2906A	60	60	5	40	0.4	10		8	30			200	40	80	30	TO-18	3L
2N2907	40	60	5	35	0.4	20		8	30			200	40	80	30	TO-18	3L
2N2907A	60	60	5	75	0.4	10		8	30			200	40	80	30	TO-18	3L

MEDIUM POWER TRANSISTOR BETA/COLLECTOR CURRENT TABLE ($V_{CE} = 10$ V)

TYPE	0.1 mA	1.0 mA	10 mA	150 mA	500 mA	1.0 A
2N2192			75	100		15
2N2192A			75	100		15
2N2192B			75	100		15
2N2193			30	40		15
2N2193A			30	40		15
2N2193B			30	40		15
2N2194			15	20		
2N2194A			15	20		
2N2194B			15	20		
2N2195				20		
2N2195A				20		
2N2195B				20		
2N2217		12	17	20		
2N2218	20	25	35	40	20	
2N2218A	20		35	40	25	
2N2219	35	50	75	100	30	
2N2219A	35		75	100	40	
2N2220		12	17	20		

TYPE	0.1 mA	1.0 mA	10 mA	150 mA	500 mA	1.0 A
2N2221	20	25	35	40	20	
2N2221A	20	25	35	40		
2N2222	35	50	75	100	30	
2N2222A	35		75	100	40	
2N2222B	35	50	75	100	40	15
2N2243	15		30	40	15	
2N2243A	15		30	40	15	
2N2297			30	40		15
2N2904	20	25	35	40	20	
2N2904A	40	40	40	40	40	
2N2905	35	50	75	100	30	
2N2905A	75	100	100	100	50	
2N2906	20	25	35	40	20	
2N2906A	40	40	40	40	40	
2N2907	35	50	75	100	30	
2N2907A	75	100	100	100	50	

NPN RF/IF TRANSISTORS

TYPE NO.	V_{CEO} V min	V_{CBO} V min	V_{EBO} V min	h_{FE} min	$V_{CE(sat)}$ V max	I_{EBO}* I_{CBO} nA max	I_{CBO} 150°C μA max	C_{ob} pf max	C_{ib} pf max	f_t MHz min	A_p db	P_o mW	PACKAGE TYPE	BASE
2N915	50	70	5.0	50	1.0	10	10	3.5	10	250			TO-18	3L
2N915A	50	70	5.0	50	0.20	2.0	3.0	3.0	5.0	500			TO-18	3L
2N916	25	45	5.0	50	0.50	10	10	6.0	10	300			TO-18	3L
2N916A	25	45	5.0	50	0.50	10	10	6.0	10	300			TO-18	3L
2N916B	30	60	5.0	50	0.20	2.0	3.0	3.0	5.0	500			TO-18	3L
2N917	15	30	3.0	20	0.50	1.0	0.1	3.0	1.6	500	9	10	TO-18	4L
2N918	15	30	3.0	20	0.40	10	1.0	3.0	2.0	600	15	30	TO-18	4L
2N2368	15	40	4.5	20	0.25	400	30	4.0		400			TO-18	3L
2N2369	15	40	4.5	40	0.25	400	30	4.0		500			TO-18	3L
2N2369A	15	40	4.5	40	0.20	400	30	4.0		500			TO-18	3L
2N2481	15	40	5.0	40	0.25		30	5.0	7.0	300			TO-18	3L
2N2616	15	30	3.0	20	0.40	1.0	1.0	2.8	2.0	600	15	30	TO-18	3L
2N2708	20	35	3.0	30		10	10	1.5		700	22		TO-18	4L
2N2729	15	30	3.0	20	0.40	1.0	1.0	2.8	2.0	600	15	30	TO-46	3L
2N2865	13	25	3.0	20	0.40	10	1.0	2.5		600	16.5	40	TO-18	4L
2N3289	15	30	3.0	10	0.40	10	3.0	1.5		300	17		TO-18	4L
2N3290	15	30	3.0	10	0.40	10	3.0	1.5		300	17		TO-18	4L
2N3291	25	25	3.0	10		100*		2.0		250	16		TO-18	4L
2N3292	25	25	3.0	10		100*		2.0		250	16		TO-18	4L
2N3293	20	20	3.0	10		100*		2.0		250			TO-18	4L
2N3294	20	20	3.0	10		100*		2.0		250	14		TO-18	4L
2N5079	30	60	5.0	100	0.20	10	10	7.0	30	400			TO-18	3L
2N5080	30	60	5.0	200	0.20	10	10	7.0	30	400			TO-18	3L

PNP RF/IF TRANSISTORS

TYPE NO.	V_{CEO} V min	V_{CBO} V min	V_{EBO} V min	h_{FE} min	$V_{CE(sat)}$ V max	I_{EBO}* I_{CBO} nA max	I_{CBO} 150°C μA max	C_{ob} pf max	C_{ib} pf max	f_t MHz min	A_p db	P_o mW	PACKAGE TYPE	BASE
2N869	18	25	5.0	20	1.0	10	25	9.0	11	100			TO-18	3L
2N995	15	20	4.0	35	0.20	5.0	25	10	11	100			TO-18	3L
2N2905A	60	60	5.0	75	0.40	10	10	8.0	30	200			TO-5	3L
2N2907A	60	60	5.0	75	0.40	10	10	8.0	30	200			TO-18	3L

MILITARY TYPES

*JAN2N718A
MIL-S-19500/181C

JAN2N910
MIL-S-19500/274A

JAN2N916
MIL-S-19500/271A

*JAN2N918
MIL-S-19500/301A

*JAN2N929
MIL-S-19500/253B

*JAN2N230
MIL-S-19500/253B

*JAN2N1613
MIL-S-19500/181C

*JAN2N2060
MIL-S-19500/270B

*JAN2N2218
MIL-S-19500/251E

*JAN2N2218A
MIL-S-19500/251E

*JAN2N2219
MIL-S-19500/251E

*JAN2N2219A
MIL-S-19500/255E

*JAN2N2221
MIL-S-19500/255E

*JAN2N2221A
MIL-S-19500/255E

*JAN2N2222
MIL-S-19500/255E

*JAN2N2222A
MIL-S-19500/255E

JAN2N2606
MIL-S-19500/292

JAN2N2607
MIL-S-19500/294

JAN2N2608
MIL-S-19500/295

JAN2N2609
MIL-S-19500/296

JAN2N2708
MIL-S-19500/302

*JAN2N2904
MIL-S-19500/290B

*JAN2N2904A
MIL-S-19500/290B

*JAN2N2905
MIL-S-19500/290B

*JAN2N2905A
MIL-S-19500/290B

*JAN2N2906
MIL-S-19500/291B

*JAN2N2906A
MIL-S-19500/291B

JAN2N2907
MIL-S-19500/291B

*JAN2N2907A
MIL-S-19500/291B

*JAN2N2919
MIL-S-19500/355

*JAN2N2920
MIL-S-19500/355

*Also Available To
Jan TX specification

NPN TRANSISTORS — DUAL ASSEMBLIES

TYPE NO.	V_{CEO} V min	V_{CBO} V min	V_{EBO} V min	h_{FE} min	h_{FE} max	h_{FE1}/h_{FE2} min	h_{FE1}/h_{FE2} max	$V_{CE(sat)}$ V max	$V_{BE(sat)}$ V max	$V_{BE}(1\text{-}2)$ mV max	$\Delta V_{BE}(1\text{-}2)/\Delta T$ $\mu V/°C$ max
2N998	60	100	15	1600	8000			1.2	1.8		
2N2060	60	100	7	40	120	0.9	1.0	1.2	0.9	5	10
2N2060A	60	100	7	40	120	0.9	1.0	0.6	0.9	3	5
2N2223	60	100	7	25	150	0.8	1.0	1.2	0.9	15	25
2N2223A	60	100	7	25	150	0.9	1.0	1.2	0.9	5	25
2N2453	30	60	7	150	600	0.9	1.0	1.0	0.9	3	10
2N2453A	50	80	7	150	600	0.9	1.0	1.0	0.9	3	5
2N2480	40	75	5	20		0.8	1.0	1.3	1.0	10	15
2N2639	45	45	5	65		0.9	1.0	1.0	1.0	5	10
2N2640	45	45	5	65		0.8	1.0	1.0	1.0	10	20
2N2641	45	45	5	65				1.0	1.0		
2N2642	45	45	5	130		0.9	1.0	1.0	1.0	5	10
2N2643	45	45	5	130		0.8	1.0	1.0	1.0	10	20
2N2644	45	45	5	130				1.0	1.0		
2N2720	60	80	6	35		0.9	1.0	1.0	0.85	5	10
2N2721	60	80	6	35		0.8	1.0	1.0	0.85	10	20
2N2722	45	45	5	100		0.9	1.0	1.0	0.85	5	10
2N2903	30	60	7	125	625	0.8	1.0	1.0	0.9	10	20
2N2903A	30	60	7	125	625	0.9	1.0	1.0	0.9	5	10
2N2913	45	45	6	150				0.35			
2N2914	45	45	6	300				0.35			
2N2915	45	45	6	150		0.9	1.0	0.35		3	10
2N2916	45	45	6	300		0.9	1.0	0.35		3	10
2N2917	45	45	6	150		0.8	1.0	0.35		5	20
2N2918	45	45	6	300		0.8	1.0	0.35		5	20
2N2919	60	60	6	150		0.9	1.0	0.35		3	10
2N2920	60	60	6	300		0.9	1.0	0.35		3	10
2N2972	45	45	6	150				0.35			
2N2973	45	45	6	300				0.35			
2N2974	45	45	6	150		0.9	1.0	0.35		3	10
2N2975	45	45	6	300		0.9	1.0	0.35		3	10
2N2976	45	45	6	150		0.8	1.0	0.35		5	20
2N2977	45	45	6	300		0.8	1.0	0.35		5	20
2N2978	60	60	6	150		0.9	1.0	0.35		3	10
2N2979	60	60	6	300		0.9	1.0	0.35		3	10
2N2980	60	100	7	40	120	0.9	1.0	1.2	0.9	3	10
2N3423	15	30	3	20	200	0.8	1.0	0.4	1.0	10	40
2N3424	15	30	3	20	200	0.9	1.0	0.4	1.0	5	20
2N3680	50	60	6	150	600	0.9	1.0	0.7	0.8	3	6
SA2253		40		25		0.7	1.0			20	30
SA2664	20	60	5	800		0.75	1.0	1.5	1.7	5	10

I_{EBO} nA max	I_{CBO} nA max	I_{CBO} 150°C μA max	C_{ob} pf max	C_{ib} pf max	f_T MHz min	REMARKS	PACKAGE TYPE	BASE	TYPE NO.
10	10	15	30	50		Darlington	TO-18	4L	2N998
2	2	10	15	85	60	Differential Amplifier	TO-5	6L	2N2060
2	2	10	15	85	60	Differential Amplifier	TO-5	6L	2N2060A
10	10	15	15	85	50	Differential Amplifier	TO-5	6L	2N2223
10	10	15	15	85	50	Differential Amplifier	TO-5	6L	2N2223A
2	5	10	8	10	60	Differential Amplifier	TO-5	6L	2N2453
2	5	10	4	10	60	Differential Amplifier	TO-5	6L	2N2453A
50	50	15	20		50	Differential Amplifier	TO-5	6L	2N2480
10	10	10	8		80	Differential Amplifier	TO-5	6L	2N2639
10	10	10	8		80	Differential Amplifier	TO-5	6L	2N2640
10	10	10	8		80	Dual Transistor	TO-5	6L	2N2641
10	10	10	8		80	Differential Amplifier	TO-5	6L	2N2642
10	10	10	8		80	Differential Amplifier	TO-5	6L	2N2643
10	10	10	8		80	Dual Transistor	TO-5	6L	2N2644
10	10	10	6		80	Differential Amplifier	TO-5	6L	2N2720
10	10	10	6		80	Differential Amplifier	TO-5	6L	2N2721
1	1	1	6		100	Differential Amplifier	TO-5	6L	2N2722
10	10	15	8	10	60	Differential Amplifier	TO-5	6L	2N2903
10	10	15	8	10	60	Differential Amplifier	TO-5	6L	2N2903A
2	10	10	6		60	Dual Transistor	TO-5	6L	2N2913
2	10	10	6		60	Dual Transistor	TO-5	6L	2N2914
2	10	10	6		60	Differential Amplifier	TO-5	6L	2N2915
2	10	10	6		60	Differential Amplifier	TO-5	6L	2N2916
2	10	10	6		60	Differential Amplifier	TO-5	6L	2N2917
2	10	10	6		60	Differential Amplifier	TO-5	6L	2N2918
2	2	10	6		60	Differential Amplifier	TO-5	6L	2N2919
2	2	10	6		60	Differential Amplifier	TO-5	6L	2N2920
2	10	10	6		60	Dual Transistor	TO-18	6L	2N2972
2	10	10	6		60	Dual Transistor	TO-18	6L	2N2973
2	10	10	6		60	Differential Amplifier	TO-18	6L	2N2974
2	10	10	6		60	Differential Amplifier	TO-18	6L	2N2975
2	10	10	6		60	Differential Amplifier	TO-18	6L	2N2976
2	10	10	6		60	Differential Amplifier	TO-18	6L	2N2977
2	2	10	6		60	Differential Amplifier	TO-18	6L	2N2978
2	2	10	6		60	Differential Amplifier	TO-18	6L	2N2979
2	2	10	8	30	60	Differential Amplifier	TO-18	6L	2N2980
10	10	1	1.7	2	600	Hf, low noise mtchd pr.	TO-5	6L	2N3423
10	10	1	1.7	2	600	Hf, low noise mtchd pr.	TO-5	6L	2N3424
10	10	10	6	6	60	Matched Pr.	TO-5	6L	2N3680
	50					Differential Amplifier	TO-5	6L	SA2253
10	10		7			Monolithic Dual Darlington	TO-5	8L	SA2664

PNP TRANSISTORS — DUAL ASSEMBLIES

TYPE NO.	V_{CEO} V min	V_{CBO} V min	V_{EBO} V min	h_{FE} min	h_{FE} max	$\frac{h_{FE1}}{h_{FE2}}$ min	$\frac{h_{FE1}}{h_{FE2}}$ max	$V_{CE(sat)}$ V max	$V_{BE(sat)}$ V max	$V_{BE}(1\text{-}2)$ mV max	$\frac{\Delta V_{BE}(1\text{-}2)}{\Delta T}$ μV/°C max
2N3347	45	60	6	60		0.9	1.0	0.5		5	10
2N3348	45	60	6	60		0.8	1.0	0.5		10	20
2N3349	45	60	6	60		0.6	1.0	0.5		20	40
2N3350	45	60	6	150		0.9	1.0	0.5		5	10
2N3351	45	60	6	150		0.8	1.0	0.5		10	20
2N3352	45	60	6	150		0.6	1.0	0.5		20	40
2N3800	60	60	5	100				0.2	0.7		
2N3801	60	60	5	225				0.2	0.7		
2N3802	60	60	5	100		0.8	1.0	0.2	0.7	5	20
2N3803	60	60	5	225		0.8	1.0	0.2	0.7	5	20
2N3804	60	60	5	100		0.9	1.0	0.2	0.7	3	10
2N3805	60	60	5	225		0.9	1.0	0.2	0.7	3	10
2N3806	60	60	5	100				0.2	0.7		
2N3807	60	60	5	225				0.2	0.7		
2N3808	60	60	5	100		0.8	1.0	0.2	0.7	5	20
2N3809	60	60	5	225		0.8	1.0	0.2	0.7	5	20
2N3810	60	60	5	100		0.9	1.0	0.2	0.7	3	10
2N3811	60	60	5	225		0.9	1.0	0.2	0.7	3	10
2N4015	60	60	5	135	350	0.9	1.0	0.25	1.0	5	20
2N4016	60	60	5	135	350	0.9	1.0	0.25	1.0	2.5	10
2N4017	80	80	6	100	500			0.25	0.9		
2N4018	60	60	6	100	600			0.25	0.9		
2N4019	45	45	6	250	600			0.25	0.9		

I_{EBO} nA max	I_{CBO} nA max	I_{CBO} 150°C μA max	C_{ob} pf max	C_{ib} pf max	f_T MHz min	REMARKS	PACKAGE TYPE	BASE	TYPE NO.
2	10	10	6	8	60	Differential Amplifier	TO-5	6L	2N3347
2	10	10	6	8	60	Differential Amplifier	TO-5	6L	2N3348
2	10	10	6	8	60	Differential Amplifier	TO-5	6L	2N3349
2	10	10	6	8	60	Differential Amplifier	TO-5	6L	2N3350
2	10	10	6	8	60	Differential Amplifier	TO-5	6L	2N3351
2	10	10	6	8	60	Differential Amplifier	TO-5	6L	2N3352
20	10	10	4	8	100	Dual Transistor	TO-18	6L	2N3800
20	10	10	4	8	100	Dual Transistor	TO-18	6L	2N3801
20	10	10	4	8	100	Differential Amplifier	TO-18	6L	2N3802
20	10	10	4	8	100	Differential Amplifier	TO-18	6L	2N3803
20	10	10	4	8	100	Differential Amplifier	TO-18	6L	2N3804
20	10	10	4	8	100	Differential Amplifier	TO-18	6L	2N3805
20	10	10	4	8	100	Dual Transistor	TO-5	6L	2N3806
20	10	10	4	8	100	Dual Transistor	TO-5	6L	2N3807
20	10	10	4	8	100	Differential Transistor	TO-5	6L	2N3808
20	10	10	4	8	100	Differential Transistor	TO-5	6L	2N3809
20	10	10	4	8	100	Differential Transistor	TO-5	6L	2N3810
20	10	10	4	8	100	Differential Transistor	TO-5	6L	2N3811
100	10	10	8	25	200	Differential Transistor	TO-5	6L	2N4015
100	10	10	8	25	200	Differential Transistor	TO-5	6L	2N4016
10	10	10	6		40	Dual Transistor	TO-5	6L	2N4017
10	10	10	6		40	Dual Transistor	TO-5	6L	2N4018
10	10	10	6		50	Dual Transistor	TO-5	6L	2N4019

N-CHANNEL FIELD EFFECT TRANSISTORS — GENERAL PURPOSE

TYPE NO.	BV_{DGO} V min	I_{GSS} nA max	I_{GSS} @ 150°C μA max	I_{DSS} mA min	I_{DSS} mA max	gm μmhos min	gm μmhos max	V_p V max	C_{rss}* or C_{DG} pf max	C_{SG} pf max	NF 10 Hz max	PACKAGE TYPE	PACKAGE BASE
2N3066	50	1.0	1.0	0.8	4.0	400	1000	10.0	1.5	3.0		TO-18	3L
2N3067	50	1.0	1.0	0.2	1.0	300	1000	5.0	1.5	3.0		TO-18	3L
2N3068	50	1.0	1.0	0.05	0.25	200	1000	2.5	1.5	3.0		TO-18	3L
2N3069	50	1.0	1.0	2.0	10.0	1000	2500	10.0	2.5	5.0		TO-18	3L
2N3070	50	1.0	1.0	0.5	2.5	750	2500	5.0	2.5	5.0		TO-18	3L
2N3071	50	1.0	1.0	0.1	0.6	500	2500	2.5	2.5	5.0		TO-18	3L
2N3365	40	5.0	1.0(100°C)	0.8	4.0	400	2000	12.0	2.0	3.0		TO-18	3L
2N3366	40	5.0	1.0(100°C)	0.2	1.0	250	1000	7.0	2.0	3.0		TO-18	3L
2N3367	40	5.0	1.0(100°C)	0.05	0.25	100	1000	2.5	2.0	3.0		TO-18	3L
2N3368	40	5.0	1.5(100°C)	2.0	12.0	1000	4000	12.0	3.5	6.0		TO-18	3L
2N3369	40	5.0	1.5(100°C)	0.5	2.5	600	2500	7.0	3.5	6.0		TO-18	3L
2N3370	40	5.0	1.5(100°C)	0.1	0.6	300	2500	3.5	3.5	6.0		TO-18	3L
2N3436	50	0.5	1.0	3.0	15.0	2500	10K	10.0	5.0	5.0		TO-18	3L
2N3437	50	0.5	1.0	0.8	4.0	1500	6000	5.0	5.0	5.0		TO-18	3L
2N3438	50	0.5	1.0	0.2	1.0	800	4500	2.5	5.0	5.0		TO-18	3L
2N3452	50	0.1	0.4	0.8	4.0	200	1200	10.0	1.2	1.8		TO-18	4L
2N3453	50	0.1	0.4	0.2	1.0	150	900	5.0	1.2	1.8		TO-18	4L
2N3454	50	0.1	0.4	0.05	0.25	100	600	2.5	1.2	1.8		TO-18	4L
2N3455	50	0.04	0.15	0.8	4.0	400	1200	10.0	1.0	1.5		TO-18	4L
2N3456	50	0.04	0.15	0.2	1.0	300	900	5.0	1.0	1.5		TO-18	4L
2N3457	50	0.04	0.15	0.05	0.25	150	600	2.5	1.0	1.5		TO-18	4L
2N3458	50	0.25	0.5	3.0	15.0	2500	10K	8.0	5.0	5.0		TO-18	3L
2N3459	50	0.25	0.5	0.8	4.0	1500	6000	4.0	5.0	5.0		TO-18	3L
2N3460	50	0.25	0.5	0.2	1.0	800	4500	2.0	5.0	5.0		TO-18	3L
2N3967	30	0.1	0.2	2.5	10.0	1600	2400	5.0		1.5		TO-18	4L
2N3967A	30	0.1	0.2	2.5	10.0	1600	2400	5.0		1.5	4.0	TO-18	4L
2N3968	30	0.1	0.2	1.0	5.0	1400	2000	3.0		1.5		TO-18	4L
2N3968A	30	0.1	0.2	1.0	5.0	1400	2000	3.0		1.5	4.0	TO-18	4L
2N3969	30	0.1	0.2	0.4	2.0	950	1450	1.7		1.5		TO-18	4L
2N3969A	30	0.1	0.2	0.4	2.0	950	1450	1.7		1.5	4.0	TO-18	4L
2N4139	50	1.0	1.0	8.0	11.0	3500	7000	8.0	5.0	5.0		TO-18	3L
2N4302	30	1.0	0.1(85°C)	0.5	5.0	1000		4.0	3.0*		2.0	RO-97B	3L
2N4303	30	1.0	0.1(85°C)	4.0	10.0	2000		6.0	3.0*		2.0	RO-97B	3L
2N4304	30	1.0	0.1(85°C)	5.0	15.0	1000		10.0	3.0*		3.0	RO-97B	3L

GENERAL PURPOSE — P CHANNEL

TYPE NO.	BV_{DGO} V min	I_{GSS} nA max	I_{GSS} 150°C μA max	I_{DSS} mA min	I_{DSS} mA max	gm μmhos min	gm μmhos max	V_p V max	C_{iss} pf max	PACKAGE TYPE	PACKAGE BASE
2N2499	20	10.0	10.0	5.0	15.0	2000	4000	8.0	32	TO-18	3L
2N2841	30	1.0	1.0	.025	.125	60	—	1.7	6	TO-18	3L
2N2842	30	3.0	3.0	.065	.325	180	—	1.7	10	TO-18	3L
2N2843	30	10.0	10.0	.2	1.0	540	—	1.7	17	TO-18	3L
2N3329	20	10.0	10.0	1.0	3.0	1000	2000	5.0	20	TO-18	4L
2N3330	20	10.0	10.0	2.0	6.0	1500	3000	6.0	20	TO-18	4L
2N3331	20	10.0	10.0	5.0	15.0	2000	4000	8.0	20	TO-18	4L
2N3376	30	3.0	3.0	0.6	6.0	800	2300	5.0	5	TO-18	4L
2N3380	30	3.0	3.0	3.0	20.0	1500	3000	9.5	5	TO-18	4L
2N3382	30	15.0	15.0	3.0	30.0	4500	12500	5.0	16	TO-18	4L
P1027	30	3.0	6.0	0.6	6.0	750	3500	3.0	20	TO-18	3L
P1028	30	3.0	6.0	2.0	20.0	2500	8000	5.0	30	TO-18	3L
P1029	30	3.0	6.0	5.0	50.0	5000	—	8.0	50	TO-18	3L

EPOXY ENCASED — N CHANNEL

TYPE NO.	BV_{DGO} V min	I_{GSS} nA max	I_{DSS} mA min	I_{DSS} mA max	gm μmhos min	V_p V max	C_{rss} pf max	g_{os} μmhos max	NF db max	PACKAGE TYPE	PACKAGE BASE
2N4302	30	1	0.5	5	1000	4	3	50	2	RO-97B	3L
2N4303	30	1	4.0	10	2000	6	3	50	2	RO-97B	3L
2N4304	30	1	5.0	15	1000	10	3	50	3	RO-97B	3L

HIGH FREQUENCY — N CHANNEL

TYPE NO.	BV_{DGO} V min	I_{GSS} nA max	I_{GSS} @ 150° μA max	I_{DSS} mA min	I_{DSS} mA max	yfs μmhos min	yfs μmhos max	V_p V max	C_{DG} pf max	C_{SG} pf max	Power Gain @ f = 200 MHz db min	PACKAGE TYPE	PACKAGE BASE
2N3823	30	0.50	0.50	4	20	3500	6500	8	2	2		TO-18	4L
2N4223	30	0.25	0.25	3	18	3000	7000	8	2	2	10	TO-18	4L
2N4224	30	0.50	0.50	2	20	2000	7500	8	2	2		TO-18	4L
2N5078	30	0.25	0.25	4	25	4500	10000	8	2	2	15	TO-18	4L

LOW CAPACITANCE — N CHANNEL

TYPE NO.	BV_{DGO} V min	I_{GSS} nA max	I_{GSS} at 150°C μA max	I_{DSS} mA min	I_{DSS} mA max	g_m μmhos min	g_m μmhos max	V_p V max	C_{DG} pf max	C_{SG} pf max	NF 10 Hz db max	PACKAGE TYPE	PACKAGE BASE
2N3452	50	0.1	0.4	0.8	4.0	200	1200	10.0	1.2	1.8		TO-18	4L
2N3453	50	0.1	0.4	0.2	1.0	150	900	5.0	1.2	1.8		TO-18	4L
2N3454	50	0.1	0.4	0.05	0.25	100	600	2.5	1.2	1.8		TO-18	4L
2N3455	50	0.04	0.15	0.8	4.0	400	1200	10.0	1.0	1.5		TO-18	4L
2N3456	50	0.04	0.15	0.2	1.0	300	900	5.0	1.0	1.5		TO-18	4L
2N3457	50	0.04	0.15	0.05	0.25	150	600	2.5	1.0	1.5		TO-18	4L
2N3967	30	0.1	0.2	2.5	10.0	1600	2400	5.0		1.5		TO-18	4L
2N3967A	30	0.1	0.2	2.5	10.0	1600	2400	5.0		1.5	4	TO-18	4L
2N3968	30	0.1	0.2	1.0	5.0	1400	2000	3.0		1.5		TO-18	4L
2N3968A	30	0.1	0.2	1.0	5.0	1400	2000	3.0		1.5	4	TO-18	4L
2N3969	30	0.1	0.2	0.4	2.0	950	1450	1.7		1.5		TO-18	4L
2N3969A	30	0.1	0.2	0.4	2.0	950	1450	1.7		1.5	4	TO-18	4L
U1277	50	0.1	0.2	1.5	8.0	450	@ 1.5 mA	8.0	1.2	1.8		TO-18	4L
U1278	50	0.1	0.2	0.5	3.0	350	@ 0.5 mA	4.5	1.2	1.8		TO-18	4L
U1279	50	0.1	0.2	0.2	1.5	250	@ 0.2 mA	2.5	1.2	1.8		TO-18	4L
U1280	50	0.1	0.2	0.1	10.0	250		10.0	1.2	1.8		TO-18	4L
U1285	30	5.0		0.1		200	1200	8.0	2.0	3.0		TO-18	4L
U1325	30	0.1	0.2	0.1	0.5	500		1.2	1.3	1.5		TO-18	4L

HIGH GAIN — N CHANNEL

TYPE NO.	BV_{DGO} V min	I_{GSS} nA max	I_{GSS} at 150°C μA max	I_{DSS} mA min	I_{DSS} mA max	g_m μmhos min	g_m μmhos max	V_p V max	C_{DG} pf max	C_{SG} pf max	NF 10 Hz db max	PACKAGE TYPE	PACKAGE BASE
2N3436	50	0.5	1.0	3.0	15.0	2500	10000	10.0	5.0	5.0		TO-18	3L
2N3437	50	0.5	1.0	0.8	4.0	1500	6000	5.0	5.0	5.0		TO-18	3L
2N3438	50	0.5	1.0	0.2	1.0	800	4500	2.5	5.0	5.0		TO-18	3L
2N3458	50	0.25	0.5	3.0	15.0	2500	10000	8.0	5.0	5.0		TO-18	3L
2N3459	50	0.25	0.5	0.8	4.0	1500	6000	4.0	5.0	5.0		TO-18	3L
2N3460	50	0.25	0.5	0.2	1.0	800	4500	2.0	5.0	5.0		TO-18	3L
2N4139	50	1.0	1.0	8.0	11.0	3500	7000	8.0	5.0	5.0		TO-18	3L
U1281	50	0.5	1.0	8.0		3000		8.0	5.0	5.0		TO-18	3L
U1282	50	0.5	1.0	4.0	20.0	2500		4.5	5.0	5.0		TO-18	3L
U1283	50	0.5	1.0	1.0	10.0	1500		2.5	5.0	5.0		TO-18	3L
U1284	50	0.5	1.0	0.2	40.0	1000		10.0	5.0	5.0		TO-18	3L
U1286	30	10.0		0.2		1000	1000	8.0	8.0	8.0		TO-18	3L

HIGH VOLTAGE — N CHANNEL

TYPE NO.	BV_{DGO} V min	I_{GSS} nA max	I_{GSS} @ 150°C µA max	I_{DSS} mA min	I_{DSS} mA max	g_m µmhos min	g_m µmhos max	V_p V max	C_{DG} pf max	C_{SG} pf max	PACKAGE TYPE	PACKAGE BASE
2N4881	300	2	4	0.4	2.0	350	1000	15	1.5	1.5	TO-5	3L
2N4882	300	2	4	1.5	7.5	600	1500	15	1.5	1.5	TO-5	3L
2N4883	200	1	2	0.4	2.0	350	1000	10	1.5	1.5	TO-5	3L
2N4884	200	1	2	1.5	7.5	600	1500	10	1.5	1.5	TO-5	3L
2N4885	125	1	2	0.4	2.0	350	1000	10	1.5	1.5	TO-5	3L
2N4886	125	1	2	1.5	7.5	600	1500	10	1.5	1.5	TO-5	3L
2N5277	150	5	5	2.5	12.5	2000	5000	7.0	5.0	5.0	TO-5	3L
2N5278	150	5	5	10.0	25.0	3000	6000	10	5.0	5.0	TO-5	3L
U1715	200	5		10.0	50.0	$R_{ON} = 400\Omega$ max		15	4.0	4.0	TO-5	3L

ULTRA LOW LEAKAGE — N CHANNEL

TYPE NO.	BV_{DGO} V min	I_{GSS} nA max	I_{GSS} @ 150°C µA max	I_{DSS} mA min	I_{DSS} mA max	g_m µmhos min	g_m µmhos max	V_p V max	C_{DG} pf max	C_{SG} pf max	PACKAGE TYPE	PACKAGE BASE
U1714	25	.005		0.5	5.0	400		5	1.2	1.2	TO-18	3L

LOW Ron — N CHANNEL

TYPE NO.	BV_{DGO} V min	BV_{SGO} V min	R_{on} Ω max	I_{DSS} mA min	I_{DSS} mA max	I_{DGO} nA max	$I_{D(off)}$ nA max	V_p V max	C_{is} pf max	t_d nSec max	t_r nSec max	t_{off} nSec max	PACKAGE TYPE	PACKAGE BASE
2N3966	30	30	220	2.0		0.1	1.0	6	6	20	100	100	TO-18	4L
2N3970	40	40	30	50.0	150	0.25	0.25	10	16	10	15	60	TO-18	3L
2N3971	40	40	60	25.0	75	0.25	0.25	5	16	15	15	60	TO-18	3L
2N3972	40	40	100	5.0	30	0.25	0.25	3	16	40	40	100	TO-18	3L
2N4091	40	40	30	30.0		0.2	0.2	10	16	15	10	40	TO-18	3L
2N4092	40	40	50	15.0		0.2	0.2	7	16	15	20	60	TO-18	3L
2N4093	40	40	80	8.0		0.2	0.2	5	16	20	40	80	TO-18	3L
2N4391	40	40	30	50.0	150	0.1	0.1	10	14		5	20	TO-18	3L
2N4392	40	40	60	25.0	75	0.1	0.1	5	14		5	35	TO-18	3L
2N4393	40	40	100	5.0	30	0.1	0.1	3	14		5	50	TO-18	3L
2N4977	30	30	15	50.0		0.5	0.5	10	35	5	5	20	TO-18	3L
2N4978	30	30	20	15.0		0.5	0.5	8	35	5	10	40	TO-18	3L
2N4979	30	30	40	7.5		0.5	0.5	5	35	10	30	60	TO-18	3L

LOW Ron — P CHANNEL

TYPE NO.	BV_{DGO} V min	BV_{SGO} V min	R_{on} Ω max	I_{DSS} mA min	I_{DSS} mA max	I_{DGO} nA max	$I_{D(off)}$ nA max	V_p V max	C_{is} pf max	t_d nSec max	t_r nSec max	t_{off} nSec max	PACKAGE TYPE	PACKAGE BASE
2N5018	30	30	75	10.0		2.0	10.0	10	45	15	20	50	TO-18	3L
2N5019	30	30	150	5.0		2.0	10.0	5	45	15	75	100	TO-18	3L

SMALL SIGNAL — P CHANNEL

Type No.	BV_{DGO} V max	I_{GSS} na max	I_{GSS} at 150°C mA max	I_{DSS} mA min	I_{DSS} mA max	g_m μmhos min	NF db max	V_p V max	C_{is} pf max	C_{DG} pf max	C_{SG} pf max	PACKAGE TYPE	PACKAGE BASE
2N606	—30	1.0	1.0	—0.1	— 0.5	110	3.0	4.0	6.0			TO-18	3L
2N607	—30	3.0	3.0	—0.3	— 1.5	330	3.0	4.0	17			TO-18	3L
2N2608	—30	10	10	—0.9	— 4.5	1000	3.0	4.0	17			TO-18	3L
2N2609	—30	30	30	—2.0	—10	2500	3.0	4.0	30			TO-18	3L

FIELD EFFECT TRANSISTORS — DUAL ASSEMBLIES

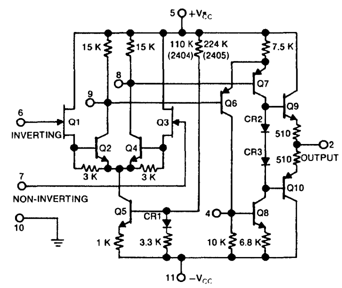
TYPE NO.	BV_{DGO} V min	V_p V max	g_m μmhos min	$\frac{g_{m_1}}{g_{m_2}}$ min	$\frac{g_{m_1}}{g_{m_2}}$ max	I_{DSS} mA min	I_{DSS} mA max	$V_{GS(1-2)}$ mV max	$\frac{\Delta V_{GS(1-2)}}{\Delta T}$ μV/°C max	I_G nA max	I_G 100°C nA max	C_{is} pf max	REMARKS	PACKAGE TYPE	PACKAGE BASE
2N3921	50	3	1500	0.95	1	1	10	5	10	0.25	25	18	Matched Pair	TO-18	6L
2N3922	50	3	1500	0.95	1	1	10	5	25	0.25	25	18	Matched Pair	TO-18	6L
2N3934	50	3	300	0.95	1	0.25	1.3	5	10	0.1	10	7	Matched Pair	TO-18	6L
2N3935	50	3	300	0.95	1	0.25	1.3	5	25	0.1	10	7	Matched Pair	TO-18	6L
2N4082	50	3	300	0.95	1	0.25	1.3	15	10	0.1	10	7	Matched Pair	TO-18	6L
2N4083	50	3	300	0.95	1	0.25	1.3	15	25	0.1	10	7	Matched Pair	TO-18	6L
2N4084	50	3	1500	0.95	1	1	10	15	10	0.25	25	18	Matched Pair	TO-18	6L
2N4085	50	3	1500	0.95	1	1	10	15	25	0.25	25	18	Matched Pair	TO-18	6L
SU2078	50	4	300	0.9	1	0.25	2	15	35	0.25	25	7	Matched Pair	TO-18	6L
SU2079	50	4	300	0.9	1	0.25	2	15	60	0.25	25	7	Matched Pair	TO-18	6L
SU2080	50	4	1500	0.9	1	1	10	15	35	0.5	50	18	Matched Pair	TO-18	6L
SU2081	50	4	1500	0.9	1	1	10	15	60	0.5	50	18	Matched Pair	TO-18	6L
SU2098	30	4	1000	0.95	1	1	8	5	10	0.1	10	7	Matched Pair	TO-18	6L
SU2099	30	4	1000	0.95	1	1	8	5	25	0.1	10	7	Matched Pair	TO-18	6L

FET INPUT OPERATIONAL AMPLIFIERS

These circuits have been designed for use in active filter and high input impedance, low power, and high voltage applications.

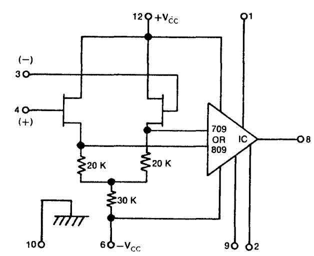
2404BG
2405BG

Power < 55 mW (2404)
Power < 110 mW (2405)
$V_{CC} = \pm 15$ V (2404)
$V_{CC} = \pm 30$ V (2405)
$E_{out} > \pm 10$ V (2404)
$E_{out} > \pm 20$ V (2405)
$I_{OFF} < 100$ pA
$Z_{IN} > 10^{10}\,\Omega$
−55°C to +125°C
TO-8 (12 Leads)



2709BG
2809BG

$V_{CC} = \pm 15$ V
$Z_{IN} > 10$ KMΩ
$I_{OFF} < 100$ pA
$E_{out} > \pm 10$ V
CMR > ±8 V
−55°C to +125°C
TO-8 (12 Leads)

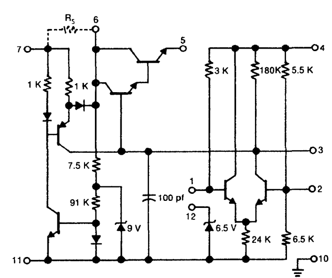


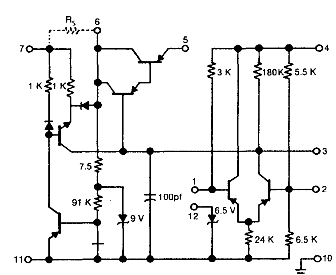
VOLTAGE REGULATORS

These circuits have been designed for use in power supply systems where a high degree of load and line regulation is required.

2802BG
2803BG

Output Range = 5 V to 40 V
Load Current > 100 mA
Load Regulation < 0.1%
Line Regulation < 0.01% /V
Temperature Stability < 0.5%
Ripple Rejection > −60 db
Output Impedance < 1.0Ω
−55°C to +125°C
TO-8 (12 Leads)



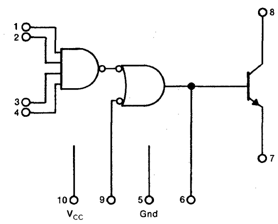


HIGH VOLTAGE/CURRENT DRIVER

This circuit has been designed for use in latching relay, lamp, core, and line driver applications.

2001BE

$V_{OL} < 350$ mV
$I_L > 250$ mA
$LV_{CEO} > 40$ V
$V_{CC} = +5$ V
−55°C to +125°C
TO-5 (10 Leads)

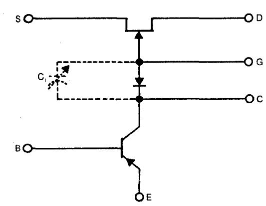


FET ANALOG SWITCHES

These circuits have been designed for use in multiplexing, sample and hold, and chopper applications.

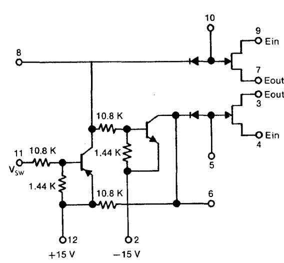
2107BE
2110BE

$R_{ON} < 50\Omega$ (2110)
$R_{ON} < 100\Omega$ (2107)
$I_{D(off)} < 1.0$ nA
$LV_{CEO} > 40$ V
−55°C to +125°C
TO-5 (6 Leads)



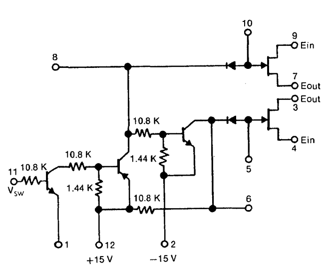
2114BF

$R_{ON} < 100\Omega$
$I_{D(off)} < 1.0$ nA
t_{on} and $t_{off} < 0.9\ \mu$Sec
$E_{out} = \pm 9$ V
−55°C to +125°C
TO-8 (12 Leads)



2126BG

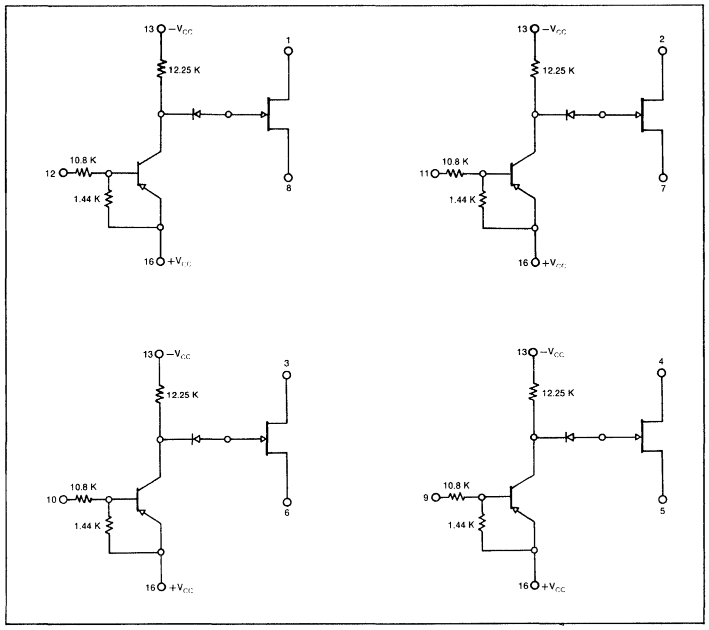
$R_{ON} < 65\Omega$
$I_{D(off)} < 1.0$ nA
t_{ON} and $t_{OFF} < 1.5\ \mu$Sec
$E_{out} = \pm 8$ V
−55°C to +125°C
TO-8 (12 Leads)



FET ANALOG SWITCHES (cont.)

2128BG

$R_{ON} < 50\Omega$
$I_{D(off)} < 1.0$ nA
t_{ON} and $t_{OFF} < 1.0$ μSec
$E_{out} = \pm 5$ V
$-55°C$ to $+125°C$
TO-8 (16 Leads)



HIGH NOISE IMMUNITY LOGIC (HNIL)

SERIES 300

PART NO.	CIRCUIT DESCRIPTION	Noise Immunity Volts	FanOut	t_{pd} nsec	V_{CC} Volts	P_{Diss} mW
301	Dual 5 Input Buffer with Expanders—Active Pull-Up	5.0	36	80	12	300
302	Quad 2 Input Buffer with Open Collector "OR" able Output	5.0	36	80	12	160
311	Master Slave Flip-Flop	5.0	5	120	12	180
312	Dual J-K Flip-Flop	5.0	5	120	12	280
321	Quad 2 Input Gate with Expanders	5.0	5	80	12	96
322	Dual 5 Input Gate with Expanders	5.0	5	80	12	48
323	Quad 2 Input "OR" able Gate with Expanders	5.0	5	100	12	80
331	Dual 5 Input Expander with Node Resistors	5.0		40	12	
341	Dual Exclusive-OR with Expanders	5.0	5	75	12	72
342	Dual One-Shot with Expandable Trigger	5.0	5	100	12	100
370	Quad "D" Flip-Flop	5.0	5	100	12	190

Available in B and C grade in 16 lead TO-8 package
Available in C grade in 16 lead dual-in package

INTERFACE CIRCUITS

PART NO.	Circuit Description	Noise Immunity Volts	Input Range Volts	Output Drive mA	Output Sink mA	t_{pd} nsec	P_{Diss} mW
361	Dual Input Interface Circuit with inverting and non-inverting inputs	5[1]	15	5	10	50	60
362	Dual Output Interface Circuit—Current sink and current drive inputs and inverting non-inverting options	5[1]	15	3	10	40	75

The 361 buffer and 362 receiver are compatible with all low level logic forms. They perform the level shifting function necessary for operation with 300 series logic or high level I/O equipment.

[1]Noise immunity with a 362 driving a 361.

Available in B and C Grade in G and H Package.
Available in C Grade in J Package.

TTL 500 SERIES

Operating Temperature −55°C to +125°C

Operating Voltage 4.0 to 5.5 Volts

	Low Power				Medium Power				High Power			
		t_{pd}	FAN	PD		t_{pd}	FAN	PD		t_{pd}	FAN	PD
PRODUCT DESCRIPTION	P/N	nsec	OUT	mW/gate	P/N	nsec	OUT	mW/gate	P/N	nsec	OUT	mW/gate
Dual 4 Input Gate▲	500	180	6	0.5	530	75	6	1.5	570	25	7	4.1
Quad 2 Input Gate▲	501	180	6	0.5	531	75	6	1.5	571	25	7	4.1
Triple 3 Input Gate▲	503	180	6	0.5	533	75	6	1.5	573	25	7	4.1
Dual 4 Input Gate■	504	140	6	0.7	534	60	7	2.0	574	25	7	5.0
Quad 2 Input Gate■	505	140	6	0.7	535	60	7	2.0	575	25	7	5.0
Triple 3 Input Gate■	507	140	6	0.7	537	60	7	2.0	577	25	7	5.0
Dual 4 NAND/NOR Gate†	508	200	6	1.4	538	100	7	3.8	578	35	7	8.9
JK Flip Flop	509	550	9	4.0	539	140	8	12.0	579	65	18	24.0
Dual 4 Input Buffer*▲					540	70	17	6.0				
Dual 4 Input Buffer*■					541	70	17	4.5				
Dual 4 Input Gate*▲					543	85	7	1.5	583	30	7	4.1
Dual 4 Input Power Gate*■					544	75	7	2.0	584	30	7	5.0
Dual 4 Input Pwr Gate & Lamp Dr.▲					547	60	45	7.5				
Dual 4 Input Pwr Gate & Lamp Dr.■					548	60	45	6.2				
Dual 4 Input Buffer*									580	45	33	17.0
Dual 4 Input Gate*									587	55	36	13.0

Low Power Medium Speed

Operating Temperature −55°C to +125°C Voltage 4.5 to 5.5 Volts

The Following Low Power TTL Family is pin to pin interchangeable and functionally equivalent in both speed and power with 9040 logic elements.

Dual 3 Input Gate*	510	120	10	6 mW
Dual 3 Input Gate	511	60	10	3 mW
Dual 4 Input Gate	513	60	10	3 mW
JF Flip Flop	512	60	10	3 mW

Low Power Low Speed

Operating Temperature −55°C to +125°C Voltage 4.5 to 5.5 Volts

When power consumption is the prime consideration the following Ultra Low Power TTL should be utilized.

Dual 4 Input Gate*	526BH	1.5 μsec	8	250 μW
Dual 3 Input Gate*	527BH	1.5 μsec	8	250 μW
Dual 3 Input Gate	528BH	1.5 μsec	8	250 μW
JK Flip Flop	529BH	2.5 μsec	8	1.0 mW

▲No Pull Up Resistor

■With Pull Up Resistor

†With Inverter

*With Expander

MILITARY GRADE OPERATIONAL AMPLIFIERS

Operating Temperature Range −55°C to +125°C

TYPE NO.	Power Supply $\pm V_{CC}$	A_{VOL} kV/V min	A_{VOL} kV/V typ	V_{OS} mV typ	V_{OS} mV max	V_{OS} $-T_A$ to $+T_A$ mV typ	V_{OS} $-T_A$ to $+T_A$ mV max	V_{OS} Drift $\mu V/°C$ typ	V_{OS} Drift $\mu V/°C$ max	I_{BIAS} nA typ	I_{BIAS} nA max	I_{BIAS} (Note 2) nA typ	I_{BIAS} (Note 2) nA max	I_{OFF} nA typ	I_{OFF} nA max	I_{OFF} (Note 2) nA typ	I_{OFF} (Note 2) nA max
709A	±15	25	45	0.5	1.0	1.0	2.0	3.0	10	100	200	250	750	10	50	50	250
709B	±15	25	45	1.0	5.0	2.0	6.0	3.0		200	500	500	1500	50	200	100	500
800/801B	±12	10	20	5.0	50	10.0		25.0	50	500	1000	1500		50	100	100	
805B	±15	30	60	1.0	5.0	2.0	7.0	5.0	20	250	500	750	1500	10	50	25	250
806B	±12	30	60	1.0	5.0	2.0	7.0	5.0	20	250	500	750	1500	10	50	25	250
807B	±15	30	60	0.1	2.5	1.0	3.0	3.0	10	250	500	750	1500	10	50	25	250
808A	±15	25	40	1.0	5.0	2.0		5.0	10	25	50	75	250	3	15	10	
808B	±15	25	40	1.0	10	2.0		10.0	30	50	50	100	250	5	30	10	
809B	±15	10	40	5.0	10	7.0		10.0	50	300	500	600	1500	50	100	50	
819B	±6	5	10	5.0	10	7.0		70.0	100	300	500	1000		50	100	50	
2404B	±15	31	100	3.0	10	5.0		5.0	25	0.02		15	40	.002		1	5
2405B	±30	31	100	3.0	10	5.0		5.0	25	0.02		15	40	.002		1	5
2709B	±15	17	45	3.0	15	4.0		15		0.02	0.1	10		.005	0.1	5	
2809B	±15	10	30	5.0	15	8.0		25		0.02	0.1	10		.005	0.1	5	

INDUSTRIAL GRADE OPERATIONAL AMPLIFIERS

Operating Temperature Range 0°C to 100°C

TYPE NO.	Power Supply $\pm V_{CC}$	A_{VOL} kV/V min	A_{VOL} kV/V typ	V_{OS} mV typ	V_{OS} mV max	V_{OS} $-T_A$ to $+T_A$ mV typ	V_{OS} $-T_A$ to $+T_A$ mV max	V_{OS} Drift $\mu V/°C$ typ	V_{OS} Drift $\mu V/°C$ max	I_{BIAS} nA typ	I_{BIAS} nA max	I_{BIAS} (Note 2) nA typ	I_{BIAS} (Note 2) nA max	I_{OFF} nA typ	I_{OFF} nA max	I_{OFF} (Note 2) nA typ	I_{OFF} (Note 2) nA max
709C	±15	15	45	2.0	7.5	2.0	10			300	1500	500	2000	100	500	200	750
805C	±15	10	60	3.0	10	5.0		5	30	250	1000	750		30	100	50	
806C	±12	10	60	3.0	10	5.0		5	30	250	1000	750		300	100	500	
808C	±15	15	40	2.0	10	5.0		4	14	25	75	50	150	5	40	10	100
809C	±15	10	40	5.0	10	8.0		10	50	500	1000	1000		50		100	
2709C	±15	17	45	3.0	25	4.0		15		.02		30		.01		9	
2809C	±15	10	30	5.0	25	8.0		25		.02		30		.01		9	

Note 1: 5 sec. maximum duration.

Note 2: At operating temperature extreme.

I_{OFF} Drift nA/°C typ	I_{OFF} Drift nA/°C max	Z_{IN} KΩ typ	Z_{IN} KΩ min	Z_{IN} (Note 2) KΩ typ	Z_{IN} (Note 2) KΩ min	CMR Volts typ	CMR Volts min	CMRR DB typ	CMRR DB min	PSRR DB typ	PSRR DB min	Z_{OUT} Ω typ	Z_{OUT} Ω max	V_{OUT} (Load) V_{pp} typ	V_{OUT} (Load) V_{pp} min	P_{DISS} No Load mW typ	P_{DISS} No Load mW max	Short Circuit Protected	PKG
1.0	3.3	400	350	100	40	±10	± 8	90	80	92	80	150		26 (2 K)	20	80	108	Note 1	E, H
1.0		400	150	100	40	±10	± 8	90	70	92	70	150		26 (2 K)	20	80	165	Note 1	E, H
1.0	5.0	1000	250	100			± 2	80	60			400	1000	(1 K)	10	120		Yes	E
0.1	1.0	1000	500	500	200	± 9	± 8	90	70	80	70	150	300	24 (1 K)	20	180	225	Yes	E, H
0.1	0.5	1000	500	500	200	± 7	± 6	90	70	80	70	150	300	18 (1 K)	12	120	160	Yes	E
0.1	0.5	1000	500	750	300	± 9	± 8	90	80	80	70	150	300	24 (1 K)	20	180	225	Yes	E, H
0.03	0.15	2000	1000	1000		± 9	± 8	90	70	80	70	150	300	24 (1 K)	20	180	225	Yes	E
0.1	0.3	2000	1000	750		± 9	± 8	90	70	80	70	150	300	24 (1 K)	20	180	225	Yes	E
1.0	3.0	200	100	50		±13	±10	90	70	90	70	2500		24 (5 K)	20	100	150	Yes	E, H
1.0	3.0	200	50	20		± 5	± 4	90	70	90	60	1500		10 (5 K)	8	15	25	Yes	E, H
0.02	0.09	10^8	10^7	10^7		±10	± 8	90	74	90	74	250		22 (10 K)	20	40	55	Yes	G
0.02	0.09	10^8	10^7	10^7		±25	±16	90	74	90	74	250		50 (10 K)	40	80	110	Yes	G
0.02		10^8	10^7	10^7		±10	± 8	80	60	80	60	150		26 (10 K)	20	90	180	Note 1	G
0.02		10^8	10^7	10^7		±13	±10	80	60	80	60	2000		24 (5 K)	20	100	180	Yes	G

1.0		250	50	100	35	±10	± 8	90	65	92	74	150		26 (2 K)	20	80	200	Note 1	E
0.1	2.0	1000	100	500		± 9	± 8	90	70	80		150	300	24 (1 K)	20	180	225	Yes	E
0.1	2.0	1000	100	500		± 7	± 6	90	70	80		150	300	18 (1 K)	15	120	160	Yes	E
0.1	0.3	750	2000	750		± 9	± 8	90	70	80	70	150	300	24 (1 K)	20	180	225	Yes	E
1.0		200	50	100		±13	±10	90		90		2000		24 (5 K)	20	80		Yes	E, J
0.02		10^8	10^7	10^7		±10	± 8	70		70		150		26 (2 K)	20	90		Note 1	G
0.02		10^8	10^7	10^7		±13	±10	70		70		2000		24 (5 K)	20	100		Yes	G

OTHER LINEAR CIRCUITS

DIFFERENTIAL AMPLIFIERS

Part No.	Description	Voltage Gain	Input Offset mV	CMRR db	Z_{in} kΩ	Drift μV/°C	BW −3 db kHz	Dissi-pation mW	Power Supply
831	Two Stage Differential Amplifier	2000	2.5	−100	40	2.0	400	100	±12 V

Available in A, B and C Grades, E and H packages.

HIGH FREQUENCY AMPLIFIERS

Part No.	Circuit Description	Voltage Gain db	Band-Width MHz	Power Gain db at 200 MHz	Dissi-pation mW	Power Supply Voltage
901	Video Amplifier	24	60		144	+12
903	VHF Amplifier	15	110		96	+12 − 6
911	IF Amplifier	20	250	25	170	+24

The 901 and 903 are available in B and C Grade and E Package.
The 911 is available in B and C Grade, E and J Package.

DEFINITION OF TERMS

V_{OS} = Input Offset Voltage—That voltage which must be applied between the input terminals to obtain zero output voltage. The input offset voltage may also be defined for the case where two equal resistances are inserted in series with the input leads.

I_{OS} = Input Offset Current—The difference in the currents into the two input terminals with the output at zero volts.

Z_{in} = Input Resistance — The resistance looking into either input terminal with the other grounded.

I_{BIAS} = Input Bias Current—The average of the two input currents.

CMR = Common Mode Range—The range of voltage which, if exceeded on either input terminal, could cause the amplifier to cease functioning properly.

CMRR = Common Mode Rejection Ratio—The ratio of the input voltage range to the maximum change in input offset voltage over this range.

PSRR = Power Supply Rejection Ratio—The ratio of the change in input offset voltage to the change in supply voltage producing it.

A_{Vol} = Large-Signal Voltage Gain—The ratio of the maximum output voltage swing with load to the change in input voltage required to drive the output from zero to this voltage.

V_{out} = Output Voltage Swing — The peak output swing, referred to zero, that can be obtained without clipping.

Z_{out} = Output Resistance—The resistance seen looking into the output terminal with the output at null. This parameter is defined only under small signal conditions at frequencies above a few hundred cycles to eliminate the influence of drift and thermal feedback.

D_{iss} = Power Consumption — The DC power required to operate the amplifier with the output at zero and with no load current.

MICROELECTRONIC MODULAR ASSEMBLIES

Electrical Characteristics $V_{CC_1} = 5$ Volts

PRODUCT DESCRIPTION	P/N	Power Level	V_{CC} mA Max	f_C MHz Max	t_d µsec Typ	V_{OL} Volts Max	I_{OL} mA Max	I_{inL} mA Max	V_{inL} Volts Max	V_{inH} Volts Min
16 Bit Ripple Counter	5598	Low	50	5.0	8.0	0.30	1.20	3.00	0.60	2.0
Rev. Binary/Decade Counter	5603	Low	14	0.2		0.30	0.70	1.00	0.60	2.0
Dual Decade Counter	5604	Low	25	0.2		0.30	0.70	1.00	0.60	2.0
16 Bit Ripple Counter	5605	Low	36	0.3	10.0	0.30	1.20	0.35	0.60	2.0
Dual Decade Decoder	5606	Low	10		0.35	0.30	0.70	0.70	0.60	2.0
Dual 4 Bit Counter	5608	Low	25	0.2		0.30	0.70	1.00	0.60	2.0
Dual 12 Bit Shift Reg	5620	Med	110	1.0		0.35	1.50	0.70	0.70	2.0
Dual 10 Bit Shift Reg	5621	Med	90	1.0		0.35	1.50	0.70	0.70	2.0
Dual 8 Bit Shift Reg	5622	Med	75	1.0		0.35	1.50	0.70	0.70	2.0
Rev. Binary/Decade Counter	5623	Med	36	1.0		0.35	1.80	6.50	0.70	2.0
Dual Decade Counter	5624	Med	75	1.0		0.35	2.80	6.50	0.70	2.0
16 Bit Ripple Counter	5625	Med	110	1.5	2.4	0.35	1.80	1.80	0.70	2.0
Dual Decade Counter	5626	Med	25		0.15	0.35	2.80	2.80	0.70	2.0
Dual Decade Decoder	5627	Med	30		0.15	0.35	22.0	2.80	0.70	2.0
Dual 4 Bit Counter	5628	Med	75	1.0		0.35	2.80	6.50	0.70	2.0
Rev. Binary/Decade Counter	5643	High	72	3.0		0.35	9.00	11.00	0.70	2.0
Dual Decade Counter	5644	High	120	3.0		0.35	9.00	11.00	0.70	2.0
16 Bit Ripple Counter	5645	High	180	5.0	1.0	0.35	12.00	3.00	0.70	2.0
Dual Decade Decoder	5646	High	50		0.085	0.35	7.50	6.00	0.70	2.0
Dual Decade Decoder	5647	High	180		0.10	0.35	36.00	6.00	0.70	2.0
Dual 4 Bit Counter	5648	High	120	3.0		0.35	9.00	11.00	0.70	2.0

	P/N	Power Level	V_{CC1}	V_{CC1}	V_{CC2}	V_{CC2}	V_{OL}	I_{OL}	I_{inL}	V_{inL}	V_{inH}
20 Bit Shift Register	5551	Med	5	60.0	7.0	30.0	0.35	1.5	1.0	0.7	2.0
16 Bit Shift Register	5552	Med	5	60.0	7.0	25.0	0.35	1.5	1.0	0.7	2.0
8 Channel Binary Multiplexer	5660	Med	12	50.0	−12	50.0	±5		0.6	0.7	2.2
8 Channel Binary Multiplexer	5661	Med	15	60.0	−20	60.0	±10		0.6	0.7	2.2
12 Channel Multiplexed	5662	Med	12	75.0	−12	75.0	±5		0.6	0.7	2.2
12 Channel Multiplexer	5663	Med	15	90.0	−20	90.0	±10		0.6	0.7	2.2

	A/N	Power Level	f MHz	VS Volt	PO Watt	PI mW max	% min
RF Power Amplifier	5670		500	28.0	1.0	250	35

NPN TRANSISTOR
GENERAL PURPOSE

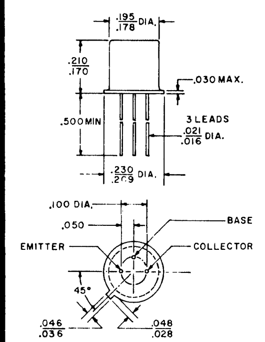
- HIGH CURRENT GAIN
- HIGH BREAKDOWN VOLTAGE
- LOW SATURATION VOLTAGE

JANUARY 1968

2N760
2N760A

MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage 2N760 2N760A	V_{CBO}	 45 60	Volts
Collector-Emitter Voltage 2N760 2N760A	V_{CEO}	 45 60	Volts
Emitter-Base Voltage	V_{EBO}	8.0	Volts
Total Device Dissipation @ $T_A = 25°C$ @ $T_C = 25°C$ @ $T_C = 100°C$	P_D	 0.5 1.5 0.86	Watts
Derating Factor above 25°C @ $T_A = 25°C$ @ $T_C = 25°C$		 2.5 8.5	mW/°C



COLLECTOR IS INTERNALLY CONNECTED TO CASE

ELECTRICAL CHARACTERISTICS at +25°C (Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Collector-Base Breakdown Voltage 2N760 2N760A	BV_{CBO}	$I_C = 50\ \mu A,\ I_E = 0$	 45 60		Volts
Emitter-Base Breakdown Voltage	BV_{EBO}	$I_C = 0,\ I_E = 100\ \mu A$	8.0		Volts
Collector-Emitter Sustaining Voltage 2N760 2N760A	$V_{CEO(sus)}$*	$I_C = 1.0\ mA,\ I_B = 0$	 45 60		Volts
Collector Saturation Voltage	$V_{CE(sat)}$	$I_C = 10\ mA,\ I_B = 1.0\ mA$		1.0	Volts
Base Saturation Voltage	$V_{BE(sat)}$	$I_C = 10\ mA,\ I_B = 1.0\ mA$	0.6	1.1	Volts
Collector-Base Cutoff Current 2N760 2N760A 2N760, 760A	I_{CBO}	$I_E = 0,\ V_{CB} = 30\ V$ $I_E = 0,\ V_{CB} = 30\ V,\ T_A = 150°C$		 200 100 10	nA μA
Small Signal Current Gain	h_{fe}	$I_C = 1.0\ mA,\ V_{CE} = 5.0\ V$ $f = 1.0\ kHz$	76	333	
Output Capacitance	C_{ob}	$I_E = 0,\ V_{CB} = 5.0\ V$ $f = 140\ kHz$		8.0	pf
Voltage Feedback Ratio	h_{rb}	$I_C = 1.0\ mA,\ V_{CB} = 5.0\ V$ $f = 1.0\ kHz$		10	$X\ 10^{-4}$
Alpha Cutoff Frequency	$f_{\alpha b}$	$I_E = 1.0\ mA,\ V_{CB} = 5.0\ V$	50		MHz

* Pulse Test: Pulse Width = 300 μsec; Duty Cycle = 1%.

AMELCO SEMICONDUCTOR 1300 Terra Bella Ave. • Mountain View • Calif. 94040
A TELEDYNE COMPANY PHONE: (415) 968-9241

JANUARY 1968

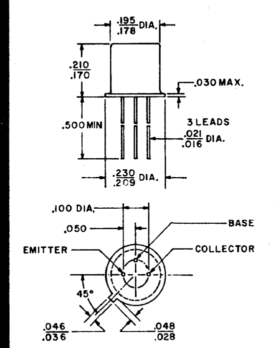
NPN TRANSISTOR
GENERAL PURPOSE

- HIGH CURRENT GAIN
- HIGH BREAKDOWN VOLTAGE
- LOW NOISE

2N929, A
2N930, A, B

MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage 2N929, 2N930 2N929A, 2N930A, B	V_{CBO}	 45 60	Volts
Collector-Emitter Voltage	V_{CEO}	45	Volts
Emitter-Base Voltage 2N929, 2N930 2N929A, 2N930A, B	V_{EBO}	 5.0 6.0	Volts
Collector Current	I_C	30	mA
Total Device Dissipation @ $T_A = 25°C$ @ $T_C = 25°C$	P_D	 0.3 0.6	Watt
Derating Factor above 25°C @ $T_A = 25°C$ @ $T_C = 25°C$		 2.0 4.0	mW/°C



COLLECTOR IS INTERNALLY CONNECTED TO CASE

ELECTRICAL CHARACTERISTICS at +25°C (Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Collector-Emitter Breakdown Voltage	BV_{CEO}*	$I_C = 10$ mA, $I_B = 0$	45		Volts
Collector-Base Breakdown Voltage 2N929A, 2N930A, B	BV_{CBO}	$I_C = 10\ \mu A$, $I_E = 0$	60		Volts
Collector-Emitter Sustaining Voltage	$V_{CEO(sus)}$*	$I_C = 10$ mA, $I_B = 0$	45		Volts
Emitter-Base Breakdown Voltage 2N929, 2N930 2N929A, 2N930A, B	BV_{EBO}	$I_E = 10\ \mu A$, $I_C = 0$	5.0 6.0		Volts
Base-Emitter Voltage 2N929, 2N930 2N929A, 2N930A, B	V_{BE}*	$I_C = 10$ mA, $I_B = 0.5$ mA	0.6 0.7	1.0 0.9	Volts
Collector Saturation Voltage 2N929, 2N930 2N929A, 2N930A, B	$V_{CE(sat)}$	$I_C = 10$ mA, $I_B = 0.5$ mA		1.0 0.5	Volts
Collector-Base Cutoff Current 2N929, 2N930 2N929A, 2N930A, B	I_{CBO}	$V_{CB} = 45$ V, $I_E = 0$		10 2.0	nA
Collector-Emitter Cutoff Current 2N929, 2N930 2N929A, 2N930A, B 2N929, 2N930 2N929A, 2N930A, B	I_{CES}	$V_{CE} = 45$ V, $V_{EB} = 0$ $V_{CE} = 45$ V, $V_{EB} = 0$, $T_A = 170°C$		10 2.0 10 2.0	nA μA
Emitter-Base Cutoff Current 2N929, 2N930 2N929A, 2N930A, B	I_{EBO}	$V_{EB} = 5$ V, $I_C = 0$		10 2.0	nA
DC Pulse Current Gain 2N929A 2N930A, B 2N929, A 2N930, A, B 2N929 2N929A 2N930 2N930A, B 2N929, A 2N930, A, B 2N929, A 2N930, A, B	h_{FE}*	$V_{CE} = 5$ V, $I_C = 1\ \mu A$ $V_{CE} = 5$ V, $I_C = 10\ \mu A$ $V_{CE} = 5$ V, $I_C = 10\ \mu A$, $T_A = -55°C$ $V_{CE} = 5$ V, $I_C = 500\ \mu A$ $V_{CE} = 5$ V, $I_C = 10$ mA	25 60 40 100 10 15 20 30 60 150	 120 300 350 600	

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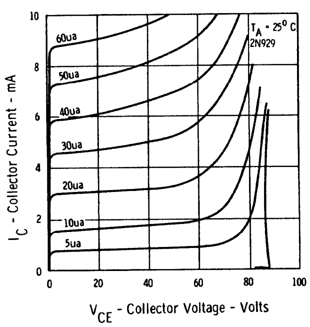
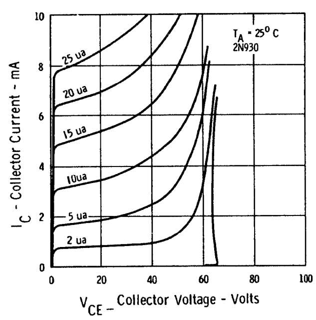
CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
High-Frequency Current Gain 2N929, 2N930 2N929A, 2N930A, B	$\mid h_{fe} \mid$	$V_{CE} = 5.0$ V, $I_C = 500\ \mu$A f = 30 MHz	 1.0 1.5		
Small-Signal Current Gain 2N929, A 2N930, A, B	h_{fe}	$V_{CE} = 5.0$ V, $I_C = 1.0$ mA f = 1.0 kHz	 60 150	 350 600	
Output Capacitance	C_{ob}	$V_{CB} = 5.0$ V, $I_E = 0$, f = 1.0 MHz		8.0	pf
Voltage Feedback Ratio	h_{rb}	$V_{CB} = 5.0$ V, $I_E = 1.0$ mA, f = 1.0 kHz		600	$X10^{-6}$
Input Resistance	h_{ib}	$V_{CB} = 5.0$ V, $I_E = 1.0$ mA, f = 1.0 kHz	25	32	Ohms
Output Conductance	h_{ob}	$V_{CB} = 5.0$ V, $I_E = 1.0$ mA, f = 1.0 kHz		1.0	μmhos
Noise Figure 2N929, A 2N930, A, B	NF	 $V_{CE} = 5.0$ V, $I_C = 10\ \mu$A, Rg = 10 kΩ BW = 10 Hz to 15.7 kHz		 4.0 3.0	 db
2N930B		$V_{CE} = 5.0$ V, $I_C = 10\ \mu$A, Rg = 10 kΩ f = 1.0 kHz, BW = 200 Hz		3.0	
2N930B		$V_{CE} = 5.0$ V, $I_C = 10\ \mu$A, Rg = 10 kΩ f = 100 Hz, BW = 20 Hz		5.0	
2N930B		$V_{CE} = 5.0$ V, $I_C = 10\ \mu$A, Rg = 10 kΩ f = 10 Hz, BW = 5.0 Hz		6.0	

* Pulse Test: Pulse Width $\leq$ 300 μsec; Duty Cycle $\leq$ 2%.

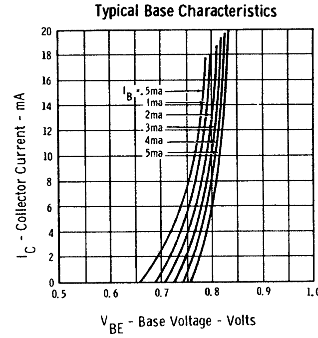
2N929 Collector Characteristics



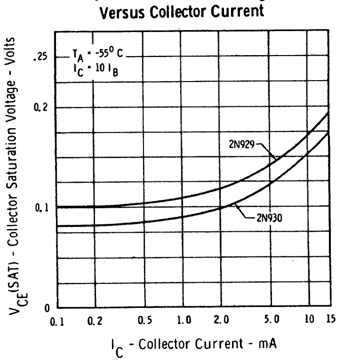
2N930 Collector Characteristics



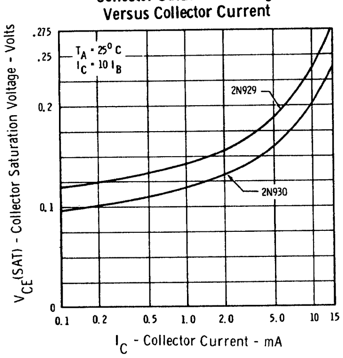
Typical Base Characteristics



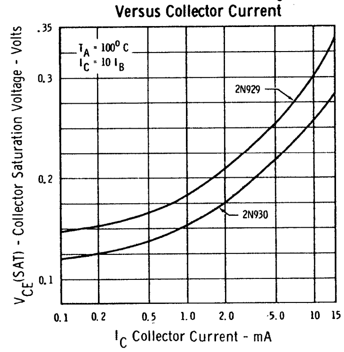
Collector Saturation Voltage
Versus Collector Current



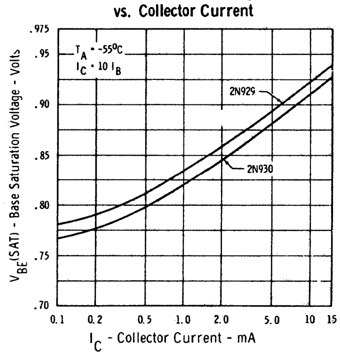
Collector Saturation Voltage
Versus Collector Current



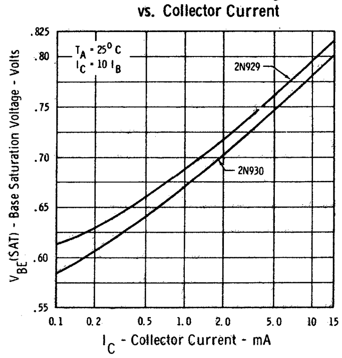
Collector Saturation Voltage
Versus Collector Current



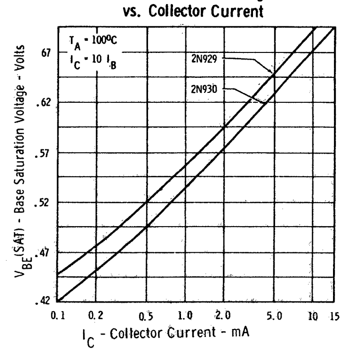
Base Saturation Voltage
vs. Collector Current



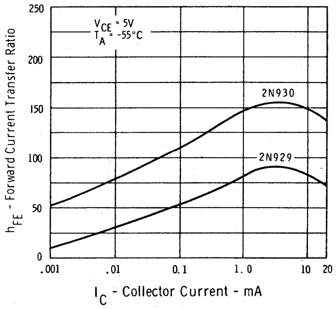
Base Saturation Voltage
vs. Collector Current



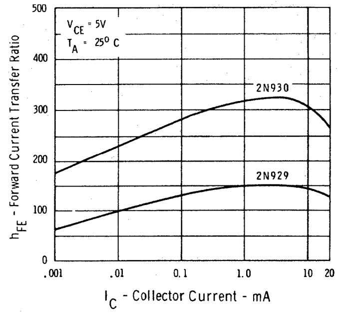
Base Saturation Voltage
vs. Collector Current



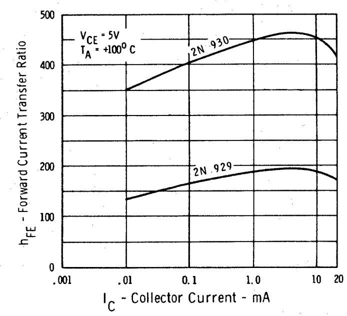
Pulsed DC Current Gain Versus Collector Current



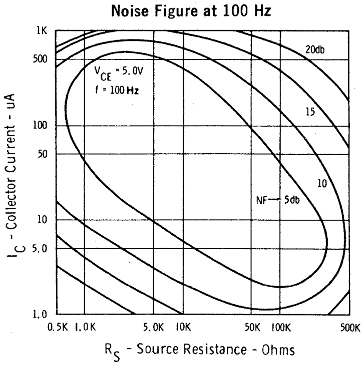
Pulsed DC Current Gain Versus Collector Current



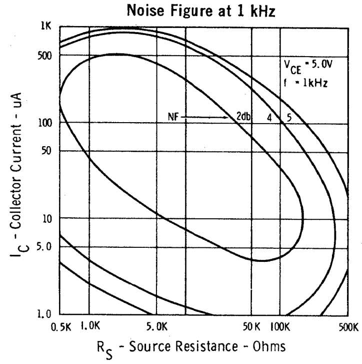
Pulsed DC Current Gain Versus Collector Current



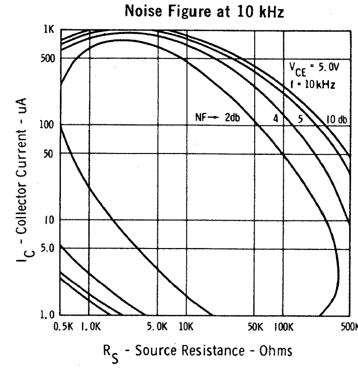
Noise Figure at 100 Hz



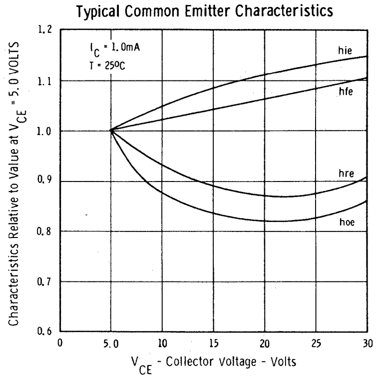
Noise Figure at 1 kHz



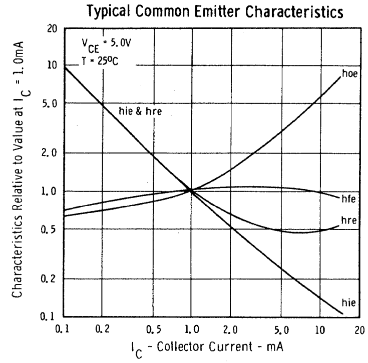
Noise Figure at 10 kHz



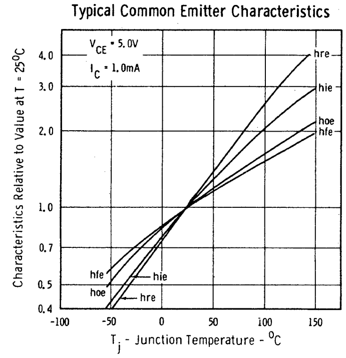
Typical Common Emitter Characteristics



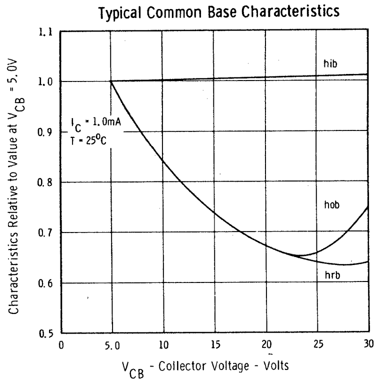
Typical Common Emitter Characteristics



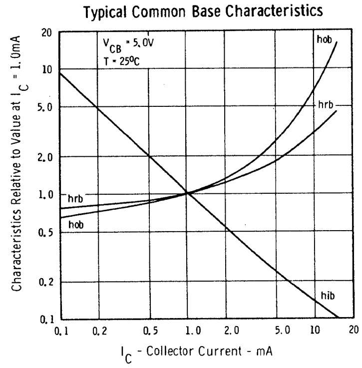
Typical Common Emitter Characteristics



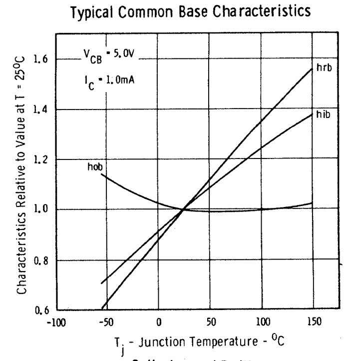
Typical Common Base Characteristics



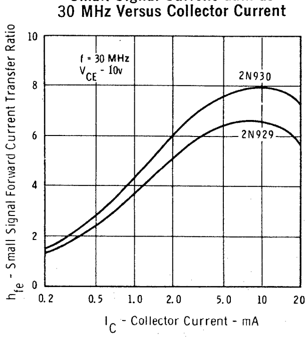
Typical Common Base Characteristics



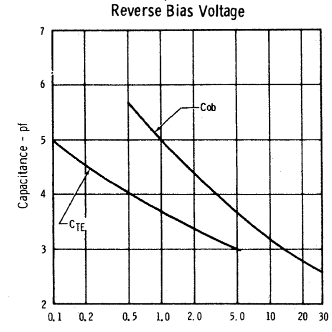
Typical Common Base Characteristics



Small Signal Current Gain at 30 MHz Versus Collector Current



Collector and Emitter Transition Capacitance Versus Reverse Bias Voltage



JANUARY 1968

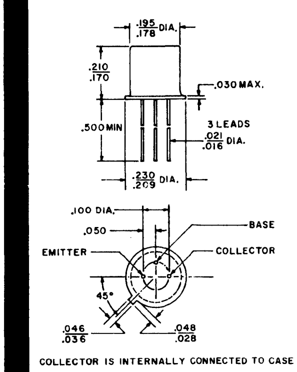
NPN TRANSISTOR
GENERAL PURPOSE

- LOW NOISE
- LOW LEVEL AMPLIFIER
- HIGH CURRENT GAIN

2N2483
2N2484
2N2484A

MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	60	Volts
Collector-Emitter Voltage	V_{CEO}	60	Volts
Emitter-Base Voltage	V_{EBO}	6	Volts
Collector Current	I_C	50	mA
Total Device Dissipation @ $T_A = 25°C$ @ $T_C = 25°C$ @ $T_C = 100°C$	P_D	 0.36 1.2 0.68	 Watts
Derating Factor above 25°C @ $T_A = 25°C$ @ $T_C = 25°C$		 2.1 6.9	 mW/°C
Storage Temperature	T_{stg}	−65 to +200	°C
Junction Temperature	T_J	+200	°C



ELECTRICAL CHARACTERISTICS at +25°C (Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Collector-Base Breakdown Voltage	BV_{CBO}	$I_C = 10\ \mu A, I_E = 0$	60		Volts
Emitter-Base Breakdown Voltage	BV_{EBO}	$I_E = 10\ \mu A, I_C = 0$	6		Volts
Collector-Emitter Sustaining Voltage	$V_{CEO(sus)}$*	$I_C = 10$ mA, $I_B = 0$	60		Volts
Emitter-Base On Voltage	$V_{BE(on)}$	$I_C = 100\ \mu A, V_{CE} = 5.0$ V	0.5	0.7	Volts
Base Saturation Voltage	$V_{BE(sat)}$	$I_C = 10$ mA, $I_B = 0.5$ mA		1.0	Volts
Collector Saturation Voltage 2N2484A	$V_{CE(sat)}$	$I_C = 1.0$ mA, $I_B = 0.1$ mA $I_C = 10$ mA, $I_B = 0.5$ mA		0.35 1.0	Volts
Collector-Base Cutoff Current	I_{CBO}	$V_{CB} = 45$ V, $I_E = 0$ $V_{CB} = 45$ V, $I_E = 0$, $T_A = 150°C$		0.010 10	μA
Emitter-Base Cutoff Current	I_{EBO}	$V_{EB} = 5.0$ V, $I_C = 0$		0.010	μA
DC Current Gain 2N2484, 84A 2N2483 2N2484, 84A 2N2483 2N2484, 84A 2N2483 2N2484, 84A 2N2483 2N2484, 84A 2N2483 2N2484, 84A 2N2483 2N2484, 84A	h_{FE}	 $I_C = 1.0\ \mu A, V_{CE} = 5.0$ V $I_C = 10\ \mu A, V_{CE} = 5.0$ V $I_C = 10\ \mu A, V_{CE} = 5.0$ V, −55°C $I_C = 100\ \mu A, V_{CE} = 5.0$ V $I_C = 500\ \mu A, V_{CE} = 5.0$ V $I_C = 1.0$ mA, $V_{CE} = 5.0$ V $I_C = 10$ mA, $V_{CE} = 5.0$ V*	 30 40 100 10 20 75 175 100 200 175 250	 120 500 500 800	
High-Frequency Current Gain 2N2483 2N2484, 84A All Types	$\lvert h_{fe} \rvert$	 $I_C = 50\ \mu A, V_{CE} = 5.0$ V, f = 5.0 MHz $I_C = 500\ \mu A, V_{CE} = 5.0$ V, f = 30MHz	 2.4 3.0 2.0		
Small Signal Current Gain 2N2483 2N2484, 84A	h_{fe}	 $I_C = 1.0$ mA, $V_{CE} = 5.0$ V, f = 1 kHz	 80 150	 450 900	
Output Capacitance	C_{ob}	$V_{CB} = 5.0$ V, $I_E = 0$, f = 140 kHz		6.0	pf

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CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Input Capacitance	C_{ib}	$V_{EB} = 0.5$ V, $I_C = 0$, f = 140 kHz		6.0	pf
Voltage Feedback Ratio	h_{re}	$I_C = 1.0$ mA, $V_{CE} = 5.0$ V, f = 1 kHz		800	$X10^{-6}$
Input Resistance	h_{ie}				
2N2483		$I_C = 1$ mA, $V_{CE} = 5$ V, f = 1 kHz	1.5	13	K ohms
2N2484, 84A			3.5	24	
Output Conductance	h_{oe}				
2N2483		$I_C = 1$ mA, $V_{CE} = 5$ V, f = 1 kHz		30	μmhos
2N2484, 84A				40	
Noise Figure	NF				
2N2483		$I_C = 10\ \mu A$, $V_{CE} = 5.0$ V, $R_S = 10$ kΩ		4	db
2N2484, 84A		Power Bandwidth of 15.7 kHz		3	
		3 db points at 10 Hz and 10 kHz			
2N2483		$I_C = 10\ \mu A$, $V_{CE} = 5.0$ V, f = 1 kHz		4	
2N2484, 84A		$R_S = 10$ kΩ, Power Bandwidth = 200 Hz		3	
2N2483		$I_C = 10\ \mu A$, $V_{CE} = 5.0$ V, f = 10 kHz		3	
2N2484, 84A		$R_S = 10$ kΩ, Power Bandwidth = 2 kHz		2	
2N2483		$I_C = 10\ \mu A$, $V_{CE} = 5.0$ V, f = 100 Hz		15	
2N2484		$R_S = 10$ kΩ, Power Bandwidth = 20 Hz		10	
2N2484A				5	
2N2484A		$I_C = 10\ \mu A$, $V_{CE} = 5.0$ V, f = 10 Hz		6	
		$R_S = 10$ kΩ, Power Bandwidth = 5 Hz			

* Pulse Test: Pulse Width $\leq 300\ \mu$sec, Duty Cycle $\leq 2\%$

JANUARY 1968

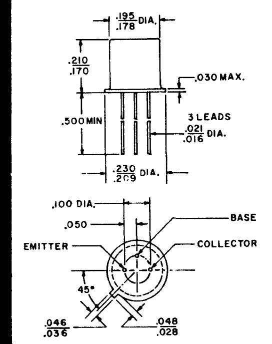
NPN TRANSISTOR
GENERAL PURPOSE

- **HIGH BREAKDOWN VOLTAGE**
- **LOW NOISE**
- **LOW LEAKAGE**

2N2509
2N2510
2N2511

MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING			UNIT
		2N2509	2N2510	2N2511	
Collector-Base Voltage	V_{CBO}	125	100	80	Volts
Collector-Emitter Voltage	V_{CEO}	80	65	50	Volts
Emitter-Base Voltage	V_{EBO}	7.0	7.0	7.0	Volts
Total Device Dissipation @ $T_A = 25°C$ @ $T_C = 25°C$ @ $T_C = 100°C$	P_D	0.36 1.20 0.68			Watts
Derating Factor Above 25°C @ $T_A = 25°C$		2.1			mW/°C
Storage Temperature	T_{stg}	−65 to +300			°C
Junction Temperature	T_J	+200			°C



ELECTRICAL CHARACTERISTICS at +25°C (Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Collector-Base Breakdown Voltage 2N2511 2N2510 2N2509	BV_{CBO}	$I_C = 10\ \mu A, I_E = 0$	80 100 125		Volts
Emitter-Base Breakdown Voltage	BV_{EBO}	$I_C = 0, I_E = 0.1\ \mu A$	7.0		Volts
Collector-Emitter Sustaining Voltage 2N2511 2N2510 2N2509	$V_{CEO(sus)}$*	$I_C = 10$ mA, $I_B = 0$	50 65 80		Volts
Collector Saturation Voltage	$V_{CE(sat)}$	$I_C = 5.0$ mA, $I_B = 0.5$ mA		1.0	Volts
Base Saturation Voltage	$V_{BE(sat)}$	$I_C = 5.0$ mA, $I_B = 0.5$ mA		0.9	Volts
Collector-Base Cutoff Current 2N2511 2N2510 2N2509 2N2511 2N2510 2N2509	I_{CBO}	$I_E = 0, V_{CB} = 100$ V $I_E = 0, V_{CB} = 80$ V $I_E = 0, V_{CB} = 60$ V $I_E = 0, V_{CB} = 100$ V, $T_A = 150°C$ $I_E = 0, V_{CB} = 80$ V, $T_A = 150°C$ $I_E = 0, V_{CB} = 60$ V, $T_A = 150°C$		5.0 5.0 5.0 10 10 10	nA μA
Emitter-Base Cutoff Current	I_{EBO}	$I_C = 0, V_{EB} = 5.0$ V		2.0	nA
DC Current Gain 2N2511 2N2511 2N2510 2N2509 2N2511 2N2510 2N2511 2N2510 2N2509 2N2511 2N2510 2N2509	h_{FE}	$I_C = 1.0\ \mu A, V_{CE} = 5.0$ V $I_C = 10\ \mu A, V_{CE} = 5.0$ V $I_C = 10\ \mu A, V_{CE} = 5.0$ V, $T_A = -55°C$ $I_C = 10$ mA, $V_{CE} = 5.0$ V $I_C = 10$ mA, $V_{CE} = 5.0$ V, $T_A = -55°C$	80 120 75 40 40 25 240 150 40 100 60 20	 750 500	

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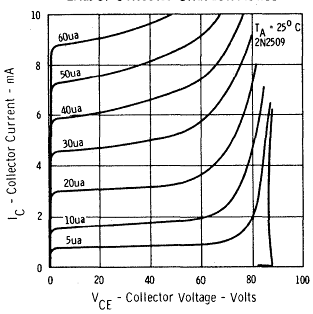
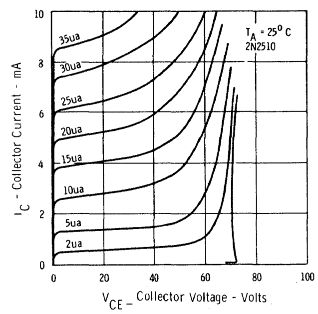
CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
High Frequency Current Gain	$\lvert h_{fe} \rvert$	$I_C = 5.0$ mA, $V_{CE} = 10$ V f = 30 MHz	1.5		
Output Capacitance	C_{ob}	$I_E = 0$, $V_{CB} = 5.0$ V f = 140 kHz		6.0	pf
Input Capacitance	C_{ib}	$I_C = 0$, $V_{BE} = 0.5$ V f = 140 kHz		10	pf
Noise Figure 2N2511 2N2510 2N2509	NF	f = 1.0 kHz Source resistance = 10 KΩ Equivalent noise power bandwidth = 200 Hz $I_C = 10$ μA, $V_{CE} = 5.0$ V		 4.0 4.0 7.0	 db

* Pulse Test: Pulse Width = 300 μsec; Duty Cycle = 1%.

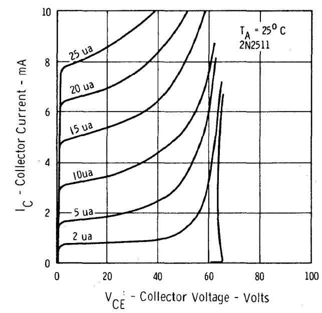
2N2509 Collector Characteristics



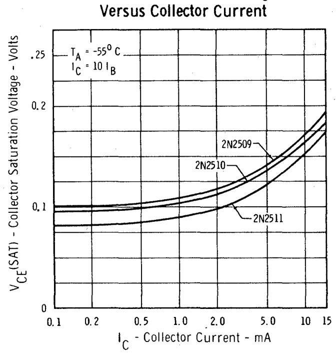
2N2510 Collector Characteristics



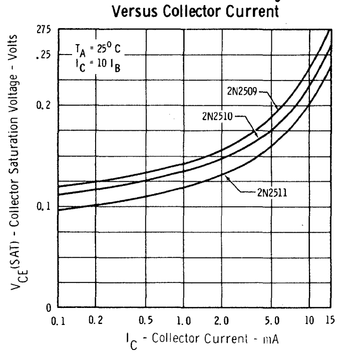
2N2511 Collector Characteristics



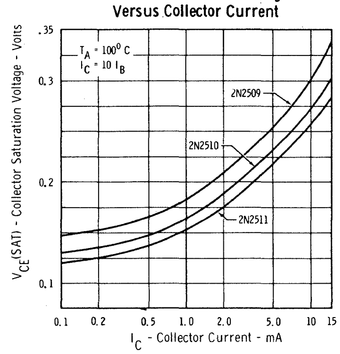
Collector Saturation Voltage
Versus Collector Current



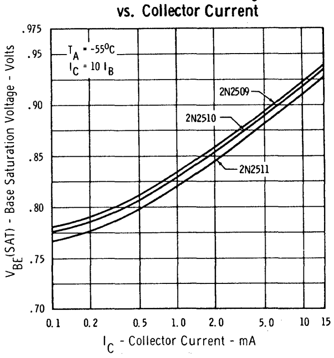
Collector Saturation Voltage
Versus Collector Current



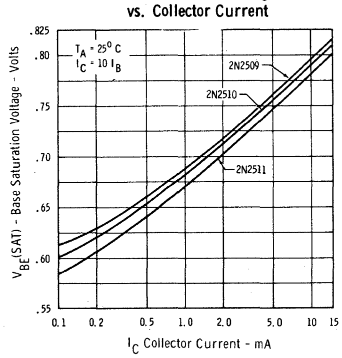
Collector Saturation Voltage
Versus Collector Current



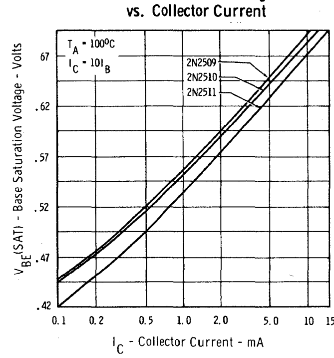
Base Saturation Voltage
vs. Collector Current



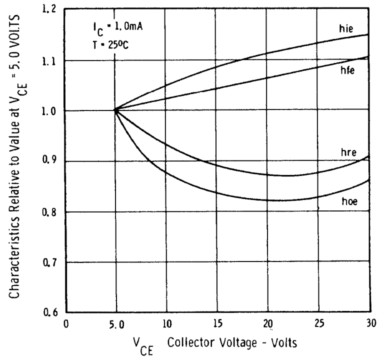
Base Saturation Voltage
vs. Collector Current



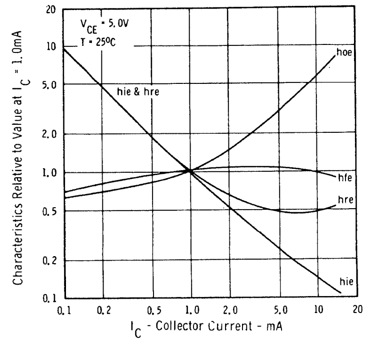
Base Saturation Voltage
vs. Collector Current



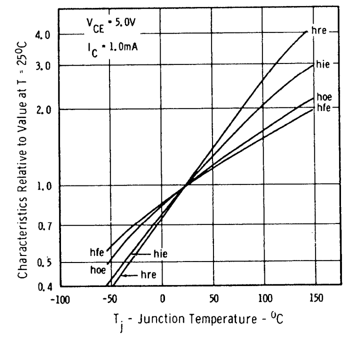
Typical Common Emitter Characteristics



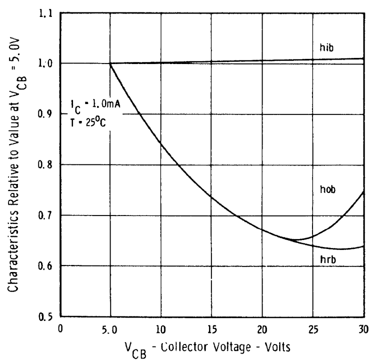
Typical Common Emitter Characteristics



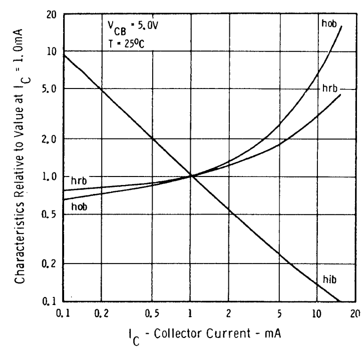
Typical Common Emitter Characteristics



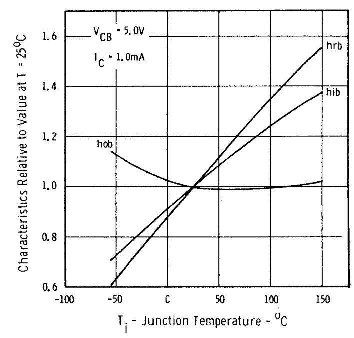
Typical Common Base Characteristics



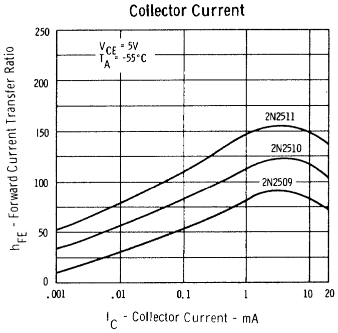
Typical Common Base Characteristics



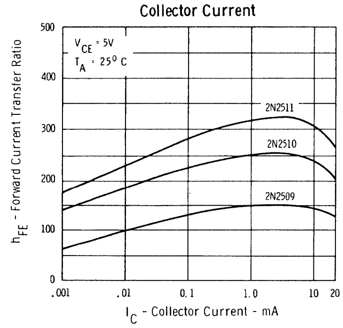
Typical Common Base Characteristics



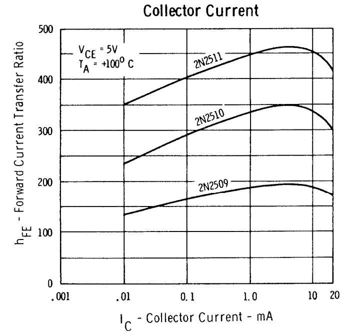
Pulsed DC Current Gain Versus
Collector Current



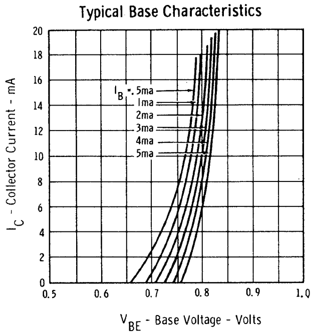
Pulsed DC Current Gain Versus
Collector Current



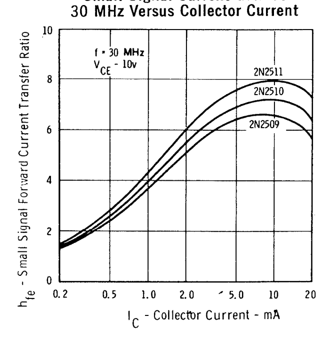
Pulsed DC Current Gain Versus
Collector Current



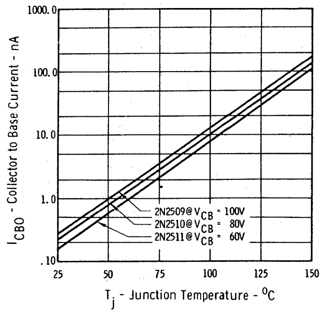
Typical Base Characteristics



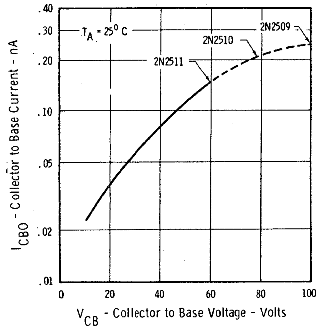
Small Signal Current Gain at
30 MHz Versus Collector Current



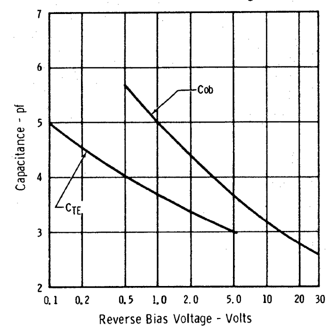
Collector - Base Diode Reverse Current versus Temperature



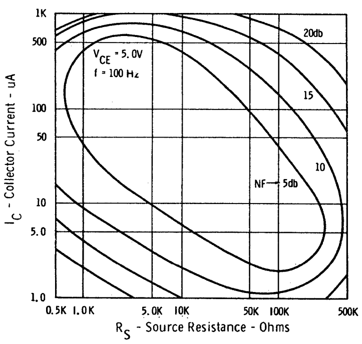
Collector - Base Diode Reverse Current Versus Voltage



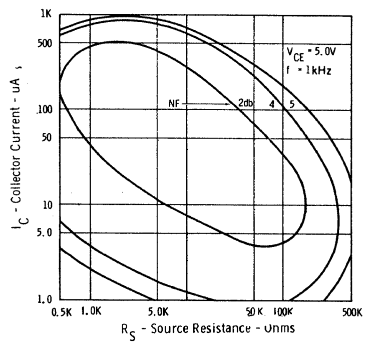
Collector and Emitter Transition Capacitance Versus Reverse Bias Voltage



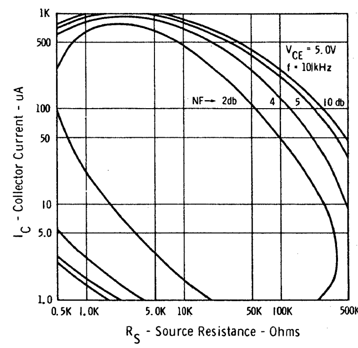
Noise Figure at 100 Hz



Noise Figure at 10 kHz



Noise Figure at 1 kHz



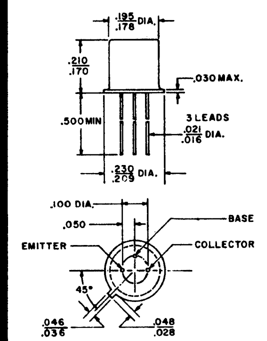
JANUARY 1968

NPN TRANSISTOR
GENERAL PURPOSE
- LOW LEAKAGE
- HIGH CURRENT GAIN
- LOW NOISE

2N2586

MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	60	Volts
Collector-Emitter Voltage	V_{CEO}	45	Volts
Emitter-Base Voltage	V_{EBO}	6.0	Volts
Collector Current	I_C	30	mA
Total Device Dissipation @ $T_A = 25°C$ @ $T_C = 25°C$	P_D	 0.3 0.6	Watts
Storage Temperature	T_{stg}	−65 to +300	°C
Junction Temperature	T_J	+175	°C
Derating Factor above 25°C @ $T_A = 25°C$ @ $T_C = 25°C$		 2.0 4.0	mW/°C



COLLECTOR IS INTERNALLY CONNECTED TO CASE

ELECTRICAL CHARACTERISTICS at +25°C (Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Collector-Base Breakdown Voltage	BV_{CBO}	$I_C = 10\ \mu A$, $I_E = 0$	60		Volts
Emitter-Base Breakdown Voltage	BV_{EBO}	$I_C = 0$, $I_E = 10\ \mu A$	6.0		Volts
Collector-Emitter Sustaining Voltage	$V_{CEO(sus)}$*	$I_C = 10$ mA, $I_B = 0$	45		Volts
Collector Saturation Voltage	$V_{CE(sat)}$	$I_C = 10$ mA, $I_B = 0.5$ mA		0.5	Volts
Base Saturation Voltage	$V_{BE(sat)}$	$I_C = 10$ mA, $I_B = 0.5$ mA	0.7	0.9	Volts
Collector-Base Cutoff Current	I_{CBO}	$I_E = 0$, $V_{CB} = 45$ V		2.0	nA
Collector-Emitter Cutoff Current	I_{CEO}	$I_B = 0$, $V_{CE} = 5.0$ V		2.0	nA
Collector-Emitter Cutoff Current	I_{CES}	$V_{BE} = 0$, $V_{CE} = 45$ V $V_{BE} = 0$, $V_{CE} = 45$ V, $T_A = 170°C$		2.0 10	nA μA
Emitter-Base Cutoff Current	I_{EBO}	$I_C = 0$, $V_{EB} = 5.0$ V		2.0	nA
DC Current Gain	h_{FE}	$I_C = 1.0\ \mu A$, $V_{CE} = 5.0$ V $I_C = 10\ \mu A$, $V_{CE} = 5.0$ V $I_C = 500\ \mu A$, $V_{CE} = 5.0$ V $I_C = 10$ mA, $V_{CE} = 5.0$ V $I_C = 10\ \mu A$, $V_{CE} = 5.0$ V $T_A = -55°C$	80 120 150 40	 360 600	
Small Signal Current Gain	h_{fe}	$I_C = 1.0$ mA, $V_{CE} = 5.0$ V f = 1 kHz	150	600	
High Frequency Current Gain	$\|h_{fe}\|$	$I_C = 0.5$ mA, $V_{CE} = 5.0$ V f = 30 MHz	1.5		
Output Capacitance	C_{ob}	$I_E = 0$, $V_{CB} = 5.0$ V, f = 1 MHz		7.0	pf
Input Resistance	h_{ie}	$I_C = 1.0$ mA, $V_{CE} = 5.0$ V f = 1 kHz	4.5	18	KΩ
Output Conductance	h_{oe}	$I_C = 1.0$ mA, $V_{CE} = 5.0$ V f = 1 kHz		100	μmhos
Low Frequency Noise Figure	NF	f = 1 kHz Source resistance = 10 kΩ $I_C = 10\ \mu A$, $V_{CE} = 5.0$ V f = 1 kHz Source resistance = 1 MΩ $I_C = 1.0\ \mu A$, $V_{CE} = 5.0$ V f = 10 kHz Source resistance = 10 kΩ $I_C = 10\ \mu A$, $V_{CE} = 5.0$ V f = 10 kHz Source resistance = 1 MΩ $I_C = 1.0\ \mu A$, $V_{CE} = 5.0$ V		3.0 3.5 2.0 2.0	db

* Pulse width = 300 μsec; duty cycle = 1%.

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NPN TRANSISTOR
GENERAL PURPOSE

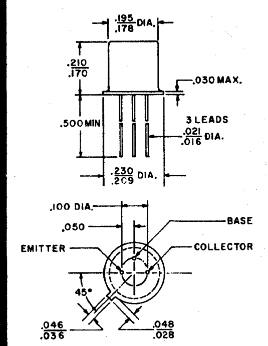
- HIGH CURRENT GAIN
- LOW NOISE
- HIGH BREAKDOWN VOLTAGE

JANUARY 1968

2N3117

MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	60	Volts
Collector-Emitter Voltage	V_{CEO}	60	Volts
Emitter-Base Voltage	V_{EBO}	6.0	Volts
Collector Current	I_C	50	mA
Total Device Dissipation @ $T_A = 25°C$ @ $T_C = 25°C$ @ $T_C = 100°C$	P_D	 0.36 1.2 0.68	 Watts
Derating Factor above 25°C @ $T_A = 25°C$ @ $T_C = 25°C$		 2.06 6.85	 mW/°C
Storage Temperature	T_{stg}	−65 to +200	°C
Junction Temperature	T_J	200	°C



COLLECTOR IS INTERNALLY CONNECTED TO CASE

ELECTRICAL CHARACTERISTICS at +25°C (Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Collector-Base Breakdown Voltage	BV_{CBO}	$I_C = 10\ \mu A$, $I_E = 0$	60		Volts
Emitter-Base Breakdown Voltage	BV_{EBO}	$I_C = 0$, $I_E = 10\ \mu A$	6.0		Volts
Collector-Emitter Sustaining Voltage	$V_{CEO(sus)}$*	$I_C = 10$ mA, $I_B = 0$	60		Volts
Nonsaturated Base Voltage	$V_{BE(on)}$	$I_C = 0.1$ mA, $V_{CE} = 5.0$ V		0.7	Volts
Collector Saturation Voltage	$V_{CE(sat)}$	$I_C = 1.0$ mA, $I_B = 0.1$ mA		0.35	Volts
Collector-Base Cutoff Current	I_{CBO}	$I_E = 0$, $V_{CB} = 45$ V $I_E = 0$, $V_{CB} = 45$ V $T_A = 150°C$		10 10	nA μA
Emitter-Base Cutoff Current	I_{EBO}	$I_C = 0$, $V_{EB} = 5.0$ V		10	nA
DC Current Gain	h_{FE}	$I_C = 1.0\ \mu A$, $V_{CE} = 5.0$ V $I_C = 10\ \mu A$, $V_{CE} = 5.0$ V $I_C = 100\ \mu A$, $V_{CE} = 5.0$ V $I_C = 1.0$ mA, $V_{CE} = 5.0$ V $I_C = 10\ \mu A$, $V_{CE} = 5.0$ V $T_A = -55°C$	100 250 300 400 50	 500	
Small Signal Current Gain	h_{fe}	$I_C = 1.0$ mA, $V_{CE} = 5.0$ V f = 1.0 kHz	400	900	
High Frequency Current Gain	$\|h_{fe}\|$	$I_C = 0.5$ mA, $V_{CE} = 5.0$ V f = 30 MHz	2.0		
Output Capacitance	C_{ob}	$I_E = 0$, $V_{CB} = 5.0$ V f = 140 kHz		4.5	pf
Input Capacitance	C_{ib}	$I_C = 0$, $V_{BE} = 5.0$ V f = 140 kHz		6.0	pf
Reverse Voltage Feedback Ratio	h_{re}	$I_C = 1.0$ mA, $V_{CE} = 5.0$ V f = 1.0 kHz		8.0	$X\ 10^{-4}$
Input Resistance	h_{ie}	$I_C = 1.0$ mA, $V_{CE} = 5.0$ V f = 1.0 kHz	10	24	K ohms
Output Conductance	h_{oe}	$I_C = 1.0$ mA, $V_{CE} = 5.0$ V f = 1.0 kHz		40	μmhos
Noise Figure	NF	f = 100 Hz Source resistance = 10 kΩ Equivalent noise power bandwidth = 20 Hz $I_C = 30\ \mu A$, $V_{CE} = 5.0$ V		4.0	db

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CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Noise Figure	NF	f = 1 kHz Source resistance = 50 kΩ Equivalent noise power bandwidth = 200 cps $I_C = 5.0\ \mu A$, $V_{CE} = 5.0$ V		1.0	db
		f = 10 kHz Source resistance = 50 kΩ Equivalent noise power bandwidth = 1000 Hz $I_C = 5.0\ \mu A$, $V_{CE} = 5.0$ V		1.0	
		f = 10 Hz Source resistance = 10 kΩ Equivalent noise power bandwidth = 2.0 Hz $I_C = 30\ \mu A$, $V_{CE} = 5.0$ V		15	

* Pulse Width = 300 μsec; duty Cycle = 1%.

JANUARY 1968

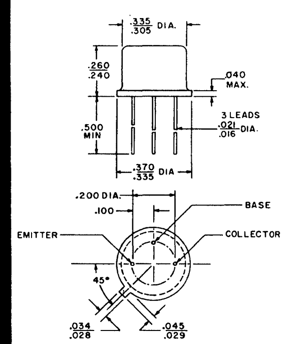
NPN TRANSISTOR
MEDIUM POWER

- HIGH CURRENT
- LOW SATURATION VOLTAGE
- HIGH CURRENT GAIN

2N2192, A, B
2N2193, A, B
2N2194, A, B
2N2195, A, B

MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	2N2192 2N2192A 2N2192B 2N2194 2N2194A 2N2194B	2N2193 2N2193A 2N2193B	2N2195 2N2195A 2N2195B	UNIT
Collector-Base Voltage	V_{CBO}	60	80	45	Volts
Collector-Emitter Voltage	V_{CEO}	40	50	25	Volts
Emitter-Base Voltage	V_{EBO}	5	8	5	Volts
Collector Current	I_C	1.0	1.0	1.0	Amp
Total Device Dissipation @ $T_A = 25°C$ @ $T_C = 25°C$ @ $T_C = 100°C$	P_D	 0.8 2.8 1.6	 0.8 2.8 1.6	 0.6 2.8 1.6	Watt
Derating Factor Above 25°C @ $T_A = 25°C$ @ $T_C = 25°C$		 4.56 16	 4.56 16	 3.43 16	mW/°C
Storage Temperature	T_{stg}		−65 to +200		°C



COLLECTOR IS INTERNALLY CONNECTED TO CASE

ELECTRICAL CHARACTERISTICS at +25°C (Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Collector-Base Breakdown Voltage 2N2192, A, B, 2N2194, A, B 2N2193, A, B 2N2195, A, B	BV_{CBO}	$I_C = 100\ \mu A,\ I_E = 0$	 60 80 45		Volts
Emitter-Base Breakdown Voltage 2N2192, A, B, 2N2194, A, B 2N2193, A, B 2N2195, A, B	BV_{EBO}	$I_E = 100\ \mu A,\ I_C = 0$	 5 8 5		Volts
Collector-Emitter Sustaining Voltage 2N2192, A, B, 2N2194, A, B 2N2193, A, B 2N2195, A, B	$V_{CEO(sus)}$*	$I_C = 25$ mA (pulsed), $I_B = 0$	 40 50 25		Volts
Collector Saturation Voltage 2N2192 thru 2N2195 2N2192A thru 2N2195A 2N2192B thru 2N2195B	$V_{CE(sat)}$	$I_C = 150$ mA, $I_B = 15$ mA		 0.35 0.25 0.18	Volts
Base Saturation Voltage	$V_{BE(sat)}$	$I_C = 150$ mA, $I_B = 15$ mA		1.3	Volts
Collector-Base Cutoff Current 2N2192, A, B, 2N2194, A, B 2N2195, A, B 2N2192, A, B, 2N2194, A, B 2N2195, A, B 2N2193, A, B 2N2193, A, B	I_{CBO}	 $V_{CB} = 30$ V, $I_E = 0$ $V_{CB} = 30$ V, $I_E = 0$, $T_A = 150°C$ $V_{CB} = 60$ V, $I_E = 0$ $V_{CB} = 60$ V, $I_E = 0$, $T_A = 150°C$		 .010 .100 15 25 50 .010 25	μA
Emitter-Base Cutoff Current 2N2192, A, B, 2N2194, A, B 2N2195, A, B 2N2193, A, B	I_{EBO}	 $V_{EB} = 3$ V, $I_C = 0$ $V_{EB} = 5$ V, $I_C = 0$		 .050 .100 .050	μA

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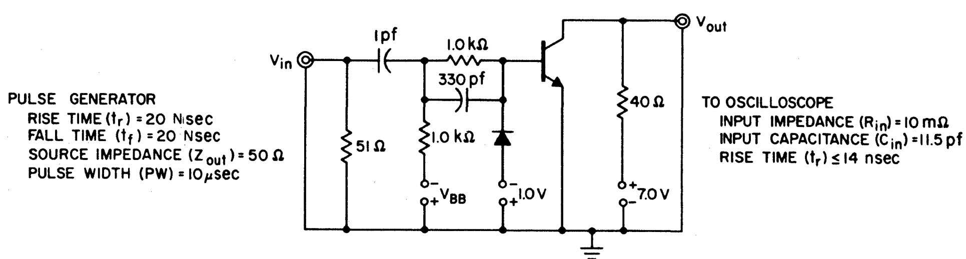
CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
DC Pulse Current Gain	h_{FE}*				
2N2192, A, B, 2N2193, A, B		$I_C = 0.1$ mA, $V_{CE} = 10$ V	15		
2N2192, A, B,		$I_C = 10$ mA, $V_{CE} = 10$ V	75		
2N2193, A, B			30		
2N2194, A, B			15		
2N2192, A, B,		$I_C = 10$ mA, $V_{CE} = 10$ V,	35		
2N2193, A, B		$T_A = -55°C$	20		
2N2192, A, B,		$I_C = 150$ mA, $V_{CE} = 10$ V	100	300	
2N2193, A, B			40	120	
2N2194, A, B			20	60	
2N2195, A, B			20		
2N2192, A, B,		$I_C = 150$ mA, $V_{CE} = 1.0$ V	70		
2N2193, A, B			30		
2N2194, A, B			15		
2N2195, A, B			10		
2N2192, A, B,		$I_C = 500$ mA, $V_{CE} = 10$ V	35		
2N2193, A, B			20		
2N2194, A, B			12		
2N2192, A, B, 2N2193, A, B		$I_C = 1.0$ A, $V_{CE} = 10$ V	15		
Rise Time	t_r			70	nsec
Fall Time	t_f	2N2192-94, 2N2192A-94A, 2N2192B-94B (See Figure 1)		50	nsec
Storage Time	t_s			150	nsec
High Frequency Current Gain	$\|h_{fe}\|$	$I_C = 50$ mA, $V_{CE} = 10$ V, f = 20 MHz	2.5		
Output Capacitance	C_{ob}	$V_{CB} = 10$ V, $I_E = 0$, f = 1.0 MHz		20	pf

* Pulse Test: Pulse Width $\leq 300\ \mu$sec; Duty Cycle $\leq 2\%$.

Figure 1



CIRCUIT CONDITIONS

	V_{IN}	V_{BB}
2N2192, A, B	7.5 V	7.5 V
2N2193, A, B & 2N2194, A, B	15.0 V	15.0 V

JANUARY 1968

NPN TRANSISTOR
MEDIUM POWER

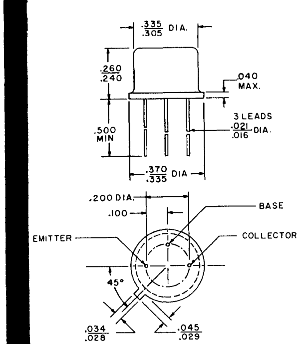
- LOW SATURATION VOLTAGE
- HIGH FREQUENCY
- LOW LEAKAGE

2N2217 THRU 2N2222

MAXIMUM RATINGS

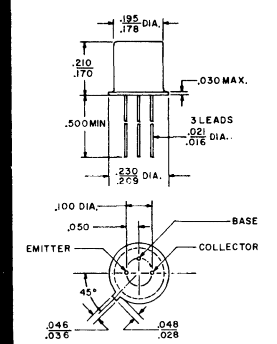
CHARACTERISTIC	SYMBOL	RATING		UNIT
Collector-Base Voltage	V_{CBO}	60		Volts
Collector-Emitter Voltage	V_{CEO}	30		Volts
Emitter-Base Voltage	V_{EBO}	5.0		Volts
Total Device Dissipation	P_D	2N2217-19	2N2220-22	
@ $T_A = 25°C$		0.8	0.5	Watts
@ $T_C = 25°C$		3.0	1.8	Watts
Derating Factor above 25°C				
@ $T_A = 25°C$		5.33	3.33	mW/°C
@ $T_C = 25°C$		20	12	mW/°C
Storage Temperature	T_{stg}	−65 to +200		°C
Junction Temperature	T_J	−65 to +175		°C

2N2217-19



COLLECTOR IS INTERNALLY CONNECTED TO CASE

2N2220-22



COLLECTOR IS INTERNALLY CONNECTED TO CASE

ELECTRICAL CHARACTERISTICS at +25°C (Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Collector-Base Breakdown Voltage	BV_{CBO}	$I_C = 10\ \mu A$, $I_E = 0$	60		Volts
Collector-Emitter Breakdown Voltage	BV_{CEO}	$I_C = 10$ mA, $I_B = 0$	30		Volts
Emitter-Base Breakdown Voltage	BV_{EBO}	$I_E = 10\ \mu A$, $I_C = 0$	5.0		Volts
Collector Saturation Voltage	$V_{CE(sat)}$*				
All Types		$I_C = 150$ mA, $I_B = 15$ mA		0.4	Volts
2N2218, 19, 21, 22		$I_C = 500$ mA, $I_B = 50$ mA		1.6	
Emitter-Base Voltage	V_{BE}*				
All Types		$I_B = 15$ mA, $I_C = 150$ mA		1.3	Volts
2N2218, 19, 21, 22		$I_B = 50$ mA, $I_C = 500$ mA		2.6	
Collector-Base Cutoff Current	I_{CBO}	$I_E = 0$, $V_{CB} = 50$ V		10	nA
		$I_E = 0$, $V_{CB} = 50$ V, $T_A = 150°C$		10	µA
Emitter-Base Cutoff Current	I_{EBO}	$I_C = 0$, $V_{EB} = 3.0$ V		10	nA
DC Current Gain	h_{FE}				
2N2218, 21		$I_C = 0.1$ mA, $V_{CE} = 10$ V	20		
2N2219, 22			35		
2N2217, 20		$I_C = 1.0$ mA, $V_{CE} = 10$ V	12		
2N2218, 21			25		
2N2219, 22			50		
2N2217, 20		$I_C = 10$ mA, $V_{CE} = 10$ V	17		
2N2218, 21			35		
2N2219, 22			75		
DC Pulsed Current Gain	h_{FE}*				
2N2217, 20		$I_C = 150$ mA, $V_{CE} = 10$ V	20	60	
2N2218, 21			40	120	
2N2219, 22			100	300	
2N2218, 21		$I_C = 500$ mA, $V_{CE} = 10$ V	20		
2N2219, 22			30		
2N2217, 20		$I_C = 150$ mA, $V_{CE} = 1.0$ V	10		
2N2218, 21			20		
2N2219, 22			50		
High Frequency Current Gain	$\|h_{fe}\|$	$I_C = 20$ mA, $V_{CE} = 20$ V, f = 100 MHz	2.5		
Output Capacitance	C_{ob}	$I_E = 0$, $V_{CB} = 10$ V, f = 1.0 MHz		8.0	pf
Real Part of Input Impedance	$R_e(h_{ie})$	$I_C = 20$ mA, $V_{CE} = 20$ V, f = 300 MHz		60	Ohms

* Pulse Test: Pulse Width = 300 µsec; Duty Cycle ≤ 2%.

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NPN TRANSISTOR
MEDIUM POWER
- **HIGH BREAKDOWN VOLTAGE**
- **HIGH CURRENT GAIN**
- **LOW SATURATION VOLTAGE**

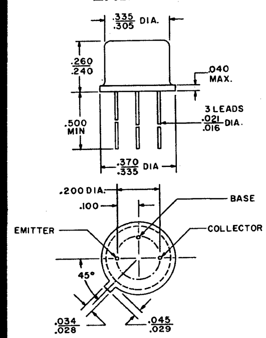
JANUARY 1968

2N2218A
2N2219A
2N2221A
2N2222A

MAXIMUM RATINGS

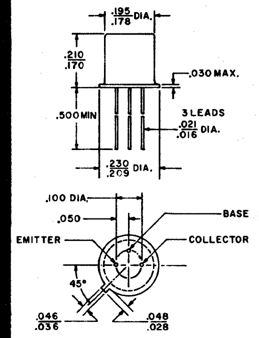
CHARACTERISTIC	SYMBOL	2N2218A 2N2219A	2N2221A 2N2222A	UNIT
Collector-Base Voltage	V_{CBO}	75	75	Volts
Collector-Emitter Voltage	V_{CEO}	40	40	Volts
Emitter-Base Voltage	V_{EBO}	6	6	Volts
Total Device Dissipation @ $T_A = 25°C$ @ $T_C = 25°C$	P_D	 0.8 3.0	 0.5 1.8	Watts
Derating Factor Above 25°C @ $T_A = 25°C$ @ $T_C = 25°C$		 5.33 20	 3.33 12	mW/°C
Storage Temperature Range	T_{stg}	−65 to +200		°C
Junction Temperature Range	T_J	−65 to +175		°C

2N2218A
2N2219A



COLLECTOR IS INTERNALLY CONNECTED TO CASE

2N2221A
2N2222A



COLLECTOR IS INTERNALLY CONNECTED TO CASE

ELECTRICAL CHARACTERISTICS at +25°C (Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Collector-Base Breakdown Voltage	BV_{CBO}	$I_C = 10\ \mu A$, $I_E = 0$	75		Volts
Collector-Emitter Breakdown Voltage	BV_{CEO}	$I_C = 10$ mA, $I_B = 0$	40		Volts
Emitter-Base Breakdown Voltage	BV_{EBO}	$I_E = 10\ \mu A$, $I_C = 0$	6		Volts
Collector Saturation Voltage	$V_{CE(sat)}$*	$I_C = 150$ mA, $I_B = 15$ mA $I_C = 500$ mA, $I_B = 50$ mA		0.3 1.0	Volts
Base Saturation Voltage	$V_{BE(sat)}$*	$I_C = 150$ mA, $I_B = 15$ mA $I_C = 500$ mA, $I_B = 50$ mA	0.6	1.2 2.0	Volts
Collector-Base Cutoff Current	I_{CBO}	$V_{CB} = 60$ V, $I_E = 0$ $V_{CB} = 60$ V, $I_E = 0$, $T_A = 150°C$		0.01 10	μA
Emitter-Base Cutoff Current	I_{EBO}	$V_{EB} = 3$ V, $I_C = 0$		10	nA
Base-Emitter Cutoff Current	I_{BEX}	$V_{CE} = 60$ V, $V_{EB} = 3$ V		20	nA
Collector-Emitter Cutoff Current	I_{CEX}	$V_{CE} = 60$ V, $V_{EB} = 3$ V		10	nA
DC Pulse Current Gain	h_{FE}*				
2N2218A, 2N2221A 2N2219A, 2N2222A		$I_C = 0.1$ mA, $V_{CE} = 10$ V	20 35		
2N2218A, 2N2221A 2N2219A, 2N2222A		$I_C = 1.0$ mA, $V_{CE} = 10$ V	25 50		
2N2218A, 2N2221A 2N2219A, 2N2222A		$I_C = 10$ mA, $V_{CE} = 10$ V	35 75		
2N2218A, 2N2221A 2N2219A, 2N2222A		$I_C = 10$ mA, $V_{CE} = 10$ V $T_A = -55°C$	15 35		
2N2218A, 2N2221A 2N2219A, 2N2222A		$I_C = 150$ mA, $V_{CE} = 10$ V	40 100	120 300	
2N2218A, 2N2221A 2N2219A, 2N2222A		$I_C = 150$ mA, $V_{CE} = 1.0$ V	20 50		
2N2218A, 2N2221A 2N2219A, 2N2222A		$I_C = 500$ mA, $V_{CE} = 10$ V	25 40		

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CHARACTERISTICS	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Small Signal Current Gain	h_{fe}				
2N2218A, 2N2221A		$I_C = 1.0$ mA, $V_{CE} = 10$ V, f = 1 kHz	30	150	
2N2219A, 2N2222A			50	300	
2N2218A, 2N2221A		$I_C = 10$ mA, $V_{CE} = 10$ V, f = 1 kHz	50	300	
2N2219A, 2N2222A			75	375	
High Frequency Current Gain	$\|h_{fe}\|$				
2N2218A, 2N2221A		$I_C = 20$ mA, $V_{CE} = 20$ V, f = 100 MHz	2.5		
2N2219A, 2N2222A			3.0		
Output Capacitance	C_{ob}	$I_E = 0$, $V_{CB} = 10$ V, f = 100 kHz		8	pf
Input Capacitance	C_{ib}	$I_C = 0$, $V_{EB} = 0.5$ V, f = 1 kHz		25	pf
Voltage Feedback Ratio	h_{re}				
2N2218A, 2N2221A		$I_C = 1.0$ mA, $V_{CE} = 10$ V, f = 1 kHz		5	$x10^{-4}$
2N2219A, 2N2222A				8	
2N2218A, 2N2221A		$I_C = 10$ mA, $V_{CE} = 10$ V, f = 1 kHz		2.5	
2N2219A, 2N2222A				4	
Input Resistance	h_{ie}				
2N2218A, 2N2221A		$I_C = 1.0$ mA, $V_{CE} = 10$ V, f = 1 kHz	1	3.5	K ohms
2N2219A, 2N2222A			2.0	8	
2N2218A, 2N2221A		$I_C = 10$ mA, $V_{CE} = 10$ V, f = 1 kHz	0.2	1.0	
2N2219A, 2N2222A			0.25	1.25	
Output Conductance	h_{oe}				
2N2218A, 2N2221A		$I_C = 1.0$ mA, $V_{CE} = 10$ V, f = 1 kHz	3	15	μmhos
2N2219A, 2N2222A			5	35	
2N2218A, 2N2221A		$I_C = 10$ mA, $V_{CE} = 10$ V, f = 1 kHz	10	100	
2N2219A, 2N2222A			25	200	
Collector-Base Time Constant	$r_b'C_c$	$I_C = 20$ mA, $V_{CE} = 20$ V, f = 31.8 MHz		150	psec
Noise Figure	NF				
2N2219A		$I_C = 100\ \mu$A, $V_{CE} = 10$ V, Rg = 1 kΩ,		4	db
2N2222A		f = 1 kHz			

* Pulse Test: Pulse Width $\leq 300\ \mu$sec; Duty Cycle $\leq 2\%$.

NPN TRANSISTOR
MEDIUM POWER

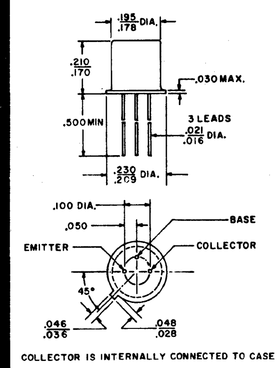
- LOW NOISE
- HIGH BREAKDOWN VOLTAGE
- LOW SATURATION VOLTAGE

JANUARY 1968

2N2222B

MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	75	Volts
Collector-Emitter Voltage	V_{CEO}	6.0	Volts
Emitter-Base Voltage	V_{EBO}	40	Volts
Collector Current	I_C	1.0	A
Total Device Dissipation @ $T_A = 25°C$ @ $T_C = 25°C$	P_D	 0.5 1.8	Watts
Derating Factor Above 25°C @ $T_A = 25°C$ @ $T_C = 25°C$		 3.3 12	mW/°C
Storage Temperature	T_{stg}	−65 to +200	°C
Junction Temperature	T_J	200	°C
Lead Temperature, 1/16 inch from case, 10 second max.		230	°C



ELECTRICAL CHARACTERISTICS at +25°C (Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Collector-Base Breakdown Voltage	BV_{CBO}	$I_E = 0, I_C = 10\ \mu A$	75		Volts
Collector-Emitter Breakdown Voltage	BV_{CEO}	$I_C = 10$ mA, $V_{BE} = 0$	40		Volts
Emitter-Base Breakdown Voltage	BV_{EBO}	$I_C = 0, I_E = 10\ \mu A$	6.0		Volts
Collector Saturation Voltage	$V_{CE(sat)}$*	$I_C = 150$ mA, $I_B = 15$ mA $I_C = 500$ mA, $I_B = 50$ mA $I_C = 1.0$ mA, $I_B = 100$ mA		0.2 0.5 1.0	Volts
Base Saturation Voltage	$V_{BE(sat)}$	$I_C = 150$ mA, $I_B = 15$ mA $I_C = 500$ mA, $I_B = 50$ mA $I_C = 1.0$ mA, $I_B = 100$ mA	0.6	1.0 1.3 1.6	Volts
Collector-Base Cutoff Current	I_{CBO}	$V_{CE} = 60$ V, $I_E = 0$ $V_{CB} = 60$ V, $I_E = 0$, $T_A = 150°C$		10 10	nA μA
Collector-Emitter Reverse Current	I_{CEX}	$V_{CE} = 60$ V, $V_{EB} = 3.0$ V		10	nA
Base Leakage Current	I_{BL}	$V_{CE} = 60$ V, $V_{EB} = 3.0$ V		20	nA
Emitter-Base Cutoff Current	I_{EBO}	$V_{EB} = 3.0$ V, $I_C = 0$		10	nA
DC Current Gain	h_{FE}	$V_{CE} = 10$ V, $I_C = 100\ \mu A$ $V_{CE} = 10$ V, $I_C = 1.0$ mA $V_{CE} = 10$ V, $I_C = 10$ mA $V_{CE} = 10$ V, $I_C = 150$ mA $V_{CE} = 10$ V, $I_C = 500$ mA $V_{CE} = 10$ V, $I_C = 1.0$ A* $V_{CE} = 1.0$ V, $I_C = 150$ mA $V_{CE} = 10$ V, $I_C = 10$ mA, $T_A = -55°C$	35 50 75 100 40 15 50 35	 300	
Rise Time	t_r	See Figure 1		25	nsec
Turn-on Delay Time	t_d	See Figure 1		10	nsec
Fall Time	t_f	See Figure 2		60	nsec
Storage Time	t_s	See Figure 2		225	nsec
Action Region Time Constant	t_a	See Figure 1		2.5	nsec
Small Signal Current Gain	h_{fe}	$V_{CE} = 10$ V, $I_C = 1.0$ mA f = 1.0 kHz $V_{CE} = 10$ V, $I_C = 10$ mA f = 1.0 kHz	50 75	300 375	

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CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
High Frequency Current Gain	$\lvert h_{fe} \rvert$	$V_{CE} = 20$ V, $I_C = 20$ mA f = 100 MHz $V_{CE} = 20$ V, $I_C = 50$ mA f = 100 MHz	3.0 4.0		
Output Capacitance	C_{ob}	$V_{CB} = 10$ V, $I_E = 0$ f = 100 kHz		8.0	pf
Input Capacitance	C_{ib}	$V_{EB} = 0.5$ V, $I_C = 0$ f = 100 kHz		25	pf
Input Resistance	h_{ie}	$V_{CE} = 10$ V, $I_C = 1.0$ mA f = 1.0 kHz $V_{CE} = 10$ V, $I_C = 10$ mA f = 1.0 kHz	2.0 0.25	8.0 1.25	k ohms
Voltage Feedback Ratio	h_{re}	$V_{CE} = 10$ V, $I_C = 1.0$ mA f = 1.0 kHz $V_{CE} = 10$ V, $I_C = 10$ mA f = 1.0 kHz		0.0008 0.0004	
Output Conductance	h_{oe}	$V_{CE} = 10$ V, $I_C = 1.0$ mA f = 1.0 kHz $V_{CE} = 10$ V, $I_C = 10$ mA f = 1.0 kHz	5.0 25	35 200	μmhos
Collector-Base Time Constant	$r_b'C_c$	$V_{CE} = 20$ V, $I_C = 20$ mA f = 31.8 MHz		150	psec
Real Part Input Impedance	$R_{e(hie)}$	$V_{CE} = 20$ V, $I_C = 20$ mA f = 300 MHz		60	Ohms
Current Gain Bandwidth Product	f_t	$V_{CE} = 20$ V, $I_C = 20$ mA f = 100 MHz	300		MHz
Noise Figure	NF	$V_{CE} = 10$ V, $I_C = 100$ μA $R_G = 1.0$ kΩ. f = 1.0 kHz BW = 1.0 Hz		4.0	db

*Pulse Test: Pulse Width $\leqq$ 300 μsec; Duty Cycle $\leqq$ 2%.

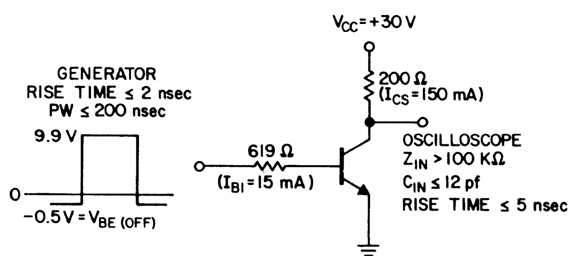


Figure 1 Equivalent Test Circuit for Measuring Delay and Rise Times

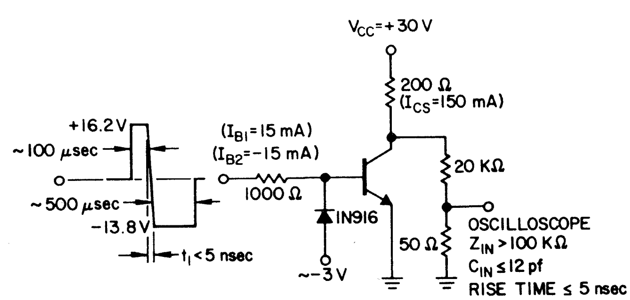


Figure 2 Equivalant Test Circuit for Measuring Storage Fall Time

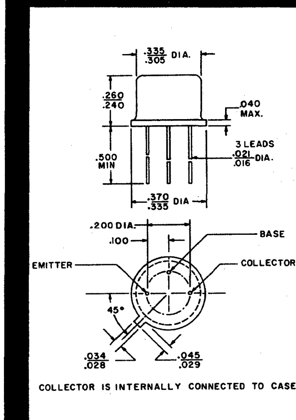
JANUARY 1968

NPN TRANSISTOR
MEDIUM POWER
- HIGH BREAKDOWN VOLTAGE
- LOW SATURATION VOLTAGE
- FAST SWITCHING SPEEDS

2N2243
2N2243A

MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	120	Volts
Collector-Emitter Voltage	V_{CEO}	80	Volts
Emitter-Base Voltage	V_{EBO}	7.0	Volts
Total Device Dissipation @ $T_A = 25°C$ @ $T_C = 25°C$ @ $T_C = 100°C$	P_D	 0.8 2.8 1.6	 Watts
Derating Factor above 25°C @ $T_A = 25°C$		 4.6	 mW/°C
Storage Temperature	T_{stg}	−65 to +200	°C
Junction Temperature	T_J	−65 to +200	°C



ELECTRICAL CHARACTERISTICS at +25°C (Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Collector-Base Breakdown Voltage	BV_{CBO}	$I_C = 100\ \mu A$, $I_E = 0$	120		Volts
Emitter-Base Breakdown Voltage	BV_{EBO}	$I_C = 0$, $I_E = 100\ \mu A$	7.0		Volts
Collector Saturation Voltage 2N2243 2N2243A	$V_{CE(sat)}$	$I_B = 15$ mA, $I_C = 150$ mA		 0.35 0.25	Volts
Collector-Base Cutoff Current	I_{CBO}	$I_E = 0$, $V_{CB} = 60$ V $I_E = 0$, $V_{CB} = 60$ V, $T_A = 150°C$		10 15	nA μA
Emitter-Base Cutoff Current	I_{EBO}	$I_C = 0$, $V_{EB} = 5.0$ V		50	nA
DC Current Gain	h_{FE}	$I_C = 100\ \mu A$, $V_{CE} = 10$ V $I_C = 10$ mA, $V_{CE} = 10$ V $I_C = 10$ mA, $V_{CE} = 10$ V $T_A = -55°C$	15 30 20		
DC Pulsed Current Gain	h_{FE}*	$I_C = 150$ mA, $V_{CE} = 10$ V $I_C = 500$ mA, $V_{CE} = 10$ V $I_C = 150$ mA, $V_{CE} = 1.0$ V	40 15 30	120	
Small Signal Current Gain	h_{fe}	$I_C = 50$ mA, $V_{CE} = 10$ V f = 1.0 kHz	2.5		
Output Capacitance	C_{ob}	$I_C = 100\ \mu A$, $I_E = 0$		15	pf
Stored-Charge Time Constant	T_b	See Figure 1		2.1	μsec

* Pulse Test: Pulse Width ≤ 300 μsec; Duty Cycle = 1%.

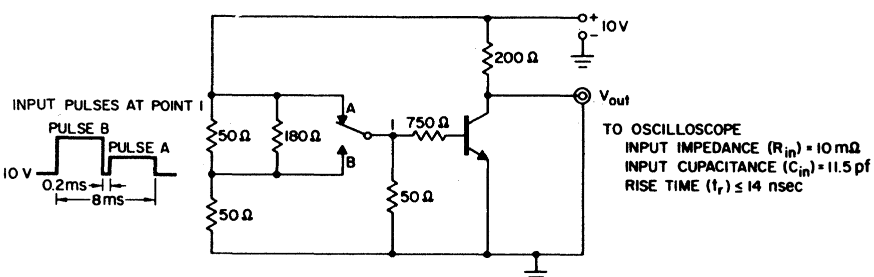


Figure 1

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JANUARY 1968

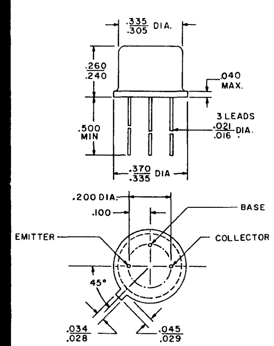
NPN TRANSISTOR
MEDIUM POWER

- LOW SATURATION VOLTAGE
- HIGH BREAKDOWN VOLTAGE
- HIGH COLLECTOR CURRENT

2N2297

MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	80	Volts
Collector-Emitter Voltage	V_{CEO}	35	Volts
Emitter-Base Voltage	V_{EBO}	7.0	Volts
Collector Current	I_C	1	Amp
Total Device Dissipation @ $T_A = 25°C$ @ $T_C = 25°C$ @ $T_C = 100°C$	P_D	 0.8 5.0 2.8	Watts
Storage Temperature	T_{stg}	−65 to +200	°C
Junction Temperature	T_J	+200	°C
Lead Temperature, 1/16 inch from case, 10 sec. max.		+300	°C
Derating Factor above 25°C $T_A = 25°C$ $T_C = 25°C$		 4.06 2.86	mW/°C



COLLECTOR IS INTERNALLY CONNECTED TO CASE

ELECTRICAL CHARACTERISTICS at +25°C (Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Collector-Base Breakdown Voltage	BV_{CBO}	$I_C = 100\ \mu A$, $I_E = 0$	80		Volts
Emitter-Base Breakdown Voltage	BV_{EBO}	$I_C = 0$, $I_E = 100\ \mu A$	7.0		Volts
Collector-Emitter Sustaining Voltage	$V_{CEO(sus)}$*	$I_C = 30$ mA, $I_B = 0$	35		Volts
Base Saturation Voltage	$V_{BE(sat)}$	$I_C = 1000$ mA, $I_B = 100$ mA		1.6	Volts
Collector-Base Cutoff Current	I_{CBO}	$I_E = 0$, $V_{CB} = 60$ V $I_E = 0$, $V_{CB} = 60$ V, $T_A = 150°C$		10 10	nA μA
Emitter-Base Cutoff Current	I_{EBO}	$I_C = 0$, $V_{EB} = 5.0$ V		10	nA
DC Pulsed Current Gain	h_{FE}*	$I_C = 150$ mA, $V_{CE} = 10$ V $I_C = 10$ mA, $V_{CE} = 10$ V $I_C = 1.0$ A, $V_{CE} = 10$ V	40 30 15	120	
High Frequency Current Gain	$\|h_{fe}\|$	$I_C = 50$ mA, $V_{CE} = 10$ V f = 20 MHz	3.0		
Output Capacitance	C_{ob}	$I_E = 0$, $V_{CB} = 10$ V f = 140 kHz		12	pf
Collector-Base Time Constant	$r_b'C_c$	$I_C = 10$ mA, $V_{CB} = 10$ V f = 4 MHz		800	psec

* Pulse Test: Pulse Width = 300 μsec; Duty Cycle ≤ 1%.

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JANUARY 1968

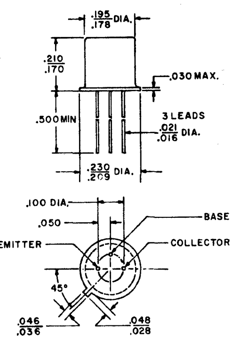
NPN TRANSISTOR
MEDIUM POWER

- LOW NOISE
- LOW SATURATION VOLTAGE
- HIGH COLLECTOR CURRENT

2N5079
2N5080

MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	60	Volts
Collector-Emitter Voltage	V_{CEO}	5	Volts
Emitter-Base Voltage	V_{EBO}	30	Volts
Collector Current	I_C	1.0	Amp
Base Current	I_B	200	mA
Total Device Dissipation @ $T_A = 25°C$	P_D	1.8	Watts
Derating Factor above 25°C @ $T_A = 25°C$		10.3	mW/°C
Storage Temperature	T_{stg}	−65 to +200	°C
Junction Temperature	T_J	200	°C
Lead Temperature, 1/16 inch from case, 10 seconds max.		300	°C



COLLECTOR IS INTERNALLY CONNECTED TO CASE

ELECTRICAL CHARACTERISTICS at +25°C (Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Collector-Base Breakdown Voltage	BV_{CBO}	$I_C = 10\ \mu A$, $I_E = 0$	60		Volts
Collector-Emitter Breakdown Voltage	BV_{CEO}*	$I_C = 10$ mA, $I_B = 0$	30		Volts
Emitter-Base Breakdown Voltage	BV_{EBO}	$I_C = 0$, $I_E = 10\ \mu A$	5.0		Volts
Base Saturation Voltage	$V_{BE(sat)}$*	$I_C = 150$ mA, $I_B = 15$ mA $I_C = 500$ mA, $I_B = 50$ mA $I_C = 1.0$ A, $I_B = 100$ mA		1.0 1.3 1.6	Volts
Collector Saturation Voltage	$V_{CE(sat)}$*	$I_C = 150$ mA, $I_B = 15$ mA $I_C = 500$ mA, $I_B = 50$ mA $I_C = 1.0$ A, $I_B = 100$ mA		0.2 0.5 1.0	Volts
Collector-Base Cutoff Current	I_{CBO}	$V_{CB} = 50$ V, $I_E = 0$ $V_{CB} = 50$ V, $I_E = 0$, $T_A = 150°C$		10 10	nA μA
Emitter-Base Cutoff Current	I_{EBO}	$V_{EB} = 3.0$ V, $I_C = 0$		10	nA
DC Current Gain	h_{FE}*				
2N5079 2N5080		$V_{CE} = 10$ V, $I_C = 0.1$ mA	35 50		
2N5079 2N5080		$V_{CE} = 10$ V, $I_C = 1.0$ mA	50 90		
2N5079 2N5080		$V_{CE} = 10$ V, $I_C = 10$ mA	75 150		
2N5079 2N5080		$V_{CE} = 10$ V, $I_C = 150$ mA	100 200	300 500	
2N5079 2N5080		$V_{CE} = 10$ V, $I_C = 500$ mA	50 90		
2N5079 2N5080		$V_{CE} = 10$ V, $I_C = 1.0$ A	15 25		
High Frequency Current Gain	$\|h_{fe}\|$	$V_{CE} = 20$ V, $I_C = 50$ mA f = 100 MHz	4		
Output Capacitance	C_{ob}	$V_{CB} = 10$ V, $I_E = 0$ f = 1.0 MHz		7	pf
Input Capacitance	C_{ib}	$V_{EB} = 0.5$ V, $I_C = 0$ f = 1.0 MHz		30	pf
Noise Figure	NF	$V_{CE} = 5.0$ V, $I_C = 200\ \mu A$, $R_S = 510\Omega$ f = 1.0 kHz, BW = 200 Hz		4.0	db

* Pulse Test: Pulse Width = 300 μsec; Duty Cycle = 1%.

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JANUARY 1968

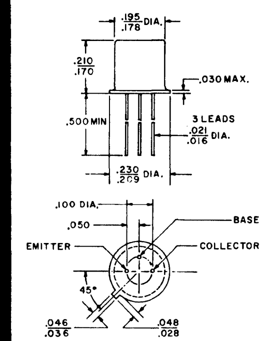
NPN TRANSISTOR
RF/IF AMPLIFIER

- HIGH FREQUENCY
- HIGH VOLTAGE
- HIGH CURRENT GAIN

2N915
2N915A

MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	70	Volts
Collector-Emitter Voltage	V_{CEO}	50	Volts
Emitter-Base Voltage	V_{EBO}	5	Volts
Collector Current	I_C	Limited by Dissipation only	
Total Device Dissipation @ $T_A = 25°C$ @ $T_C = 25°C$ @ $T_C = 100°C$	P_D	 0.36 1.2 0.68	Watts
Derating Factor above 25°C @ $T_A = 25°C$ @ $T_C = 25°C$		 2.1 6.85	mW/°C
Storage Temperature	T_{stg}	−65 to +200	°C
Junction Temperature	T_J	+200	°C



COLLECTOR IS INTERNALLY CONNECTED TO CASE

ELECTRICAL CHARACTERISTICS at +25°C (Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Collector-Base Breakdown Voltage 2N915 2N915A	BV_{CBO}	 $I_C = 100\ \mu A$, $I_E = 0$ $I_C = 10\ \mu A$, $I_E = 0$	 70 70		 Volts Volts
Emitter-Base Breakdown Voltage	BV_{EBO}	$I_E = 10\ \mu A$, $I_C = 0$	5		Volts
Collector-Emitter Sustaining Voltage	$V_{CEO(sus)}$*	$I_C = 10$ mA, $I_B = 0$	50		Volts
Base Saturation Voltage	$V_{BE(sat)}$	$I_C = 10$ mA, $I_B = 1$ mA		0.9	Volts
Collector Saturation Voltage 2N915 2N915A	$V_{CE(sat)}$	 $I_C = 10$ mA, $I_B = 1$ mA		 1.0 0.2	 Volts
Collector-Base Cutoff Current 2N915 2N915A 2N915 2N915A	I_{CBO}	 $V_{CB} = 60$ V, $I_E = 0$ $V_{CB} = 60$ V, $I_E = 0$, $T_A = 150°C$		 10 2 30 3	 nA μA
DC Pulse Current Gain	h_{FE}*	$I_C = 10$ mA, $V_{CE} = 5$ V	50	200	
DC Pulse Current Gain 2N915A Both Types Both Types Both Types Both Types	h_{FE}*	 $I_C = 10\ \mu A$, $V_{CE} = 5$ V $I_C = 100\ \mu A$, $V_{CE} = 5$ V $I_C = 1.0$ mA, $V_{CE} = 5$ V $I_C = 10$ mA, $V_{CE} = 1$ V $I_C = 100$ mA, $V_{CE} = 1$ V	 50 50 50 50 15	 200 200 200 200	
Emitter-Base Cutoff Current 2N915A	I_{EBO}	 $V_{EB} = 3$ V, $I_C = 0$		 2	 nA
High Frequency Current Gain 2N915 2N915A	$\vert h_{fe} \vert$	 $V_{CE} = 15$ V, $I_C = 10$ mA f = 100 MHz	 2.5 6.0		
Small Signal Current Gain 2N915 2N915A	h_{fe}	 $V_{CE} = 5$ V, $I_C = 1$ mA f = 1 kHz	 40 50	 200 200	
Small Signal Current Gain	h_{fe}	$V_{CE} = 5$ V, $I_C = 5$ mA f = 1 kHz	50	250	

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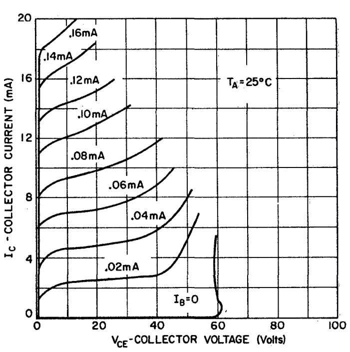
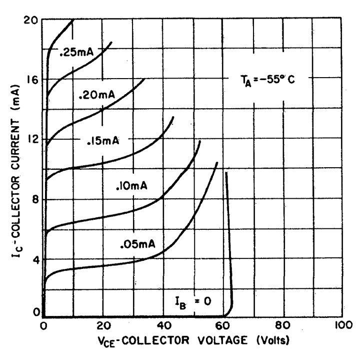
CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Output Capacitance 2N915 2N915A	C_{ob}	$V_{CB} = 10$ V, $I_E = 0$		3.5 3.0	pf pf
Input Capacitance 2N915 2N915A	C_{ib}	$V_{EB} = 0.5$ V, $I_C = 0$		10 5	pf pf
Input Resistance	h_{ie}	$V_{CE} = 5$ V, $I_C = 5$ mA f = 1 kHz $V_{CE} = 5$ V, $I_C = 1$ mA f = 1 kHz		2000 6000	ohms ohms
Output Conductance	h_{oe}	$V_{CE} = 5$ V, $I_C = 5$ mA f = 1 kHz $V_{CE} = 5$ V, $I_C = 1$ mA f = 1 kHz		75 125	μmhos μmhos
Collector-Base Time Constant	$r_b'C_c$	$V_{CB} = 10$ V, $I_C = 10$ mA f = 40 MHz		300	psec
Noise Figure 2N915A	NF	$V_{CE} = 5$ V, $I_C = 10\ \mu$A f = 1 kHz $R_S = 10$ kΩ BW = 200 Hz		4	db

* Pulse Test: Pulse Width = 300 μsec; Duty Cycle = 1%.

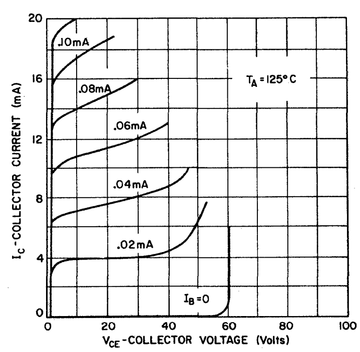
Collector Characteristics



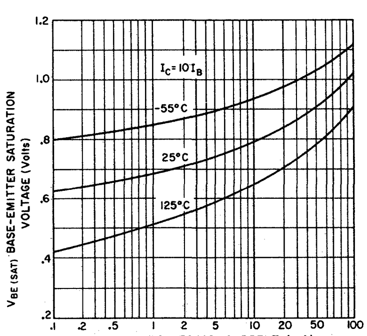
Collector Characteristics



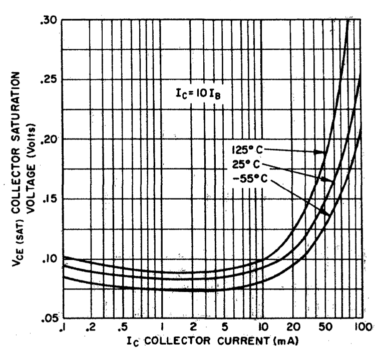
Collector Characteristics



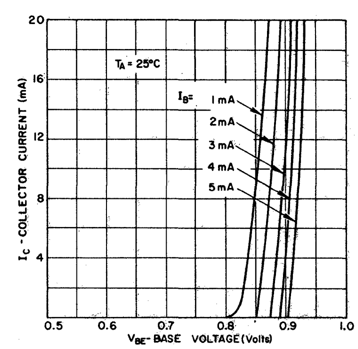
Base-Emitter Saturation Voltage
vs
Collector Current



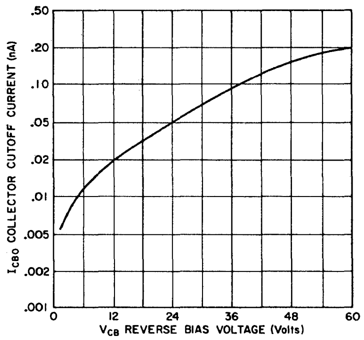
Collector Saturation Voltage
vs
Collector Current



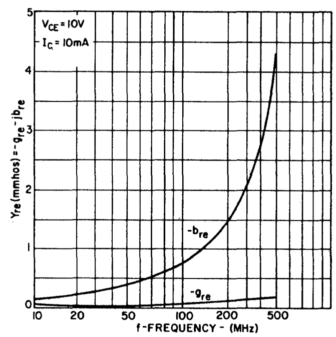
Typical Base Characteristics



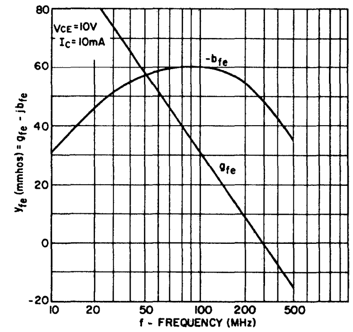
Collector Bias Reverse Current
vs
Reverse Bias Voltage



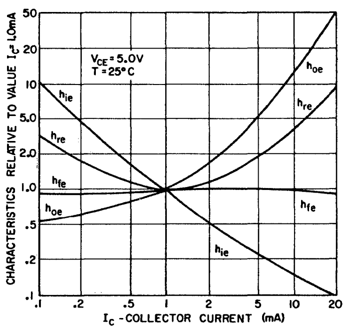
Reverse Transfer Admittance
vs
Frequency — Input Short Circuit



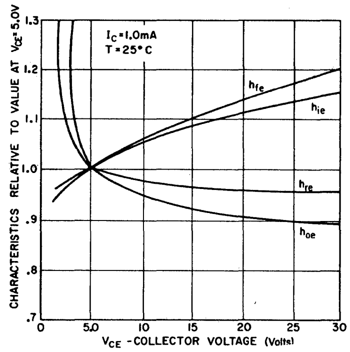
Forward Transfer Admittance
vs
Frequency — Output Short Circuit



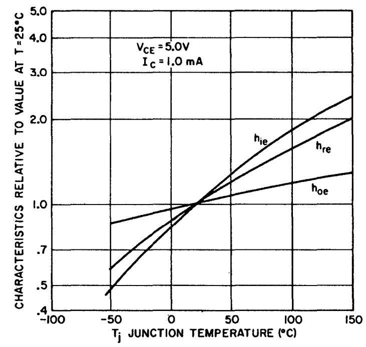
Typical Common Emitter Characteristics



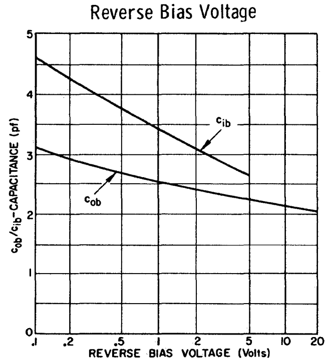
Typical Common Emitter Characteristics



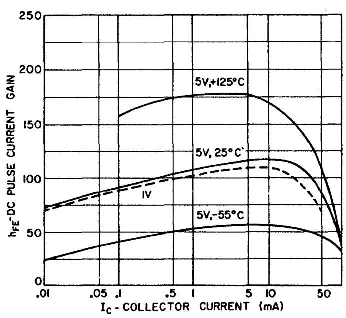
Typical Common Emitter Characteristics



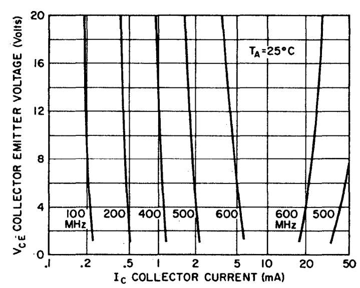
Output and Input Capacitance
vs
Reverse Bias Voltage



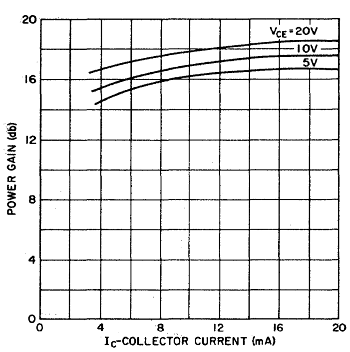
DC Pulse Current Gain
vs
Collector Current



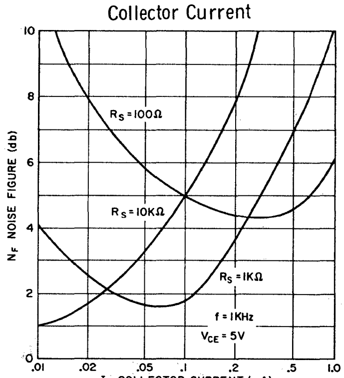
Contours of Constant Gain
Bandwidth Product — f_T



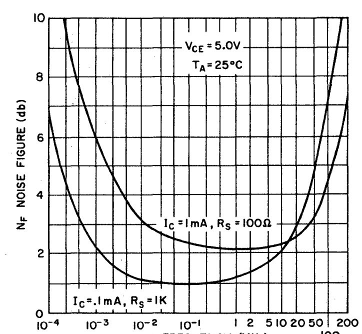
Neutralized 200 MHz Power Gain vs I_C



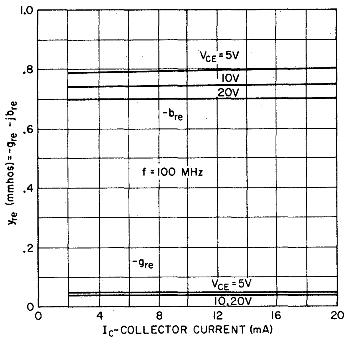
Noise Figure
vs
Collector Current



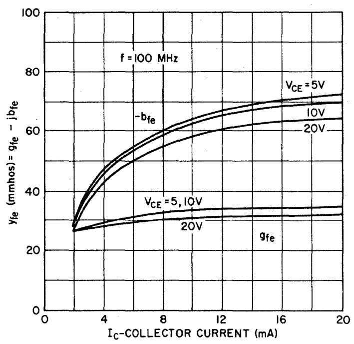
Noise Figure
vs
Frequency



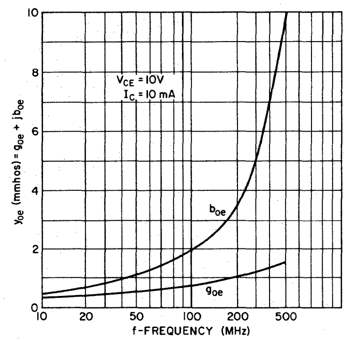
Reverse Transfer Admittance
vs
Collector Current and
Voltage-Input Short Circuit



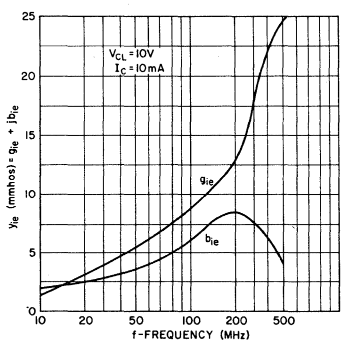
Forward Transfer Admittance
vs
Collector Current and
Voltage-Output Short Circuit



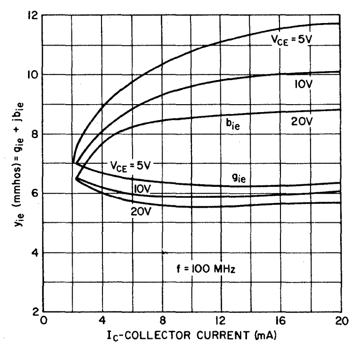
Output Admittance
vs
Frequency – Input Short Circuit



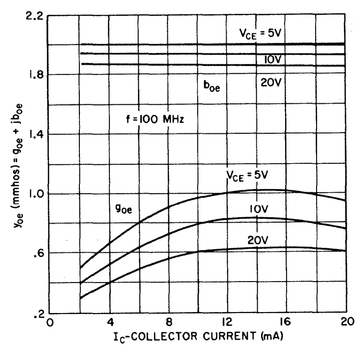
Input Admittance
vs
Frequency – Output Short Circuit



Input Admittance
vs
Collector Current and
Voltage-Output Short Circuit



Output Admittance
vs
Collector Current and
Voltage-Output Short Circuit



JANUARY 1968

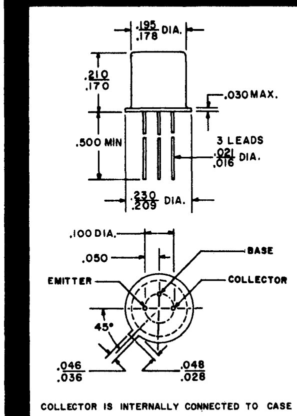
NPN TRANSISTOR
RF/IF AMPLIFIER

- HIGH FREQUENCY
- HIGH VOLTAGE
- HIGH CURRENT GAIN

2N916
2N916A

MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING		UNIT
		2N916, 2N916A	2N916B	
Collector-Base Voltage	V_{CBO}	45	60	Volts
Collector-Emitter Voltage	V_{CEO}	25	30	Volts
Emitter-Base Voltage	V_{EBO}	5	5	Volts
Collector Current	I_C	Limited by Dissipation Only		
Total Device Dissipation @ $T_A = 25°C$ @ $T_C = 25°C$ @ $T_C = 100°C$	P_D	 0.36 1.2 0.68		Watts
Derating Factor above 25°C @ $T_A = 25°C$ @ $T_C = 25°C$		 2.1 6.85		mW/°C
Storage Temperature	T_{stg}	−65 to +200		°C
Junction Temperature	T_J	+200		°C



ELECTRICAL CHARACTERISTICS at +25°C (Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Collector-Base Breakdown Voltage 2N916, 2N916A 2N916B	BV_{CBO}	 $I_C = 10\ \mu A, I_E = 0$ $I_C = 10\ \mu A, I_E = 0$	 45 60		 Volts Volts
Emitter-Base Breakdown Voltage	BV_{EBO}	$I_E = 10\ \mu A, I_C = 0$	5		Volts
Collector-Emitter Sustaining Voltage 2N916, 2N916A 2N916B	$V_{CEO(sus)}$*	$I_C = 10$ mA, $I_B = 0$	 25 30		 Volts Volts
Collector Saturation Voltage 2N916, 2N916A 2N916B	$V_{CE(sat)}$	$I_C = 10$ mA, $I_B = 1$ mA		 0.5 0.2	 Volts Volts
Collector Saturation Voltage 2N916A 2N916B	$V_{CE(sat)}$	$I_C = 100$ mA, $I_B = 10$ mA		 1.0 0.5	 Volts Volts
Base Saturation Voltage	$V_{BE(sat)}$	$I_C = 10$ mA, $I_B = 1$ mA		0.9	Volts
Base Saturation Voltage 2N916A 2N916B	$V_{BE(sat)}$	$I_C = 100$ mA, $I_B = 10$ mA		 1.3 1.2	Volts
Collector-Base Cutoff Current 2N916, 2N916A 2N916B 2N916, 2N916A 2N916B	I_{CBO}	 $V_{CB} = 30$ V, $I_E = 0$ $V_{CB} = 45$ V, $I_E = 0$ $V_{CB} = 30$ V, $I_E = 0$, $T_A = 150°C$ $V_{CB} = 45$ V, $I_E = 0$, $T_A = 150°C$		 10 2 10 3	 nA μA
Emitter-Base Cutoff Current 2N916B	I_{EBO}	$V_{EB} = 3$ V, $I_C = 0$		2	nA
DC Pulse Current Gain	h_{FE}*	$I_C = 10$ mA, $V_{CE} = 5$ V	50	200	
DC Pulse Current Gain 2N916A, 2N916B	h_{FE}*	$I_C = 100$ mA, $V_{CE} = 1$ V	15		

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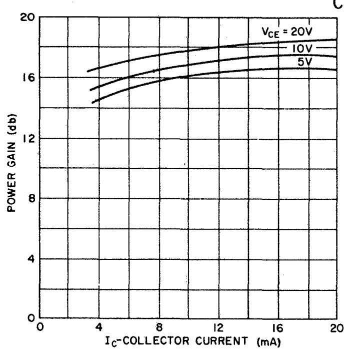
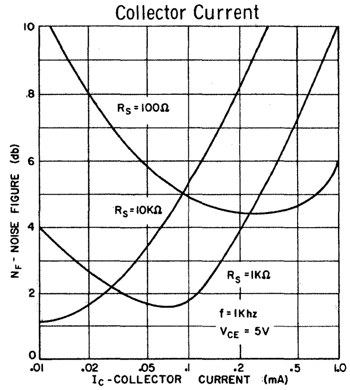
CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
DC Pulse Current Gain	h_{FE}*				
2N916B		$I_C = 10\ \mu A$, $V_{CE} = 5\ V$	50	200	
All Types		$I_C = 100\ \mu A$, $V_{CE} = 5\ V$	50	200	
All Types		$I_C = 1.0\ mA$, $V_{CE} = 5\ V$	50	200	
All Types		$I_C = 10\ mA$, $V_{CE} = 1\ V$	50	200	
High Frequency Current Gain	$\lvert h_{fe} \rvert$				
2N916, 2N916A		$I_C = 10\ mA$, $V_{CE} = 15\ V$	3.0		
2N916B		f = 100 MHz	5.0		
Small Signal Current Gain	h_{fe}	$I_C = 5\ mA$, $V_{CE} = 5\ V$ f =1 kHz	50	250	
Small Signal Current Gain	h_{fe}				
2N916, 2N916A		$I_C = 1\ mA$, $V_{CE} = 5\ V$	40	200	
2N916B		f =1 kHz	50	200	
Output Capacitance	C_{ob}				
2N916, 2N916A		$V_{CB} = 5\ V$, $I_E = 0$		6	pf
2N916B				3	pf
Input Capacitance	C_{ib}				
2N916, 2N916A		$V_{EB} = 0.5\ V$, $I_C = 0$		10	pf
2N916B				5	pf
Input Resistance	h_{ie}	$I_C = 5\ mA$, $V_{CE} = 5\ V$ f =1 kHz		2000	ohms
		$I_C = 1\ mA$, $V_{CE} = 5\ V$ f =1 kHz		6000	ohms
Output Conductance	h_{oe}	$I_C = 1\ mA$, $V_{CE} = 5\ V$ f =1 kHz		75	μmhos
		$I_C = 5\ mA$, $V_{CE} = 5\ V$ f =1 kHz		125	μmhos
Collector-Base Time Constant	$r_b'C_c$	$I_C = 10\ mA$, $V_{CB} = 10\ V$ f = 40 MHz		300	psec
Noise Figure	NF				
2N916B		$I_C = 10\ \mu A$, $V_{CE} = 5\ V$ f =1 kHz $R_S = 10\ K$ BW = 200 Hz		4.0	db

* Pulse Test: Pulse Width = 300 μsec; Duty Cycle = 1%.

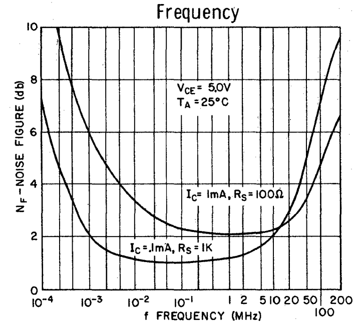
Neutralized 200 MHz Power Gain vs I_C



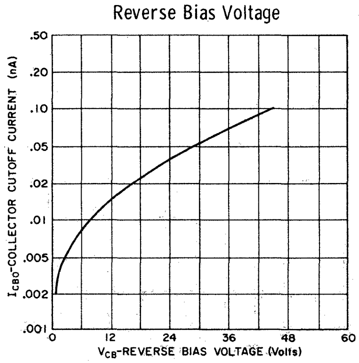
Noise Figure vs Collector Current



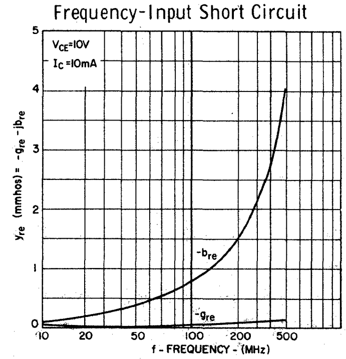
Noise Figure vs Frequency



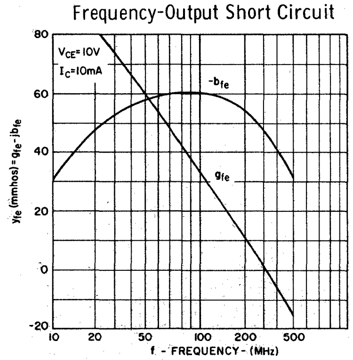
Collector Bias Reverse Current vs Reverse Bias Voltage



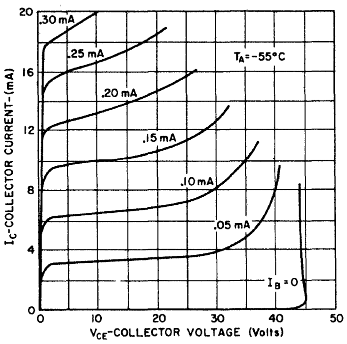
Reverse Transfer Admittance vs Frequency-Input Short Circuit



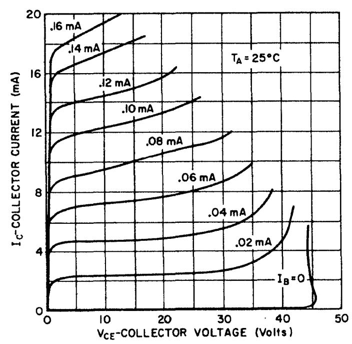
Forward Transfer Admittance vs Frequency-Output Short Circuit



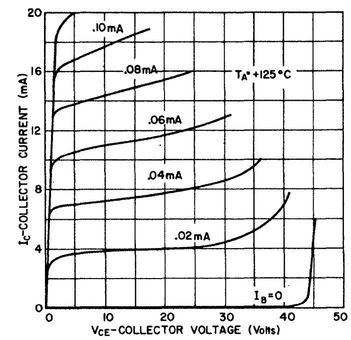
Collector Characteristics



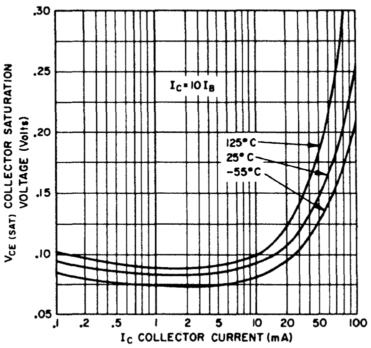
Collector Characteristics



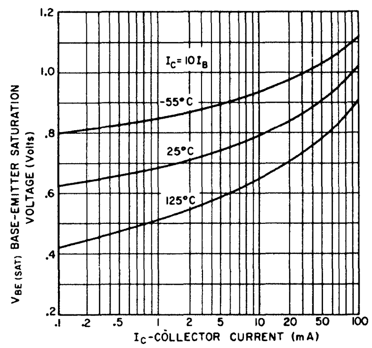
Collector Characteristics



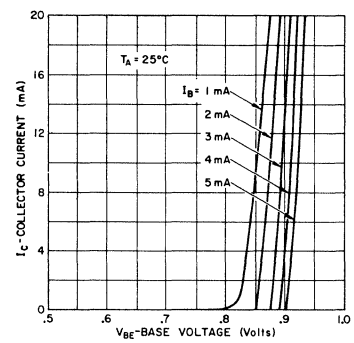
Collector Saturation Voltage
vs
Collector Current



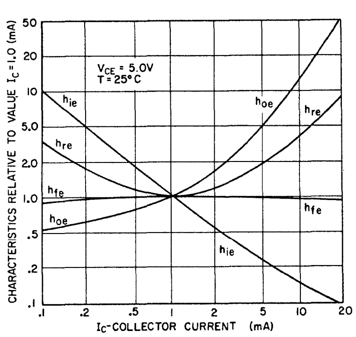
Base-Emitter Saturation Voltage
vs
Collector Current



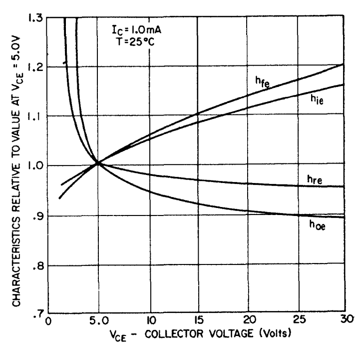
Typical Base Characteristics



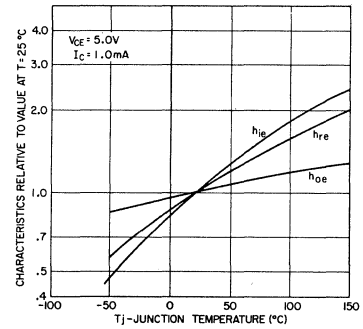
Typical Common Emitter Characteristics



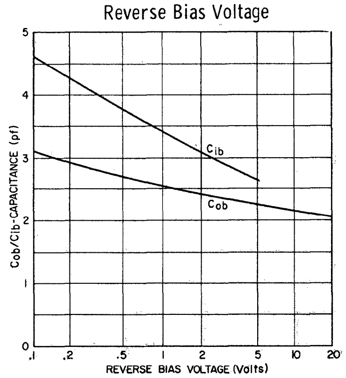
Typical Common Emitter Characteristics



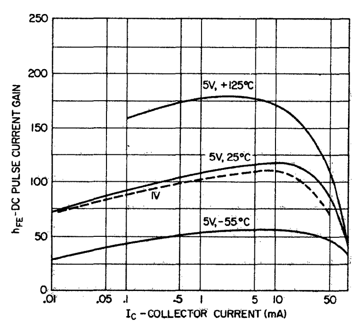
Typical Common Emitter
Characteristics



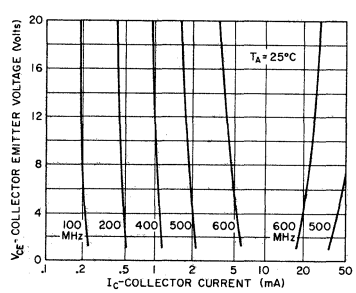
Output and Input Capacitance
vs
Reverse Bias Voltage



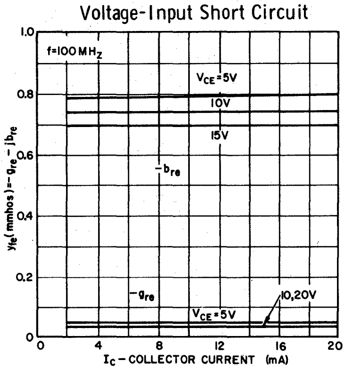
DC Pulse Current Gain
vs
Collector Current



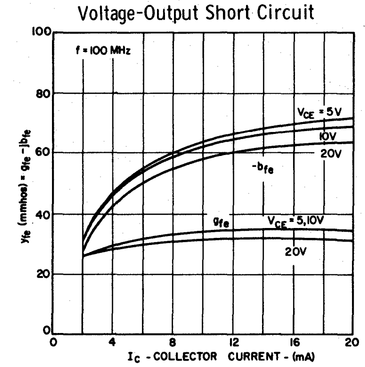
Contours of Constant Gain
Bandwidth Product – f_T



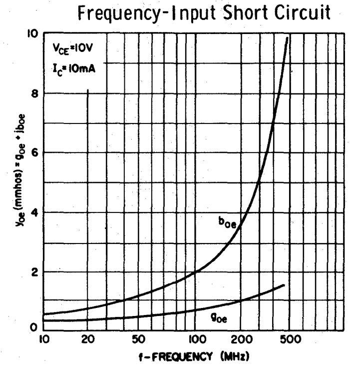
Reverse Transfer Admittance vs Collector Current and Voltage-Input Short Circuit



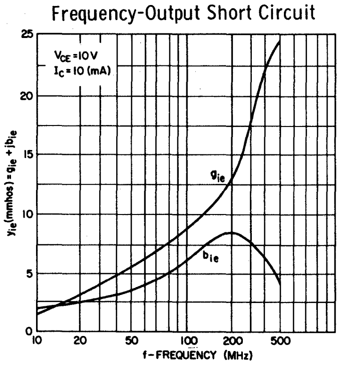
Forward Transfer Admittance vs Collector Current and Voltage-Output Short Circuit



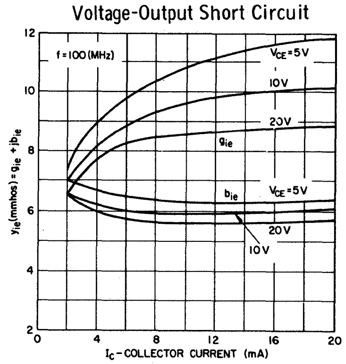
Output Admittance vs Frequency-Input Short Circuit



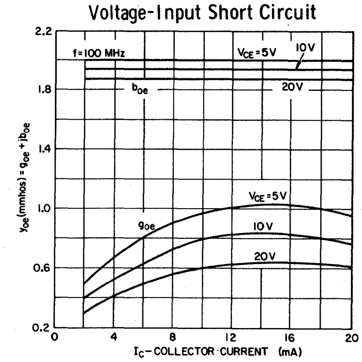
Input Admittance vs Frequency-Output Short Circuit



Input Admittance vs Collector Current and Voltage-Output Short Circuit



Output Admittance vs Collector Current and Voltage-Input Short Circuit



NPN TRANSISTOR
RF/IF AMPLIFIER

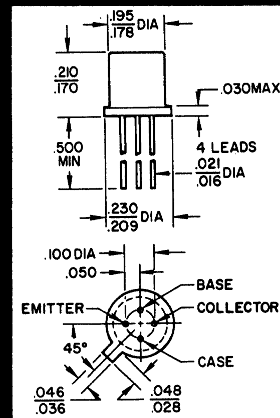
- HIGH FREQUENCY
- LOW SATURATION VOLTAGE
- LOW CAPACITANCE

JANUARY 1968

2N918

MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	30	Volts
Collector-Emitter Voltage	V_{CEO}	15	Volts
Emitter-Base Voltage	V_{EBO}	3.0	Volts
Collector Current	I_C	50	mA
Total Dissipation @ $T_A = 25°C$ @ $T_C = 25°C$	P_D	 0.2 0.3	 Watt
Derating Factor above 25°C @ $T_A = 25°C$		 2.0	 mW/°C
Storage Temperature	T_{stg}	−65 to +300	°C
Junction Temperature	T_J	+200	°C



ELECTRICAL CHARACTERISTICS at +25°C (Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Collector-Base Breakdown Voltage	BV_{CBO}	$I_C = 1.0\ \mu A$, $I_E = 0$	30		Volts
Collector-Emitter Sustaining Voltage	$V_{CEO(sus)}$*	$I_C = 3$ mA, $I_B = 0$	15		Volts
Emitter-Base Breakdown Voltage	BV_{EBO}	$I_C = 10\ \mu A$, $I_C = 0$	3		Volts
Collector Saturation Voltage	$V_{CE(sat)}$	$I_C = 10$ mA, $I_B = 1.0$ mA		0.4	Volt
Base Saturation Voltage	$V_{BE(sat)}$	$I_C = 10$ mA, $I_B = 1.0$ mA		1.0	Volt
Collector-Base Cutoff Current	I_{CBO}	$V_{CB} = 15$ V, $I_E = 0$ $V_{CB} = 15$ V, $T_A = 150°C$, $I_E = 0$		10 1.0	nA μA
DC Current Gain	h_{FE}	$V_{CE} = 1.0$ V, $I_C = 3.0$ mA	20		
High Frequency Current Gain	$\|h_{fe}\|$	$I_C = 4.0$ mA $V_{CE} = 10$ V f = 100 MHz	6.0		
Output Capacitance	C_{ob}	$V_{CB} = 10$ V $I_E = 0$, f = 140 kHz $V_{CB} = 0$, f = 140 kHz $I_E = 0$		1.7 3.0	pf
Input Capacitance	C_{ib}	$V_{EB} = 0.5$ V $I_C = 0$, f = 140 kHz		2.0	pf
Collector Efficiency	η	$V_{CB} = 15$ V f = 500 MHz $I_C = 8.0$ mA	25		%
Available Power Gain	A_p	$I_C = 6.0$ mA $V_{CB} = 12$ V f = 200 MHz (Figure 1)	15		db
Power Output	P_o	$I_C = 8.0$ mA $V_{CB} = 15$ V f = 500 MHz (Figure 2)	30		mW
Noise Figure	NF	$I_C = 1.0$ mA $V_{CE} = 6.0$ V f = 60 MHz $R_G = 400\ \Omega$		6	db

* Pulse Test: Pulse Width = 300 μsec; Duty Cycle = 1%.

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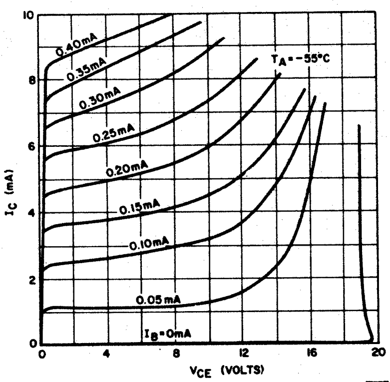
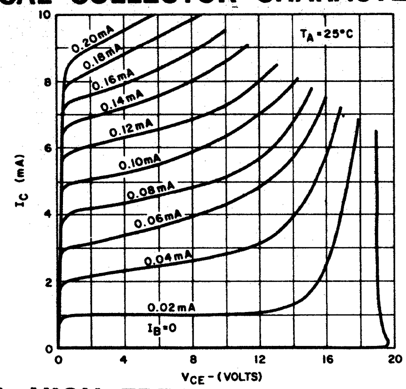
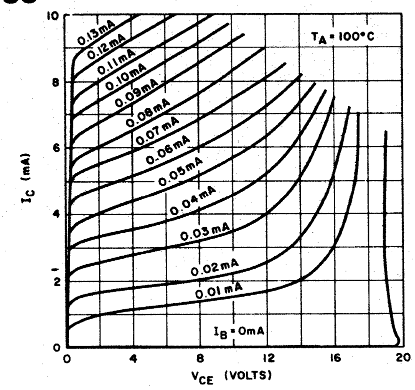
TYPICAL COLLECTOR CHARACTERISTICS

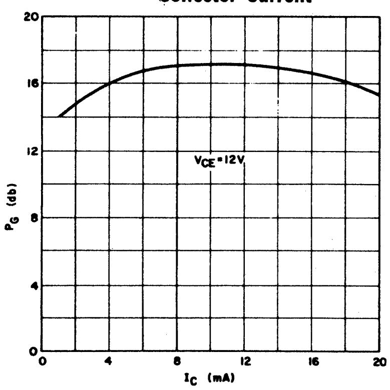






TYPICAL HIGH FREQUENCY CHARACTERISTICS

200 MHz Power Gain vs Collector Current



Neutralized 200 MHz Power Gain Amplifier Test Circuit

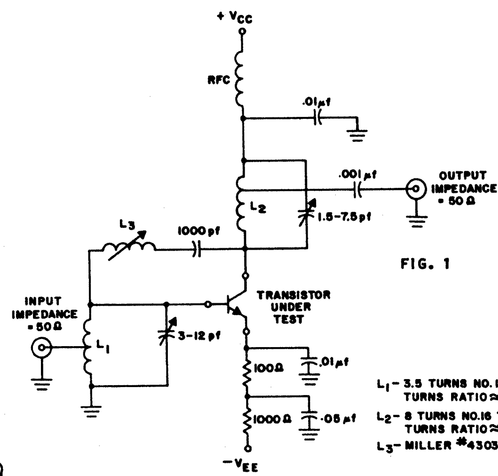


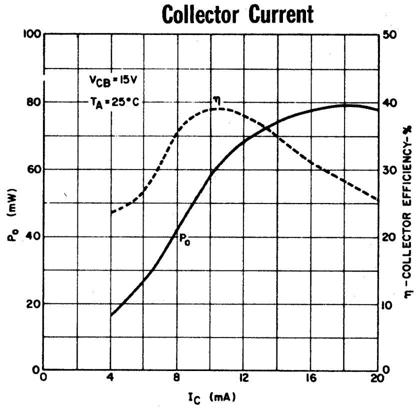
FIG. 1

L_1 – 3.5 TURNS NO. 16 TINNED COPPER WIRE; $\frac{5}{16}$ DIA; $\frac{7}{16}$ LONG. TURNS RATIO ≈ 4 TO 2

L_2 – 8 TURNS NO. 16 TINNED COPPER WIRE; $\frac{1}{8}$ DIA; $\frac{7}{8}$ LONG TURNS RATIO ≈ 8 TO 1

L_3 – MILLER #4303 (.4–.65µh)

500 MHz Power Output and Collector Efficiency vs Collector Current



500 MHz Oscillator Test Circuit

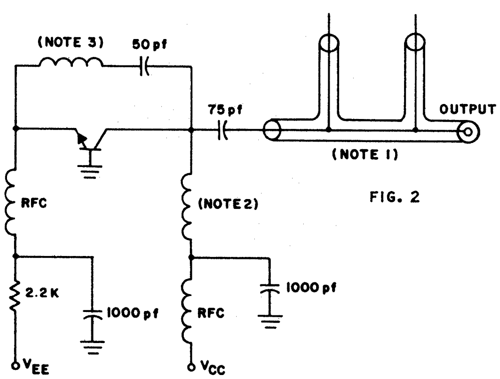


FIG. 2

NOTES:

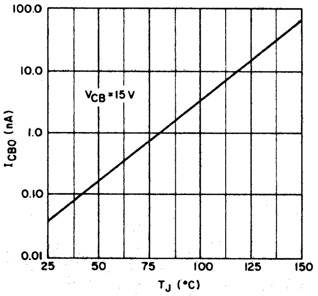
(1) COAX PLUMBING CONSIST OF THE FOLLOWING GR AIR LINES:
- 2 TYPE 874 TEE
- 1 TYPE 874-D20 ADJUSTABLE STUB
- 1 TYPE 874-LA ADJUSTABLE STUB
- 1 TYPE 874-WN3 SHORT-CIRCUIT TERMINATION

(2) 2 TURNS #16 AWG WIRE, 3/8 INCH OD, 1 1/4 INCH LONG

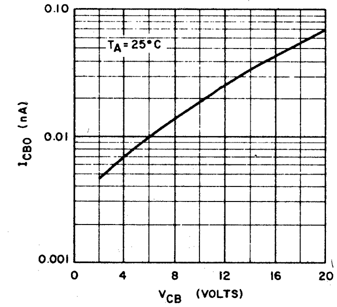
(3) 9 TURNS #22 AWG WIRE, 3/16 INCH OD, 1/2 INCH LONG

TYPICAL ELECTRICAL CHARACTERISTICS

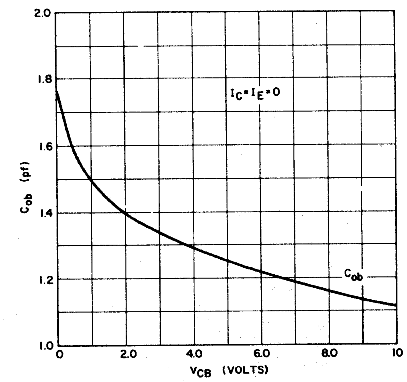
Collector-Base Diode Reverse Current vs Temperature



Collector-Base Diode Reverse Current vs Voltage

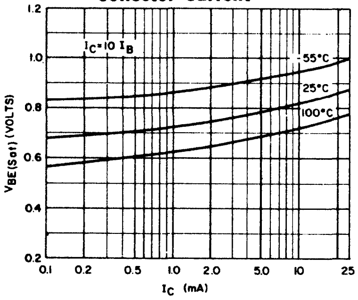


Output Capacitance vs Reverse Bias Voltage

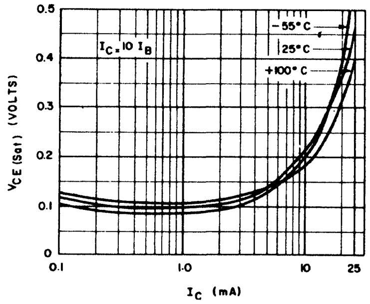


TYPICAL ELECTRICAL CHARACTERISTICS

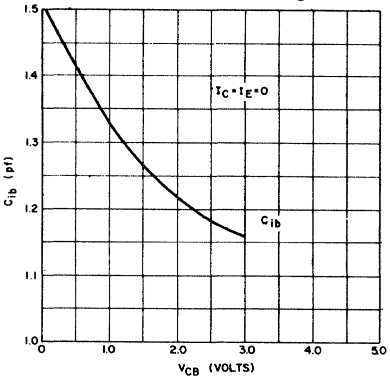
Base Saturation Voltage vs Collector Current



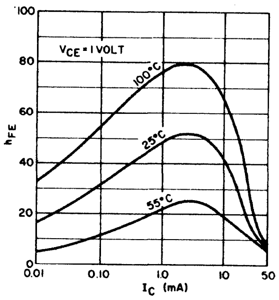
Collector Saturation Voltage vs Collector Current



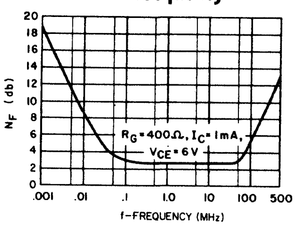
Input Capacitance vs Reverse Bias Voltage



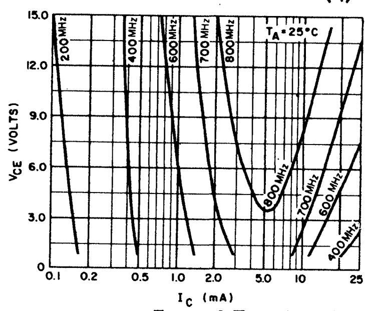
Pulsed DC Current Gain vs Collector Current



Noise Figure vs Frequency

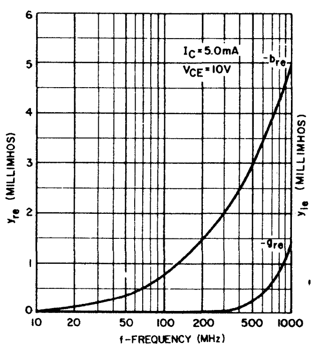


Contours of Constant Gain Bandwidth Product (f_T)

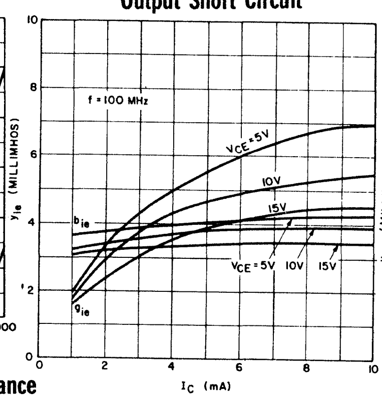


TYPICAL SMALL SIGNAL PARAMETERS

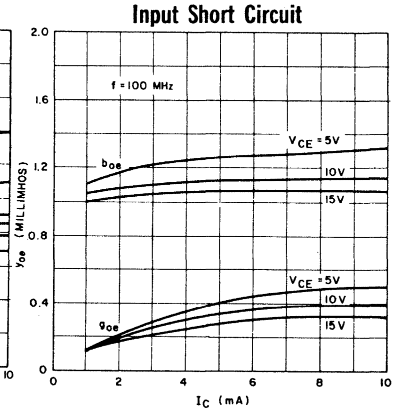
Reverse Transfer Admittance vs Frequency — Input Short Circuit



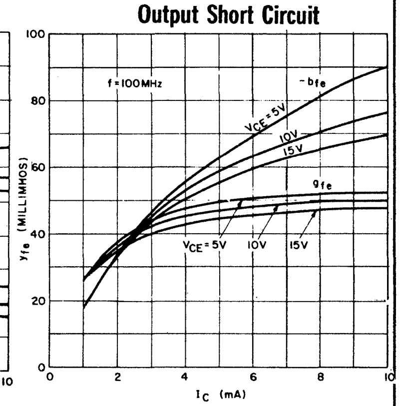
Input Admittance vs Collector Current — Output Short Circuit



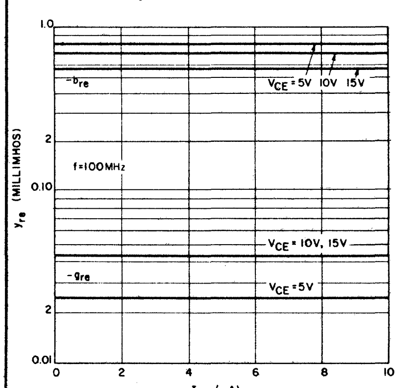
Output Admittance vs Collector Current — Input Short Circuit



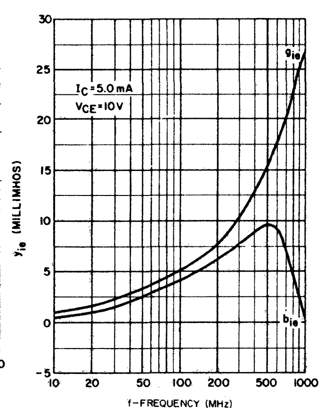
Forward Transfer Admittance vs Collector Current — Output Short Circuit



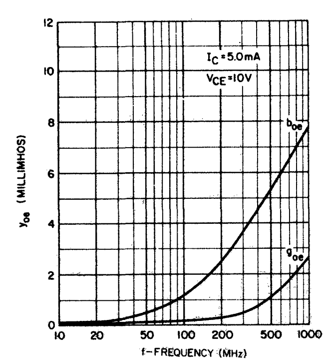
Reverse Transfer Admittance vs Collector Current — Input Short Circuit



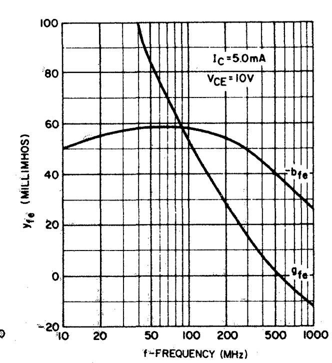
Input Admittance vs Frequency — Output Short Circuit



Output Admittance vs Frequency — Input Short Circuit



Forward Transfer Admittance vs Frequency — Output Short Circuit



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NPN TRANSISTOR
RF/IF AMPLIFIER

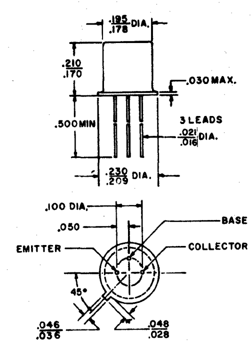
- HIGH FREQUENCY
- LOW SATURATION VOLTAGE
- FAST SWITCHING SPEEDS

JANUARY 1968

2N2369A

MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	40	Volts
Collector-Emitter Voltage	V_{CES}	40	Volts
Collector-Emitter Voltage	V_{CEO}	15	Volts
Emitter-Base Voltage	V_{EBO}	4.5	Volts
Collector Current	I_C	200	mA
Total Device Dissipation @ $T_A = 25°C$ @ $T_C = 25°C$ @ $T_C = 100°C$	P_D	 0.36 1.2 0.68	 Watt
Derating Factor Above 25°C @ $T_A = 25°C$ @ $T_C = 25°C$		 2.1 6.85	 mW/°C
Storage Temperature	T_{stg}	−65 to +200	°C
Junction Temperature	T_J	+200	°C



ELECTRICAL CHARACTERISTICS at +25°C (Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Collector-Base Breakdown Voltage	BV_{CBO}	$I_C = 10\ \mu A, I_B = 0$	40		Volts
Collector-Emitter Sustaining Voltage	$V_{CEO(sus)}$*	$I_C = 10\ mA, I_B = 0$	15		Volts
Collector-Emitter Voltage	BV_{CES}	$I_C = 10\ \mu A, I_B = 0$	40		Volts
Emitter-Base Breakdown Voltage	BV_{EBO}	$I_E = 10\ \mu A, I_C = 0$	4.5		Volts
Base Current	I_B	$V_{CE} = 20\ V, V_{BE} = 0$		−0.4	μA
Collector-Emitter Cutoff Current	I_{CES}	$V_{CE} = 20\ V, V_{BE} = 0$		0.4	μA
Collector Saturation Voltage	$V_{CE(sat)}$	$I_C = 10\ mA, I_B = 1\ mA$ $I_C = 30\ mA, I_B = 3\ mA$ $I_C = 100\ mA, I_B = 10\ mA$ $I_C = 10\ mA, I_B = 1\ mA$ $T_A = 125°C$		0.2 0.25 0.5 0.3	Volts
Base Saturation Voltage	$V_{BE(sat)}$	$I_C = 10\ mA, I_B = 1\ mA$ $I_C = 30\ mA, I_B = 3\ mA$ $I_C = 100\ mA, I_B = 10\ mA$ $I_C = 10\ mA, I_B = 1\ mA$ $T_A = 125°C$ $I_C = 10\ mA, I_B = 1\ mA$ $T_A = -55°C$	0.7 0.59	0.85 1.15 1.6 1.02	Volts
Collector-Base Cutoff Current	I_{CBO}	$V_{CB} = 20\ V, I_E = 0$ $V_{CB} = 20\ V, T_A = 150°C$		0.4 30	μA
DC Pulse Current Gain	h_{FE}*	$I_C = 10\ mA, V_{CE} = 0.35\ V$ $I_C = 10\ mA, V_{CE} = 0.35\ V, T_A = -55°C$ $I_C = 100\ mA, V_{CE} = 1.0\ V$ $I_C = 30mA, V_{CE} = 0.4\ V$	40 20 20 20	 120	
High Frequency Current Gain	$\|h_{fe}\|$	$I_C = 10\ mA, V_{CE} = 10\ V, f = 100\ MHz$	5		
Output Capacitance	C_{ob}	$V_{CB} = 5\ V, I_E = 0, f = 140\ kHz$		4	pf
Storage Time	$t_s(\tau_s)$	$I_C = I_{B1} = I_{B2} = 10\ mA$ (See Figure 1)		13	nsec
Turn-On Time	t_{on}	$I_C = 10\ mA, I_{B1} = 3\ mA, V_{CC} = 3\ V,$ $V_{OB} = 1.5\ V$ (See Figure 2)		12	nsec
Turn-Off Time	t_{off}	$I_C = 10\ mA, I_{B1} = 3\ mA, I_{B2} = 1.5\ mA,$ $V_{CC} = 3\ V$ (See Figure 2)		18	nsec

* Pulse Test: Pulse Width = 300 μsec, Duty Cycle = 2%

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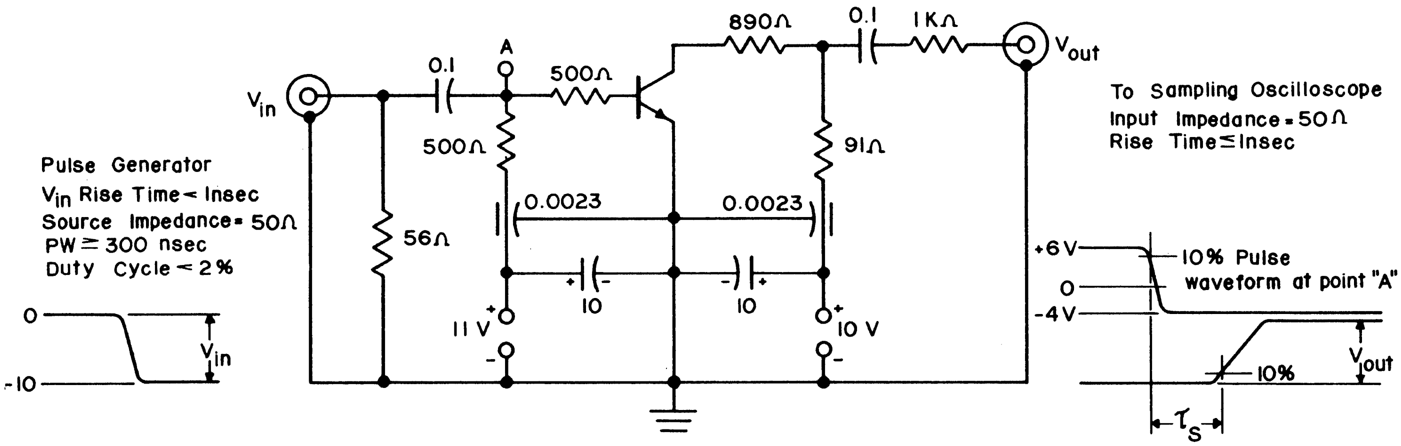


FIGURE 1

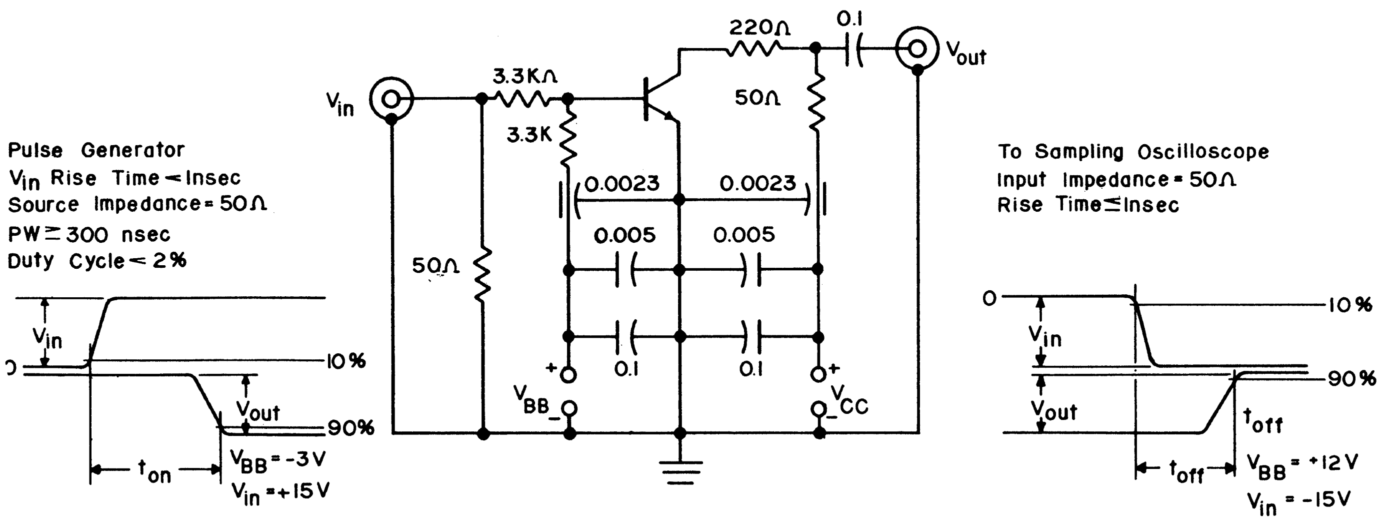


FIGURE 2

JANUARY 1968

NPN TRANSISTOR
RF/IF AMPLIFIER

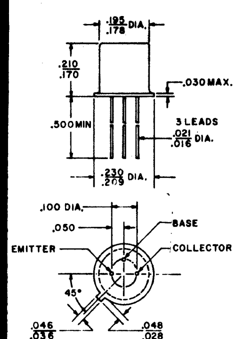
- HIGH FREQUENCY
- LOW LEAKAGE
- HIGH POWER GAIN

2N2616
2N2729

MAXIMUM RATINGS

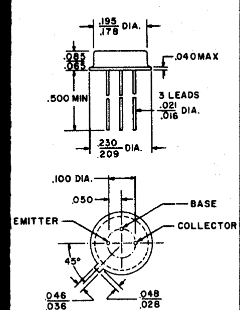
CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	30	Volts
Collector-Emitter Voltage	V_{CEO}	15	Volts
Emitter-Base Voltage	V_{EBO}	3.0	Volts
Collector Current	I_C	50	mA
Total Device Dissipation @ $T_A = 25°C$ @ $T_C = 25°C$	P_D	 0.3 0.8	Watts
Derating Factor above 25°C @ $T_A = 25°C$ @ $T_C = 25°C$		 2.1 4.56	mW/°C
Storage Temperature	T_{stg}	−65 to +300	°C
Junction Temperature	T_J	+200	°C

2N2616



COLLECTOR IS INTERNALLY CONNECTED TO CASE!

2N2729



COLLECTOR IS INTERNALLY CONNECTED TO CASE

ELECTRICAL CHARACTERISTICS at +25°C (Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Collector-Base Breakdown Voltage	BV_{CBO}	$I_C = 1.0\ \mu A$, $I_E = 0$	30		Volts
Emitter-Base Breakdown Voltage	BV_{EBO}	$I_C = 0$, $I_E = 10\ \mu A$	3.0		Volts
Collector-Emitter Sustaining Voltage	$V_{CEO(sus)}$*	$I_C = 3.0$ mA, $I_B = 0$	15		Volts
Collector Saturation Voltage	$V_{CE(sat)}$	$I_C = 10$ mA, $I_B = 1.0$ mA		0.4	Volts
Base Saturation Voltage	$V_{BE(sat)}$	$I_C = 10$ mA, $I_B = 1.0$ mA		1.0	Volts
Collector-Base Cutoff Current	I_{CBO}	$I_E = 0$, $V_{CB} = 15$ V $I_E = 0$, $V_{CB} = 15$ V, $T_A = 150°C$		1.0 1.0	nA µA
DC Pulsed Current Gain	h_{FE}*	$I_C = 3.0$ mA, $V_{CE} = 1.0$ V	20		
High Frequency Current Gain	$\|h_{fe}\|$	$I_C = 4.0$ mA, $V_{CE} = 10$ V f = 100 MHz	6.0		
Output Capacitance	C_{ob}	$I_E = 0$, $V_{CB} = 10$ V f = 140 kHz		2.8	pf
Input Capacitance	C_{ib}	$I_C = 0$, $V_{BE} = 0.5$ V f = 140 kHz		2.0	pf
Available Power Gain (See Figure 1)	A_p	$I_C = 6.0$ mA, $V_{CE} = 12$ V f = 200 MHz (Figure 1)	15		db
Power Output (See Figure 2)	P_o	$I_C = 8.0$ mA, $V_{CE} = 15$ V f = 500 MHz (Figure 2)	30		mW
Noise Figure	NF	f = 60 MHz Source resistance = 400 Ω $I_C = 1.0$ mA, $V_{CE} = 6.0$ V		6.0	db
Collector Efficiency	η	$I_C = 8.0$ mA, $V_{CB} = 15$ V f = 500 MHz	25		%

*Pulse Test: Pulse Width = 300 µsec; Duty Cycle = 1%

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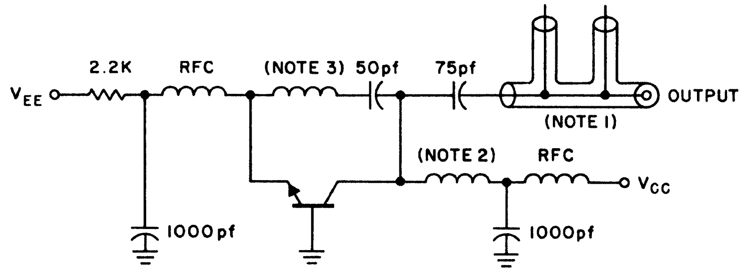
500 MHz OSCILLATOR TEST CIRCUIT



Notes:

(1) Coax plumbing consists of the following GR air lines:
- 2 Type 874 TEE
- 1 Type 874 - D20 Adjustable Stub
- 1 Type 874 - LA Adjustable Line
- 1 Type 874 - WN3 Short-Circuit Termination

(2) 2 turns #16 AWG wire, 3/8 inch OD, 1-1/4 inch long

(3) 9 turns #22 AWG wire, 3/16 inch OD, 1/2 inch long

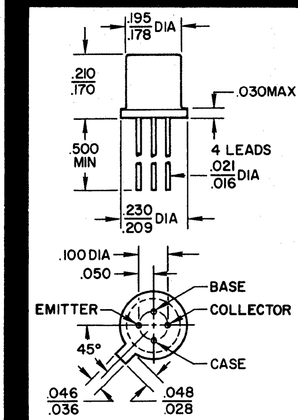
JANUARY 1968

NPN TRANSISTOR
RF/IF AMPLIFIER
- HIGH FREQUENCY
- HIGH POWER GAIN
- LOW CAPACITANCE

2N2708

MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	35	Volts
Collector-Emitter Voltage	V_{CEO}	20	Volts
Emitter-Base Voltage	V_{EBO}	3.0	Volts
Collector Current	I_C	Limited by P_D only	
Total Device Dissipation $T_A = 25°C$	P_D	0.2	Watts
Storage Temperature	T_{stg}	−65 to +200	°C
Junction Temperature	T_J	+200	°C
Derating Factor above 25°C @ $T_A = 25°C$		1.14	mW/°C

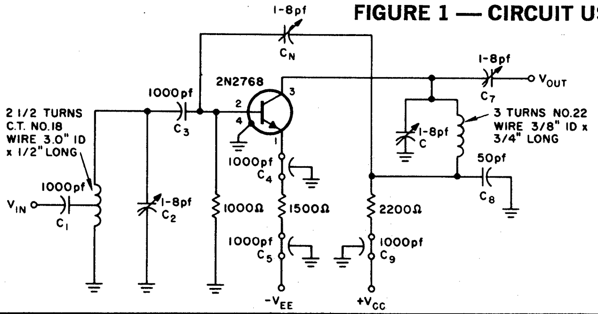


ELECTRICAL CHARACTERISTICS at +25°C (Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Collector-Base Breakdown Voltage	BV_{CBO}	$I_C = 1.0\ \mu A$, $I_E = 0$	35		Volts
Emitter-Base Breakdown Voltage	BV_{EBO}	$I_C = 0$, $I_E = 10\ \mu A$	3.0		Volts
Collector-Emitter Sustaining Voltage	$V_{CEO(sus)}$*	$I_C = 3.0$ mA, $I_B = 0$	20		Volts
Collector-Base Cutoff Current	I_{CBO}	$I_E = 0$, $V_{CB} = 15$ V $I_E = 0$, $V_{CB} = 15$ V, $T_A = 150°C$		10 10	nA μA
DC Current Gain	h_{FE}	$I_C = 2.0$ mA, $V_{CE} = 2.0$ V	30	200	
Small Signal Current Gain	h_{fe}	$I_C = 2.0$ mA, $V_{CE} = 15$ V f = 1 kHz	30	180	
High Frequency Current Gain	$\lvert h_{fe} \rvert$	$I_C = 2.0$ mA, $V_{CE} = 15$ V f = 100 MHz	7.0	12	
Output Capacitance	C_{ob}	$I_E = 0$, $V_{CB} = 15$ V f = 140 kHz		1.5	pf
Collector-Base Time Constant	$r_b'C_c$	$I_C = 2.0$ mA, $V_{CB} = 15$ V f = 31.9 MHz, 4th Lead = gnd	15	33	psec
Available Power Gain Neutralized	G_{pe}	$I_C = 2.0$ mA, $V_{CE} = 15$ V f = 200 MHz (Figure 1)	15	22	db
Noise Figure	NF	Source Resistance 50Ω $I_C = 2.0$ mA, $V_{CE} = 15$ V f = 200 MHz		8.5	db

* Pulse Test: Pulse Width = 300 μsec; Duty Cycle = 1%.

FIGURE 1 — CIRCUIT USED TO MEASURE POWER GAIN AT 200 MHz



NOTE 1 (Neutralization Procedure): (a) Connect a 200 MHz signal generator (with Z_{OUT} = 50 ohms) to the input terminals of the amplifier. (b) Connect a 50-ohm r-f voltmeter across the output terminals of the amplifier. (c) Apply V_{EE} and V_{CC}, and with the signal generator adjusted for 10 mV output, tune C_2, C_6, and C_7 for maximum output. (d) Interchange the connections to the signal generator and the output indicator. (e) With sufficient signal applied to the output terminals of the amplifier, adjust C_N for a minimum indication at the input. (f) Repeat steps (a), (b), and (c) to determine if retuning is necessary.

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NPN TRANSISTOR
RF/IF AMPLIFIER

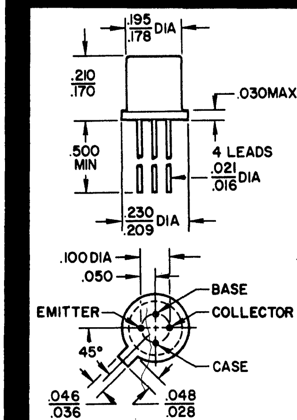
- HIGH POWER GAIN
- HIGH FREQUENCY
- LOW SATURATION VOLTAGE

JANUARY 1968

2N2865

MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	25	Volts
Collector-Emitter Voltage	V_{CEO}	13	Volts
Emitter-Base Voltage	V_{EBO}	3.0	Volts
Collector Current	I_C	50	mA
Total Device Dissipation @ $T_A = 25°C$ @ $T_C = 25°C$	P_D	 0.2 0.3	Watts
Storage Temperature	T_{stg}	−65 to +200	°C
Junction Temperature	T_J	+200	°C
Derating Factor above 25°C @ $T_A = 25°C$		1.14	mW/°C



ELECTRICAL CHARACTERISTICS at +25°C (Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Collector-Base Breakdown Voltage	BV_{CBO}	$I_C = 1.0\ \mu A$, $I_E = 0$	25		Volts
Emitter-Base Breakdown Voltage	BV_{EBO}	$I_C = 0$, $I_E = 10\ \mu A$	3.0		Volts
Collector-Emitter Sustaining Voltage	$V_{CEO(sus)}$*	$I_C = 4.0$ mA, $I_B = 0$	13		Volts
Collector Saturation Voltage	$V_{CE(sat)}$	$I_C = 10$ mA, $I_B = 1.0$ mA		0.4	Volts
Base Saturation Voltage	$V_{BE(sat)}$	$I_C = 10$ mA, $I_B = 1.0$ mA		1.0	Volts
Collector-Base Cutoff Current	I_{CBO}	$I_E = 0$, $V_{CB} = 15$ V $I_E = 0$, $V_{CB} = 15$ V, $T_A = 150°C$		10 1.0	nA μA
DC Current Gain	h_{FE}	$I_C = 4.0$ mA, $V_{CE} = 10$ V	20	200	
Small Signal Current Gain	h_{fe}	$I_C = 4.0$ mA, $V_{CE} = 10$ V, f = 1 kHz	20	200	
High Frequency Current Gain	$\lvert h_{fe} \rvert$	$I_C = 4.0$ mA, $V_{CE} = 10$ V f = 200 MHz	3.0		
Output Capacitance	C_{ob}	$I_E = 0$, $V_{CB} = 10$ V f = 1 MHz		2.5	pf
Collector-Base Time Constant	$r_b'C_c$			15	psec
Neutralized Small-Signal Power Gain	G_{pe}	$I_C = 4.0$ mA, $V_{CE} = 10$ V f = 200 MHz (Figure 1)	16.5		db
Unneutralized Small-Signal Power Gain	G_{pe}	$I_C = 4.0$ mA, $V_{CE} = 10$ V f = 200 MHz (Figure 2)	10		db
Power Output	P_o	$I_E = -12$ mA, $V_{CB} = 10$ V f = 500 MHz (Figure 3)	40		mW
Spot Noise Figure	NF	f = 200 MHz Source resistance = 75Ω $I_E = 1.5$ mA, $V_{CB} = 10$ V		4.5	db

* Pulse Test: Pulse Width = 300 μsec; Duty Cycle = 1%.

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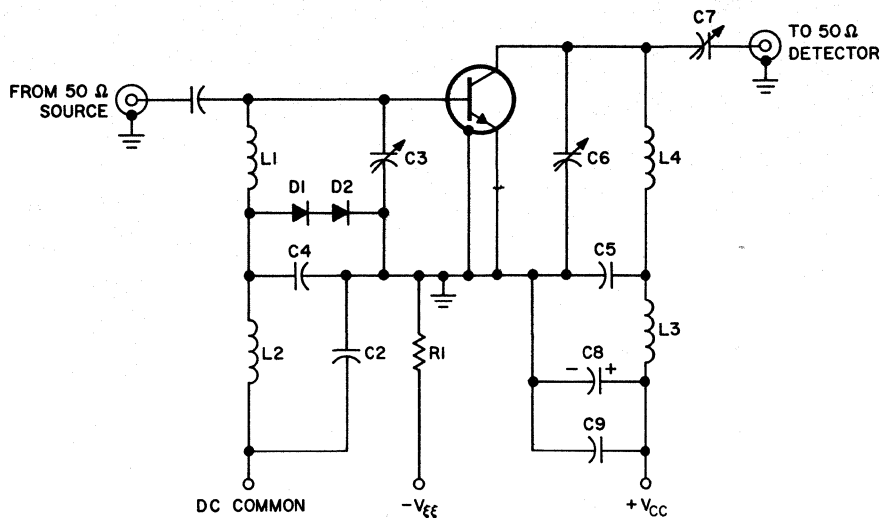
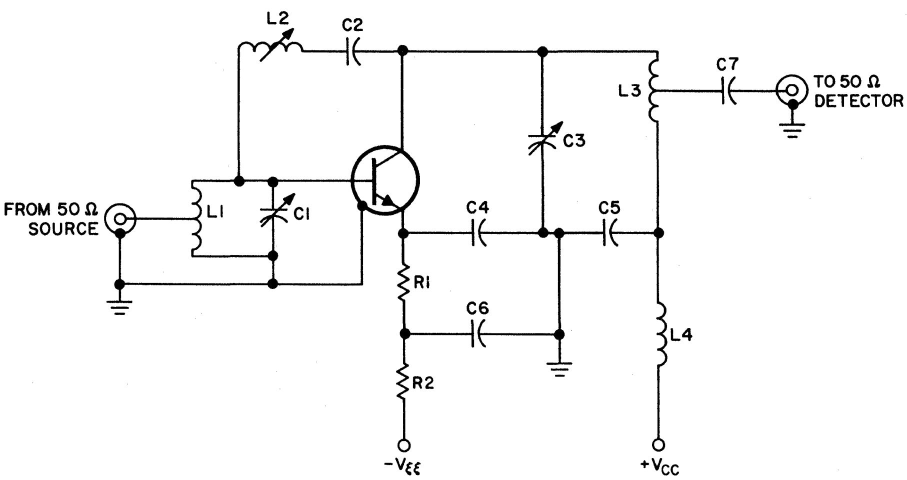


CIRCUIT COMPONENT INFORMATION

C1, C2, and C9: 0.05 μf
C3: 1.5—10 pf
C4 and C5: 1000 pf
C6 and C7: 3—15 pf
C8: 25 μf
R1: 2.2 kΩ
L1: 1 T #12 AWG, 2 cm ID
L2 and L3: 200 MHz RFC
L4: ½ T #12 AWG, 3 cm ID
D1 and D2: 1N2070

FIGURE 1 – NEUTRALIZED 200 MHz INSERTION POWER GAIN TEST CIRCUIT



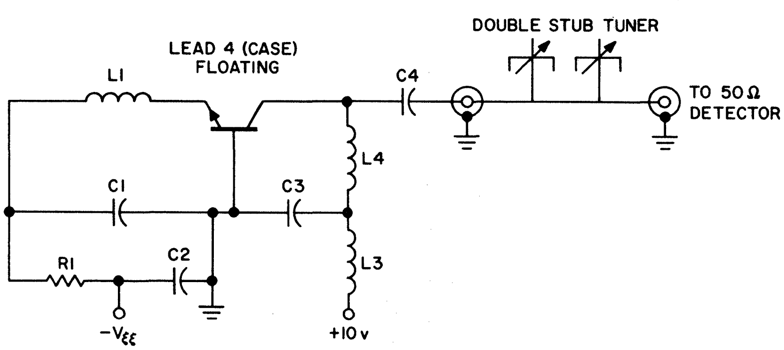
NEUTRALIZATION ADJUSTMENT PROCEDURE

After tuning amplifier as for normal gain measurement, reverse input and output connections and tune L2 for minimum indication on detector.

CIRCUIT COMPONENT INFORMATION

C1: 3—12 pf
C2: 1000 pf
C3: 1.5—7.5 pf
C4 and C5: 0.01 μf
C6: 0.05 μf
C7: 0.001 μf
R1: 100 Ω
R2: 1 kΩ
L1: 3½ T #16 AWG, 5/16″ ID, 1″ length, Turns Ratio ≈ 3½ to 3
L2: 0.4—1.0 μh, Q ≥ 75
L3: 8 T #16 AWG, ⅛″ ID, ⅞″ length, Turns Ratio ≈ 8 to 1
L4: 200 MHz RFC

FIGURE 2 – UNNEUTRALIZED 200 MHz INSERTION POWER GAIN TEST CIRCUIT



CIRCUIT COMPONENT INFORMATION

C1, C2 and C3: 1000 pf
C4: 250 pf
R1: 2.2 kΩ
L1: 7 T #22 AWG, ⅛″ ID, ½″ length
L2: 3¾ T #18 AWG, ½″ ID, ¾″ length
L3: 500 MHz RFC
Double Stub Tuner: Weinschel DS 109L (or equivalent)

FIGURE 3 – 500 MHz OSCILLATOR POWER OUTPUT TEST CIRCUIT

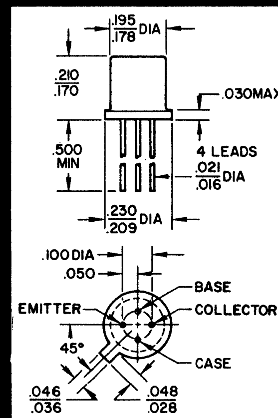
NPN TRANSISTOR
RF/IF AMPLIFIER
- **HIGH FREQUENCY**
- **LOW SATURATION VOLTAGE**
- **LOW CAPACITANCE**

JANUARY 1968

2N3289
2N3290

MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	2N3289 2N3290	UNIT
Collector-Base Voltage	V_{CBO}	30	Volts
Collector-Emitter Voltage	V_{CES}	30	Volts
Collector-Emitter Voltage	V_{CEO}	15	Volts
Emitter-Base Voltage	V_{EBO}	3.0	Volts
Collector Current	I_C	50	mA
Total Device Dissipation @ $T_A = 25°C$ @ $T_C = 25°C$	P_D	 200 300	mW
Derating Factor above 25°C @ $T_A = 25°C$ @ $T_C = 25°C$		 1.14 1.71	mW/°C
Storage Temperature	T_{stg}	−65 to +200	°C
Junction Temperature	T_J	+200	°C



ELECTRICAL CHARACTERISTICS at +25°C (Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Collector-Base Breakdown Voltage	BV_{CBO}	$I_C = 10\ \mu A$, $I_E = 0$	30		Volts
Collector-Emitter Breakdown Voltage	BV_{CES}	$I_C = 10\ \mu A$, $V_{BE} = 0$	30		Volts
Collector-Emitter Breakdown Voltage	BV_{CEO}	$I_C = 2.0$ mA, $I_B = 0$	15		Volts
Emitter-Base Breakdown Voltage	BV_{EBO}	$I_E = 10\ \mu A$, $I_C = 0$	3.0		Volts
Collector Saturation Voltage	$V_{CE(sat)}$	$I_C = 5$ mA, $I_B = 0.5$ mA		0.4	Volts
Base Saturation Voltage	$V_{BE(sat)}$	$I_C = 5$ mA, $I_B = 0.5$ mA		1.0	Volts
Collector-Base Cutoff Current	I_{CBO}	$V_{CB} = 15$ V		.010	μA
DC Current Gain	h_{FE}	$V_{CE} = 10$ V, $I_C = 2$ mA	10	150	
Small Signal Current Gain	h_{fe}	$V_{CE} = 10$ V, $I_C = 2$ mA f = 1 kHz	10	200	
Output Capacitance	C_{ob}*	$V_{CB} = 10$ V, $I_E = 0$ f = 0.1 MHz		1.5	pf
Collector-Base Time Constant	$r_b'C_c$	$V_{CB} = 10$ V, $I_C = 2$ mA f = 31.8 MHz	3	20	psec
High Frequency Current Gain	$\lvert h_{fe} \rvert$	$I_C = 2$ mA, $V_{CE} = 10$ V f = 100 MHz	3.0	12	
Maximum Frequency of Oscillation	f_{max}	$V_{CE} = 10$ V, $I_C = 2$ mA	2000 (Typ)		MHz
Power Gain	G_e	$V_{CE} = 10$ V, $I_C = 2$ mA f = 200 MHz	17	24	db
Power Gain (AGC) 2N3289	G_e**	$V_{CE} = 5$ V, $I_C = 20$ mA f = 200 MHz		+5	db
Noise Figure	NF	$V_{CE} = 10$ V, $I_C = 2$ mA f = 200 MHz		7.0	db

*C_{ob} is measured in guarded circuit such that the can capacitance is not included.
**AGC is obtained by increasing I_C. The circuit remains adjusted for $V_{CE} = 10$ Vdc, $I_C = 2$ mAdc operation.

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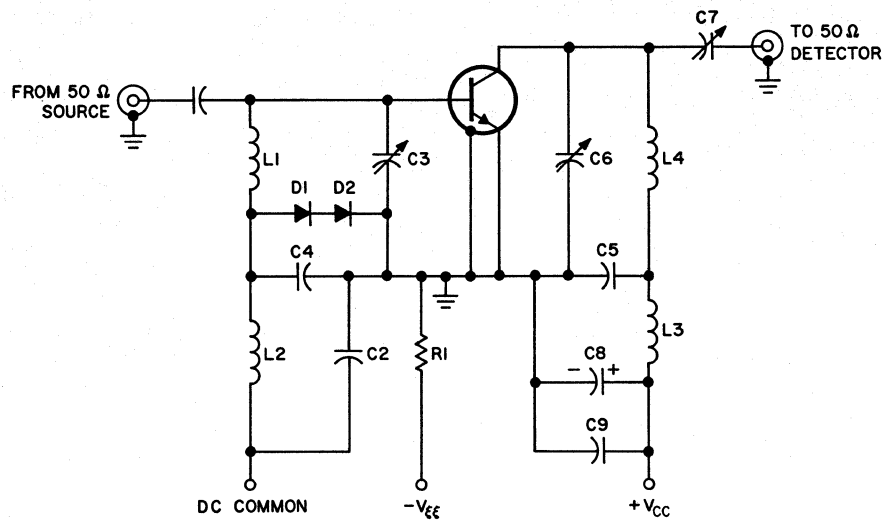


CIRCUIT COMPONENT INFORMATION

C1, C2, and C9: 0.05 μf
C3: 1.5—10 pf
C4 and C5: 1000 pf
C6 and C7: 3—15 pf
C8: 25 μf
R1: 2.2 kΩ
L1: 1 T #12 AWG, 2 cm ID
L2 and L3: 200 MHz RFC
L4: ½ T #12 AWG, 3 cm ID
D1 and D2: 1N2070

FIGURE 1 – NEUTRALIZED 200 MHz INSERTION POWER GAIN TEST CIRCUIT

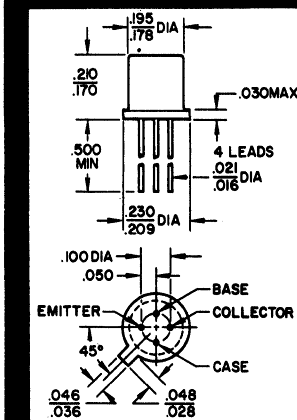
JANUARY 1968

NPN TRANSISTOR
RF/IF AMPLIFIER
- HIGH FREQUENCY
- HIGH POWER GAIN
- LOW CAPACITANCE

2N3291 THRU 2N3294

MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	2N3291 2N3292	2N3293 2N3294	UNIT
Collector-Base Voltage	V_{CBO}	25	20	Volts
Collector-Emitter Voltage	V_{CES}	25	20	Volts
Emitter-Base Voltage	V_{EBO}	3.0	3.0	Volts
Collector Current	I_C	50	50	mA
Total Device Dissipation @ $T_A = 25°C$ @ $T_C = 25°C$	P_D	 200 300	 200 300	mW
Derating Factor above 25°C @ $T_A = 25°C$ @ $T_C = 25°C$		 1.14 1.71	 1.14 1.71	mW/°C
Storage Temperature	T_{stg}	−65 to +200		°C
Junction Temperature	T_J	+200	+200	°C



ELECTRICAL CHARACTERISTICS at +25°C (Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Collector-Emitter Breakdown Voltage 2N3291, 2N3292 2N3293, 2N3294	BV_{CES}	$I_C = 25\ \mu A$, $V_{BE} = 0$	 25 20		Volts
Collector-Base Cutoff Current	I_{CBO}	$V_{CB} = 10$ V, $I_E = 0$		0.1	μA
Emitter-Base Cutoff Current	I_{EBO}	$V_{EB} = 0.5$ V, $I_C = 0$		100	μA
DC Current Gain	h_{FE}	$V_{CE} = 10$ V, $I_C = 2$ mA	10		
Small Signal Current Gain	h_{fe}	$V_{CE} = 10$ V, $I_C = 2$ mA f = 1 kHz	10	200	
High Frequency Current Gain	$\|h_{fe}\|$	$V_{CE} = 10$ V, $I_C = 2$ mA f = 100 MHz	2.5	12	
Output Capacitance	C_{ob}*	$V_{CB} = 10$ V, $I_E = 0$ f = 100 kHz*		2.0	pf
Collector-Base Time Constant	$r_b'C_c$	$V_{CB} = 10$ V, $I_C = 2$ mA f = 31.8 MHz		30	psec
Maximum Frequency of Oscillation	f_{max}	$V_{CE} = 10$ V, $I_C = 2$ mA	2000 (Typ)		MHz
Power Gain 2N3291, 2N3292 2N3294	G_e	$I_C = 2$ mA, $V_{CE} = 10$ V f = 200 MHz (Figure 1)	 16 14		db
Noise Figure 2N3291 2N3292 2N3294	NF	$I_C = 2$ mA, $V_{CE} = 10$ V f = 200 MHz (Figure 1)	 8 (Typ) 9 (Typ) 7 (Typ)		db
Power Gain 2N3293	P_o	$V_{EE} = -11$ V, f = 257 MHz (Figure 2)	 2.0		db

* C_{ob} is measured in guarded circuit such that the can capacitance is not included.

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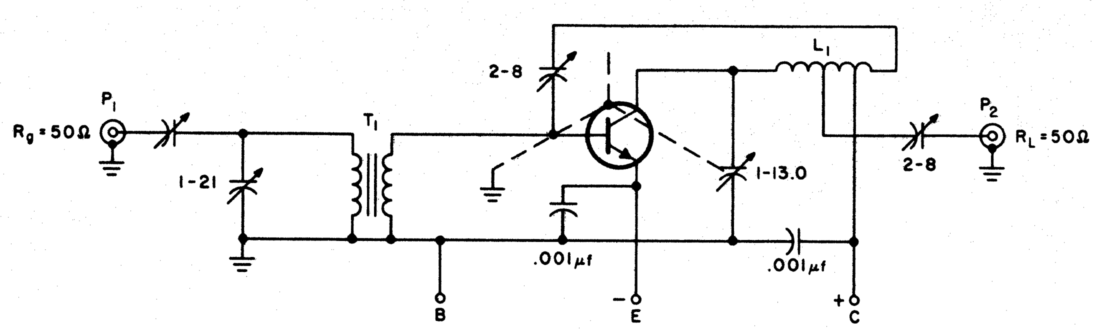
FIGURE 1 — 200 MHz TEST CIRCUIT: POWER GAIN, NOISE FIGURE, & AGC



L_1 – 6 turns of #16 tinned wire; 3/8" ID; Air wound; winding length 3/4"; V_{CC} feeds tap 4-3/4 turns from collector end; output tap 3-1/2 turns from collector end.

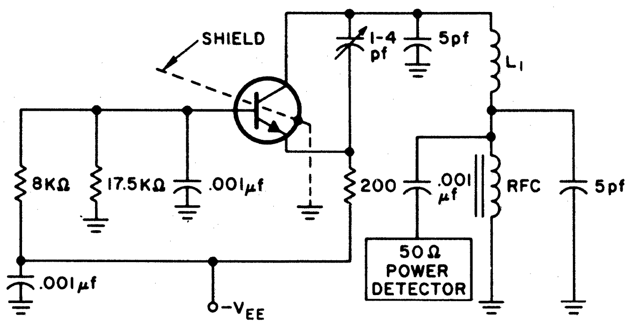
T_1 – 3 turns primary and secondary Bifilar wound (close wound) on 1/4" ceramic form Cambion type) with brass slug. #22 enameled wire.

P_1 – General Radio 874 G6 Pad (6 db)

P_2 – General Radio 874 G6 Pad (6 db)

Figure 1

FIGURE 2 — 257 MHz OSCILLATOR POWER OUTPUT TEST CIRCUIT



L_1 – 4 turns of #22 Nykland wire spaced for 257 mc coil form 7/32" center Cambion LST ceramic aircore

RFC – 4.5 μh, 24 turns #30 Nykland wire close wound 7/32" Cambion ceramic form

All capacitors are ceramic type

Figure 2

PNP TRANSISTOR
GENERAL PURPOSE

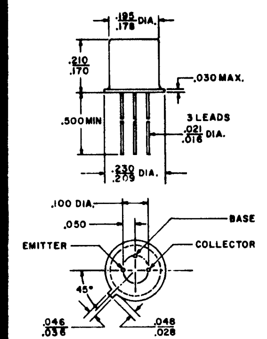
- HIGH FREQUENCY
- LOW SATURATION VOLTAGE
- LOW CAPACITANCE

JANUARY 1968

2N869

MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	25	Volts
Collector-Emitter Voltage	V_{CEO}	18	Volts
Emitter-Base Voltage	V_{EBO}	5	Volts
Total Device Dissipation @ $T_A = 25°C$ @ $T_C = 25°C$ @ $T_C = 100°C$	P_D	 0.36 1.2 0.68	 Watts
Derating Factor above 25°C @ $T_A = 25°C$ @ $T_C = 25°C$		 2.1 6.85	 mW/°C
Storage Temperature	T_{stg}	−65 to +200	°C
Junction Temperature	T_J	+200	°C



COLLECTOR IS INTERNALLY CONNECTED TO CASE

ELECTRICAL CHARACTERISTICS at +25°C (Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Collector-Base Breakdown Voltage	BV_{CBO}	$I_C = 10\ \mu A, I_E = 0$	25		Volts
Emitter-Base Breakdown Voltage	BV_{EBO}	$I_E = 10\ \mu A, I_C = 0$	5		Volts
Collector-Emitter Sustaining Voltage*	$V_{CEO(sust)}$*	$I_C = 10$ mA, $I_B = 0$	18		Volts
Collector Saturation Voltage	$V_{CE(sat)}$	$I_C = 10$ mA, $I_B = 1.0$ mA		1.0	Volt
Base Saturation Voltage	$V_{BE(sat)}$	$I_C = 10$ mA, $I_B = 1.0$ mA		1.0	Volt
Collector-Base Cutoff Current	I_{CBO}	$V_{CB} = 15$ V, $I_E = 0$ $V_{CB} = 15$ V, $I_E = 0$, $T_A = 150°C$		.010 25	μA
DC Pulse Current Gain	h_{FE}*	$I_C = 10$ mA, $V_{CE} = 5.0$ V	20	120	
High Frequency Current Gain	h_{fe}	$I_C = 10$ mA, $V_{CE} = 15$ V, f = 100 MHz	1.0		
Output Capacitance	C_{ob}	$V_{CB} = 10$ V, $I_E = 0$		9	pf
Input Capacitance	C_{ib}	$V_{BE} = 0.5$ V, $I_C = 0$		11	pf

*Pulse Test: Pulse Width = 300 μsec, Duty Cycle = 1%

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PNP TRANSISTOR
GENERAL PURPOSE

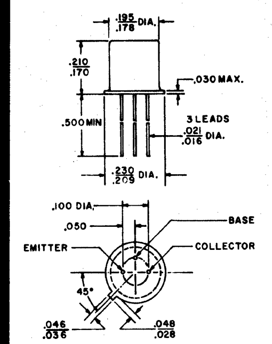
- LOW LEAKAGE
- LOW SATURATION VOLTAGE
- LOW NOISE

JANUARY 1968

2N995

MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	−20	Volts
Collector-Emitter Voltage	V_{CEO}	−15	Volts
Emitter-Base Voltage	V_{EBO}	−4.0	Volts
Total Device Dissipation @ $T_A = 25°C$ @ $T_C = 25°C$ @ $T_C = 100°C$	P_D	 0.36 1.2 0.68	Watts
Storage Temperature	T_{stg}	−65 to +200	°C
Junction Temperature	T_J	+200	°C
Derating Factor above 25°C $T_A = 25°C$ $T_C = 25°C$		 2.06 6.86	mW/°C



COLLECTOR IS INTERNALLY CONNECTED TO CASE

ELECTRICAL CHARACTERISTICS at +25°C (Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Collector-Base Breakdown Voltage	BV_{CBO}	$I_C = 10\ \mu A$, $I_E = 0$	−20		Volts
Emitter-Base Breakdown Voltage	BV_{EBO}	$I_C = 0$, $I_E = 10\ \mu A$	−4		Volts
Collector-Emitter Sustaining Voltage	$V_{CEO(sus)}$*	$I_C = 10$ mA, $I_B = 0$	−15		Volts
Collector Saturation Voltage	$V_{CE(sat)}$	$I_C = 20$ mA, $I_B = 2.0$ mA		0.2	Volts
Base Saturation Voltage	$V_{BE(sat)}$	$I_C = 20$ mA, $I_B = 2.0$ mA		0.95	Volts
Collector-Base Cutoff Current	I_{CBO}	$I_E = 0$, $V_{CB} = -15$ V $I_E = 0$, $V_{CB} = -15$ V, $T_A = 150°C$		5.0 25.0	nA μA
Emitter-Base Cutoff Current	I_{EBO}	$I_C = 0$, $V_{EB} = 4.0$ V		10	μA
DC Current Gain	h_{FE}*	$I_C = 20$ mA, $V_{CE} = -1.0$ V $I_C = 50$ mA, $V_{CE} = -1.0$ V $I_C = 1.0$ mA, $V_{CE} = -1.0$ V	35 25 25	140	
High Frequency Current Gain	$\|h_{fe}\|$	$I_C = 10$ mA, $V_{CE} = -10$ V f = 100 MHz	1.0		
Output Capacitance	C_{ob}	$I_E = 0$, $V_{CB} = -10$ V		10	pf
Input Capacitance	C_{ib}	$I_C = 0$, $V_{BE} = -0.5$ V		11	pf
Low Frequency Noise Figure	NF	f = 1 kHz Source resistance = 2 kΩ Equivalent noise power bandwidth = 200 Hz $I_C = 100\ \mu A$, $V_{CE} = 5.0$ V	6.0 Typ		db
100 MHz Oscillator Efficiency	η	$I_C = 10$ mA, $V_{CB} = -10$ V (Figure 1)	40		%

* Pulse Test: Pulse Width = 300 μs; Duty Cycle = 1%.

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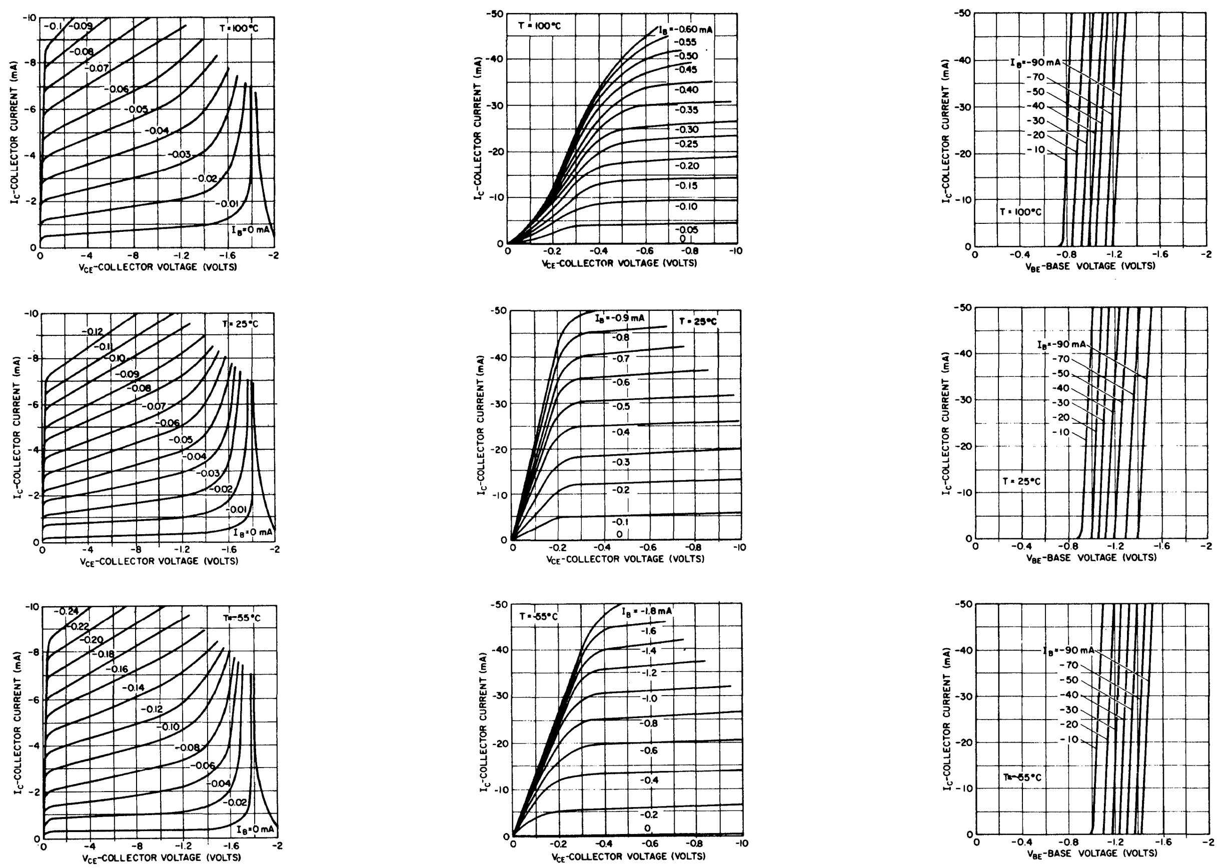
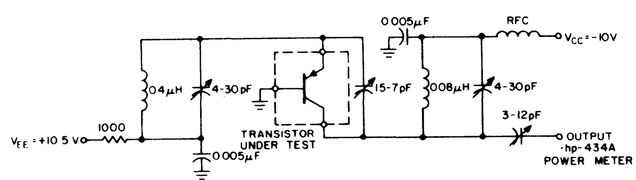
TYPICAL COLLECTOR AND BASE CHARACTERISTICS*

Active Region	Saturation Region	
Collector Characteristics	Collector Characteristics	Base Characteristics



*Single family characteristics on transistor curve tracer.

Oscillator Efficiency Circuit (I_C = 10 mA, V_{CB} = -10V)



PNP TRANSISTOR
GENERAL PURPOSE

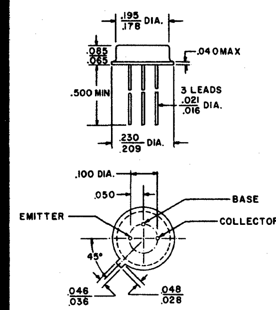
- HIGH BREAKDOWN VOLTAGE
- LOW SATURATION VOLTAGE
- LOW NOISE

JANUARY 1968

2N2601
2N2602
2N2603

MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	−60	Volts
Collector-Emitter Voltage	V_{CEO}	−60	Volts
Emitter-Base Voltage	V_{EBO}	−6	Volts
Collector Current	I_C	−50	mA
Total Device Dissipation @ $T_A = 25°C$	P_D	0.400	Watts
Storage Temperature	T_{stg}	−65 to +200	°C
Junction Temperature	T_J	+200	°C
Derating Factor above 25°C @ $T_A = 25°C$		2.28	mW/°C



COLLECTOR IS INTERNALLY CONNECTED TO CASE

ELECTRICAL CHARACTERISTICS at +25°C (Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Collector-Base Breakdown Voltage	BV_{CBO}	$I_C = -50\ \mu A$, $I_E = 0$	−60		Volts
Collector-Emitter Breakdown Voltage	BV_{CEO}	$I_C = -1$ mA, $I_B = 0$	−60		Volts
Emitter-Base Breakdown Voltage	BV_{EBO}	$I_C = 0$, $I_E = -100\ \mu A$	−6		Volts
Collector Saturation Voltage	$V_{CE(sat)}$	$I_C = -10$ mA, $I_B = -1$ mA		−0.5	Volts
Base Saturation Voltage	$V_{BE(sat)}$	$I_C = -10$ mA, $I_B = -1$ mA	−0.7	−0.9	Volts
Collector-Base Cutoff Current	I_{CBO}	$I_E = 0$, $V_{CB} = -45$ V $I_E = 0$, $V_{CB} = -45$ V, $T_A = 150°C$		−25 −25	nA μA
Emitter-Base Cutoff Current	I_{EBO}	$I_C = 0$, $V_{EB} = -5$ V		−5	nA
DC Current Gain 2N2601 2N2602 2N2603	h_{FE}	$I_C = -1$ mA, $V_{CE} = -5$ V	 12.5 25.0 50.0		
Small Signal Current Gain 2N2601 2N2602 2N2603	h_{fe}	$I_E = 100\ \mu A$, $V_{CB} = -5$ V f = 1 kHz	 12 25 50		
2N2601 2N2602 2N2603		$I_E = 1$ mA, $V_{CB} = -5$ V f = 1 kHz	18 36 76	90 90 333	
2N2601 2N2602 2N2603		$I_E = 10$ mA, $V_{CB} = -5$ V f = 1 kHz	25 50 100		
2N2601 2N2602 2N2603		$I_E = 10$ mA, $V_{CB} = -5$ V f = 1 kHz, $T_A = -55°C$	12 25 50		
High Frequency Current Gain 2N2601 2N2602 2N2603	$\lvert h_{fe} \rvert$	$I_C = -5$ mA, $V_{CE} = -5$ V f = 20 MHz	 1.0 2.0 3.0		
Output Capacitance	C_{ob}	$I_E = 0$, $V_{CB} = -5$ V, f = 140 kHz		6.0	pf
Voltage Feedback Ratio	h_{rb}	$I_E = 1$ mA, $V_{CB} = -5$ V f = 1 kHz		10^{-3}	
Input Resistance	h_{ib}	$I_E = 1$ mA, $V_{CB} = -5$ V f = 1 kHz	25	35	ohms
Output Conductance	h_{ob}	$I_E = 1$ mA, $V_{CB} = -5$ V f = 1 kHz		1	μmhos
Real Part of Input Impedance	$Re(h_{ie})$	$I_E = 1$ mA, $V_{CE} = 5$ V f = 100 MHz		200	Ohms

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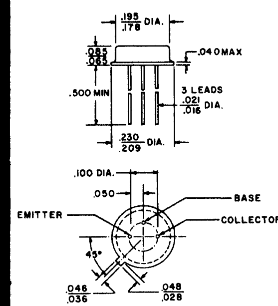
PNP TRANSISTOR
GENERAL PURPOSE

- LOW NOISE
- HIGH BREAKDOWN VOLTAGE
- HIGH CURRENT GAIN

2N2604
2N2605

MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	−60	Volts
Collector-Emitter Voltage	V_{CEO}	−45	Volts
Emitter-Base Voltage	V_{EBO}	−6.0	Volts
Collector Current	I_C	30	mA
Total Device Dissipation @ $T_A = 25°C$ @ $T_C = 25°C$	P_D	 0.4 1.2	Watts
Storage Temperature	T_{stg}	−65 to +200	°C
Junction Temperature	T_J	+175	°C
Derating Factor above 25°C @ $T_A = 25°C$ @ $T_C = 25°C$		 2.28 6.9	mW/°C



COLLECTOR IS INTERNALLY CONNECTED TO CASE

ELECTRICAL CHARACTERISTICS at +25°C (Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Collector-Base Breakdown Voltage	BV_{CBO}	$I_C = 10\ \mu A$, $I_E = 0$	−60		Volts
Emitter-Base Breakdown Voltage	BV_{EBO}	$I_C = 0$, $I_E = -10\ \mu A$	−6		Volts
Collector-Emitter Sustaining Voltage	$V_{CEO(sus)}$*	$I_C = -10$ mA, $I_B = 0$	−45		Volts
Nonsaturated Base Voltage	V_{BE}	$I_C = -10$ mA, $I_B = -0.5$ mA	−0.7	−0.9	Volts
Collector Saturation Voltage	$V_{CE(sat)}$	$I_C = -10$ mA, $I_B = -0.5$ mA		−0.5	Volts
Collector-Base Cutoff Current	I_{CBO}	$I_E = 0$, $V_{CB} = -45$ V		−10	nA
Collector-Emitter Cutoff Current	I_{CES}	$V_{EB} = 0$, $V_{CE} = -45$ V $V_{EB} = 0$, $V_{CE} = -45$ V, $T_A = 170°C$		−10 −10	nA μA
Emitter-Base Cutoff Current	I_{EBO}	$I_C = 0$, $V_{EB} = -5$ V		−2	nA
DC Current Gain 2N2604 2N2605 2N2604 2N2605 2N2604 2N2605 2N2604 2N2605	h_{FE}	 $I_C = -10\ \mu A$, $V_{CE} = -5$ V $I_C = -500\ \mu A$, $V_{CE} = -5$ V $I_C = -10\ \mu A$, $V_{CE} = -5$ V $T_A = -55°C$ $I_C = -10$ mA, $V_{CE} = -5$ V	 40 100 60 150 10 20	 120 300 350 600	
Small Signal Current Gain 2N2604 2N2605	h_{fe}	 $I_C = -1.0$ mA, $V_{CE} = -5$ V f = 1 kHz	 60 150	 350 600	
High Frequency Current Gain	$\lvert h_{fe} \rvert$	$I_C = -0.5$ mA, $V_{CE} = -5$ V f = 30 MHz	1.0		
Output Capacitance	C_{ob}	$I_E = 0$, $V_{CB} = -5$ V f = 1 MHz		6	pf
Voltage Feedback Ratio	h_{rb}	$I_E = -1.0$ mA, $V_{CB} = -5$ V f = 1 kHz		10	$x10^{-4}$
Input Resistance	h_{ie}	$I_E = 1.0$ mA, $V_{CB} = -5$ V	25	35	ohms
Output Conductance	h_{oe}	$I_E = 1.0$ mA, $V_{CE} = -5$ V f = 1 kHz		1.0	μmhos

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CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Real Part of Input Impedance	$Re(h_{ie})$	$I_C = 1$ mA, $V_{CE} = -5$ V f = 100 MHz		200	ohms
Wideband Noise Factor 2N2604 2N2605	NF	f = 10 kHz Source resistance = 10 kΩ Equivalent noise power bandwidth = 15 kHz $I_C = -10$ μA, $V_{CE} = -5$ V		 4 3	 db

* Pulse Test: Pulse Width = 300 μsec; Duty Cycle ≤ 2%.

JANUARY 1968

PNP TRANSISTOR
MEDIUM POWER

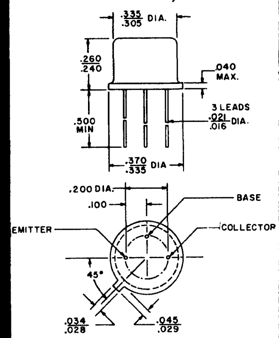
- LOW SATURATION VOLTAGE
- FAST SWITCHING SPEEDS
- HIGH BREAKDOWN VOLTAGE

2N2904 THRU 2N2907A

MAXIMUM RATINGS

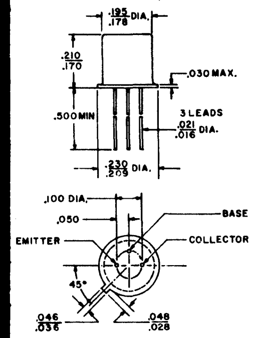
CHARACTERISTIC	SYMBOL	RATING		UNIT
Collector-Base Voltage	V_{CBO}	60		Volts
Collector-Emitter Voltage 2N2904-2N2907, 2N2904A, 2N2907A	V_{CEO}	 40 60		Volts
Emitter-Base Voltage	V_{EBO}	5		Volts
Collector Current	I_C	600		mA
Total Device Dissipation @ $T_A = 25°C$ @ $T_C = 25°C$	P_D	2N2904, A 2N2905, A 0.6 3.0	2N2906, A 2N2907, A 0.4 1.8	Watts
Derating Factor above 25°C @ $T_A = 25°C$ @ $T_C = 25°C$		 3.43 17.2	 2.28 10.3	mW/°C
Storage Temperature	T_{stg}	−65 to +200		°C
Junction Temperature	T_J	−65 to +200		°C

2N2904, A
2N2905, A



COLLECTOR IS INTERNALLY CONNECTED TO CASE

2N2906, A
2N2907, A



COLLECTOR IS INTERNALLY CONNECTED TO CASE

ELECTRICAL CHARACTERISTICS at +25°C (Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Collector-Base Breakdown Voltage	BV_{CBO}	$I_C = 10\ A, I_E = 0$	60		Volts
Collector-Emitter Sustaining Voltage 2N2904 thru 2N2907, 2N2904A thru 2N2907A,	$V_{CEO(sus)}$*	$I_C = 10\ mA, I_B = 0$	 40 60		Volts
Emitter-Base Breakdown Voltage	BV_{EBO}	$I_B = 10A, I_C = 0$	5		Volts
Collector Saturation Voltage	$V_{CE(sat)}$*	$I_C = 150\ mA, I_B = 15\ mA$ $I_C = 500\ mA, I_B = 50\ mA$		0.4 1.6	Volts
Base Saturation Voltage	$V_{BE(sat)}$*	$I_C = 150\ mA, I_B = 15\ mA$ $I_C = 500\ mA, I_B = 50\ mA$		1.3 2.6	Volts
Collector-Base Cutoff Current 2N2904 thru 2N2907, 2N2904A thru 2N2907A, 2N2904 thru 2N2907, 2N2904A thru 2N2907A,	I_{CBO}	 $V_{CB} = 50\ V, I_E = 0$ $V_{CB} = 50\ V, I_E = 0, T_A = 150°C$		 .020 .010 20 10	μA
Base Cutoff Current	I_{BL}	$V_{CE} = 30\ V, V_{BE} = 0.5\ V$		50	nA
Collector-Emitter Cutoff Current	I_{CEX}	$V_{CE} = 30\ V, V_{BE} = 0.5\ V$		50	nA
DC Current Gain 2N2904, 2N2906, 2N2905, 2N2907, 2N2904A, 2N2906A, 2N2905A, 2N2907A,	h_{FE}	 $I_C = 0.1\ mA, V_{CE} = 10\ V$	 20 35 40 75		
2N2904, 2N2906, 2N2905, 2N2907, 2N2904A, 2N2906A, 2N2905A, 2N2907A,		$I_C = 1\ mA, V_{CE} = 10\ V$	25 50 40 100		
2N2904, 2N2906, 2N2905, 2N2907, 2N2904A, 2N2906A, 2N2905A, 2N2907A,		$I_C = 10\ mA, V_{CE} = 10\ V$	35 75 40 100		
2N2904, 2N2904A, 2N2906, 2N2906A, 2N2905, 2N2905A, 2N2907, 2N2907A		$I_C = 150\ mA, V_{CE} = 10\ V$*	40 100	120 300	
2N2904, 2N2906, 2N2905, 2N2907, 2N2904A, 2N2906A, 2N2905A, 2N2907A,		$I_C = 500\ mA, V_{CE} = 10\ V$*	20 30 40 50		

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CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Rise Time	t_r	$I_{CS} = 150$ mA, $I_{B1} = 15$ mA (Figure 1)		40	nsec
Delay Time	t_d	$I_{CS} = 150$ mA, $I_{B1} = 15$ mA (Figure 1)		10	nsec
Fall Time	t_f	$I_{CS} = 150$ mA, $I_{B1} = I_{B2} = 15$ mA (Figure 2)		30	nsec
Storage Time	t_s	$I_{CS} = 150$ mA, $I_{B1} = I_{B2} = 15$ mA (Figure 2)		80	nsec
Turn-On Time	t_{on}	$I_{CS} = 150$ mA, $I_{B1} = 15$ mA (Figure 1)		45	nsec
Turn-Off Time	t_{off}	$I_{CS} = 150$ mA, $I_{B1} = I_{B2} = 15$ mA (Figure 2)		100	nsec
Output Capacitance	C_{ob}	$V_{CE} = 10$ V, $I_E = 0$, f = 100 kHz		8	pf
Input Capacitance	C_{ib}	$V_{BE} = 2$ V, $I_C = 0$, f = 100 kHz		30	pf
High Frequency Current Gain	$\|h_{fe}\|$	$I_C = 50$ mA, $V_{CE} = 20$ V f = 100 MHz	2		

* Pulse Test: Pulse Width = 300 μsec; Duty Cycle ≤ 2%.

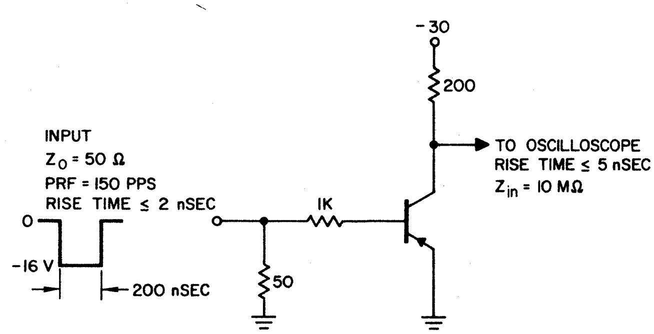


Figure 1. Test Circuit for Determining Delay Time and Rise Time

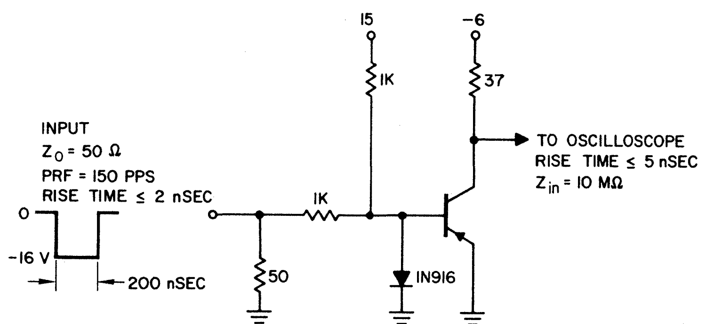


Figure 2. Test Circuit for Determining Storage Time and Fall Time

DUAL NPN TRANSISTOR
GENERAL PURPOSE

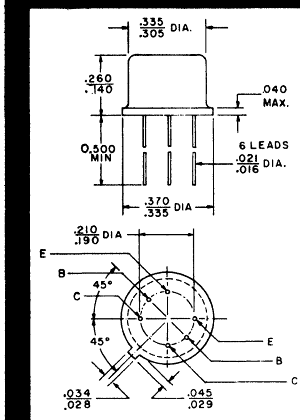
- CLOSELY MATCHED CURRENT GAIN
- VERY CLOSELY MATCHED, V_{BE}
- LOW DIFFERENTIAL DRIFT

JANUARY 1968

2N2453
2N2453A

MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING		UNIT
Collector-Base Voltage 2N2453 2N2453A	V_{CBO}	60 80		Volts
Collector-Emitter Voltage 2N2453 2N2453A	V_{CEO}	30 50		Volts
Emitter-Base Voltage	V_{EBO}	7.0		Volts
		Each Side	Both Sides	
Total Device Dissipation @ $T_A = 25°C$ @ $T_C = 100°C$ @ $T_C = 25°C$	P_D	0.2 0.35 0.6	0.3 0.7 1.2	Watts
Storage Temperature	T_{stg}	−65 to +200		°C
Junction Temperature	T_J	+200		°C
Derating Factor above 25°C 2N2453 2N2453A		1.14 1.71		mW/°C



ELECTRICAL CHARACTERISTICS at +25°C (Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Collector-Base Breakdown Voltage 2N2453 2N2453A	BV_{CBO}	$I_C = 10\ \mu A$, $I_E = 0$	60 80		Volts
Emitter-Base Breakdown Voltage	BV_{EBO}	$I_C = 0$, $I_E = 0.1\ \mu A$	7.0		Volts
Collector-Emitter Sustaining Voltage 2N2453 2N2453A	$V_{CEO(sus)}$**	$I_C = 10$ mA, $I_B = 0$	30 60		Volts
Collector Saturation Voltage	$V_{CE(sat)}$	$I_C = 5.0$ mA, $I_B = 0.5$ mA		1.0	Volts
Base Saturation Voltage	$V_{BE(sat)}$	$I_C = 5.0$ mA, $I_B = 0.5$ mA		0.9	Volts
Collector-Base Cutoff Current 2N2453 2N2453A 2N2453 2N2453A	I_{CBO}	$I_E = 0$, $V_{CB} = 50$ V $I_E = 0$, $V_{CB} = 60$ V $I_E = 0$, $V_{CB} = 50$ V, $T_A = 150°C$ $I_E = 0$, $V_{CB} = 60$ V, $T_A = 150°C$		5.0 5.0 10 10	nA μA
Emitter-Base Cutoff Current	I_{EBO}	$I_C = 0$, $V_{EB} = 5.0$ V		2.0	nA
DC Current Gain	h_{FE}	$I_C = 10\ \mu A$, $V_{CE} = 5.0$ V $I_C = 10\ \mu A$, $V_{CE} = 5.0$ V $T_A = -55°C$ $I_C = 1.0$ mA, $V_{CE} = 5.0$ V $I_C = 1.0$ mA, $V_{CE} = 5.0$ V $T_A = -55°C$	80 40 150 75	 600	
DC Current Gain Ratio 2N2453A only Both Types Both Types	h_{FE1}/h_{FE2}*	$I_C = 100\ \mu A$, $V_{CE} = 5.0$ V $I_C = 1.0$ mA, $V_{CE} = 5.0$ V $I_C = 1.0$ mA, $V_{CE} = 5.0$ V $T_A = -55°C$ to $+125°C$	0.9 0.9 0.85	1.0 1.0 1.0	
Base Voltage Differential	$V_{BE1}-V_{BE2}$	$I_C = 1.0$ mA, $V_{CE} = 5.0$ V $I_C = 10\ \mu A$, $V_{CE} = 5.0$ V		5.0 3.0	mV

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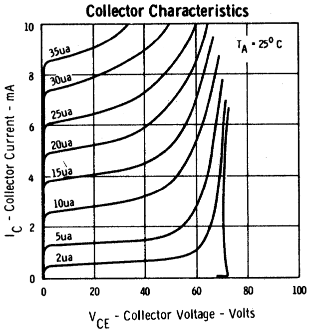
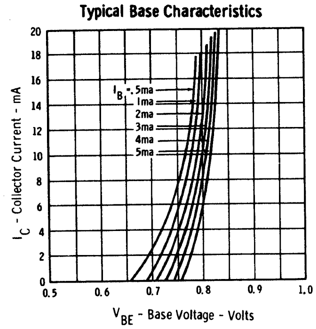
CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Base Voltage Differential Drift 2N2453 2N2453A	$\Delta(V_{BE1}-V_{BE2})/\Delta T$	$I_C = 10\ \mu A$, $V_{CE} = 5.0\ V$ $T_A = -55°C$ to $+125°C$		10 5.0	$\mu V/°C$
Small Signal Current Gain	h_{fe}	$I_C = 1.0\ mA$, $V_{CE} = 5.0\ V$ f = 1 kHz	150	600	
High Frequency Current Gain	$\|h_{fe}\|$	$I_C = 5.0\ mA$, $V_{CE} = 10\ V$ f = 30 MHz	2.0		
Output Capacitance 2N2453 2N2453A	C_{ob}	$I_E = 0$, $V_{CB} = 10\ V$ f = 140 kHz		8.0 4.0	pf
Input Capacitance	C_{ib}	$I_C = 0$, $V_{BE} = 0.5\ V$ f = 140 kHz		10	pf
Voltage Feedback Ratio	h_{rb}	$I_C = 1.0\ mA$, $V_{CE} = 5.0\ V$ f = 1 kHz		5.0	$x10^{-4}$
Reverse Voltage Feedback Ratio	h_{re}	$I_C = 1.0\ mA$, $V_{CE} = 5.0\ V$ f = 1 kHz		6.0	$x10^{-4}$
Input Resistance	h_{ib}	$I_C = 1.0\ mA$, $V_{CB} = 5.0\ V$ f = 1 kHz	20	30	ohms
Input Resistance	h_{ie}	$I_C = 1.0\ mA$, $V_{CE} = 5.0\ V$ f = 1 kHz		5.0	kΩ
Output Conductance	h_{ob}	$I_C = 1.0\ mA$, $V_{CB} = 5.0\ V$ f = 1 kHz		0.2	μmhos
Output Conductance	h_{oe}	$I_C = 1.0\ mA$, $V_{CB} = 5.0\ V$ f = 1 kHz	5.0	30	μmhos
Low Frequency Noise Figure 2N2453 2N2453A	NF	f = 1 kHz Source resistance = 10 kΩ Equivalent noise power bandwidth = 200 Hz $I_C = 10\ \mu A$, $V_{CE} = 5.0\ V$		7.0 4.0	db

* The lower of the h_{FE} readings is taken as h_{FE1}.
** Pulse Test: Pulse Width = 300 μsec; Duty Cycle = 1%.

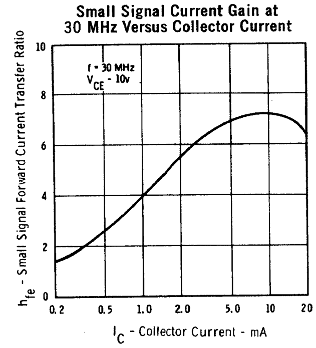
Collector Characteristics



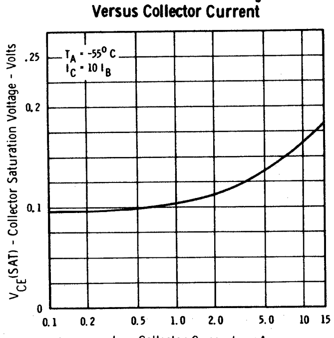
Typical Base Characteristics



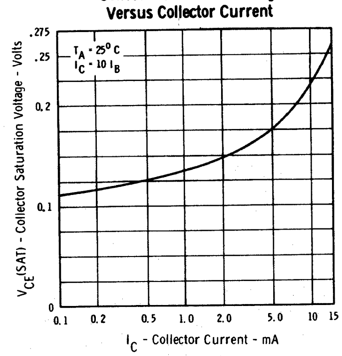
Small Signal Current Gain at 30 MHz Versus Collector Current



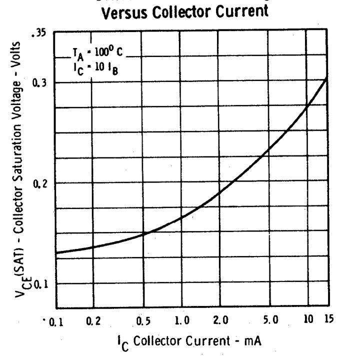
Collector Saturation Voltage Versus Collector Current



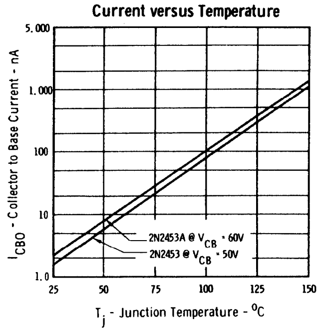
Collector Saturation Voltage Versus Collector Current



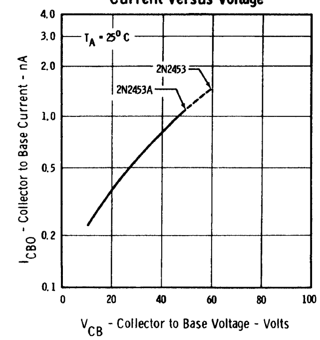
Collector Saturation Voltage Versus Collector Current



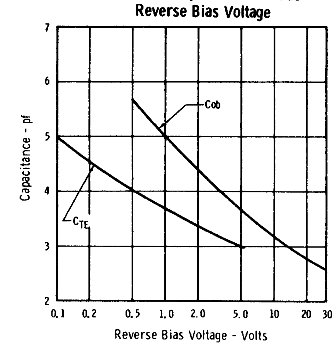
Collector - Base Diode Reverse Current versus Temperature



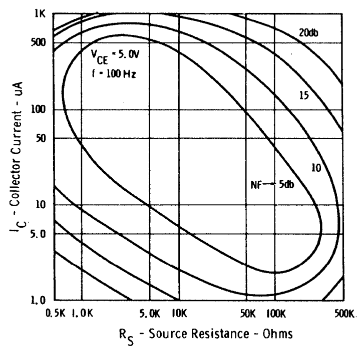
Collector - Base Diode Reverse Current Versus Voltage



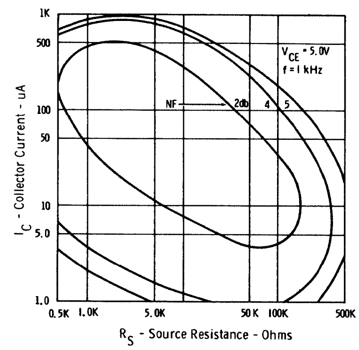
Collector and Emitter Transition Capacitance Versus Reverse Bias Voltage



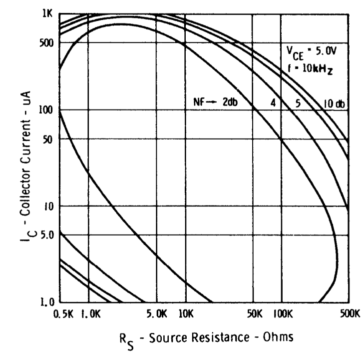
Noise Figure at 100 Hz



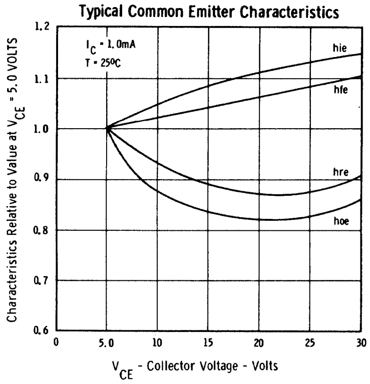
Noise Figure at 1 kHz



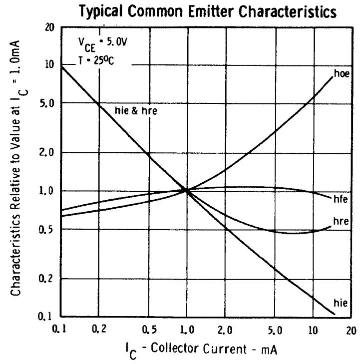
Noise Figure at 10 kHz



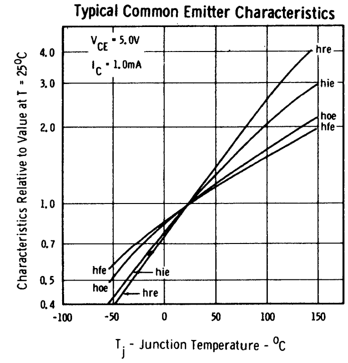
Typical Common Emitter Characteristics



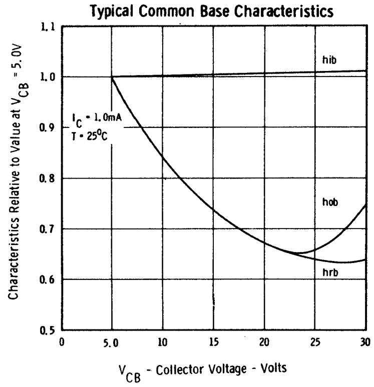
Typical Common Emitter Characteristics



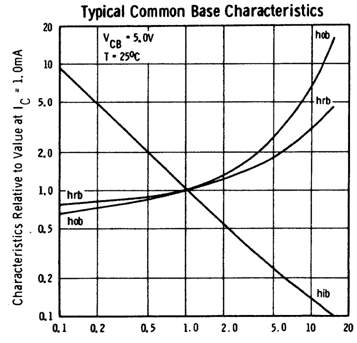
Typical Common Emitter Characteristics



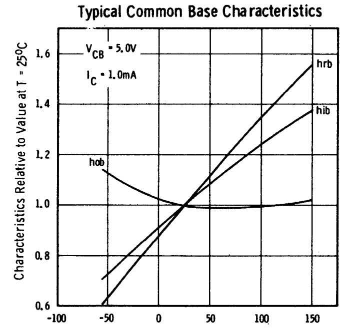
Typical Common Base Characteristics



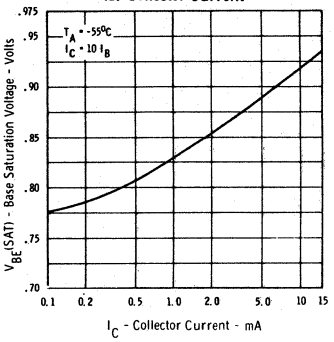
Typical Common Base Characteristics



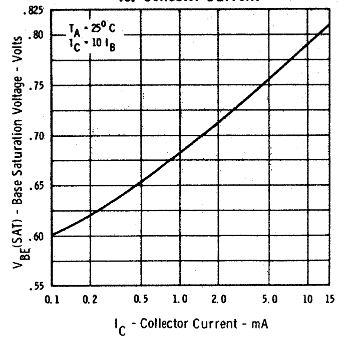
Typical Common Base Characteristics



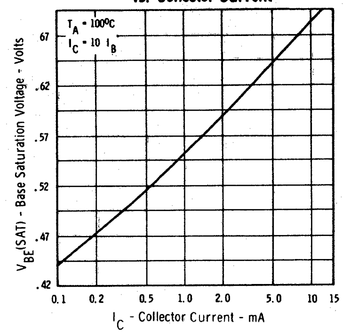
Base Saturation Voltage vs. Collector Current



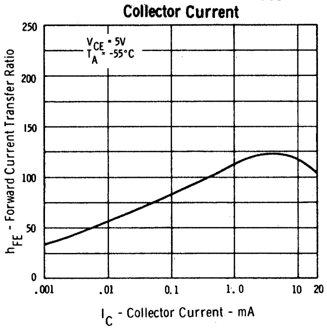
Base Saturation Voltage vs. Collector Current



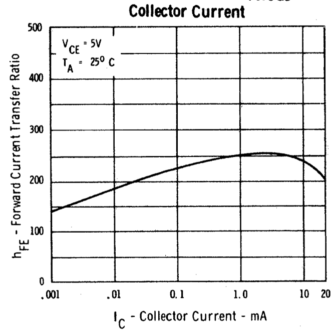
Base Saturation Voltage vs. Collector Current



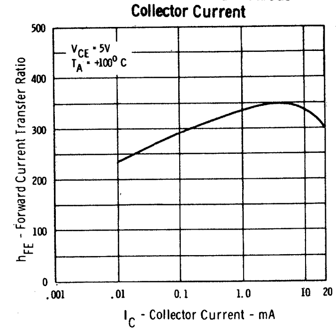
Pulsed DC Current Gain Versus Collector Current



Pulsed DC Current Gain Versus Collector Current



Pulsed DC Current Gain Versus Collector Current



DUAL NPN TRANSISTOR
GENERAL PURPOSE

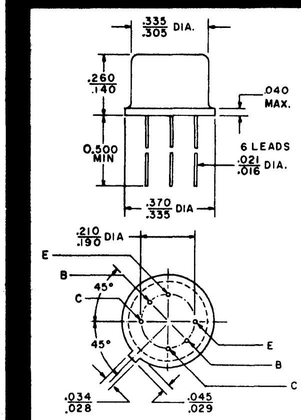
- CLOSELY MATCHED CURRENT GAIN
- VERY LOW DIFFERENTIAL DRIFT
- LOW NOISE

JANUARY 1968

2N2639 THRU 2N2644

MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING		UNIT
Collector-Base Voltage	V_{CBO}	45		Volts
Collector-Emitter Voltage	V_{CEO}	45		Volts
Emitter-Base Voltage	V_{EBO}	5.0		Volts
Collector Current	I_C	30		mA
Total Device Dissipation	P_D	One Side	Both Sides	
@ $T_A = 25°C$		0.3	0.6	Watts
@ $T_C = 25°C$		0.6	1.2	
Derating Factor above 25°C				
@ $T_A = 25°C$		2.0	4.0	mW/°C
@ $T_C = 25°C$		4.0	8.0	
Storage Temperature	T_{stg}	−65 to +300		°C
Junction Temperature	T_J	+175		°C



ELECTRICAL CHARACTERISTICS at +25°C (Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Collector-Base Breakdown Voltage	BV_{CBO}	$I_C = 10\ \mu A,\ I_E = 0$	45		Volts
Emitter-Base Breakdown Voltage	BV_{EBO}	$I_C = 0,\ I_E = 10\ \mu A$	5.0		Volts
Collector-Emitter Sustaining Voltage	$V_{CEO(sus)}$**	$I_C = 10$ mA, $I_B = 0$	45		Volts
Collector Saturation Voltage	$V_{CE(sat)}$	$I_C = 10$ mA, $I_B = 0.5$ mA		1.0	Volts
Base Saturation Voltage	$V_{BE(sat)}$	$I_C = 10$ mA, $I_B = 0.5$ mA	0.6	1.0	Volts
Collector-Base Cutoff Current	I_{CBO}	$I_E = 0,\ V_{CB} = 45$ V $I_E = 0,\ V_{CB} = 45$ V, $T_A = 150°C$		10 10	nA μA
Collector-Emitter Cutoff Current	I_{CEO}	$I_B = 0,\ V_{CE} = 5.0$ V		10	nA
Emitter-Base Cutoff Current	I_{EBO}	$I_C = 0,\ V_{EB} = 5.0$ V		10	nA
DC Current Gain	h_{FE}				
2N2639-41		$I_C = 10\ \mu A,\ V_{CE} = 5.0$ V $I_C = 100\ \mu A,\ V_{CE} = 5.0$ V $I_C = 1.0$ mA, $V_{CE} = 5.0$ V $I_C = 10\ \mu A,\ V_{CE} = 5.0$ V $T_A = -55°C$	50 55 65 10	300	
2N2642-44		$I_C = 10\ \mu A,\ V_{CE} = 5.0$ V $I_C = 100\ \mu A,\ V_{CE} = 5.0$ V $I_C = 1.0$ mA, $V_{CE} = 5.0$ V $I_C = 10\ \mu A,\ V_{CE} = 5.0$ V $T_A = -55°C$	100 110 130 20	300	
DC Current Gain Ratio 2N2639, 2N2642 2N2640, 2N2643	h_{FE1}/h_{FE2}*	$I_C = 10\ \mu A,\ V_{CE} = 5.0$ V	0.9 0.8	1.0 1.0	
Base Voltage Differential 2N2639, 2N2642 2N2640, 2N2643	V_{BE1}-V_{BE2}	$I_C = 10\ \mu A,\ V_{CE} = 5.0$ V		5.0 10	mV
Base Voltage Differential Drift 2N2639, 2N2642 2N2640, 2N2643	$\Delta(V_{BE1}$-$V_{BE2})/\Delta T$	$I_C = 10\ \mu A,\ V_{CE} = 5.0$ V $T_A = -55°C$ to $+125°C$		10 20	μV/°C
Small Signal Current Gain 2N2639-41 2N2642-44	h_{fe}	$I_C = 1.0$ mA, $V_{CE} = 5.0$ V f = 1.0 kHz	65 130	600 600	

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CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
High Frequency Current Gain	$\|h_{fe}\|$	$I_C = 1.0$ mA, $V_{CE} = 5.0$ V f = 20 MHz	4.0		
Output Capacitance	C_{ob}	$I_E = 0$, $V_{CB} = 5.0$ V f = 1.0 MHz		8.0	pf
Voltage Feedback Ratio	h_{rb}	$I_E = -1.0$ mA, $V_{CB} = 5.0$ V f = 1.0 kHz		6.0	$X\,10^{-4}$
Input Resistance	h_{ib}	$I_E = -1.0$ mA, $V_{CB} = 5.0$ V f = 1.0 kHz	25	32	Ohms
Output Conductance	h_{ob}	$I_E = -1.0$ mA, $V_{CB} = 5.0$ V f = 1.0 kHz		1.0	μmhos
Noise Figure	NF	f = 10 Hz to 15.7 kHz Source Resistance = 10 kΩ $I_C = 10$ μA, $V_{CE} = 5.0$ V		4.0	db

* The lower h_{FE} reading is taken as h_{FE1}.
** Pulse Conditions: Pulse Width = 300 μsec; Duty Cycle = 1%.

DUAL NPN TRANSISTOR
GENERAL PURPOSE

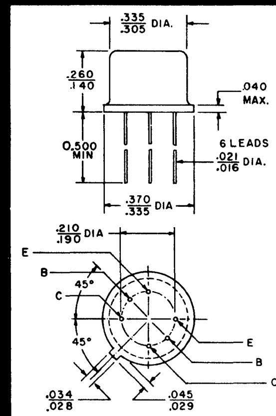
- **LOW NOISE**
- **CLOSELY MATCHED CURRENT GAIN**
- **HIGH BREAKDOWN VOLTAGE**

JANUARY 1968

2N2720
2N2721
2N2722

MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING		UNIT
Collector-Base Voltage 2N2720, 21 2N2722	V_{CBO}	80 45		Volts
Collector-Emitter Voltage 2N2720, 21 2N2722	V_{CEO}	60 45		Volts
Emitter-Base Voltage 2N2720, 21 2N2722	V_{EBO}	6.0 5.0		Volts
Total Device Dissipation @ $T_A = 25°C$ @ $T_C = 25°C$	P_D	One Side 0.3 0.6	Both Sides 0.6 1.2	Watts
Derating Factor above 25°C @ $T_A = 25°C$		1.71	3.4	mW/°C



ELECTRICAL CHARACTERISTICS at +25°C (Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Collector-Base Breakdown Voltage 2N2720, 21 2N2722	BV_{CBO}	$I_C = 10\ \mu A, I_E = 0$	80 45		Volts
Emitter-Base Breakdown Voltage 2N2720, 21 2N2722	BV_{EBO}	$I_C = 0, I_E = 10\ \mu A$	6.0 5.0		Volts
Collector-Emitter Sustaining Voltage 2N2720, 21 2N2722	$V_{CEO(sus)}$**	$I_C = 10$ mA, $I_B = 0$	60 45		Volts
Collector Saturation Voltage 2N2720, 21 2N2722	$V_{CE(sat)}$	$I_C = 10$ mA, $I_B = 1.0$ mA $I_C = 10$ mA, $I_B = 0.5$ mA		1.0 1.0	Volts
Base Saturation Voltage 2N2720, 21 2N2722	$V_{BE(sat)}$	$I_C = 10$ mA, $I_B = 1.0$ mA $I_C = 10$ mA, $I_B = 0.5$ mA	0.65 0.65	0.85 0.85	Volts
Collector-Base Cutoff Current 2N2720, 21 2N2722 2N2720, 21 2N2722	I_{CBO}	$I_E = 0, V_{CB} = 60$ V $I_E = 0, V_{CB} = 30$ V $I_E = 0, V_{CB} = 60$ V, $T_A = 150°C$ $I_E = 0, V_{CB} = 30$ V, $T_A = 150°C$		10 1.0 10 1.0	nA μA
Collector-Emitter Reverse Current 2N2720, 21 2N2722	I_{CEO}	$I_B = 0, V_{CE} = 5.0$ V		10 2.0	nA
Emitter-Base Cutoff Current 2N2720, 21 2N2722	I_{EBO}	$I_C = 0, V_{EB} = 5.0$ V		10 1.0	nA
DC Current Gain 2N2722 2N2722 2N2720, 21 2N2722 2N2720, 21 2N2720, 21	h_{FE}	$I_C = 1.0\ \mu A, V_{CE} = 5.0$ V $I_C = 10\ \mu A, V_{CE} = 5.0$ V $I_C = 100\ \mu A, V_{CE} = 5.0$ V $I_C = 1.0$ mA, $V_{CE} = 5.0$ V $I_C = 10$ mA, $V_{CE} = 5.0$ V	50 100 30 125 35 42	250 120	

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CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
DC Current Gain Ratio 2N2720 2N2721 2N2722	h_{FE1}/h_{FE2}*	$I_C = 100\ \mu A$, $V_{CE} = 5.0\ V$ $I_C = 1.0\ \mu A$, $V_{CE} = 5.0\ V$	0.9 0.8 0.9	1.0 1.0 1.0	
Base Voltage Differential 2N2720 2N2721 2N2722	V_{BE1}-V_{BE2}	$I_C = 100\ \mu A$, $V_{CE} = 5.0\ V$ $I_C = 10\ \mu A$, $V_{CE} = 5.0\ V$		5.0 10 5.0	mV
Base Voltage Differential Change 2N2720 2N2721 2N2722 2N2720 2N2721 2N2722	$\Delta(V_{BE1}$-$V_{BE2})$	$I_C = 100\ \mu A$, $V_{CE} = 5.0\ V$ $T_A = -55°C$ to $+25°C$ $I_C = 10\ \mu A$, $V_{CE} = 5.0\ V$ $T_A = -55°C$ to $+25°C$ $I_C = 100\ \mu A$, $V_{CE} = 5.0\ V$ $T_A = 25°C$ to $125°C$ $I_C = 10\ \mu A$, $V_{CE} = 5.0\ V$ $T_A = 25°C$ to $125°C$		0.8 1.6 0.8 1.0 2.0 1.0	mV
Small Signal Current Gain 2N2720, 21 2N2722	h_{fe}	$I_C = 1.0\ mA$, $V_{CE} = 5.0\ V$ f = 1.0 kHz $I_C = 0.1\ mA$, $V_{CE} = 5.0\ V$ f = 1.0 kHz	30 100	200 700	
High Frequency Current Gain 2N2720, 21 2N2722	$\|h_{fe}\|$	$I_C = 10\ mA$, $V_{CE} = 10\ V$ f = 20 MHz	4.0 5.0		
Output Capacitance 2N2720, 21 2N2722	C_{ob}	$I_E = 0$, $V_{CB} = 5.0\ V$ f = 1.0 MHz $I_E = 0$, $V_{CB} = 5.0\ V$ f = 140 kHz		6.0 6.0	pf
Voltage Feedback Ratio 2N2720, 21 2N2722	h_{rb}	$I_E = 1.0\ mA$, $V_{CB} = 5.0\ V$ f = 1.0 kHz		5.0 6.0	$X\ 10^{-4}$
Input Resistance	h_{ib}	$I_E = 1.0\ mA$, $V_{CB} = 5.0\ V$ f = 1.0 kHz	25	32	Ohms
Output Conductance	h_{ob}	$I_E = 1.0\ mA$, $V_{CB} = 5.0\ V$ f = 1.0 kHz		1.0	μmhos
Noise Figure 2N2722	NF	f = 10 Hz to 15.7 kHz Source resistance = 10 kΩ $I_C = 10\ \mu A$, $V_{CE} = 5.0\ V$		4.0	db

* The lower h_{FE} reading is taken as h_{FE1}.
** Pulse Test: Pulse Width = 300 μsec; Duty Cycle = 1%.

DUAL NPN TRANSISTOR
GENERAL PURPOSE

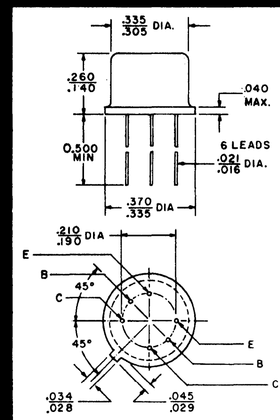
- **CLOSELY MATCHED CURRENT GAIN**
- **VERY LOW DIFFERENTIAL DRIFT**
- **LOW NOISE**

JANUARY 1968

2N2913-20
2N2915A, 16A
2N2919A, 20A

MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING		UNIT
Collector-Base Voltage 2N2913, 14, 15, 15A, 16, 16A, 17, 18 2N2919, 19A, 20, 20A	V_{CBO}	 45 60		Volts
Collector-Emitter Voltage 2N2913, 14, 15, 15A, 16, 16A, 17, 18 2N2919, 19A, 20, 20A	V_{CEO}	 45 60		Volts
Emitter-Base Voltage	V_{EBO}	6.0		Volts
Collector Current	I_C	30		mA
Total Device Dissipation @ $T_A = 25°C$ @ $T_C = 25°C$ @ $T_C = 100°C$	P_D	One Side 0.30 0.75 0.43	Both Sides 0.6 1.5 0.86	Watts
Derating Factor above 25°C @ $T_A = 25°C$ @ $T_C = 25°C$		One Side 1.7 4.3	Both Sides 3.4 8.6	mW/°C



ELECTRICAL CHARACTERISTICS at +25°C (Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Collector-Base Breakdown Voltage 2N2913, 14, 15, 15A, 16, 16A, 17, 18 2N2919, 19A, 20, 20A	BV_{CBO}	$I_C = 10\ \mu A, I_E = 0$	 45 60		Volts
Emitter-Base Breakdown Voltage	BV_{EBO}	$I_C = 0, I_E = 10\ \mu A$	6.0		Volts
Collector-Emitter Sustaining Voltage 2N2913, 14, 15, 15A, 16, 16A, 17, 18 2N2919, 19A, 20, 20A	$V_{CEO(sus)}$**	$I_C = 10$ mA, $I_B = 0$	 45 60		Volts
Collector Saturation Voltage	$V_{CE(sat)}$	$I_C = 1.0$ mA, $I_B = 0.1$ mA		0.35	Volts
Nonsaturated Base Voltage	$V_{BE(ON)}$	$I_C = 0.1$ mA, $V_{CE} = 5.0$ V		0.7	Volts
Collector-Base Cutoff Current 2N2913, 14, 15, 15A, 16, 16A, 17, 18 2N2919, 19A, 20, 20A	I_{CBO}	$I_E = 0, V_{CB} = 45$ V $I_E = 0, V_{CB} = 45$ V, $T_A = 150°C$		10 2.0 10	nA μA
Collector-Emitter Reverse Current	I_{CEO}	$I_B = 0, V_{CB} = 5.0$ V		2.0	nA
Emitter-Base Cutoff Current	I_{EBO}	$I_C = 0, V_{EB} = 5.0$ V		2.0	nA
DC Current Gain 2N2913, 15, 15A, 17, 19, 19A 2N2914, 16, 16A, 18, 20, 20A 2N2913, 15, 15A, 17, 19, 19A 2N2914, 16, 16A, 18, 20, 20A 2N2913, 15, 15A, 17, 19, 19A 2N2914, 16, 16A, 18, 20, 20A 2N2913, 15, 15A, 17, 19, 19A 2N2914, 16, 18, 20 2N2916A, 20A	h_{FE}	$I_C = 10\ \mu A, V_{CE} = 5.0$ V $I_C = 100\ \mu A, V_{CE} = 5.0$ V $I_C = 1.0$ mA, $V_{CE} = 5.0$ V $I_C = 10\ \mu A, V_{CE} = 5.0$ V $T_A = -55°C$	60 150 100 225 150 300 15 30 40	240 600	
DC Current Gain Ratio 2N2915, 15A, 16, 16A, 19, 19A, 20, 20A 2N2917, 18 2N2915A, 16A, 19A, 20A	h_{FE1}/h_{FE2}*	$I_C = 100\ \mu A, V_{CE} = 5.0$ V $I_C = 100\ \mu A, V_{CE} = 5.0$ V $T_A = -55°C$ to $+125°C$	0.9 0.8 0.85	1.0 1.0 1.0	

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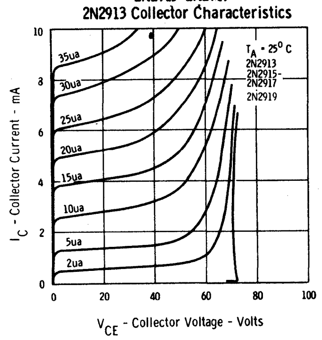
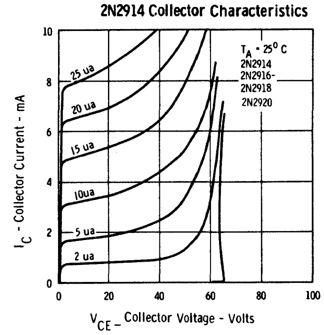
CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Base Voltage Differential 2N2915, 16, 19, 20 2N2917, 18 2N2915A, 16A, 19A, 20A 2N2915, 16, 19, 20 2N2917, 18 2N2915A, 16A, 19A, 20A	V_{BE1}-V_{BE2}	$I_C = 10\ \mu A$ to 1.0 mA, $V_{CE} = 5.0$ V $I_C = 100\ \mu A$, $V_{CE} = 5.0$ V		5.0 10 2.0 3.0 5.0 1.5	mV
Base Voltage Differential Change 2N2915, 16, 19, 20 2N2915A, 16A, 19A, 20A 2N2917, 18 2N2915, 16, 19, 20 2N2915A, 16A, 19A, 20A 2N2917, 18	$\Delta(V_{BE1}$-$V_{BE2})$	$I_C = 100\ \mu A$, $V_{CE} = 5.0$ V $T_A = -55°C$ to 125°C $I_C = 100\ \mu A$, $V_{CE} = 5.0$ V $T_A = 25°C$ to 125°C		0.8 0.4 1.6 1.0 0.5 2.0	mV
High Frequency Current Gain	$\|h_{fe}\|$	$I_C = 0.5$ mA, $V_{CE} = 5.0$ V f = 20 MHz	3.0		
Output Capacitance	C_{ob}	$I_E = 0$, $V_{CB} = 5.0$ V f = 140 kHz		6.0	pf
Input Capacitance 2N2915A, 16A, 19A, 20A	C_{ib}	$I_C = 0$, $V_{BE} = 5.0$ V f = 1.0 MHz		10	pf
Input Resistance	h_{ib}	$I_C = 1.0$ mA, $V_{CB} = 5.0$ V f = 1.0 kHz	25	32	Ohms
Output Conductance	h_{ob}	$I_C = 1.0$ mA, $V_{CB} = 5.0$ V f = 1.0 kHz		1.0	μmhos
Noise Figure 2N2913, 15, 15A, 17, 19, 19A 2N2914, 16, 16A, 18, 20, 20A 2N2913, 15, 15A, 17, 19, 19A 2N2914, 16, 16A, 18, 20, 20A	NF	f = 1.0 kHz Source resistance = 10 kΩ Equivalent noise power bandwidth = 200 Hz $I_C = 10\ \mu A$, $V_{CE} = 5.0$ V f = 10 Hz to 10 kHz Source resistance = 10 kΩ Equivalent noise power bandwidth = 15.7 kHz $I_C = 10\ \mu A$, $V_{CE} = 5.0$ V		 4.0 3.0 4.0 3.0	 db

* Lowest of the two h_{FE} readings is taken as h_{FE1} for purposes of this ratio.
** Pulse Test: Pulse Width = 300 μsec; Duty Cycle = 1%.

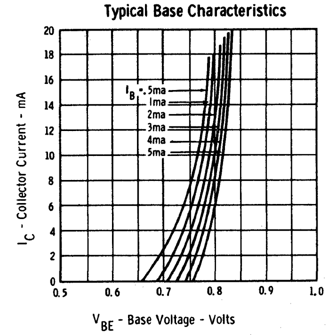
2N2919
2N2915-2N2917
2N2913 Collector Characteristics



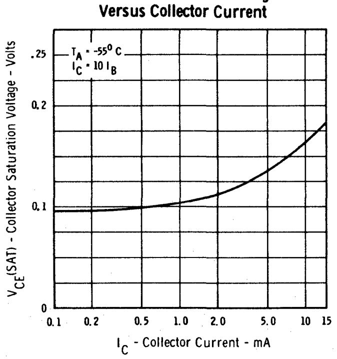
2N2920
2N2916-2N2918
2N2914 Collector Characteristics



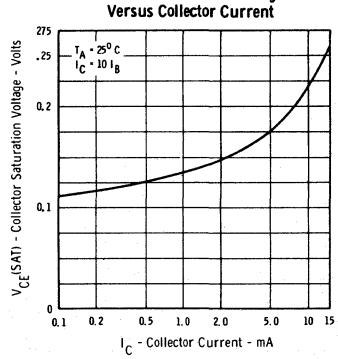
Typical Base Characteristics



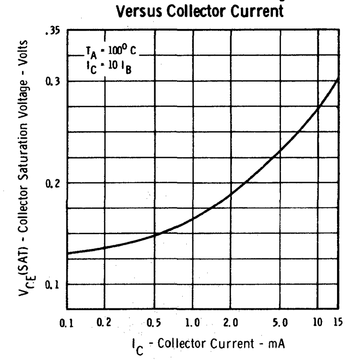
Collector Saturation Voltage
Versus Collector Current



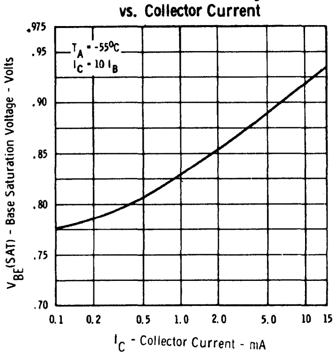
Collector Saturation Voltage
Versus Collector Current



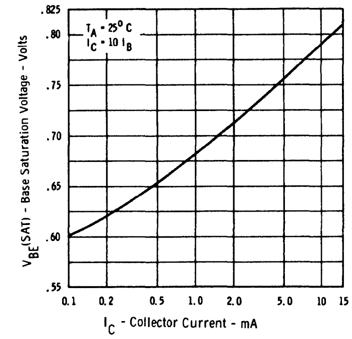
Collector Saturation Voltage
Versus Collector Current



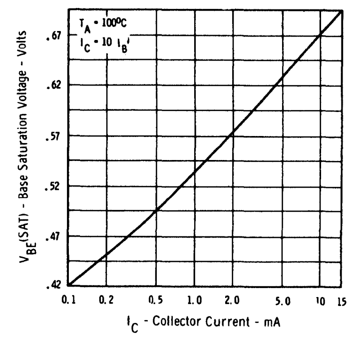
Base Saturation Voltage vs. Collector Current



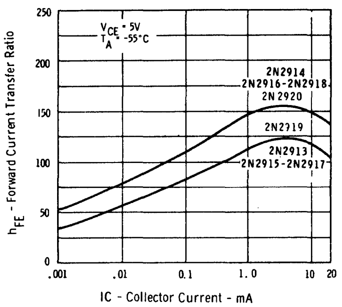
Base Saturation Voltage vs. Collector Current



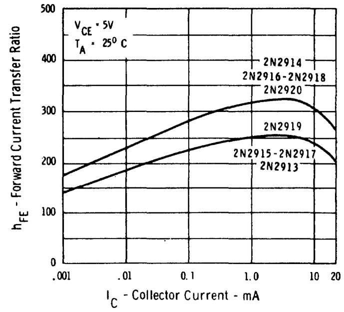
Base Saturation Voltage vs. Collector Current



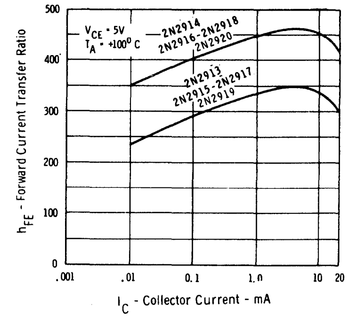
Pulsed DC Current Gain Versus Collector Current



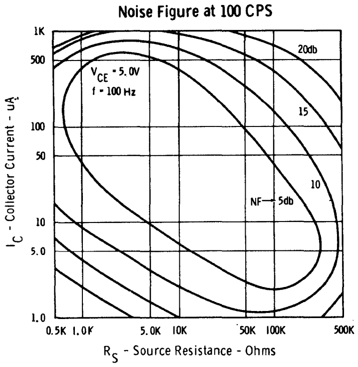
Pulsed DC Current Gain Versus Collector Current



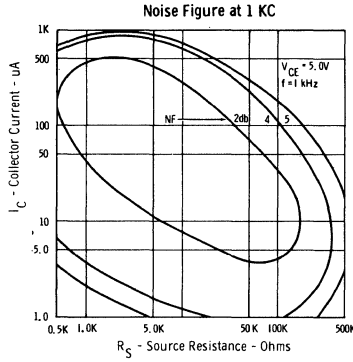
Pulsed DC Current Gain Versus Collector Current



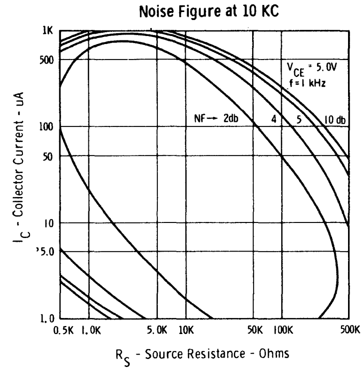
Noise Figure at 100 CPS



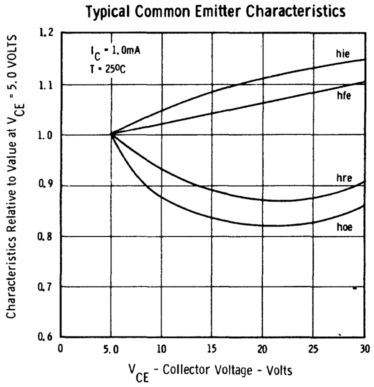
Noise Figure at 1 KC



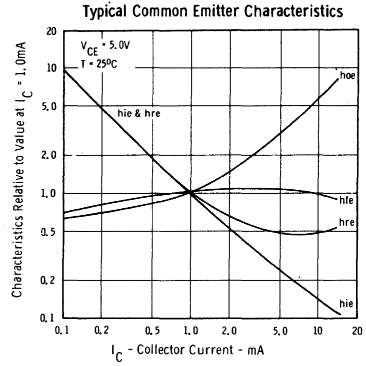
Noise Figure at 10 KC



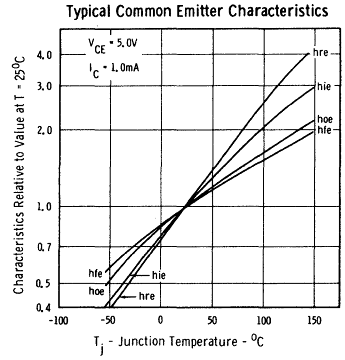
Typical Common Emitter Characteristics



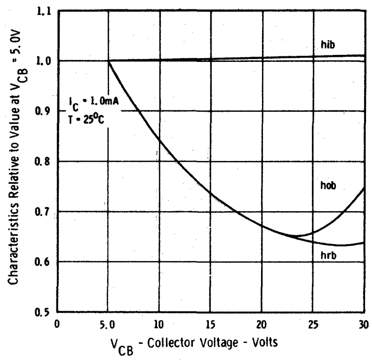
Typical Common Emitter Characteristics



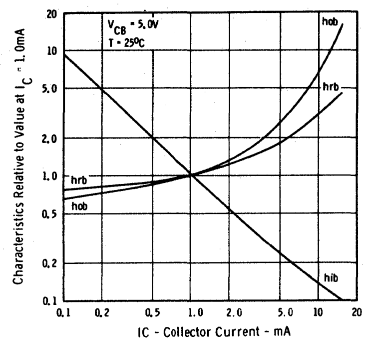
Typical Common Emitter Characteristics



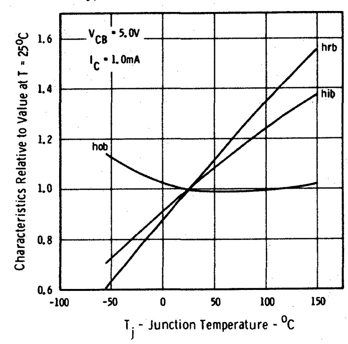
Typical Common Base Characteristics



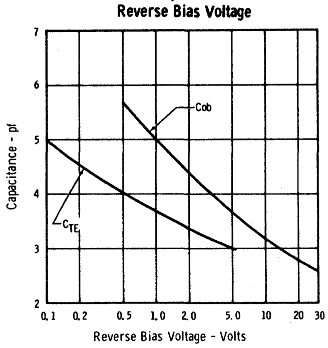
Typical Common Base Characteristics



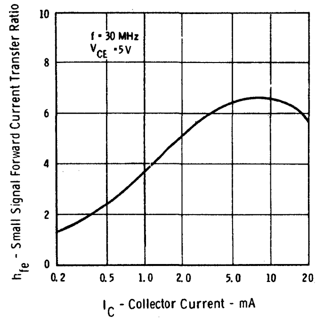
Typical Common Base Characteristics



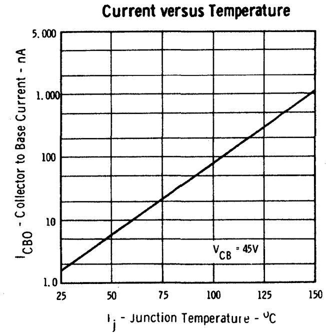
Collector and Emitter Transition Capacitance Versus Reverse Bias Voltage



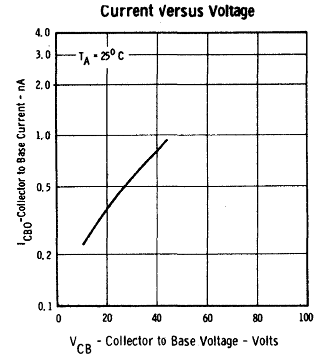
Small Signal Current Gain at 30 mc Versus Collector Current



Collector - Base Diode Reverse Current versus Temperature



Collector - Base Diode Reverse Current Versus Voltage



DUAL NPN TRANSISTOR
GENERAL PURPOSE

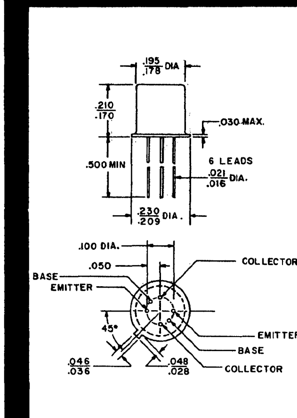
- LOW NOISE
- CLOSELY MATCHED CURRENT GAIN
- VERY CLOSELY MATCHED, V_{BE}

JANUARY 1968

2N2972 THRU 2N2979

MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING 2N2972 to 2N2977	RATING 2N2978-2N2979	UNIT
Collector-Base Voltage	V_{CBO}	45	60	Volts
Collector-Emitter Voltage	V_{CEO}	45	60	Volts
Emitter-Base Voltage	V_{EBO}	6.0	6.0	Volts
Collector Current	I_C	30		mA
Total Device Dissipation @ $T_A = 25°C$ @ $T_C = 25°C$ @ $T_C = 100°C$	P_D	 0.3 0.75 0.43		Watts
Storage Temperature	T_{stg}	−65 to +200		°C
Junction Temperature	T_J	+200		°C



ELECTRICAL CHARACTERISTICS at +25°C (Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Collector-Base Breakdown Voltage 2N2972-2N2977 2N2978, 2N2979	BV_{CBO}	$I_C = 10\ \mu A, I_E = 0$	 45 60		Volts
Emitter-Base Breakdown Voltage	BV_{EBO}	$I_C = 0, I_E = 10\ \mu A$	6.0		Volts
Collector-Emitter Sustaining Voltage 2N2972-2N2977 2N2978, 2N2979	$V_{CEO(sus)}$*	$I_C = 10$ mA, $I_B = 0$	 45 60		Volts
Collector Saturation Voltage	$V_{CE(sat)}$	$I_C = 1.0$ mA, $I_B = 0.1$ mA		0.35	Volts
Nonsaturated Base Voltage	$V_{BE(on)}$	$I_C = 0.1$ mA, $V_{CE} = 5.0$ V		0.7	Volts
Collector-Base Cutoff Current 2N2972-2N2977 2N2978, 2N2979 2N2972-2N2979	I_{CBO}	 $I_E = 0, V_{CB} = 45$ V $I_E = 0, V_{CB} = 45$ V, $T_A = 150°C$		 10 2.0 10	 nA μA
Collector-Emitter Cutoff Current	I_{CEO}	$I_B = 0, V_{CE} = 5.0$ V		2.0	nA
Emitter-Base Cutoff Current	I_{EBO}	$I_C = 0, V_{EB} = 5.0$ V		2.0	nA
DC Current Gain 2N2972, 74, 76, 78 2N2973, 79 2N2975, 77 2N2972, 74, 76, 78 2N2973, 75, 77, 79 2N2972, 74, 76, 78 2N2973, 75, 77, 79 2N2972, 74, 76, 78 2N2973, 75, 77 2N2979	h_{FE}	 $I_C = 10\ \mu A, V_{CE} = 5.0$ V $I_C = 100\ \mu A, V_{CE} = 5.0$ V $I_C = 1.0$ mA, $V_{CE} = 5.0$ V $I_C = 10\ \mu A, V_{CE} = 5.0$ V $T_A = -55°C$	 60 150 150 100 225 150 300 15 30 40	 240 600	
DC Current Ratio 2N2974, 75, 78, 79 2N2976, 77	h_{FE1}/h_{FE2}*	$I_C = 100\ \mu A, V_{CE} = 5.0$ V	 0.9 0.8	 1.0 1.0	
Base Voltage Differential 2N2974, 75, 78, 79 2N2976, 77 2N2974, 75, 78, 79 2N2976, 77	V_{BE1}-V_{BE2}	 $I_C = 10\ \mu A$ to 1.0 mA, $V_{CE} = 5.0$ V $I_C = 100\ \mu A, V_{CE} = 5.0$ V		 5.0 10 3.0 5.0	 mV

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CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Base Voltage Differential Change 2N2974, 75, 78, 79 2N2976, 77 2N2974, 75, 78, 79 2N2976, 77	$\Delta(V_{BE1}-V_{BE2})$	$I_C = 100\ \mu A$, $V_{CE} = 5.0$ V $T_A = -55°C$ to $+25°C$ $I_C = 100\ \mu A$, $V_{CE} = 5.0$ V $T_A = 25°C$ to $125°C$		0.8 1.6 1.0 2.0	mV
High Frequency Current Gain	$\lvert h_{fe} \rvert$	$I_C = 0.5$ mA, $V_{CE} = 5.0$ V f = 20 MHz	3.0		
Output Capacitance	C_{ob}	$I_E = 0$, $V_{CB} = 5.0$ V f = 140 kHz		6.0	pf
Input Resistance	h_{ib}	$I_C = 1.0$ mA, $V_{CE} = 5.0$ V f = 1.0 kHz	25	32	Ohms
Output Conductance	h_{ob}	$I_C = 1.0$ mA, $V_{CE} = 5.0$ V f = 1.0 kHz		1.0	μmhos
Noise Figure 2N2972, 74, 76, 78 2N2973, 75, 77, 79 2N2972, 74, 76, 78 2N2973, 75, 77, 79	NF	f = 1.0 kHz Source resistance = 10 kΩ Equivalent noise power bandwidth = 200 Hz $I_C = 10\ \mu A$, $V_{CE} = 5.0$ V f = 10 Hz to 10 kHz Source resistance = 10 kΩ Equivalent noise power bandwidth = 15.7 kHz $I_C = 10\ \mu A$, $V_{CE} = 5.0$ V		 4.0 3.0 4.0 3.0	 db

* Lowest of the two h_{FE} readings is taken as h_{FE1} for purposes of this ratio.
** Pulse Test: Pulse Width = 300 μsec; Duty Cycle = 1%.

DUAL NPN TRANSISTOR
GENERAL PURPOSE

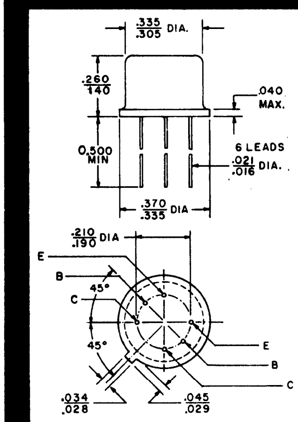
- VERY CLOSELY MATCHED, V_{BE}
- VERY LOW DIFFERENTIAL DRIFT
- CLOSELY MATCHED CURRENT GAIN

JANUARY 1968

2N3680

MAXIMUM RATINGS

CHARACTERISTIC	RATING	RATING		UNIT
Collector-Base Voltage	V_{CBO}	60		Volts
Collector-Emitter Voltage	V_{CEO}	50		Volts
Emitter-Base Voltage	V_{EBO}	6.0		Volts
		Each Side	Both Sides	
Collector Current	I_C	30	—	mA
Total Device Dissipation	P_D			
@ $T_A = 25°C$		0.3	0.6	Watts
@ $T_C = 25°C$		0.6	1.2	
Storage Temperature	T_{stg}	−65 to +200		°C
Junction Temperature	T_J	+175		°C
Derating Factor above 25°C @ $T_A = 25°C$		2.0	4.0	mW/°C



ELECTRICAL CHARACTERISTICS at +25°C (Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Collector-Base Breakdown Voltage	BV_{CBO}	$I_C = 10\ \mu A$, $I_E = 0$	60		Volts
Emitter-Base Breakdown Voltage	BV_{EBO}	$I_C = 0$, $I_E = 10\ \mu A$	60		Volts
Collector-Emitter Sustaining Voltage	$V_{CEO(sus)}$**	$I_C = 10$ mA, $I_B = 0$	50		Volts
Nonsaturated Base Voltage	$V_{BE(on)}$	$I_C = 10$ mA, $V_{CE} = 5.0$ V	0.6	0.8	Volts
Collector Saturation Voltage	$V_{CE(sat)}$	$I_C = 10$ mA, $V_{CE} = 0.5$ V		0.7	Volts
Collector-Base Cutoff Current	I_{CBO}	$I_E = 0$, $V_{CB} = 45$ V $I_E = 0$, $V_{CB} = 45$ V, $T_A = 150°C$		10 10	nA μA
Collector-Emitter Cutoff Current	I_{CEO}	$I_B = 0$, $V_{CE} = 5.0$ V		10	nA
DC Current Gain	h_{FE}	$I_C = 1.0\ \mu A$, $V_{CE} = 5.0$ V $I_C = 10\ \mu A$, $V_{CE} = 5.0$ V $I_C = 10\ \mu A$, $V_{CE} = 5.0$ V $T_A = -55°C$ $I_C = 100\ \mu A$, $V_{CE} = 5.0$ V $I_C = 1.0$ mA, $V_{CE} = 5.0$ V	80 150 45 225 300	 600	
DC Current Gain Ratio	$h_{FE1}/_{FE2}$*	$I_C = 1.0\ \mu A$, $V_{CE} = 5.0$ V $I_C = 10\ \mu A$, $V_{CE} = 5.0$ V $T_A = -55°C$ to $+125°C$	0.9 0.85	1.0 1.0	
Base Voltage Differential	V_{BE1}-V_{BE2}	$I_C = 10\ \mu A$, $V_{CE} = 5.0$ V		3.0	mV
Base Voltage Differential Change	$\Delta(V_{BE1}-V_{BE2})/\Delta T$	$I_C = 10\ \mu A$, $V_{CE} = 5.0$ V $T_A = -55°C$ to $+25°C$ $I_C = 10\ \mu A$, $V_{CE} = 5.0$ V $T_A = 25°C$ to $125°C$		0.4 0.5	mV
Small Signal Current Gain	h_{fe}	$I_C = 1.0$ mA, $V_{CE} = 5.0$ V f = 1 kHz	300	900	
High Frequency Current Gain	h_{fe}	$I_C = 0.5$ mA, $V_{CE} = 5.0$ V f= 30 MHz	2.0	6.0	
Output Capacitance	C_{ob}	$I_E = 0$, $V_{CB} = 5.0$ V f = 1 MHz		6.0	pf
Input Capacitance	C_{ib}	$I_C = 0$, $V_{BE} = 0.5$ V f = 1 MHz		6.0	pf

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CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Reverse Voltage Feedback Ratio	h_{re}	$I_C = 1.0$ mA, $V_{CE} = 5.0$ V f = 1 kHz		10	$x10^{-4}$
Input Resistance	h_{ie}	$I_C = 1.0$ mA, $V_{CE} = 5.0$ V f = 1 kHz	7.5	24	k ohms
Output Conductance	h_{oe}	$I_C = 1.0$ mA, $V_{CE} = 5.0$ V f = 1 kHz		45	μmhos
Noise Figure	NF	f = 15.7 kHz Source resistance = 10 kΩ $I_E = 10$ μA, $V_{CB} = 5.0$ V		3.0	db

* The lower reading is taken as h_{FE1}.
** Pulse Test: Pulse Width = 300 μsec; Duty Cycle = 1%.

DUAL NPN TRANSISTOR

MEDIUM POWER

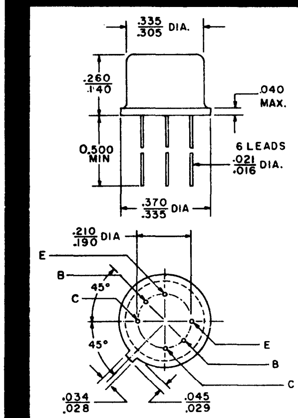
- HIGH VOLTAGE
- LOW VOLTAGE
- HIGH CURRENT GAIN

JANUARY 1968

2N2223
2N2223A

MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING		UNIT
Collector-Base Voltage	V_{CBO}	100		Volts
Collector-Emitter Voltage	V_{CEO}	60		Volts
Collector-Emitter Voltage ($R_{BE} \leqq 10\Omega$)	V_{CER}	80		Volts
Emitter-Base Voltage	V_{EBO}	7		Volts
Collector Current	I_C	500		mA
Total Device Dissipation	P_D	One Side	Both Sides	
@ $T_A = 25°C$		0.5	0.6	Watt
@ $T_C = 25°C$		1.6	3.0	
@ $T_C = 100°C$		0.9	1.7	
Derating Factor above 25°C		One Side	Both Sides	
@ $T_A = 25°C$		2.86	3.43	mW/°C
@ $T_C = 25°C$		9.1	17.2	
Storage Temperature	T_{stg}	−65 to +300		°C
Junction Temperature	T_J	+200		°C



ELECTRICAL CHARACTERISTICS at +25°C (Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Collector-Base Breakdown Voltage	BV_{CBO}	$I_C = 100\,\mu A$, $I_E = 0$	100		Volts
Collector-Emitter Sustaining Voltage	$V_{CEO(sus)}$*	$I_C = 30$ mA, $I_B = 0$	60		Volts
Collector-Emitter Sustaining Voltage	$V_{CER(sus)}$*	$I_C = 100$ mA, $R_{BE} \leqq 10\Omega$	80		Volts
Emitter-Base Breakdown Voltage	BV_{EBO}	$I_E = 100\,\mu A$, $I_C = 0$	7		Volts
Collector-Base Cutoff Current	I_{CBO}	$V_{CB} = 80$ V, $I_E = 0$ $V_{CB} = 80$ V, $I_E = 0$, $T_A = 150°C$		.010 15	μA
Emitter-Base Cutoff Current	I_{EBO}	$V_{EB} = 5$ V, $I_C = 0$		10	nA
DC Current Gain	h_{FE}	$I_C = 10\,\mu A$, $V_{CE} = 5$ V $I_C = 100\,\mu A$, $V_{CE} = 5$ V $I_C = 10$ mA, $V_{CE} = 5$ V	15 25 50	 150 200	
DC Current Gain Ratio 2N2223A 2N2223	h_{FE1}/h_{FE2}**	$I_C = 100\,\mu A$, $V_{CE} = 5$ V	 0.9 0.8	 1.0 1.0	
Base Voltage Differential 2N2223A 2N2223	$\lvert V_{BE1} - V_{BE2} \rvert$	$I_C = 100\,\mu A$, $V_{CE} = 5$ V		 5 15	mV
Base Voltage Differential Drift	$\Delta(V_{BE1}-V_{BE2})/\Delta T$	$I_C = 100\,\mu A$, $V_{CE} = 5$ V $T_A = -55°C$ to $+125°C$		25	$\mu V/°C$
Collector Saturation Voltage	$V_{CE(sat)}$	$I_C = 50$ mA, $I_B = 5$ mA		1.2	Volts
Base Saturation Voltage	$V_{BE(sat)}$	$I_C = 50$ mA, $I_B = 5$ mA		0.9	Volts
Small Signal Current Gain	h_{fe}	$I_C = 1$ mA, $V_{CE} = 5$ V, f = 1 kHz	40	200	
High Frequency Current Gain	$\lvert h_{fe} \rvert$	$I_C = 50$ mA, $V_{CE} = 10$ V, f = 20 MHz	2.5		
Output Capacitance	C_{ob}	$I_E = 0$, $V_{CB} = 10$ V, f = 140 kHz		15	pf
Input Capacitance	C_{ib}	$I_C = 0$, $V_{BE} = 0.5$ V, f = 140 kHz		85	pf
Input Resistance	h_{ib}	$I_C = 1$ mA, $V_{CB} = 5$ V, f = 1 kHz	20	30	Ohms
Output Conductance	h_{ob}	$I_C = 1$ mA, $V_{CB} = 5$ V, f = 1 kHz		0.5	μmhos
Voltage Feedback Ratio	h_{rb}	$I_C = 1$ mA, $V_{CB} = 5$ V, f = 1 kHz		300	$\times 10^{-6}$

*The lower of the two h_{FE} readings is taken as h_{FE1}.
** Pulse Test: Pulse Width $\leq 300\,\mu$sec; Duty Cycle = 1%.

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DUAL NPN TRANSISTOR

RF/IF AMPLIFIER

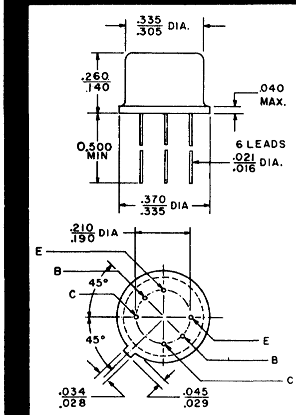
- LOW DIFFERENTIAL DRIFT
- CLOSELY MATCHED CURRENT GAIN
- HIGH FREQUENCY

JANUARY 1968

2N3423
2N3424

MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING		UNIT
Collector-Base Voltage	V_{CBO}	30		Volts
Collector-Emitter Voltage	V_{CEO}	15		Volts
Emitter-Base Voltage	V_{EBO}	3.0		Volts
Collector Current	I_C	50		mA
Total Device Dissipation	P_D	Each Side	Both Sides	Watts
@ $T_A = 25°C$		0.3	0.6	
@ $T_C = 100°C$		0.25	0.5	
@ $T_C = 25°C$		0.6	1.2	
Derating Factor above 25°C		Each Side	Both Sides	mW/°C
@ $T_A = 25°C$		1.7	3.4	
@ $T_C = 25°C$		3.4	6.8	
Storage Temperature	T_{stg}	−65 to +200		°C
Junction Temperature	T_J	+200		°C



ELECTRICAL CHARACTERISTICS at +25°C (Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Collector-Base Breakdown Voltage	BV_{CBO}	$I_C = 1.0\ \mu A$, $I_E = 0$	30		Volts
Emitter-Base Breakdown Voltage	BV_{EBO}	$I_C = 0$, $I_E = 10\ \mu A$	3.0		Volts
Collector-Emitter Sustaining Voltage	$V_{CEO(sus)}$*	$I_C = 3.0$ mA, $I_B = 0$	15		Volts
Collector Saturation Voltage	$V_{CE(sat)}$	$I_C = 10$ mA, $I_B = 1.0$ mA		0.4	Volts
Base Saturation Voltage	$V_{BE(sat)}$	$I_C = 10$ mA, $I_B = 1.0$ mA		1.0	Volts
Collector-Base Cutoff Current	I_{CBO}	$I_E = 0$, $V_{CB} = 15$ V		10	nA
		$I_E = 0$, $V_{CB} = 15$ V, $T_A = 150°C$		1.0	µA
Emitter-Base Cutoff Current	I_{EBO}	$I_C = 0$, $V_{EB} = 3.0$ V		10	µA
DC Pulse Current Gain	h_{FE}*	$I_C = 3.0$ mA, $V_{CE} = 3.0$ V	20	200	
DC Current Gain Ratio	h_{FE1}/h_{FE2}**	$I_C = 3.0$ mA, $V_{CE} = 3.0$ V			
2N3423			0.8	1.0	
2N3424			0.9	1.0	
Base Voltage Differential	V_{BE1}-V_{BE2}				
2N3423		$I_C = 3.0$ mA, $V_{CE} = 3.0$ V		10	mV
2N3424				5.0	
Base Voltage Differential Change	$\Delta(V_{BE1}$-$V_{BE2})/\Delta T$				
2N3423		$I_C = 3.0$ mA, $V_{CE} = 3.0$ V		3.2	mV
2N3424		$T_A = -55°C$ to $+25°C$		1.6	
2N3423		$I_C = 3.0$ mA, $V_{CE} = 3.0$ V		4.0	
2N3424		$T_A = +25°C$ to $+125°C$		2.0	
High Frequency Current Gain	$\lvert h_{fe} \rvert$	$I_C = 4.0$ mA, $V_{CE} = 10$ V f = 100 MHz	6.0	12	
Output Capacitance	C_{ob}	$I_E = 0$, $V_{CB} = 10$ V f = 140 kHz		1.7	pf
		$I_E = 0$, $V_{CB} = 0$ f = 140 kHz		3.0	
Input Capacitance	C_{ib}	$I_C = 0$, $V_{BE} = 0.5$ V f = 140 kHz		2.0	pf
Input Resistance	h_{ie}	$I_C = 3.0$ mA, $V_{CE} = 3.0$ V f = 350 kHz		45	ohms
Low Frequency Noise Figure	NF	f = 60 MHz Source Resistance = 400Ω $I_C = 1.0$ mA, $V_{CE} = 6.0$ V		3.5 (typ.)	db

* Pulse Test: Pulse Width = 300 µsec; Duty Cycle = 1%.
** Lowest of the two h_{FE} readings is taken as h_{FE1} for purposes of this ratio.

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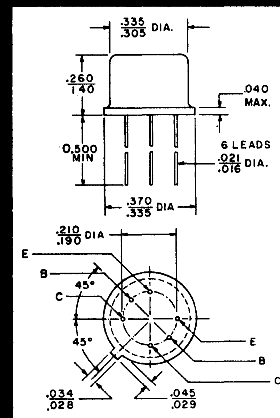
DUAL PNP TRANSISTOR
GENERAL PURPOSE
- CLOSELY MATCHED, V_{BE} LOW DIFFERENTIAL DRIFT
- HIGH CURRENT GAIN

JANUARY 1968

2N3347 THRU 2N3352

MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING		UNIT
Collector-Base Voltage	V_{CBO}	60		Volts
Collector-Emitter Voltage	V_{CEO}	45		Volts
Emitter-Base Voltage	V_{EBO}	6		Volts
Collector Current	I_C	30		mA
Total Device Dissipation	P_D	Each Side	Both Sides	
@ $T_A = 25°C$		300	600	mW
@ $T_C = 25°C$		0.6	1.2	
Storage Temperature	T_{stg}	−65 to +200		°C



ELECTRICAL CHARACTERISTICS at +25°C (Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Collector-Base Breakdown Voltage	BV_{CBO}	$I_C = 10\ \mu A$, $I_E = 0$	60		Volts
Collector-Emitter Breakdown Voltage	BV_{CEO}	$I_C = 10$ mA, $I_B = 0$	45		Volts
Emitter-Base Breakdown Voltage	BV_{EBO}	$I_E = 10\ \mu A$, $I_C = 0$	6		Volts
Base-Emitter Voltage	V_{BE}	$I_C = 10$ mA, $V_{CE} = 5$ V		0.9	Volts
Collector Saturation Voltage	$V_{CE(sat)}$	$I_C = 10$ mA, $I_B = 0.5$mA		0.5	Volts
Collector-Base Cutoff Current	I_{CBO}	$V_{CB} = 45$ V, $I_E = 0$ $V_{CB} = 45$ V, $I_E = 0$, $T_A = 150°C$		10 10	nA μA
Emitter-Base Cutoff Current	I_{EBO}	$V_{EB} = 6$ V, $I_C = 0$		2	nA
DC Current Gain 2N3347, 48, 49 2N3350, 51, 52 2N3347, 48, 49 2N3350, 51, 52	h_{FE}	 $I_C = 10\ \mu A$, $V_{CE} = 5$ V $I_C = 10\ \mu A$, $V_{CE} = 5$ V $I_C = 1.0$ mA, $V_{CE} = 5$ V $I_C = 1.0$ mA, $V_{CE} = 5$ V	 40 100 60 150	 300 300	
DC Current Gain Ratio 2N3347, 50 2N3348, 51 2N3349, 52	h_{FE1}/h_{FE2}*	$I_C = 10\ \mu A$, $V_{CE} = 5$ V	 0.9 0.8 0.6	 1.0 1.0 1.0	
Base-Emitter Voltage Differential 2N3347, 50 2N3348, 51 2N3349, 52	V_{BE1}-V_{BE2}	$I_C = 10\ \mu A$, $V_{CE} = 5$ V		 5.0 10 20	 mV
Base-Emitter Voltage Differential Change 2N3347, 50 2N3348, 51 2N3349, 52	$\Delta(V_{BE1}$-$V_{BE2})/\Delta T$	$I_C = 10\ \mu A$, $V_{CE} = 5$ V $T_1 = 25°C$, $T_2 = -55°C$		 0.8 1.6 3.2	 mV
Base-Emitter Voltage Differential Change 2N3347, 50 2N3348, 51 2N3349, 52	$\Delta(V_{BE1}$-$V_{BE2})/\Delta T$	$I_C = 10\ \mu A$, $V_{CE} = 5$ V $T_1 = 25°C$, $T_2 = 125°C$		 1.0 2.0 40	 mV
High Frequency Current Gain	$\|h_{fe}\|$	$I_C = 1.0$ mA, $V_{CE} = 5$ V f = 30 MHz	2.0	8.0	

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CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Small Signal Current Gain 2N3347, 48, 49 2N3350, 51, 52	h_{fe}	$I_C = 10$ mA, $V_{CE} = 5$ V f = 1 kHz	 60 150	 600 600	
Output Capacitance	C_{ob}	$V_{CE} = 5$ V, f = 1 MHz		6	pf
Output Capacitance	C_{ib}	$V_{EB} = 0.5$ V, f = 1 MHz		8	pf
Output Admittance	h_{oe}	$I_C = 1.0$ mA, $V_{CE} = 5$ V f = 1 kHz		100	μmhos
Input Impedance 2N3347, 48, 49 2N3350, 51, 52	h_{ie}	$I_C = 1.0$ mA, $V_{CE} = 5$ V f = 1 kHz	 1.5 3.7	 2.0 2.0	 K ohms

* The lowest h_{FE} reading is taken as h_{FE1} for this ratio.

DUAL PNP TRANSISTOR
GENERAL PURPOSE

- **LOW NOISE**
- **VERY LOW DIFFERENTIAL DRIFT**
- **CLOSELY MATCHED CURRENT GAIN**

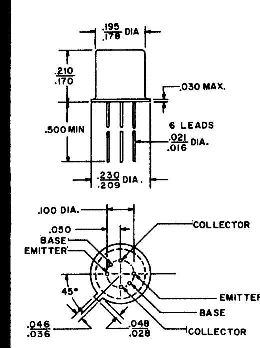
JANUARY 1968

2N3800 THRU 2N3811

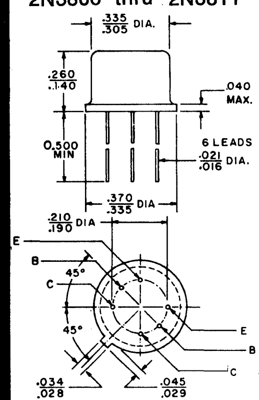
MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING				UNIT
Collector-Base Voltage	V_{CBO}	60				Volts
Collector-Emitter Voltage	V_{CEO}	60				Volts
Emitter-Base Voltage	V_{EBO}	5				Volts
Collector Current	I_C	50				mA
		2N3800 thru 2N3805		2N3806 thru 2N3811		
		Each Side	Both Sides	Each Side	Both Sides	
Total Device Dissipation @ $T_A = 25°C$	P_D	250	360	500	600	mW
Derating Factor above 25°C @ $T_A = 25°C$		1.5	2.1	2.9	3.4	mW/°C
Storage Temperature	T_{stg}	−65 to +200				°C
Junction Temperature	T_J	+200				°C
Lead Temperature 1/16 inch from case, 10 seconds max.		+230				°C

2N3800 thru 2N3805



2N3806 thru 2N3811



ELECTRICAL CHARACTERISTICS at +25°C (Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Collector-Base Breakdown Voltage	BV_{CBO}	$I_C = 10\mu A, I_E = 0$	60		Volts
Collector-Emitter Breakdown Voltage	BV_{CEO}	$I_C = 10mA, I_B = 0$	60		Volts
Emitter-Base Breakdown Voltage	BV_{EBO}	$I_E = 10\mu A, I_C = 0$	5		Volts
Base Emitter "ON" Voltage	$V_{BE(ON)}$	$I_C = 100\mu A, V_{CE} = 5\ V$		0.7	Volts
Collector Saturation Voltage	$V_{CE(sat)}$*	$I_C = 100\mu A, I_B = 10\ \mu A$ $I_C = 1\ mA, I_B = 100\ \mu A$		0.2 0.25	Volts
Base Saturation Voltage	$V_{BE(sat)}$*	$I_C = 100\mu A, I_B = 10\ \mu A$ $I_C = 1\ mA, I_B = 100\ \mu A$		0.7 0.8	Volts
Collector-Base Cutoff Current	I_{CBO}	$V_{CB} = 50\ V, I_E = 0$ $V_{CB} = 50\ V, I_E = 0, T_A = 150°C$		0.010 10	μA
Emitter-Base Cutoff Current	I_{EBO}	$V_{EB} = 4\ V, I_C = 0$		20	nA
DC Current Gain	h_{FE}*				
2N3801, 03, 05, 07, 09, 11		$I_C = 1\ \mu A, V_{CE} = 5\ V$	75		
2N3800, 02, 04, 06, 08, 10 2N3801, 03, 05, 07, 09, 11		$I_C = 10\ \mu A, V_{CE} = 5\ V$	100 225		
2N3800, 02, 04, 06, 08, 10 2N3801, 03, 05, 07, 09, 11		$I_C = 100\ \mu A, V_{CE} = 5\ V$	150 300	450 900	
2N3800, 02, 04, 06, 08, 10 2N3801, 03, 05, 07, 09, 11		$I_C = 100\ \mu A, V_{CE} = 5\ V$ $T_A = -55°C$	75 150		
2N3800, 02, 04, 06, 08, 10 2N3801, 03, 05, 07, 09, 11		$I_C = 500\ \mu A, V_{CE} = 5\ V$	150 300	450 900	
2N3800, 02, 04, 06, 08, 10 2N3801, 03, 05, 07, 09, 11		$I_C = 1\ mA, V_{CE} = 5\ V$	150 300	450 900	
2N3800, 02, 04, 06, 08, 10 2N3801, 03, 05, 07, 09, 11		$I_C = 10\ mA, V_{CE} = 5\ V$	125 250		
DC Current Gain Ratio 2N3802, 03, 08, 09 2N3804, 05, 10, 11	h_{FE1}/h_{FE2}**	$I_C = 100\ \mu A, V_{CE} = 5\ V$	0.8 0.9	1.0 1.0	

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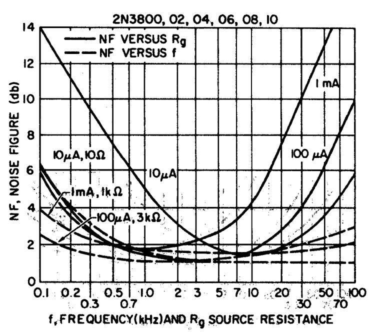
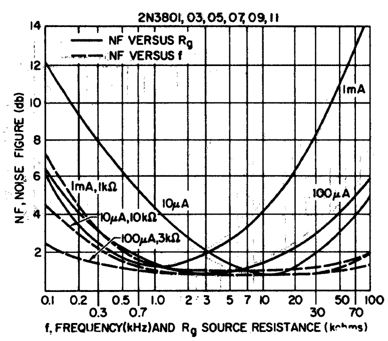
CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Base Voltage Differential	$\lvert V_{BE1}\text{-}V_{BE2}\rvert$				
2N3802, 03, 08, 09		$I_C = 10\ \mu A$ to 10 mA, $V_{CE} = 5$ V		8	mV
2N3804, 05, 10, 11				5	
2N3802, 03, 08, 09		$I_C = 100\ \mu A$, $V_{CE} = 5$ V		5	
2N3804, 05, 10, 11				3	
Base Voltage Differential Change	$\Delta(V_{BE1}\text{-}V_{BE2})/\Delta T$				
2N3802, 03, 08, 09		$I_C = 100\ \mu A$, $V_{CE} = 5$ V		1.6	mV
2N3804, 05, 10, 11		$T_A = -55°C$ to $+25°C$		0.8	
2N3802, 03, 08, 09		$I_C = 100\ \mu A$, $V_{CE} = 5$ V		2.0	
2N3804, 05, 10, 11		$T_A = 25°C$ to $125°C$		1.0	
High Frequency Current Gain	$\lvert h_{fe}\rvert$	$I_C = 500\ \mu A$, $V_{CE} = 5$ V, f = 30 MHz	1.0		
		$I_C = 1$ mA, $V_{CE} = 5$ V, f = 100 MHz	1.0	5	
Small Signal Current Gain	h_{fe}				
2N3800, 02, 04, 06, 08, 10		$I_C = 1$ mA, $V_{CE} = 10$ V, f = 1 kHz	150	600	
2N3801, 03, 05, 07, 09, 11			300	900	
Output Capacitance	C_{ob}	$V_{CB} = 5$ V, $I_E = 0$, f = 100 kHz		4	pf
Input Capacitance	C_{ib}	$V_{EB} = 0.5$ V, $I_E = 0$, f = 100 kHz		8	pf
Voltage Feedback Ratio	h_{re}	$I_C = 1.0$ mA, $V_{CE} = 10$ V, f = 1 kHz		25	$X10^{-4}$
Input Resistance	h_{ie}				
2N3800, 02, 04, 06, 08, 10		$I_C = 1.0$ mA, $V_{CE} = 10$ V, f = 1 kHz	3	15	K ohms
2N3081, 03, 05, 07, 09, 11			10	40	
Output Conductance	h_{oe}	$I_C = 1.0$ mA, $V_{CE} = 10$ V, f = 1 kHz	5	60	μ mhos
Noise Figure	NF				
2N3800, 02, 04, 06, 08, 10		$I_C = 100\ \mu A$, $V_{CE} = 10$ V, $R_S = 3\ k\Omega$		7	db
2N3801, 03, 05, 07, 09, 11		f = 100 Hz, BW = 20 Hz		4	
2N3800, 02, 04, 06, 08, 10		f = 1 kHz, BW = 200 Hz		3	
2N3801, 03, 05, 07, 09, 11				1.5	
2N3800, 02, 04, 06, 08, 10		f = 10 kHz, BW = 2 kHz		2.5	
2N3801, 03, 05, 07, 09, 11				1.5	
2N3800, 02, 04, 06, 08, 10		Noise Bandwidth 10 Hz to 10 kHz		3.5	
2N3801, 03, 05, 07, 09, 11		BW = 15.7 kHz		2.5	

* Pulse Test $\leq 300\mu$sec, duty cycle $\leq 2\%$

** The lowest h_{FE} reading is taken as h_{FE1} for this ratio

Noise Figure vs Frequency and Source Resistance





DUAL PNP TRANSISTOR
GENERAL PURPOSE

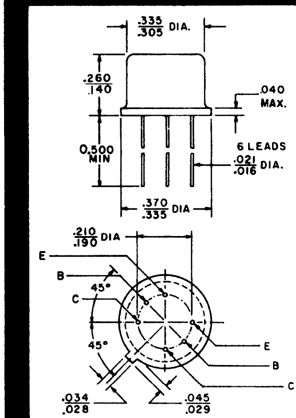
- LOW NOISE
- LOW SATURATION VOLTAGE
- HIGH BREAKDOWN VOLTAGE

JANUARY 1968

2N4017
2N4018
2N4019

MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING			UNIT
		4017	4018	4019	
Collector-Base Voltage	V_{CBO}	−45	−60	−80	Volts
Collector-Emitter Voltage	V_{CEO}	−45	−60	−80	Volts
Emitter-Base Voltage	V_{EBO}	6	6	6	Volts
		Each Side	Both Sides		
Collector Current	I_C	200			mA
Total Device Dissipation @ $T_A = 25°C$ @ $T_C = 25°C$	P_D	 0.4 0.8	 0.6 1.3		Watts
Storage Temperature	T_{stg}	−65 to +200			°C
Junction Temperature	T_J	+200			°C
Derating Factor above 25°C @ $T_A = 25°C$ @ $T_C = 25°C$		 2.28 4.57	 3.4 7.4		mW/°C



ELECTRICAL CHARACTERISTICS at +25°C (Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Collector-Base Breakdown Voltage 2N4017 2N4018 2N4019	BV_{CBO}	$I_C = 10\ \mu A, I_E = 0$	 80 60 45		Volts
Collector-Emitter Breakdown Voltage 2N4017 2N4018 2N4019	BV_{CEO}	$I_C = 5.0\ mA, I_B = 0$	 80 60 45		Volts
Emitter-Base Breakdown Voltage	BV_{EBO}	$I_E = 10\ \mu A, I_C = 0$	6.0		Volts
Base Saturation Voltage	$V_{BE(sat)}$	$I_C = 10\ mA, I_B = 0.5\ mA$ $I_C = 50\ mA, I_B = 5.0\ mA$		0.9 0.95	Volts
Collector Saturation Voltage	$V_{CE(sat)}$	$I_C = 10\ mA, I_B = 0.5\ mA$ $I_C = 50\ mA, I_B = 5.0\ mA$		0.25 0.4	Volts
Collector-Base Cutoff Current 2N4017 2N4018 2N4019 2N4017 2N4018 2N4019	I_{CBO}	 $V_{CB} = 70\ V, I_E = 0$ $V_{CB} = 50\ V, I_E = 0$ $V_{CB} = 30\ V, I_E = 0$ $V_{CB} = 70\ V, I_E = 0, T_A = 125°C$ $V_{CB} = 50\ V, I_E = 0, T_A = 125°C$ $V_{CB} = 30\ V, I_E = 0, T_A = 125°C$		 10 10 10 10 10 10	 nA μA
Emitter-Base Cutoff Current	I_{EBO}	$V_{EB} = 4.0\ V, I_C = 0$		10	nA
DC Current Gain 2N4017, 2N4018 2N4019 2N4017 2N4018 2N4019 2N4017, 2N4018 2N4019 2N4017 2N4018 2N4019 2N4017, 2N4018 2N4019	h_{FE}	 $I_C = 1.0\ \mu A, V_{CE} = 5\ V$ $I_C = 10\ \mu A, V_{CE} = 5\ V$ $I_C = 100\ \mu A, V_{CE} = 5\ V$ $I_C = 1.0\ mA, V_{CE} = 5\ V$ $I_C = 10\ mA, V_{CE} = 5\ V$	 60 180 100 100 250 100 250 100 100 250 100 200	 350 500 500 500 600 600	

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CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
DC Current Gain	h_{FE}				
2N4017, 2N4018		$I_C = 50$ mA, $V_{CE} = 5$ V	90		
2N4019			180		
2N4017		$I_C = 1.0$ mA, $V_{CE} = 5$ V		600	
2N4018, 2N4019		$T_A = 100°C$		800	
2N4017, 2N4018		$I_C = 10\ \mu A$, $V_{CE} = 5$ V	40		
2N4019		$T_A = -55°C$	100		
2N4017, 2N4018		$I_C = 50$ mA, $V_{CE} = 5$ V	40		
2N4019		$T_A = -55°C$	80		
2N4017		$I_C = 1.0$ mA, $V_{CE} = 5$ V	100	550	
2N4018		$T_A = -55°C$	100	700	
2N4019			250	700	
High Frequency Current Gain	$\|h_{fe}\|$				
2N4017, 2N4018		$I_C = 0.5$ mA, $V_{CE} = 5$ V	2.0	8.0	
2N4019		f = 20 MHz	2.5	8.0	
Output Capacitance	C_{ob}	$V_{CB} = 5.0$ V, f = 1.0 MHz, $I_E = 0$		6.0	pf
Small Signal Feedback Ratio	h_{re}	$I_C = 1.0$ mA, $V_{CE} = 5$ V f = 1 kHz		10	$X10^{-4}$
Input Impedance	h_{ie}				
2N4017		$I_C = 1.0$ mA, $V_{CE} = 5$ V	2.5	17	K ohms
2N4018		f = 1 kHz	2.5	20	
2N4019			6.0	20	
Output Conductance	h_{oe}				
2N4017		$I_C = 1.0$ mA, $V_{CE} = 5$ V	5	40	μmhos
2N4018, 2N4019		f = 1 kHz	5	40	
Noise Figure	NF	$I_C = 20\ \mu A$, $V_{CE} = 5$ V			
2N4017, 2N4018		f = 1 kHz, BW = 150 Hz		3	db
2N4019		Rg = 10 kΩ		2	
		$I_C = 20\ \mu A$, $V_{CE} = 5$ V			
2N4017, 2N4018		f = 100 Hz, BW = 15 Hz		10	
2N4019		Rg = kΩ		4	
2N4019		$I_C = 20\ \mu A$, $V_{CE} = 5$ V f = 10 Hz, BW = 2 Hz Rg = 10 kΩ		8	

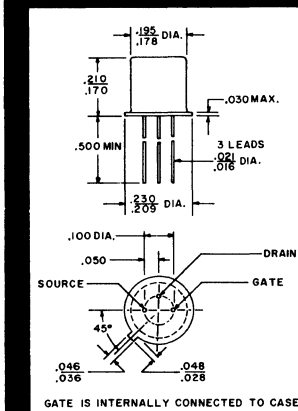
N-CHANNEL FIELD EFFECT TRANSISTOR
GENERAL PURPOSE
- LOW NOISE
- LOW CAPACITANCE
- HIGH TRANSCONDUCTANCE

JANUARY 1968

2N3069-71
2N3368-70

MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING 2N3069-71	2N3368-70	UNIT
Total Device Dissipation @ $T_A = 25°C$	P_D	350	300	mW
Derating Factor above 25°C @ $T_A = 25°C$		2.0	2.4	mW/°C
Storage Temperature	T_{stg}	−65 to +300	−65 to +175	°C
Junction Temperature	T_J	200	150	°C



ELECTRICAL CHARACTERISTICS at +25°C (Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Drain-Gate Breakdown Voltage	BV_{DGO}	$I_D = 1.0\ \mu A, I_S = 0$			Volts
2N3069-71			50		
2N3368-70			40		
Total Gate Leakage Current	I_{GSS}				
2N3069-71		$V_{GS} = -30\ V, V_{DS} = 0$		1.0	nA
2N3368-70				5.0	
2N3069-71		$V_{GS} = -30\ V, V_{DS} = 0$, $T_A = 150°C$		1.0	μA
2N3368-70		$V_{GS} = -30\ V, V_{DS} = 0$, $T_A = 100°C$		1.5	
Saturation Current	I_{DSS}	$V_{DS} = 30\ V, V_{GS} = 0$			mA
2N3068			2.0	10	
2N3069			2.0	12	
2N3369, 2N3070			0.5	2.5	
2N3370, 2N3071			0.1	0.6	
Pinch Off Voltage	V_P	$V_{DS} = 30\ V, I_D = 1.0\ nA$			Volts
2N3069				10	
2N3070				5.0	
2N3071				2.5	
2N3368				12	
2N3369				7.0	
2N3370				3.5	
Transconductance	g_m	$V_{DS} = 30\ V, V_{GS} = 0$, $f = 1.0\ kHz$			μmhos
2N3368			1000	2500	
2N3069			1000	4000	
2N3070			750	2500	
2N3369			600	2500	
2N3071			500	2500	
2N3370			300	2500	
Output Conductance	g_{os}	$V_{DS} = 30\ V, V_{GS} = 0$			μmhos
2N3069				80	
2N3070				30	
2N3071				7.0	
Output Capacitance	C_{os}				
2N3069-71		$V_{DS} = 30\ V, V_{GS} = 0$		1.5	pf

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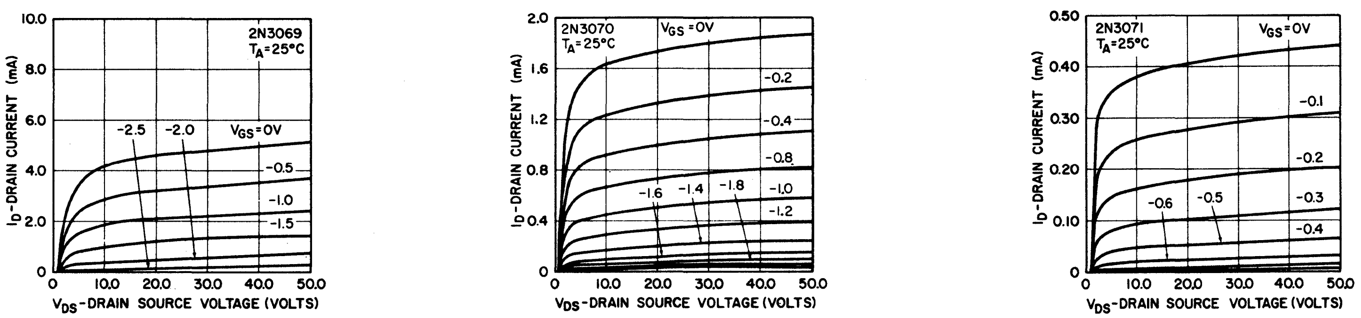
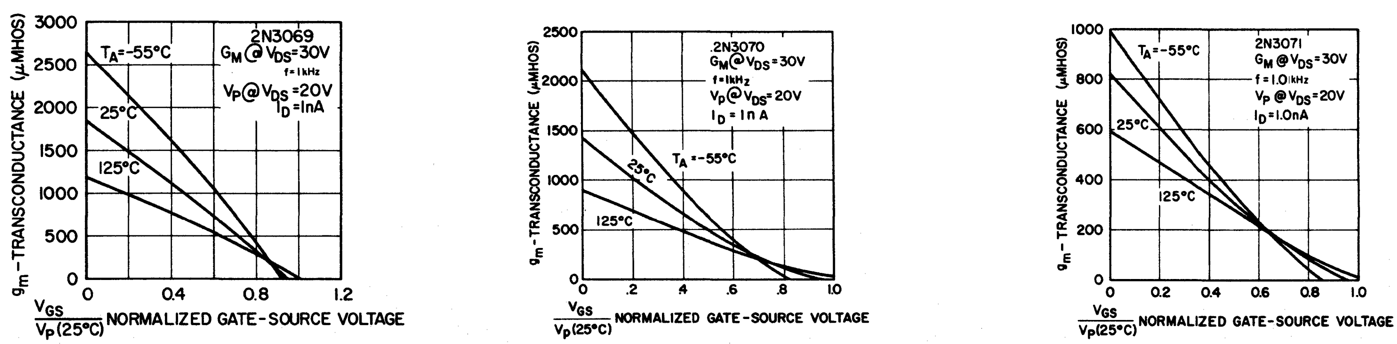
CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Input Capacitance	C_{is}				
2N3069		$V_{DS} = 12$ V, $V_{GS} = 0$		15	pf
2N3070		$V_{DS} = 8.0$ V, $V_{GS} = 0$		15	
2N3071		$V_{DS} = 5.0$ V, $V_{GS} = 0$		15	
Drain-Gate Capacitance	C_{DG}				
2N3069		$V_{DG} = 10$ V, $I_S = 0$, f = 140 kHz		2.5	pf
2N3070		$V_{DG} = 8.0$ V, $I_S = 0$, f = 140 kHz		2.5	
2N3071		$V_{DG} = 5.0$ V, $I_S = 0$, f = 140 kHz		2.5	
2N3368		$V_{DG} = 10$ V, $I_S = 0$, f = 140 kHz		3.5	
2N3369		$V_{DG} = 8.0$ V, $I_S = 0$, f = 140 kHz		3.5	
2N3370		$V_{DG} = 5.0$ V, $I_S = 0$, f = 140 kHz		3.5	
Source-Gate Capacitance	C_{SG}				
2N3069		$V_{GS} = -10$ V, $I_D = 0$, f = 140 kHz		5.0	pf
2N3070		$V_{GS} = -8.0$ V, $I_D = 0$, f = 140 kHz		5.0	
2N3071		$V_{GS} = -5.0$ V, $I_D = 0$, f = 140 kHz		5.0	
2N3368		$V_{GS} = -10$ V, $I_D = 0$, f = 140 kHz		6.0	
2N3369		$V_{GS} = -8.0$ V, $I_D = 0$, f = 140 kHz		6.0	
2N3370		$V_{GS} = -5.0$ V, $I_D = 0$, f = 140 kHz		6.0	
Noise Figure	NF				
2N3069		$V_{DS} = 15$ V, $V_{GS} = 0$ f = 1.0 kHz, Rg = 10 MΩ, BW = 200 Hz		4	db
2N3070		$V_{DS} = 10$ V, $V_{GS} = 0$ f = 1.0 kHz, Rg = 10 MΩ, BW = 200 Hz		4	
2N3071		$V_{DS} = 5.0$ V, $V_{GS} = 0$ f = 1.0 kHz, Rg = 10 MΩ, BW = 200 Hz		4	

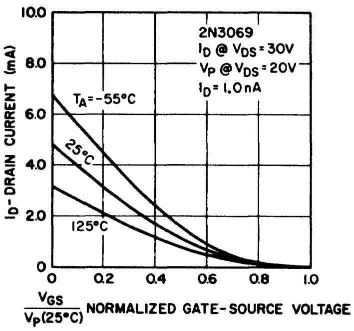
COMMON SOURCE – DRAIN CHARACTERISTICS

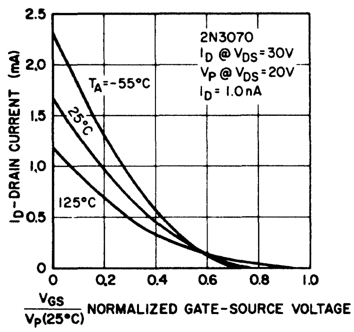


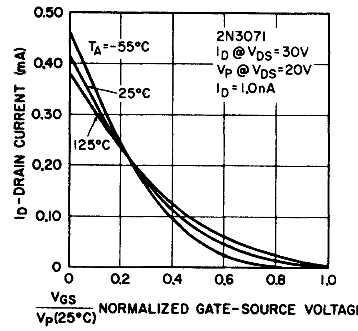
TRANSCONDUCTANCE VS. NORMALIZED GATE-SOURCE VOLTAGE



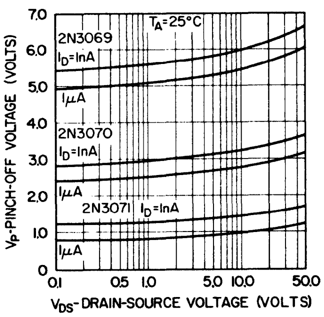
DRAIN CURRENT VS. NORMALIZED GATE-SOURCE VOLTAGE



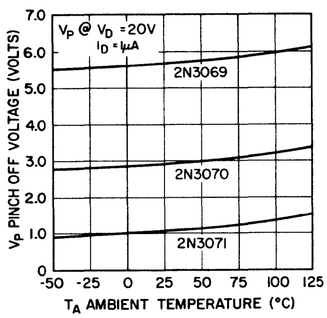




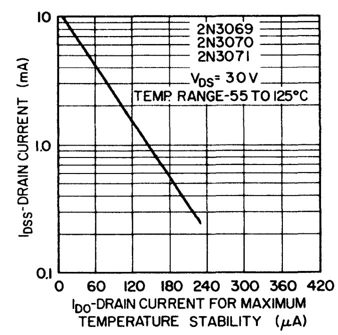
Pinch Off Voltage
vs
Drain Source Voltage



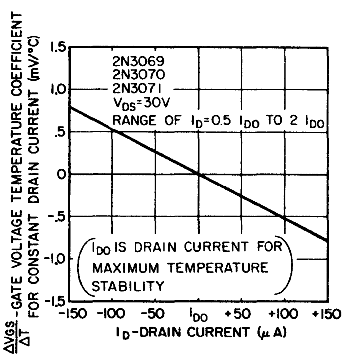
Pinch Off Voltage
vs
Temperature



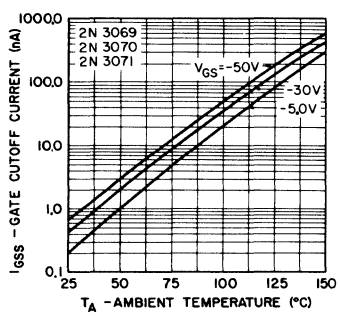
Drain Current For
Maximum Temperature
Stability
vs
IDSS



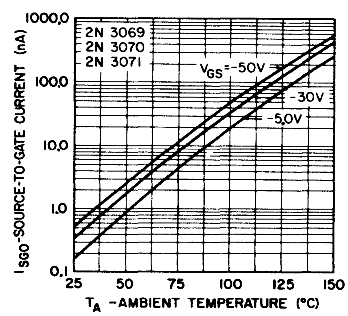
Gate Voltage Temperature
Coefficient For Constant
Drain Current
vs
Drain Current



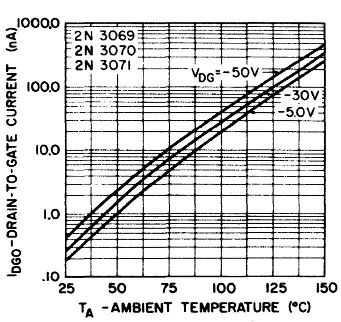
Gate Cutoff Current
vs
Temperature



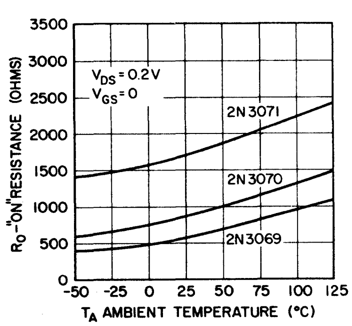
Source – Gate
Reverse Current
vs
Temperature



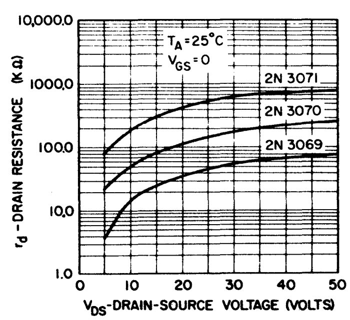
Drain – Gate
Reverse Current
vs
Temperature



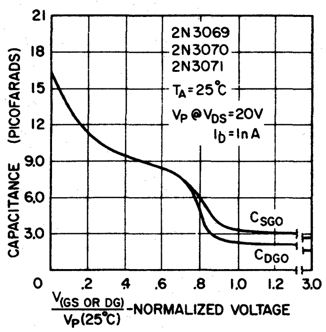
"ON" Resistance
vs
Temperature



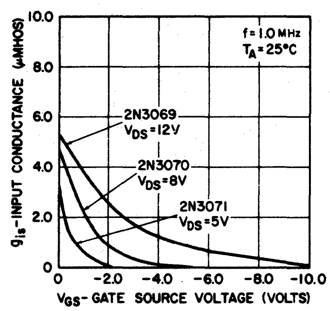
Dynamic Resistance
vs
Drain – Source Voltage



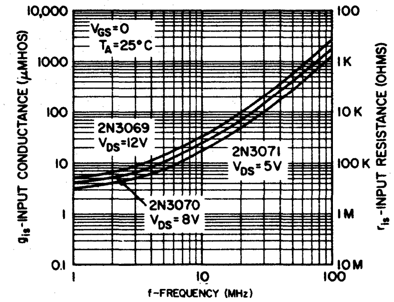
Junction Capacity vs Normalized Bias



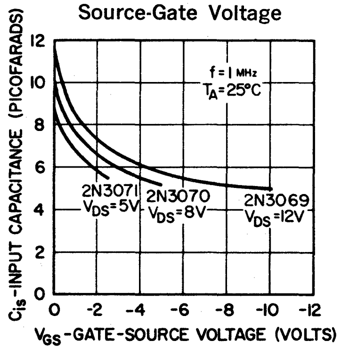
Input Conductance vs Gate – Source Voltage



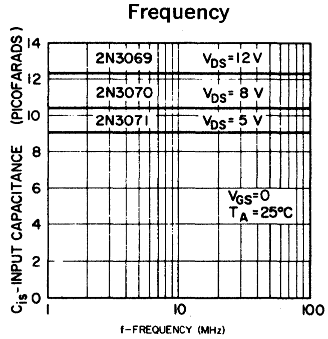
Input Conductance vs Frequency



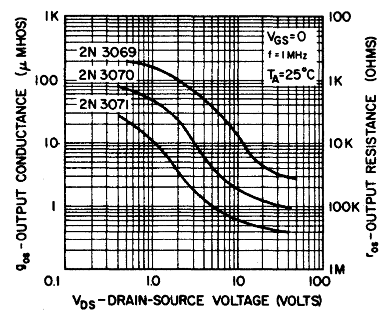
Input Capacitance vs Source-Gate Voltage



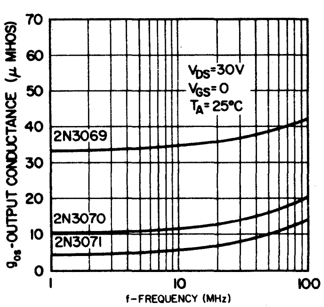
Input Capacitance vs Frequency



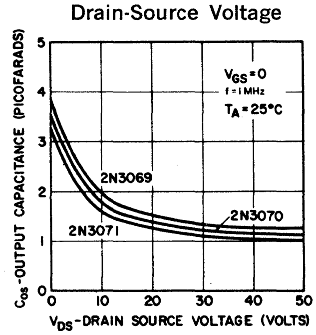
Output Conductance vs Drain Source Voltage



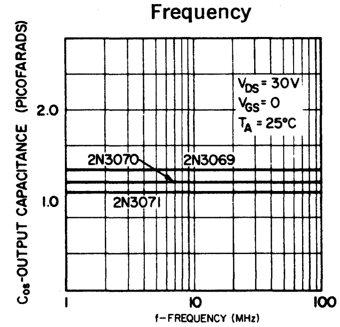
Output Conductance vs Frequency



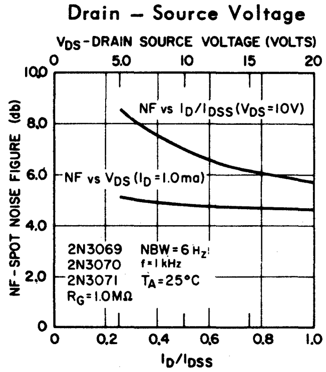
Output Capacitance vs Drain-Source Voltage



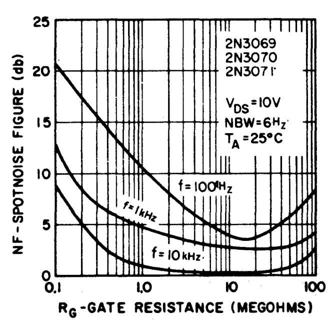
Output Capacitance vs Frequency



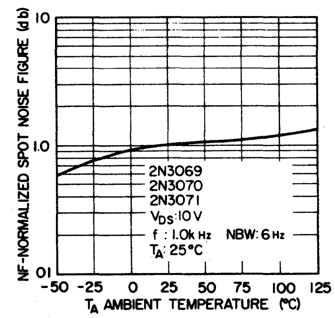
Spot Noise vs Drain – Source Voltage



Spot Noise vs Gate Resistance



Spot Noise vs Temperature



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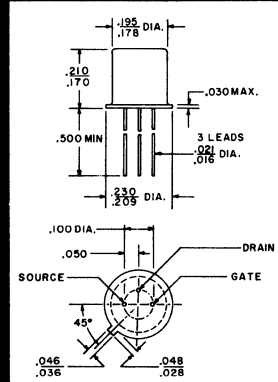
JANUARY 1968

N-CHANNEL FIELD EFFECT TRANSISTOR
GENERAL PURPOSE
- **HIGH TRANSCONDUCTANCE**
- **HIGH BREAKDOWN VOLTAGE**
- **LOW NOISE**

2N3436-38
2N3458-60

MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
Total Device Dissipation @ $T_A = 25°C$	P_D	300	mW
Derating Factor above 25°C @ $T_A = 25°C$		1.7	mW/°C
Storage Temperature	T_{stg}	−65 to +200	°C
Junction Temperature	T_J	200	°C



GATE IS INTERNALLY CONNECTED TO CASE

ELECTRICAL CHARACTERISTICS at +25°C (Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Drain-Gate Breakdown Voltage	BV_{DGO}	$I_D = 1.0\ \mu A$, $I_S = 0$	50		Volts
Total Gate Leakage Current	I_{GSS}				
2N3436-38		$V_{GS} = -30$ V, $V_{DS} = 0$		0.5	nA
2N3458-60				0.25	
2N3436-38		$V_{GS} = -30$ V, $V_{DS} = 0$, $T_A = 150°C$		1.0	μA
2N3458-60				0.5	
Saturation Current	I_{DSS}				
2N3436, 2N3458		$V_{DS} = 20$ V, $V_{GS} = 0$	3.0	15	mA
2N3437, 2N3459			0.8	4.0	
2N3438, 2N3460			0.2	1.0	
Pinch Off Voltage	V_P				
2N3436		$V_{DS} = 20$ V, $I_D = 1.0$ nA		10	Volts
2N3437				5.0	
2N3438				2.5	
2N3458				8.0	
2N3459				4.0	
2N3460				2.0	
Transconductance	g_m				
2N3436, 2N3458		$V_{DS} = 20$ V, $V_{GS} = 0$	2500	10,000	μmhos
2N3437, 2N3459			1500	6000	
2N3438, 2N3460			800	4500	
Input Conductance	G_{is}				
2N3436, 2N3458		$V_{DS} = 10$ V, $V_{GS} = 0$, f = 1.0 MHz		4.0	μmhos
2N3437, 2N3459		$V_{DS} = 6.0$ V, $V_{GS} = 0$, f = 1.0 MHz		3.5	
2N3438, 2N3460		$V_{DS} = 4.0$ V, $V_{GS} = 0$, f = 1.0 MHz		2.5	
Output Conductance	G_{os}				
2N3436, 2N3458		$V_{DS} = 30$ V, $V_{GS} = 0$, f = 1.0 MHz		35	μmhos
2N3437, 2N3459				20	
2N3438, 2N3460				5.0	

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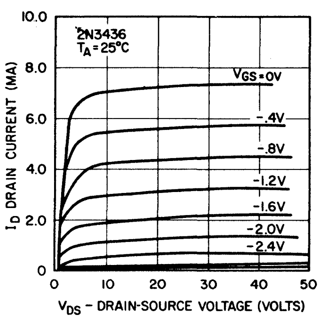
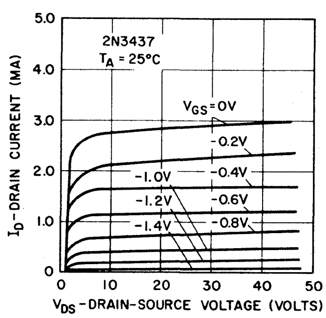
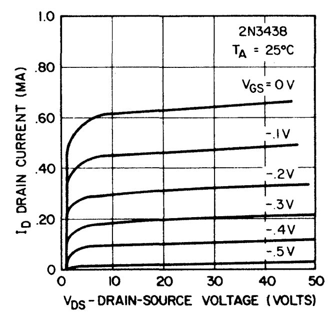
CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Input Capacitance	C_{is}				
2N3436, 2N3458		$V_{DS} = 10$ V, $V_{GS} = 0$		18	pf
2N3437, 2N3459		$V_{DS} = 6.0$ V, $V_{GS} = 0$		18	
2N3438, 2N3460		$V_{DS} = 4.0$ V, $V_{GS} = 0$		18	
Output Capacitance	C_{os}				
2N3436-38		$V_{DS} = 30$ V, $V_{GS} = 0$		6.0	pf
2N3458-60		f = 1.0 MHz		5.0	
Drain-Gate Capacitance	C_{DG}	$V_{DG} = 10$ V, $I_S = 0$; f = 140 kHz		5.0	pf
Source-Gate Capacitance	C_{SG}	$V_{GS} = -10$ V, $I_D = 0$; f = 140 kHz		5.0	pf
Noise Figure	NF				
2N3458		$V_{DS} = 10$ V, $R_G = 1.0$ MΩ		6.0	db
2N3459		BW = 6.0 Hz, f = 20 Hz		2.0	
2N3460				1.5	
2N3436-38		$V_{DS} = 10$ V, $R_G = 1.0$ MΩ		2.0	
2N3458-60		BW = 6.0 Hz, f = 1.0 kHz		1.0	

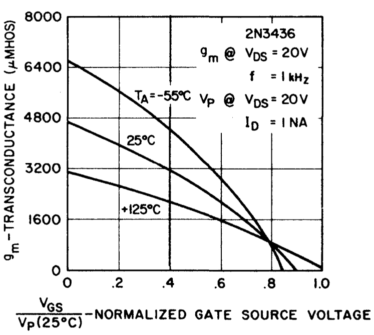
COMMON SOURCE-DRAIN CHARACTERISTICS

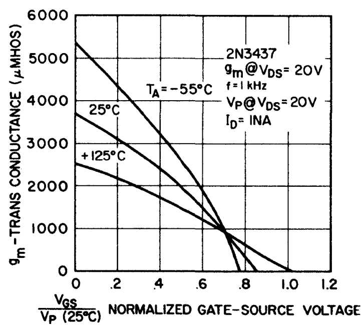


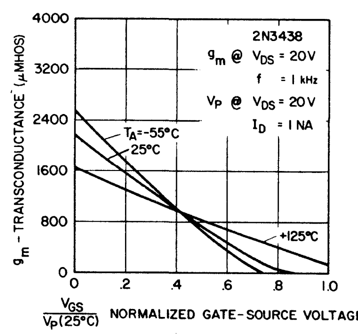




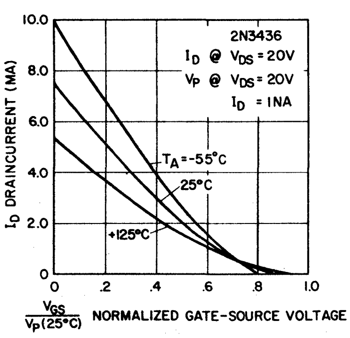
TRANSCONDUCTANCE VS NORMALIZED GATE-SOURCE VOLTAGE

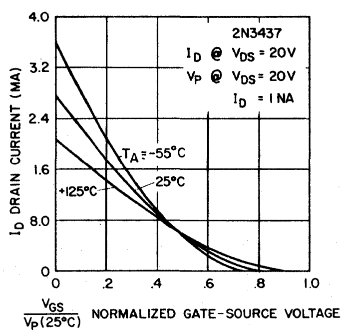


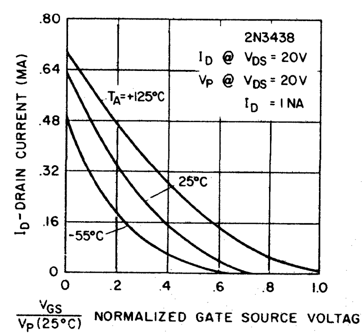




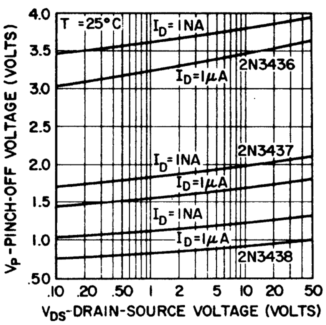
DRAIN CURRENT VS NORMALIZED GATE-SOURCE VOLTAGE



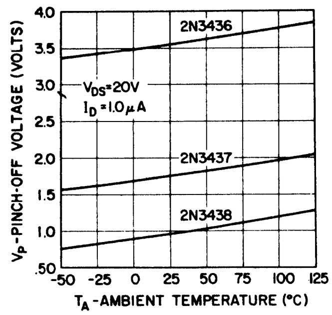




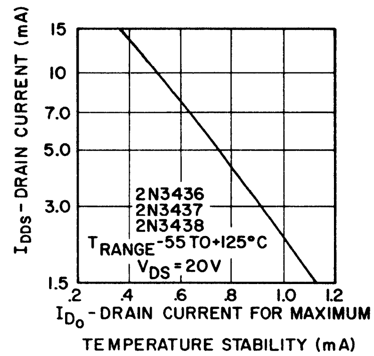
Pinch Off Voltage vs Drain-Source Voltage



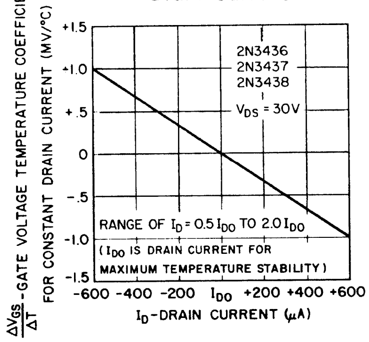
Pinch Off Voltage vs Temperature



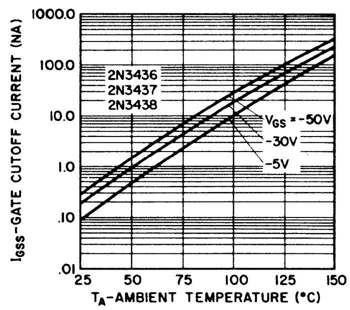
Drain Current for Maximum Temperature Stability vs I_{DSS}



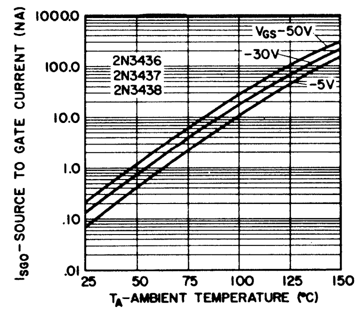
Gate Voltage Temperature Coefficient for Constant Drain Current vs Drain Current



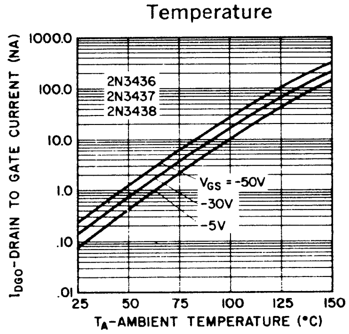
Gate Cutoff Current vs Temperature



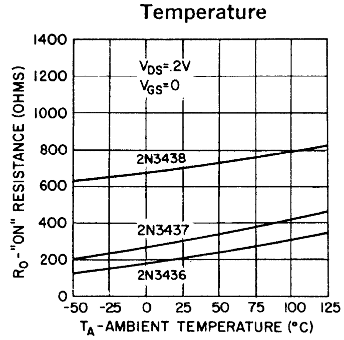
Source-Gate Reverse Current vs Temperature



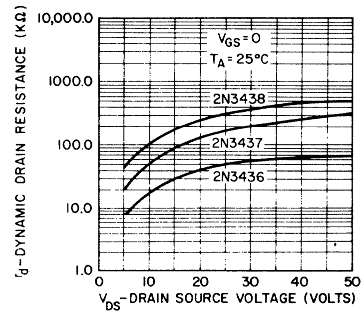
Drain-Gate Reverse Current vs Temperature



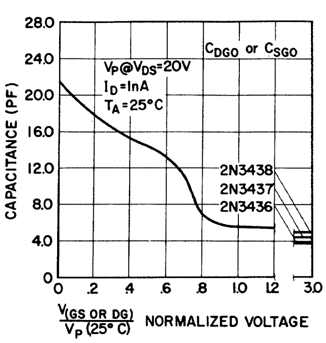
"On" Resistance vs Temperature



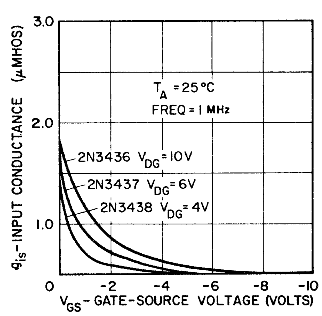
Dynamic Resistance vs Drain-Source Voltage



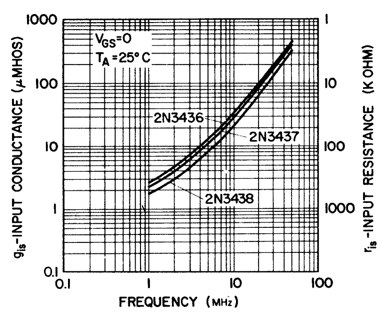
Junction Capacitance vs Normalized Bias



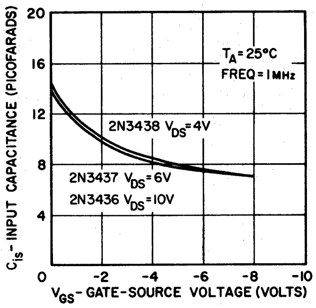
Input Conductance vs Gate-Source Voltage



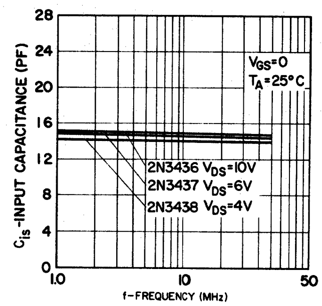
Input Conductance vs Frequency



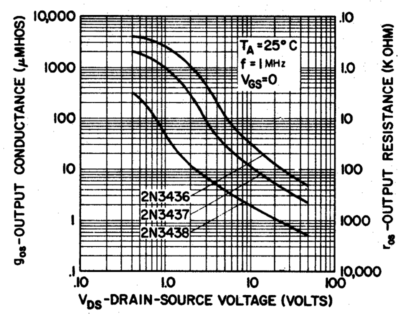
Input Capacitance vs Source-Gate Voltage



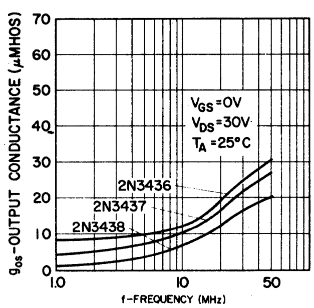
Input Capacitance vs Frequency



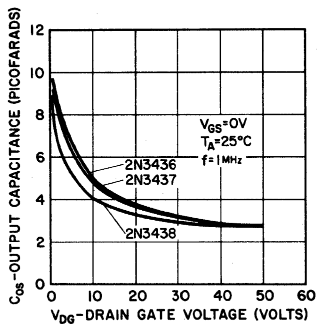
Output Conductance vs Drain-Source Voltage



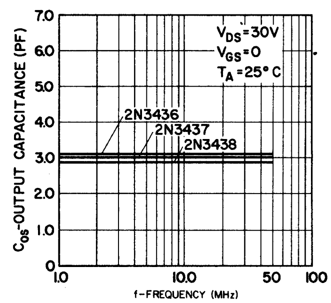
Output Conductance vs Frequency



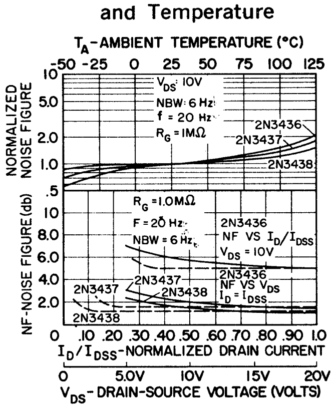
Output Capacitance vs Drain-Source Voltage



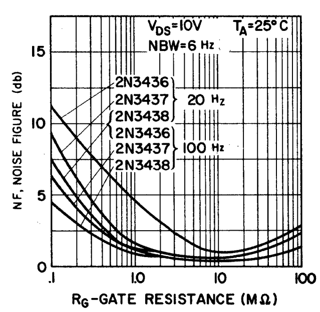
Output Capacitance vs Frequency



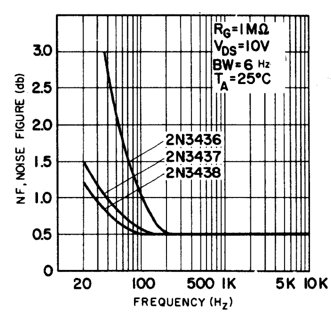
Noise Figure vs Drain Current Drain-Source Voltage and Temperature



Noise Figure vs Gate Resistance



Noise Figure vs Frequency



N-CHANNEL FIELD EFFECT TRANSISTOR
GENERAL PURPOSE

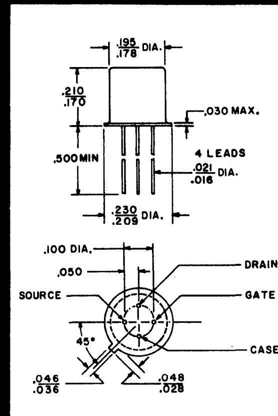
- LOW NOISE
- HIGH BREAKDOWN VOLTAGE
- LOW LEAKAGE

JANUARY 1968

2N3452 THRU 2N3457

MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
Storage Temperature	T_{stg}	−55 to +200	°C
Junction Temperature	T_J	200	°C
Total Device Dissipation @ $T_A = 25°C$	P_D	300	mW
Derating Factor above 25°C @ $T_A = 25°C$		1.7	mW/°C



ELECTRICAL CHARACTERISTICS at +25°C (Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Drain-Gate Breakdown Voltage	BV_{DGO}	$I_D = 1.0\ \mu A$, $I_S = 0$	50		Volts
Total Gate Leakage Current	I_{GSS}				
2N3452-54		$V_{GS} = -30\ V$, $V_{DS} = 0$		0.1	nA
2N3455-57				0.04	
2N3452-54		$V_{GS} = -30\ V$, $V_{DS} = 0$, $T_A = 150°C$		400	
2N3455-57				150	
Saturation Current	I_{DSS}				
2N3452, 2N3455		$V_{DS} = 30\ V$, $V_{GS} = 0$	0.8	4.0	mA
2N3453, 2N3456			0.2	1.0	
2N3454, 2N3457			0.05	0.25	
Pinch Off Voltage	V_P				
2N3452, 2N3455		$V_{DS} = 20\ V$, $I_D = 0.5\ nA$		10	Volts
2N3453, 2N3456				5.0	
2N3454, 2N3457				2.5	
Transconductance	g_m				
2N3452		$V_{DS} = 30\ V$, $V_{GS} = 0$, $f = 1.0\ kHz$	200	1200	μmhos
2N3453			150	900	
2N3454			100	600	
2N3455			400	1200	
2N3456			300	900	
2N3457			150	600	
Input Conductance	g_{is}				
2N3452, 2N3455		$V_{DS} = 12\ V$, $V_{GS} = 0$, $f = 1.0\ MHz$		1.0	μmhos
2N3453, 2N3456		$V_{DS} = 8.0\ V$, $V_{GS} = 0$, $f = 1.0\ MHz$		1.0	
2N3454, 2N3457		$V_{DS} = 4.0\ V$, $V_{GS} = 0$, $f = 1.0\ MHz$		1.0	
Output Conductance	g_{os}				
2N3452, 2N3455		$V_{DS} = 30\ V$, $V_{GS} = 0$, $f = 1.0\ MHz$		15	μmhos
2N3453, 2N3456				5.0	
2N3454, 2N3457				3.0	

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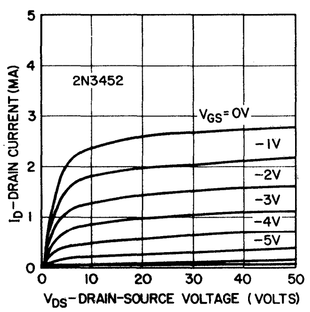
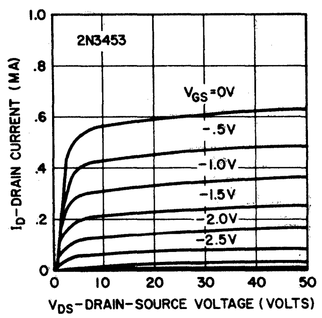
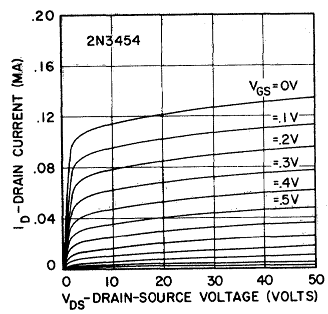
CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Input Capacitance	C_{is}				
2N3452		$V_{DS} = 12\,V, V_{GS} = 0$		6.0	pf
2N3455		$f = 1.0\,MHz$		5.0	
2N3453		$V_{DS} = 8.0\,V, V_{GS} = 0$		6.0	
2N3456		$f = 1.0\,MHz$		5.0	
2N3454		$V_{DS} = 4.0\,V, V_{GS} = 0$		6.0	
2N3457		$f = 1.0\,MHz$		5.0	
Output Capacitance	C_{os}	$V_{DS} = 30\,V, V_{GS} = 0$, $f = 1.0\,MHz$		1.5	pf
Drain-Gate Capacitance	C_{DG}				
2N3452-54		$V_{DG} = 10\,V, I_S = 0$		1.2	pf
2N3455-57		$f = 140\,kHz$		1.0	
Source-Gate Capacitance	C_{SG}				
2N3452-54		$V_{GS} = -10\,V, I_D = 0$		1.8	pf
2N3455-57		$f = 140\,kHz$		1.5	
Noise Figure	NF				
2N3455-57		$V_{DS} = 10\,V, R_G = 1.0\,M\Omega$		4.0	db
2N3452		$BW = 6.0\,Hz, f = 20\,Hz$		6.0 (Typ.)	
2N3453				5.0 (Typ.)	
2N3454				4.0 (Typ.)	
2N3455-57		$V_{DS} = 10\,V, R_G = 1.0\,M\Omega$		1.0	
2N3452-54		$BW = 6.0\,Hz, f = 100\,Hz$		2.0	

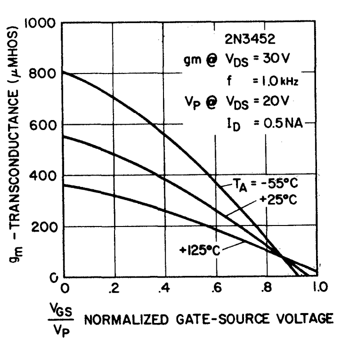
COMMON SOURCE — DRAIN CHARACTERISTICS

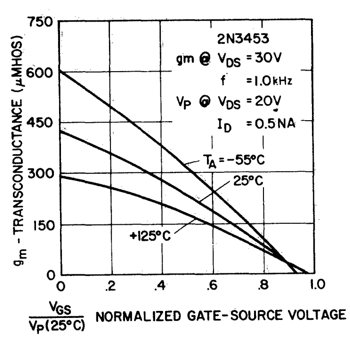


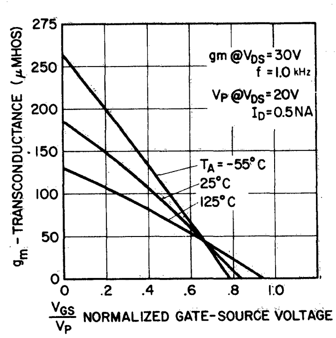




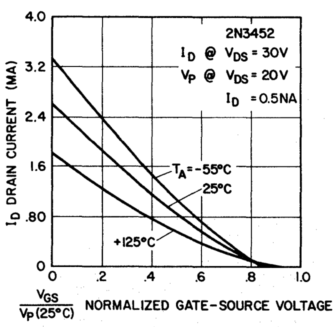
TRANSCONDUCTANCE VS NORMALIZED GATE - SOURCE VOLTAGE

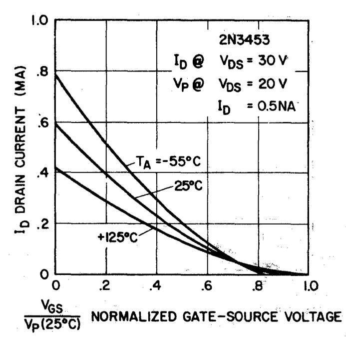


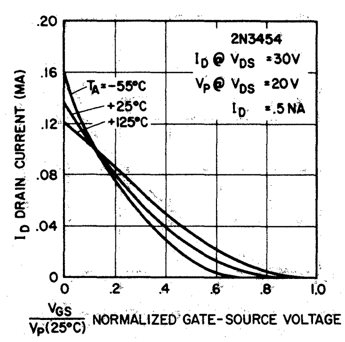




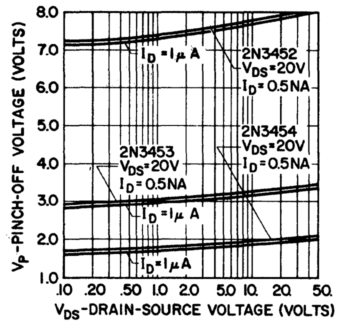
DRAIN CURRENT VS NORMALIZED GATE - SOURCE VOLTAGE



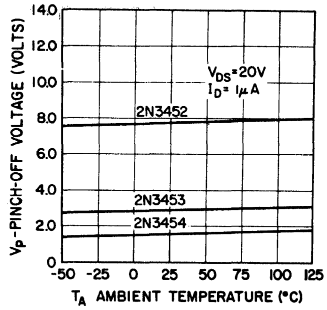




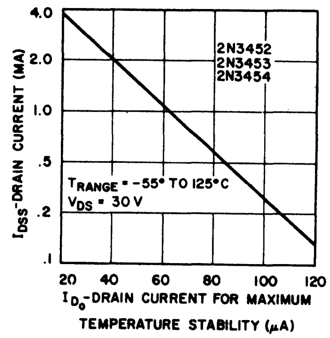
Pinch Off Voltage vs Drain-Source Voltage



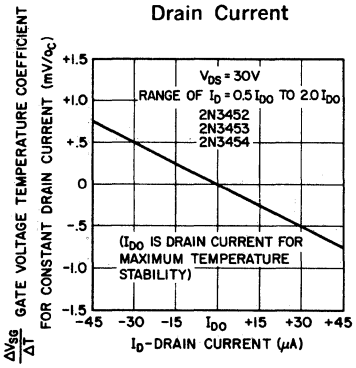
Pinch Off Voltage vs Temperature



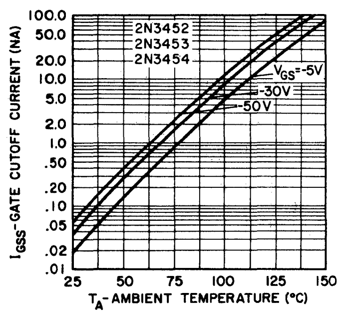
Drain Current for Maximum Temperature Stability vs I_{DSS}



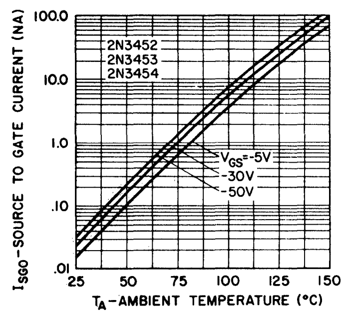
Gate Voltage Temperature Coefficient for Constant Drain Current vs Drain Current



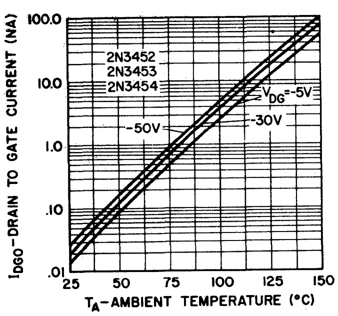
Gate Cutoff Current vs Temperature



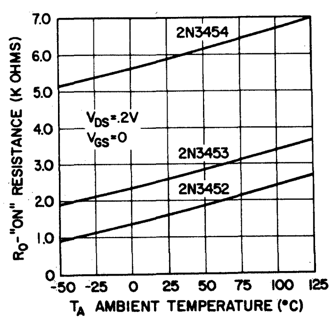
Source-Gate Reverse Current vs Temperature



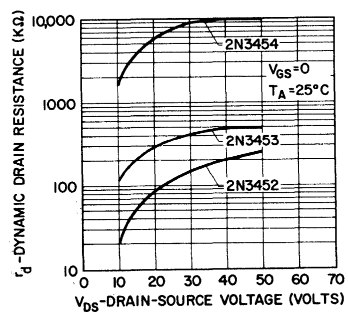
Drain-Gate Reverse Current vs Temperature



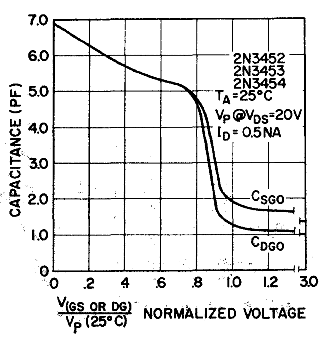
"On" Resistance vs Temperature



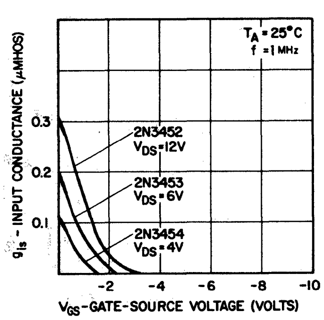
Dynamic Resistance vs Drain-Source Voltage



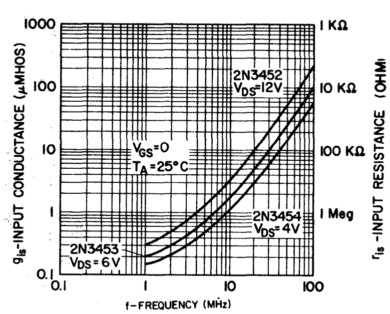
Junction Capacitance vs Normalized Bias



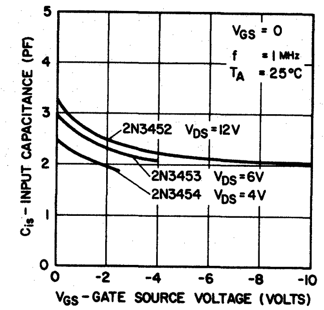
Input Conductance vs Gate-Source Voltage



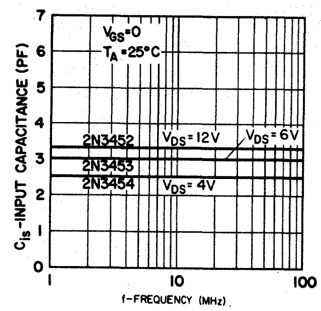
Input Conductance vs Frequency



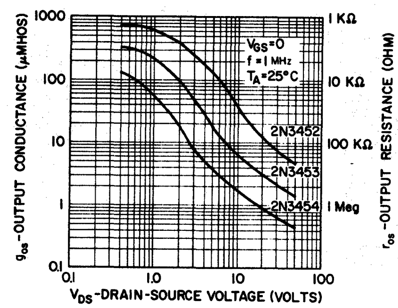
Input Capacitance vs Source-Gate Voltage



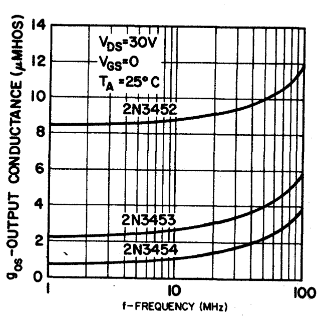
Input Capacitance vs Frequency



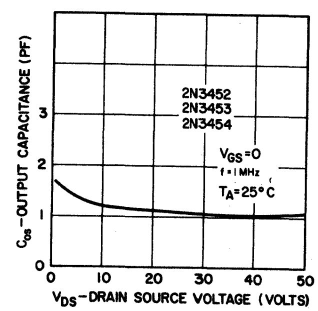
Output Conductance vs Drain-Source Voltage



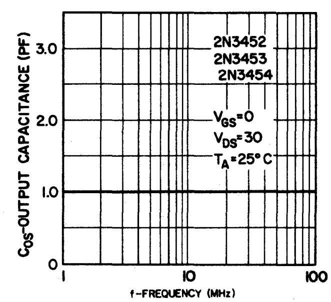
Output Conductance vs Frequency



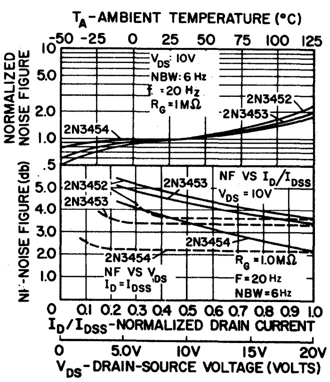
Output Capacitance vs Drain-Source Voltage



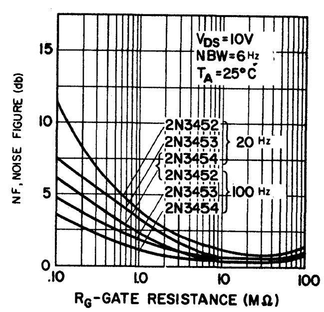
Output Capacitance vs Frequency



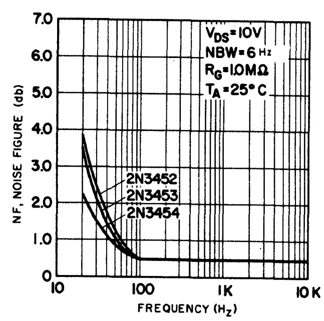
Noise Figure vs Drain Current Drain-Source Voltage and Temperature



Noise Figure vs Gate Resistance



Noise Figure vs Frequency



N-CHANNEL FIELD EFFECT TRANSISTOR
GENERAL PURPOSE

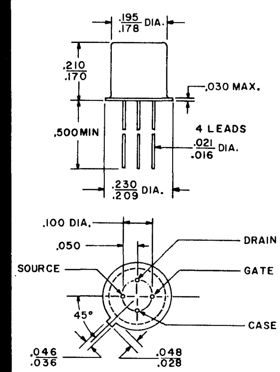
- LOW NOISE
- LOW CAPACITANCE
- FAST SWITCHING SPEEDS

JANUARY 1968

2N3966-69
THRU
2N3967A-69A

MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
Drain-Source Voltage	V_{DS}	30	Volts
Drain-Gain Voltage	V_{DG}	30	Volts
Reverse Gate-Source Voltage	V_{GS}	30	Volts
Gate Current	I_G	10	mA
Total Device Dissipation @ $T_A = 25°C$	P_D	0.3	Watts
Derating Factor Above 25°C @ $T_A = 25°C$		1.71	mW/°C
Storage Temperature	T_{stg}	−65 to +200	°C
Junction Temperature	T_J	200	°C



ELECTRICAL CHARACTERISTICS at +25°C (Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Gate-Source Breakdown Voltage	$V_{(BR)GSS}$	$I_G = 1.0\ \mu A, V_{DS} = 0$	30		Volts
Gate-Source Voltage	V_{GS}				Volts
2N3967, 2N3967A		$V_{DS} = 20\ V, I_D = 0.25\ mA$	1.0	4.5	
2N3968, 2N3968A		$V_{DS} = 20\ V, I_D = 0.10\ mA$	0.5	2.8	
2N3969, 2N3969A		$V_{DS} = 20\ V, I_D = 0.04\ mA$	0.3	1.6	
Gate-Source Cutoff Voltage	$V_{GS(OFF)}$				Volts
2N3966		$V_{DS} = 10\ V, I_D = 10\ nA$	4.0	6.0	
2N3967, 2N3967A		$V_{DS} = 20\ V, I_D = 1.0\ nA$	2.0	5.0	
2N3968, 2N3968A				3.0	
2N3969, 2N3969A				1.7	
Drain Cutoff Current	$I_{D(OFF)}$				
2N3966		$V_{DS} = 10\ V, V_{GS} = -7.0\ V$		1.0	nA
2N3966		$V_{DS} = 10\ V, V_{GS} = -7.0\ V, T_A = 150°C$		2.0	µA
Gate-Drain Leakage Current	I_{DGO}				
2N3966		$V_{DG} = 20\ V, I_S = 0$		0.1	nA
2N3966		$V_{DG} = 20\ V, I_D = 0, T_A = 150°C$		0.2	µA
Gate Reverse Current	I_{GSS}	$V_{GS} = 20\ V, V_{DS} = 0$		0.1	nA
		$V_{GS} = 20\ V, V_{DS} = 0, T_A = 150°C$		0.2	µA
Zero-Gate-Voltage Drain Current	I_{DSS}				
2N3966		$V_{DS} = 20\ V, V_{GS} = 0$	2.0		mA
2N3967, 2N3967A			2.5	10	
2N3968, 2N3968A			1.0	5.0	
2N3969, 2N3969A			0.4	2.0	
Drain-Source "ON" Resistance	$r_{ds(ON)}$				
2N3966		$V_{DS} = 0, V_{GS} = 0$		220	Ohms
2N3967, 2N3967A		$f = 1.0\ kHz$		400	
2N3968, 2N3968A				700	
Rise Time	t_r				
2N3966		See Figures 1 & 2		100	nsec
Turn-on Delay Time	t_d				
2N3966		See Figures 1 & 2		20	nsec
Turn-off Time	t_{off}				
2N3966		See Figures 1 & 2		100	nsec

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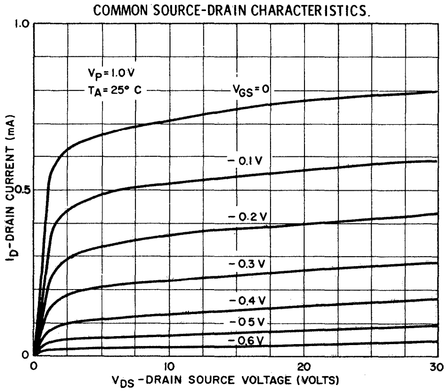
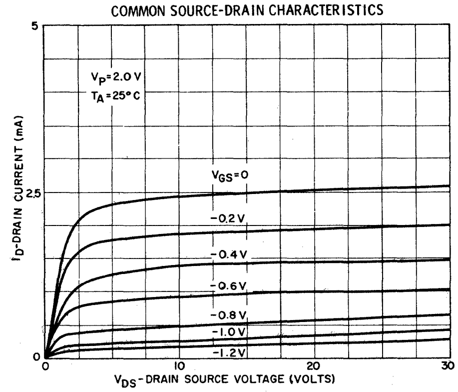
CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Input Capacitance	C_{iss}				
2N3966		$V_{DS} = 20$ V, $V_{GS} = 0$ f = 1.0 MHz		6.0	pf
2N3967A		$V_{DS} = 20$ V, $I_D = 0.25$ mA f = 1.0 MHz		5.0	
2N3968A		$V_{DS} = 20$ V, $I_D = 0.10$ mA f = 1.0 MHz		5.0	
2N3969, 2N3969A		$V_{DS} = 20$ V, $I_D = 0.04$ mA f = 1.0 MHz		5.0	
Reverse Transfer Capacitance	C_{rss}				
2N3966		$V_{DS} = 0$, $V_{GS} = 7.0$ V f = 1.0 MHz		1.5	pf
2N3967, 2N3967A		$V_{DS} = 20$ V, $I_D = 1.0$ mA f = 1.0 MHz		1.3	
2N3968, 2N3968A		$V_{DS} = 20$ V, $I_D = 0.5$ mA f = 1.0 MHz		1.3	
2N3969, 2N3969A		$V_{DS} = 20$ V, $I_D = 0.2$ mA f = 1.0 MHz		1.3	
Transadmittance	Y_{fs}				
2N3967, 2N3967A 2N3968, 2N3968A 2N3969, 2N3969A		$V_{DS} = 20$ V, $V_{GS} = 0$ f = 1.0 kHz	2500 2000 1300		μmhos
Forward Transadmittance	Y_{fs}				
2N3967, 2N3967A		$V_{DS} = 20$ V, $I_D = 0.25$ mA	1600	2400	μmhos
2N3968, 2N3968A		$V_{DS} = 20$ V, $I_D = 0.10$ mA	1400	2000	
2N3969, 2N3969A		$V_{DS} = 20$ V, $I_D = 0.04$ mA	950	1450	
Forward Transadmittance	Y_{fs}				
2N3967, 2N3967A 2N3968, 2N3968A 2N3969, 2N3969A		$V_{DS} = 20$ V, $V_{GS} = 0$ f = 10 MHz	1600 1400 950		μmhos
Output Admittance	Y_{os}				
2N3967, 2N3967A		$V_{DS} = 20$ V, $I_D = 0.25$ mA f = 1.0 MHz		35	μmhos
2N3968, 2N3968A		$V_{DS} = 20$ V, $I_D = 0.10$ mA f = 1.0 MHz		15	
2N3969, 2N3969A		$V_{DS} = 20$ V, $I_D = 0.04$ mA f = 1.0 MHz		5.0	
Noise Figure	NF				
2N3967-2N3969A		$V_{DS} = 20$ V, $V_{GS} = 0$ $R_G = 1.0$ MΩ f = 100 Hz BW = 6 Hz		1.5	db
2N3967A, 68A, 69A		$V_{DS} = 10$ V, $V_{GS} = 0$ $R_G = 1.0$ MΩ f = 10 Hz BW = 6 Hz		4.0	
2N3967A, 68A, 69A		$V_{DS} = 10$ V, $V_{GS} = 0$ $R_G = 1.0$ MΩ f = 1.0 kHz BW = 200 Hz		1.0	

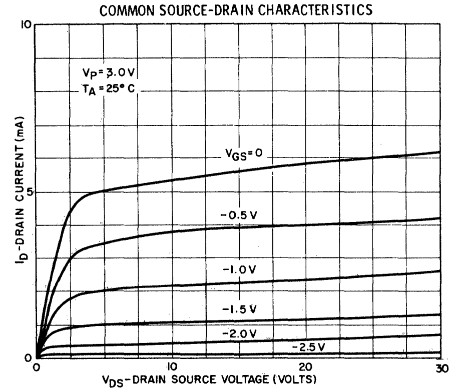
COMMON SOURCE-DRAIN CHARACTERISTICS.



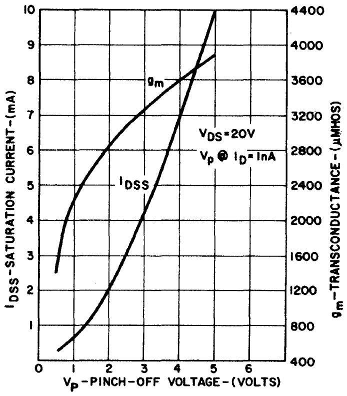
COMMON SOURCE-DRAIN CHARACTERISTICS



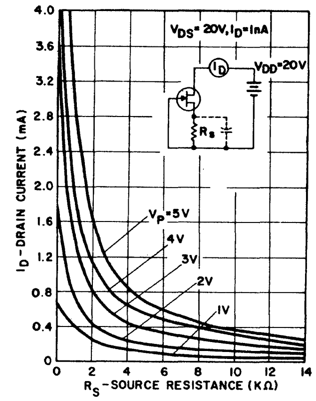
COMMON SOURCE-DRAIN CHARACTERISTICS



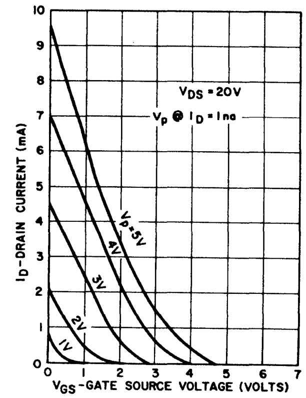
TRANSCONDUCTANCE AND DRAIN CURRENT VS PINCH-OFF VOLTAGE



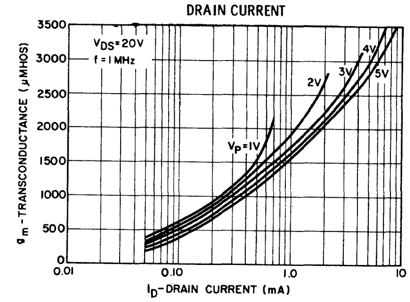
SOURCE FOLLOWER DRAIN CURRENT VS SOURCE RESISTANCE



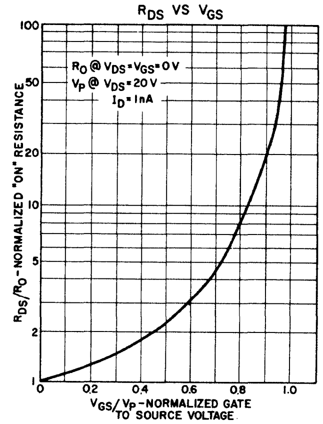
DRAIN CURRENT VS GATE-SOURCE BIAS



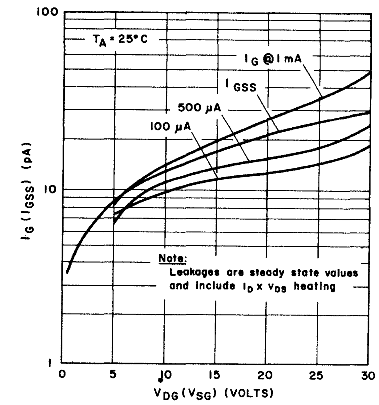
TRANSCONDUCTANCE VS DRAIN CURRENT



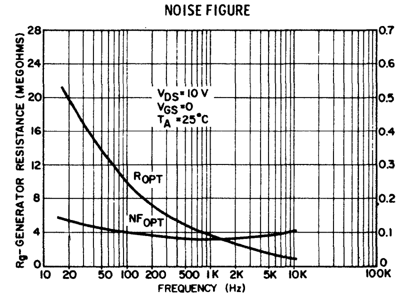
NORMALIZED R_{DS} VS V_{GS}



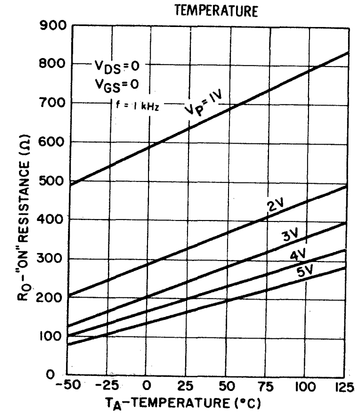
GATE LEAKAGE CURRENT VS VOLTAGE



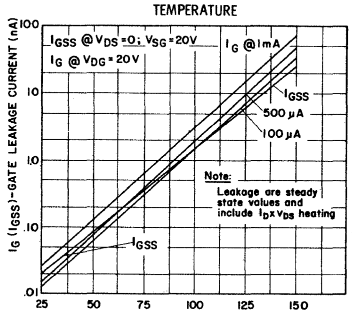
OPTIMUM GENERATOR RESISTANCE AND NOISE FIGURE



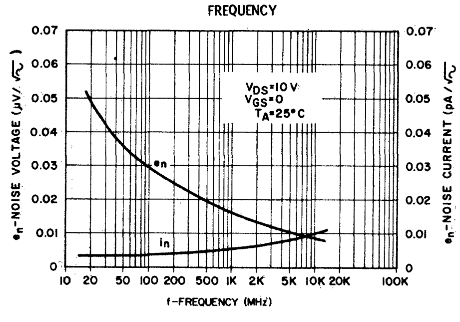
"ON" RESISTANCE VS TEMPERATURE



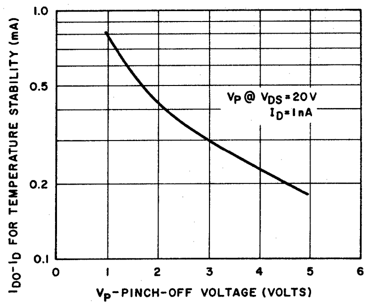
GATE LEAKAGE CURRENT VS TEMPERATURE



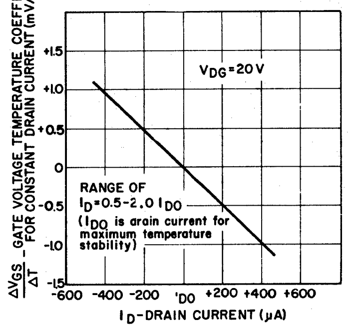
NOISE VOLTAGE/CURRENT VS FREQUENCY



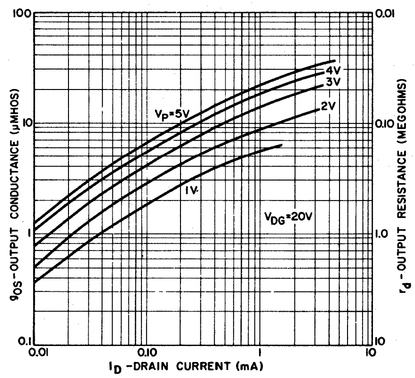
DRAIN CURRENT FOR MAXIMUM TEMPERATURE STABILITY



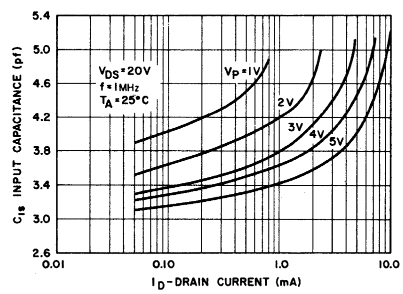
GATE VOLTAGE TEMPERATURE COEFFICIENTS FOR CONSTANT DRAIN CURRENT VS DRAIN VOLTAGE



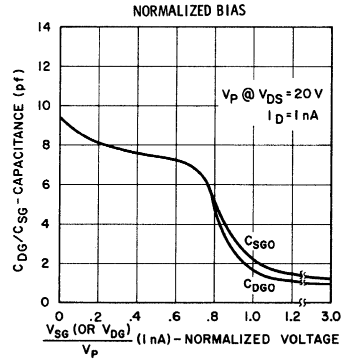
OUTPUT CONDUCTANCE VS DRAIN CURRENT



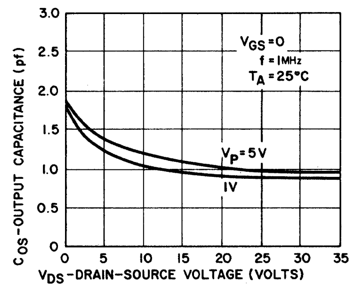
INPUT CAPACITANCE VS DRAIN CURRENT



JUNCTION CAPACITANCE VS NORMALIZED BIAS



OUTPUT CAPACITANCE VS DRAIN SOURCE VOLTAGE



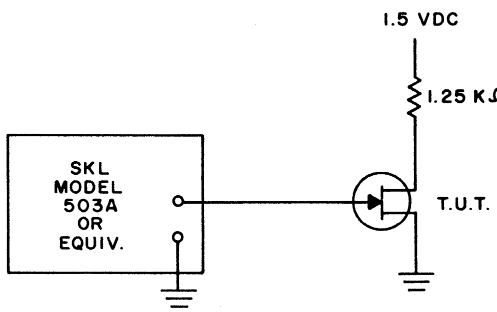


FIGURE 1

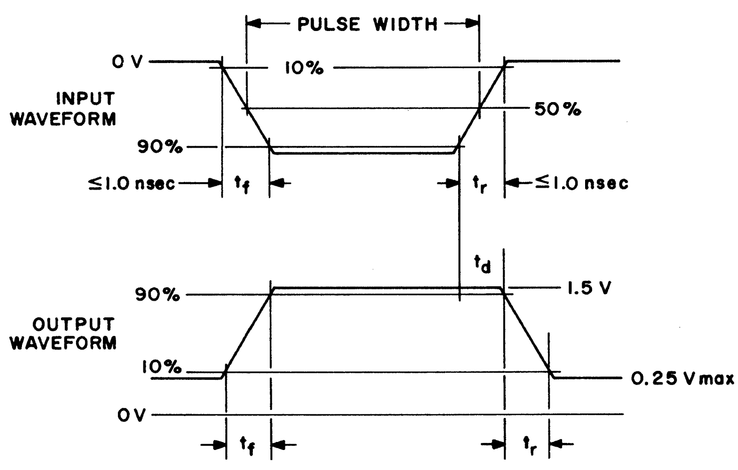


FIGURE 2

N-CHANNEL FIELD EFFECT TRANSISTOR

GENERAL PURPOSE SWITCH

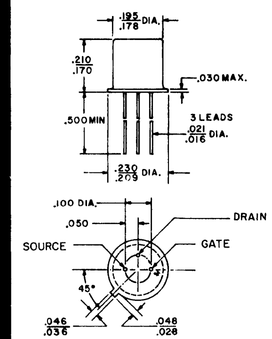
- LOW LEAKAGE
- VERY LOW "ON" RESISTANCE
- FAST SWITCHING SPEEDS

JANUARY 1968

2N3970
2N3971
2N3972

MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
Total Device Dissipation @ $T_C = 25°C$	P_D	1.8	Watts
Derating Factor above 25°C @ $T_C = 25°C$		10	mW/°C
Storage Temperature	T_{stg}	200	°C
Junction Temperature	T_J	200	°C



ELECTRICAL CHARACTERISTICS at +25°C (Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Drain-Gate Breakdown Voltage	BV_{DGO}	$I_D = 1.0\ \mu A$, $I_S = 0$	40		Volts
Source-Gate Breakdown Voltage	BV_{SGO}	$I_S = 1.0\ \mu A$, $I_D = 0$	40		Volts
Saturation Current 2N3970 2N3971 2N3972	I_{DSS}*	$V_{DS} = 20$ V, $V_{GS} = 0$	50 25 5.0	150 75 30	mA
Gate-Drain Leakage Current	I_{DGO}	$V_{DG} = 20$ V, $I_S = 0$ $V_{DG} = 20$ V, $I_S = 0$ $T_A = 150°C$		0.25 0.5	nA μA
Drain Cutoff Current	$I_{D(OFF)}$	$V_{GS} = -12$ V $V_{GS} = -12$ V $T_A = 150°C$		0.25 0.5	nA μA
Drain-Source "ON" Voltage 2N3970 2N3971 2N3972	$V_{DS(ON)}$	$I_D = 20$ mA, $V_{GS} = 0$ $I_D = 10$ mA, $V_{GS} = 0$ $I_D = 5.0$ mA, $V_{GS} = 0$		1.0 1.5 2.0	Volts
Pinch Off Voltage 2N3970 2N3971 2N3972	V_P	$V_{DS} = 20$ V, $I_D = 1.0$ nA	4.0 2.5 0.5	10 5.0 3.0	Volts
Small-Signal Drain-Source "ON" Resistance 2N3970 2N3971 2N3972	$r_{ds(ON)}$	$I_D = 0$, $V_{GS} = 0$		30 60 100	Ohms
"ON" Resistance 2N3970 2N3971 2N3972	R_{ON}	$I_D = 1.0$ mA, $V_{GS} = 0$		30 60 100	Ohms
Rise Time 2N3970 2N3971 2N3972	t_r	See Figures 1 & 2		10 15 40	nsec

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CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Delay Time 2N3970 2N3971 2N3972	t_d	See Figures 1 & 2		10 15 40	nsec
Turn-Off Time 2N3970 2N3971 2N3972	t_{off}	See Figures 1 & 2		30 60 100	nsec
Input Capacitance	C_{is}	$V_{DS} = 20\ V, V_{GS} = 0$ $f = 1.0\ MHz$		25	pf
Drain-Gate Feedback Capacitance	C_{rss}	$V_{DS} = 0, V_{GS} = -12\ V$ $f = 1.0\ MHz$		6.0	pf

* Pulse Test: Pulse Width = 300 μsec; Duty Cycle = 3%.

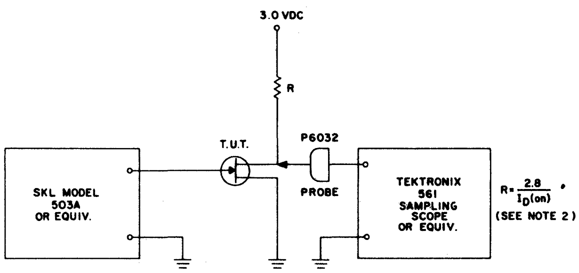


Figure 1

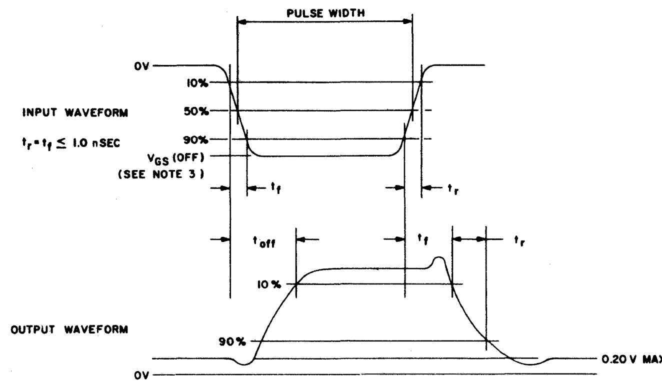


Figure 2

JANUARY 1968

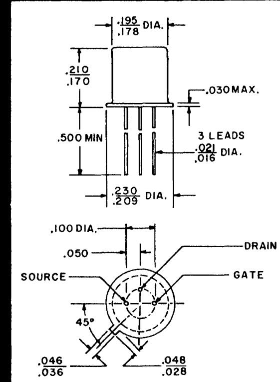
N-CHANNEL FIELD EFFECT TRANSISTOR
GENERAL PURPOSE SWITCH

- VERY LOW "ON" RESISTANCE
- FAST SWITCHING SPEEDS
- LOW LEAKAGE

2N4091
2N4092
2N4093

MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
Power Dissipation @ $T_C = 25°C$	P_D	1.8	Watt
Derating Temperature @ $T_C = 25°C$		10	mW/°C
Storage Temperature	T_{stg}	−55 to +200	°C
Junction Temperature	T_J	+200	°C



GATE IS INTERNALLY CONNECTED TO CASE

ELECTRICAL CHARACTERISTICS at +25°C (Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Drain-Gate Breakdown Voltage	BV_{DGO}	$I_D = 1.0\ \mu A$, $I_S = 0$	40		Volts
Source-Gate Breakdown Voltage	BV_{SGO}	$I_S = 1.0\ \mu A$, $I_D = 0$	40		Volts
Drain-Source "ON" Voltage	$V_{DS(ON)}$	$I_D = (^{**})$, $V_{GS} = 0$		0.2	Volts
Saturation Current 2N4091 2N4092 2N4093	$I_{DSS}{}^*$	$V_{DS} = 20\ V$, $V_{GS} = 0$	 30 15 8.0		mA
Gate-Drain Leakage Current	I_{DGO}	$V_{DG} = 20\ V$, $I_S = 0$		0.2	nA
Drain Cutoff Current	$I_{D(OFF)}$	$V_{GS} = (^{***})$, $V_{DS} = 20\ V$ $V_{GS} = (^{***})$, $V_{DS} = 20\ V$, $T_A = 150°C$		0.2 0.4	nA μA
Gate-Source Leakage Current	I_{SGO}	$V_{SG} = 20\ V$, $I_D = 0$		0.2	nA
Pinch Off Voltage 2N4091 2N4092 2N4093	V_p	$V_{DS} = 20\ V$, $I_D = 1.0\ nA$	 5.0 2.0 1.0	 10 7.0 5.0	Volts
Small-Signal Drain-Source "ON" Resistance 2N4091 2N4092 2N4093	$r_{ds(ON)}$	$V_{DS} = 0$, $V_{GS} = 0$		 30 50 80	Ohms
"ON" Resistance 2N4091 2N4092 2N4093	R_O	$I_D = 1.0\ mA$, $V_{GS} = 0$		 30 50 80	Ohms
Rise Time 2N4091 2N4092 2N4093	t_r	See Figures 1 & 2		 10 20 40	nsec
Delay Time 2N4091 2N4092 2N4093	t_d	See Figures 1 & 2		 15 15 20	nsec

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CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MAX.	MIN.	UNIT
Turn-Off Time 2N4091 2N4092 2N4093	t_{off}	See Figures 1 & 2		40 60 80	nsec
Input Capacitance	C_{is}	$V_{DS} = 20$ V, $V_{GS} = 0$ f = 1.0 MHz		16	pf
Drain-Gate Capacitance	C_{DG}	$V_{DG} = 20$ V, $I_S = 0$ f = 1.0 MHz		5.0	pf
Source Gate Capacitance	C_{SG}	$V_{SG} = 20$ V, $I_D = 0$ f = 1.0 MHz		5.0	pf

NOTES: * Pulse Test: Pulse Width $\leq$ 300 μsec; Duty Cycle $\leq$ 3%.

** 2N4091 $I_D = 6.6$ mA
2N4092 $I_D = 4.0$ mA
2N4093 $I_D = 2.5$ mA

*** 2N4091 $V_{GS(OFF)} = -12$ V
2N4092 $V_{GS(OFF)} = -8.0$ V
2N4093 $V_{GS(OFF)} = -6.0$ V

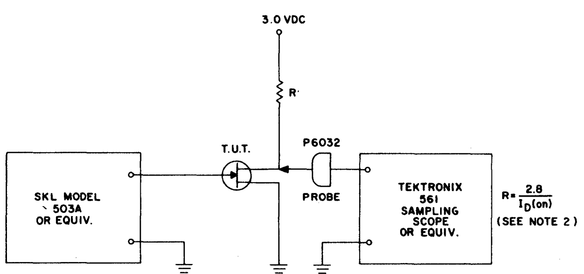


Figure 1

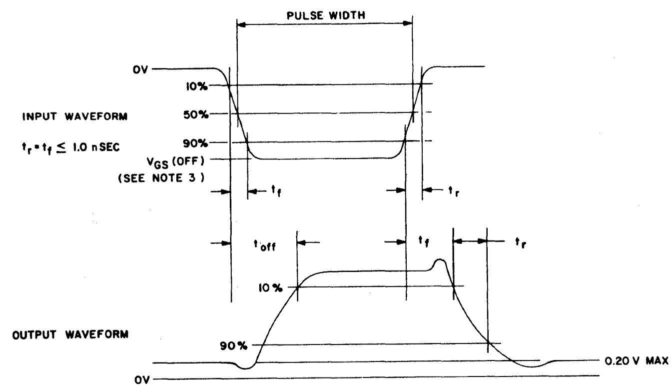
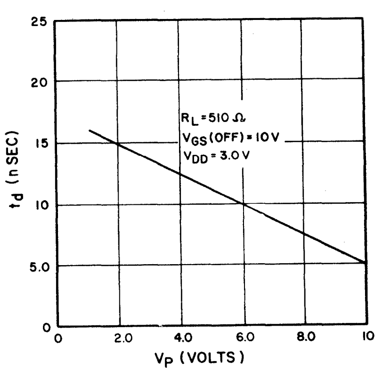
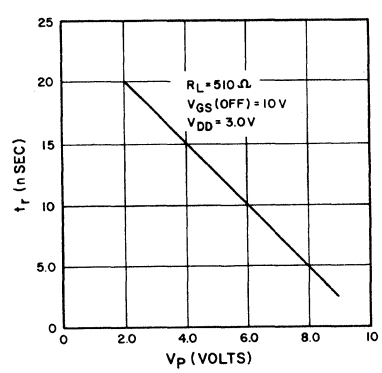
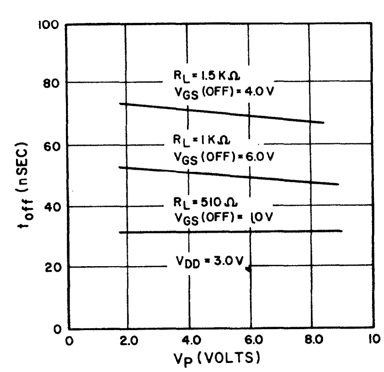


Figure 2

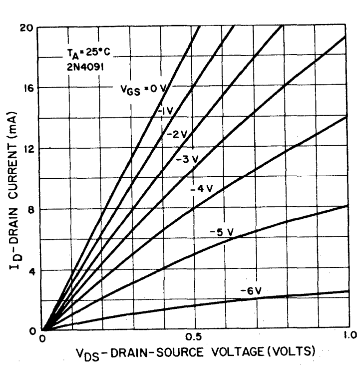
Switching Characteristics

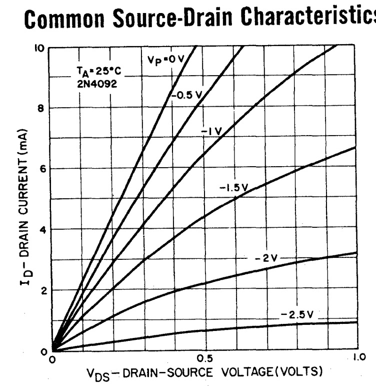


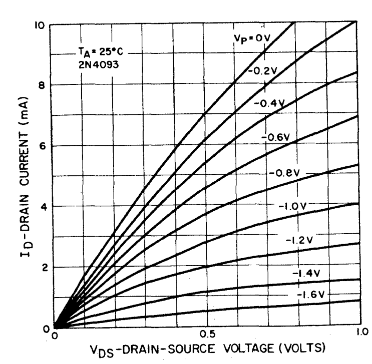




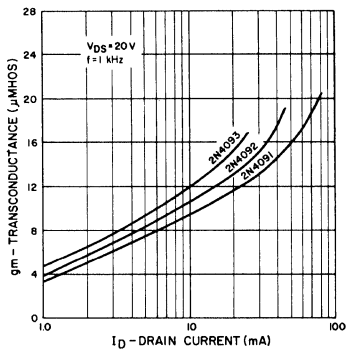
Common Source-Drain Characteristics



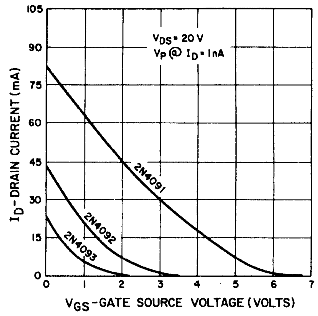




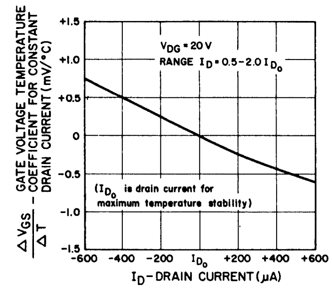
Transconductance vs Drain Current



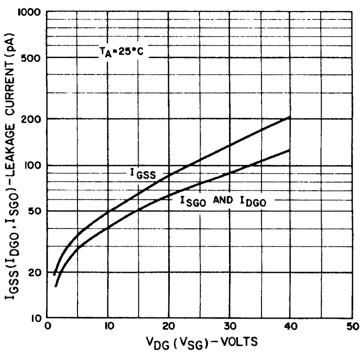
Drain Current vs Gate-Source Bias



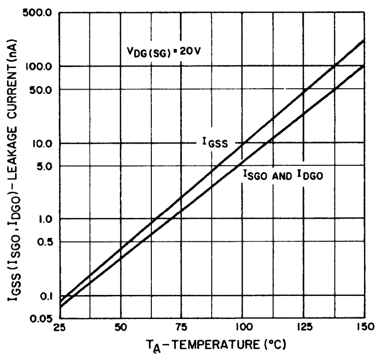
Gate Voltage Temperature Coefficients for Constant Drain Current vs Drain Voltage



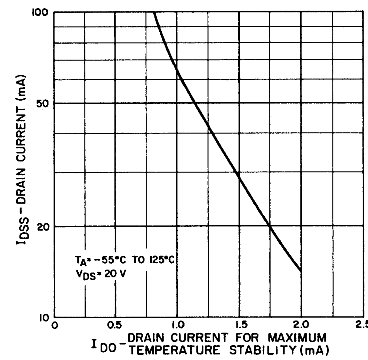
Leakage Current vs Voltage



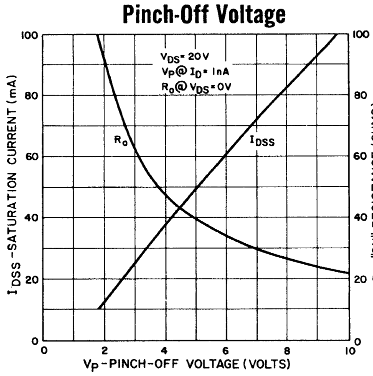
Gate Leakage Current vs Temperature



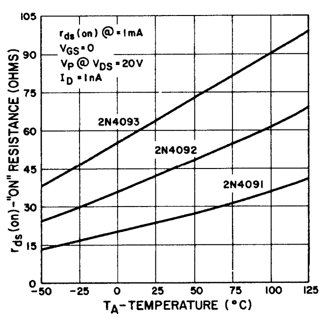
Drain Current for Maximum Temperature Stability



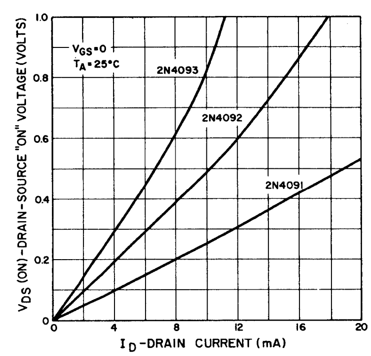
"ON" Resistance And Drain Current vs Pinch-Off Voltage



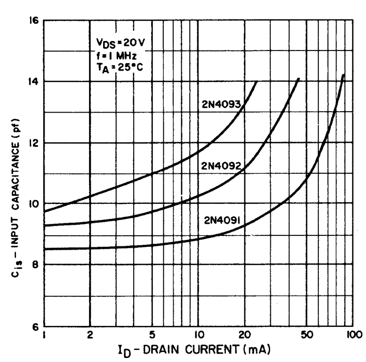
"ON" Resistance vs Temperature



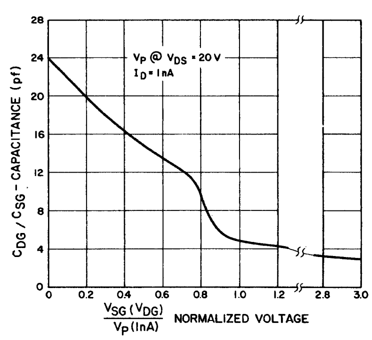
Drain-Source "ON" Voltage vs Drain Current



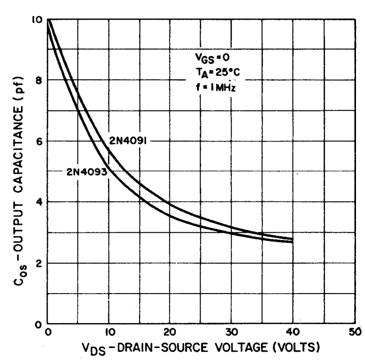
Input Capacitance vs Drain Current



Junction Capacitance vs Normalized Bias



Output Capacitance vs Drain-Source Voltage



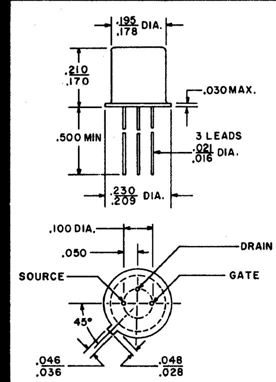
N-CHANNEL FIELD EFFECT TRANSISTOR
GENERAL PURPOSE
- **HIGH TRANSCONDUCTANCE**
- **LOW LEAKAGE**
- **LOW NOISE**

JANUARY 1968

2N4139

MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
Gate Current	I_G	10	mA
Total Device Dissipation @ $T_A = 25°C$	P_D	300	mW
Derating Factor Above 25°C @ $T_A = 25°C$		1.7	mW/°C
Storage Temperature	T_{stg}	−65 to +200	°C
Junction Temperature	T_J	200	°C



GATE IS INTERNALLY CONNECTED TO CASE

ELECTRICAL CHARACTERISTICS at +25°C (Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Drain-Gate Breakdown Voltage	BV_{DGO}	$I_D = 1.0\ \mu A, I_S = 0$	50		Volts
Source-Gate Breakdown Voltage	BV_{SGO}	$I_S = 1.0\ \mu A, I_D = 0$	50		Volts
Total Gate Leakage Current	I_{GSS}	$V_{GS} = -30\ V, V_{DS} = 0$ $V_{GS} = -30\ V, V_{DS} = 0, T_A = 125°C$		1.0 1.0	nA μA
Saturation Current	I_{DSS}	$V_{DS} = 20\ V, V_{GS} = 0$	8.0	11	mA
Pinch Off Voltage	V_P	$V_{DS} = 20\ V, I_D = 1.0\ nA$	2.0	8.0	Volts
Transconductance	g_m	$V_{DS} = 20\ V, V_{GS} = 0$, f = 1.0 kHz $V_{DS} = 20\ V, V_{GS} = 0$, f = 1.0 MHz	3500 3000	7000	μmhos
Short-circuit, common-source input conductance	G_{is}	$V_{DS} = 20\ V, V_{GS} = 0$, f = 1.0 MHz		4.0	μmhos
Output Conductance	g_{os}	$V_{DS} = 20\ V, V_{GS} = 0$, f = 1.0 MHz		35	μmhos
Input Capacitance	C_{is}	$V_{DS} = 20\ V, V_{GS} = 0$, f = 1.0 MHz		18	pf
Reverse Transfer Capacitance	C_{rss}	$V_{DS} = 20\ V, V_{GS} = 0$, f = 140 kHz		5.0	pf
Drain to Gate Capacitance	C_{DG}	$V_{DG} = 10\ V, I_S = 0$, f = 140 kHz		5.0	pf
Noise Figure	NF	$V_{DS} = 20\ V, V_{gs} = 0, R_G = 1.0\ M\Omega$, f = 1.0 kHz, BV = 6.0 Hz		2.0	db

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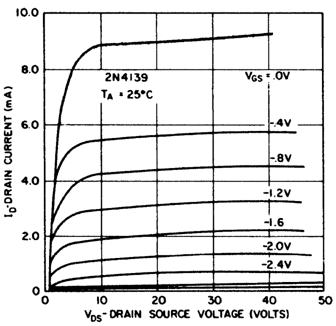
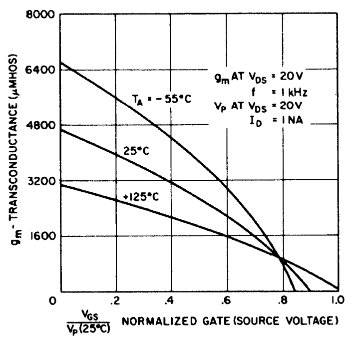
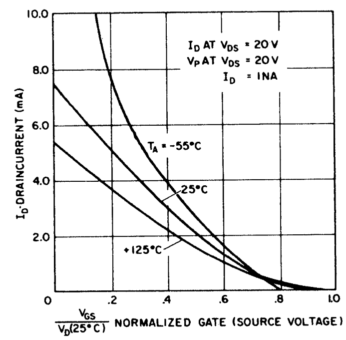
Common Source-Drain Characteristics



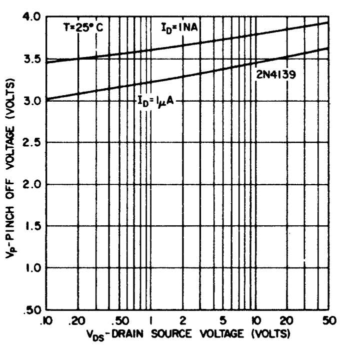
Transconductance vs Normalized Gate-Source Voltage



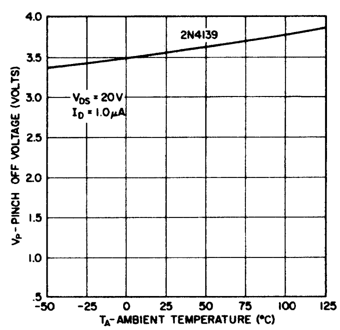
Drain Current vs Normalized Gate-Source Voltage



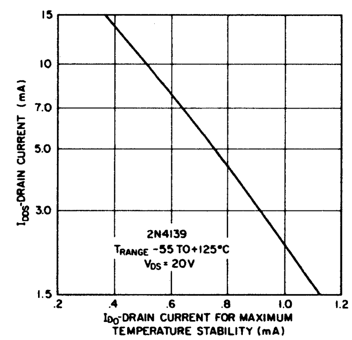
Pinch Off Voltage vs Drain-Source Voltage



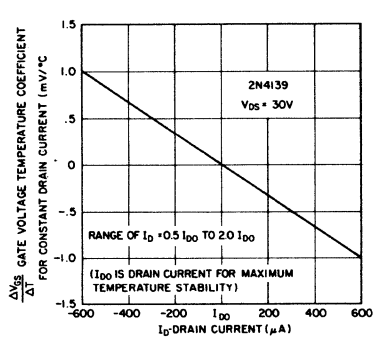
Pinch Off Voltage vs Temperature



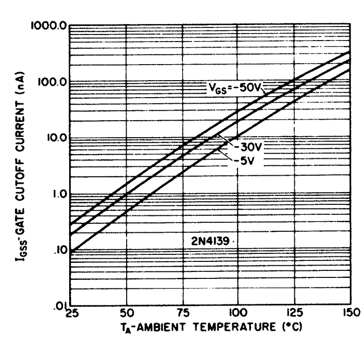
Drain Current for Maximum Temperature Stability vs I_{DSS}



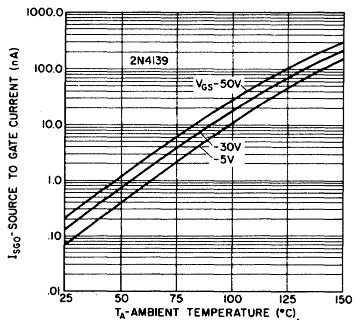
Gate Voltage Temperature Coefficient for Constant Drain Current vs Drain Current



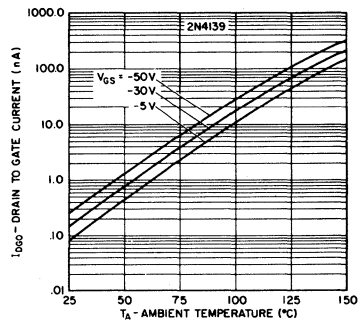
Gate Cutoff Current vs Temperature



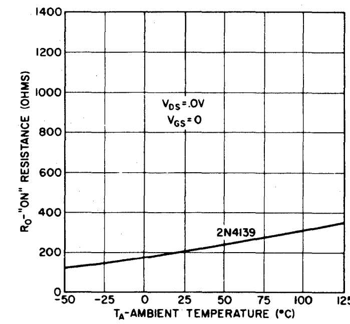
Source-Gate Reverse Current vs Temperature



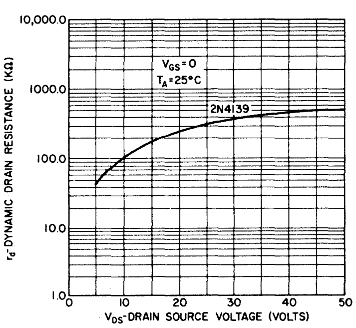
Drain-Gate Reverse Current vs Temperature



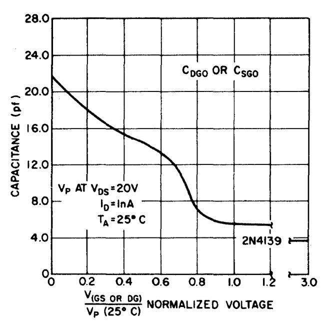
"On" Resistance vs Temperature



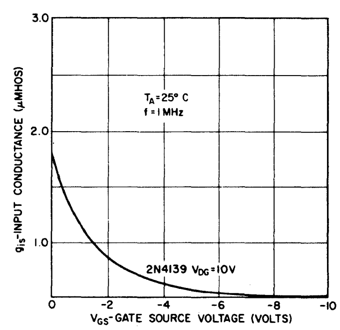
Dynamic Resistance vs Drain-Source Voltage



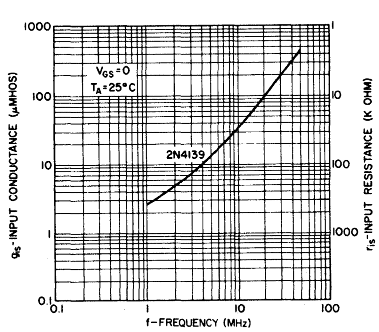
Junction Capacity vs Normalized Bias



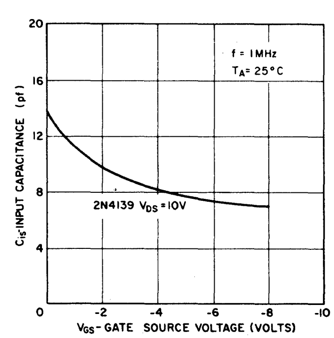
Input Conductance vs Gate-Source Voltage



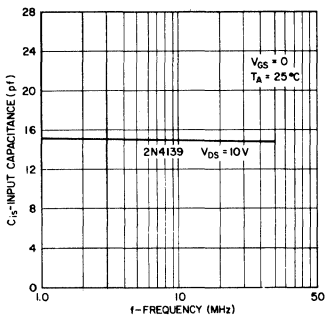
Input Conductance vs Frequency



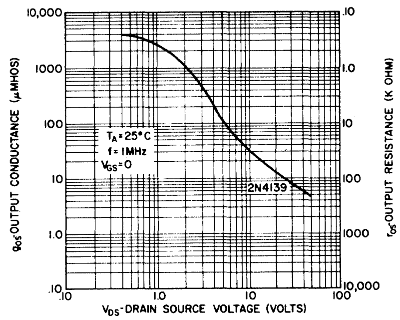
Input Capacity vs Source-Gate Voltage



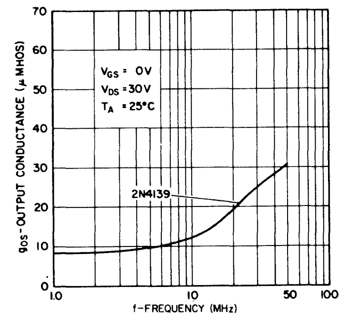
Input Capacity vs Frequency



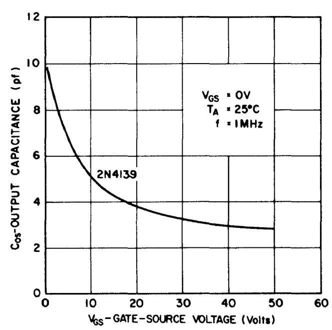
Output Conductance vs Drain-Source Voltage



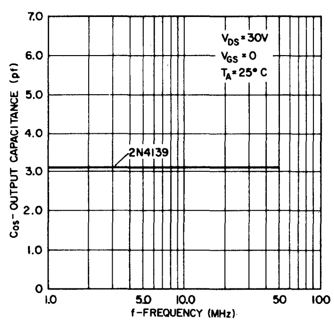
Output Conductance vs Frequency



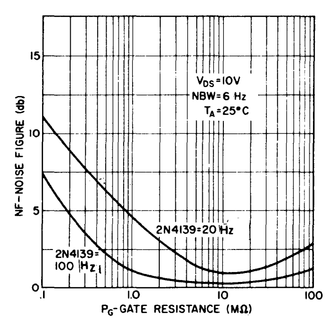
Output Capacitance vs Drain-Source Voltage



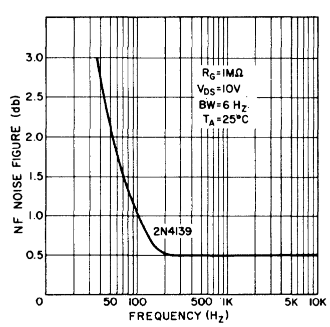
Output Capacitance vs Frequency



Noise Figure vs Gate Resistance



Noise Figure vs Frequency



N-CHANNEL FIELD EFFECT TRANSISTOR

GENERAL PURPOSE SWITCH

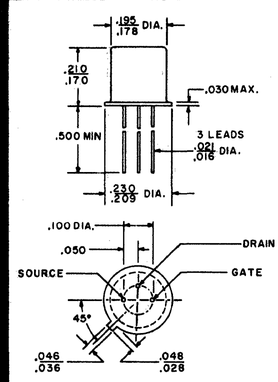
- LOW LEAKAGE
- FAST SWITCHING SPEEDS
- VERY LOW "ON" RESISTANCE

JANUARY 1968

2N4977
2N4978
2N4979

MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
Drain-Source Voltage	V_{DS}	30	Volts
Drain-Gate Voltage	V_{DG}	30	Volts
Reverse Gate-Source Voltage	V_{GS}	30	Volts
Gate Current	I_G	10	mA
Total Device Dissipation @ $T_C = 25°C$	P_D	1.8	Watts
Derating Factor Above 25°C @ $T_C = 25°C$		10.3	mW/°C
Storage Temperature	T_{stg}	−65 to +200	°C
Junction Temperature	T_J	200	°C
Lead Temperature, 1/16 inch from case, 10 sec. max.		300	°C



GATE IS INTERNALLY CONNECTED TO CASE

ELECTRICAL CHARACTERISTICS at +25°C (Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Gate-Source Breakdown Voltage	$V_{(BR)GSS}$	$I_G = 1.0\ \mu A, V_{DS} = 0$	30		Volts
Gate-Source Cutoff Voltage	$V_{GS(OFF)}$	$V_{DS} = 15\ V, I_D = 1.0\ nA$			Volts
2N4977			4.0	10	
2N4978			4.0	8.0	
2N4979			0.5	5.0	
Drain-Source "ON" Voltage	$V_{DS(ON)}$				nA
2N4977		$I_D = 25\ mA, V_{GS} = 0$		0.4	
2N4978		$I_D = 10\ mA, V_{GS} = 0$		0.4	
2N4979		$I_D = 5\ mA, V_{GS} = 0$		0.4	
Gate Reverse Current	I_{GSS}	$V_{GS} = 15\ V, V_{DS} = 0$		0.5	nA
Drain Reverse Current	I_{DGO}	$V_{DG} = 15\ V, I_S = 0$		0.5	nA
		$V_{DG} = 15\ V, I_S = 0, T_A = 150°C$		1.0	μA
Drain Cutoff Current	$I_{D(OFF)}$	$V_{DS} = 15\ V, V_{GS} = -12\ V$		0.5	nA
		$V_{DS} = 15\ V, V_{GS} = -12\ V, T_A = 150°C$		1.0	μA
Zero-Gate-Voltage Drain Current	I_{DSS}	$V_{DS} = 20\ V, V_{GS} = 0$			mA
2N4977			50		
2N4978			15		
2N4979			7.5		
Drain-Source "ON" Resistance	$r_{DS(ON)}$	$I_D = 1.0\ mA, V_{GS} = 0$			Ohms
2N4977				15	
2N4978				20	
2N4979				40	
Drain-Source "ON" Resistance	$r_{ds(ON)}$				
2N4977		$V_{GS} = 0, I_D = 0$, f = 1.0 kHz		15	Ohms
2N4978		$V_{GS} = 0, I_D = 0$, f = 1.0 kHz		20	
2N4979		$V_{GS} = 0, I_D = 0$, f = 1.0 kHz		40	
Input Capacitance	C_{iss}	$V_{DS} = 15\ V, V_{GS} = 0$, f = 1.0 MHz		35	pf
Reverse Transfer Capacitance	C_{rss}	$V_{DS} = 0, V_{GS} = -12\ V$, f = 1.0 MHz		8.0	pf

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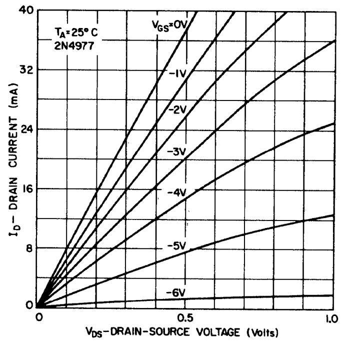
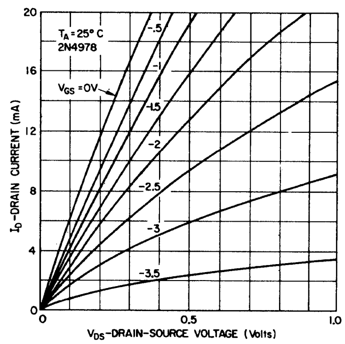
CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Delay Time	t_d				
2N4977		See Figure 1		5	nsec
2N4978		See Figure 2		5	
2N4979		See Figure 3		10	
Rise Time	t_r				
2N4977		See Figure 1		5	nsec
2N4978		See Figure 2		10	
2N4979		See Figure 3		30	
Turn-Off Time	t_{off}				
2N4977		See Figure 1		20	nsec
2N4978		See Figure 2		40	
2N4979		See Figure 3		60	

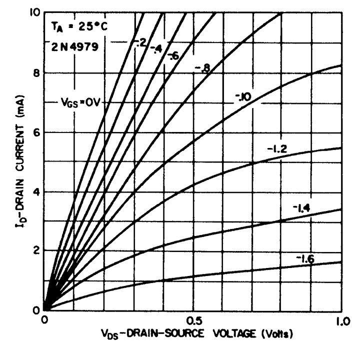
Common Source-Drain Characteristics



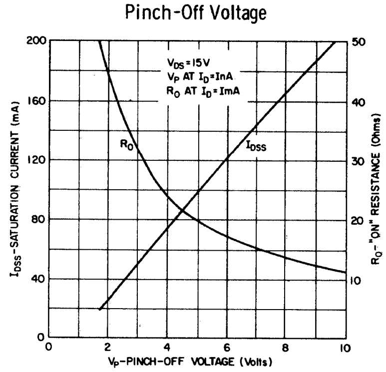
Common Source-Drain Characteristics



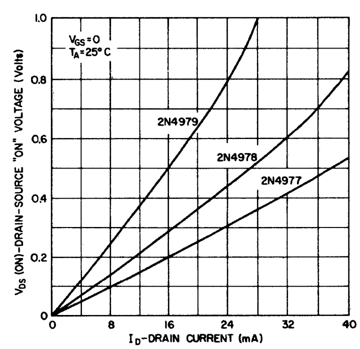
Common Source-Drain Characteristics



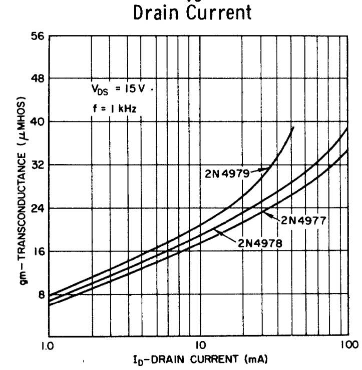
"On" Resistance and Drain Current vs Pinch-Off Voltage



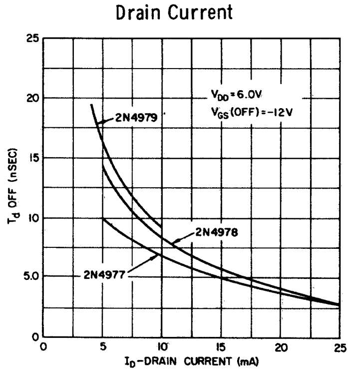
Drain-Source "On" Voltage vs Drain Current



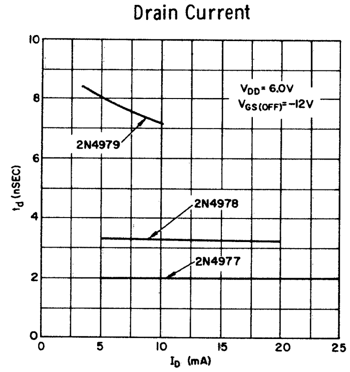
Transconductance vs Drain Current



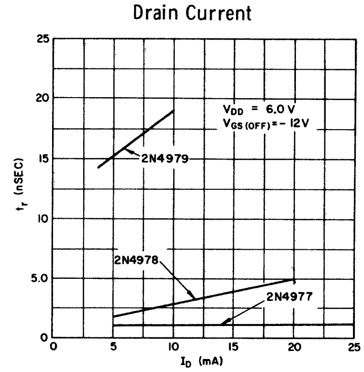
Switching Characteristics Turn-Off Delay Time vs Drain Current



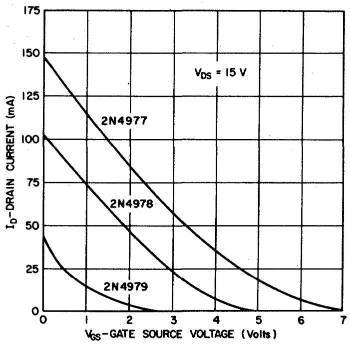
Switching Characteristics Delay Time vs Drain Current



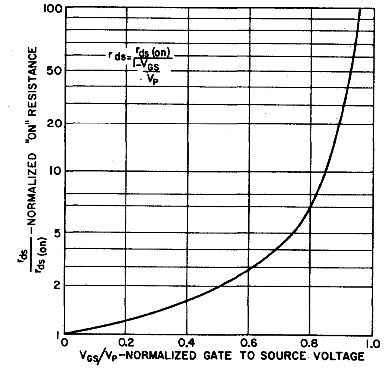
Switching Characteristics Rise Time vs Drain Current



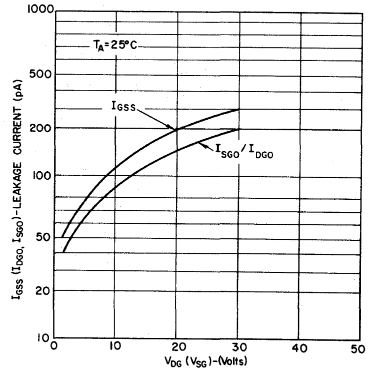
Drain Current
vs
Gate-Source Bias



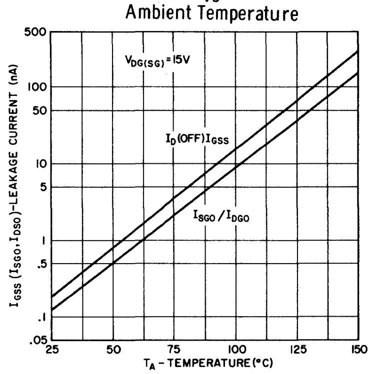
Normalized r_{ds}
vs
V_{GS}



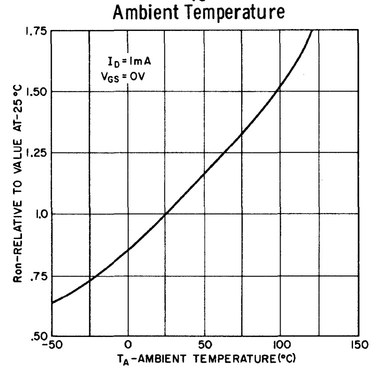
Leakage Current
vs
Voltage



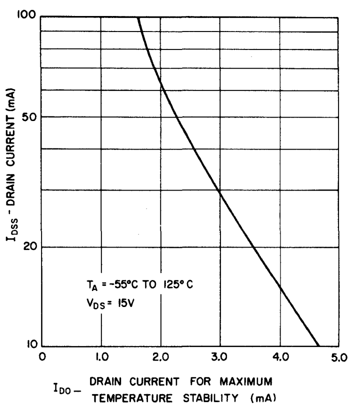
Leakage Gate
vs
Ambient Temperature



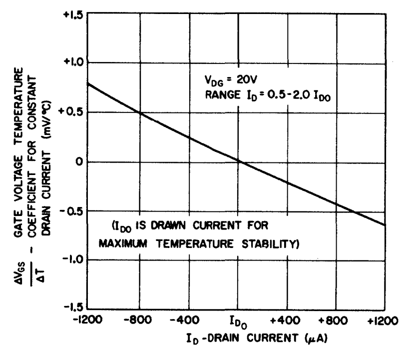
Normalized "On" Resistance
vs
Ambient Temperature



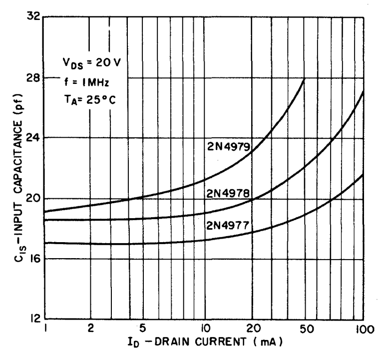
Drain Current for Maximum
Temperature Stability



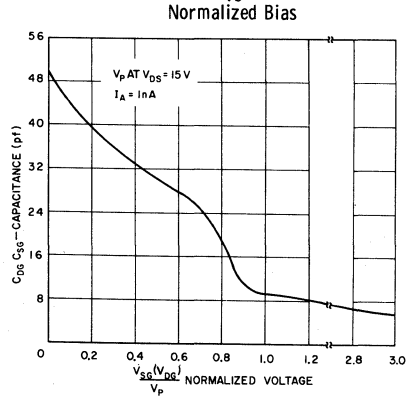
Gate Voltage Temperature Coefficients
for Constant Drain Current
vs
Drain Voltage



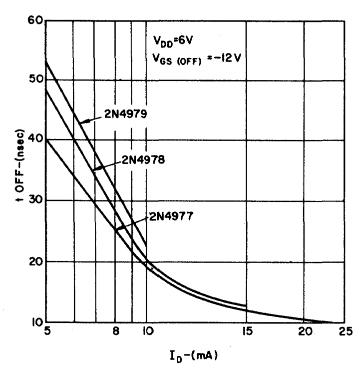
Input Capacitance
vs
Drain Current



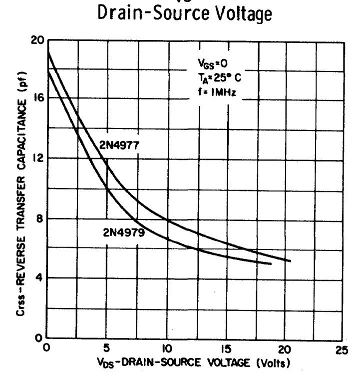
Junction Capacitance
vs
Normalized Bias

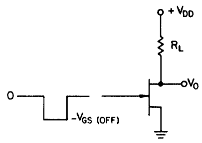


Switching Characteristics
Turn-Off Time
vs
Drain Current



Reverse Transfer Capacitance
vs
Drain-Source Voltage



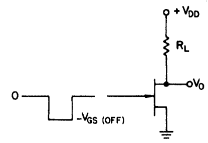


R_L = 220Ω
$I_{D(ON)}$ = 25 mA
$V_{GS(OFF)}$ = -10V
$V_{GS(ON)}$ = 0V
V_{DD} = 6.0V

Input Pulse
- Rise Time < 1.0 ns
- Fall Time < 1.0 ns
- Pulse Width ≤ 110 ns, 10.0% Duty Cycle
- Gen. Source Imp. = 50Ω

Oscilloscope
- Rise Time ≤ 0.4 nsec
- Input Resistance ≥ 9.8 MΩ
- Input Capacitance ≤ 1.7 pf

Figure 1.

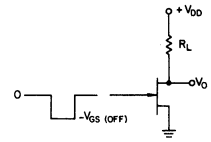


R_L = 560 Ohms
$I_{D(ON)}$ = 10 mA
$V_{GS(OFF)}$ = -8V
$V_{GS(ON)}$ = 0V
V_{DD} = 6.0V

Input Pulse
- Rise Time < 1.0 ns
- Fall Time < 1.0 ns
- Pulse Width ≤ 110 ns, 10.0% Duty Cycle
- Gen. Source Imp. = 50Ω

Oscilloscope
- Rise Time ≤ 0.4 nsec
- Input Resistance ≥ 9.8 MΩ
- Input Capacitance ≤ 1.7 pf

Figure 2.



R_L = 1.1 kΩ
$I_{D(ON)}$ = 5.0 mA
$V_{GS(OFF)}$ = -5.0V
$V_{GS(ON)}$ = 0V
V_{DD} = 6.0V

Input Pulse
- Rise Time < 1.0 ns
- Fall Time < 1.0 ns
- Pulse Width ≤ 110 ns, 10.0% Duty Cycle
- Gen. Source Imp. = 50Ω

Oscilloscope
- Rise Time ≤ 0.4 nsec
- Input Resistance ≥ 9.8 MΩ
- Input Capacitance ≤ 1.7 pf

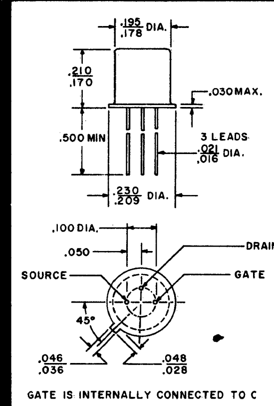
Figure 3.

N-CHANNEL FIELD EFFECT TRANSISTOR
LOW LEAKAGE AMPLIFIER
- VERY LOW LEAKAGE
- LOW NOISE
- LOW CAPACITANCE

JANUARY 1968

U1714

MAXIMUM RATINGS



CHARACTERISTIC	SYMBOL	RATING	UNIT
Drain-Gate Voltage		25	Volts
Total Device Dissipation @ $T_A = 25°C$	P_D	300	mW
Derating Factor above 25°C @ $T_A = 25°C$		1.71	mW/°C
Storage Temperature	T_{stg}	−65 to +200	°C
Junction Temperature	T_J	200	°C

ELECTRICAL CHARACTERISTICS at +25°C (Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Drain-Gate Breakdown Voltage	BV_{GSS}	$I_G = 1.0\ \mu A$, $V_{DS} = 0$	25		Volts
Total Gate Leakage Current	I_{GSS}	$V_{GS} = -10$ V, $V_{DS} = 0$		5.0	pA
Saturation Current	I_{DSS}	$V_{DS} = 10$ V, $V_{GS} = 0$	0.5	5.0	mA
Source-Gate Cutoff Voltage	$V_{GS(off)}$	$V_{DS} = 10$ V, $I_D = 1.0$ nA		5.0	Volts
Transconductance	gm	$V_{DS} = 10$ V, $V_{GS} = 0$, f = 1.0 kHz	400		μmhos
Input Capacitance	C_{iss}	$V_{DS} = 10$ V, $V_{GS} = 0$, f = 1.0 MHz		3.0	pf
Reverse Transfer Capacitance	C_{rss}	$V_{DS} = 10$ V, $I_S = 0$, f = 140 kHz		1.2	pf
Noise Figure	NF	$V_{DS} = 10$ V, $V_{GS} = 0$, f = 100 Hz, BW = 6.0 Hz, $R_G = 1.0\ M\Omega$		3.0	db

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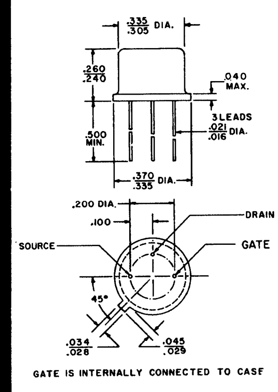
N-CHANNEL FIELD EFFECT TRANSISTOR
HIGH VOLTAGE AMPLIFIER
- HIGH BREAKDOWN VOLTAGE
- LOW NOISE
- LOW R_{ON} RESISTANCE

JANUARY 1968

U1715

MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
Drain-Gate Voltage		200	Volts
Source-Gate Voltage		125	Volts
Total Device Dissipation @ $T_A = 25°C$	P_D	800	mW
Derating Factor above 25°C @ $T_A = 25°C$		4.57	mW/°C
Storage Temperature	T_{stg}	−65 to +200	°C
Junction Temperature	T_J	+200	°C



ELECTRICAL CHARACTERISTICS at +25°C (Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Drain-Gate Breakdown Voltage	BV_{GSS}	$I_G = 1.0\ \mu A$, $I_S = 0$	200		Volts
Source-Gate Breakdown Voltage	BV_{SGO}	$I_S = 1.0\ \mu A$, $I_G = 0$	125		Volts
Total Gate Leakage Current	I_{GSS}	$V_{GS} = 75$ V, $V_{DS} = 0$		5.0	nA
Drain-Gate Leakage Current	I_{DGO}	$V_{DG} = 150$ V		3.0	nA
Saturation Current	I_{DSS}	$V_{DS} = 50$ V, $V_{GS} = 0$	10	50	mA
Source-Gate Cutoff Voltage	$V_{GS(off)}$	$V_{DS} = 50$ V, $I_D = 10$ nA		15	Volts
Drain-Source "ON" Resistance	R_O	$I_D = 100\ \mu A$, $V_{GS} = 0$		400	Ohms
Input Capacitance	C_{iss}	$V_{DS} = 50$ V, $V_{GS} = 0$ f = 1.0 MHz		25	pf
Reverse Transfer Capacitance	C_{rss}	$V_{DS} = 50$ V, $V_{GS} = 0$ f = 1.0 MHz		4.0	pf
Noise Figure	NF	$V_{DS} = 30$ V, $V_{GS} = 0$ f = 1.0 kHz, BW = 200 Hz $R_G = 1.0\ M\Omega$		3.0	db

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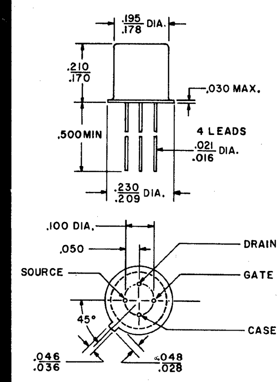
N-CHANNEL FIELD EFFECT TRANSISTOR
RF/IF AMPLIFIER
- LOW NOISE
- HIGH TRANSCONDUCTANCE
- LOW CAPACITANCE

JANUARY 1968

2N3823

MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
Drain-Source Voltage	V_{DS}	30	Volts
Drain-Gate Voltage	V_{DG}	30	Volts
Gate-Source Voltage	V_{GS}	30	Volts
Gate Current	I_G	10	mA
Total Device Dissipation @ $T_A = 25°C$	P_D	300	mW
Derating Factor above 25°C @ $T_A = 25°C$		2.0	mW/°C
Storage Temperature	T_{stg}	−65 to +200	°C
Junction Temperature	T_J	175	°C
Lead Temperature, 1/16 inch from case, 10 seconds max.		300	°C



ELECTRICAL CHARACTERISTICS at +25°C (Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Gate-Source Breakdown Voltage	$V_{(BR)GSS}$	$I_G = 1.0\ \mu A, V_{DS} = 0$	30		Volts
Gate-Source Cutoff Voltage	$V_{GS(OFF)}$	$I_D = 50$ nA, $V_{DS} = 15$ V		8.0	Volts
Gate-Source Voltage	V_{GS}	$I_D = 0.4$ mA, $V_{DS} = 15$ V	1.0	7.5	Volts
Gate Reverse Current	I_{GSS}	$V_{GS} = 20$ V, $V_{DS} = 0$ $V_{GS} = 20$ V, $V_{DS} = 0$, $T_A = 150°C$		0.50 500	nA
Zero-Gate-Voltage Current	I_{DSS}*	$V_{DS} = 15$ V, $V_{GS} = 0$	4.0	20	mA
Input Capacitance	C_{iss}	$V_{DS} = 15$ V, $V_{GS} = 0$ f = 1.0 MHz		6.0	pf
Reverse Transfer Capacitance	C_{rss}	$V_{DS} = 15$ V, $V_{GS} = 0$ f = 1.0 MHz		2.0	pf
Forward Transfer Admittance	$\|Y_{fs}\|$*	$V_{DS} = 15$ V, $V_{GS} = 0$ f = 1.0 kHz $V_{DS} = 15$ V, $V_{GS} = 0$ f = 200 MHz	3500 3200	6500	μmhos
Input Admittance	Y_{is}	$V_{DS} = 15$ V, $V_{GS} = 0$ f = 200 MHz		800	μmhos
Output Admittance	$\|Y_{os}\|$*	$V_{DS} = 15$ V, $V_{GS} = 0$ f = 1.0 kHz $V_{DS} = 15$ V, $V_{GS} = 0$ f = 200 MHz		35 200	μmhos
Noise Figure	NF	$V_{DS} = 15$ V, $V_{GS} = 0$ $R_S = 1000\ \Omega$, f = 100 MHz		2.5	db

* Pulse Test: Pulse Width = 100 ms; Duty Cycle = 10%.

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N-CHANNEL FIELD EFFECT TRANSISTOR

RF/IF AMPLIFIER

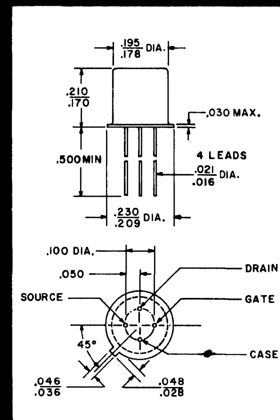
- HIGH TRANSCONDUCTANCE
- LOW LEAKAGE
- LOW NOISE

JANUARY 1968

2N4223
2N4224

MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
Drain-Source Voltage	V_{DS}	30	Volts
Drain-Gate Voltage	V_{DG}	30	Volts
Gate-Source Voltage	V_{GS}	−30	Volts
Drain Current	I_D	20	mA
Total Device Dissipation @ $T_A = 25°C$	P_D	300	mW
Derating Factor above 25°C @ $T_A = 25°C$		2	mW/°C
Storage Temperature	T_{stg}	−65 to +200	°C
Junction Temperature	T_J	+175	°C



ELECTRICAL CHARACTERISTICS at +25°C (Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Gate-Source Breakdown Voltage	$V_{(BR)GSS}$	$I_G = 10\ \mu A, V_{DS} = 0$	−30		Volts
Gate-Source Cutoff Voltage	$V_{GS(off)}$				
2N4223		$I_D = 0.25$ nA, $V_{DS} = 15$ V		−8	Volts
2N4224		$I_D = 0.50$ nA, $V_{DS} = 15$ V		−8	
Gate-Source Voltage	V_{GS}				
2N4223		$I_D = 0.3$ mA, $V_{DS} = 15$ V	−1.0	−7.0	Volts
2N4224		$I_D = 0.2$ mA, $V_{DS} = 15$ V	−1.0	−7.5	
Gate Reverse Current	I_{GSS}				
2N4223		$V_{GS} = -20$ V, $V_{DS} = 0$		−0.25	nA
2N4224				−0.50	
2N4223		$V_{GS} = -20$ V, $V_{DS} = 0$, $T_A = 100°C$		−250	
2N4224				−500	
Zero-Gate-Voltage Drain Current	I_{DSS}*				
2N4223		$V_{DS} = 15$ V, $V_{GS} = 0$	3	18	mA
2N4224			2	20	
Input Conductance	Y_{is}	$V_{DS} = 15$ V, $V_{GS} = 0$, f = 200 MHz		800	μmhos
Output Conductance	Y_{os}	$V_{DS} = 15$ V, $V_{GS} = 0$, f = 200 MHz		200	μmhos
Small-Signal Power Gain 2N4223	G_{ps}	$V_{DS} = 15$ V, $V_{GS} = 0$, f = 200 MHz (Figure 1)	10		db
Input Capacitance	C_{iss}	$V_{DS} = 15$ V, $V_{GS} = 0$, f = 1 MHz		6	pf
Reverse Transfer Capacitance	C_{rss}	$V_{DS} = 15$ V, $V_{GS} = 0$, f = 1 MHz		2	pf
Forward Transfer Admittance	$\|y_{fs}\|$				
2N4223		$V_{DS} = 15$ V, $V_{GS} = 0$, f = 1 kHz	3000	7000	μmhos
2N4224			2000	7500	
2N4223		$V_{DS} = 15$ V, $V_{GS} = 0$, f = 200 MHz	2700		
2N4224			1700		
Noise Figure 2N4223	NF	$V_{DS} = 15$ V, $V_{GS} = 0$, $R_S = 1$ kΩ, f = 200 MHz (Figure 1)		5	db

* Pulse Test: Pulse Width ≦ 630 ms, Duty Cycle ≦ 10%

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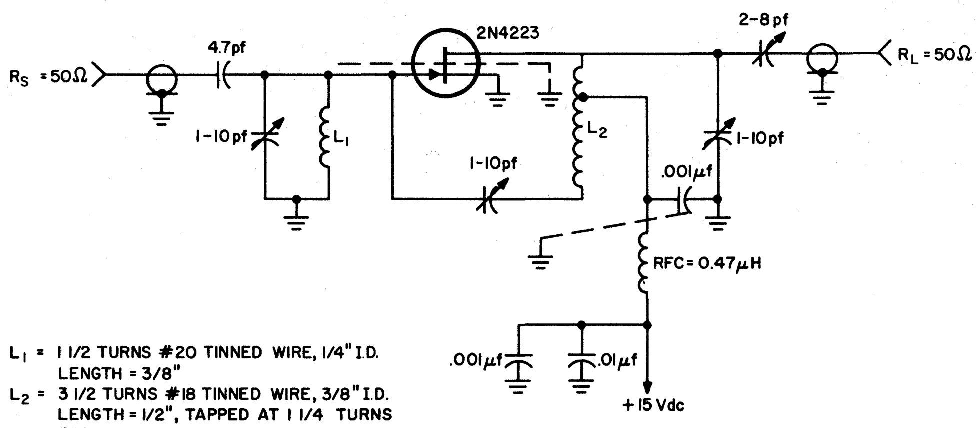
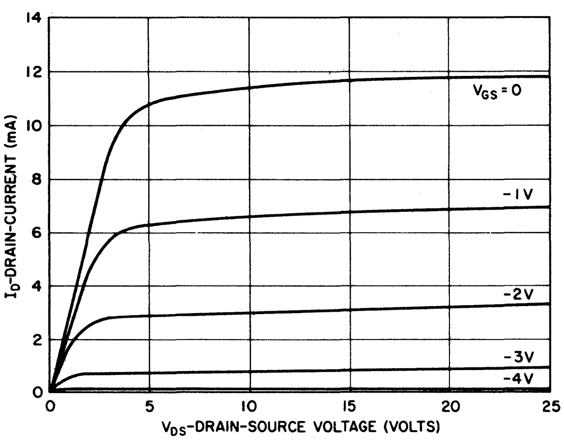
Figure 1. Noise Figure and Power Gain Test Circuit

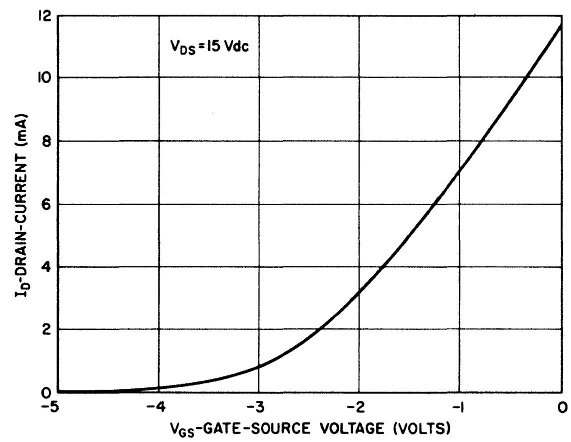


L_1 = 1 1/2 TURNS #20 TINNED WIRE, 1/4" I.D. LENGTH = 3/8"
L_2 = 3 1/2 TURNS #18 TINNED WIRE, 3/8" I.D. LENGTH = 1/2", TAPPED AT 1 1/4 TURNS FROM DRAIN

Drain Characteristics



Common Source Transfer Characteristics



N-CHANNEL FIELD EFFECT TRANSISTOR

GENERAL PURPOSE

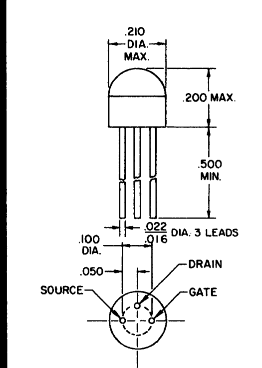
- LOW NOISE
- LOW LEAKAGE
- LOW CAPACITANCE

JANUARY 1968

2N4302
2N4303
2N4304

MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
Drain-Source Voltage	V_{DS}	30	Volts
Drain-Gate Voltage	V_{DG}	30	Volts
Reverse-Gate-Source Voltage	V_{GS}	20	Volts
Gate Current	I_G	10	mA
Total Device Dissipation @ $T_A = 25°C$	P_D	300	mW
Derating Factor Above 25°C @ $T_A = 25°C$		2.5	mW/°C
Storage Temperature	T_{stg}	−55 to +125	°C
Junction Temperature	T_J	125	°C



LEADS ELECTRICALLY ISOLATED FROM CASE

ELECTRICAL CHARACTERISTICS at +25°C (Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Drain-Gate Breakdown Voltage	BV_{GSS}	$I_G = 1.0\ \mu A, V_{DS} = 0$		30	Volts
Total Gate Leakage Current	I_{GSS}	$V_{GS} = -10\ V, V_{DS} = 0$ $V_{GS} = -10\ V, V_{DS} = 0, T_A = 85°C$		1.0 0.1	nA μA
Saturation Current 2N4302 2N4303 2N4304	I_{DSS}	$V_{DS} = 20\ V, V_{GS} = 0$	0.5 4.0 0.5	5.0 10 15	mA
Pinch Off Voltage 2N4302 2N4303 2N4304	V_P	$V_{DS} = 20\ V, I_D = 10\ nA$		4.0 6.0 10	Volts
Transconductance 2N4302 2N4303 2N4304	g_m	$V_{DS} = 20\ V, V_{GS} = 0$ f = 1.0 kHz	1000 2000 1000		μmhos
Output Conductance	g_{os}	$V_{DS} = 20\ V, V_{GS} = 0$ f = 1.0 kHz		50	μmhos
Input Capacitance	C_{iss}	$V_{DS} = 20\ V, V_{GS} = 0$ f = 1.0 MHz		6.0	pf
Reverse Transfer Capacitance	C_{rss}	$V_{DS} = 20\ V, V_{GS} = 0$ f = 1.0 MHz		3.0	pf
Drain-Gate Capacitance	C_{DG}	$V_{DG} = 10\ V, I_S = 0$ f = 140 kHz		2.0	pf
Magnitude of Small Signal, Common Source, Short Circuit, forward Transadmittance 2N4302 2N4303 2N4304	Y_{fs}	$V_{DS} = 20\ V, V_{GS} = 0$ f = 10 MHz	700 1400 700		μmhos
Noise Figure 2N4302 2N4303 2N4304	NF	$V_{DS} = 10\ V, R_G = 1.0\ M\Omega$ f = 1.0 kHz $V_{GS} = 0$, BW = 200 Hz		2.0 2.0 3.0	db

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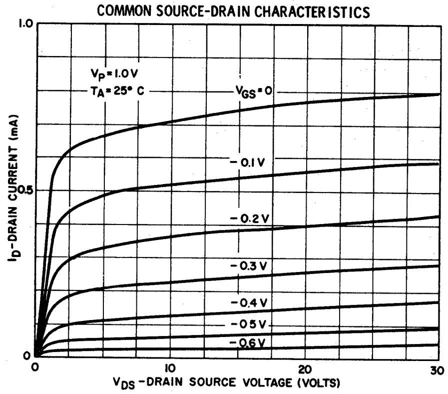
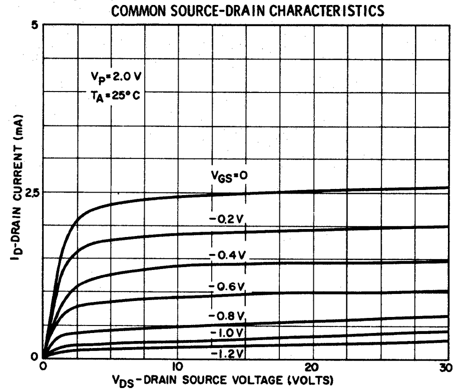
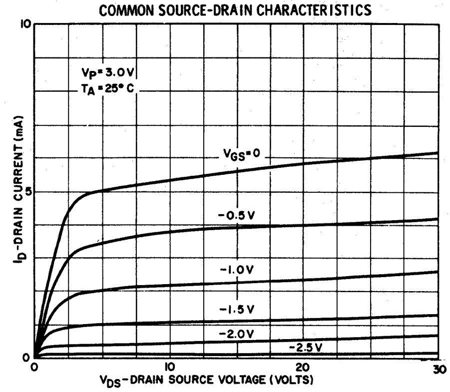
COMMON SOURCE-DRAIN CHARACTERISTICS



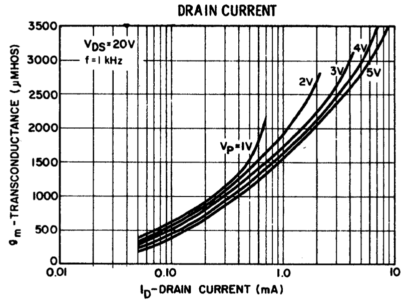
COMMON SOURCE-DRAIN CHARACTERISTICS



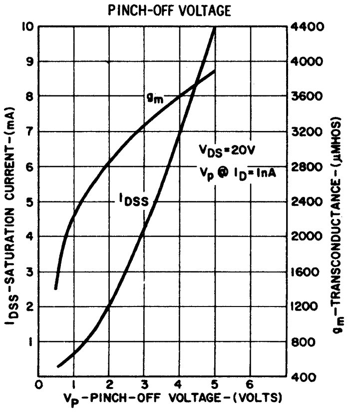
COMMON SOURCE-DRAIN CHARACTERISTICS



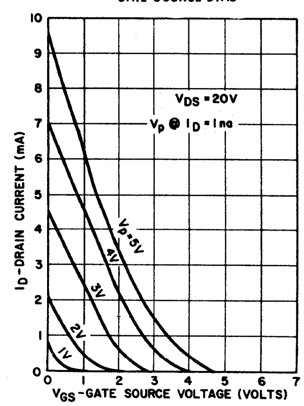
TRANSCONDUCTANCE
VS
DRAIN CURRENT



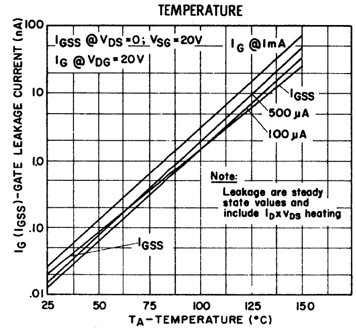
TRANSCONDUCTANCE
AND DRAIN CURRENT
VS
PINCH-OFF VOLTAGE



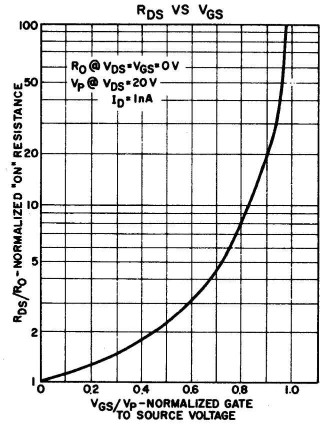
DRAIN CURRENT
VS
GATE-SOURCE BIAS



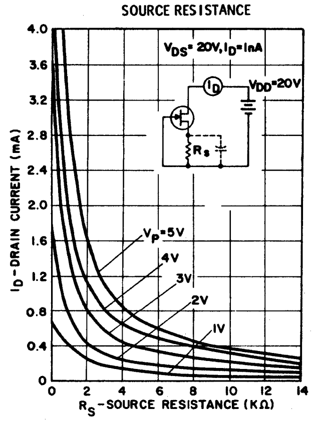
GATE LEAKAGE CURRENT
VS
TEMPERATURE



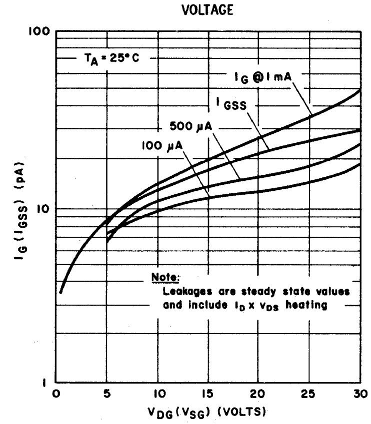
NORMALIZED
R_{DS} VS V_{GS}



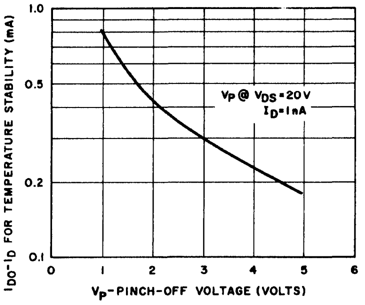
SOURCE FOLLOWER
DRAIN CURRENT
VS
SOURCE RESISTANCE



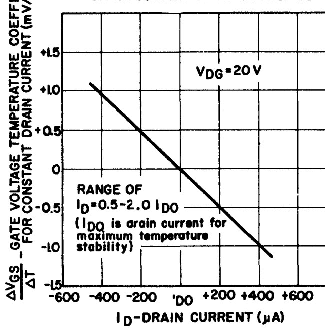
GATE LEAKAGE CURRENT
VS
VOLTAGE



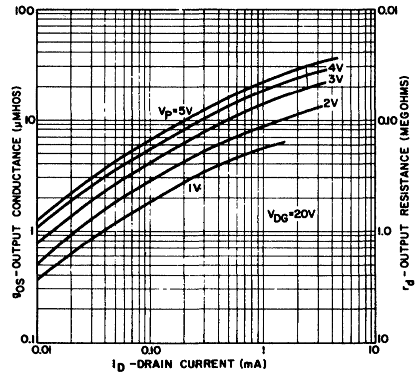
DRAIN CURRENT FOR MAXIMUM
TEMPERATURE STABILITY



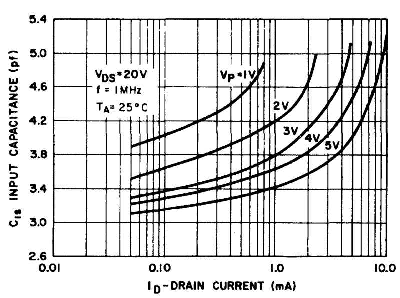
GATE VOLTAGE TEMPERATURE
COEFFICIENTS FOR CONSTANT
DRAIN CURRENT VS DRAIN VOLTAGE



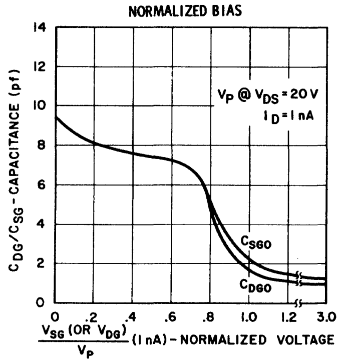
OUTPUT CONDUCTANCE
VS
DRAIN CURRENT



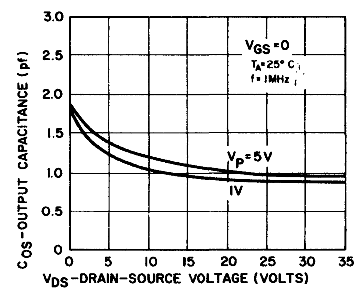
INPUT CAPACITANCE
VS
DRAIN CURRENT



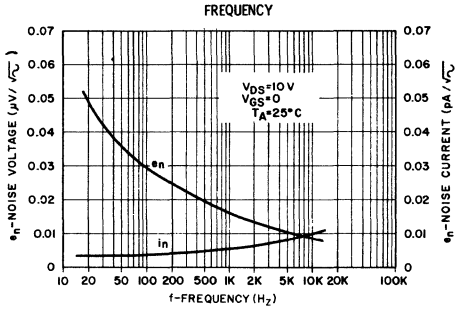
JUNCTION CAPACITANCE
VS
NORMALIZED BIAS



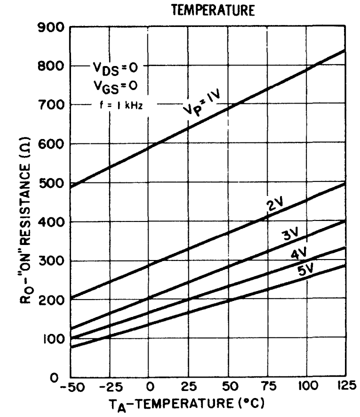
OUTPUT CAPACITANCE
VS
DRAIN SOURCE VOLTAGE



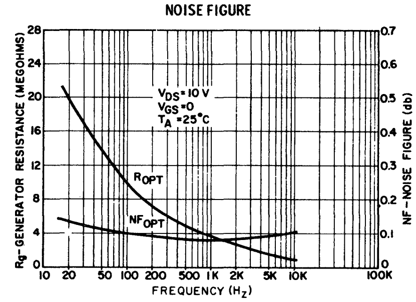
NOISE VOLTAGE/CURRENT
VS
FREQUENCY



"ON" RESISTANCE
VS
TEMPERATURE



OPTIMUM GENERATOR RESISTANCE
AND
NOISE FIGURE



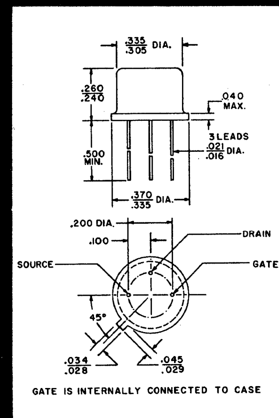
N-CHANNEL FIELD EFFECT TRANSISTOR

HIGH VOLTAGE AMPLIFIER

- HIGH BREAKDOWN VOLTAGE
- LOW LEAKAGE
- LOW CAPACITANCE

JANUARY 1968

2N4881 THRU 2N4886



MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING			UNIT
		2N4881-2	2N4883-4	2N4885-6	
Drain-Source Voltage	V_{DS}	300	200	125	Volts
Drain-Gate Voltage	V_{DG}	300	200	125	Volts
Reverse Gate-Source Voltage	V_{GS}	100	100	75	Volts
Gate Current	I_G	10			mA
Total Device Dissipation @ $T_A = 25°C$	P_D	800			mW
Derating Factor Above 25°C @ $T_A = 25°C$		4.57			mW/°C
Storage Temperature	T_{stg}	−65 to +200			°C
Junction Temperature	T_J	200			°C
Lead Temperature, 1/16 inch from case, 10 sec. max.		300			°C

ELECTRICAL CHARACTERISTICS at +25°C (Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Gate-Source Breakdown Voltage 2N4881-4 2N4885-6	$V_{(BR)GSS}$	$I_G = 1.0\ \mu A, V_{DS} = 0$	100 75		Volts
Gate-Source Cutoff Voltage 2N4881-2 2N4883-6	$V_{GS(OFF)}$	$V_{DS} = 50\ V, I_D = 2.0\ nA$ $V_{DS} = 50\ V, I_D = 1.0\ nA$	0.5 0.5	15 10	Volts
Gate-Source Voltage 2N4881 2N4882 2N4883, 5 2N4884, 6	V_{GS}	$V_{DS} = 50\ V, I_D = 40\ \mu A$ $V_{DS} = 50\ V, I_D = 150\ \mu A$ $V_{DS} = 50\ V, I_D = 40\ \mu A$ $V_{DS} = 50\ V, I_D = 150\ \mu A$	0.5 0.5 0.5 0.5	14.5 14.5 9.5 9.5	Volts
Gate Reverse Current 2N4881-2 2N4883-6 2N4881-2 2N4883-6	I_{GSS}	$V_{GS} = 50\ V, V_{DS} = 0$ $V_{GS} = 50\ V, V_{DS} = 0, T_A = 150°C$		2.0 1.0 4.0 2.0	nA μA
Zero-Gate-Voltage Drain Current 2N4881, 3, 5 2N4882, 4, 6	I_{DSS}*	$V_{DS} = 50\ V, V_{GS} = 0$	0.4 1.5	2.0 7.5	mA
Drain-Source "ON" Resistance 2N4881, 3, 5 2N4882, 4, 6	r_{DS}	$I_D = 100\ \mu A, V_{GS} = 0$		5000 3000	Ohms
Input Capacitance	C_{iss}	$V_{DS} = 50\ V, V_{GS} = 0$ $f = 1.0\ MHz$		15	pf
Reverse Transfer Capacitance	C_{rss}	$V_{DS} = 50\ V, V_{GS} = 0$ $f = 1.0\ MHz$		1.5	pf
Drain-Gate Capacitance	C_{dgo}	$V_{DG} = 50\ V, I_S = 0$ $f = 1.0\ MHz$		1.5	pf
Forward Transfer Admittance 2N4881, 3, 5 2N4882, 4, 6	$\lvert Y_{fs} \rvert$	$V_{DS} = 50\ V, V_{GS} = 0$ $f = 1.0\ kHz$	350 600	1000 1500	μmhos

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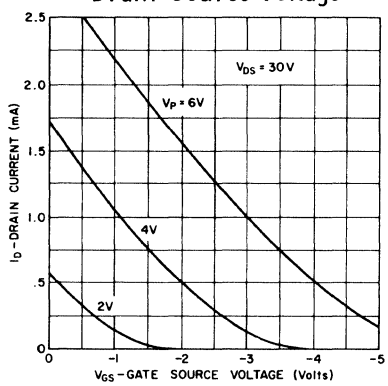
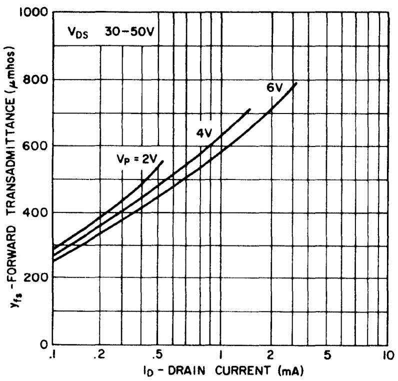
CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Forward Transfer Admittance 2N4881, 3, 5 2N4882, 4, 6	$\lvert Y_{fs} \rvert$	$V_{DS} = 50$ V, $V_{GS} = 0$ f = 1.0 MHz	 300 550		μmhos
Output Admittance 2N4881, 3, 5 2N4882, 4, 6 2N4881, 3, 5 2N4882, 4, 6	$\lvert Y_{os} \rvert$	$V_{DS} = 50$ V, $V_{GS} = 0$ f = 1.0 kHz $V_{DS} = 50$ V, $I_D = 0.2$ mA f = 1.0 kHz		 10 20 2.5 5.0	μmhos
Noise Figure	NF	$V_{DS} = 50$ V, $V_{GS} = 0$ $R_G = 1.0$ MΩ f = 1.0 kHz BW = 200 Hz		3.0	db

* Pulse Test: Pulse Width = 300μsec; Duty Cycle = 1%.

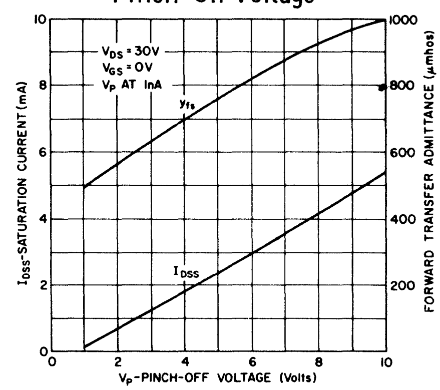
Drain Current vs Drain-Source Voltage



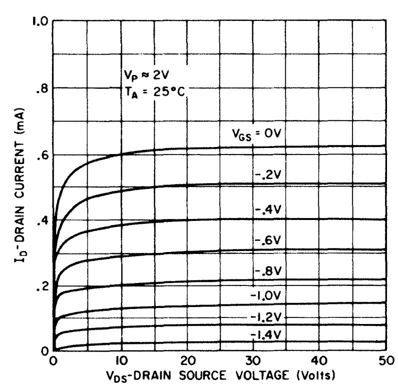
Forward Transadmittance vs Drain Current



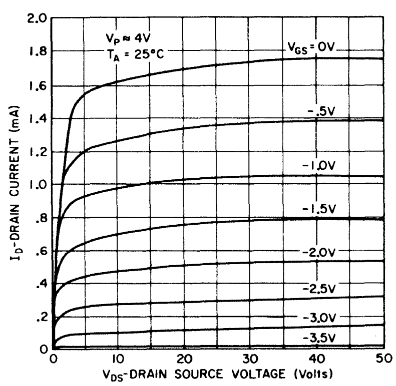
Forward Transfer Admittance And Drain Current vs Pinch-Off Voltage



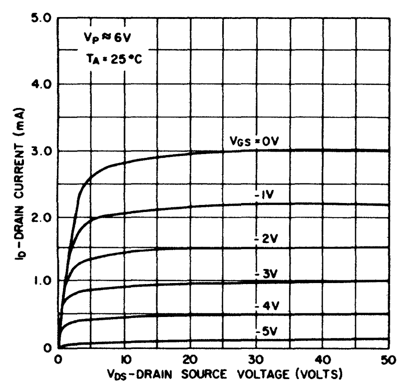
Common Source Drain Characteristics



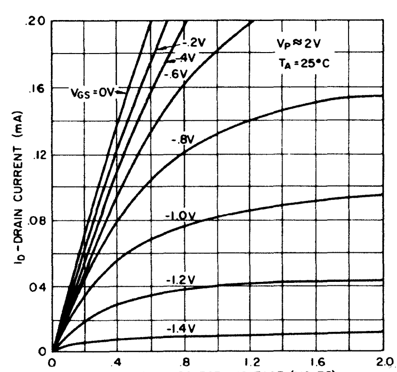
Common Source Drain Characteristics



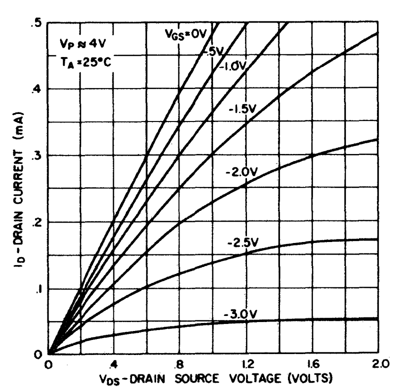
Common Source Drain Characteristics



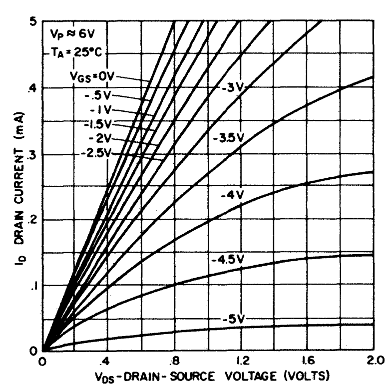
Common Source Drain Characteristics



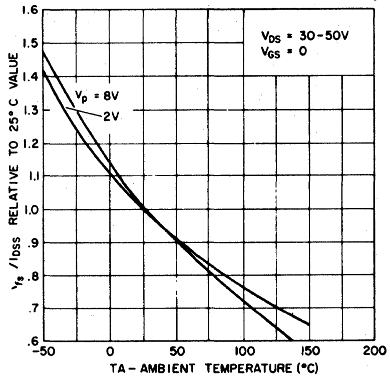
Common Source Drain Characteristics



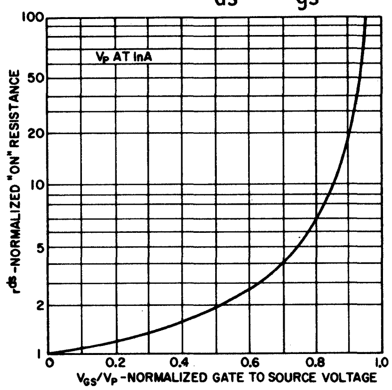
Common Source Drain Characteristics



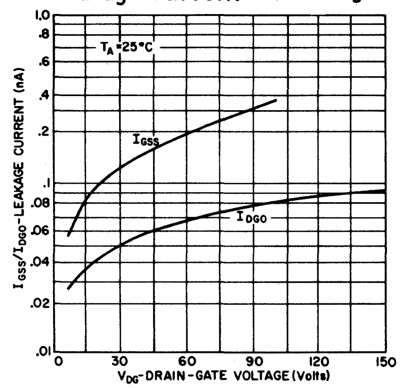
Normalized Forward Transfer Admittance/ Saturation Current vs Ambient Temperature



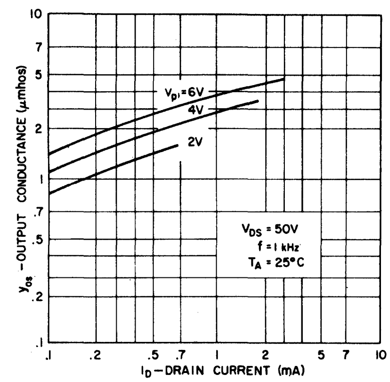
Normalized r_{ds} vs V_{gs}



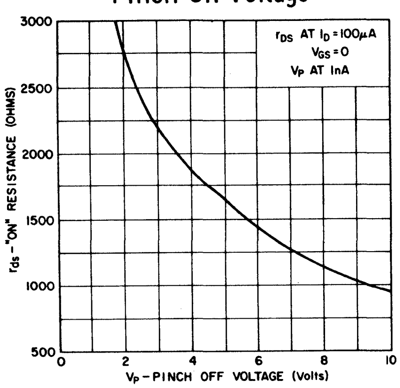
Leakage Current vs Voltage



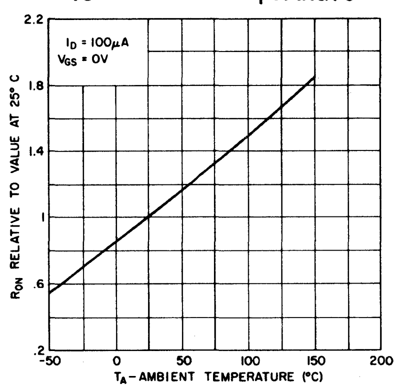
Output Conductance vs Drain Current



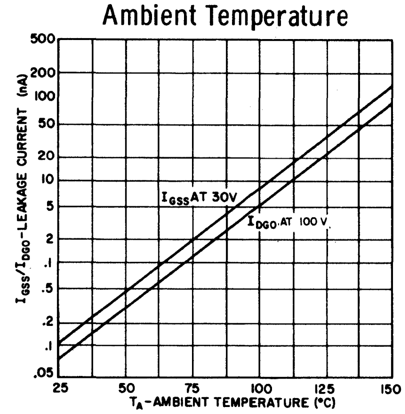
"On" Resistance vs Pinch Off Voltage



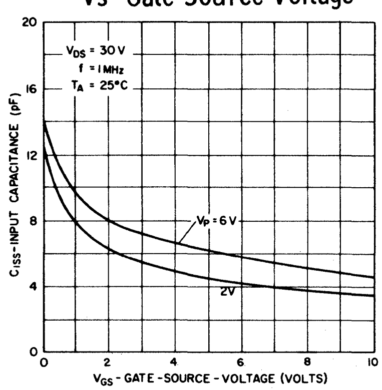
Normalized "On" Resistance vs Ambient Temperature



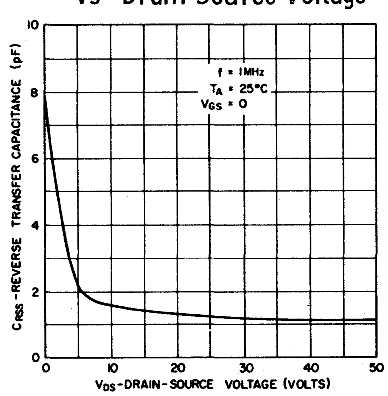
Leakage Current vs Ambient Temperature



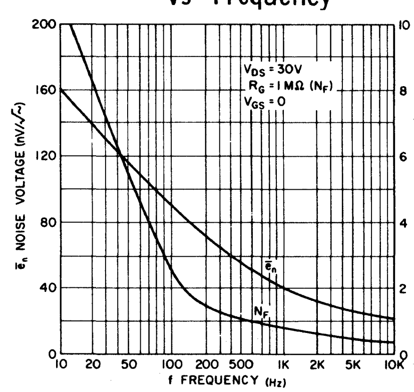
Short Circuit Input Capactance vs Gate Source Voltage



Reverse Transfer Capacitance vs Drain Source Voltage



Noise Voltage/Noise Figure vs Frequency



N-CHANNEL FIELD EFFECT TRANSISTOR

RF/IF AMPLIFIER

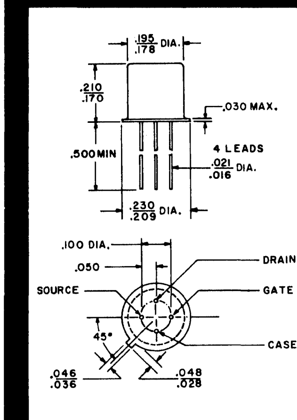
- HIGH TRANSCONDUCTANCE
- LOW LEAKAGE
- LOW NOISE

JANUARY 1968

2N5078

MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
Reverse Gate-Source Voltage	V_{GS}	−30	Volts
Drain-Source Voltage	V_{DS}	30	Volts
Drain-Gain Voltage	V_{DG}	30	Volts
Drain Current	I_D	30	mA
Gate Current	I_G	10	mA
Total Device Dissipation @ $T_A = 25°C$	P_D	0.3	Watts
Derating Factor above 25°C @ $T_A = 25°C$		1.7	mW/°C
Storage Temperature	T_{stg}	−65 to +200	°C
Junction Temperature	T_J	+200	°C
Lead Temperature, 1/16 inch from case, 10 seconds max.		+300	°C



ELECTRICAL CHARACTERISTICS at +25°C (Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Gate-Source Breakdown Voltage	$V_{(BR)GSS}$	$I_G = 1.0\ \mu A$, $V_{DS} = 0$	30		Volts
Gate-Source Cutoff Voltage	$V_{GS(off)}$	$V_{DS} = 15$ V, $I_D = 1.0\ \mu A$	−0.5	−8.0	Volts
Gate-Source Voltage	V_{GS}	$V_{DS} = 15$ V, $I_D = 0.4$ mA	−0.5	−7.0	Volts
Gate Reverse Current	I_{GSS}	$V_{GS} = -20$ V, $V_{DS} = 0$ $V_{GS} = -20$ V, $V_{DS} = 0$, $T_A = 150°C$		−0.25 −0.25	nA µA
Zero-Gate-Voltage Drain Current	I_{DSS}	$V_{DS} = 15$ V, $V_{GS} = 0$	4.0	25	mA
Power Gain	G_{ps}	$V_{DS} = 15$ V, $V_{GS} = 0$ f = 200 MHz (figure 1)	15		db
Power Gain	G_{ps}	$V_{DS} = 15$ V, $I_D = 4$ mA f = 400 MHz (figure 2)	12		db
Input Capacitance	C_{iss}	$V_{DS} = 15$ V, $V_{GS} = 0$ f = 1 MHz		6.0	pf
Reverse Transfer Capacitance	C_{rss}	$V_{DS} = 15$ V, $V_{GS} = 0$ f = 2 MHz		2.0	pf
Forward Transadmittance	$\|Y_{fs}\|$	$V_{DS} = 15$ V, $V_{GS} = 0$ f = 1 kHz $V_{DS} = 15$ V, $V_{GS} = 0$ f = 200 MHz	4500 4000	10000	µmhos
Input Conductance	Y_{is}	$V_{DS} = 15$ V, $V_{GS} = 0$ f = 200 MHz		800	µmhos
Output Admittance	Y_{os}	$V_{DS} = 15$ V, $V_{GS} = 0$ f = 200 MHz		150	µmhos
Noise Figure	NF	$V_{DS} = 15$ V, $V_{GS} = 0$ $R_S = 1$ MΩ, f = 10 Hz BW = 5 Hz $V_{DS} = 15$ V, $V_{GS} = 0$ $R_S = 1$ kΩ f = 200 MHz (figure 1) $V_{DS} = 15$ V, $I_D = 4$ mA f = 400 MHz, $R_S = 1$ kΩ (figure 2)		5.0 3.0 4.0	db

NOTE: Case Lead Grounded During All Electric Tests

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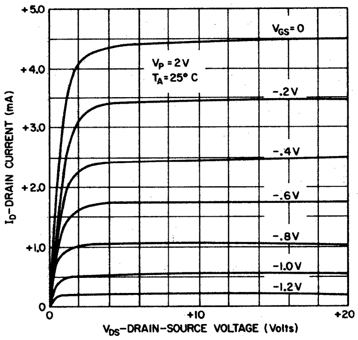
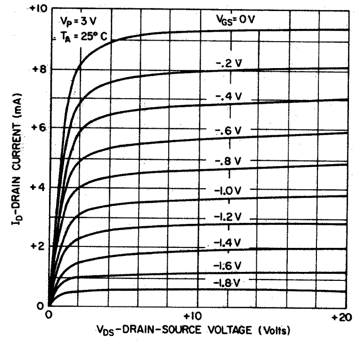
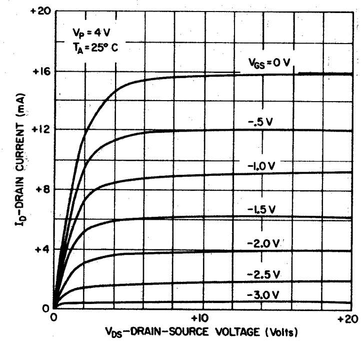
Common Source-Drain
Characteristics



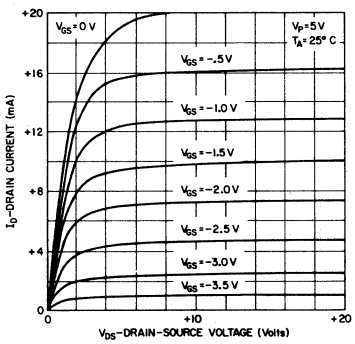
Common Source-Drain
Characteristics



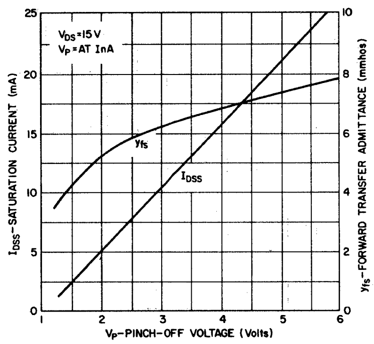
Common Source-Drain
Characteristics



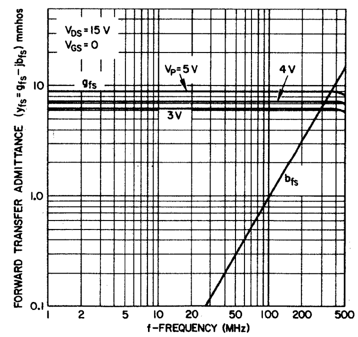
Common Source-Drain
Characteristics



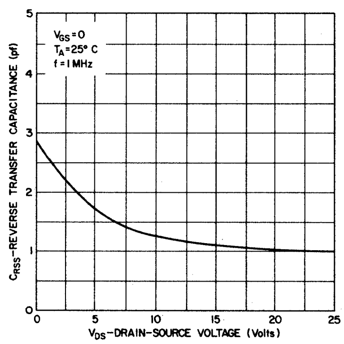
Forward Transfer Admittance
and Drain Current
vs
Pinch Off Voltage



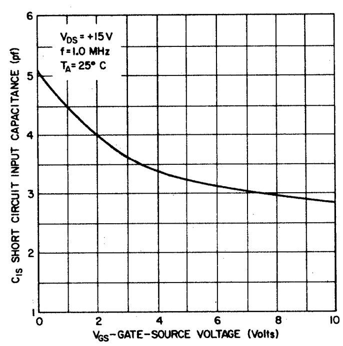
Forward Transfer Admittance
vs
Frequency



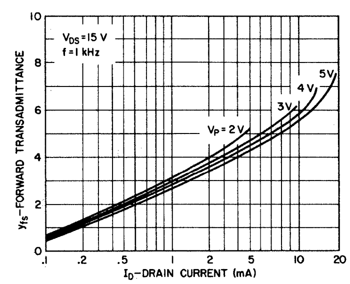
Reverse Transfer Capacitance
vs
Drain-Source Voltage



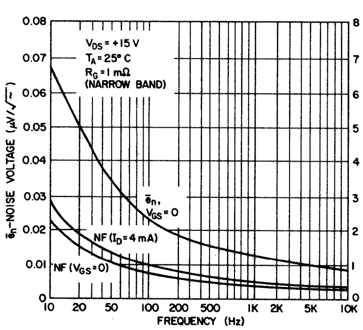
Short Circuit Input Capacitance
vs
Gate-Source Voltage



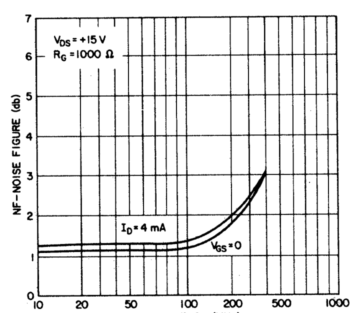
Forward Transadmittance
vs
Drain Current



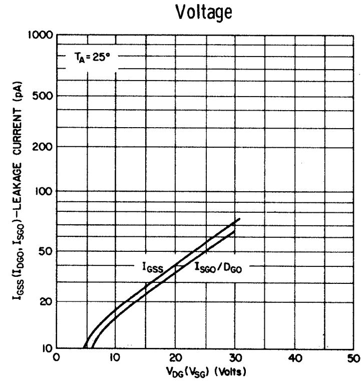
Noise Voltage/Noise Figure
vs
Frequency



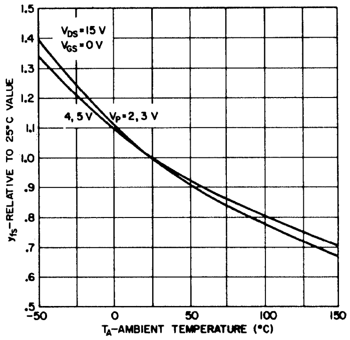
Noise Figure
vs
Frequency



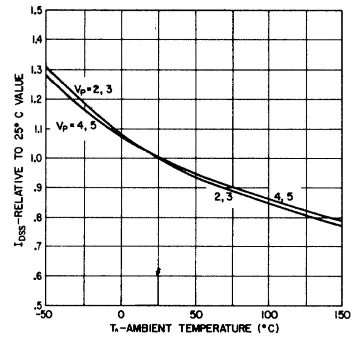
Leakage Current
vs
Voltage



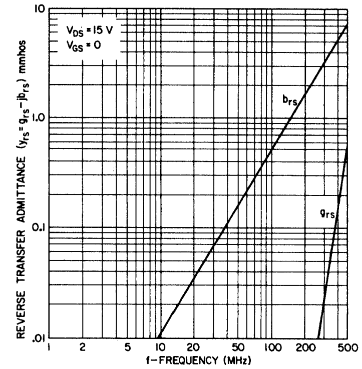
Normalized Forward Transfer Admittance vs Ambient Temperature



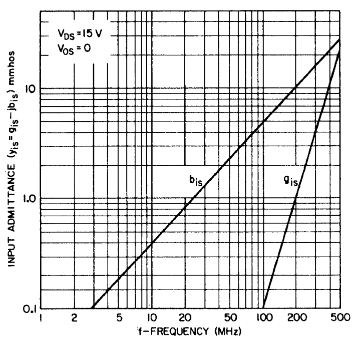
Normalized Drain Saturation Current vs Ambient Temperature



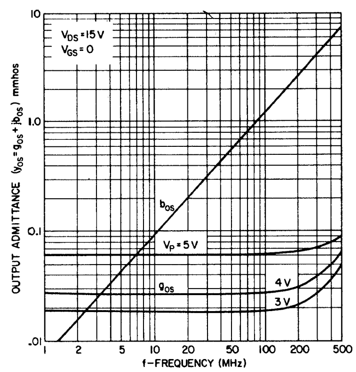
Reverse Transfer Admittance vs Frequency



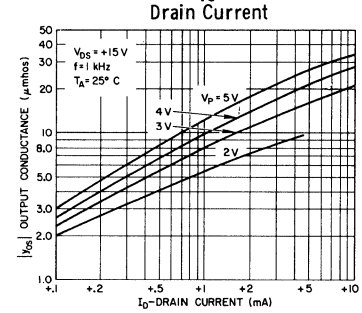
Input Admittance vs Frequency



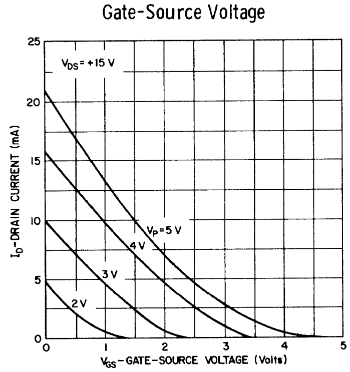
Output Admittance vs Frequency



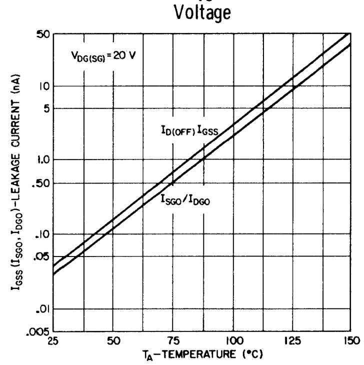
Output Conductance vs Drain Current



Drain Current vs Gate-Source Voltage



Gate Leakage vs Voltage



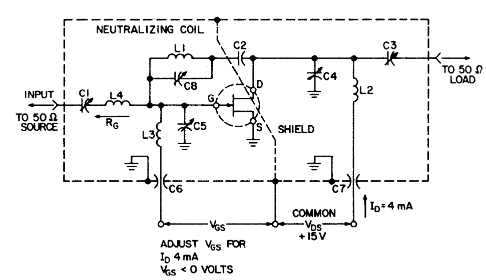
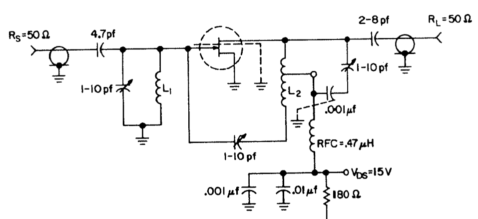


Figure 2.

C_1	Arco 400	.9-7 pf
C_2	27 pf	
C_3	Arco 420	1-12 pf
C_4	Johansen 2954	.8-10 pf
C_5	Johansen 2954	.8-10 pf
C_6	.001 μF	
C_7	.001 μF	
C_8	Arco 420	1-12 pf
L_1	5/16 dia x 3/8 long, #14 Copper wire	
L_2	5/8" Straight, #12 Copper wire	
L_3	3/8" Straight, #18 Copper wire	
L_4	3 turns 1/4 ID, 1/4" long x 14 Copper wire	



L_1 1-1/2 turns, #20 tinned wire, 1/4 ID, Length = 3/8"

L_2 3-1/2 turns, #18 tinned wire, 3/8" ID, Length = 1/2"
Tapped at 1-1/4 turns from drain

Figure 1.

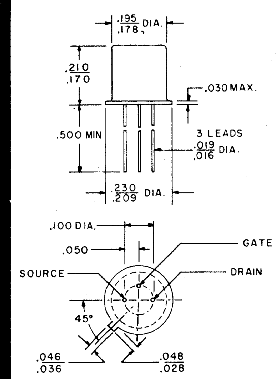
P-CHANNEL FIELD EFFECT TRANSISTOR
GENERAL PURPOSE
- **LOW LEAKAGE**
- **LOW NOISE**

JANUARY 1968

2N2606 THRU 2N2609

MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
Total Device Dissipation @ $T_A = 25°C$	P_D	300	mW
Storage Temperature	T_{stg}	−65 to +200	°C
Junction Temperature	T_J	+175	°C
Derating Factor above 25°C @ $T_A = 25°C$		2	mW/°C



GATE IS INTERNALLY CONNECTED TO CASE

ELECTRICAL CHARACTERISTICS at +25°C (Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Gate to Source Breakdown Voltage	BV_{GSS}	$I_G = 1.0\ \mu A$, $V_{DS} = 0$	30		Volts
Total Gate Leakage Current	I_{GSS}				
2N2606		$V_{GS} = 5.0\ V$, $V_{DS} = 0$		1.0	nA
2N2607				3.0	
2N2608				10	
2N2609				30	
2N2606		$V_{GS} = 5.0\ V$, $V_{DS} = 0$, $T_A = 150°C$		1.0	µA
2N2607				3.0	
2N2608				10	
2N2609				30	
Saturation Current	I_{DSS}				
2N2606		$V_{DS} = -5.0\ V$, $V_{GS} = 0$	100	500	µA
2N2607			300	1500	
2N2608			0.9	4.5	mA
2N2609			2.0	10	
Transconductance	g_m				
2N2606		$V_{DS} = -5.0\ V$, $V_{GS} = 0$, f = 1 kHz	110		µmhos
2N2607			330		
2N2608			1000		
2N2609			2500		
Input Capacitance	C_{ib}				
2N2606		$V_{DS} = -5.0\ V$, $V_{GS} = 1.0\ V$, f = 140 kHz		6.0	pf
2N2607				10	
2N2608				17	
2N2609				30	
Pinch Off Voltage	Vp	$V_{DS} = -5.0\ V$, $I_D = 1.0\ \mu A$	1.0	4.0	Volts
Noise Figure	NF	$V_{DS} = -5.0\ V$, f = 1 kHz			
2N2606, 2N2607		BW = 160 Hz, Rg = 10 MΩ		3.0	db
2N2608, 2N2609		Rg = 1.0 MΩ		3.0	

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P-CHANNEL FIELD EFFECT TRANSISTOR

GENERAL PURPOSE SWITCH

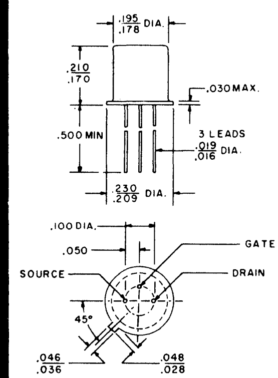
- VERY LOW "ON" RESISTANCE
- FAST SWITCHING SPEEDS
- LOW LEAKAGE

JANUARY 1968

2N5018
2N5019

MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
Drain-Source Voltage	V_{DS}	−30	Volts
Drain-Gate Voltage	V_{DG}	−30	Volts
Reverse Gate-Source Voltage	V_{GS}	−30	Volts
Gate Current	I_G	10	mA
Total Device Dissipation @ $T_C = 25°C$	P_D	1.8	Watts
Derating Factor Above 25°C @ $T_A = 25°C$		10	mW/°C
Storage Temperature	T_{stg}	−65 to +200	°C
Junction Temperature	T_J	200	°C
Lead Temperature, 1/16 inch from case, 10 seconds max.		300	°C



GATE IS INTERNALLY CONNECTED TO CASE

ELECTRICAL CHARACTERISTICS at +25°C (Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Gate-Source Breakdown Voltage	$V_{(BR)GSS}$	$I_G = 1.0\ \mu A, V_{DS} = 0$	30		Volts
Gate-Source Cutoff Voltage	$V_{GS(OFF)}$				
2N5018		$V_{DS} = -15\ V, I_D = 1.0\ \mu A$		10	Volts
2N5019		$V_{DS} = -15\ V, I_D = 1.0\ \mu A$		5	
Drain-Source "On" Voltage	$V_{DS(ON)}$				
2N5018		$I_D = -6.0\ mA, V_{GS} = 0$		−0.5	Volts
2N5019		$I_D = -3.0\ mA, V_{GS} = 0$		−0.5	
Gate Reverse Current	I_{GSS}	$V_{GS} = 15\ V, V_{DS} = 0$		2.0	nA
Zero-Gate-Voltage Drain Current	I_{DSS}				
2N5018		$V_{DS} = -20\ V, V_{GS} = 0$	−10		mA
2N5019		$V_{DS} = -20\ V, V_{GS} = 0$	−5		
Drain Cutoff Current	$I_{D(OFF)}$				
2N5018		$V_{DS} = -15\ V, V_{GS} = 12\ V$		10	nA
2N5019		$V_{DS} = -15\ V, V_{GS} = 7.0\ V$		10	
2N5018		$V_{DS} = -15\ V, V_{GS} = 12\ V, T_A = 150°C$		10	μA
2N5019		$V_{DS} = -15\ V, V_{GS} = 7.0\ V, T_A = 150°C$		10	
Drain Reverse Current	I_{DGO}	$V_{DG} = -15\ V, I_S = 0$		2.0	nA
		$V_{DG} = -15\ V, I_S = 0, T_A = 150°C$		3.0	μA
Drain-Source "ON" Resistance	$r_{DS(ON)}$				
2N5018		$I_D = 1.0\ mA, V_{GS} = 0$		75	Ohms
2N5019		$I_D = 1.0\ mA, V_{GS} = 0$		150	
Drain-Source "ON" Resistance	$r_{ds(ON)}$				
2N5018		$V_{GS} = 0, I_D = 0$, f = 1.0 kHz		75	Ohms
2N5019		$V_{GS} = 0, I_D = 0$, f = 1.0 kHz		150	
Rise Time	t_r				
2N5018		See Figure 1		20	nsec
2N5019		See Figure 2		75	
Delay Time	t_d				
2N5018		See Figure 1		15	nsec
2N5019		See Figure 2		15	

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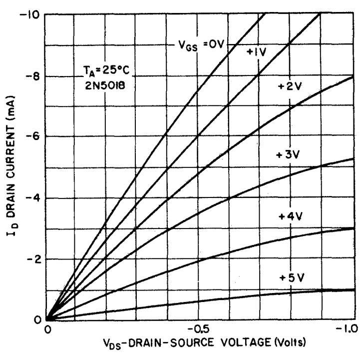
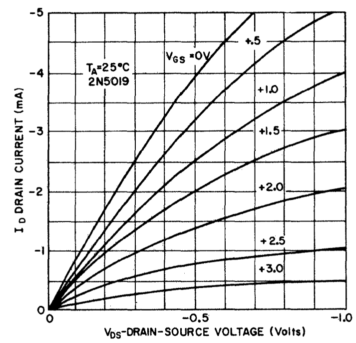
CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Turn-Off Delay Time 2N5018 2N5019	$t_{d(OFF)}$	See Figure 1 See Figure 2		15 25	nsec
Turn-Off Time 2N5018 2N5019	$t_{(OFF)}$	See Figure 1 See Figure 2		50 100	nsec
Input Capacitance	C_{iss}	$V_{DS} = -15\ V, V_{GS} = 0$ $f = 1.0$ MHz		45	pf
Reverse Transfer Capacitance 2N5018 2N5019	C_{rss}	$V_{DS} = 0, V_{GS} = 12\ V$ $f = 1.0$ MHz $V_{DS} = 0, V_{GS} = 7.0\ V$ $f = 1.0$ MHz		10 10	pf

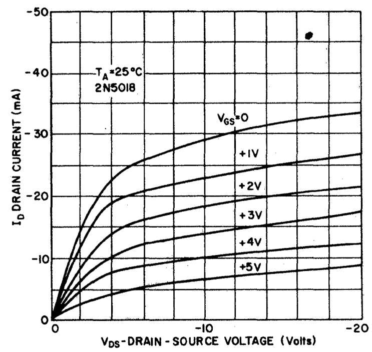
Common Source-Drain Characteristics



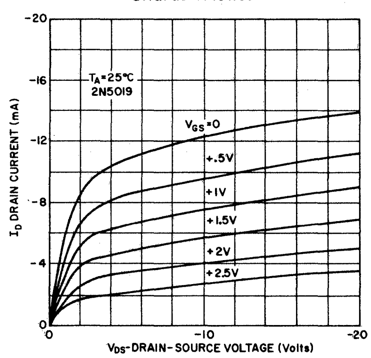
Common Source-Drain Characteristics



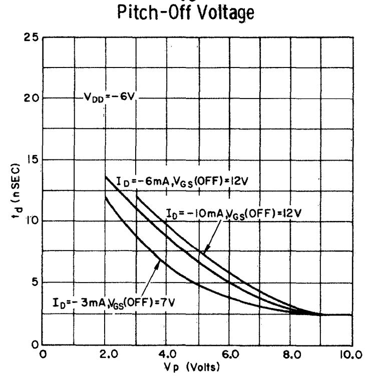
Common Source-Drain Characteristics



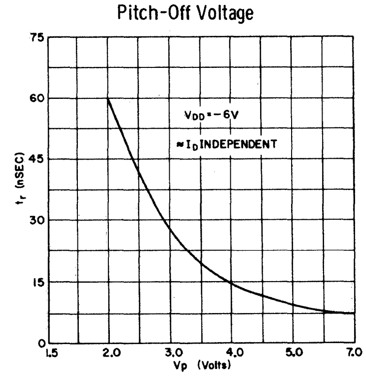
Common Source-Drain Characteristics



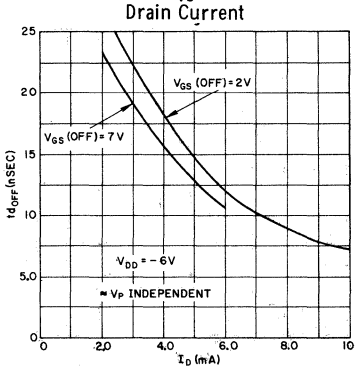
Switching Characteristics
Delay Time
vs
Pitch-Off Voltage



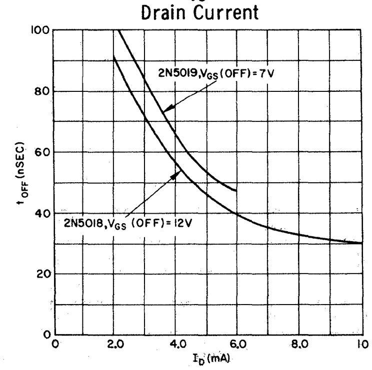
Switching Characteristics
Rise Time
vs
Pitch-Off Voltage



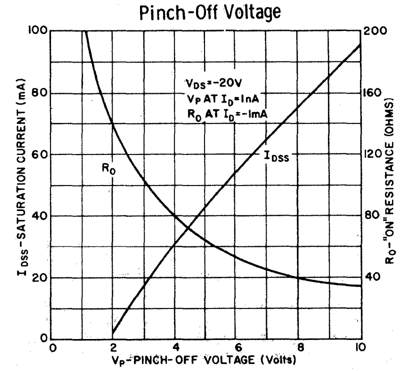
Switching Characteristics
Turn-Off Delay Time
vs
Drain Current



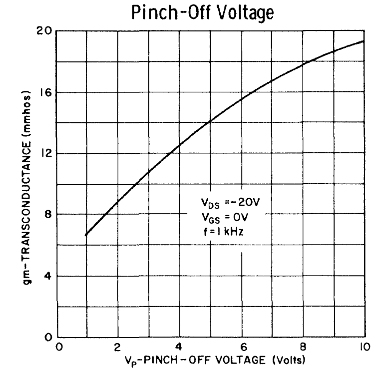
Switching Characteristics
Turn-Off Time
vs
Drain Current



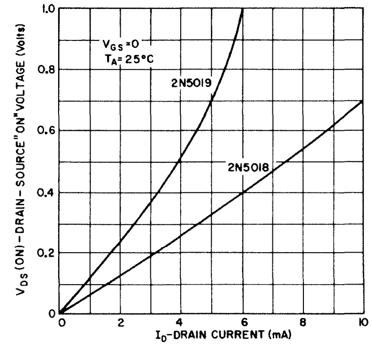
"On" Resistance and Drain Current
vs
Pinch-Off Voltage



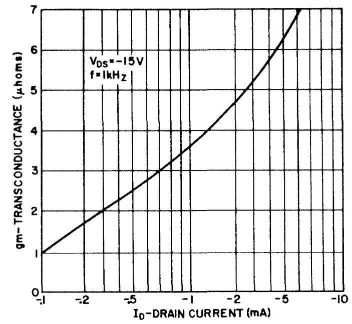
Transconductance
vs
Pinch-Off Voltage



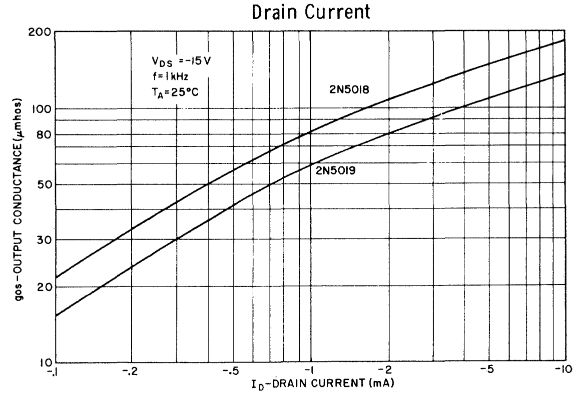
Drain-Source "On" Voltage
vs
Drain Current



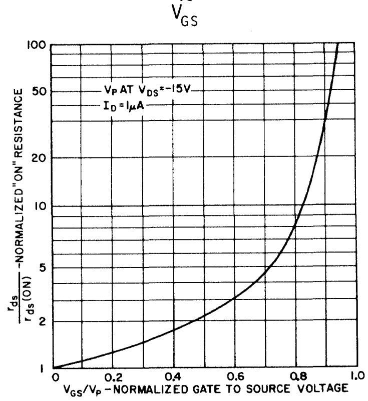
Transconductance
vs
Drain Current



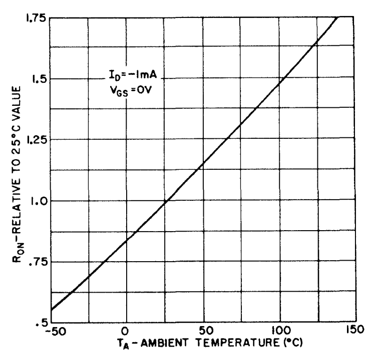
Output Conductance
vs
Drain Current



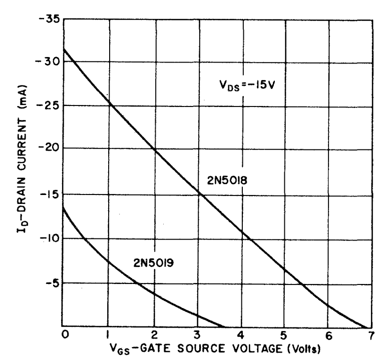
Normalized r_{ds}
vs
V_{GS}



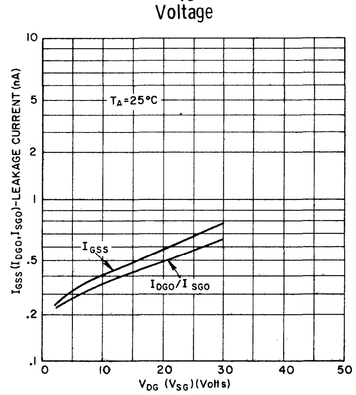
Normalized "On" Resistance
vs
Ambient Temperature



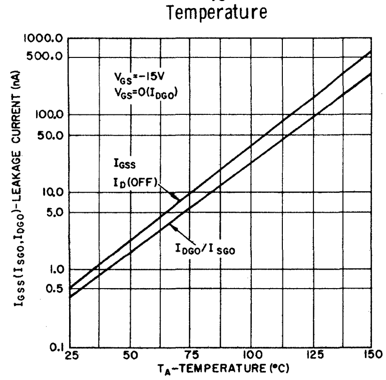
Drain Current
vs
Gate-Source Bias



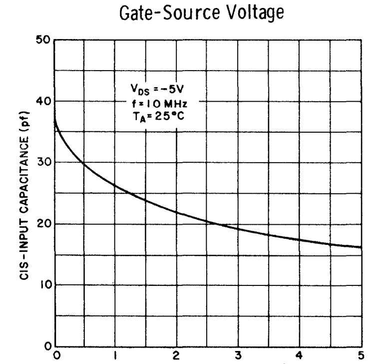
Leakage Current
vs
Voltage



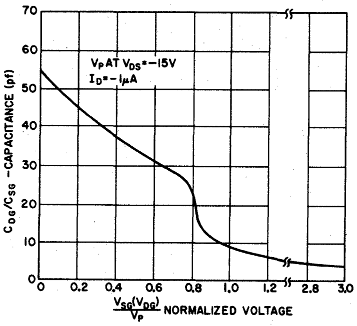
Gate Leakage Current
vs
Temperature



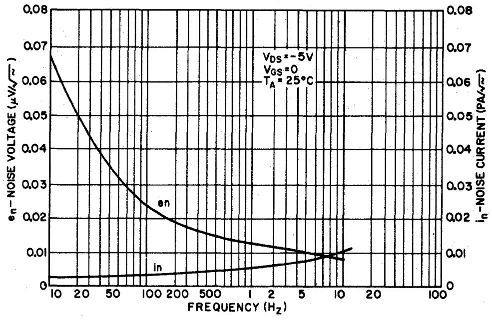
Input Capacitance
vs
Gate-Source Voltage



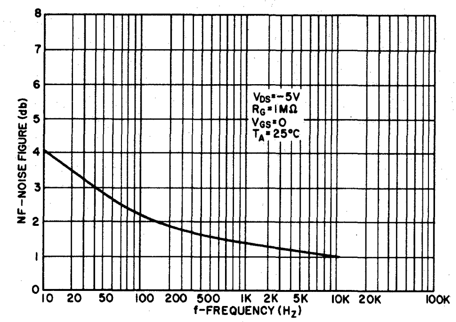
Junction Capacitance vs Normalized Bias

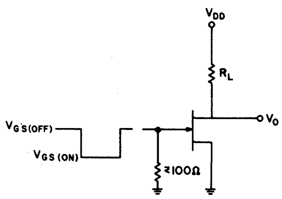


Noise Voltage/Current vs Frequency



Noise Figure vs Frequency



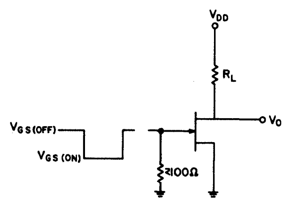


R_L = 910Ω
$I_{D(ON)}$ = 6.0 mA
$V_{GS(OFF)}$ = +12
$V_{GS(ON)}$ = 0V
V_{DD} = -6V

Input Pulse
- Rise Time < 1.0 ns
- Fall Time < 1.0 ns
- Pulse Width ≤ 110 ns, 10% Duty Cycle
- Gen. Source Imp. ≤ 100Ω

Oscilloscope
- Rise Time ≤ 0.4 ns
- Input Resistance ≥ 9.8 MΩ
- Input Capacitance ≤ 1.7 pf

Figure 1.



R_L = 1.8k
$I_{D(ON)}$ = 3 mA
$V_{GS(OFF)}$ = +7V
$V_{GS(ON)}$ = 0V
V_{DD} = -6V

Input Pulse
- Rise Time < 1.0 ns
- Fall Time < 1.0 ns
- Pulse Width ≤ 100 ns, 10% Duty Cycle
- Gen. Source Imp. ≤ 100Ω

Oscilloscope
- Rise Time ≤ 0.4 ns
- Input Resistance ≥ 9.8 MΩ
- Input Capacitance ≤ 1.7 pf

Figure 2.

P-CHANNEL FIELD EFFECT TRANSISTOR
GENERAL PURPOSE SWITCH

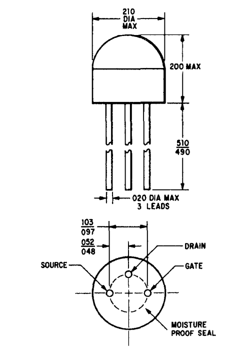
- VERY LOW "ON" RESISTANCE
- FAST SWITCHING SPEEDS
- LOW LEAKAGE

NOVEMBER 1968

P1086E
P1087E

MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
Drain-Source Voltage	V_{DS}	−30	Volts
Drain-Gate Voltage	V_{DG}	−30	Volts
Reverse Gate-Source Voltage	V_{GS}	−30	Volts
Gate Current	I_G	10	mA
Total Device Dissipation @ $T_A = 25°C$	P_D	300	mWatts
Derating Factor Above 25°C @ $T_A = 25°C$		2.5	mW/°C
Storage Temperature	T_{stg}	−55 to +125	°C
Junction Temperature	T_J	+125	°C



NOTES: ALL LEADS ELECTRICALLY ISOLATED FROM CASE
ALL DIMENSIONS IN INCHES

ELECTRICAL CHARACTERISTICS at +25°C (Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Gate-Source Breakdown Voltage	$V_{(BR)GSS}$	$I_G = 1.0\ \mu A, V_{DS} = 0$	30		Volts
Gate-Source Cutoff Voltage	$V_{GS(OFF)}$				
P1086E		$V_{DS} = -15\ V, I_D = 1.0\ \mu A$		10	Volts
P1087E		$V_{DS} = -15\ V, I_D = 1.0\ \mu A$		5	
Drain-Source "On" Voltage	$V_{DS(ON)}$				
P1086E		$I_D = -6.0\ mA, V_{GS} = 0$		−0.5	Volts
P1087E		$I_D = -3.0\ mA, V_{GS} = 0$		−0.5	
Gate Reverse Current	I_{GSS}	$V_{GS} = 15\ V, V_{DS} = 0$		2.0	nA
Zero-Gate-Voltage Drain Current	I_{DSS}				
P1086E		$V_{DS} = -20\ V, V_{GS} = 0$	−10		mA
P1087E		$V_{DS} = -20\ V, V_{GS} = 0$	−5		
Drain Cutoff Current	$I_{D(OFF)}$				
P1086E		$V_{DS} = -15\ V, V_{GS} = 12\ V$		10	nA
P1087E		$V_{DS} = -15\ V, V_{GS} = 7.0\ V$		10	
P1086E		$V_{DS} = -15\ V, V_{GS} = 12\ V, T_A = 85°C$		0.5	μA
P1087E		$V_{DS} = -15\ V, V_{GS} = 7.0\ V, T_A = 85°C$		0.5	
Drain Reverse Current	I_{DGO}	$V_{DG} = -15\ V, I_S = 0$		2.0	nA
		$V_{DG} = -15\ V, I_S = 0, T_A = 85°C$		0.1	μA
Drain-Source "ON" Resistance	$r_{DS(ON)}$				
P1086E		$I_D = 1.0\ mA, V_{GS} = 0$		75	Ohms
P1087E		$I_D = 1.0\ mA, V_{GS} = 0$		150	
Drain-Source "ON" Resistance	$r_{ds(ON)}$				
P1086E		$V_{GS} = 0, I_D = 0$, f = 1.0 kHz		75	Ohms
P1087E		$V_{GS} = 0, I_D = 0$, f = 1.0 kHz		150	
Rise Time	t_r				
P1086E		See Figure 1		20	nsec
P1087E		See Figure 2		75	
Delay Time	t_d				
P1086E		See Figure 1		15	nsec
P1087E		See Figure 2		15	

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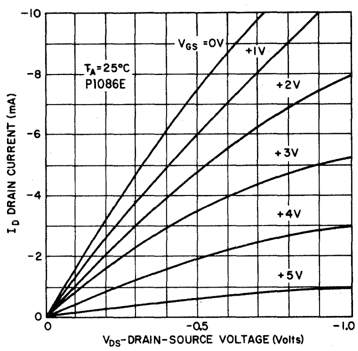
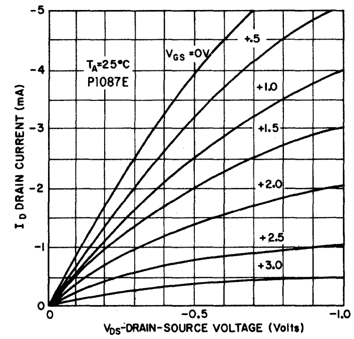
CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Turn-Off Delay Time P1086E P1087E	$t_{d(OFF)}$	 See Figure 1 See Figure 2		 15 25	 nsec
Turn-Off Time P1086E P1087E	$t_{(OFF)}$	 See Figure 1 See Figure 2		 50 100	 nsec
Input Capacitance	C_{iss}	$V_{DS} = -15$ V, $V_{GS} = 0$ f = 1.0 MHz		45	pf
Reverse Transfer Capacitance P1086E P1087E	C_{rss}	 $V_{DS} = 0$, $V_{GS} = 12$ V f = 1.0 MHz $V_{DS} = 0$, $V_{GS} = 7.0$ V f = 1.0 MHz		 10 10	 pf

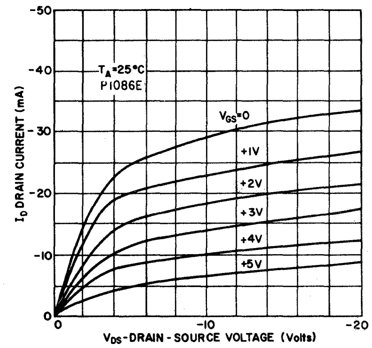
Common Source-Drain Characteristics



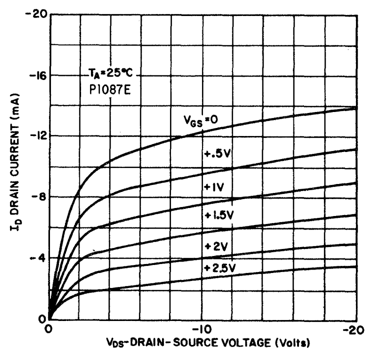
Common Source-Drain Characteristics



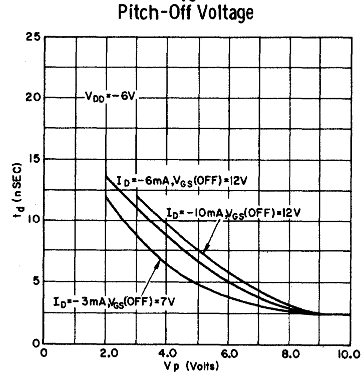
Common Source-Drain Characteristics



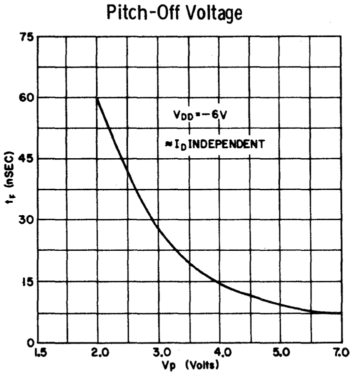
Common Source-Drain Characteristics



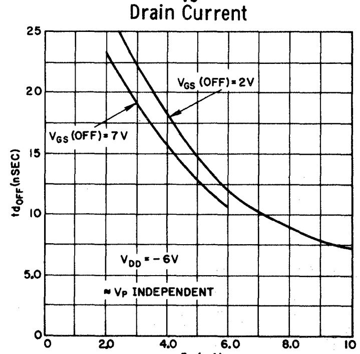
Switching Characteristics Delay Time vs Pitch-Off Voltage



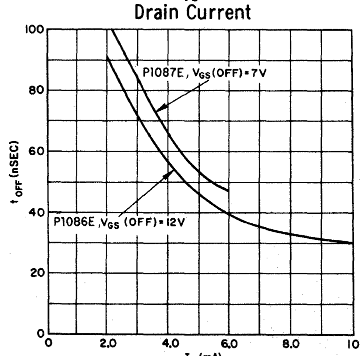
Switching Characteristics Rise Time vs Pitch-Off Voltage



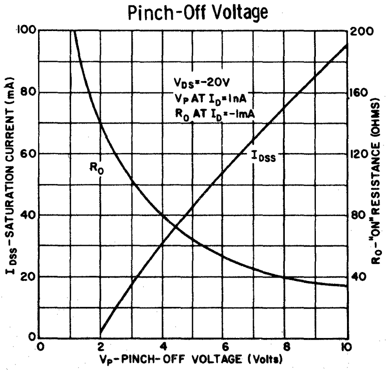
Switching Characteristics Turn-Off Delay Time vs Drain Current



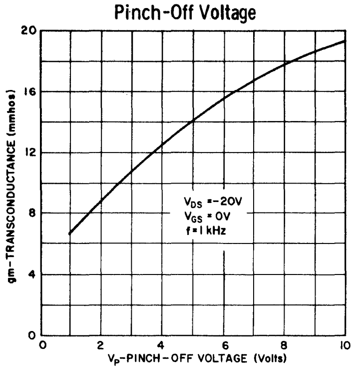
Switching Characteristics Turn-Off Time vs Drain Current



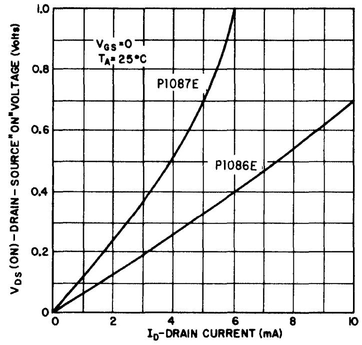
"On" Resistance and Drain Current vs Pinch-Off Voltage



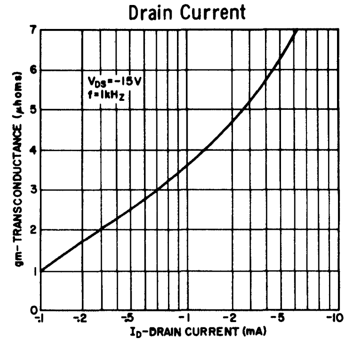
Transconductance
vs
Pinch-Off Voltage



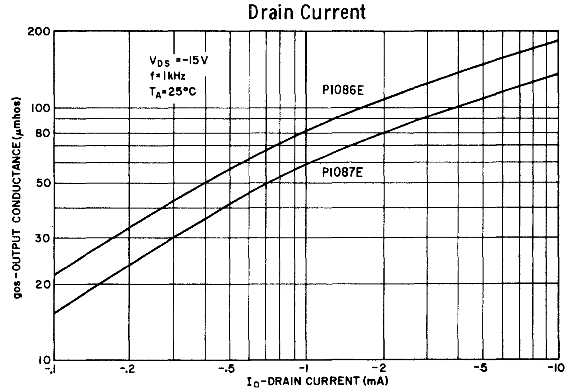
Drain-Source "On" Voltage
vs
Drain Current



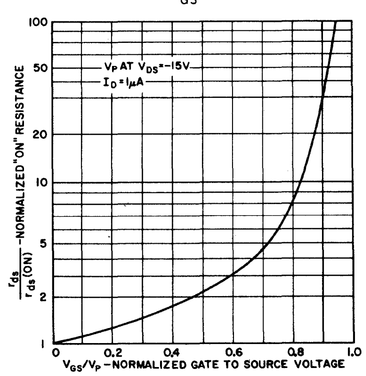
Transconductance
vs
Drain Current



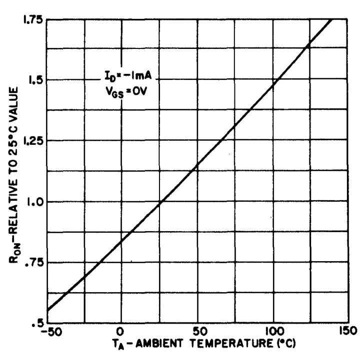
Output Conductance
vs
Drain Current



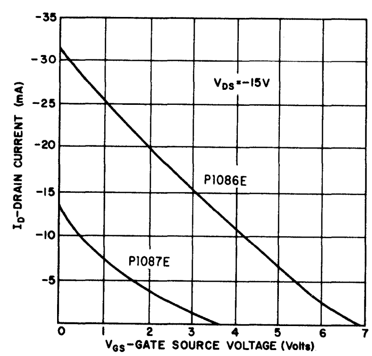
Normalized r_{ds}
vs
V_{GS}



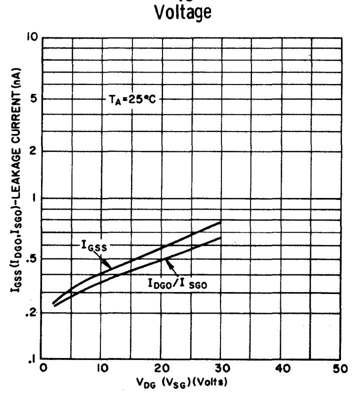
Normalized "On" Resistance
vs
Ambient Temperature



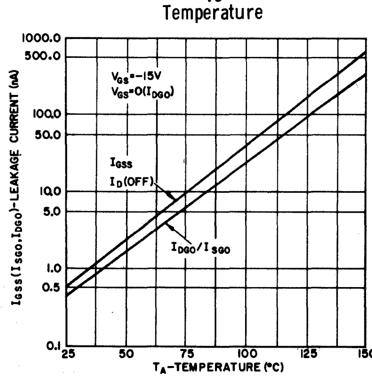
Drain Current
vs
Gate-Source Bias



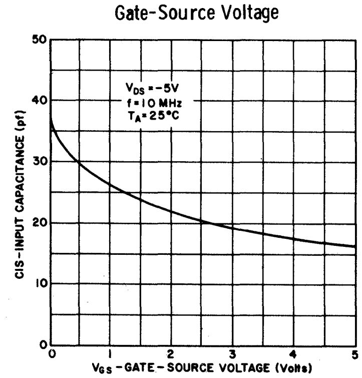
Leakage Current
vs
Voltage



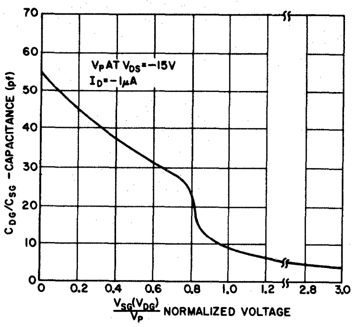
Gate Leakage Current
vs
Temperature



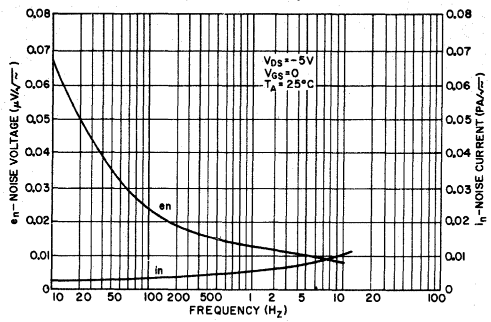
Input Capacitance
vs
Gate-Source Voltage



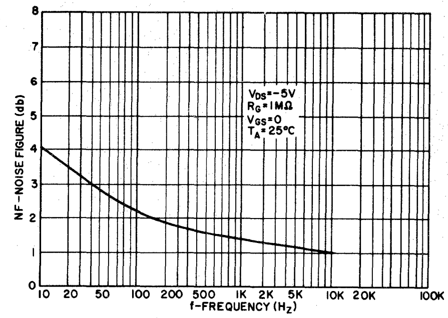
Junction Capacitance vs Normalized Bias

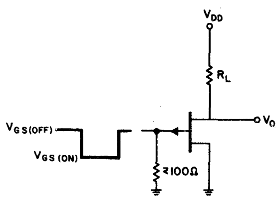


Noise Voltage/Current vs Frequency



Noise Figure vs Frequency



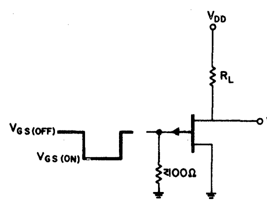


R_L = 910Ω
$I_{D(ON)}$ = 6.0 mA
$V_{GS(OFF)}$ = +12
$V_{GS(ON)}$ = 0V
V_{DD} = -6V

Input Pulse
- Rise Time < 1.0 ns
- Fall Time < 1.0 ns
- Pulse Width ≤ 110 ns, 10% Duty Cycle
- Gen. Source Imp. ≤ 100Ω

Oscilloscope
- Rise Time ≤ 0.4 ns
- Input Resistance ≥ 9.8 MΩ
- Input Capacitance ≤ 1.7 pf

Figure 1.



R_L = 1.8k
$I_{D(ON)}$ = 3 mA
$V_{GS(OFF)}$ = +7V
$V_{GS(ON)}$ = 0V
V_{DD} = -6V

Input Pulse
- Rise Time < 1.0 ns
- Fall Time < 1.0 ns
- Pulse Width ≤ 100 ns, 10% Duty Cycle
- Gen. Source Imp. ≤ 100Ω

Oscilloscope
- Rise Time ≤ 0.4 ns
- Input Resistance ≥ 9.8 MΩ
- Input Capacitance ≤ 1.7 pf

Figure 2.

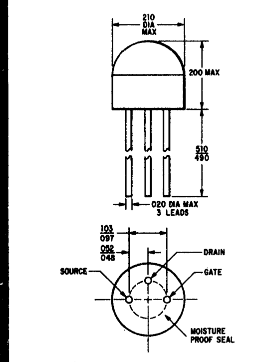
NOVEMBER 1968

N-CHANNEL FIELD EFFECT TRANSISTOR
GENERAL PURPOSE AMPLIFIER

2N5163

MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
Drain-Source Voltage	V_{DS}	25	Volts
Drain-Gate Voltage	V_{DG}	25	Volts
Total Device Dissipation @ $T_A = 25°C$	P_D	300	mW
Derating Factor Above 25°C @ $T_A = 25°C$		2.5	mW/°C
Storage Temperature	T_{stg}	−55 to +125	°C
Junction Temperature	T_J	+125	°C



ELECTRICAL CHARACTERISTICS at 25°C (Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Gate-Source Breakdown Voltage	$V_{(BR)GSS}$	$I_G = -10\ \mu A$, $V_{DS} = 0$	25		Volts
Gate Reverse Current	I_{GSS}	$V_{GS} = -15$ V, $V_{DS} = 0$		10	nA
Gate Reverse Current	I_{GSS} (85°C)	$V_{GS} = -15$ V, $V_{DS} = 0$		0.6	µA
Zero-Gate-Voltage Drain Current	I_{DSS}	$V_{DS} = 15$ V, $V_{GS} = 0$	1.0	40	mA
Gate-Source Cutoff Voltage	$V_{GS(off)}$	$V_{DS} = 15$ V, $I_D = 1.0\ \mu A$	−0.4	−8.0	Volts
Forward Transadmittance	$\|Y_{fs}\|$	$V_{DS} = 15$ V, $V_{GS} = 0$, f = 1 kHz	1800		µmhos
Output Admittance	Y_{os}	$V_{DS} = 15$ V, $V_{GS} = 0$, f = 1 kHz		200	µmhos
Input Capacitance	C_{iss}	$V_{DS} = 15$ V, $V_{GS} = 0$, f = 1 MHz		12	pF
Reverse Transfer Capacitance	C_{rss}	$V_{DS} = 15$ V, $V_{GS} = 0$, f = 1 MHz		3.0	pF
Noise Figure	NF	$V_{DS} = 15$ V, $I_D = 1$ mA, $R_S = 150$ K ohm, f = 1 kHz, BW = 150 Hz		3.0	dB

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N-CHANNEL FIELD EFFECT TRANSISTOR
GENERAL PURPOSE

- LOW NOISE
- HIGH VOLTAGE
- HIGH TRANSCONDUCTANCE

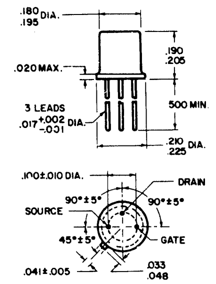
SEPTEMBER 1968

2N5391 THRU 2N5396

MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
Drain-Gain Voltage	V_{DG}	70	Volts
Reverse Gate-Source Voltage	V_{GS}	70	Volts
Gate Current	I_G	10	mA
Total Device Dissipation @ $T_A = 25°C$	P_D	300	mW
Derating Factor above 25°C @ $T_A = 25°C$		1.71	mW/°C
Storage Temperature Range	T_{stg}	−65 to +200	°C
Operating Junction Temperature	T_J	200	°C
Lead Temperature, 1/16 inch from case, 10 seconds max.		300	°C

PHYSICAL DIMENSIONS IN ACCORDANCE WITH JEDEC (TO 18) OUTLINE
NOTE: ALL DIMENSIONS IN INCHES



GATE IS INTERNALLY CONNECTED TO CASE

ELECTRICAL CHARACTERISTICS at +25°C (Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Gate-Source Breakdown Voltage	$V_{(BR)GSS}$	$I_G = 1.0\ \mu A$, $V_{DS} = 0$	70		Volts
Gate-Source Cutoff Voltage	$V_{GS(OFF)}$				
2N5391		$V_{DS} = 20\ V$, $I_D = 1.0\ nA$	0.5	2.0	Volts
2N5392			0.5	2.5	
2N5393			1.0	3.0	
2N5394			1.0	4.0	
2N5395			1.5	4.0	
2N5396			2.0	5.0	
Gate-Source Voltage	V_{GS}				
2N5391		$V_{DS} = 20\ V$, $I_D = (**)$	0.1	1.1	Volts
2N5392			0.3	1.4	
2N5393			0.5	1.6	
2N5394			0.7	1.8	
2N5395			1.0	2.1	
2N5396			1.2	2.6	
Gate Reverse Current	I_{GSS}	$V_{GS} = -35\ V$, $V_{DS} = 0$		0.2	nA
		$V_{GS} = -10\ V$, $V_{DS} = 0$		0.1	
Zero-Gate Voltage Drain Current	I_{DSS}				
2N5391		$V_{DS} = 20\ V$, $V_{GS} = 0$	0.5	1.5	mA
2N5392			1.0	3.0	
2N5393			2.5	4.5	
2N5394			4.0	6.0	
2N5395			5.5	8.0	
2N5396			7.5	10	
Forward Transadmittance	$\lvert Y_{fs} \rvert$				
2N5391		$V_{DS} = 20\ V$, $V_{GS} = 0$, f = 1 kHz	1500	4500	μmhos
2N5392			2000	6000	
2N5393			3000	6500	
2N5394			4000	7000	
2N5395			4500	7000	
2N5396			4500	7500	
Forward Transadmittance	$\lvert Y_{fs} \rvert$				
2N5391		$V_{DS} = 20\ V$, $I_D = ***$, f = 1 kHz	1000		μmhos
2N5392			1000		
2N5393			1000		
2N5394			2000		
2N5395			1900		
2N5396			1800		

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CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Input Capacitance	C_{iss}	$V_{DS} = 20$ V, $V_{GS} = 0$ f = 0.14-1.0 MHz		18	pf
Reverse Transfer Capacitance	C_{rss}	$V_{DS} = 20$ V, $V_{GS} = 0$ f = 0.14-1.0 MHz		5.0	pf
Output Admittance 2N5391 2N5392 2N5393 2N5394 2N5395 2N5396	$\|Y_{os}\|$	$V_{DS} = 20$ V, $V_{GS} = 0$ f = 1 kHz		4.0 7.0 10 15 20 25	μmhos
Output Admittance 2N5391 2N5392 2N5393 2N5394 2N5395 2N5396	$\|Y_{os}\|$	$V_{DS} = 20$ V, $I_D = $ (***) f = 1 kHz		2.0 2.5 3.0 8.0 10 12	μmhos
Noise Figure	NF	$V_{DS} = 20$ V, $V_{GS} = 0$, $R_G = 1$ MΩ, f = 100 Hz, NBW = 6 Hz		1.0	db
		$V_{DS} = 20$ V, $V_{GS} = 0$, $R_G = 10$ KΩ, f = 100 Hz, NBW = 6 Hz		2.5	
		$V_{DS} = 20$ V, $V_{GS} = 0$, $R_G = 10$ KΩ, f = 1 kHz, NBW = 200 Hz		1.5	
		$V_{DS} = 20$ V, $V_{GS} = 0$, $R_G = 1$ KΩ, f = 1 kHz, NBW = 200 Hz		5.0	
		$V_{DS} = 20$ V, $V_{GS} = 0$, $R_G = 1$ MΩ, f = 10 Hz, NBW = 6 Hz		2.0	
Equivalent Input Noise Voltage	En	$V_{DS} = 20$ V, $V_{GS} = 0$ f = 10 Hz, NBW = 6 Hz		17.5	nv/ $\sqrt{Hz}$
		$V_{DS} = 20$ V, $V_{GS} = 0$ f = 100 Hz, NBW = 6 Hz		10	

Notes: (**) 2N5391 $I_D = 0.05$ mA (***) 2N5391 $I_D = 200$ μA
Notes: (**) 2N5392 $I_D = 0.10$ mA (***) 2N5392 $I_D = 200$ μA
Notes: (**) 2N5393 $I_D = 0.25$ mA (***) 2N5393 $I_D = 200$ μA
Notes: (**) 2N5394 $I_D = 0.40$ mA (***) 2N5394 $I_D = 700$ μA
Notes: (**) 2N5395 $I_D = 0.55$ mA (***) 2N5395 $I_D = 700$ μA
Notes: (**) 2N5396 $I_D = 0.75$ mA (***) 2N5396 $I_D = 700$ μA

N-CHANNEL FIELD EFFECT TRANSISTOR

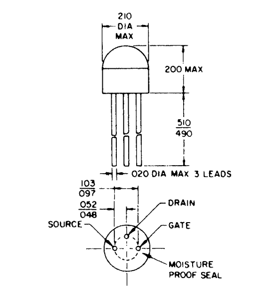
- RF/IF AMPLIFIER
- HIGH TRANSCONDUCTANCE
- LOW LEAKAGE
- LOW NOISE

SEPTEMBER 1968

u1837E

MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
Drain-Source Voltage	V_{DS}	30	Volts
Drain-Gain Voltage	V_{DG}	30	Volts
Reverse Gate-Source Voltage	V_{GS}	−30	Volts
Gate Current	I_G	10	mA
Drain Current	I_D	30	mA
Total Device Dissipation @ T_A = 25°C @ T_C = 25°C @ T_C = 100°C	P_D	300	mWatts
Derating Factor above 25°C @T_A = 25°C		2.5	mW/°C
Storage Temperature Range	T_{stg}	−55 to +125	°C
Operating Junction Temperature	T_J	+125	°C



ELECTRICAL CHARACTERISTICS at +25°C (Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Gate-Source Breakdown Voltage	$V_{(BR)GSS}$	$I_G = -1.0\ \mu A$, $V_{DS} = 0$	30		Volts
Gate-Source Cutoff Voltage	$V_{GS(OFF)}$	$V_{DS} = 15$ V, $I_D = 1.0\ \mu A$	−0.5	−8.0	Volts
Gate Reverse Current	I_{GSS}	$V_{GS} = -20$ V, $V_{DS} = 0$ $V_{GS} = -20$ V, $V_{DS} = 0$, $T_A = +85°C$		−0.25 −15	nA nA
Zero-Gate Voltage Drain Current	I_{DSS}	$V_{DS} = 15$ V, $V_{GS} = 0$	4.0	25	
Forward Transadmittance	$\|Y_{fs}\|$	$V_{DS} = 15$ V, $V_{GS} = 0$ f = 1 kHz	4500	10000	μmhos
Forward Transadmittance	$\|Y_{fs}\|$	$V_{DS} = 15$ V, $V_{GS} = 0$ f = 200 MHz	4000		μmhos
Drain-Source "ON" Resistance	$r_{DS(ON)}$	$I_D = 1$ mA, $V_{GS} = 0$		300	Ohms
Input Capacitance	C_{iss}	$V_{DS} = 15$ V, $V_{GS} = 0$ f = 1 MHz		6.0	pf
Reverse Transfer Capacitance	C_{rss}	$V_{DS} = 15$ V, $V_{GS} = 0$ f = 1 MHz		2.0	pf
Input Admittance	$\|Y_{is}\|$	$V_{DS} = 15$ V, $V_{GS} = 0$ f = 200 MHz		800	μmhos
Output Admittance	$\|Y_{os}\|$	$V_{DS} = 15$ V, $V_{GS} = 0$ f = 200 MHz		150	μmhos
Power Gain	G_{ps}	$V_{DS} = 15$ V, $V_{GS} = 0$ f = 200 MHz (Figure 1)	15		db
Noise Figure	NF	$V_{DS} = 15$ V, $R_G = 1$ MΩ, $V_{GS} = 0$, f = 10 Hz, BW = 5 Hz		5.0	db
Noise Figure	NF	$V_{DS} = 15$ V, $R_G = 1$ KΩ, $V_{GS} = 0$, f = 200 MHz, (Figure 1)		3.0	db

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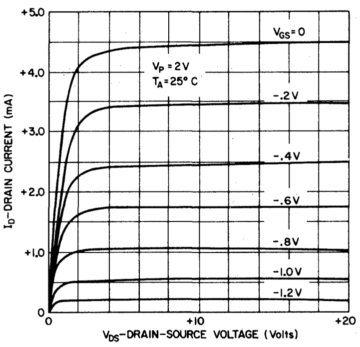
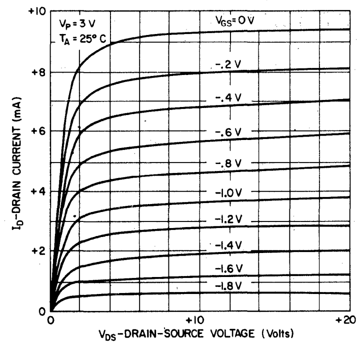
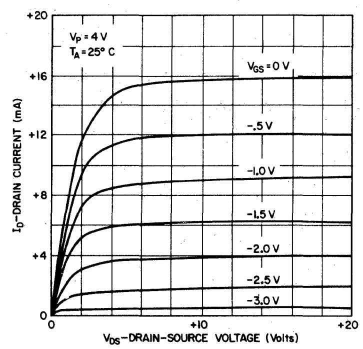
Common Source-Drain Characteristics



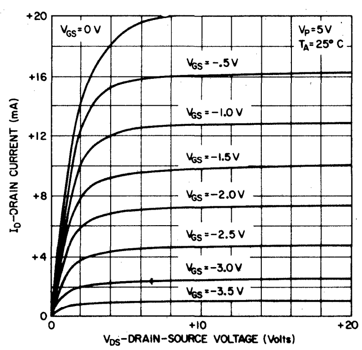
Common Source-Drain Characteristics



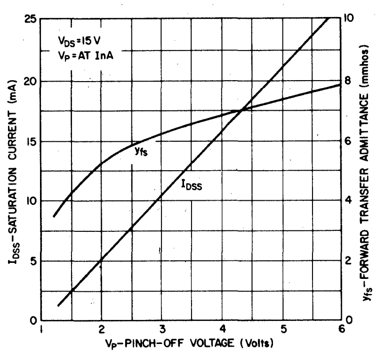
Common Source-Drain Characteristics



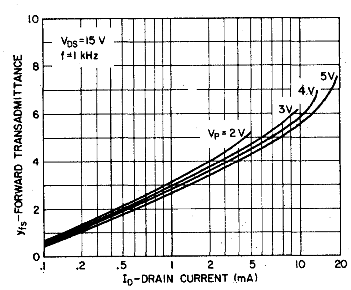
Common Source-Drain Characteristics



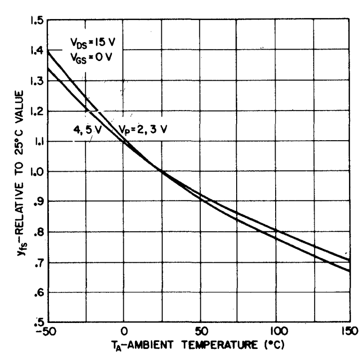
Forward Transfer Admittance and Drain Current vs Pinch Off Voltage



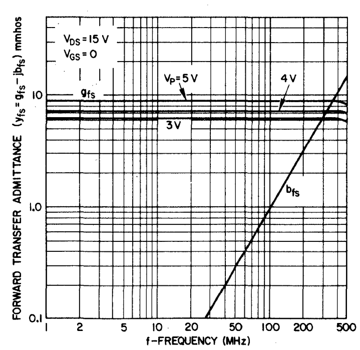
Forward Transadmittance vs Drain Current



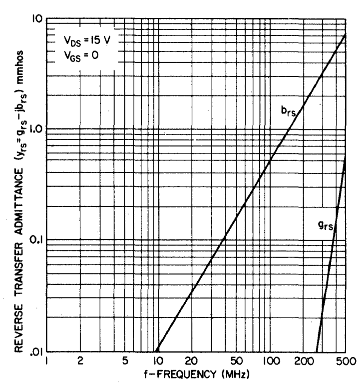
Normalized Forward Transfer Admittance vs Ambient Temperature



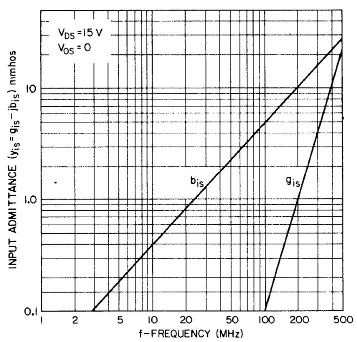
Forward Transfer Admittance vs Frequency



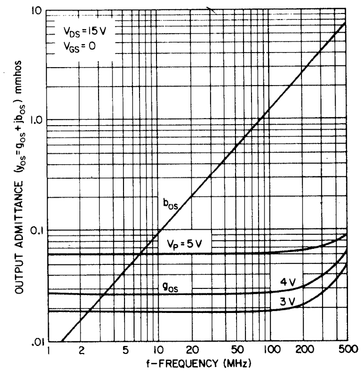
Reverse Transfer Admittance vs Frequency



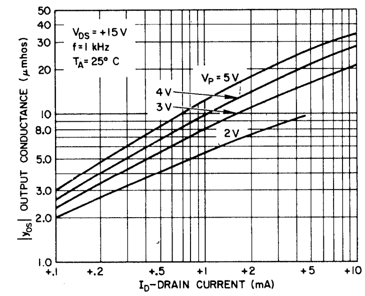
Input Admittance vs Frequency



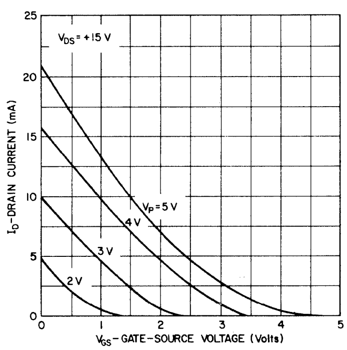
Output Admittance vs Frequency



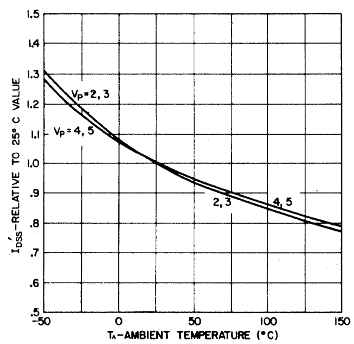
Output Conductance vs Drain Current



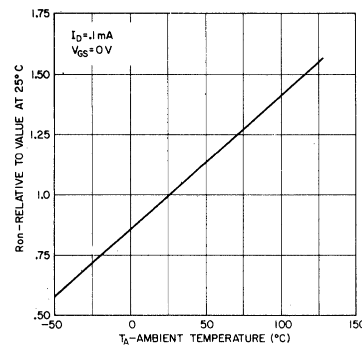
Drain Current vs Gate-Source Voltage



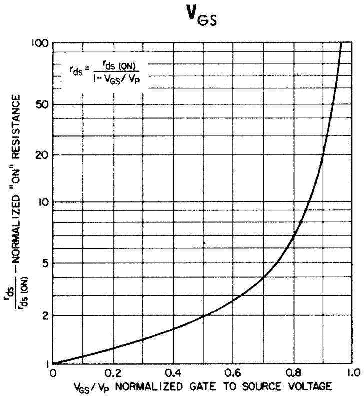
Normalized Drain Saturation Current vs Ambient Temperature



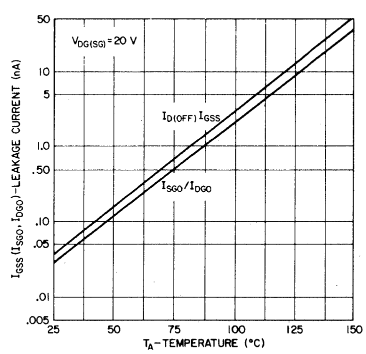
Normalized "On" Resistance vs Ambient Temperature



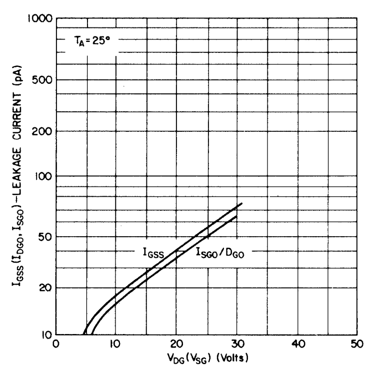
Normalized r_{ds} vs V_{GS}



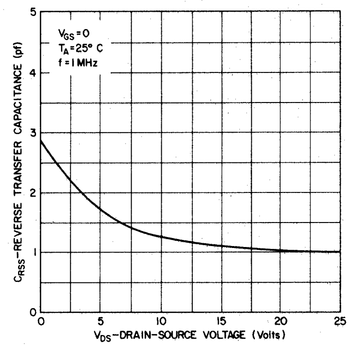
Gate Leakage vs Voltage



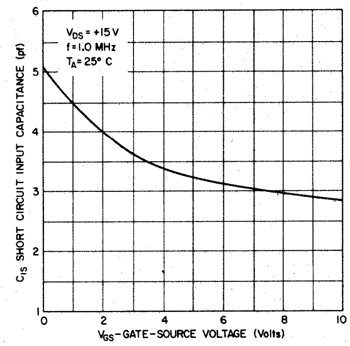
Leakage Current vs Voltage



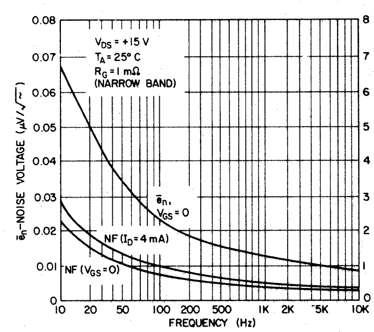
Reverse Transfer Capacitance vs Drain-Source Voltage



Short Circuit Input Capacitance vs Gate-Source Voltage



Noise Voltage/Noise Figure vs Frequency



Noise Figure vs Frequency

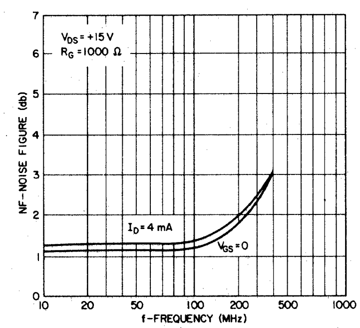
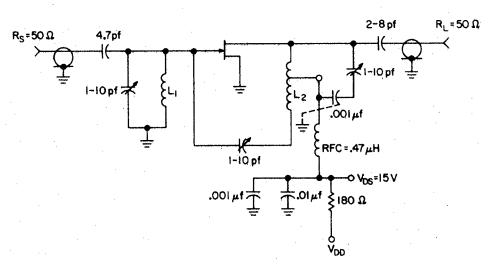


Figure 1.



L_1 1-1/2 turns, #20 tinned wire, 1/4 ID, Length = 3/8"

L_2 3-1/2 turns, #18 tinned wire, 3/8" ID, Length = 1/2"
Tapped at 1-1/4 turns from drain

SEPTEMBER 1968

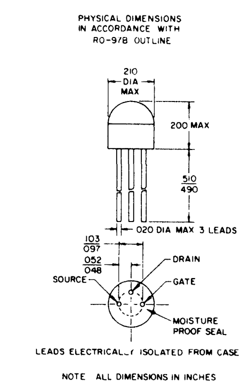
N-CHANNEL FET
GENERAL PURPOSE SWITCH

- LOW "ON" RESISTANCE
- FAST SWITCHING SPEEDS
- LOW LEAKAGE

u1897E
u1898E
u1899E

MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
Drain-Source Voltage	V_{DS}	40	Volts
Drain-Gain Voltage	V_{DG}	40	Volts
Total Device Dissipation @ $T_A = 25°C$	P_D	300	mW
Derating Factor above 25°C @ $T_A = 25°C$		2.5	mW/°C
Storage Temperature Range	T_{stg}	—55 to +125	°C
Operating Junction Temperature	T_J	+125	°C



ELECTRICAL CHARACTERISTICS at +25°C (Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Drain-Gate Breakdown Voltage	BV_{DGO}	$I_D = 1.0\ \mu A$, $I_S = 0$	40		Volts
Source-Gate Breakdown Voltage	BV_{SGO}	$I_S = 1.0\ \mu A$, $I_D = 0$	40		Volts
Gate-Source Cutoff Voltage	$V_{GS(OFF)}$	$V_{DS} = 20$ V, $I_D = 1.0$ nA			Volts
U1897E			5.0	10	
U1898E			2.0	7.0	
U1899E			1.0	5.0	
Drain Source "ON" Voltage	$V_{DS(on)}$	$I_D = (**)$, $V_{GS} = 0$		0.2	Volts
Gate-Drain Leakage Current	I_{DGO}	$V_{DG} = 20$ V, $I_S = 0$		0.2	nA
Gate-Source Leakage Current	I_{SGO}	$V_{SG} = 20$ V, $I_D = 0$		0.2	nA
Drain Cutoff Current	$I_{D(OFF)}$	$V_{GS} = (***)$, $V_{DS} = 20$ V		0.2	nA
		$V_{GS} = (***)$, $V_{DS} = 20$ V, $T_A = +85°C$		10	nA
Zero-Gate Voltage Drain Current	I_{DSS}*	$V_{DS} = 20$ V, $V_{GS} = 0$			mA
U1897E			30		
U1898E			15		
U1899E			8.0		
Drain-Source "ON" Resistance	$r_{DS(ON)}$	$I_D = 1.0$ mA, $V_{GS} = 0$			Ohms
U1897E				30	
U1898E				50	
U1899E				80	
Input Capacitance	C_{iss}	$V_{DS} = 20$ V, $V_{GS} = 0$, f = 1 MHz		16	pf
Drain-Gate Capacitance	C_{DG}	$V_{DG} = 20$ V, $I_S = 0$, f = 1 MHz		5.0	pf
Source-Gate Capacitance	C_{SG}	$V_{SG} = 20$ V, $I_D = 0$, f = 1 MHz		5.0	pf

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CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Rise Time	t_r				
U1897E		See Figures 1 & 2		10	nsec
U1898E				20	
U1899E				40	
Delay Time	t_d				
U1897E		See Figures 1 & 2		15	nsec
U1898E				15	
U1899E				20	
Turn-OFF Time	t_{off}	See Figures 1 & 2			
U1897E				40	nsec
U1898E				60	
U1899E				80	

NOTES: *Measure under pulse conditions: pulse width $\leq$ 300 μsec; duty cycle $\leq$ 3%.

**U1897E $I_D = 6.6$ mA ***U1897E $V_{GS(OFF)} = -12$ V
U1898E $I_D = 4.0$ mA U1898E $V_{GS(OFF)} = -8.0$ V
U1899E $I_D = 2.5$ mA U1899E $V_{GS(OFF)} = -6.0$ V

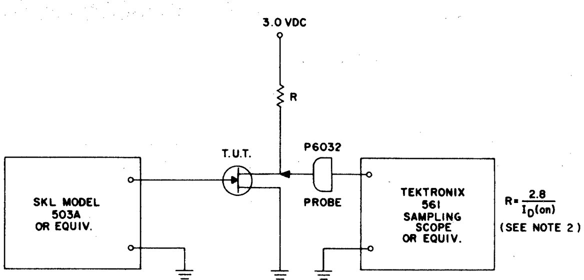


Figure 1

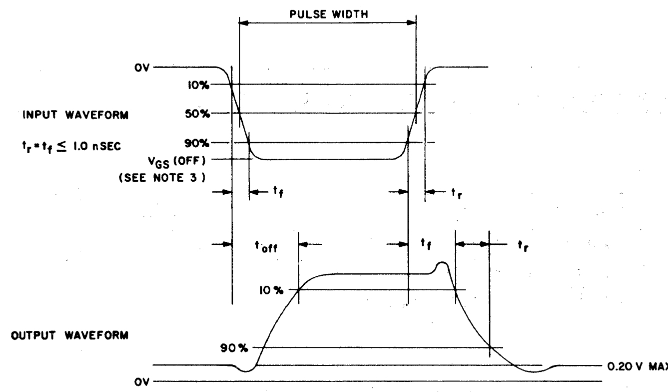
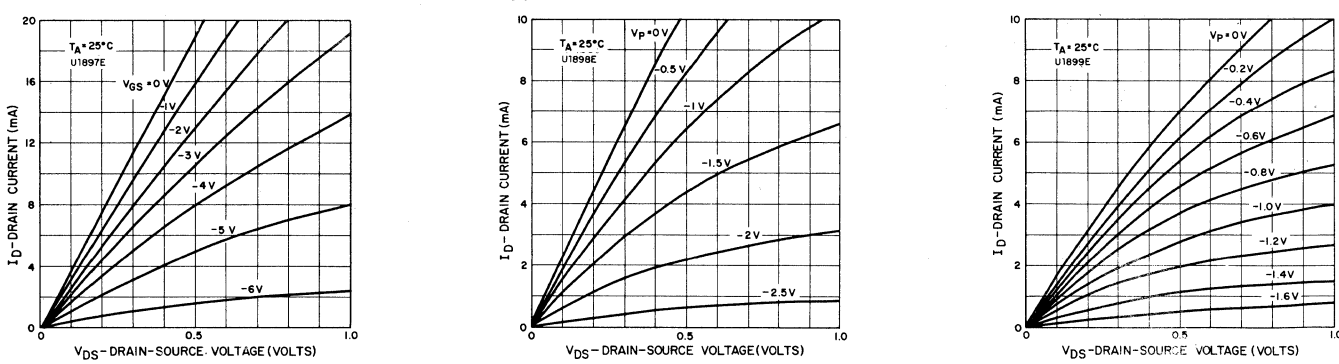
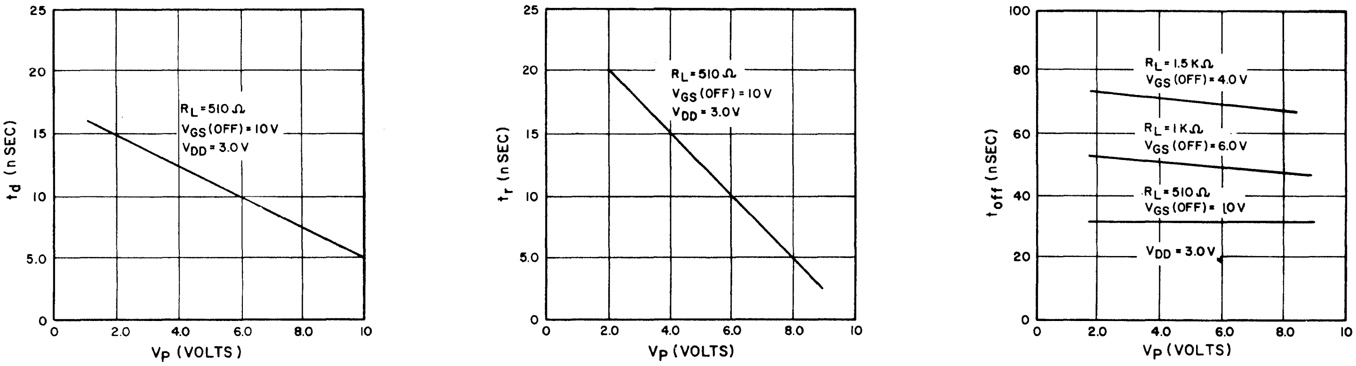


Figure 2

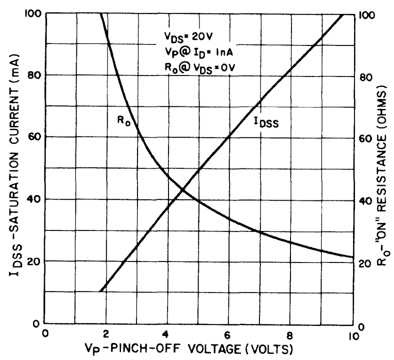
Common Source-Drain Characteristics



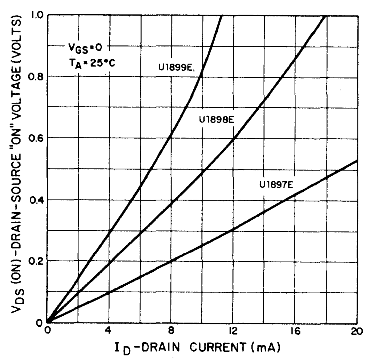
Switching Characteristics



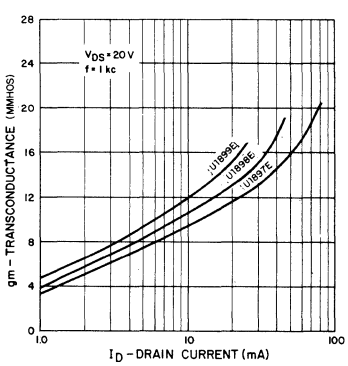
"ON" Resistance And Drain Current vs Pinch-Off Voltage



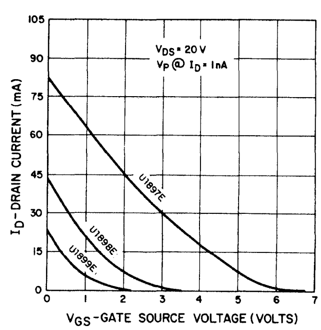
Drain-Source "ON" Voltage vs Drain Current



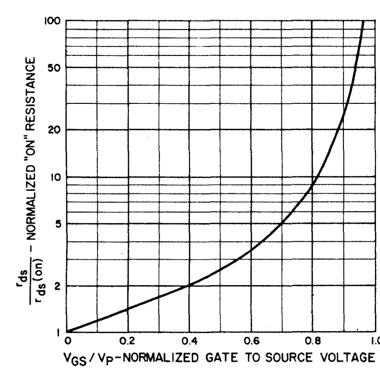
Transconductance vs Drain Current



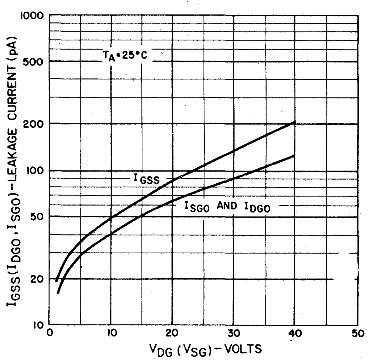
Drain Current vs Gate-Source Bias



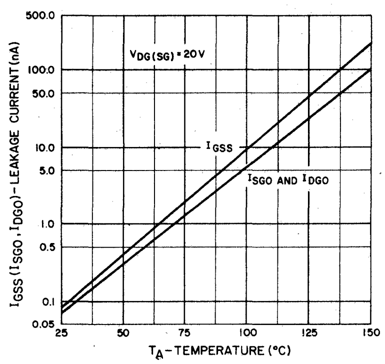
Normalized r_{ds} vs V_{GS}



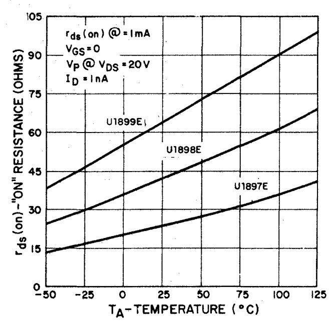
Leakage Current vs Voltage



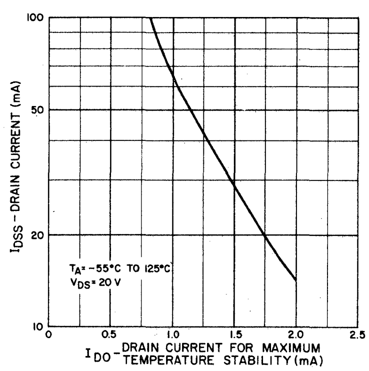
Gate Leakage Current vs Temperature



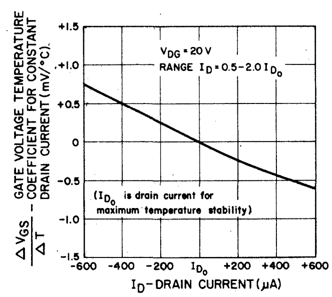
"ON" Resistance vs Temperature



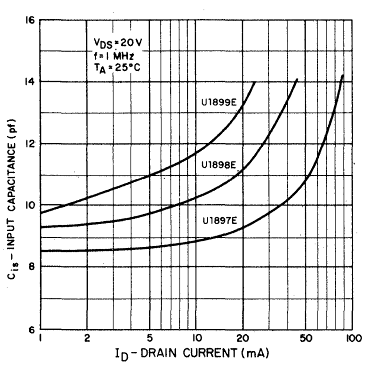
Drain Current for Maximum Temperature Stability



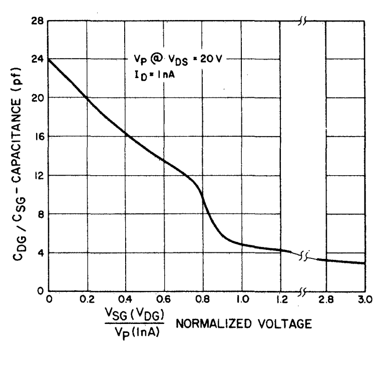
Gate Voltage Temperature Coefficients for Constant Drain Current vs Drain Voltage



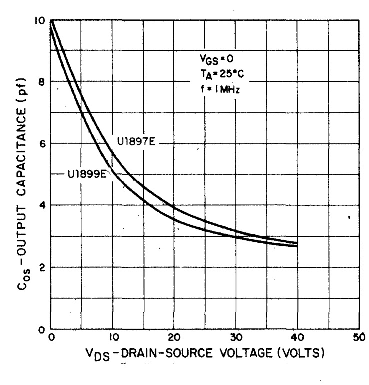
Input Capacitance vs Drain Current



Junction Capacitance vs Normalized Bias



Output Capacitance vs Drain-Source Voltage



DUAL N-CHANNEL FIELD EFFECT TRANSISTOR
GENERAL PURPOSE

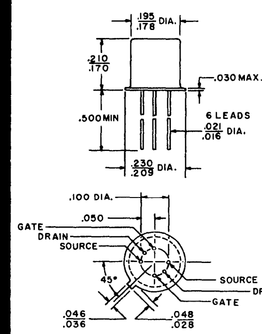
- VERY CLOSELY MATCHED gm
- LOW DIFFERENTIAL DRIFT
- CLOSELY MATCHED V_{GS}

JANUARY 1968

SU2098
SU2099

MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING		UNIT
		Each Side	Both Sides	
Total Device Dissipation	P_D	250	300	mW
Storage Temperature	T_{stg}	−55 to +200		°C
Junction Temperature	T_J	+200		°C
Derating Factor above 25°C @ T_A = 25°C		1.7		mW/°C



ELECTRICAL CHARACTERISTICS at +25°C (Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Drain to Gate Breakdown Voltage	BV_{DGO}	$I_D = 1.0\ \mu A$, $I_S = 0$	30		Volts
Pinch off Voltage	V_P	$V_{DS} = 10$ V, $I_D = 0.5$ nA		4.0	Volts
Gate Leakage Current	I_G	$V_{DG} = 10$ V, $I_D = 0.2$ mA		0.1	nA
Gate Leakage Current	I_G(100°C)	$V_{DG} = 10$ V, $I_D = 0.2$ mA		10	nA
Total Gate Leakage Current	I_{GSS}	$V_{GS} = -10$ V, $V_{DS} = 0$ $V_{GS} = -10$ V, $V_{DS} = 0$, $T_A = 100°C$		0.4 0.4	nA μA
Saturation Current	I_{DSS}	$V_{DS} = 10$V, $V_{GS} = 0$	1.0	8.0	mA
Transconductance	g_m	$V_{DS} = 10$V, $V_{GS} = 0$ f = 1 kHz	1000		μmhos
Transconductance	g_m	$V_{DG} = 10$ V, $I_D = 0.2$ mA f = 1 kHz	700		μmhos
Transconductance Ratio	g_{m1}/g_{m2}*	$V_{DG} = 10$ V, $I_D = 0.2$ mA	0.95	1.0	
Gate to Source Voltage Differential	V_{GS1}-V_{GS2}	$V_{DG} = 10$ V, $I_D = 0.2$ mA		5.0	mV
Gate to Source Voltage Differential Drift SU2098 SU2099	$\Delta\|V_{GS1}-V_{GS2}\|/\Delta T$	$V_{DG} = 10$ V, $I_D = 0.2$ mA T_A = 0°C to 100°C		10 25	μV/°C
Input Capacitance	C_{iss}	$V_{DS} = 10$ V, $V_{GS} = 0$ f = 1 MHz		7.0	pf
Output Capacitance	C_{oss}	$V_{DS} = 10$ V, $V_{GS} = 0$ f = 1 MHz		2.2	pf
Input Conductance	$\|Y_{is}\|$	$V_{DS} = 10$ V, $V_{GS} = 0$ f = 1 MHz		4.0	μmhos
Output Conductance	$\|Y_{os}\|$	$V_{DG} = 10$ V, $I_D = 0$ f = 1 MHz		15	μmhos
Noise Figure	NF	$V_{DS} = 10$ V, $R_G = 1$ MΩ f = 100 Hz		2.0	db

* The lowest g_m reading is taken as g_{m1} for this ratio.

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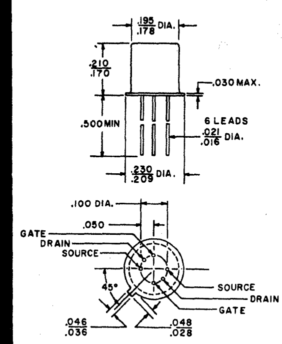
DUAL N-CHANNEL FIELD EFFECT TRANSISTOR
GENERAL PURPOSE
- VERY CLOSELY MATCHED gm
- CLOSELY MATCHED V_{GS}
- VERY LOW DIFFERENTIAL DRIFT

JANUARY 1968

2N3921-22
2N4084-85

MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING		UNIT
		One Side	Both Sides	
Total Device Dissipation @ $T_A = 25°C$	P_D	250	300	mW
Derating Factor above 25°C @ $T_A = 25°C$		1.7		mW/°C
Storage Temperature	T_{stg}	−55 to +200		°C
Junction Temperature	T_J	+200		°C



ELECTRICAL CHARACTERISTICS at +25°C (Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Drain-Gate Breakdown Voltage	BV_{DGO}	$I_D = 1.0\ \mu A, I_S = 0$	50		Volts
Gate-Source Voltage	V_{GS}	$V_{DS} = 10\ V, I_D = 0.1\ mA$	0.2	2.7	Volts
Total Gate Leakage Current	I_{GSS}	$V_{GS} = -30\ V, V_{DS} = 0$ $V_{GS} = -30\ V, V_{DS} = 0, T_A = 100°C$		1.0 1.0	nA μA
Gate Leakage Current	I_G	$V_{DG} = 10\ V, I_D = 0.7\ mA$ $V_{DG} = 10\ V, I_D = 0.7\ mA, T_A = 100°C$		0.25 25	nA
Saturation Current	I_{DSS}	$V_{DS} = 10\ V, V_{GS} = 0$	1.0	10	mA
Pinch Off Voltage	V_P	$V_{DS} = 10\ V, I_D = 1.0\ nA$		3.0	Volts
Input Conductance	g_{is}	$V_{DS} = 10\ V, V_{GS} = 0$ f = 1.0 MHz		4.0	μmhos
Output Conductance	g_{os}	$V_{DG} = 10\ V, I_D = 0.7\ mA$ f = 1.0 MHz $V_{DS} = 10\ V, V_{GS} = 0$ f = 1.0 kHz		20 35	μmhos
Input Capacitance	C_{is}	$V_{DS} = 10\ V, V_{GS} = 0$ f = 1.0 MHz		18	pf
Output Capacitance	C_{os}	$V_{DS} = 10\ V, V_{GS} = 0$ f = 1.0 MHz		6.0	pf
Noise Figure	NF	$V_{DS} = 10\ V, R_G = 1.0\ M\Omega$ f = 1.0 kHz		2.0	db
Transconductance	g_m	$V_{DS} = 10\ V, V_{GS} = 0$ f = 1.0 kHz $V_{DG} = 10\ V, I_D = 0.7\ mA$ f = 1.0 kHz	1500 1500	7500	μmhos
Transconductance Ratio	g_{m1}/g_{m2}	$V_{DG} = 10\ V, I_D = 0.7\ mA$	0.95	1.0	
Gate-Source Voltage Differential 2N3921, 22 2N4084, 85	$V_{GS1}\text{-}V_{GS2}$	$V_{DG} = 10\ V, I_D = 0.7\ mA$		5.0 15	mV
Gate-Source Voltage Differential Drift 2N3921 & 2N4084 2N3922 & 2N4085	$\Delta\lvert V_{GS1}\text{-}V_{GS2}\rvert/\Delta T$	$V_{DG} = 10\ V, I_D = 0.7\ mA$ $T_A = 0°C$ to $100°C$		10 25	μV/°C

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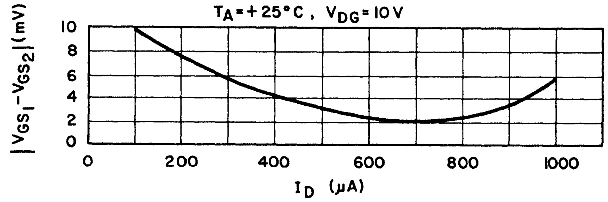
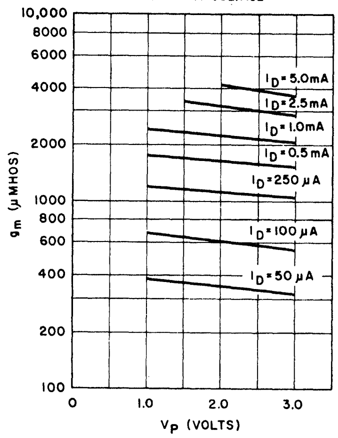
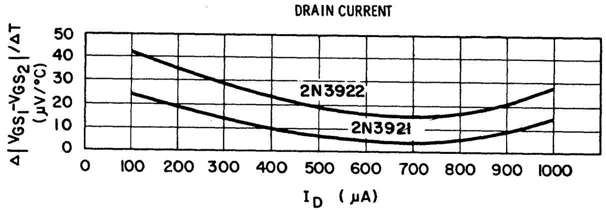
GATE TO SOURCE
VOLTAGE DIFFERENTIAL
VS
DRAIN CURRENT



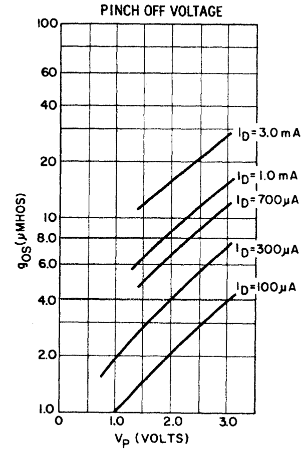
TRANSCONDUCTANCE
VS
PINCH OFF VOLTAGE



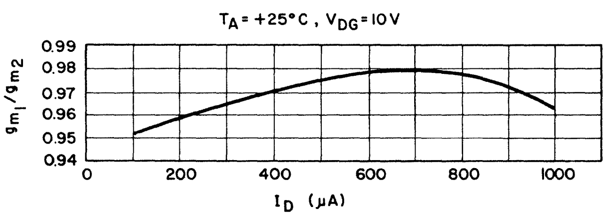
GATE TO SOURCE
VOLTAGE DIFFERENTIAL DRIFT
VS
DRAIN CURRENT



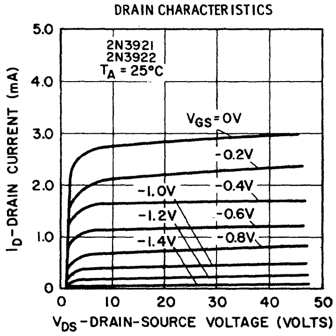
OUTPUT CONDUCTANCE
VS
PINCH OFF VOLTAGE



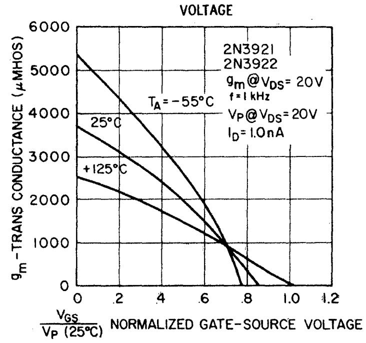
TRANSCONDUCTANCE RATIO
VS
DRAIN CURRENT



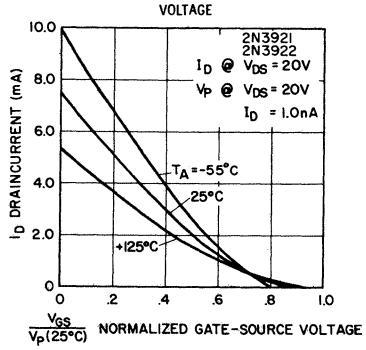
COMMON SOURCE-
DRAIN CHARACTERISTICS



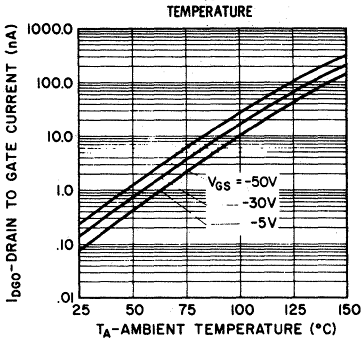
TRANSCONDUCTANCE
VS
NORMALIZED GATE-SOURCE
VOLTAGE



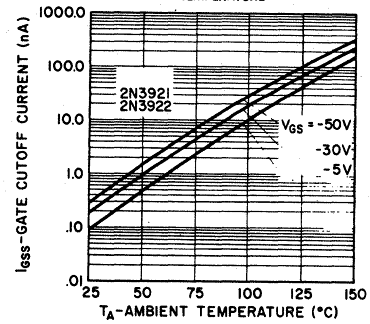
DRAIN CURRENT
VS
NORMALIZED GATE-SOURCE
VOLTAGE



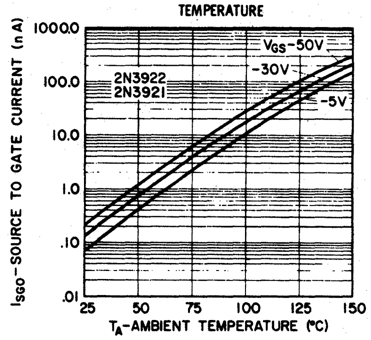
DRAIN-GATE
REVERSE CURRENT
VS
TEMPERATURE



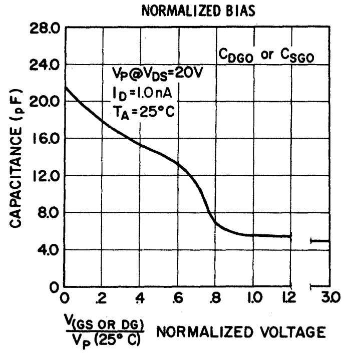
GATE CUTOFF CURRENT
VS
TEMPERATURE



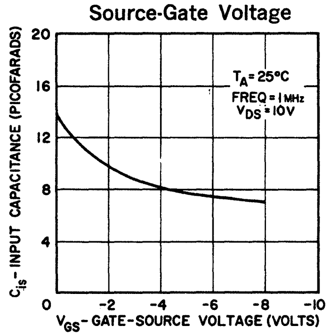
SOURCE-GATE
REVERSE CURRENT
VS
TEMPERATURE



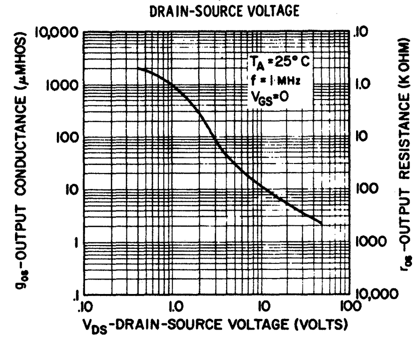
JUNCTION CAPACITY
VS
NORMALIZED BIAS



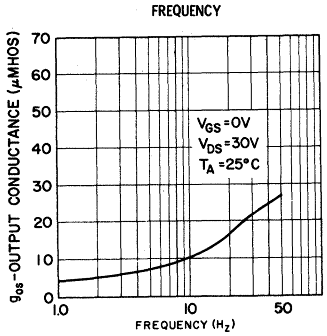
Input Capacitance
vs
Source-Gate Voltage



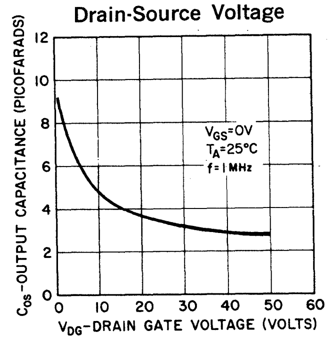
OUTPUT CAPACITY
VS
DRAIN-SOURCE VOLTAGE



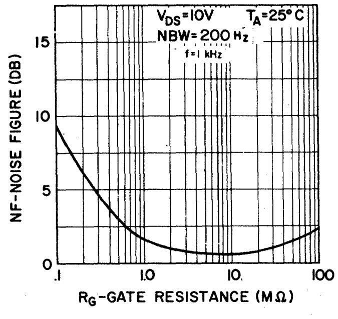
OUTPUT CONDUCTANCE
VS
FREQUENCY



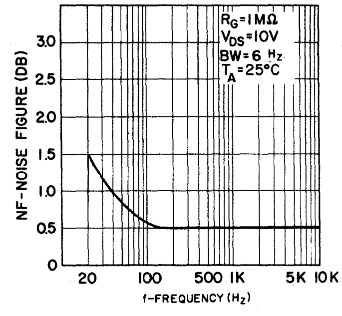
Output Capacitance
vs
Drain-Source Voltage



NOISE FIGURE
VS
GATE RESISTANCE



NOISE FIGURE
VS
FREQUENCY



DUAL N-CHANNEL FIELD EFFECT TRANSISTOR
GENERAL PURPOSE

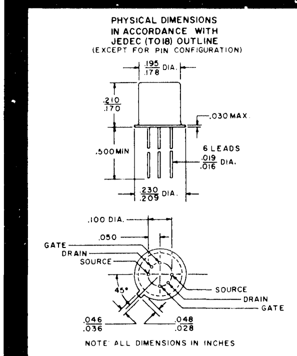
- CLOSELY MATCHED gm
- LOW DIFFERENTIAL DRIFT
- CLOSELY MATCHED V_{GS}

SEPTEMBER 1968

SU2098A
SU2098B
SU2099A

MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING		UNIT
Total Device Dissipation @ $T_A = 25°C$ @ $T_C = 25°C$ @ $T_C = 100°C$	P_D	One Side 250	Both Sides 300	mW
Derating Factor above 25°C @ $T_A = 25°C$		1.7		mW/°C
Storage Temperature Range	T_{stg}	−55 to +200		°C
Operating Junction Temperature	T_J	+200		°C



ELECTRICAL CHARACTERISTICS at +25°C (Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Gate-Source Breakdown Voltage	$V_{(BR)GSS}$	$I_G = 1.0\ \mu A$, $V_{DS} = 0$	50		Volts
Gate-Source Cutoff Voltage	$V_{GS(OFF)}$	$V_{DS} = 10\ V$, $I_D = 0.5\ nA$	0.5	4.0	Volts
Gate-Source Voltage	V_{GS}	$V_{DG} = 10\ V$, $I_D = 0.2\ mA$	0.5	3.0	Volts
Total Gate Leakage Current	I_{GSS}	$V_{GS} = -10\ V$, $V_{DS} = 0$ $V_{GS} = -10\ V$, $V_{DS} = 0$, $T_A = +100°C$		0.1 10	nA
Gate Leakage Current	I_G	$V_{DG} = 10\ V$, $I_D = 0.2\ mA$ $V_{DG} = 10\ V$, $I_D = 0.2\ mA$, $T_A = +100°C$		0.05 5.0	nA
Gate Leakage Current Differential	I_{G1}-I_{G2}	$V_{DG} = 10\ V$, $I_D = 0.2\ mA$ $V_{DG} = 10\ V$, $I_D = 0.2\ mA$, $T_A = +100°C$		0.03 3.0	nA
Zero-Gate Voltage Drain Current	I_{DSS}	$V_{DS} = 10\ V$, $V_{GS} = 0$	1.0	8.0	mA
Transconductance	g_m	$V_{DG} = 10\ V$, $I_D = 0.2\ mA$ $f = 1\ kHz$	700		μmhos
Transconductance	g_m	$V_{DG} = 10\ V$, $V_{GS} = 0$, $f = 1\ kHz$	1500	4500	μmhos
Transconductance Ratio	g_{m1}/g_{m2}	$V_{DG} = 10\ V$, $I_D = 0.2\ mA$	0.95	1.0	
Gate-Source Voltage Differential	V_{GS1}-V_{GS2}	$V_{DG} = 10\ V$, $I_D = 0.2\ mA$		5.0	mV
Gate-Source Voltage Differential Drift SU2098A SU2099A SU2098B	$\Delta\lvert V_{GS1}-V_{GS2}\rvert/\Delta T$	$V_{DG} = 10\ V$, $I_D = 0.2\ mA$ $T_A = 0°C$ to $+100°C$		10 25 5.0	μV/°C
Input Capacitance	C_{iss}	$V_{DS} = 10\ V$, $V_{GS} = 0$, $f = 1\ MHz$		6.0	pf
Reverse Transfer Capacitance	C_{rss}	$V_{DS} = 10\ V$, $V_{GS} = 0$, $f = 1\ MHz$		2.0	pf
Input Conductance	g_{is}	$V_{DS} = 10\ V$, $V_{GS} = 0$, $f = 1\ MHz$		4.0	μmhos
Output Conductance	g_{os}	$V_{DG} = 10\ V$, $I_D = 0$, $f = 1\ kHz$		15	μmhos
Output Conductance Differential	g_{os1} - g_{os2}	$V_{DG} = 10\ V$, $I_D = 0.2\ mA$ $f = 1\ kHz$		2.0	μmhos
Noise Figure	NF	$V_{DS} = 10\ V$, $R_G = 1\ M\Omega$ $f = 100\ Hz$, $BW = 6\ Hz$		1.0	db
Equivalent Input Noise Voltage	En	$V_{DS} = 10\ V$, $V_{GS} = 0$ $f = 1\ kHz$		20	nv/$\sqrt{Hz}$

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JANUARY 1968

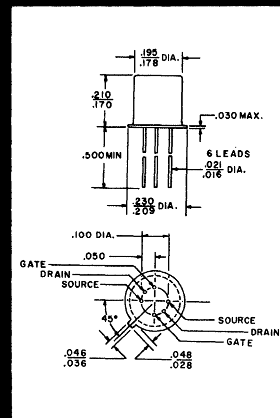
DUAL N-CHANNEL FIELD EFFECT TRANSISTOR
GENERAL PURPOSE

- VERY CLOSELY MATCHED gm
- LOW DIFFERENTIAL DRIFT
- LOW LEAKAGE

2N3934
2N3935
2N4082
2N4083

MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING		UNIT
Total Device Dissipation @ $T_A = 25°C$	P_D	One Side 300	Both Sides 250	mW
Derating Factor Above 25°C @ $T_A = 25°C$		1.7		mW/°C
Storage Temperature	T_{stg}	−55 to +200		°C
Junction Temperature	T_J	+200		°C



ELECTRICAL CHARACTERISTICS at +25°C (Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Drain-Gate Breakdown Voltage	BV_{DGO}	$I_D = 1.0\ \mu A$, $I_S = 0$	50		Volts
Gate-Source Voltage	V_{GS}	$V_{DS} = 10\ V$, $I_D = 25\ \mu A$	0.2	2.7	Volts
Total Gate Leakage Current	I_{GSS}	$V_{GS} = 10\ V$, $V_{DS} = 0$ $V_{GS} = 10\ V$, $V_{DS} = 0$, $T_A = 100°C$		0.4 0.4	nA μA
Gate Leakage Current	I_G	$V_{DG} = 10\ V$, $I_D = 0.2\ mA$ $V_{DG} = 10\ V$, $I_D = 0.2\ mA$, $T_A = 100°C$		0.1 10	nA nA
Saturation Current	I_{DSS}	$V_{DS} = 10\ V$, $V_{GS} = 0$	0.25	1.3	mA
Pinch Off Voltage	V_P	$V_{DS} = 10\ V$, $I_D = 0.5\ nA$		3.0	Volts
Transconductance	g_m	$V_{DG} = 10\ V$, $I_D = 0.2\ mA$, f = 1.0 kHz $V_{DS} = 10\ V$, $V_{GS} = 0$, f = 1.0 kHz	300 300	 900	μmhos
Input Conductance	g_{is}	$V_{DS} = 10\ V$, $V_{GS} = 0$, f = 1.0 MHz		1.0	μmhos
Output Conductance	g_{os}	$V_{DS} = 10\ V$, $V_{GS} = 0$, f = 1.0 kHz $V_{DG} = 10\ V$, $I_D = 0.2\ mA$, f = 1.0 MHz		10 5.0	μmhos
Input Capacitance	C_{is}	$V_{DS} = 10\ V$, $V_{GS} = 0$, f = 1.0 MHz		7.0	pf
Output Capacitance	C_{os}	$V_{DS} = 10\ V$, $V_{GS} = 0$, f = 1.0 MHz		2.2	pf
Noise Figure	NF	$V_{DS} = 10\ V$, $R_G = 1.0\ M\Omega$, f = 100 Hz		2.0	db
Transconductance Ratio	g_{m1}/g_{m2}*	$V_{DG} = 10\ V$, $I_D = 0.2\ mA$	0.95	1.0	
Gate-Source Voltage Differential 2N3934, 2N3935 2N4082, 2N4083	$V_{GS1}-V_{GS2}$	$V_{DG} = 10\ V$, $I_D = 0.2\ mA$		 5.0 15	mV
Gate-Source Voltage Differential Drift 2N4082, 2N3934 2N4083, 2N3935	$\Delta \lvert V_{GS1}-V_{GS2} \rvert / \Delta T$	$V_{DG} = 10\ V$, $I_D = 0.2\ mA$ $T_A = 0°C$ to $100°C$		 10 25	μV/°C

* The lowest g_m reading is g_{m1} for this ratio.

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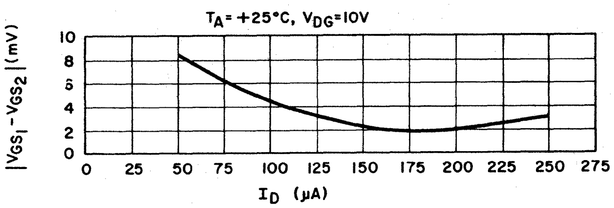
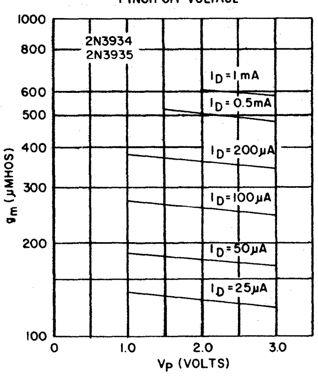
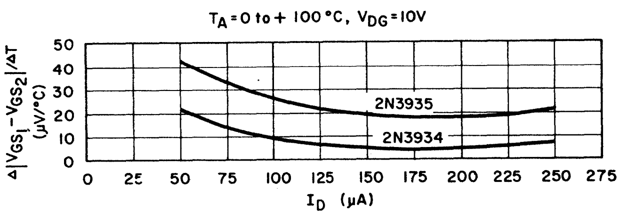
GATE TO SOURCE
VOLTAGE DIFFERENTIAL
VS
DRAIN CURRENT



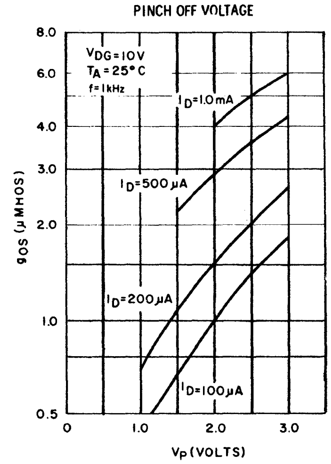
TRANSCONDUCTANCE
VS
PINCH OFF VOLTAGE



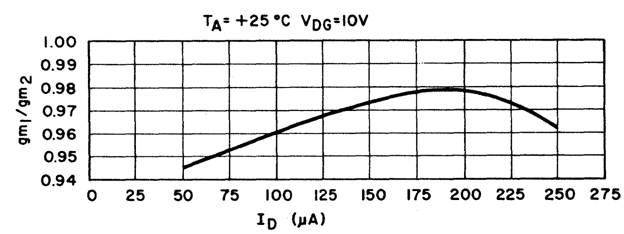
GATE TO SOURCE
VOLTAGE DIFFERENTIAL DRIFT
VS
DRAIN CURRENT



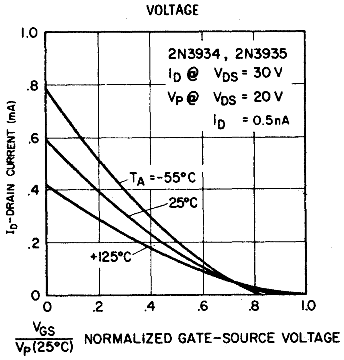
OUTPUT CONDUCTANCE
VS
PINCH OFF VOLTAGE



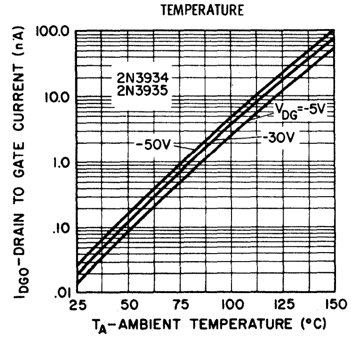
TRANSCONDUCTANCE RATIO
VS
DRAIN CURRENT



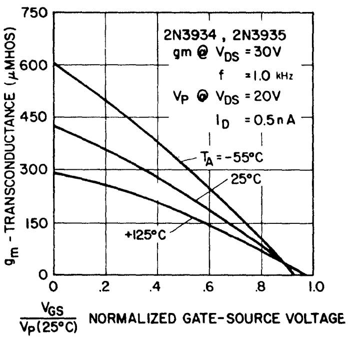
DRAIN CURRENT
VS
NORMALIZED GATE-SOURCE
VOLTAGE



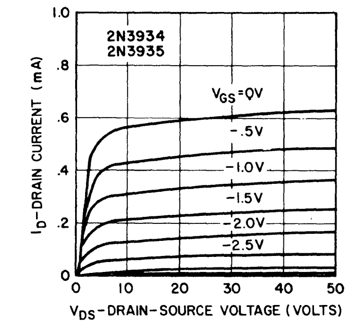
DRAIN-GATE
REVERSE CURRENT
VS
TEMPERATURE



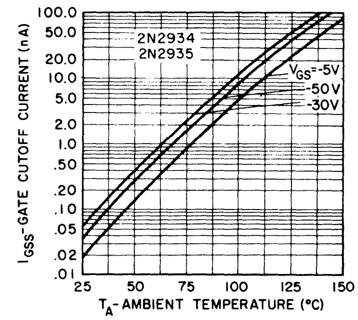
TRANSCONDUCTANCE
VS
NORMALIZED GATE-SOURCE
VOLTAGE



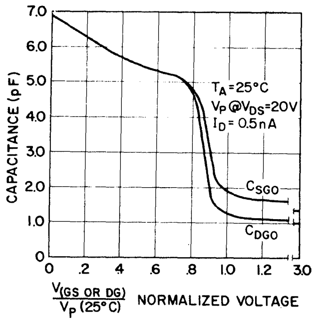
COMMON SOURCE-
DRAIN CHARACTERISTICS



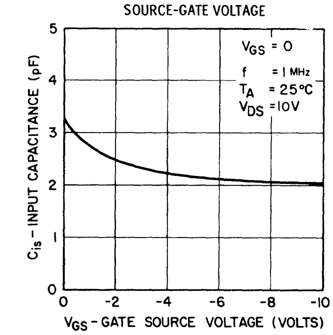
GATE CUTOFF CURRENT
VS
TEMPERATURE



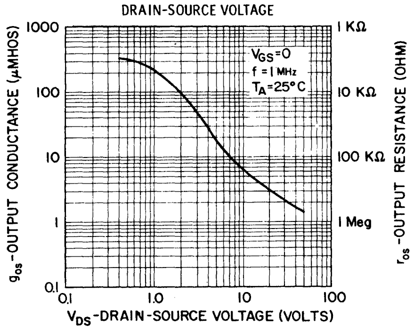
JUNCTION CAPACITY
VS
NORMALIZED BIAS



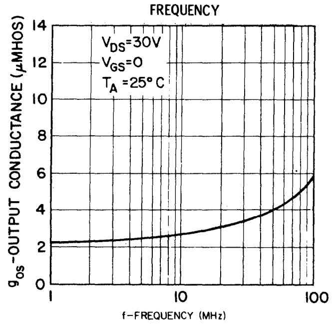
INPUT CAPACITY
VS
SOURCE-GATE VOLTAGE



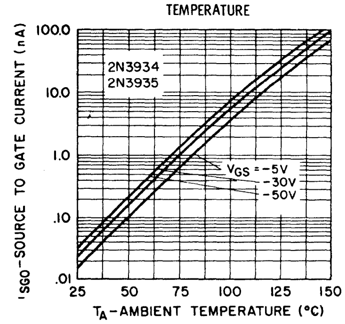
OUTPUT CONDUCTANCE
VS
DRAIN-SOURCE VOLTAGE



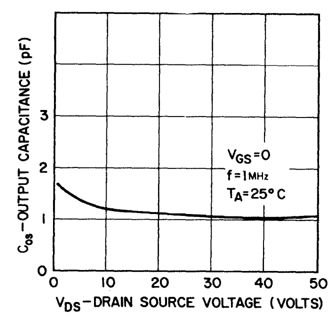
OUTPUT CONDUCTANCE
VS
FREQUENCY



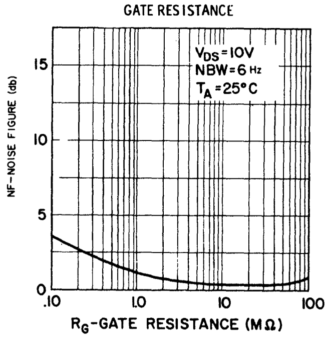
SOURCE-GATE
REVERSE CURRENT
VS
TEMPERATURE



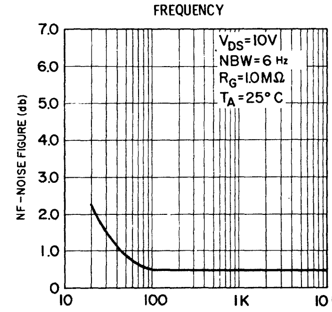
OUTPUT CAPACITY
VS
DRAIN-SOURCE VOLTAGE



NOISE FIGURE
VS
GATE RESISTANCE



NOISE FIGURE
VS
FREQUENCY



MONOLITHIC DUAL P-CHANNEL FIELD EFFECT TRANSISTOR
GENERAL PURPOSE

- CLOSELY MATCHED gm
- LOW DIFFERENTIAL DRIFT
- CLOSELY MATCHED V_{GS}

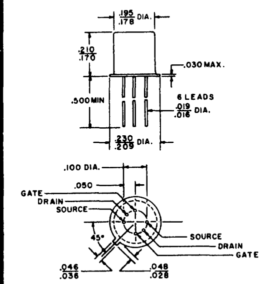
SEPTEMBER 1968

2N5505
THRU
2N5509

MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING		UNIT
Drain-Gain Voltage	V_{DG}	30		Volts
Reverse Gate-Source Voltage	V_{GS}	30		Volts
Drain-Drain Voltage	V_{DD}	30		Volts
Gate Current	I_G	10		mA
Total Device Dissipation @ $T_A = 25°C$	P_D	One Side 250	Both Sides 300	mWatts
Derating Factor above 25°C @ $T_A = 25°C$		2.0	2.4	mW/°C
Storage Temperature Range	T_{stg}	−55 to +200		°C
Lead Temperature, 1/16 inch from case, 10 seconds max.		300		°C

PHYSICAL DIMENSIONS IN ACCORDANCE WITH JEDEC (TO18) OUTLINE (EXCEPT FOR PIN CONFIGURATION)



NOTE: ALL DIMENSIONS IN INCHES

ELECTRICAL CHARACTERISTICS at +25°C (Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Gate-Source Breakdown Voltage	$V_{(BR)GSS}$	$I_G = 1.0\ \mu A$, $V_{DS} = 0$	30		Volts
Gate-Source Cutoff Voltage DP1001-DP1004 DP1005	$V_{GS(OFF)}$	$V_{DS} = -10$ V, $I_D = -1.0$ nA	0.5 0.5	4.0 5.0	Volts
Gate-Source Voltage DP1001-DP1004 DP1005	V_{GS}	$V_{DS} = -10$ V, $I_D = -100\ \mu A$	0.2 0.2	3.7 4.5	Volts
Gate Reverse Current	I_{GSS}	$V_{GS} = 15$ V, $V_{DS} = 0$ $V_{GS} = 15$ V, $V_{DS} = 0$, $T_A = 100°C$		0.25 25	nA
Gate Leakage Current	I_G	$V_{DG} = -10$ V, $I_D = -700\ \mu A$ $V_{DG} = -10$ V, $I_D = -700\ \mu A$ $T_A = 100°C$		0.20 25	nA
Zero-Gate Voltage Drain Current	I_{DSS}	$V_{DS} = -10$ V, $V_{GS} = 0$	−0.8	−7.0	mA
Forward Transadmittance	$\|Y_{fs}\|$	$V_{DS} = -10$ V, $V_{GS} = 0$ f = 1 kHz	1000	3500	μmhos
Forward Transadmittance	$\|Y_{fs}\|$	$V_{DG} = -10$ V, $I_D = -700\ \mu A$ f = 1 kHz	1000		μmhos
Output Admittance	$\|Y_{os}\|$	$V_{DG} = -10$ V, $I_D = -700\mu A$ f = 1 kHz		15	μmhos
Output Admittance	$\|Y_{os}\|$	$V_{DS} = -10$ V, $V_{GS} = 0$ f = 1 kHz		60	μmhos
Input Capacitance	C_{iss}	$V_{DS} = -10$ V, $V_{GS} = 0$ f = 0.14 MHz-1 MHz		16	pf
Reverse Transfer Capacitance	C_{rss}	$V_{DS} = -10$ V, $V_{GS} = 0$ f = 0.14 MHz-1 MHz		6.0	pf
Noise Figure	NF	$V_{DS} = -10$ V, $R_G = 1\ M\Omega$, $V_{GS} = 0$, f = 1 kHz, BW = 200 Hz		2.0	db

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MATCHING CHARACTERISTICS at +25°C (Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Differential Gate-Leakage Current	I_{G1}-I_{G2}	$V_{DG} = -10$ V, $I_D = -700 \mu A$ $V_{DG} = -10$ V, $I_D = -700 \mu A$, $T_A = 100°C$		50 4	pA nA
Differential Output Admittance	$\|Y_{os1}\|-\|Y_{os2}\|$	$V_{DG} = -10$ V, $I_D = -700 \mu A$ f = 1 kHz		1.5	μmhos
Forward Transadmittance Ratio	$\|Y_{fs1}\|/\|Y_{fs2}\|$*				
2N5505		$V_{DG} = -10$ V, $I_D = -700 \mu A$ f = 1 kHz	0.95	1.0	
2N5506			0.95	1.0	
2N5507			0.95	1.0	
2N5508			0.95	1.0	
2N5509			0.90	1.0	
Gate-Source Voltage Differential	V_{GS1}-V_{GS2}				
2N5505		$V_{DG} = -10$ V, $I_D = -700 \mu A$		5.0	mV
2N5506				15	
2N5507				5.0	
2N5508				15	
2N5509				25	
Gate-Source Voltage Differential Drift	$\Delta\|V_{GS1}-V_{GS2}\|/\Delta T$				
2N5505		$V_{DG} = -10$ V, $I_D = -700 \mu A$ $T_A = 0°C$ to $100°C$		10	μV/°C
2N5506				10	
2N5507				15	
2N5508				25	
2N5509				50	

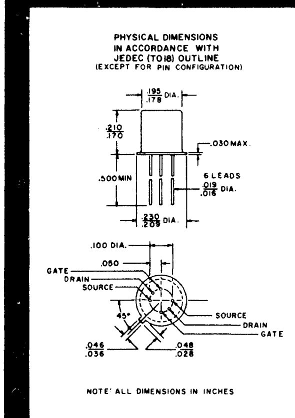
* The lowest Y_{fs} reading is taken as Y_{fs1} for this ratio.

MONOLITHIC DUAL P-CHANNEL FIELD EFFECT TRANSISTOR
GENERAL PURPOSE

- CLOSELY MATCHED gm
- LOW DIFFERENTIAL DRIFT
- CLOSELY MATCHED V_{GS}

SEPTEMBER 1968

2N5510 THRU 2N5514



MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING		UNIT
Drain-Gain Voltage	V_{DG}	30		Volts
Reverse Gate-Source Voltage	V_{GS}	30		Volts
Gate Current	I_G	10		mA
Total Device Dissipation @ $T_A = 25°C$	P_D	One Side 250	Both Sides 300	mW
Derating Factor above 25°C @ $T_A = 25°C$		2.0	2.4	mW/°C
Storage Temperature Range	T_{stg}	−55 to +200		°C
Lead Temperature, 1/16 inch from case, 10 seconds max.		300		°C

ELECTRICAL CHARACTERISTICS at +25°C (Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Gate-Source Breakdown Voltage	$V_{(BR)GSS}$	$I_G = 1.0\ \mu A$, $V_{DS} = 0$	30		Volts
Gate-Source Cutoff Voltage DP1001-DP1004 DP1005	$V_{GS(OFF)}$	$V_{DS} = -10$ V, $I_D = -1.0$ nA	0.5 0.5	4.0 5.0	Volts
Gate-Source Voltage DP1001-DP1004 DP1005	V_{GS}	$V_{DS} = -10$ V, $I_D = -25\ \mu A$	0.2 0.2	3.7 4.5	Volts
Gate Reverse Current	I_{GSS}	$V_{GS} = 15$ V, $V_{DS} = 0$ $V_{GS} = 15$ V, $V_{DS} = 0$, $T_A = 100°C$		0.25 25	nA
Gate Leakage Current	I_G	$V_{DG} = -10$ V, $I_D = -200\ \mu A$ $V_{DG} = -10$ V, $I_D = -200\ \mu A$ $T_A = 100°C$		0.20 25	nA
Zero-Gate Voltage Drain Current	I_{DSS}	$V_{DS} = -10$ V, $V_{GS} = 0$	−0.25	−5.0	mA
Forward Transadmittance	$\|Y_{fs}\|$	$V_{DS} = -10$ V, $V_{GS} = 0$ f = 1 kHz	500	3000	µmhos
Forward Transadmittance	$\|Y_{fs}\|$	$V_{DG} = -10$ V, $I_D = -200\mu A$ f = 1 kHz	500		µmhos
Output Admittance	$\|Y_{os}\|$	$V_{DG} = -10$ V, $I_D = -200\ \mu A$ f = 1 kHz		10	µmhos
Output Admittance	$\|Y_{os}\|$	$V_{DG} = -10$ V, $V_{GS} = 0$ f = 1 kHz		60	µmhos
Input Capacitance	C_{iss}	$V_{DS} = -10$ V, $V_{GS} = 0$ f = 0.14 MHz-1 MHz		16	pf
Reverse Transfer Capacitance	C_{rss}	$V_{DS} = -10$ V, $V_{GS} = 0$ f = 0.14 MHz-1 MHz		6.0	pf
Noise Figure	NF	$V_{DS} = -10$ V, $R_G = 1\ M\Omega$, $V_{GS} = 0$, f = 1 kHz, BW = 200 Hz		2.0	db

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MATCHING CHARACTERISTICS at +25°C (Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
Differential Gate-Leakage Current	I_{G1}-I_{G2}	$V_{DG} = -10$ V, $I_D = -200\mu A$		50	pa
		$V_{DG} = -10$ V, $I_D = -200\mu A$, $T_A = 100°C$		4.0	na
Differential Output Admittance	$\|Y_{os1}\|-\|Y_{os2}\|$	$V_{DG} = -10$ V, $I_D = -200\mu A$ f = 1 kHz		1.0	μmhos
Forward Transadmittance Ratio	$\|Y_{fs1}\|/\|Y_{fs2}\|$*				
2N5510		$V_{DG} = -10$ V, $I_D = -200\mu A$	0.95	1.0	
2N5511		f = 1 kHz	0.95	1.0	
2N5512			0.95	1.0	
2N5513			0.95	1.0	
2N5514			0.90	1.0	
Gate-Source Voltage Differential	V_{GS1}-V_{GS2}				
2N5510		$V_{DG} = -10$ V, $I_D = -200\mu A$		5.0	mV
2N5511				15	
2N5512				5.0	
2N5513				15	
2N5514				25	
Gate-Source Voltage Differential Drift	$\Delta\|V_{GS1}-V_{GS2}\|/\Delta T$				
2N5510		$V_{DG} = -10$ V, $I_D = -200\mu A$,		10	μV/°C
2N5511		$T_A = 0°C$ to 100°C		10	
2N5512				25	
2N5513				25	
2N5514				50	

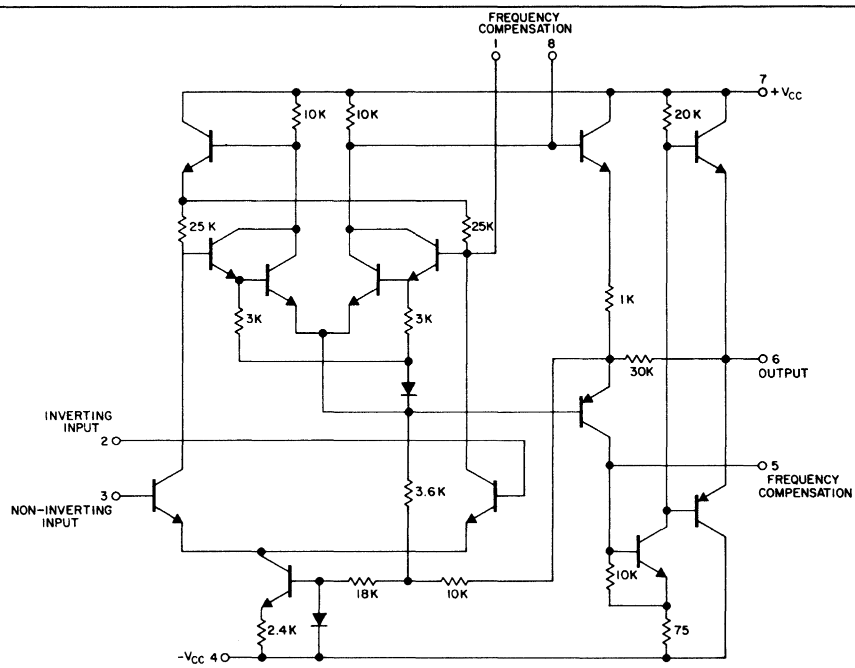
* The lowest Y_{fs} reading is taken as Y_{fs1} for this ratio.

JANUARY 1968

LINEAR CIRCUIT
OPERATIONAL AMPLIFIER

709

The Amelco 709 operational amplifier is designed for high performance applications and features silicon planar epitaxial construction on a single monolithic substrate. Outstanding electrical characteristics include low offset voltage and current, high input impedance, high common mode input range, and exceptional thermal stability.



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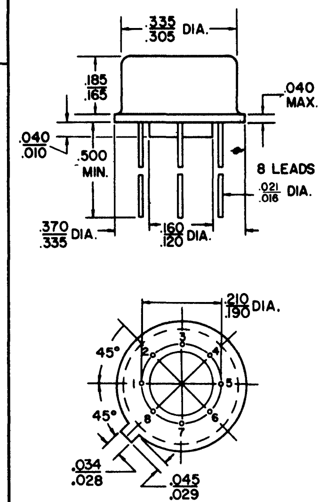


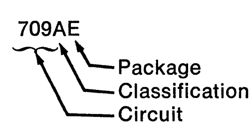
PIN 4 IS INTERNALLY CONNECTED TO CASE

ABSOLUTE MAXIMUM RATINGS

Storage Temperature Range	−65°C to +150°C
Operating Temperature Range	−55°C to +125°C
Lead Soldering Temperature (60 sec.)	300°C
Power Dissipation (Note 1.)	300 mW
Supply Voltage	±18 V
Input Voltage	±10 V
Differential Input Voltage	±5 V
Output Short-Circuit Duration ($T_A = 25°C$)	5 sec.

Note 1. Rating applies for case temperatures to +125°C, derate linearly at 5.6 mW/°C for ambient temperatures above +95°C.

Complete part number designation consists of three digits and two letters, for example:



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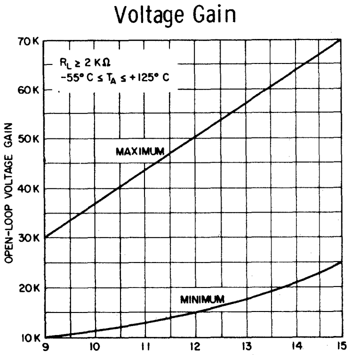
ELECTRICAL CHARACTERISTICS ($T_A = +25°C$, $\pm 9\text{ V} < V_{CC} < \pm 15\text{ V}$ unless otherwise specified)

PARAMETER	709A MIN.	709A TYP.	709A MAX.	709B MIN.	709B TYP.	709B MAX.	UNITS
Open Loop Voltage Gain (Note 2) $V_{CC} = \pm 15$ V, $R_L \geqq 2$ KΩ, $V_{OUT} = \pm 10$ V	25K	45K	70K	25K	45K	70K	
Input Offset Voltage $R_S \leqq 1.0$ KΩ $R_S \leqq 10$ KΩ		0.5 0.5	1.0 1.5		1.0	5.0	mV
Input Offset Voltage (Note 2) $R_S \leqq 1.0$ KΩ $R_S \leqq 10$ KΩ			2.0			6.0	mV
Average Input Offset Voltage Drift (Note 2) $R_S = 50Ω$ $R_S \leqq 10$ KΩ		3.0 6.0	10		3.0 6.0		μV/°C
Input Bias Current		100	200		200	500	nA
Input Bias Current $T_A = -55°C$		0.25	0.75		0.5	1.5	μA
Input Offset Current		10	50		50	200	nA
Input Offset Current $T_A = +125°C$ $T_A = -55°C$		10 50	50 250		20 100	200 500	nA
Input Offset Current Drift 125°C to 25°C +25°C to −55°C			0.5 2.8				nA/°C
Input Resistance	350	400		150	400		K ohms
Input Resistance (Note 2)	40	100		40	100		K ohms
Common Mode Voltage Range $V_{CC} = \pm 15$ V, (Note 2)	±8.0	±10		±8.0	±10		V
Common Mode Rejection Ratio $R_S \leqq 10$ KΩ (Note 2)		−90	−80		−90	−70	db
Power Supply Rejection Ratio $R_S \leqq 10$ KΩ (Note 2)		25	100		25	150	μV/V
Output Resistance		150			150		Ohms
Output Voltage Swing $V_{CC} = \pm 15$ V, $R_L \geqq 10$ KΩ $V_{CC} = \pm 15$ V, $R_L \geqq 2.0$ KΩ	24 20	28 26		24 20	28 26		V_{p-p}
Power Consumption $V_{CC} = \pm 15$ V		80	108		80	165	mW
Transient Response $V_{in} = 20$ mV, $R_L = 2.0$ KΩ, $R_1 = 1.5$ KΩ, $R_2 = 50Ω$ $C_1 = 5000$ pf, $C_2 = 200$ pf, $C_L \leqq 100$ pf Rise Time Overshoot		0.3 10	1.0 30		0.3 10	1.0 30	μsec %

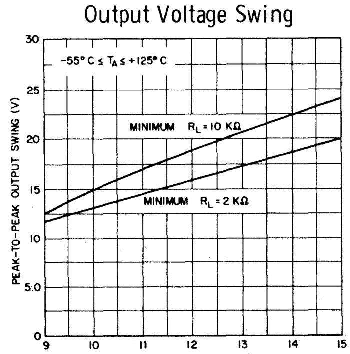
NOTE 2. The Electrical Specifications apply for the Temperature Range of −55°C to +125°C.

GUARANTEED ELECTRICAL CHARACTERISTICS

Voltage Gain

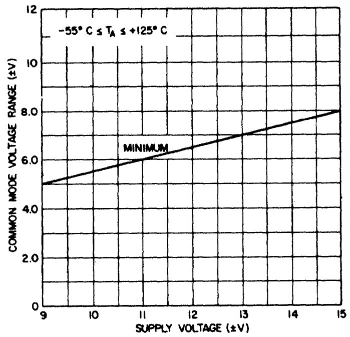


Output Voltage Swing

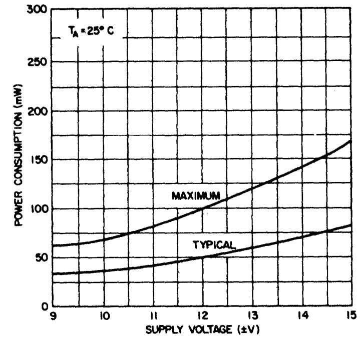


GUARANTEED ELECTRICAL CHARACTERISTICS (Cont)

Input Common Mode Voltage Range

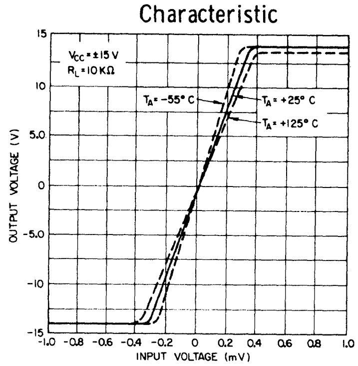


Power Consumption

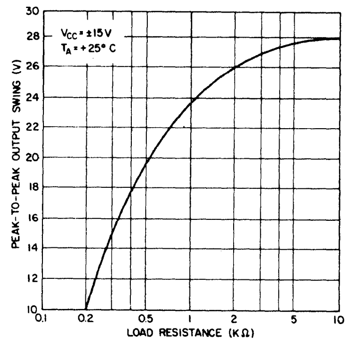


TYPICAL PERFORMANCE CURVES

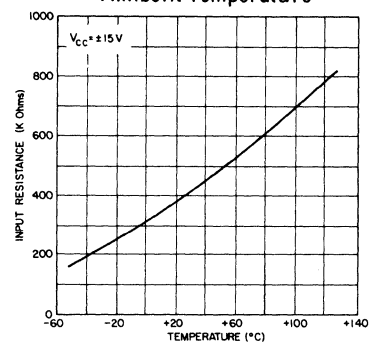
Voltage Transfer Characteristic



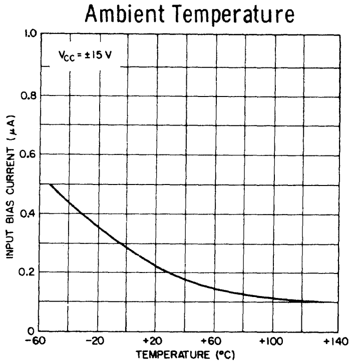
Output Voltage Swing as a Function of Load Resistance



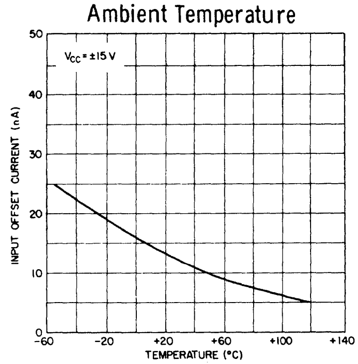
Input Resistance as a Function of Amibent Temperature



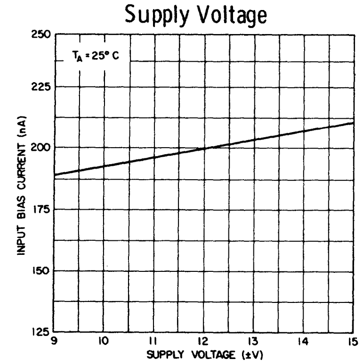
Input Bias Current as a Function of Ambient Temperature



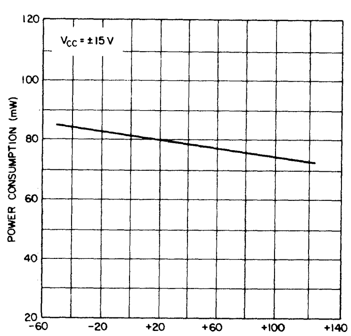
Input Offset Current as a Function of Ambient Temperature



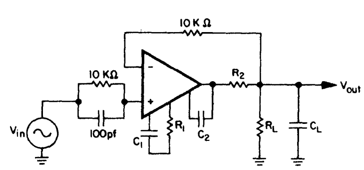
Input Bias Current as a Function of Supply Voltage



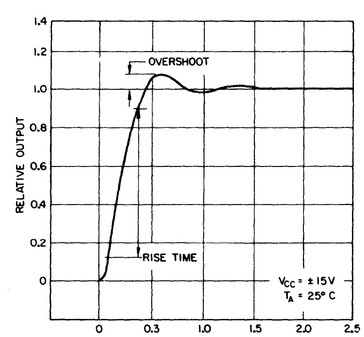
Power Consumption as a Function of Ambient Temperature



Transient Response Test Circuit

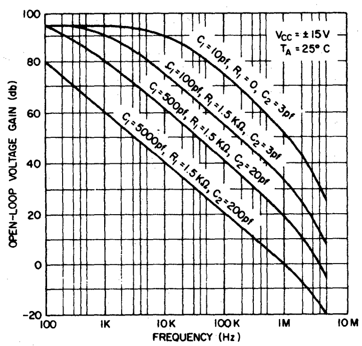


Transient Response

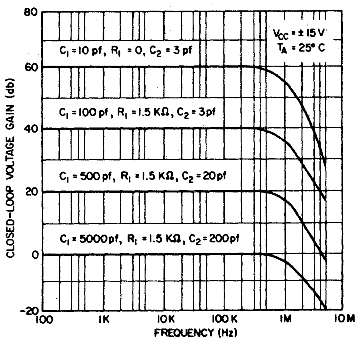


TYPICAL PERFORMANCE CURVES (Cont)

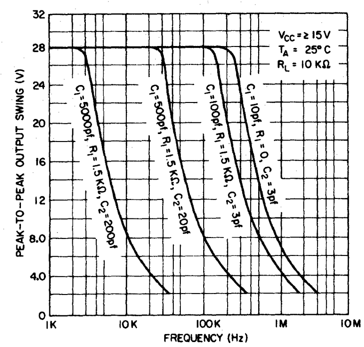
Open-Loop Frequency Response for Various Values of Compensation



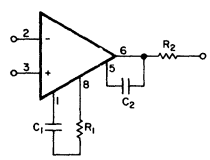
Frequency Response for Various Closed-Loop Gains



Output Voltage Swing as a Function of Frequency for Various Compensation Networks



Frequency Compensation Circuit



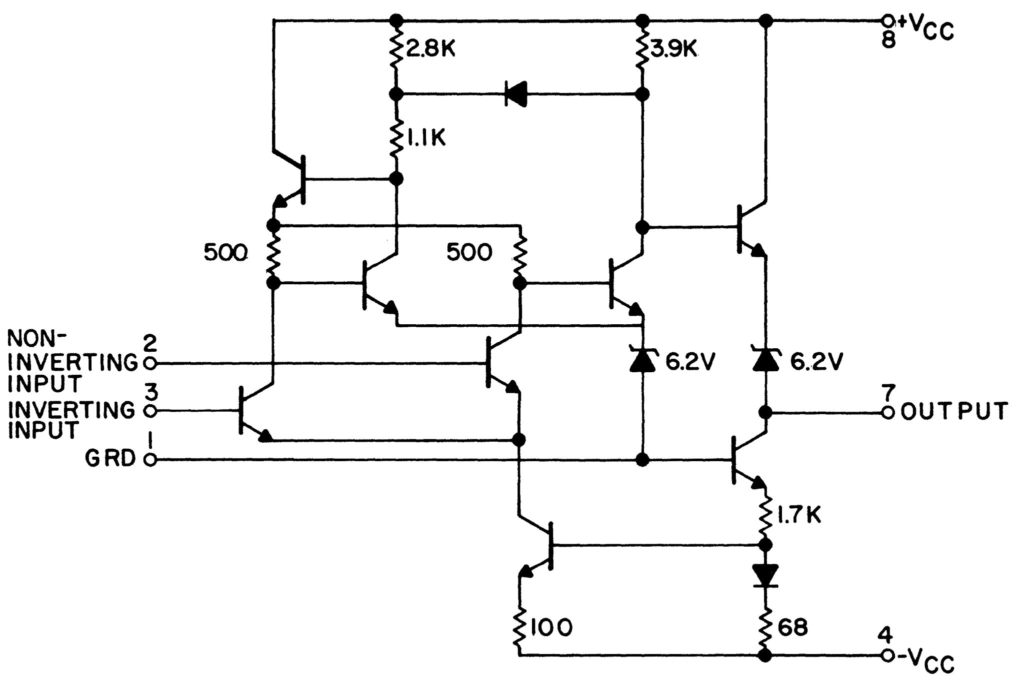
*Use R_2 = 50Ω when the amplifier is operated with capacitive loading.

JANUARY 1968

LINEAR CIRCUIT
DIFFERENTIAL COMPARATOR

710

The Amelco 710 is a Differential Voltage Comparator featuring silicon planar epitaxial construction on a single monolithic substrate. Outstanding electrical characteristics include high accuracy, fast response times, large input voltage range, low power dissipation, adjustable threshold voltages, and very low offsets.



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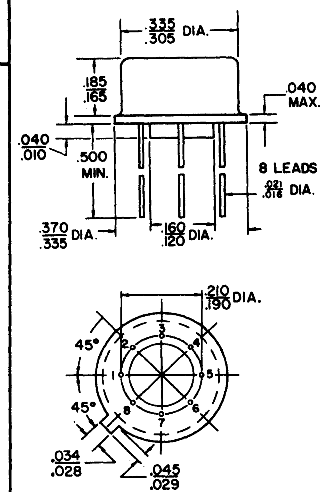
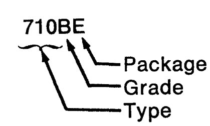


PIN 4 IS INTERNALLY CONNECTED TO CASE

ABSOLUTE MAXIMUM RATINGS

	710B	710C
Operating Temperature Range	−55°C to +125°C	0°C to 70°C
Storage Temperature Range	−65°C to +150°C	
Lead Temperature, 1/16 inch from case, 60 seconds maximum.	300°C	
Internal Power Dissipation TO-99 (Note 1)	300mW	
Differential Input Voltage	±5.0 V	
Input Voltage	±7.0 V	
Positive Supply Voltage	+14 V	
Negative Supply Voltage	−7.0 V	
Peak Output Current	10 mA	

Complete part number designation consists of three digits and two letters, for example:



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ELECTRICAL CHARACTERISTICS ($T_A = 25°C$, $+V_{CC} = +12V$, $-V_{CC} = -6.0V$, Unless Otherwise Specified)

PARAMETER	710B MIN.	710B TYP.	710B MAX.	710C MIN.	710C TYP.	710C MAX.	UNITS
Voltage Gain	1250	1700		1000	1500		
Voltage Gain (Note 2)	1000			800			
Input Offset Voltage (Note 3) $R_S \leq 200\Omega$		0.6	2.0		1.6	5.0	mV
Input Offset Voltage (Note 2 and 3) $R_S \leq 200\Omega$			3.0			6.5	mV
Input Offset Voltage Drift $R_S = 50\Omega$							μV/°C
T_A = 25°C to 125°C		3.5	10				
T_A = +25°C to −55°C		2.7	10				
T_A = (Note 2)					5.0	20	
Input Bias Current		13	20		16	25	μA
T_A = −55°C		27	45				
T_A = 0°C					25	40	
Input Offset Current (Note 3)		0.75	3.0		1.8	5.0	μA
T_A = 125°C		0.25	3.0				
T_A = −55°C		1.8	7.0				
T_A = (Note 2)						7.5	
Input Offset Current Drift							nA/°C
T_A = 25°C to 125°C		5.0	25				
T_A = +25°C to −55°C		15	75				
T_A = 25°C to 70°C					15	50	
T_A = 25°C to 0°C					24	100	
Input Voltage Range (Note 2) $-V_{CC}$ = −7.0 V	±5.0			±5.0			Volts
Differential Input Voltage Range (Note 2)	±5.0			±5.0			Volts
Common Mode Rejection Ratio (Note 2)		−100	−80		−98	−70	Volts
Response Time (Note 4)		40			40		nsec.
Positive Output Level $V_{IN} \geq$ 5.0 mV, I_o = 5.0 mA (Note 2)	2.5	3.2	40	2.5	3.2	40	Volts
Negative Output Level $V_{IN} \geq$ 5.0 mV (Note 2)	−1.0	−0.5		−1.0	−0.5		Volts
Output Resistance		200			200		Ohms
Output Sink Current							mA
$V_{IN} \geq$ 5.0 mV, V_{OUT} = 0 V	2.0	2.5		1.6	2.5		
T_A = 125°C	0.5	1.7					
T_A = −55°C	1.0	2.3					
T_A = (Note 2)				0.5			
Positive Supply Current $V_{OUT} \leq$ 0 V, (Note 2)		5.2	9.0		5.2	9.0	mA
Negative Supply Current (Note 2)		4.6	7.0		4.6	7.0	mA
Power Dissipation		90	150		90	150	mW

NOTES: 1. Rating applies for case temperatures to +125°C, derate linearly at 5.6 mW/°C for ambient temperatures above +105°C. For the 710C, rating applies for ambient temperatures to +70°C.
2. 710B, −55°C to +125°C; 710C, 0°C to +70°C.
3. The input offset voltage/current is specified for a logic threshold voltage of 1.8 V @ −55°C, 1.5 V @ 0°C, 1.4 V @
4. +25°C, 1.2 V @ +70°C, and 1.0 V @ +125°C.
The response time is for a 100mV input step with a 5.0 mV overdrive.
5.

DEFINITIONS

VOLTAGE GAIN—The ratio of the change in output voltage to the change in voltage between the input terminals producing it with the DC output level in the vicinity of the logic threshold voltage.

INPUT OFFSET VOLTAGE—The voltage between the input terminals when the output is at the logic threshold voltage. The input offset voltage may also be defined for the case where two equal resistances are inserted in a series with the input leads.

INPUT BIAS CURRENT—The average of the two input currents.

INPUT OFFSET CURRENT—The difference in the currents into the two input terminals with the output at the logic threshold voltage.

INPUT VOLTAGE RANGE—The range of voltage on the input terminals for which the comparator will operate within specifications.

DIFFERENTIAL INPUT VOLTAGE RANGE—The range of voltage between the input terminals for which operation within specifications is assured.

INPUT COMMON MODE REJECTION RATIO—The ratio of the input voltage range to the maximum change in input offset voltage over this range.

RESPONSE TIME—The interval between the application of an input step function and the time when the output crosses the logic threshold voltage. The input step drives the comparator from some initial, saturated input voltage to an input level just barely in excess of that required to bring the output from saturation to the logic threshold voltage. This excess is referred to as the voltage overdrive.

POSITIVE OUTPUT LEVEL—The DC output voltage in the positive direction with the input voltage equal to or greater than a minimum specified amount.

NEGATIVE OUTPUT LEVEL—The DC output voltage in the negative direction with the input voltage equal to or greater than a minimum specified amount.

OUTPUT RESISTANCE—The resistance seen looking into the output terminal with the DC output level at the logic threshold voltage.

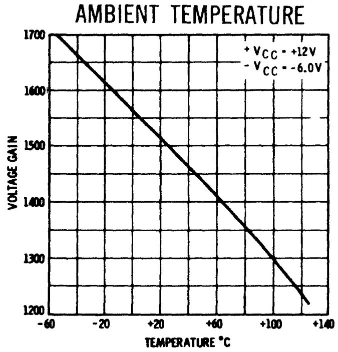
OUTPUT SINK CURRENT—The maximum negative current that can be delivered by the comparator.

PEAK OUTPUT CURRENT—The maximum current that may flow into the output load without causing damage to the comparator.

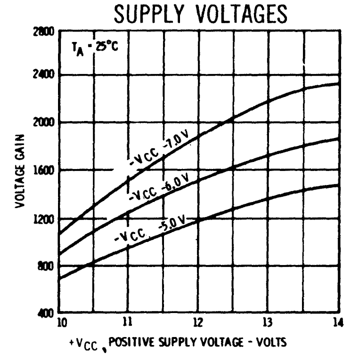
POWER DISSIPATION—The DC power into the amplifier with no output load. The DC power will vary with signal level, but is specified as a maximum for the entire range of input-signal conditions.

LOGIC THRESHOLD VOLTAGE—The approximate voltage at the output of the comparator at which the loading logic circuitry changes its digital state.

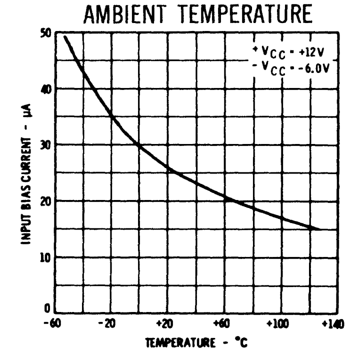
VOLTAGE GAIN VS. AMBIENT TEMPERATURE



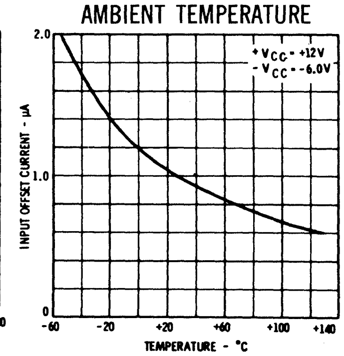
VOLTAGE GAIN VS. SUPPLY VOLTAGES



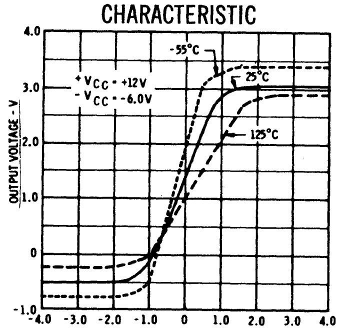
INPUT BIAS CURRENT VS. AMBIENT TEMPERATURE



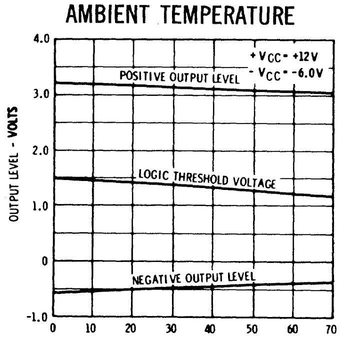
INPUT OFFSET CURRENT VS. AMBIENT TEMPERATURE



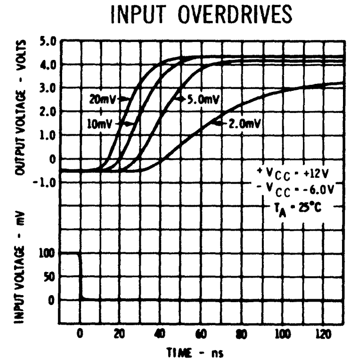
INPUT/OUTPUT VOLTAGE TRANSFER CHARACTERISTIC



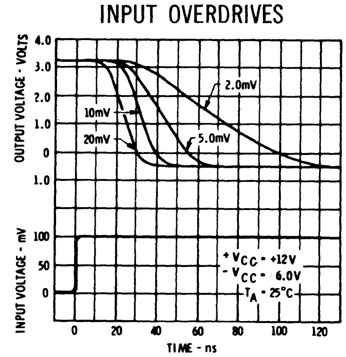
OUTPUT VOLTAGE LEVELS VS. AMBIENT TEMPERATURE



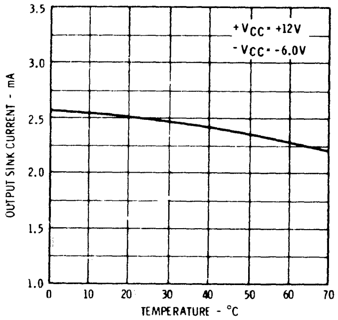
RESPONSE TIME VS. INPUT OVERDRIVES



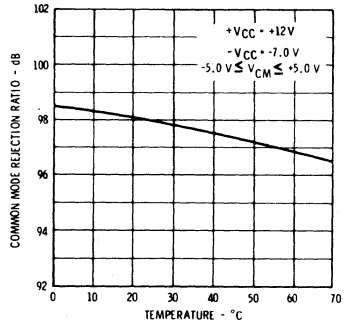
RESPONSE TIME VS. INPUT OVERDRIVES



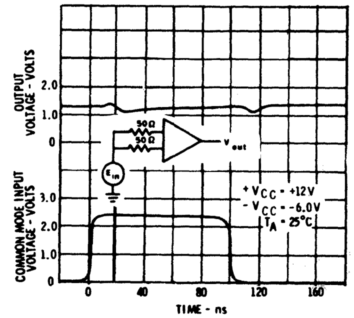
OUTPUT SINK CURRENT VS. AMBIENT TEMPERATURE



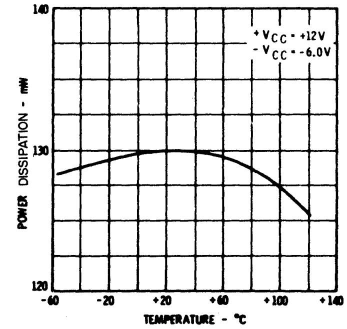
COMMON MODE REJECTION RATIO VS. AMBIENT TEMPERATURE



COMMON MODE PULSE RESPONSE



POWER DISSIPATION VS. AMBIENT TEMPERATURE

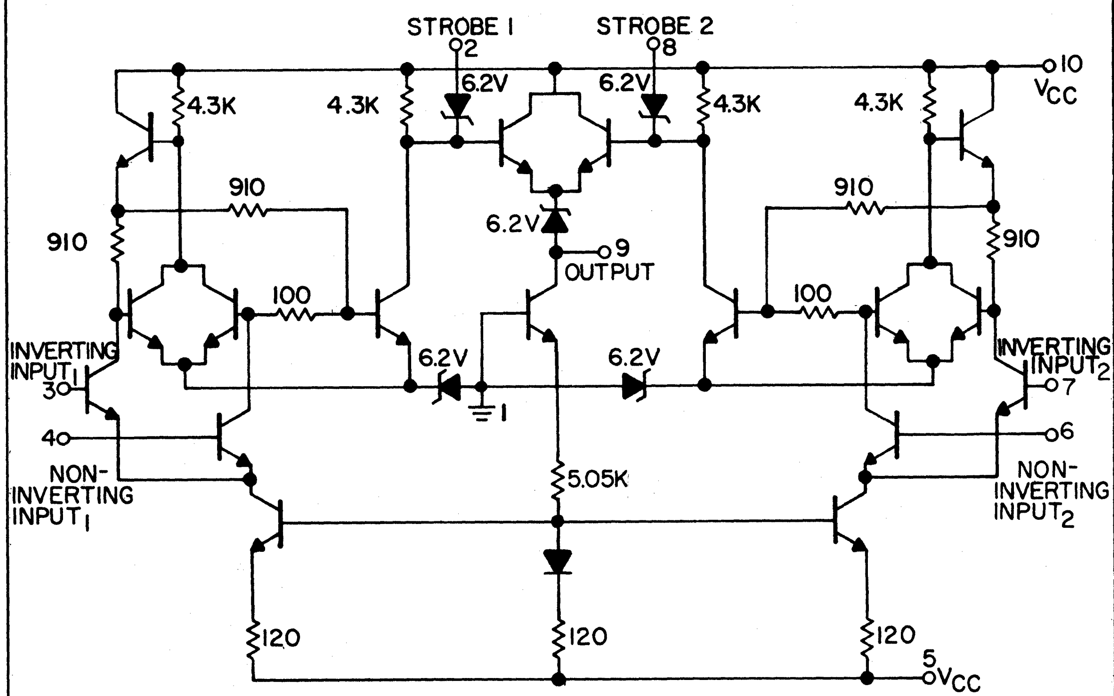


JANUARY 1968

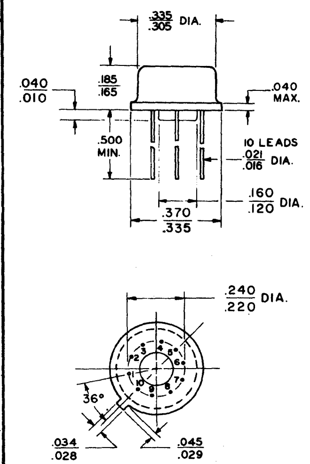
LINEAR CIRCUIT
DUAL
DIFFERENTIAL COMPARATOR

711

The Amelco 711 is a dual Differential Voltage Comparator featuring silicon planar epitaxial construction on a single monolithic substrate. Outstanding electrical characteristics include high accuracy, fast response times, large input voltage range, low power dissipation, adjustable threshold voltages, and independent strobing of each comparator channel.



E PACKAGE



PIN 5 IS INTERNALLY CONNECTED TO CASE

ABSOLUTE MAXIMUM RATINGS

	711B	711C
Operating Temperature Range	−55°C to +125°C	0°C to 70°C
Storage Temperature Range	−65°C to +150°C	
Lead Temperature, 1/16 inch from case, 10 seconds max.	300°C	
Internal Power Dissipation (Note 1)	300mW	
Differential Input Voltage	±5.0 V	
Input Voltage	±7.0 V	
Strobe Voltage	0 to 6.0 V	
Positive Supply Voltage	+14 V	
Negative Supply Voltage	−7.0 V	
Peak Output Current	50 mA	

Complete part number designation consists of three digits and two letters, for example:

711BE
- E — Package
- B — Grade
- 711 — Type

AMELCO SEMICONDUCTOR 1300 Terra Bella Ave. • Mountain View • Calif. 94040

A TELEDYNE COMPANY PHONE: (415) 968-9241

Printed in U.S.A.

ELECTRICAL CHARACTERISTICS ($T_A = 25°C$, $+V_{CC} = +12V$, $-V_{CC} = -6.0V$, Unless Otherwise Specified)

PARAMETER	711B MIN.	711B TYP.	711B MAX.	711C MIN.	711C TYP.	711C MAX.	UNITS
Voltage Gain*	750	1500		700	1500		
Voltage Gain* (Note 2)	500			500			
Input Offset Voltage* $V_{OUT} = 1.4$ V, $R_S \leq 200\Omega$, $V_{CM} = 0$ $V_{OUT} = 1.4$ V, $R_S \leq 200\Omega$		 1.0 1.0	 3.5 5.0		 1.0 1.0	 5.0 7.5	mV
Input Offset Voltage* (Note 2) V_{OUT} (Note 3), $R_S = 200\Omega$, $V_{CM} = 0$ V_{OUT} (Note 3), $R_S = 200\Omega$			 4.5 6.0			 6.0 10	mV
Input Offset Voltage Drift* (Note 2)		5.0			5.0		μV/°C
Input Bias Current*		25	75		25	100	μA
Input Bias Current* (Note 2)			150			150	μA
Input Offset Current* $V_{OUT} = 1.4$ V		0.5	10		0.5	15	μA
Input Offset Current* V_{OUT} = (Note 3) and (Note 2)			20			25	μA
Input Voltage Range* $-V_{CC} = -7.0$ V	±5.0			±5.0			Volts
Differential Input Voltage Range*	±5.0			±5.0			Volts
Response Time* (Note 4)		40			40		nsec
Strobe Release Time*		12			12		nsec
Positive Output Level* $V_{IN} \geq 10$ mV		4.5	5.0		4.5	5.0	Volts
Loaded Positive Output Level* $V_{IN} \geq 10$ mV, $I_O = 5.0$ mA	2.5	3.5		2.5	3.5		Volts
Negative Output Level* $V_{IN} \geq 10$ mV	−1.0	−0.5		−1.0	−0.5		Volts
Strobed Output Level* $V_{STROBE} \leq 0.3$ V	−1.0			−1.0			Volts
Output Resistance*		200			200		Ohms
Output Sink Current $V_{IN} \geq 10$ mV, $V_{OUT} = 0$	0.5	0.8		0.5	0.8		mA
Strobe Current $V_{STROBE} = 100$ mV		1.2	2.5		1.2	2.5	mA
Positive Supply Current $V_{OUT} \leq 0$		8.6			8.6		mA
Negative Supply Current		3.9			3.9		mA
Power Dissipation		130	200		130	230	mW

* These Specifications apply for either side with the other side disabled with the strobe.

NOTES:
1. Rating applies for case temperatures to +125°C; derate linearly at 5.6 mW/°C for ambient temperatures above +105°C. For the 711C, this rating applies for ambient temperatures to +70°C.
2. 711B, −55°C to +125°C; 711C, 0°C to 70°C.
3. The input offset voltage/current is specified for a logic threshold voltage of 1.8 V at −55°C, 1.5 V at 0°C, 1.4 V at +25°C, 1.2 V at +70°C, and 1.0 V at +125°C.
4. The response time is for a 100 mV input step with a 5.0 mV overdrive.

DEFINITIONS

VOLTAGE GAIN—The ratio of the change in output voltage to the change in voltage between the input terminals producing it with the DC output level in the vicinity of the logic threshold voltage.

INPUT OFFSET VOLTAGE—The voltage between the input terminals when the output is at the logic threshold voltage. The input offset voltage may also be defined for the case where two equal resistances are inserted in a series with the input leads.

INPUT BIAS CURRENT—The average of the two input currents.

INPUT OFFSET CURRENT—The difference in the currents into the two input terminals with the output at the logic threshold voltage.

INPUT VOLTAGE RANGE—The range of voltage on the input terminals for which the comparator will operate within specifications.

DIFFERENTIAL INPUT VOLTAGE RANGE—The range of voltage between the input terminals for which operation within specifications is assured.

RESPONSE TIME—The interval between the application of an input step function and the time when the output crosses the logic threshold voltage. The input step drives the comparator from some initial, saturated input voltage to an input level just barely in excess of that required to bring the output from saturation to the logic threshold voltage. This excess is referred to as the voltage overdrive.

STROBE RELEASE TIME—The time required for the output to rise to the logic threshold voltage after the strobe terminal has been driven from the zero to the one logic level. Appropriate input conditions are assumed.

POSITIVE OUTPUT LEVEL—The DC output voltage in the positive direction with the input voltage equal to or greater than a minimum specified amount.

NEGATIVE OUTPUT LEVEL—The DC output voltage in the negative direction with the input voltage equal to or greater than a minimum specified amount.

STROBED OUTPUT LEVEL—The DC output voltage, independent of input voltage, with the voltage on the strobe terminal equal to or less than a minimum specified amount.

OUTPUT RESISTANCE—The resistance seen looking into the output terminal with the DC output level at the logic threshold voltage.

OUTPUT SINK CURRENT—The maximum negative current that can be delivered by the comparator.

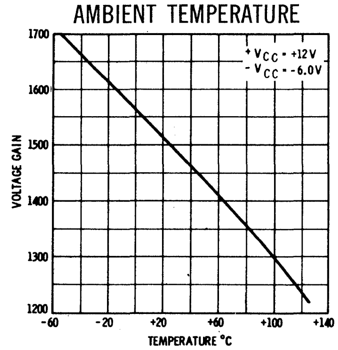
STROBE CURRENT—The maximum current drawn by the strobe terminal when it is at the zero logic level.

PEAK OUTPUT CURRENT—The maximum current that may flow into the output load without causing damage to the comparator.

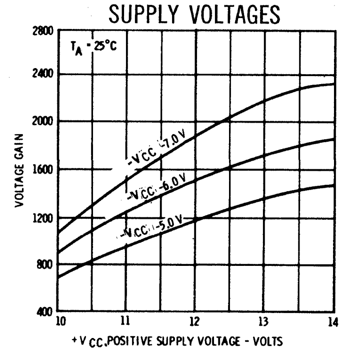
POWER DISSIPATION—The DC power into the amplifier with no output load. The DC power will vary with signal level, but is specified as a maximum for the entire range of input-signal conditions.

LOGIC THRESHOLD VOLTAGE—The approximate voltage at the output of the comparator at which the loading logic circuitry changes its digital state.

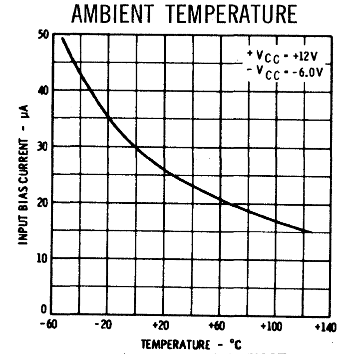
VOLTAGE GAIN VS. AMBIENT TEMPERATURE



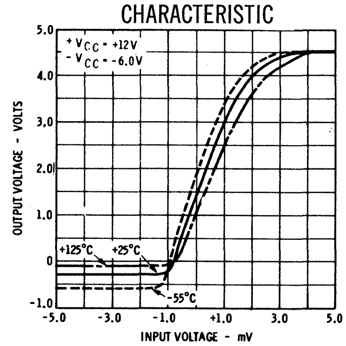
VOLTAGE GAIN VS. SUPPLY VOLTAGES



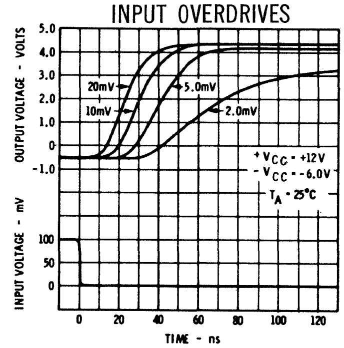
INPUT BIAS CURRENT VS. AMBIENT TEMPERATURE



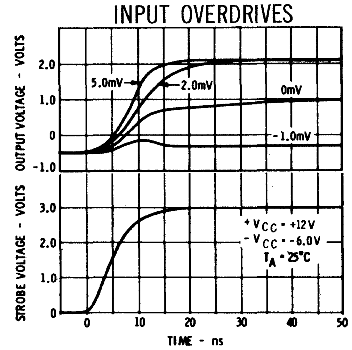
INPUT/OUTPUT VOLTAGE CHARACTERISTIC



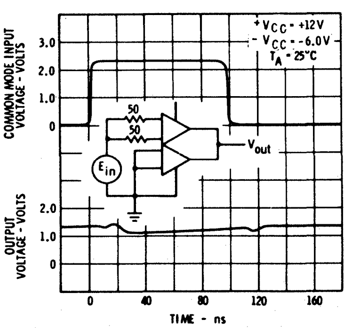
RESPONSE TIME VS. INPUT OVERDRIVES



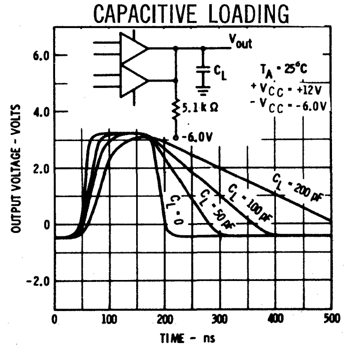
STROBE RELEASE TIME VS. INPUT OVERDRIVES



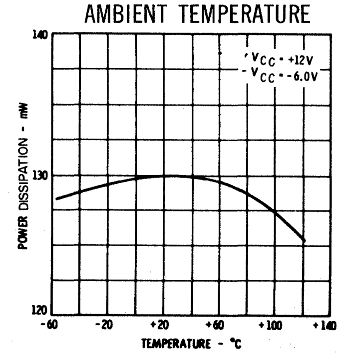
COMMON MODE PULSE RESPONSE



OUTPUT PULSE STRETCHING VS. CAPACITIVE LOADING



POWER DISSIPATION VS. AMBIENT TEMPERATURE

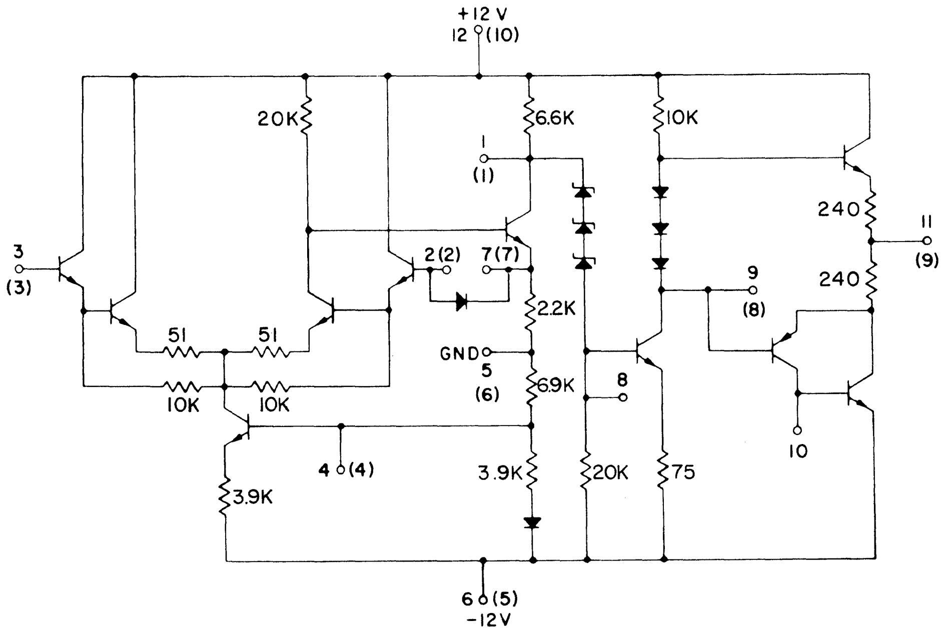


JANUARY 1968

LINEAR CIRCUIT
OPERATIONAL AMPLIFIER

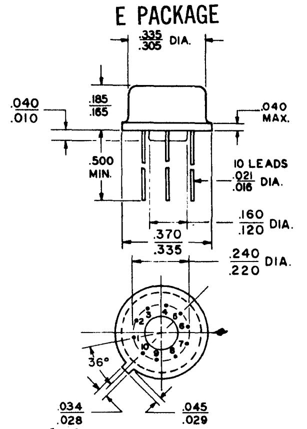
800
801

This General Purpose Amplifier is constructed on a single monolithic silicon substrate. It is ideally suited for applications requiring high input impedance, high voltage swing, high gain, low offset and low drift.



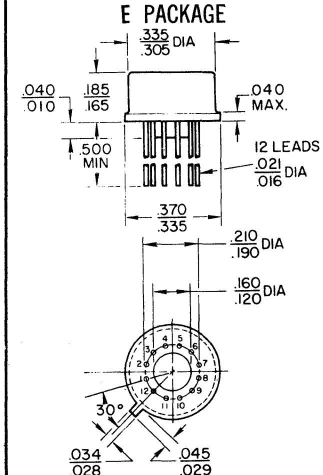
Note: NUMBERS IN PARENTHESES REFER TO 10 PIN PACKAGE.

800
E PACKAGE



PIN 5 IS INTERNALLY CONNECTED TO CASE

801
E PACKAGE



PIN 6 IS INTERNALLY CONNECTED TO CASE

ABSOLUTE MAXIMUM RATINGS

Total supply voltage between pins 6 and 12	30 volts.
Storage temperature	−65°C to +150°C
Operating temperature	−55°C to +125°C

SUPPLY VOLTAGES

Pin 12 to ground	+12 Volts, 5.0 mA Typical
Pin 6 to ground	−12 Volts, 5.0 mA Typical

Complete part number designation consists of three digits and two letters, for example:

800DE
- Package
- Temperature Range
- Circuit

AMELCO SEMICONDUCTOR 1300 Terra Bella Ave. • Mountain View • Calif. 94040
A TELEDYNE COMPANY PHONE: (415) 968-9241

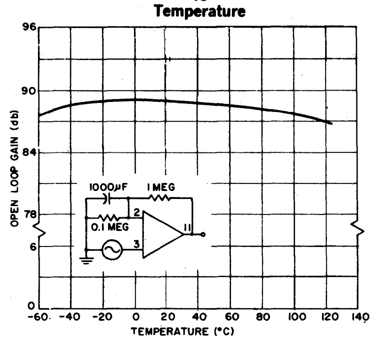
ELECTRICAL CHARACTERISTICS AT +25°C (Unless Otherwise Specified)

PARAMETER AND CONDITIONS	800BE, 801BE			800DE, 801DE			UNITS
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	
Open Loop DC Gain (No Load)	10,000	20,000		10,000	20,000		
Open Loop Bandwidth (1, 2)		10			10		MHz
Input Offset Voltage (Untrimmed)		5.0	50				mV
Input Bias Current			1000			2000	nA
Input Offset Current			100			200	nA
Input Offset Voltage Drift		25	50				μV/°C
Input Current Drift −55°C to +125°C			5.0				nA/°C
Input Impedance	250	1000		100	500		KΩ
Output Impedance (Open Loop)		400	1000		400	1000	Ohms
Common Mode Input Range	−2.0		+2.0	−2.0		+2.0	Volts
Dynamic Output Range (No Load)	18			16			V_{p-p}
Dynamic Output Range (1.0 KΩ Load)	10			10			V_{p-p}
Common Mode Rejection		−80	−60				db

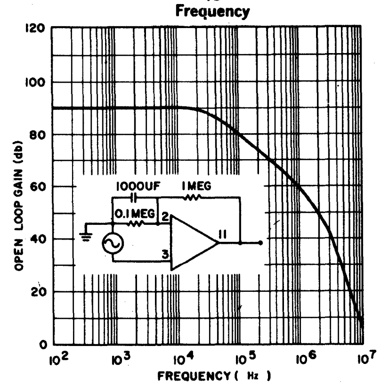
NOTES: (1) Bandwidth measured at unity gain.

(2) For closed loop stabilization, a capacitor should be connected across pins 2 and 7. For additional compensation a capacitor can be connected to pins 1 and 9. Recommended values range from 5 pf to 250 pf depending on the amount of feedback.

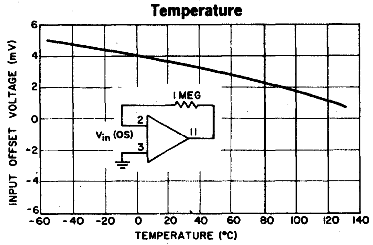
Open Loop Gain vs Temperature



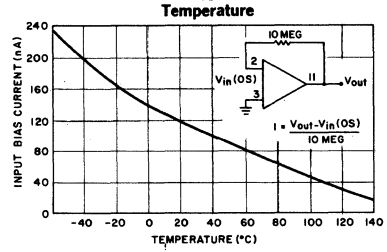
Open Loop Gain vs Frequency

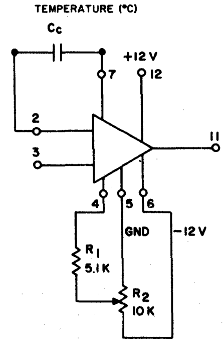


Input Offset Voltage vs Temperature



Input Bias Current vs Temperature





C_C = COMPENSATION CAPACITOR

R_1 & R_2 = OFFSET ADJUSTMENT RESISTORS

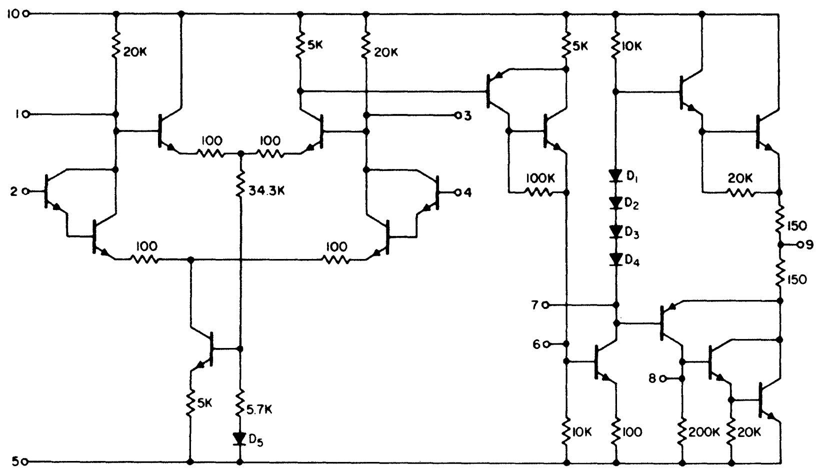
Circuit for input offset adjustment and AC feedback compensation.

JANUARY 1968

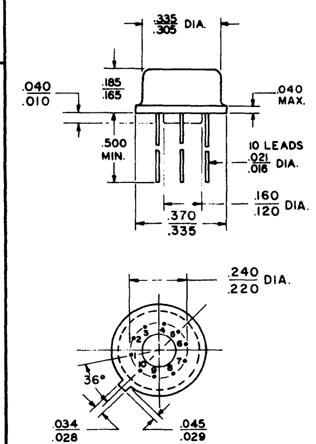
LINEAR CIRCUIT
OPERATIONAL AMPLIFIER

805
THRU
808

The Amelco 805, 806, 807 and 808 series of high performance operational amplifiers feature silicon planar epitaxial construction on a single monolithic substrate. Outstanding electrical characteristics include low offset voltage and current, high input impedance, high common mode input range, excellent thermal stability and output short-circuit protection.



E PACKAGE



PIN 5 IS INTERNALLY CONNECTED TO CASE

ABSOLUTE MAXIMUM RATINGS

Differential Input Voltage	±5.0 V	
Input Voltage	±10 V	
Internal Power Dissipation @ $T_A = 25°C$	300 mW	
Output Short-Circuit Duration @ $T_A = 25°C$	Continuous	
Lead Temperature, 1/16 inch from case, 10 seconds max.	+300°C	
Storage Temperature	−65°C to +150°C	
Operating Temperature Range	805B/806B 807B/808A/808B −55°C to +125°C	805C/806C 0° to 100°C
Supply Voltage	±18 V	±15 V
Operating Supply Voltage	±15 V	±12 V

Complete part number designation consists of three digits and two letters, for example:

805BE
- Package
- Grade
- Type

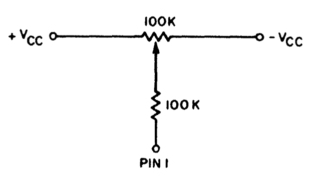
AMELCO SEMICONDUCTOR 1300 Terra Bella Ave. • Mountain View • Calif. 94040
A TELEDYNE COMPANY PHONE: (415) 968-9241

Printed in U.S.A.

ELECTRICAL CHARACTERISTICS AT +25°C (Unless Otherwise Specified)

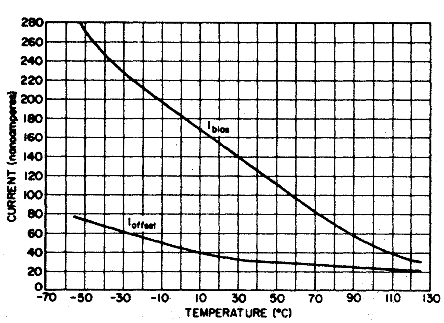
	805B/806B			805C/806C			807B			808AE			808BE			UNITS
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	
Open Loop Voltage Gain −55°C +125°C	30 20 20	60	120	10	60		30 20 20	60	120	25	40		25	40		KV/V
Input Offset Voltage −55°C to +125°C		1.0 2.0	5.0 7.0		3.0	10		0.1 1.0	2.5 3.0		1.0	5.0		1.0	10	mV
Input Bias Current −55°C +125°C		250	500 1500 250		250	1000		250	500 1500 250		25	50 250		25	50 250	nA
Input Offset Current −55°C +125°C		10	50 250 100		30	100		10	50 250 50		3.0	15		5.0	30	nA
Input Impedance −55°C +125°C	500 200 500	1000		100	1000		500 300 500	1000		1000	2000		1000	2000		KΩ
Input Offset Voltage Drift (−55°C to +125°C) (0°C to100°C)		 5.0	 20		 5.0	 30		 3.0	 10		 5.0	 10		 10	 30	 μV/°C
Input Offset Current Drift (+25°C to +125°C) (−55°C to +125°C) (0°C to 100°C)		 0.02 0.5	 0.5 1.0		 0.1	 2.0		 0.02 0.5	 0.5 1.0		 0.01	 0.15		 0.1	 0.3	 nA/°C
Common Mode Voltage Range $V_{CC} = \pm15$ V $V_{CC} = \pm12$ V	 ±8.0 ±6.0	 ±9.0 ±7.0		 ±8.0 ±8.0	 ±9.0 ±7.0		 ±8.0 ±6.0	 ±9.0 ±7.0		 ±8.0 ±6.0	 ±9.0 ±7.0		 ±8.0 ±6.0	 ±9.0 ±7.0		 Volts
Common Mode Rejection Ratio		−90	−70		−90	−70		−90	−80		−90	−70		−90	−70	db
Output Impedance −55°C +125°C		150	300 300 360		150	300		150	300 300 360		150	300		150	300	Ohms
Power Supply Rejection Ratio		−80	−70		−80			−80	−70		−80	−70		−80	−70	db
Output Voltage Swing (+25°C to Temp.*) No Load, $V_{CC} = \pm15$ V No Load, $V_{CC} = \pm12$ V 1.0 K Load, $V_{CC} = \pm15$ V 1.0 K Load, $V_{CC} = \pm12$ V (−55°C) No Load, $V_{CC} = \pm15$ V 1.0 K Load, $V_{CC} = \pm15$ V	 24 18 20 15 20 16	 26 20 24 18 25 23		 24 18 20 15	 26 20 24 18		 24 18 20 15 20 16	 26 20 24 18 25 23		 24 18 20 15	 26 20 24 18		 24 18 20 15	 26 20 24 18		 V_{p-p}
Power Supply Current No Load, ±15 V No Load, ±12 V		 6.0 5.0	 7.5 6.7		 6.0 5.0	 7.5 6.7		 6.0 5.0	 7.5 6.7		 6.0 5.0	 7.5 6.7		 6.0 5.0	 7.5 6.7	 mA

* Upper limit for "A & B" grade unit = 125°C
Upper limit for "C" grade unit = 100°C

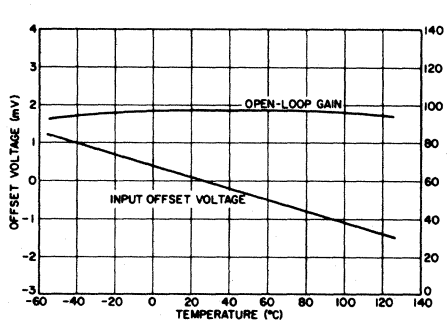


RECOMMENDED OFFSET ADJUSTMENT

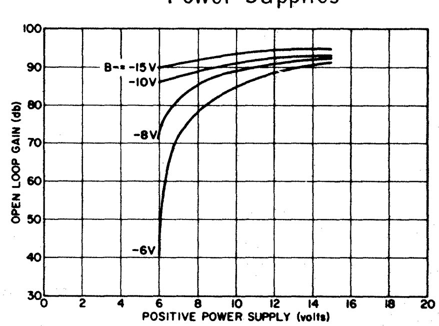
Input Bias and Offset Current vs Temperature



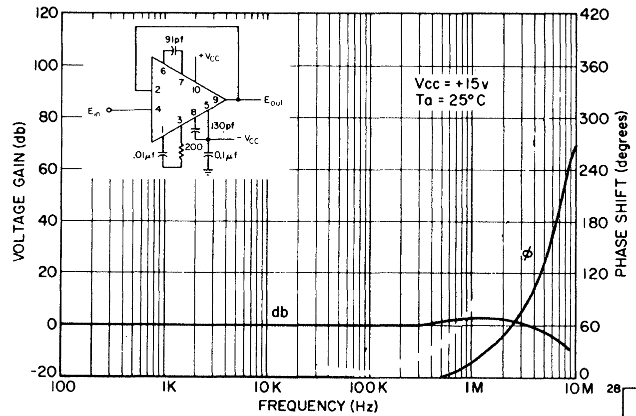
Offset Voltage and Open Loop Gain vs Temperature



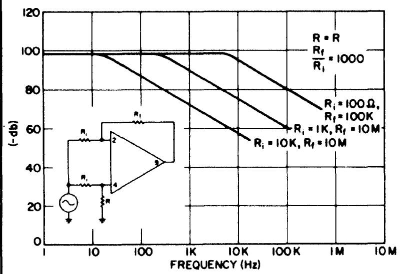
Open Loop Gain vs Power Supplies



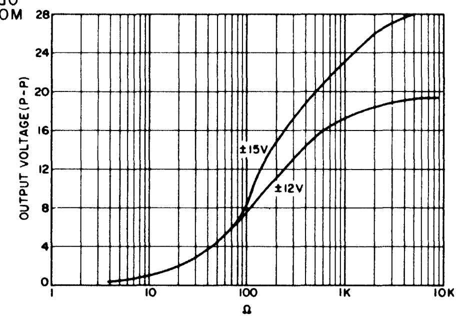
Unity Gain Voltage Follower Voltage Gain & Closed-Loop Phase Shift vs Frequency



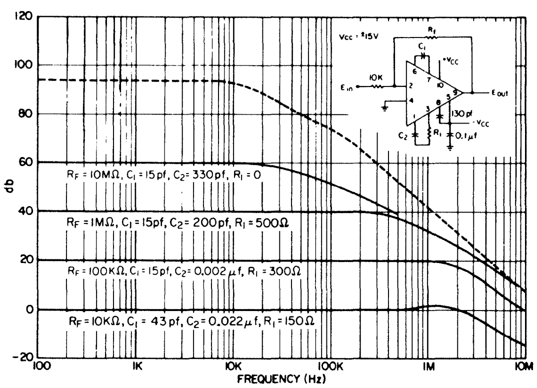
Common Mode Rejection Ratio vs Frequency



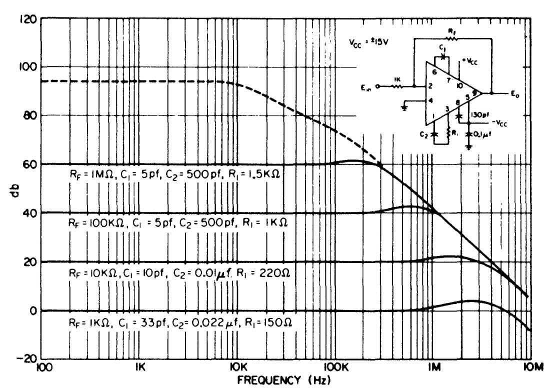
Output Swing (Open Loop) vs Load Resistance



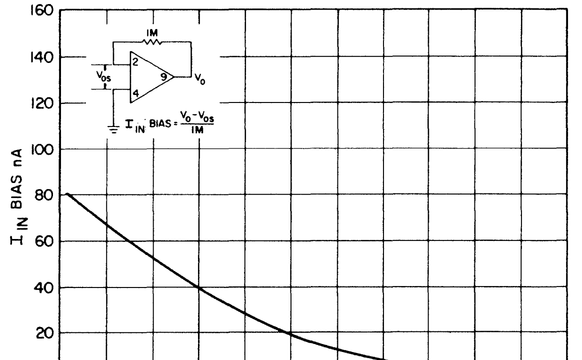
Frequency Response 10K Input Resistance (Optimized for Various Gains)



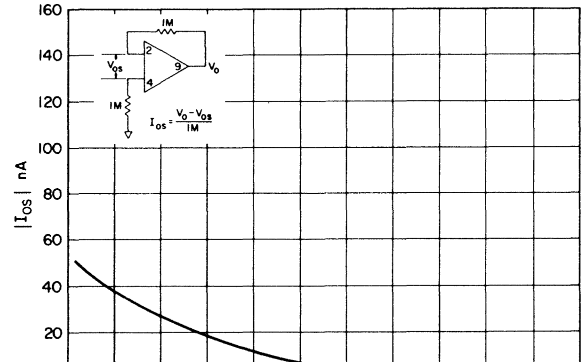
Frequency Response 1K Input Resistance (Optimized for Various Gains)



Typical Input Bias Current vs Temperature



Typical Input Offset Current vs Temperature

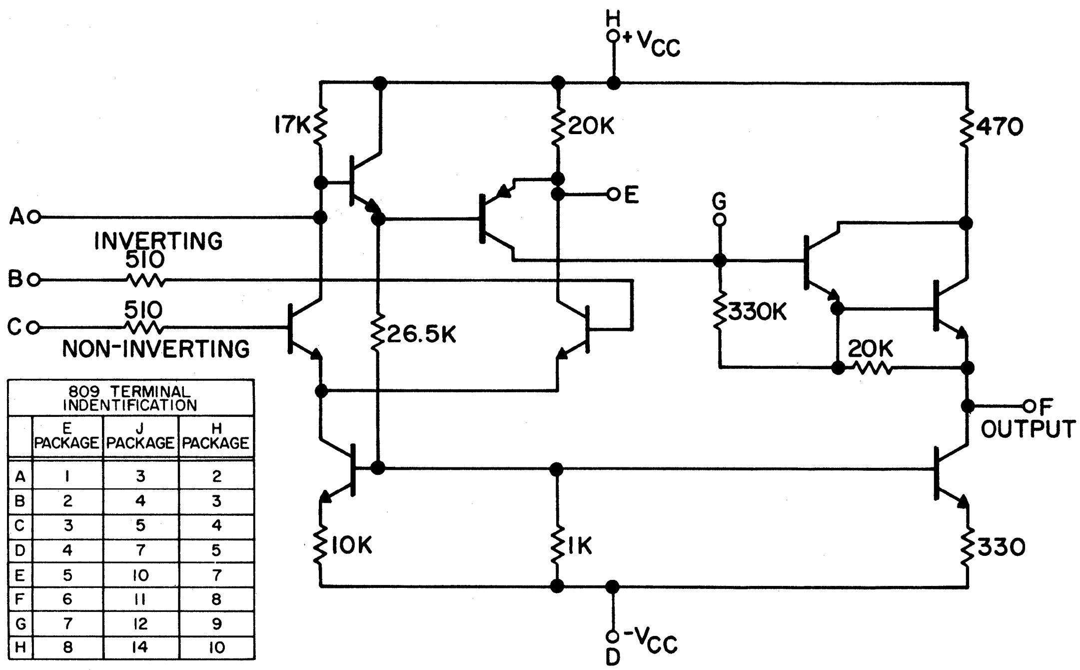


JANUARY 1968

LINEAR CIRCUIT
OPERATIONAL AMPLIFIER

809

The Amelco 809 Operational Amplifier is constructed on a single monolithic silicon substrate using planar epitaxial techniques. The unique simplicity of this design results in a low cost, high performance amplifier. It is ideally suited for applications requiring high common mode range, high input impedance, and low current and voltage offsets and offset drifts. This amplifier can also be operated over a large range of supply voltages.



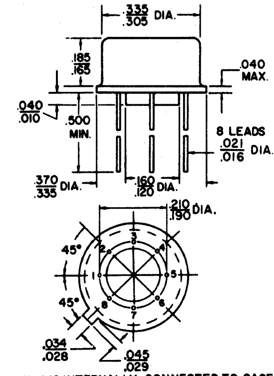
809 TERMINAL INDENTIFICATION			
	E PACKAGE	J PACKAGE	H PACKAGE
A	1	3	2
B	2	4	3
C	3	5	4
D	4	7	5
E	5	10	7
F	6	11	8
G	7	12	9
H	8	14	10

ABSOLUTE MAXIMUM RATINGS

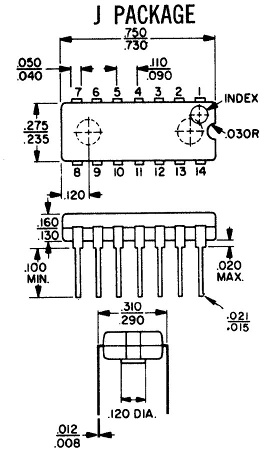
	809B	809C
Storage Temperature Range	−65°C to +150°C	−65°C to +150°C
Operating Temperature Range	−55°C to +125°C	0°C to 100°C
Maximum Supply Voltage	±18 V	±18 V
Maximum Operating Voltage	±15 V	±15 V

"J" Package only available in "C" Grade.

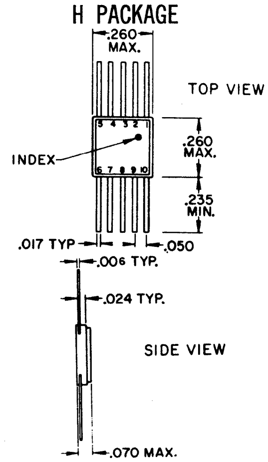
E PACKAGE



J PACKAGE



H PACKAGE



Complete part number designation consists of three digits and two letters, for example:

809BE
- Package
- Temperature Range
- Circuit

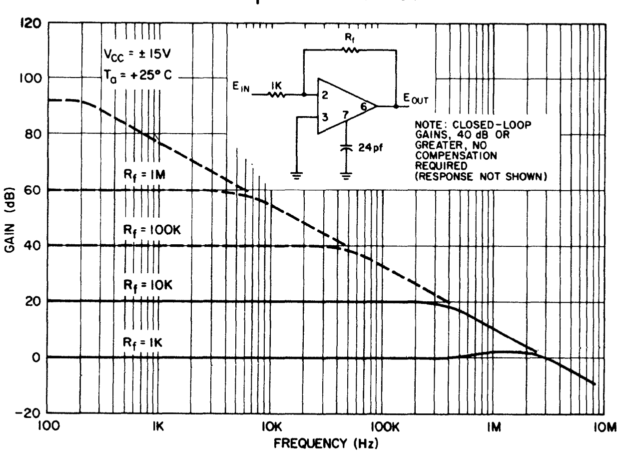
AMELCO SEMICONDUCTOR 1300 Terra Bella Ave. • Mountain View • Calif. 94040

A TELEDYNE COMPANY PHONE: (415) 968-9241

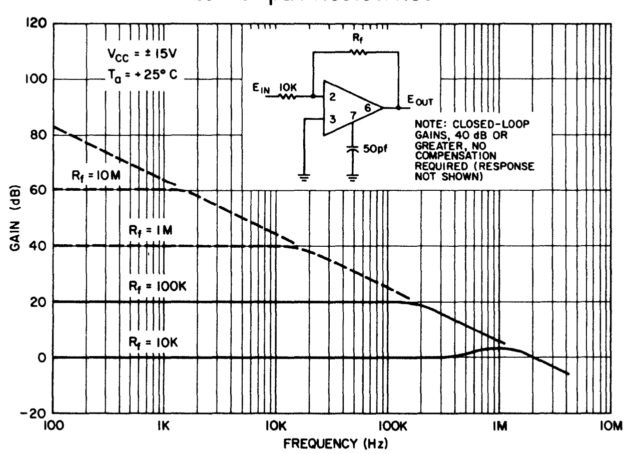
ELECTRICAL CHARACTERISTICS At +25°C and V_{CC} = ±15 V (Unless Otherwise Specified)

PARAMETER	809B			809C			UNITS
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	
Open Loop Voltage Gain (−55°C to +125°C)	10K	40K		10K	40K		v/v
Input Offset Voltage		5.0	10		5.0	10	mV
Input Offset Voltage Drift		10	50		10	50	μV/°C
Input Bias Current		300	500		0.5	1.0	nA
Input Bias Current (−55°C to +125°C) (0°C to 100°C)		 600 	 1500 		 750	 1500	nA
Input Offset Current −55°C 0°C		50	100 250		50	350 500	nA
Input Offset Current Drift		1.0	3.0		1.0		nA/°C
Input Noise Flicker (0.016 to 16 Hz) Midband (1.6 to 160 Hz) Broadband (160 to 16 kHz) 		 10 1.0 2.0 60 1.5 200			 10 1.0 2.0 60 1.5 200		 μV_{p-p} nA_{p-p} μV_{p-p} pA_{p-p} μV_{rms} pA_{rms}
Common Mode Voltage Range	±10	±13		±10	±13		V
Common Mode Rejection Ratio		−90	−70		−90	−70	db
Power Supply Rejection Ratio		−90	−70		−90	−70	db
Input Imepdance	100K	200K		50K	200K		Ohms
Output Voltage Swing (R_L = 5.0 KΩ, V_{CC} = ±15 V)	20	24		20	24		V_{p-p}
Power Dissipation (No Load, V_{CC} = ±15 V)		100	150		100		mW

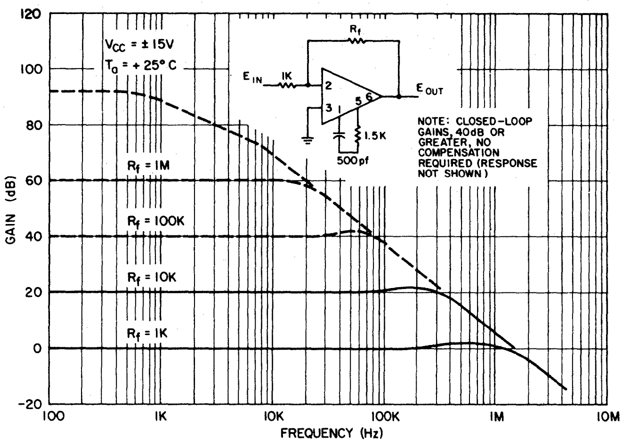
Frequency Response
1K Input Resistance



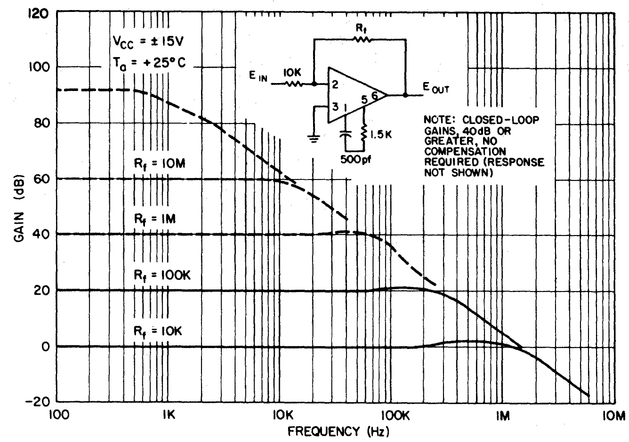
Frequency Response
10K Input Resistance



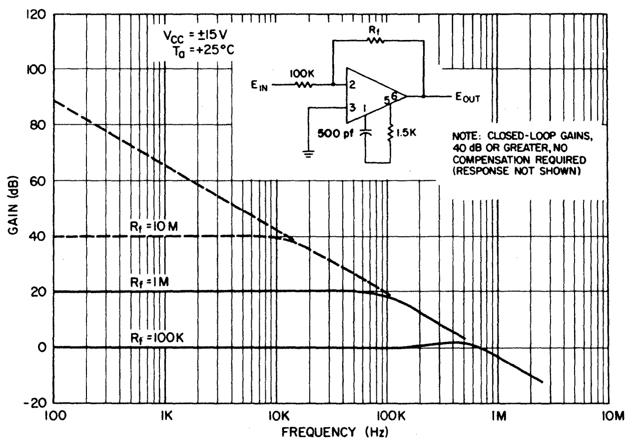
Frequency Response
1K Input Resistance



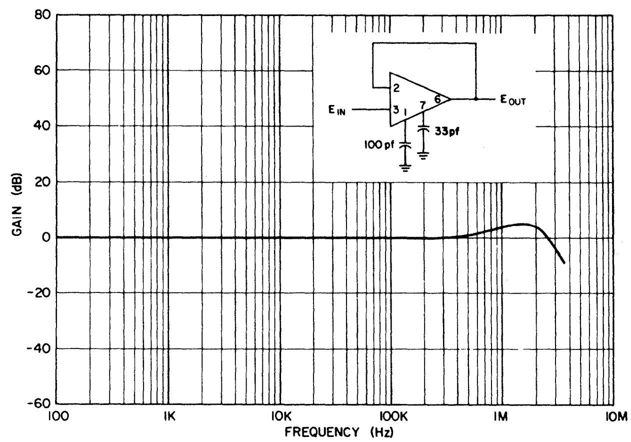
Frequency Response
10K Input Resistance



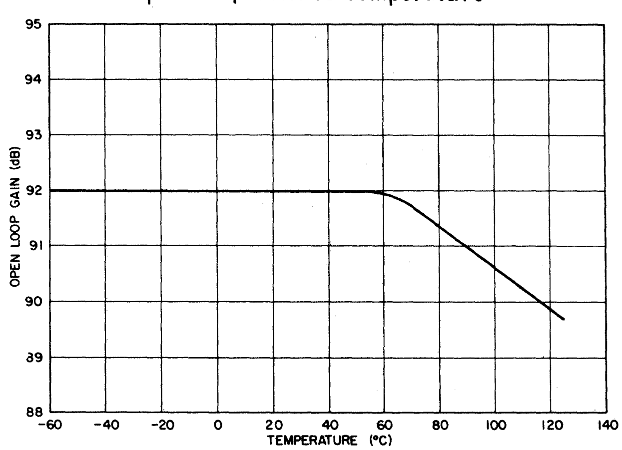
Frequency Response
100K Input Resistance



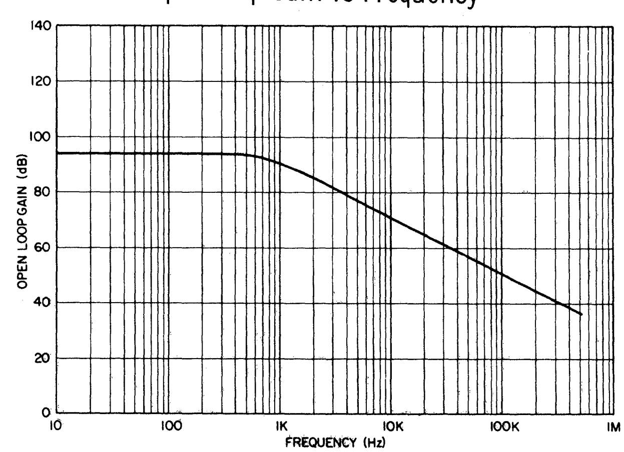
Frequency Response
Voltage Follower



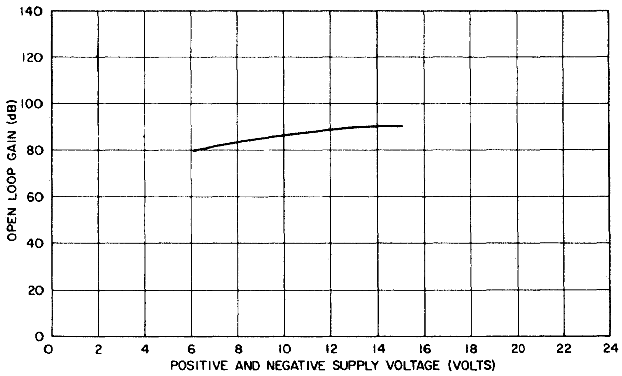
Open Loop Gain vs Temperature



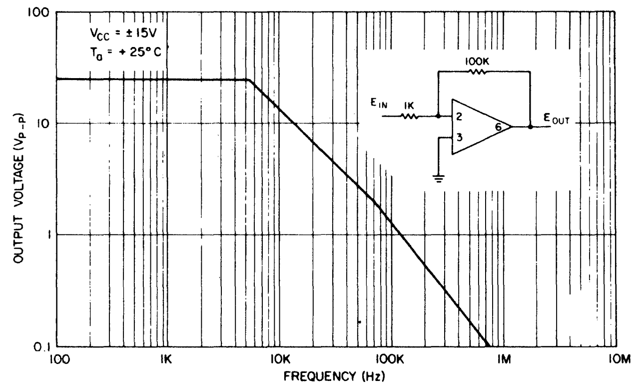
Open Loop Gain vs Frequency



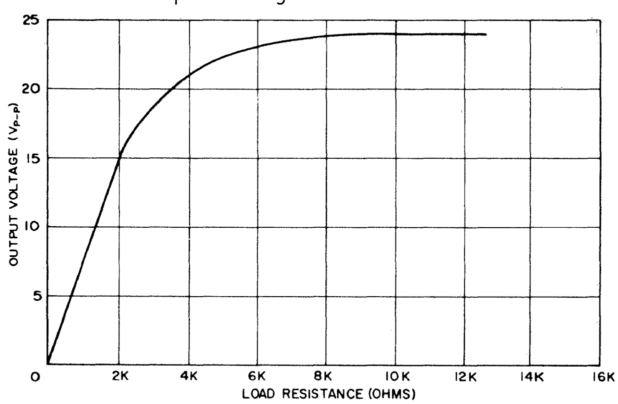
Open Loop Gain vs Positive and Negative Supply Voltage



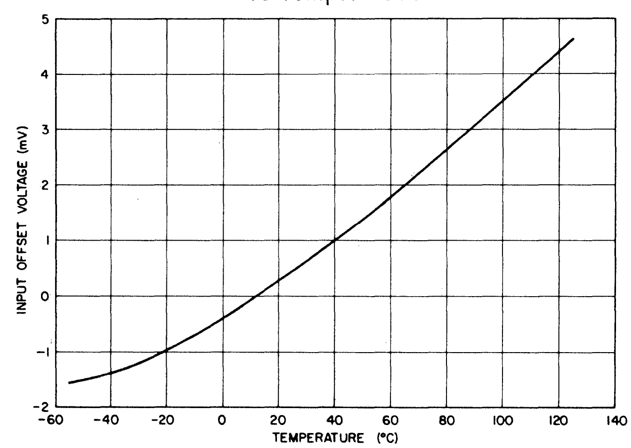
Maximum Output Voltage vs Frequency



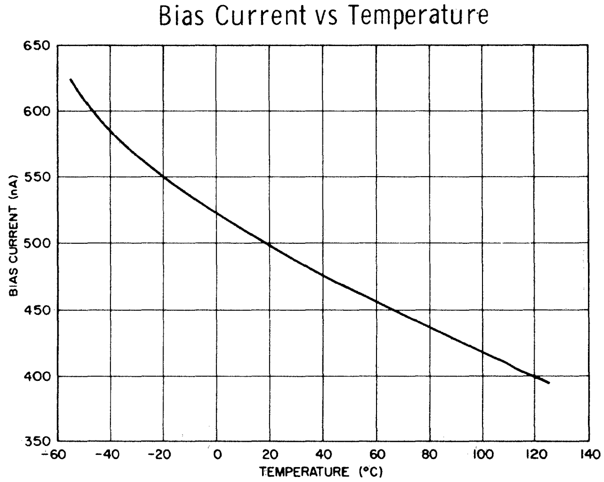
Output Voltage vs Load Resistance



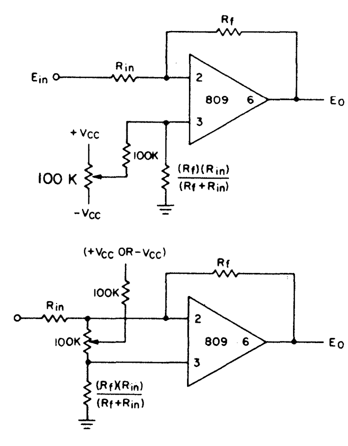
Untrimmed Offset Voltage vs Temperature



Bias Current vs Temperature



SUGGESTED OFFSET ADJUSTMENT

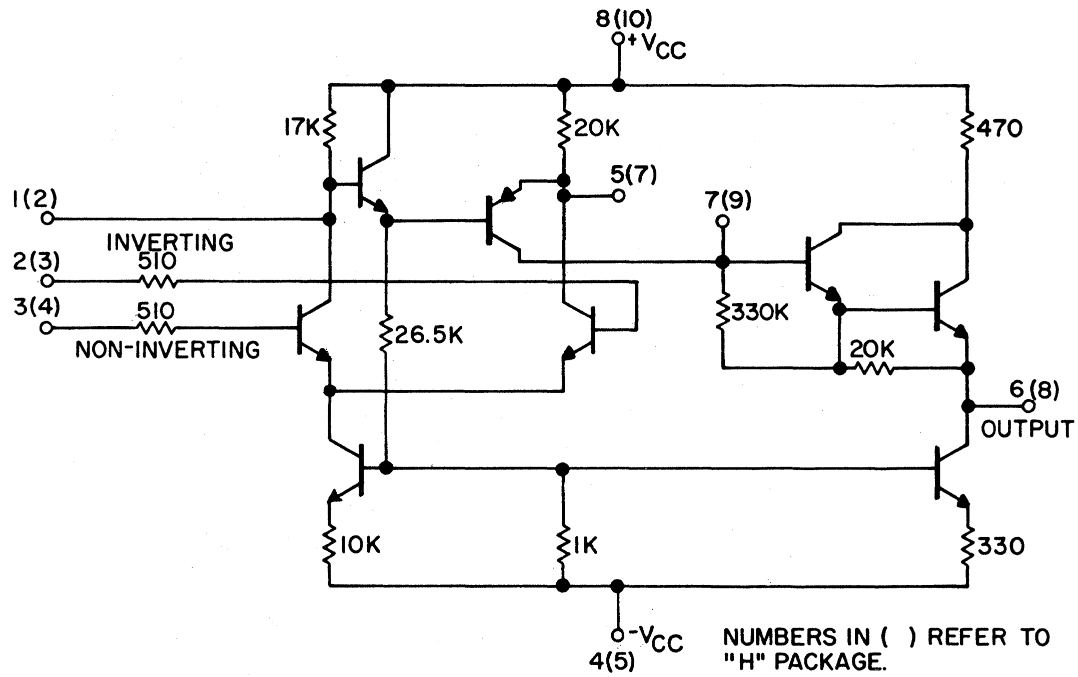


JANUARY 1968

LINEAR CIRCUIT OPERATIONAL AMPLIFIER

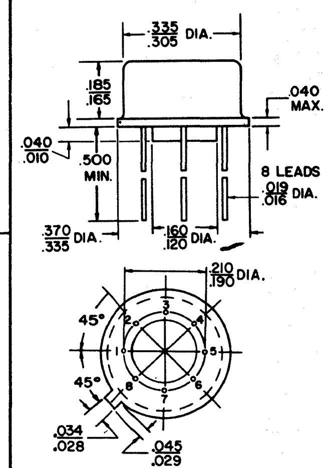
819B

The Amelco 819 Operational Amplifier is constructed on a single monolithic silicon substrate using planar epitaxial techniques. The unique simplicity of this design results in a low cost, high performance amplifier. It is ideally suited for applications requiring high common mode range, high input impedance, and low current and voltage offsets and offset drifts, and low power.



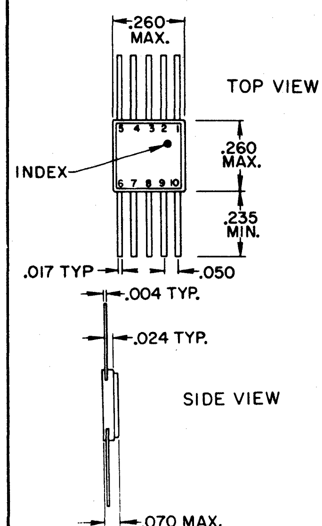
NUMBERS IN ( ) REFER TO "H" PACKAGE.

E PACKAGE



PIN 4 IS INTERNALLY CONNECTED TO CASE

H PACKAGE



ABSOLUTE MAXIMUM RATINGS

Storage Temperature Range	−65°C to +150°C
Operating Temperature Range	−55°C to +125°C
Maximum Supply Voltage	±18 V
Maximum Operating Voltage	±15 V

Complete part number designation consists of three digits and two letters, for example:

819BE
- Package
- Temperature Range
- Type

AMELCO SEMICONDUCTOR 1300 Terra Bella Ave. • Mountain View • Calif. 94040
A TELEDYNE COMPANY PHONE: (415) 968-9241

Printed in U.S.A.

ELECTRICAL CHARACTERISTICS at 25°C and V_{CC} = ±6.0 Volts (Unless Otherwise Specified)

CHARACTERISTIC	MIN.	TYP.	MAX.	UNIT
Open Loop Voltage Gain (−55°C to +125°C)	5.0 K	10 K		V/V
Input Offset Voltage		5.0	10	mV
Input Offset Voltage Drift		70	100	μV/°C
Input Bias Current		300	500	nA
Input Offset Current		50	100	nA
Input Offset Current Drift		1.0	3.0	nA/°C
Common Mode Voltage Range	±4.0	±5.0		Volts
Common Mode Rejection Ratio		−90	−70	db
Power Supply Rejection Ratio		−90	−60	db
Input Impedance	50 K	200 K		Ohms
Output Voltage Swing (R_l = 5.0 K ohms)	8.0	10		V_{p-p}
Power Dissipation (No Load)		15	25	mW

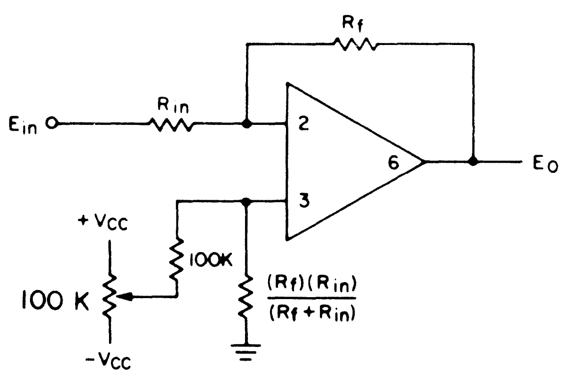
SUGGESTED COMPENSATION TECHNIQUES

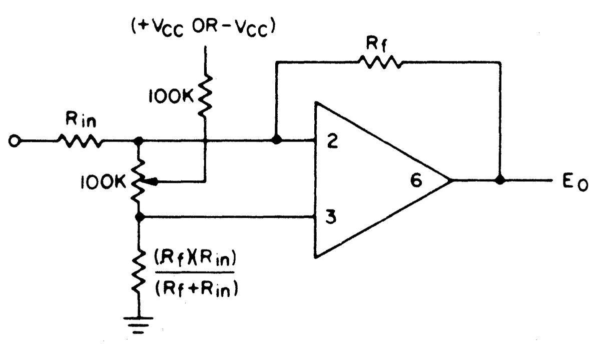
RC Series Network Between Terminal 1 and 5; 1.5 K ohms and 500 pf.

For Minimum Number of Components;
- For 1.0 K ohm Input Non-Inverting Amplifier, A 24 pf Capacitor from Terminal 7 to Ground.
- For 10 K ohm Input Non-Inverting Amplifier, A 50 pf Capacitor from Terminal 7 to Ground.
- For A Voltage Follower Amplifier, A 100 pf Capacitor from Terminal 1 to Ground and a 33 pf Capacitor from Terminal 7 to Ground.

For Applications of Close Loop Gains of 40 db or greater, No Compensation is required.

SUGGESTED OFFSET ADJUSTMENT



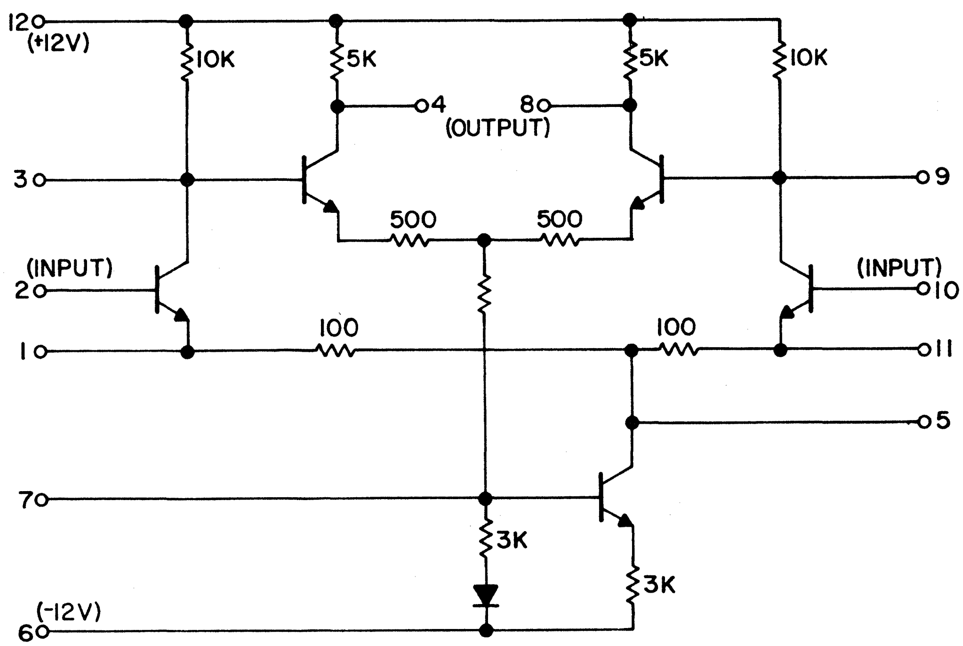


LINEAR CIRCUIT
DIFFERENTIAL AMPLIFIER

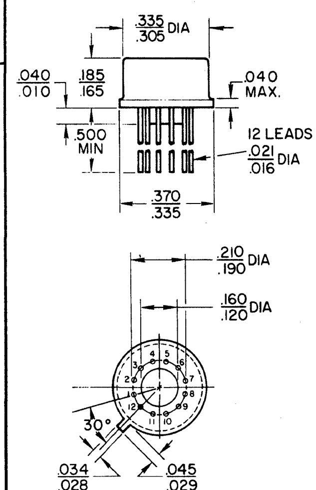
JANUARY 1968

831

This low-level differential amplifier consists of five NPN transistors and associated resistors constructed on a single silicon chip. The amplifier design features tight thermal coupling, close beta and V_{BE} match with common-mode feedback. Because of its design, the amplifier exhibits extremely low drift characteristics and excellent stability over a wide temperature range.



E PACKAGE



PIN 6 IS INTERNALLY CONNECTED TO CASE

TEMPERATURE RANGE:

	831A 831B	831C	831D
Storage	−65°C to +150°C	−65°C to +150°C	−65°C to +150°C
Operating	−55°C to +125°C	−25°C to +85°C	0°C to 70°C

POWER SUPPLY REQUIREMENTS:

+12 Volts at 4.0 mA typical, 5.0 mA maximum
−12 Volts at 4.0 mA typical, 5.0 mA maximum

Complete part number designation consists of three digits and two letters, for example:

831DE
- Package
- Temperature Range
- Circuit

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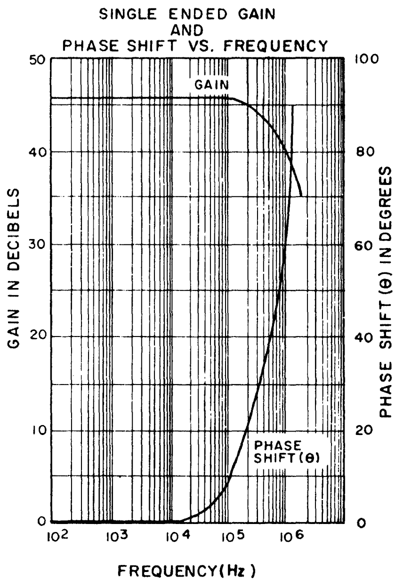
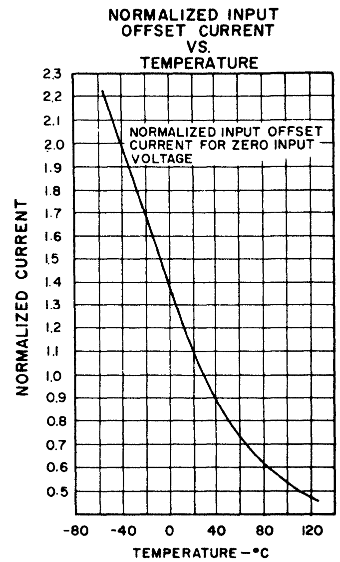
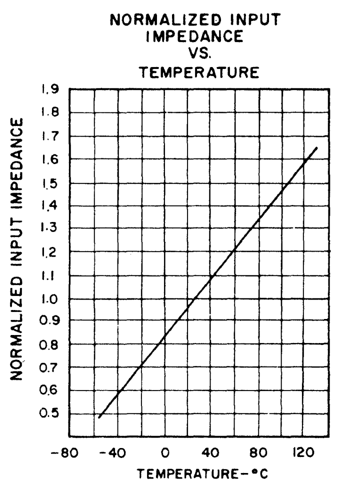
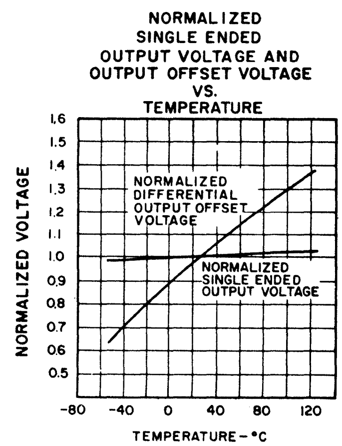
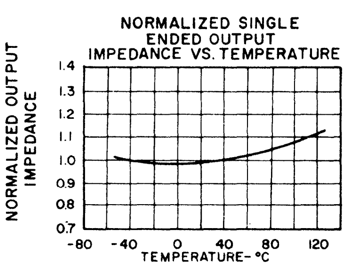
A TELEDYNE COMPANY PHONE: (415) 968-9241

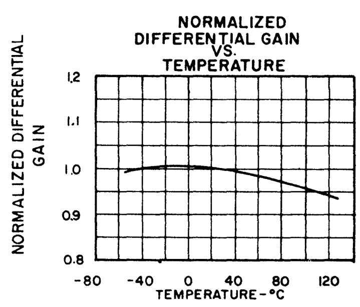

SINGLE ENDED GAIN
AND
PHASE SHIFT VS. FREQUENCY
GAIN
PHASE SHIFT (θ)
GAIN IN DECIBELS
PHASE SHIFT (θ) IN DEGREES
FREQUENCY (Hz)


NORMALIZED INPUT
OFFSET CURRENT
VS.
TEMPERATURE
NORMALIZED INPUT OFFSET
CURRENT FOR ZERO INPUT
VOLTAGE
NORMALIZED CURRENT
TEMPERATURE – °C


NORMALIZED INPUT
IMPEDANCE
VS.
TEMPERATURE
NORMALIZED INPUT IMPEDANCE
TEMPERATURE – °C


NORMALIZED
SINGLE ENDED
OUTPUT VOLTAGE AND
OUTPUT OFFSET VOLTAGE
VS.
TEMPERATURE
NORMALIZED
DIFFERENTIAL
OUTPUT OFFSET
VOLTAGE
NORMALIZED
SINGLE ENDED
OUTPUT VOLTAGE
NORMALIZED VOLTAGE
TEMPERATURE – °C


NORMALIZED SINGLE
ENDED OUTPUT
IMPEDANCE VS. TEMPERATURE
NORMALIZED OUTPUT
IMPEDANCE
TEMPERATURE – °C


NORMALIZED
DIFFERENTIAL GAIN
VS.
TEMPERATURE
NORMALIZED DIFFERENTIAL
GAIN
TEMPERATURE – °C

ELECTRICAL CHARACTERISTICS at 25°C Unless Otherwise Noted

CHARACTERISTICS	831A			831B			831C			831D			UNITS
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	
OUTPUT CHARACTERISTICS Single Ended DC Output Voltage (Both Inputs at Zero Volts)	6.0	7.0	8.0	4.5	7.0	9.5	2.5	7.0	11.5				Volts
Differential Output Offset Voltage[1] (With Zero Input Voltage)		1.0	2.0		2.5	5.0		5.0	9.0				Volts
Differential Output Offset Voltage[1] (Referred to Input)		2.5	5.0		8.0	17		20	40		10	40	mV
Single Ended Dynamic Range (No Load)	6.0	6.8		6.0			5.0			5.0	6.0		Volts
Single Ended Output Impedance		5.0	6.0		5.5	7.0		5.5	7.0		5.5	7.0	KΩ
Mean Differential Output Voltage Drift[2] (Referred to Input) −55°C to +125°C		2.0	4.0		5.0	10							μV/°C
−25°C to +85°C								10					
INPUT CHARACTERISTICS Input Offset Current (Input Voltage = 0)		0.2	2.0		1.0	5.0		1.0	10			2.0	μA
Input Impedance	20	40		10	20		5.0[3]	20		5.0	20		KΩ
Mean Input Offset Current Drift[2] (Input Voltage = 0) −55°C to +125°C		2.0			5.0								nA/°C
TRANSFER CHARACTERISTICS Differential Gain (No Load)	400			300			250[3]			200[3]			
Differential Gain (No Load with Pins 1, 5, and 11 Tied Together)		2000			2000			1500[4]			1500[4]		
Bandwidth (−3 db)	300	400		300	400		200[3]	400		250[3]	400		kHz
Common Mode Rejection (CM Input Voltage = 1.0 V pp, 100 Hz		−100	−90			−80			−60[3]		−80	−60[3]	db
Common Mode Input Range	−2.0		+1.5	−2.0		+1.0	−1.0		+1.0	−1.0		+1.0	Volts
Power Supply Rejection (+12 V or −12 V Supply)	−80		−70		−70	−60		−70			−70	−50	db

NOTES: (1) The differential output offset voltages given are for untrimmed devices. The offset voltage for all devices can be adjusted to zero by means of a trim potentiometer connected across pins 1, 5, and 11 as shown in test circuit for balancing the amplifier.

(2) The mean differential output voltage drift referred to the input is given by

$$\frac{\dfrac{\text{Output Offset Voltage (125°C)}}{\text{Differential Gain (125°C)}} - \dfrac{\text{Output Offset Voltage (−55°C)}}{\text{Differential Gain (−55°C)}}}{(125°C) - (-55°C)}$$

The mean input offset current drift ($V_{in} = 0$) is given by

$$\frac{\text{Input Offset Current (125°C)} - \text{Input Offset Current (−55°C)}}{(125°C) - (-55°C)}$$

(3) When balanced with a 1000 ohm potentiometer across pins 1, 5, and 11.

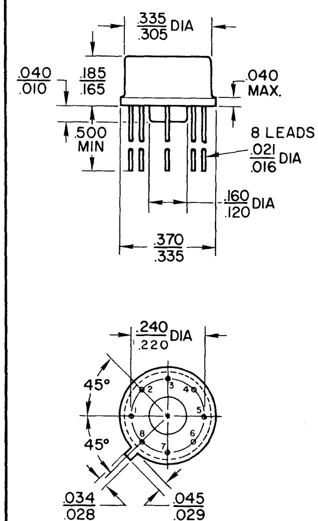
(4) When balanced with a 10 ohm potentiometer across pins 1, 5, and 11.

LINEAR CIRCUIT AMPLIFIER
UHF

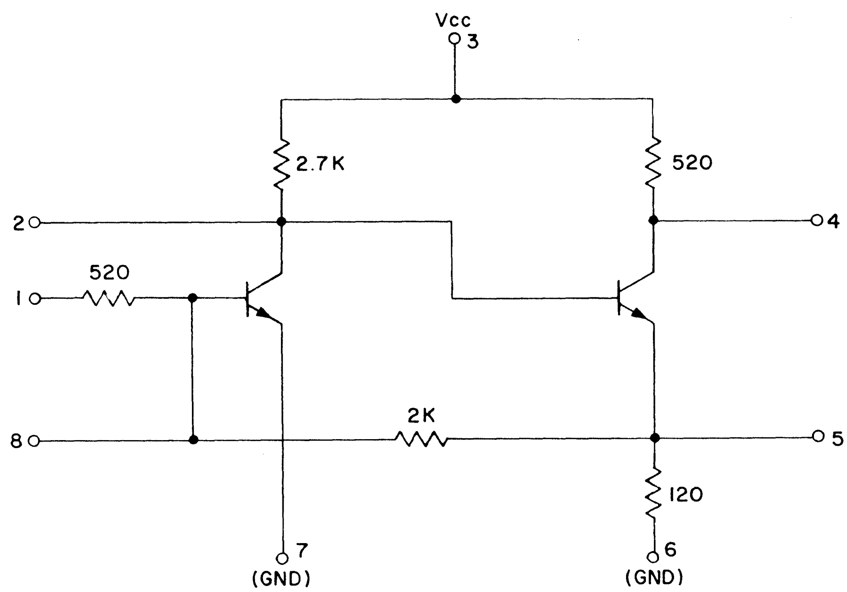
901

The 901BE and 901CE are epitaxial integrated circuits. Precise device design in conjunction with exacting photoetching techniques have resulted in a VHF monolithic amplifier suitable for video and IF amplifier applications in excess of 50 MHz.

E PACKAGE



PIN 7 IS INTERNALLY CONNECTED TO CASE



ABSOLUTE MAXIMUM RATINGS

Total supply voltage between pins 3 and 7	15 volts	
Storage temperature	−65°C to +150°C	
Operating temperature	901BE −55°C to +125°C	901CE 0°C to 70°C

SUPPLY VOLTAGES

Pin 3 to ground	+12 volts, 12 mA Typical

Complete part number designation consists of three digits and two letters, for example:

901BE
- Package
- Grade
- Type

AMELCO SEMICONDUCTOR 1300 Terra Bella Ave. • Mountain View • Calif. 94040

A TELEDYNE COMPANY PHONE: (415) 968-9241

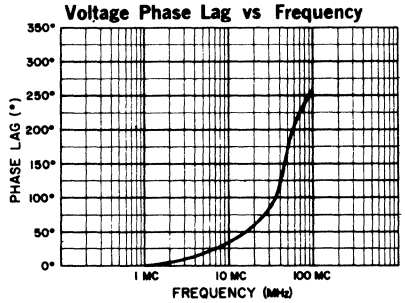
Printed in U.S.A.

ELECTRICAL CHARACTERISTICS at 25°C (Unless Otherwise Noted)

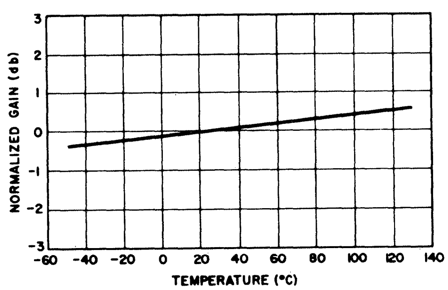
CHARACTERISTICS	MIN.	TYP.	MAX.	UNITS
OUTPUT CHARACTERISTICS Dynamic Range (no load) +25°C Temp*	 5.0 4.0	 7.0		V_{p-p}
Output Impedance		520		Ohms
DC Output Level		8.7		Volts
INPUT CHARACTERISTICS Input Impedance		520		Ohms
Input Signal Level			260	mV_{p-p}
TRANSFER CHARACTERISTICS Voltage Gain	22	24	26	db
Gain Variation Temp*		±0.3		db
Gain Variation (DC to 10 MHz)	−0.5		+0.5	db
Bandwidth (−3.0 db)	40	60		MHz

* Limit applies for "B" grade unit for −55°C to +125°C,
Limit applies for "C" grade unit for 0°C to 70°C.

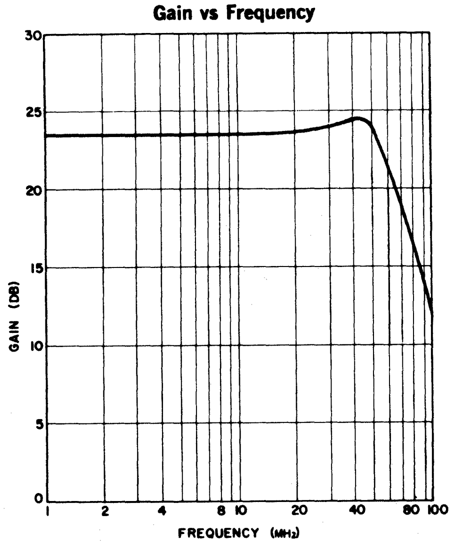
Voltage Phase Lag vs Frequency



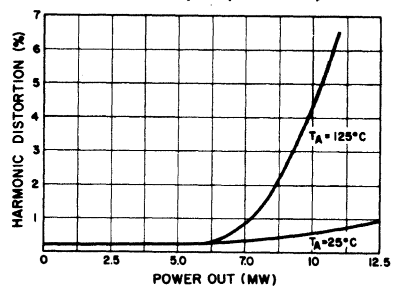
Gain vs Temperature



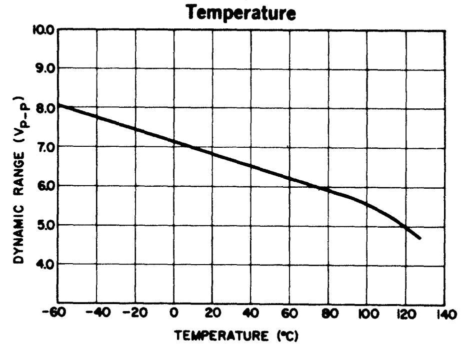
Gain vs Frequency



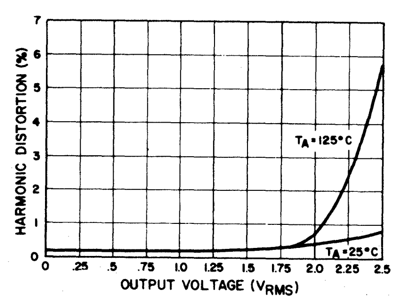
Percent Harmonic Distortion vs Power Output (Milliwatts)



Dynamic Range vs Temperature



Percent Harmonic Distortion vs Output Voltage Swing (RMS)



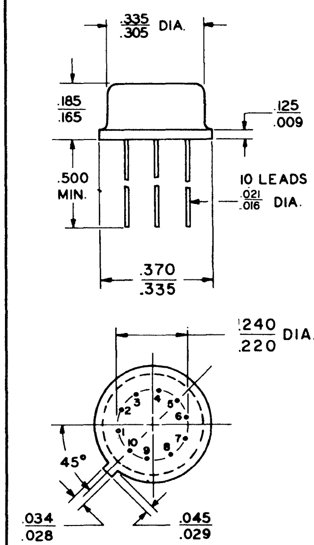
JANUARY 1968

LINEAR CIRCUIT AMPLIFIER UHF

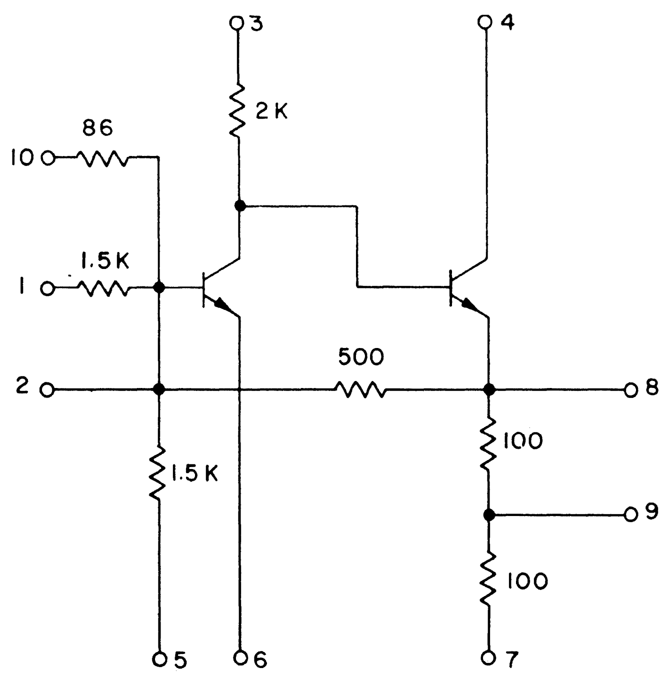
903

The 903BR and 903CR are epitaxial monolithic circuit suitable for oscillator, video and IF amplifier applications, including frequencies in the VHF Band.

R PACKAGE



PIN 6 IS INTERNALLY CONNECTED TO CASE



ABSOLUTE MAXIMUM RATINGS

Storage Temperature	−65°C to+150°C
Operating Temperature 903BR 903CR	−55°C to +125°C 0°C to 70°C
Total supply voltage between pins 4 and 8 (See Test Circuit)	15 Volts

POWER SUPPLY REQUIREMENTS

+12 Volts at 8.0 mA typical	
−6 Volts at 4.0 mA typical	

Complete part number designation consists of three digits and two letters, for example:

903BR
- Package
- Temperature Range
- Circuit

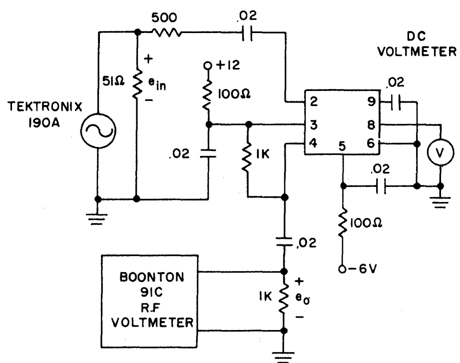
AMELCO SEMICONDUCTOR 1300 Terra Bella Ave. • Mountain View • Calif. 94040
A TELEDYNE COMPANY PHONE: (415) 968-9241

Printed in U.S.A.

ELECTRICAL CHARACTERISTICS at 25°C (Unless Otherwise Noted)

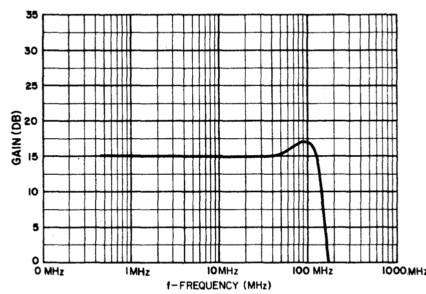
CHARACTERISTICS	MIN.	TYP.	MAX.	UNITS
OUTPUT CHARACTERISTICS Dynamic Range (Note 1) Temp.*	 3.0 2.5	 4.0 3.5		V_{p-p}
DC Level (Pin 8)	2.4	3.0	3.4	Volts
Output Admittance		7.0 0.6	15 1.5	pf mmhos
INPUT CHARACTERISTICS Input Admittance	 −10	 −25 10		 pf mmhos
TRANSFER CHARACTERISTICS Voltage Gain	 13	 15	 17	 db
Bandwidth (−3 db)	60	110		MHz

Note 1: f = 500 kHz measured from pin 4 to Ground (see test circuit)
* Limit applies for "B" grade unit for −55°C to +125°C,
Limit applies for "C" grade unit for 0°C to 70°C.

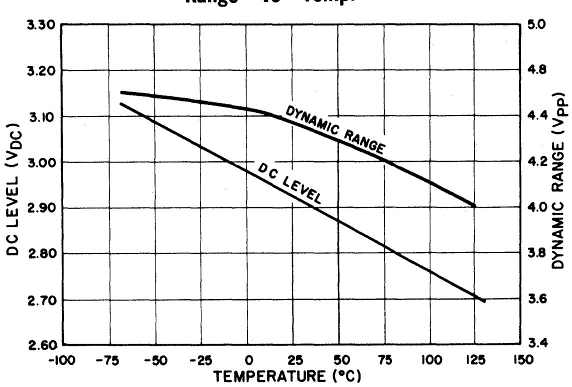


TEST CIRCUIT I

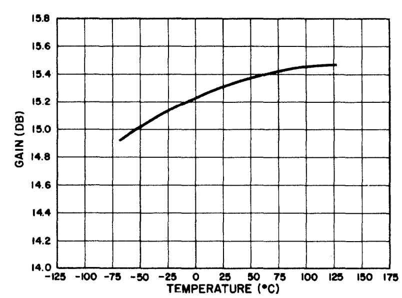
Gain vs Freq.



DC Level & Dynamic Range vs Temp.



Gain vs Temp.



JANUARY 1968

LINEAR CIRCUIT
RF/IF AMPLIFIER

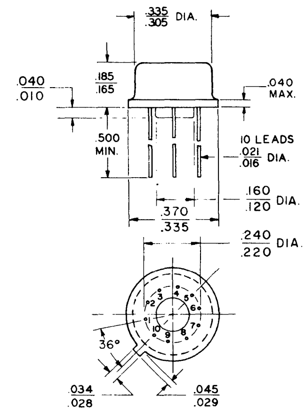
911C

This versatile high frequency device may be used as:

- Tuned Emitter Coupled Amplifier
- Tuned Cascode Amplifier with AGC
- Mixer
- Modulator
- Oscillator
- Video Amplifier
- Differential DC Amplifier
- Numerous other applications

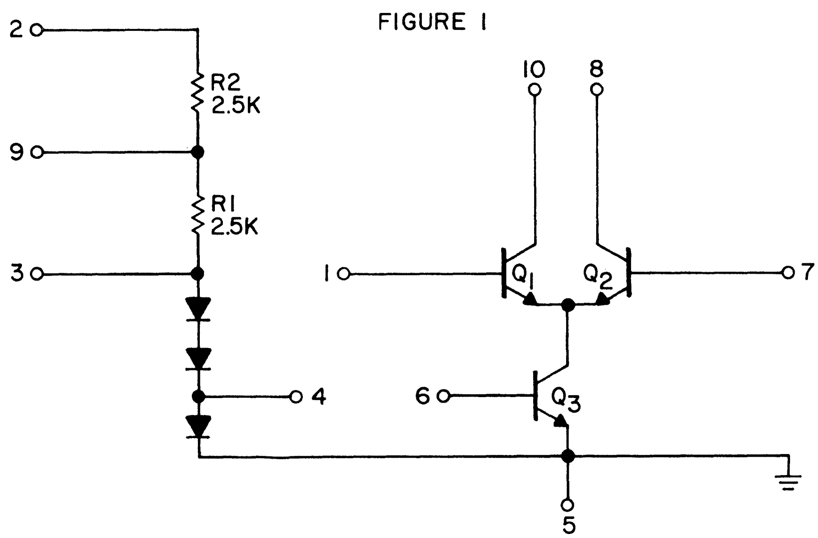
Available terminals allow the user to tailor the amplifier to his requirements, including selection of biasing configuration.

E PACKAGE



PIN 5 IS INTERNALLY CONNECTED TO CASE

FIGURE I



ABSOLUTE MAXIMUM RATINGS

	911B	911C
Total Supply Voltage	30 Volts	30 Volts
Storage Temperature	−65°C to +150°C	−65°C to +150°C
Operating Temperature	−55°C to +125°C	0 to 100°C
Maximum Operating Voltage	24 Volts	24 Volts
Power Dissipation	230 mW	230 mW
Voltage between 1 and 7	±5 Volts	±5 Volts
Voltage between 4 and 6	±5 Volts	±5 Volts

Complete part number designation consists of three digits and two letters, for example:

911 CE
- Package
- Grade
- Type

AMELCO SEMICONDUCTOR 1300 Terra Bella Ave. • Mountain View • Calif. 94040

A TELEDYNE COMPANY PHONE: (415) 968-9241

ELECTRICAL CHARACTERISTICS AT +25°C & Vcc = + 12 V. (Unless Otherwise Specified)

PARAMETER	SYMBOL	TEST CONDITIONS	BIAS	FIG.	MIN.	TYP.	MAX.	UNITS
DC CHARACTERISTICS								
DC Output Voltage	VoDC	ein = 0	d	27	4.5		9.5	V_{DC}
Power Supply Drain Current	IPS	ein = 0	d	27		8.0	10	mA
Input Offset Voltage	Vio	$I_8 = I_{10}$	b	27		0.3	5.0	mV
EMITTER COUPLED CHARACTERISTICS (Input Signal < 10 mv RMS)								
Input Conductance	G_{11}	455 kHz	b	16		0.30	0.40	mmhos
Output Conductance	G_{22}	455 kHz	b	16		0.01	0.04	mmhos
Magnitude of Forward Transadmittance	$\lvert Y_{21} \rvert$	455 kHz	b	16	17	22		mmhos
Magnitude of Reverse Transadmittance	$\lvert Y_{12} \rvert$	200 MHz	b	16		0.1		mmhos
Tuned Power Gain	Ap	10.7 MHz, BW = 470 kHz	b	16		24.6		db
Tuned Power Gain	Ap	100 MHz, BW = 5 MHz	b	16		22.7		db
CASCODE CHARACTERISTICS (Input Signal < 10 mv RMS)								
Input Conductance	G_{11}	455 kHz	b	5		1.0	2.5	mmhos
Output Conductance	G_{22}	455 kHz Connect pin 1 to 7	b	5		0.01	0.04	mmhos
Magnitude of Forward Transadmittance	$\lvert Y_{21} \rvert$	455 kHz Pin 1 grounded	b	5	25	40		mmhos
Magnitude of Reverse Transadmittance	$\lvert Y_{12} \rvert$	200 MHz	b	5		0.001		mmhos
Tuned Power Gain	Ap	100 MHz Pin 1 grounded BW = 5 MHz	b	5		27.5		db
Tuned Power Gain	Ap	200 MHz Pin 1 grounded BW = 6 MHz	b	5		25		db

Total Supply Current vs Supply Voltage

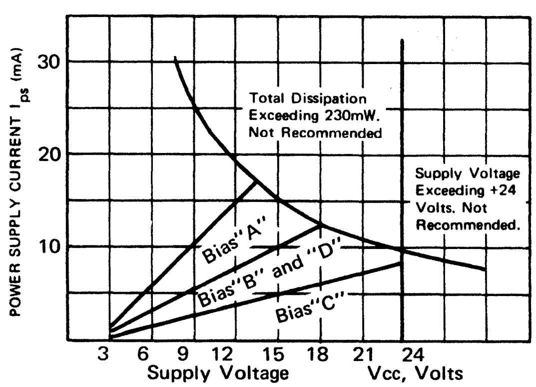


FIGURE 2

Current Source - Diode Current Ratio vs Current Forced Through Diode Chain

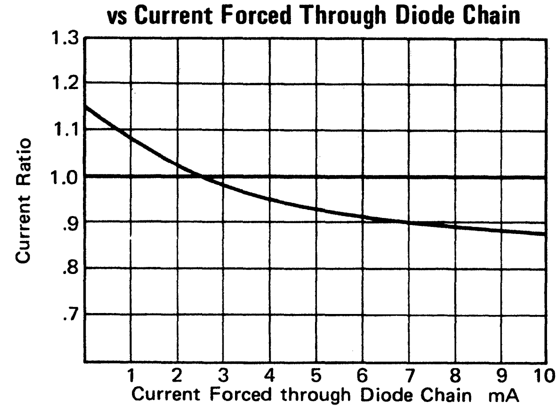


FIGURE 3

BIASING CONSIDERATIONS

DC biasing of the 911 is achieved through monolithic matching of diode-transistor characteristics. Combinations of resistors R1 and R2 may be chosen to force a desired current from Vcc to ground through a three diode chain. If pin 4 is connected to pin 6 directly, through an inductor, or resistor having DC resistance less than 100 ohms, approximately the same current will be established in Q3 as is forced in the diode chain. (See figure 3.)

A DC reference voltage appears at pin 3, which may be used to bias the differential amplifier bases, pins 1 and 7. (See figure 4.) The reference voltage is approximately the minimum voltage required to operate the current source transistor, permitting maximum available output voltage swing in Q1 and Q2 under all conditions.

Currents other than those forced by the internal resistance may be obtained from a given supply voltage with an external resistance from Vcc to pin 3, but care should be taken not to exceed the rated maximum total dissipation. (See figure 2.)

DC Reference Voltage (Pin 3 to 5) vs Diode Chain Current and Supply Current

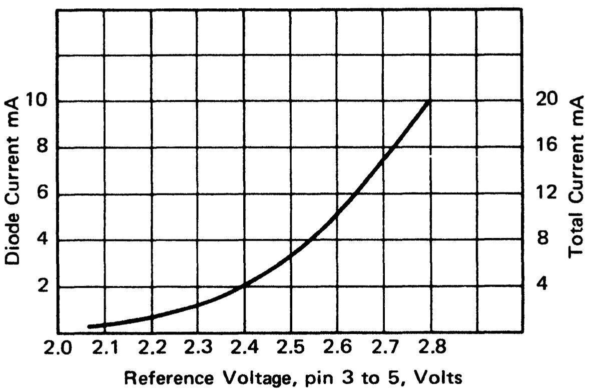


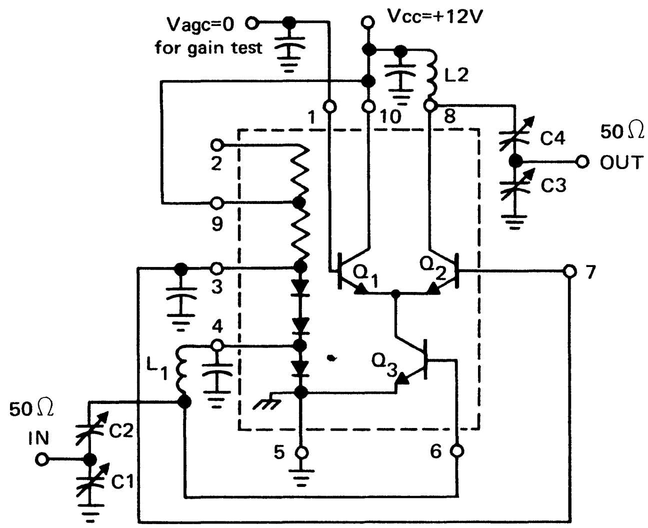
FIGURE 4

Definition of Bias Configurations

BIAS	CONNECT	TYP. BIAS RESISTANCE
a	2 to 3, Vcc to 9	1.25 kΩ
b	Vcc to 9	2.5 kΩ
c	Vcc to 2	5.0 kΩ
d*	2 to 8, Vcc to 9	2.5 kΩ

* Bias "d" is the "General Purpose Amplifier" Configuration, with R_2 as collector load.

100 MHz Cascode Test Circuit



C_1=C_3 = 9-36 pf trimmer L_1=L_2= 7t. #16 a.w.g.
C_2=C_4 = 2-8 pf trimmer spaced 1 turn, ¼" inside diam.

FIGURE 5

CASCODE OPERATION

The common-emitter, common-base, or cascode, configuration is useful as a tuned RF or IF amplifier to 250 MHz. Two common-base stages are formed by the differential pair, Q1 and Q2, which may be used as a gain control system by applying a differential gain control voltage between pins 1 and 7. (Figures 11 and 13.) With Q1 cut off, maximum gain is obtained, being reduced as Q1 is progressively turned on and Q2 turned off. The input common-emitter transistor presents a nearly constant input admittance as AGC is applied (Figure 12.)

DC input bias is obtained through the input inductor from the bias chain, pin 4.

Pin 3 may be used as the DC reference for the AGC input, to assure adequate bias voltage for the collector of Q3. Where large AGC voltages are used, an external resistive divider, from pin 3 to 1 to the AGC voltage may be used to optimize the DC AGC requirements. VAGC is defined as the voltage between pin 1 and 7.

At some frequencies, bypassing may be required at pins 1, 3, 4 or the Vcc connection.

Input Resistance & Capacitance vs Frequency

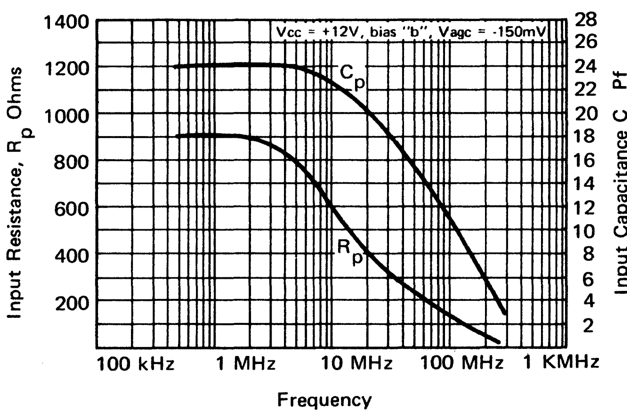


FIGURE 6

Output Resistance & Capacitance vs Frequency

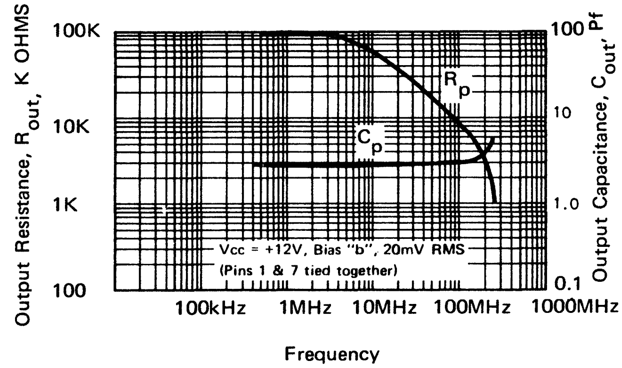


FIGURE 7

Input Resistance & Capacitance vs Vcc

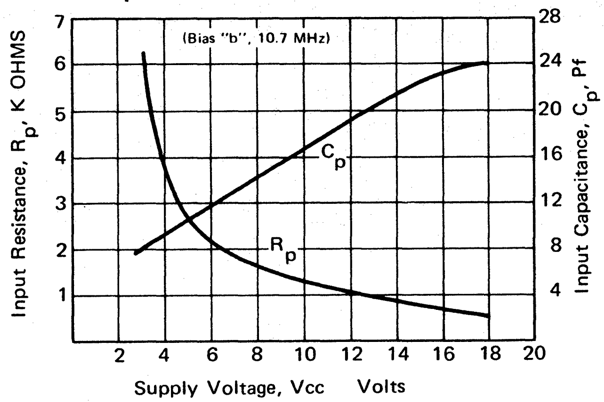


FIGURE 8

Output Resistance & Capacitance vs Vcc

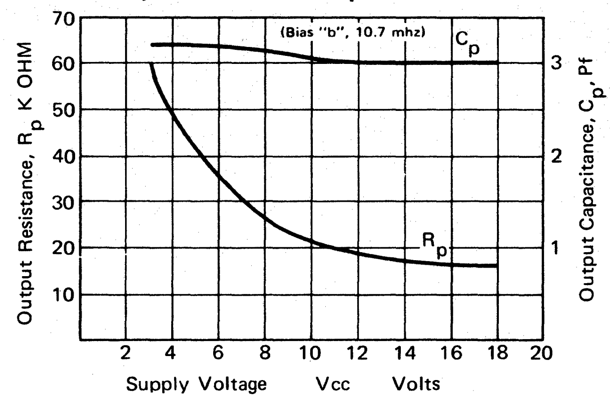


FIGURE 9

Forward Transadmittance vs Frequency

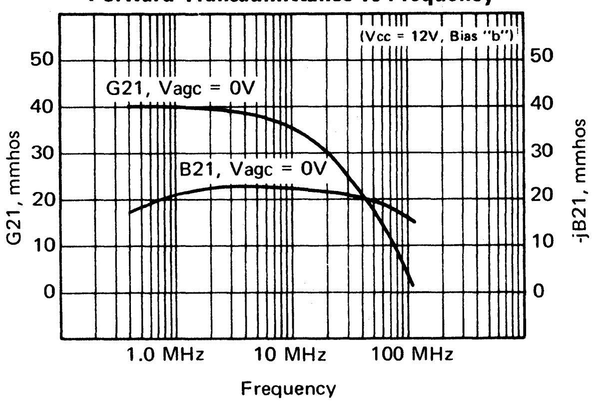


FIGURE 10

Forward Transadmittance vs AGC Voltage

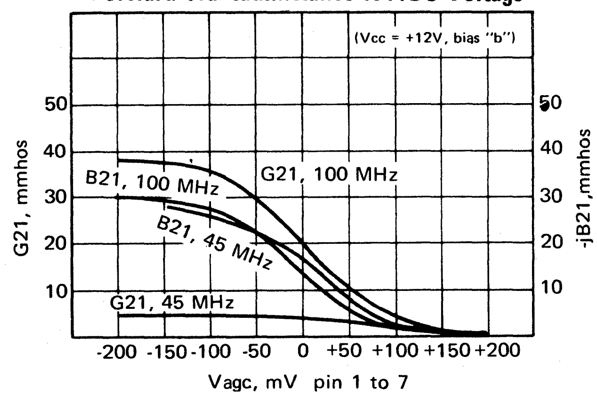


FIGURE 11

Input Resistance & Capacitance vs AGC Voltage

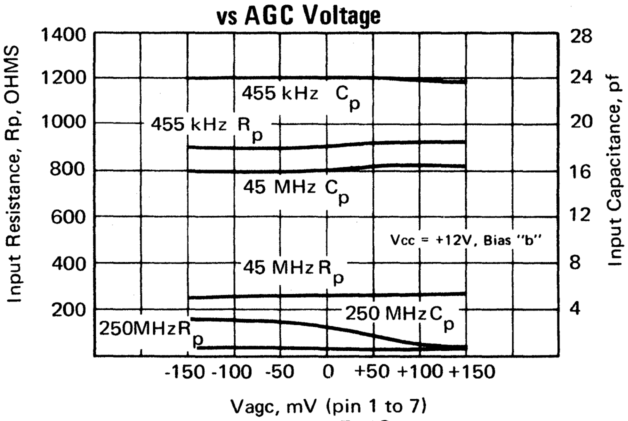


FIGURE 12

Tuned Power Gain vs AGC Voltage

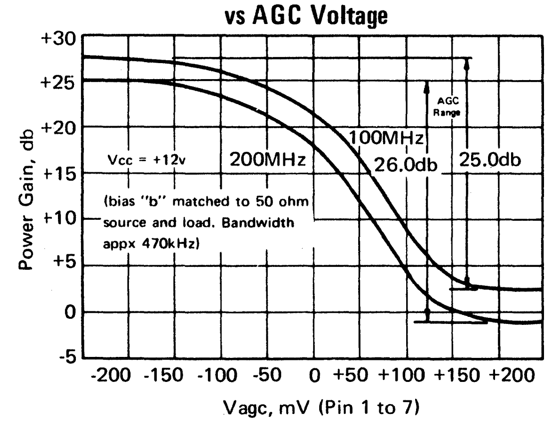


FIGURE 13

Noise Figure vs Frequency

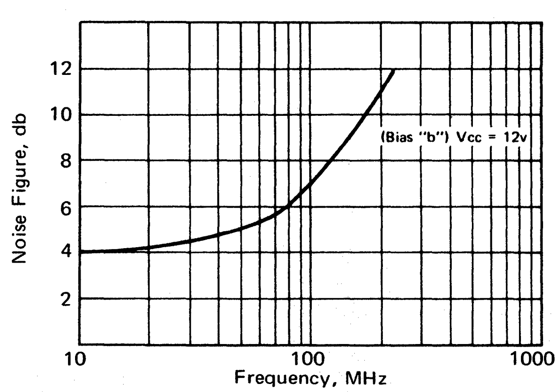


FIGURE 14

Noise Figure & Optimum Source Resistance vs Vcc

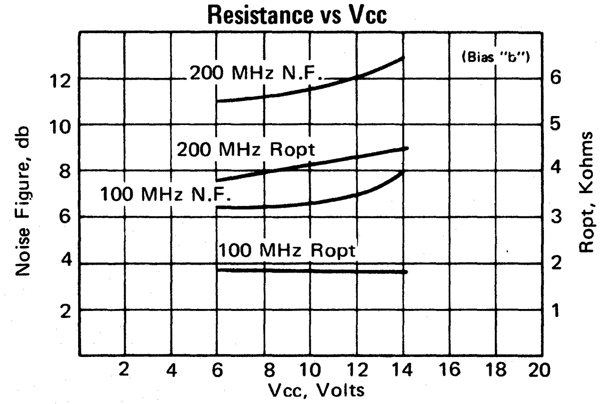


FIGURE 15

EMITTER COUPLED OPERATION

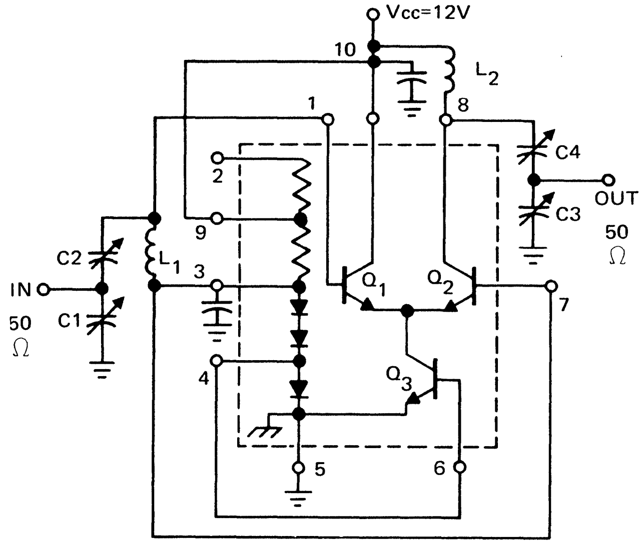
The common-collector, common-base, or emitter-coupled configuration is useful as a symmetrically non-saturated limiting RF or IF amplifier to 150 MHz. Basically a differential amplifier, this configuration is especially suited to FM IF strips using conventional interstage tuning. While available gain is lower and noise figure higher than the cascode, emitter coupled operation may be considered wherever fast recovery from large-signal overdrive or excellent AM rejection is required.

Q3 is used as a current source, obtaining its bias from the diode chain. Current available from Q3 is shunted through Q1 or Q2, depending on input signal, and is equally divided when no signal is present, assuring inherently symmetrical operation. DC bias for pin 7 is obtained from the divider chain, and through the input inductor, the same bias is applied to pin 1.

For non-saturated operation, the output load must be chosen so that the collector voltage of the output transistor is higher than the DC reference voltage, with all source current shunted into the output, for the particular bias levels used.

At some frequencies, bypassing of pins 3, 6, 7, or the Vcc connection may be required.

100 MHz Emitter Coupled Test Circuit



$C_1=C_3$ = 9-36 pf trimmer
$C_2=C_4$ = 2-8 pf trimmer

$L_1=L_2$= 7t. #16 a.w.g. spaced 1 turn, ¼" inside diam.

FIGURE 16

Input Resistance & Capacitance vs Frequency

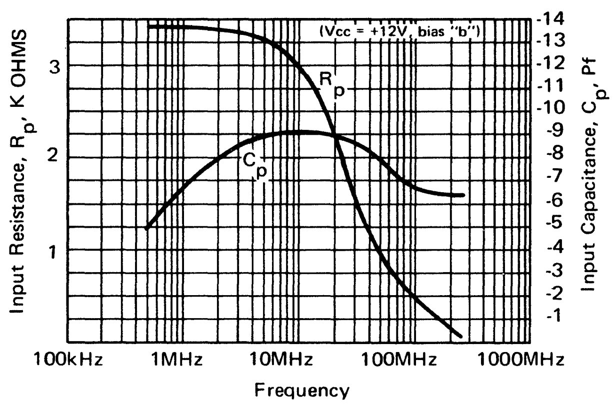


FIGURE 17

Output Resistance & Capacitance vs Frequency

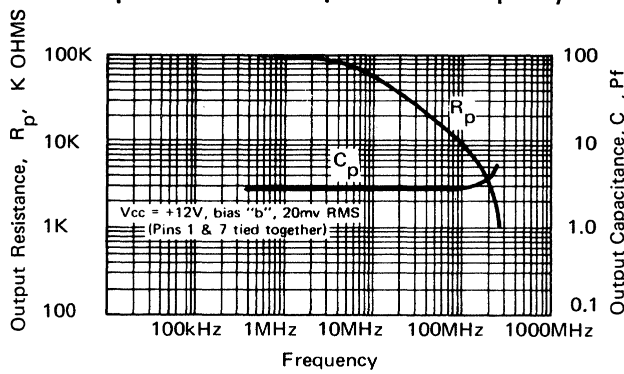


FIGURE 18

Input Resistance & Capacitance vs Vcc

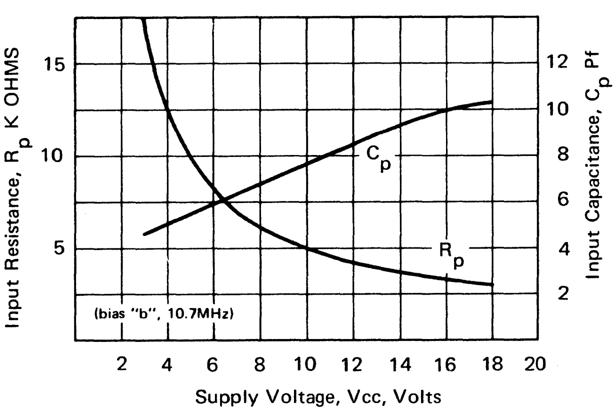


FIGURE 19

Output Resistance & Capacitance vs Vcc

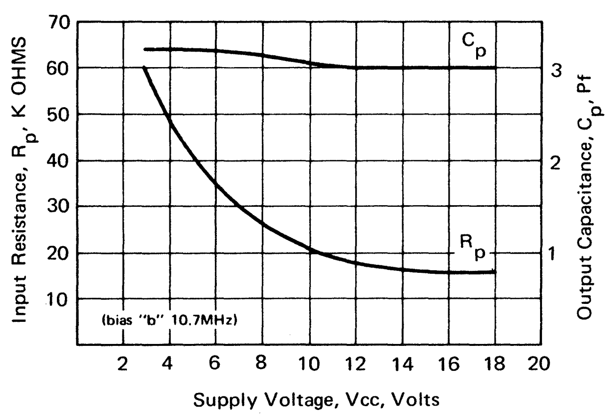


FIGURE 20

Forward Transadmittance vs Frequency

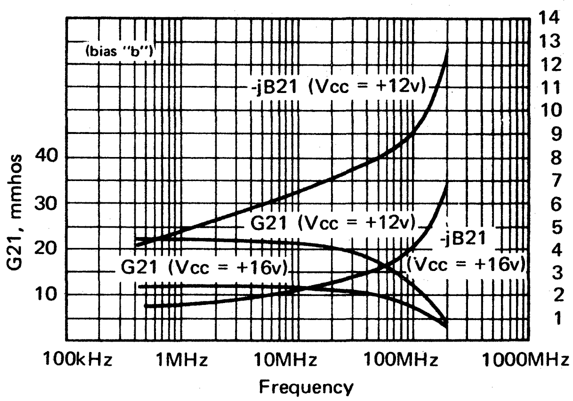


FIGURE 21

Forward Transadmittance vs Vcc

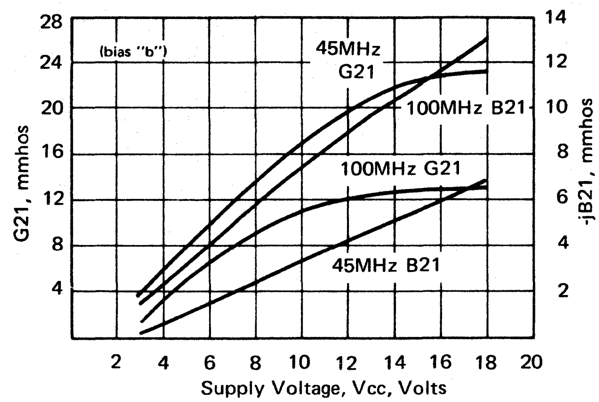


FIGURE 22

Input Resistance & Capacitance vs Input Signal Level

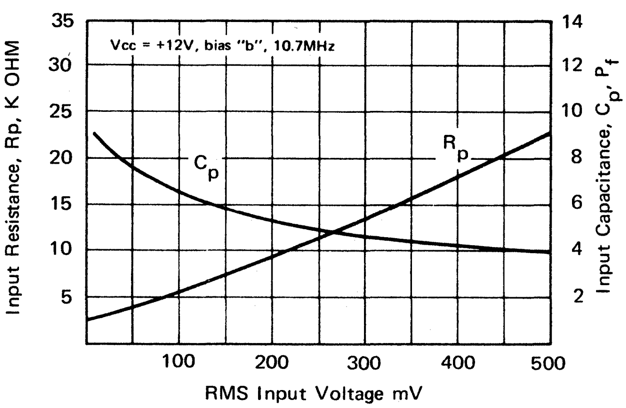


FIGURE 23

Limiting Characteristic
Output Power vs Input Power

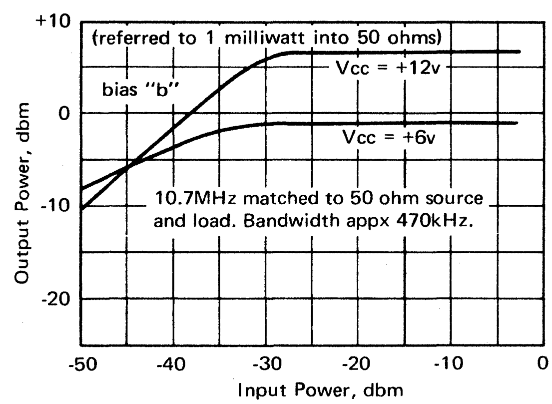


FIGURE 24

Noise Figure vs Frequency

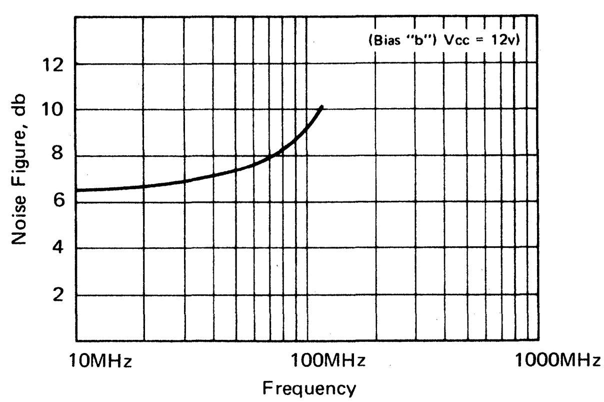


FIGURE 25

Noise Figure & Optimum Source Resistance vs Vcc

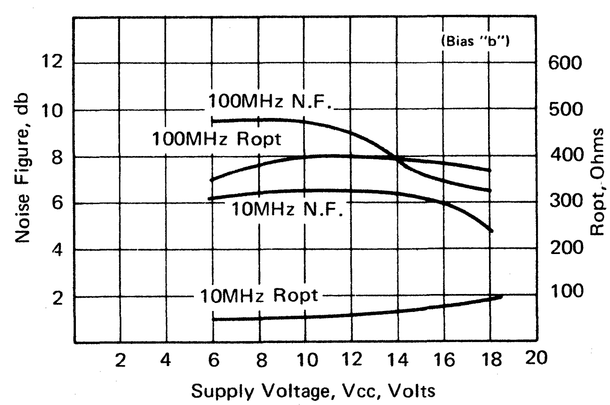


FIGURE 26

DIRECT COUPLED OPERATION

Convenient self-contained biasing, excellent monolithic matching, and high gain-bandwidth product make a wide variety of applications possible using resistive loads.

Bias "d", the "General Purpose Amplifier", uses R2 as collector load for a single-ended output, differential input amplifier, with no external components required, and with large dynamic range for all supply voltages.

By choosing the proper external load resistor, bias configuration, and supply voltage, video amplifiers may be constructed to meet specific gain and bandwidth requirements, in either cascode or emitter coupled form.

With matched pairs of external load resistors, true differential DC amplifiers may be constructed, with large common-mode input range, input offset voltages typically 0.3 mV, and monolithically matched, self-contained current sources easily tailored to specific operating point requirements.

Direct Coupled Test Circuit (Connect Pins 2 and 8 For Bias "d")

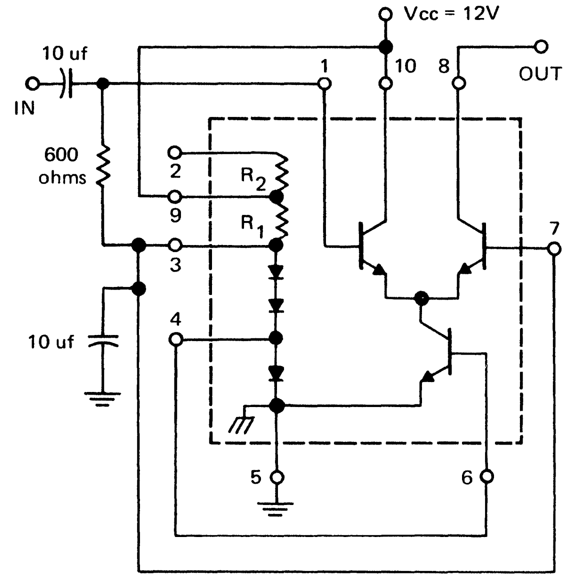


FIGURE 27

General Purpose Amplifier Voltage Gain, DC Output Voltage & Dynamic Range vs Vcc

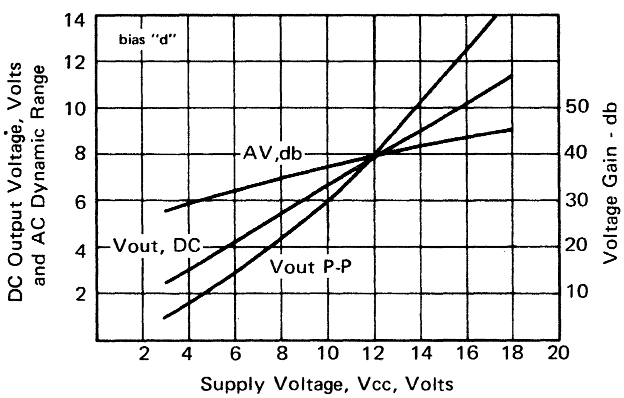


FIGURE 28

Cascode & Emitter Coupled Video Amplifiers Voltage Gain & Load Resistance vs Bandwidth

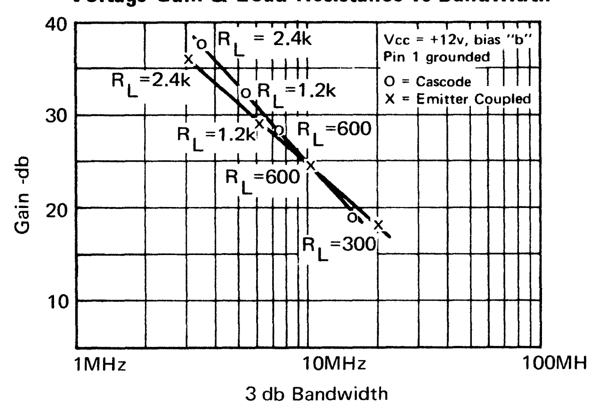


FIGURE 29

Cascode & Emitter Coupled Video Amplifiers Dynamic Range vs Load Resistance

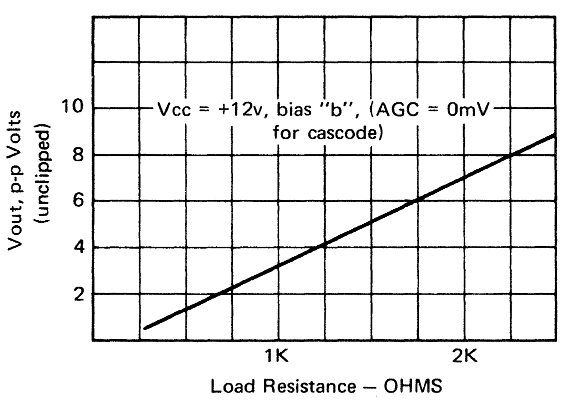


FIGURE 30

Cascode Video Amplifier Voltage Gain & Dynamic Range vs AGC Voltage

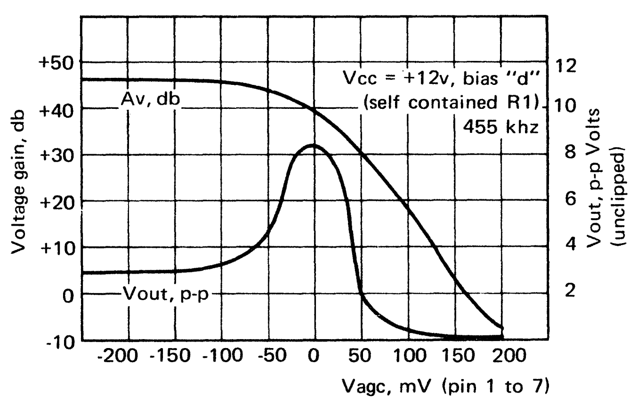


FIGURE 31

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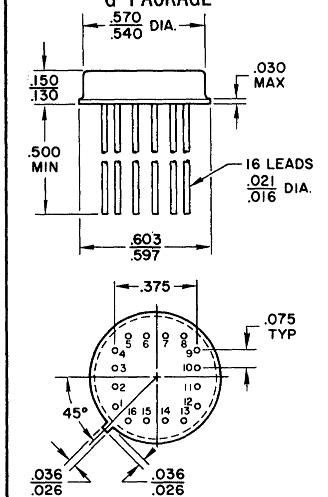
DIGITAL CIRCUIT
HIGH NOISE IMMUNITY LOGIC

300 SERIES

High Noise Immunity Logic (HNIL) is ideally suited for applications requiring maximum noise immunity and excellent line driving capability. A sixteen pin package and complex logic functions result in a minimum number of packages per system. Buffered outputs on all elements and 12 volt logic swings eliminate the necessity for interface circuitry in most applications. This logic family is also available in 15 volt logic levels as special order.

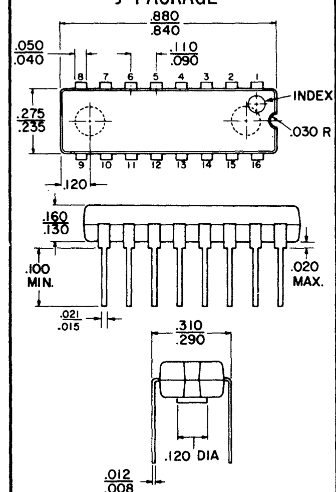
DUAL 5 INPUT BUFFER
QUAD 2 INPUT "OR" ABLE BUFFER
QUAD 2 INPUT GATE
QUAD 2 INPUT "OR" ABLE GATE
DUAL 5 INPUT GATE
DUAL 5 INPUT EXPANDER
DUAL EXCLUSIVE-OR
RST FLIP-FLOP
DUAL JK FLIP-FLOP
QUAD "D" FLIP-FLOP
DUAL ONE SHOT
DUAL INPUT INTERFACE
DUAL OUTPUT INTERFACE

G PACKAGE



BOTTOM VIEW

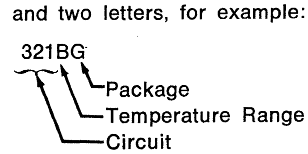
J PACKAGE



ABSOLUTE MAXIMUM RATINGS

Storage Temperature Range	−65°C to +150°C
Operating Temperature Range 300 B 300 C	 −55°C to +125°C −30°C to +100°C
Lead Temperature, 1/16 inch from case, 10 seconds maximum	 300°C
Supply Voltage - Continuous	+15 Volts
Supply Voltage - Continuous	+10.5 Volts min.
Supply Voltage - Pulsed < 0.1 second	+18 Volts
Input Voltage - (exclusive of expanders)	−0.5 V to +15 Volts
Input Voltage - expanders	0 V to +6.0 Volts
Input Voltage, (RTL inputs, 362)	5.0 Volts
Voltage applied to output	−0.5 V to +13.0 Volts
Sink Current at $T_A = 25°C$, continuous 301 & 302 All other types	 80 mA 15 mA
Surge Sink Current at $T_A = 25°C$, <1 sec. 301 & 302 All other types	 100 mA 20 mA
Output Short Circuit Duration to GND	Continuous
Input Current, (RTL inputs, 362)	10 mA

Complete part number designation consists of three digits and two letters, for example:



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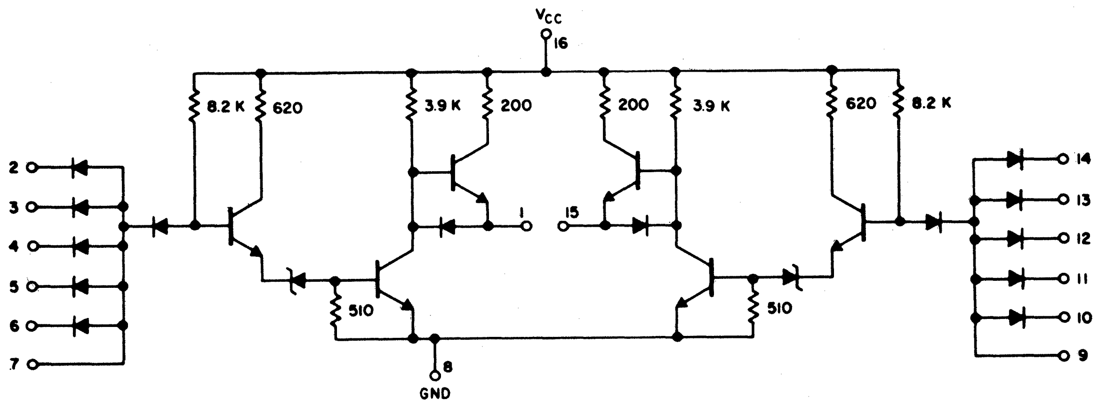
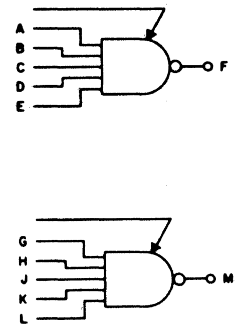
DUAL 5 INPUT BUFFER

HIGH FAN-OUT
60 mA CAPABILITY

301





$F = \overline{A \cdot B \cdot C \cdot D \cdot E}$
$M = \overline{G \cdot H \cdot J \cdot K \cdot L}$

LIMITS	301 B			301 C			
	−55°C	+25°C	+125°C	−30°C	+25°C	+100°C	
V_{OH}	10.5	10.5	10.5	10.5	10.5	10.5	Volts min.
V_{OH}		11.3			11.3		Volts typ.
V_{OHL}	7.0	7.0	7.0	7.0	7.0	7.0	Volts min.
V_{OHL}		8.0			8.0		Volts typ.
V_{OL} @ I_{OL1}	1.6	1.5	1.5	2.0	1.8	1.8	Volts max.
V_{OL} @ I_{OL1}		1.2			1.2		Volts typ.
V_{OL} @ I_{OL2}				1.6	1.5	1.5	Volts max.
I_{IL}	−1.9	−1.7	−1.5	−1.9	−1.7	−1.6	mA max.
I_{IL}		−1.2			−1.2		mA typ.
I_L	1.0	1.0	100	1.0	1.0	100	μA max.
I_L		0.05			0.05		μA typ.
T_{PD} (2−1+)	80	100	180	90	100	160	nsec typ.
T_{PD} (2+1−)	70	80	90	75	80	90	nsec typ.
I_{PS} (inputs open)		40			40		mA max.

CONDITIONS							
V_{CC}	12	12	12	12	12	12	Volts
V_{IH}	6.5	6.5	6.5	6.5	6.5	6.5	Volts
V_{IL}	5.0	5.0	5.0	5.0	5.0	5.0	Volts
I_{OL1}	68	60	54	68	60	54	mA
I_{OL2}				45	40	38	mA
I_{OH}	−15	−15	−15	−15	−15	−15	mA

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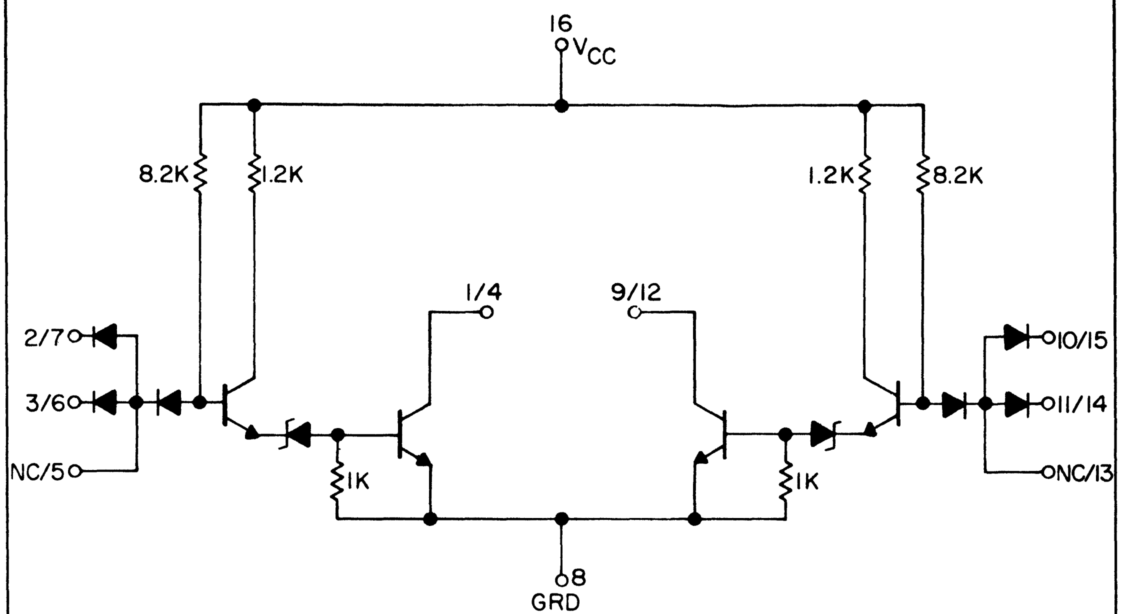
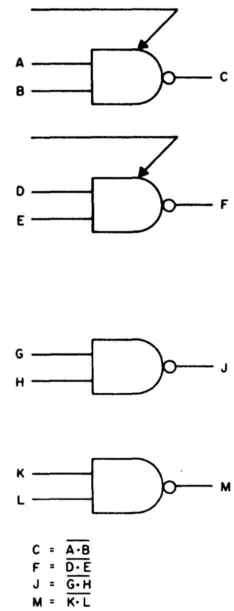
QUAD 2 INPUT BUFFER

COLLECTOR - "OR" ABLE
HIGH FAN-OUT
60 mA CAPABILITY

302





LIMITS	302 B			302 C			
	−55°C	+25°C	+125°C	−30°C	+25°C	+100°C	
V_{OL} @ I_{OL1}	1.2	1.2	1.2	1.2	1.2	1.2	Volts max.
V_{OL} @ I_{OL1}		0.8			0.8		Volts typ.
V_{OL} @ I_{OL2}	0.5	0.5	0.5	0.5	0.5	0.5	Volts max.
V_{OL} @ I_{OL2}		0.3			0.3		Volts typ.
I_{IL}	−1.9	−1.7	−1.5	−1.9	−1.7	−1.6	mA max.
I_{IL}		−1.2			−1.2		mA typ.
I_L	1.0	1.0	100	1.0	1.0	100	μA max.
I_L		0.05			0.05		μA typ.
I_{CEX}	1.0	1.0	100	1.0	1.0	100	μA max.
I_{CEX}		0.05			0.05		μA typ.
I_{PS} (inputs open)		30			30		mA max.

CONDITIONS							
V_{CC}	12	12	12	12	12	12	Volts
V_{IH}	6.5	6.5	6.5	6.5	6.5	6.5	Volts
V_{IL}	5.0	5.0	5.0	5.0	5.0	5.0	Volts
V_{IN}	1.6	1.5	1.5	1.6	1.5	1.5	Volts
I_{OL1}	68	60	54	68	60	58	mA
I_{OL2}	34	30	27	34	30	29	mA

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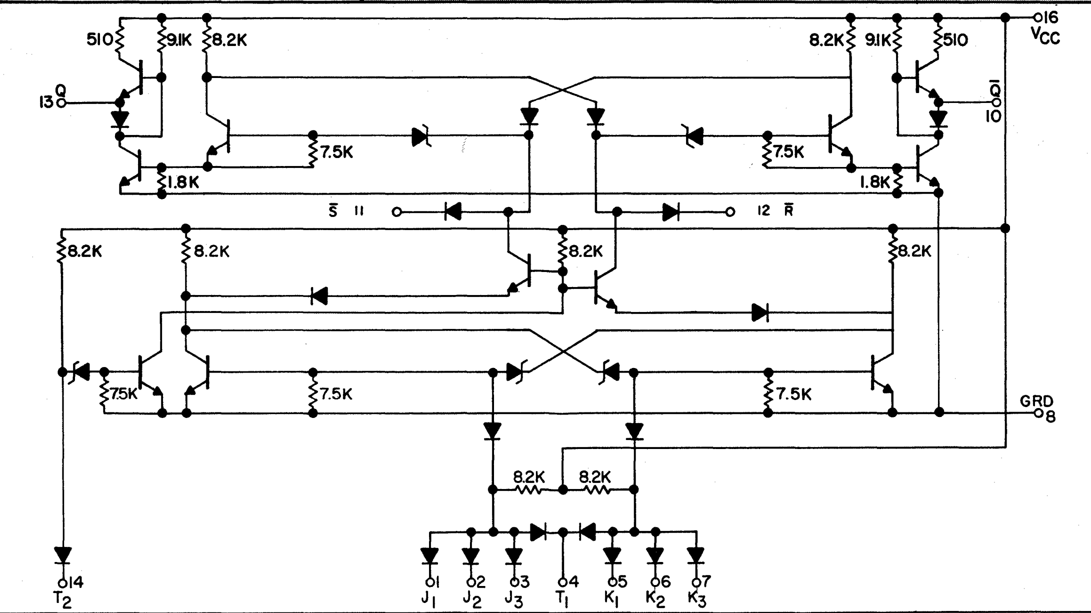
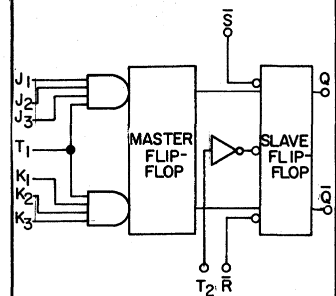
MASTER SLAVE FLIP-FLOP

311





TRUTH TABLE
$J=J_1=J_2$ $K=K_1=K_2$
$J_3=\overline{Q}$ $K_3=Q$

J	K	Q^{n+1}
L	L	Q^n
L	H	L
H	L	H
H	H	$\overline{Q}^n$

TRUTH TABLE
$J=J_1=J_2=J_3$
$K=K_1=K_2=K_3$

J	K	Q^{n+1}
L	L	Q^n
L	H	L
H	L	H
H	H	?

FOR SINGLE PHASE OPERATION CONNECT T_1 TO T_2

LIMITS	311 B			311 C			
	−55°C	+25°C	+125°C	−30°C	+25°C	+100°C	
V_{OH}	10.5	10.5	10.5	10.5	10.5	10.5	Volts min.
V_{OH}		11.3			11.3		Volts typ.
V_{OHL}	7.0	7.0	7.0	7.0	7.0	7.0	Volts min.
V_{OHL}		8.0			8.0		Volts typ.
V_{OL} @ I_{OL}	1.6	1.5	1.5	1.6	1.5	1.5	Volts max.
V_{OL} @ I_{OL}		1.2			1.2		Volts typ.
I_{IL}	−1.9	−1.7	−1.5	−1.9	−1.7	−1.6	mA max.
I_{IL}		−1.2			−1.2		mA typ.
I_{IL} (pin 4)	−3.8	−3.4	−3.0	−3.8	−3.4	−3.2	mA max.
I_{IL} (pin 4)		−2.4			−2.4		mA typ.
I_L	1.0	1.0	100	1.0	1.0	100	μA max.
I_L		0.05			0.05		μA typ.
T_{PD} ($\overline{R}$−$\overline{Q}$+)	70	90	160	70	90	130	nsec typ.
T_{PD} (t−$\overline{Q}$+)	120	190	270	140	190	255	nsec typ.
T_{PD} ($\overline{S}$−$\overline{Q}$−)	90	90	110	90	90	100	nsec typ.
T_{PD} (t+$\overline{Q}$−)	100	160	240	120	160	210	nsec typ.
Toggle		2.0			2.0		MHz min.
I_{PS} (inputs open)		15			15		mA max.

CONDITIONS							
V_{CC}	12	12	12	12	12	12	Volts
V_{IH}	6.5	6.5	6.5	6.5	6.5	6.5	Volts
V_{IL}	5.0	5.0	5.0	5.0	5.0	5.0	Volts
V_{IN}	1.6	1.5	1.5	1.6	1.5	1.5	Volts
I_{OH}	−5.0	−5.0	−5.0	−5.0	−5.0	−5.0	mA
I_{OL}	9.5	8.5	7.5	9.5	8.5	8.0	mA
V_{IH} ($\overline{S}$ & $\overline{R}$)	7.0	7.0	7.0	7.0	7.0	7.0	Volts

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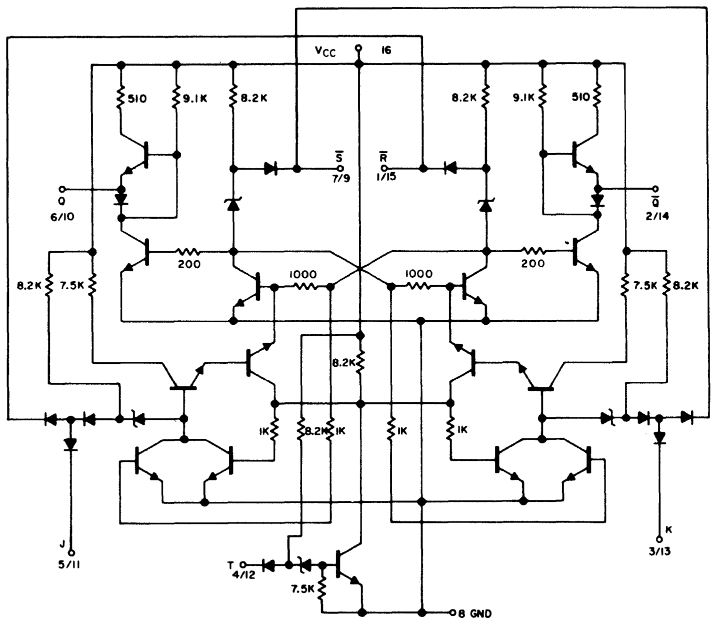
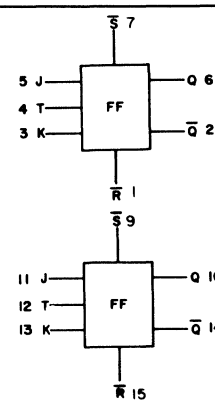
DUAL JK FLIP-FLOP

312





TRUTH TABLE

CLOCKED

J	K	Q^{n+1}
L	L	Q^n
L	H	L
H	L	H
H	H	$\overline{Q^n}$

SET-RESET

$\overline{S}$	$\overline{R}$	Q
H	H	?
H	L	L
L	H	H
L	L	H

LIMITS	312 B			312 C			
	−55°C	+25°C	+125°C	−30°C	+25°C	+100°C	
V_{OH}	10.5	10.5	10.5	10.5	10.5	10.5	Volts min.
V_{OH}		11.3			11.3		Volts typ.
V_{OHL}	7.0	7.0	7.0	7.0	7.0	7.0	Volts min.
V_{OHL}		8.0			8.0		Volts typ.
V_{OL} @ I_{OL}	1.6	1.5	1.5	1.6	1.5	1.5	Volts max.
V_{OL} @ I_{OL}		1.2			1.2		Volts typ.
I_{IL}	−1.9	−1.7	−1.5	−1.9	−1.7	−1.6	mA max.
I_{IL}		−1.2			−1.2		mA typ.
I_{IL} (1, 7, 9, 15)	−3.8	−3.4	−3.0	−3.8	−3.4	−3.2	mA max.
I_{IL} (1, 7, 9, 15)		−2.4			−2.4		mA typ.
I_L	1.0	1.0	100	1.0	1.0	100	μA max.
I_L		0.05			0.05		μA typ.
T_{PD} (t−$\overline{Q}$−)		80			80		nsec typ.
T_{PD} (t−$\overline{Q}$+)		70			70		nsec typ.
T_{PD} ($\overline{R}$−$\overline{Q}$+)		30			30		nsec typ.
T_{PD} ($\overline{S}$−$\overline{Q}$−)		35			35		nsec typ.
I_{PS} (inputs open)		24			24		mA max.

CONDITIONS							
V_{CC}	12	12	12	12	12	12	Volts
V_{IH}	6.5	6.5	6.5	6.5	6.5	6.5	Volts
V_{IL}	5.0	5.0	5.0	5.0	5.0	5.0	Volts
V_{IN}	1.6	1.5	1.5	1.6	1.5	1.5	Volts
I_{OH}	−5.0	−5.0	−5.0	−5.0	−5.0	−5.0	mA
I_{OL}	9.5	8.5	7.5	9.5	8.5	8.0	mA

* NOTE: Fall time of clock should be 3 volts per microsecond or faster.

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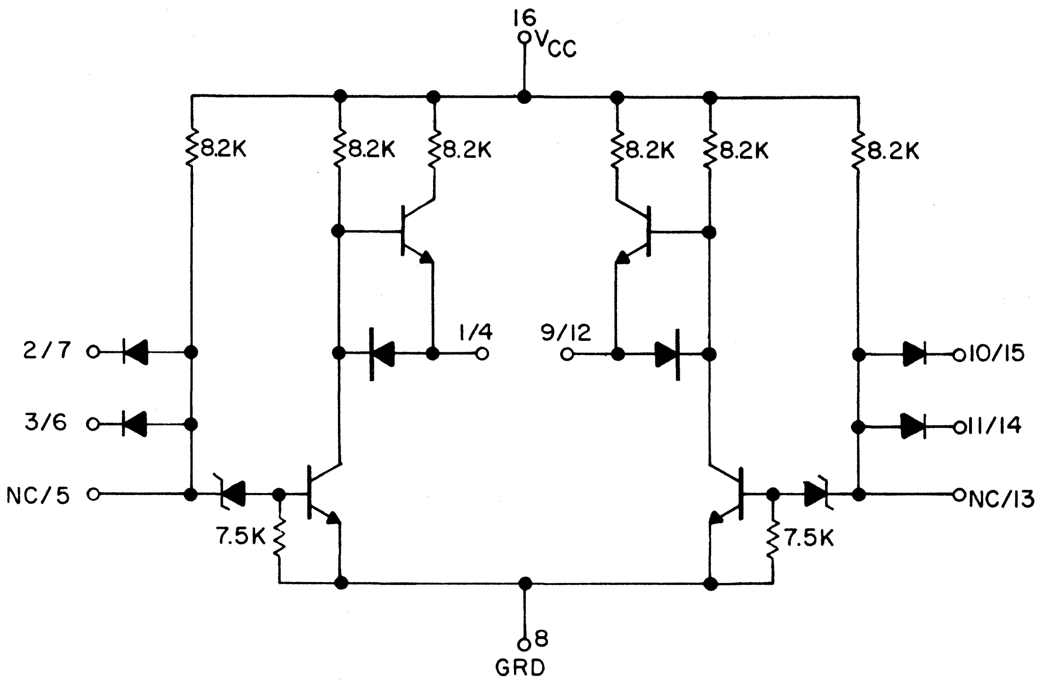
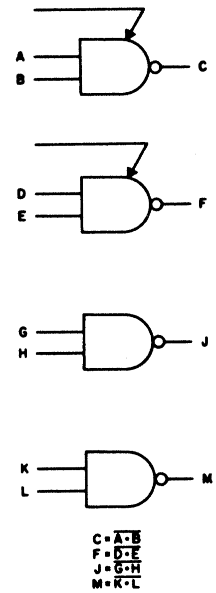
QUAD 2 INPUT GATE

321





LIMITS	321 B			321 C			
	−55°C	+25°C	+125°C	−30°C	+25°C	+100°C	
V_{OH}	10.5	10.5	10.5	10.5	10.5	10.5	Volts min.
V_{OH}		11.3			11.3		Volts typ.
V_{OHL}	7.0	7.0	7.0	7.0	7.0	7.0	Volts min.
V_{OHL}		8.0			8.0		Volts typ.
V_{OL} @ I_{OL}	1.6	1.5	1.5	1.6	1.5	1.5	Volts max.
V_{OL} @ I_{OL}		1.2			1.2		Volts typ.
I_{IL}	−1.9	−1.7	−1.5	−1.9	−1.7	−1.6	mA max.
I_{IL}		−1.2			−1.2		mA typ.
I_L	1.0	1.0	100	1.0	1.0	100	μA max.
I_L		0.05			0.05		μA typ.
T_{PD} (2−1+)	120	160	250	130	160	220	nsec typ.
T_{PD} (2+1−)	80	70	70	75	70	70	nsec typ.
I_{PS} (inputs open)		13			13		mA max.

CONDITIONS							
V_{CC}	12	12	12	12	12	12	Volts
V_{IH}	6.5	6.5	6.5	6.5	6.5	6.5	Volts
V_{IL}	5.0	5.0	5.0	5.0	5.0	5.0	Volts
V_{IN}	1.6	1.5	1.5	1.6	1.5	1.5	Volts
I_{OH}	−5.0	−5.0	−5.0	−5.0	−5.0	−5.0	mA
I_{OL}	9.5	8.5	7.5	9.5	8.5	8.0	mA

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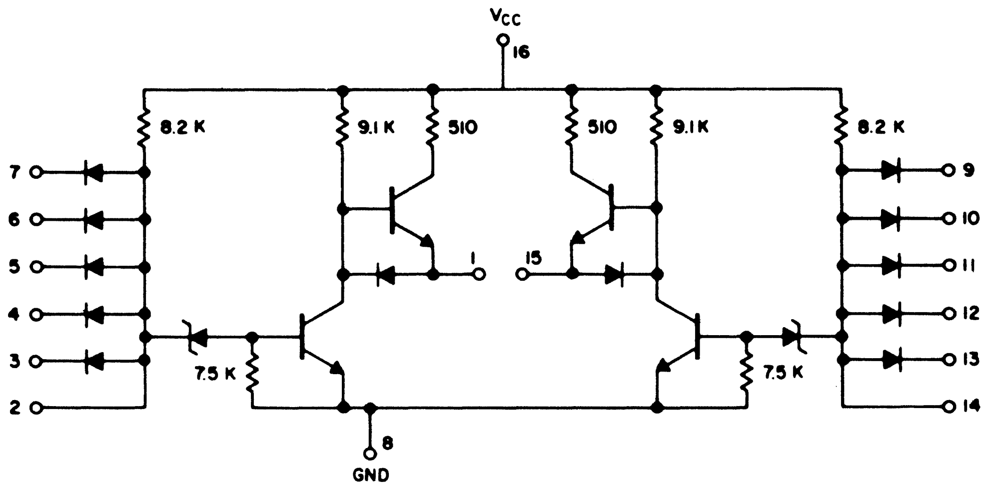
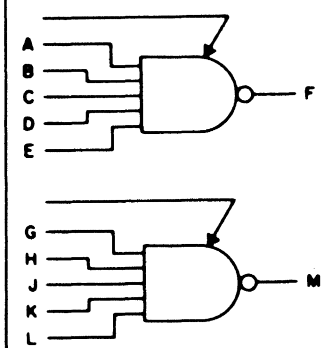
DUAL 5 INPUT GATE

322





$F = \overline{A \cdot B \cdot C \cdot D \cdot E}$

$M = \overline{G \cdot H \cdot J \cdot K \cdot L}$

LIMITS	322 B			322 C			
	−55°C	+25°C	+125°C	−30°C	+25°C	+100°C	
V_{OH}	10.5	10.5	10.5	10.5	10.5	10.5	Volts min.
V_{OH}		11.3			11.3		Volts typ.
V_{OHL}	7.0	7.0	7.0	7.0	7.0	7.0	Volts min.
V_{OHL}		8.0			8.0		Volts typ.
V_{OL} @ I_{OL}	1.6	1.5	1.5	1.6	1.5	1.5	Volts max.
V_{OL} @ I_{OL}		1.2			1.2		Volts typ.
I_{IL}	−1.9	−1.7	−1.5	−1.9	−1.7	−1.6	mA max.
I_{IL}		−1.2			−1.2		mA typ.
I_L	1.0	1.0	100	1.0	1.0	100	μA max.
I_L		0.05			0.05		μA typ.
T_{PD} (3−1+)	120	160	250	130	160	220	nsec typ.
T_{PD} (3+1−)	130	100	80	120	100	85	nsec typ.
I_{PS} (inputs open)		6.0			6.0		mA max.

CONDITIONS							
V_{CC}	12	12	12	12	12	12	Volts
V_{IH}	6.5	6.5	6.5	6.5	6.5	6.5	Volts
V_{IL}	5.0	5.0	5.0	5.0	5.0	5.0	Volts
V_{IN}	1.6	1.5	1.5	1.6	1.5	1.5	Volts
I_{OH}	−5.0	−5.0	−5.0	−5.0	−5.0	−5.0	mA
I_{OL}	9.5	8.5	7.5	9.5	8.5	8.0	mA

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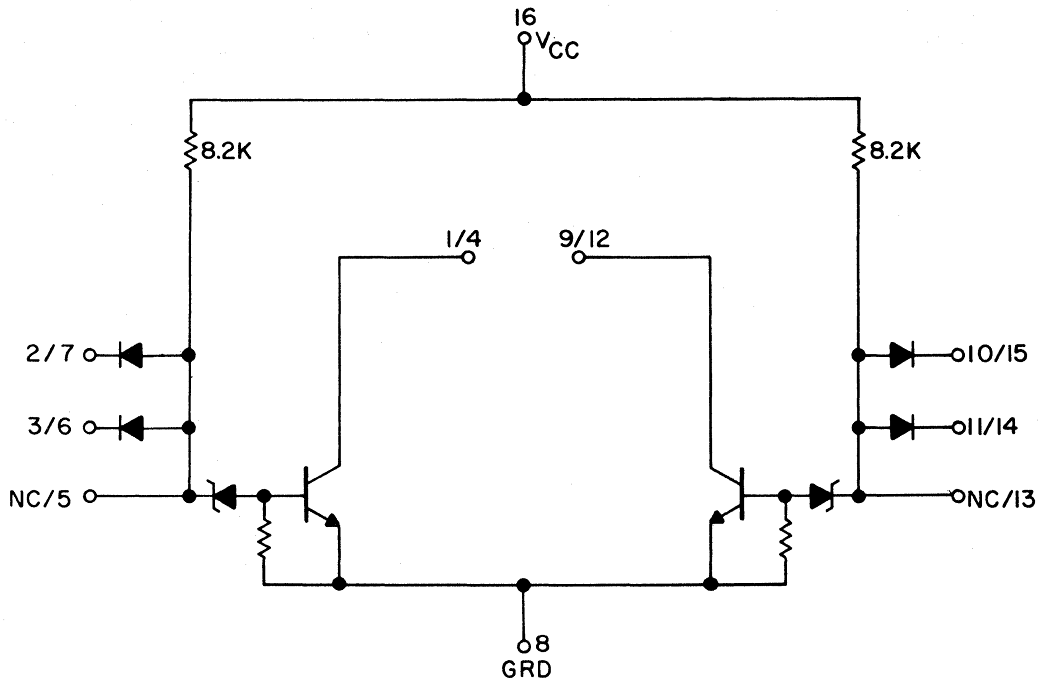
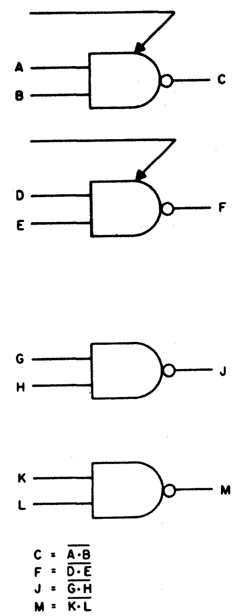
QUAD 2 INPUT GATE
COLLECTOR "OR" ABLE

323





LIMITS	323 B			323 C			
	−55°C	+25°C	+125°C	−30°C	+25°C	+100°C	
V_{OL} @ I_{OL}	0.5	0.5	0.5	0.5	0.5	0.5	Volts max.
V_{OL} @ I_{OL}		0.3			0.3		Volts typ.
I_{IL}	−1.9	−1.7	−1.5	−1.9	−1.7	−1.6	mA max.
I_{IL}		−1.2			−1.2		mA typ.
I_L	1.0	1.0	100	1.0	1.0	100	μA max.
I_L		0.05			0.05		μA typ.
I_{CEX}	1.0	1.0	100	1.0	1.0	100	μA max.
I_{CEX}		0.05			0.05		μA typ.
I_{PS} (inputs open)		4.5			4.5		mA max.

CONDITIONS							
V_{CC}	12	12	12	12	12	12	Volts
V_{IH}	6.5	6.5	6.5	6.5	6.5	6.5	Volts
V_{IL}	5.0	5.0	5.0	5.0	5.0	5.0	Volts
V_{IN}	1.6	1.5	1.5	1.6	1.5	1.5	Volts
I_{OL}	11	10	9.0	11	10	9.5	mA

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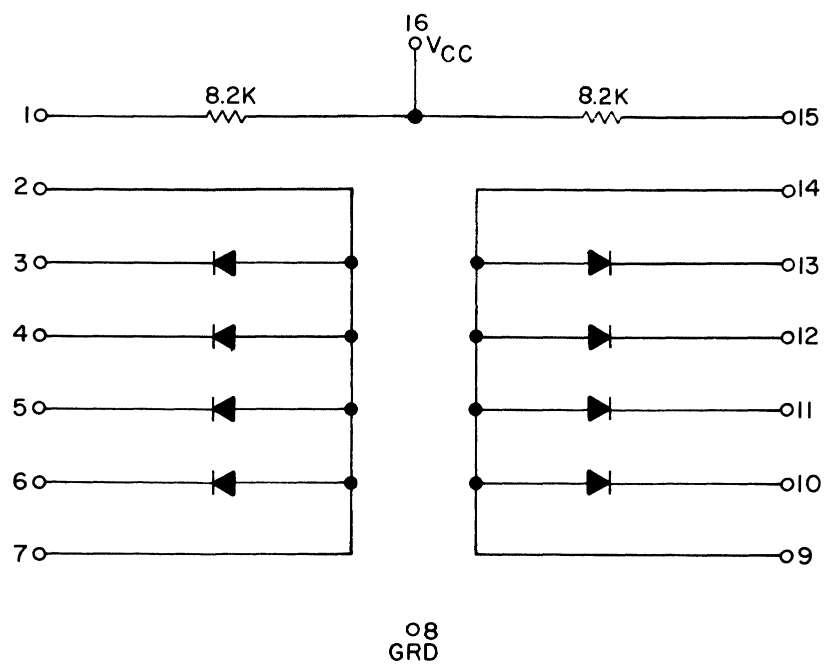
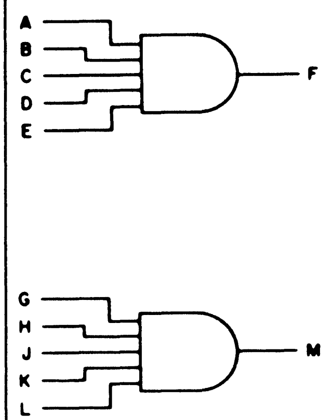
DUAL 5 INPUT EXPANDER

331





F = A·B·C·D·E
M = G·H·J·K·L

LIMITS	331 B			331 C			
	−55°C	+25°C	+125°C	−30°C	+25°C	+100°C	
I_{IL}	−1.9	−1.7	−1.5	−1.9	−1.7	−1.6	mA max.
I_{IL}		−1.2			−1.2		mA typ.
I_L	1.0	1.0	100	1.0	1.0	100	μA max.
I_L		0.05			0.05		μA typ.

CONDITIONS							
V_{CC}	12	12	12	12	12	12	Volts
V_{IN}	1.6	1.5	1.5	1.6	1.5	1.5	Volts

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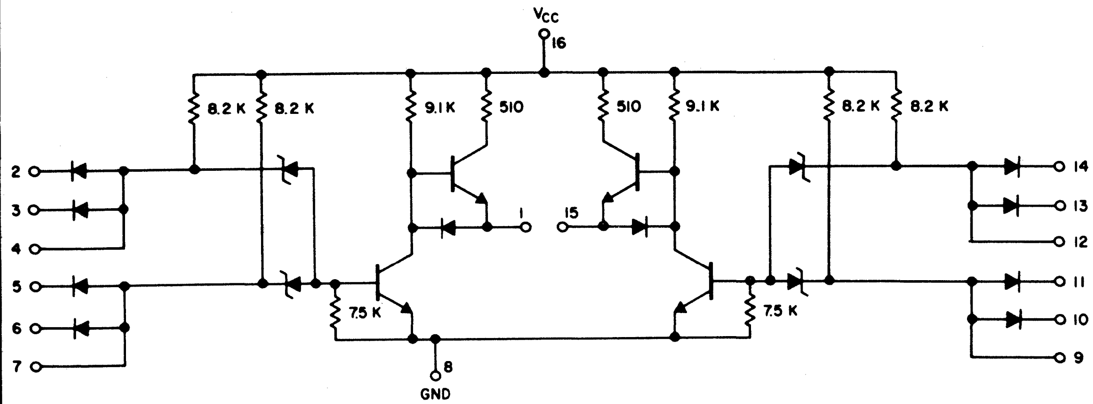
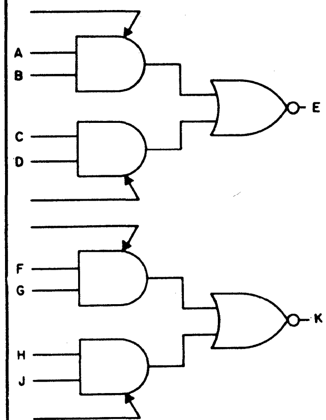
DUAL EXCLUSIVE- OR

341





$E = \overline{A \cdot B + C \cdot D}$
$K = \overline{F \cdot G + H \cdot J}$

LIMITS	341 B			341 C			
	−55°C	+25°C	+125°C	−30°C	+25°C	+100°C	
V_{OH}	10.5	10.5	10.5	10.5	10.5	10.5	Volts min.
V_{OH}		11.3			11.3		Volts typ.
V_{OHL}	7.0	7.0	7.0	7.0	7.0	7.0	Volts min.
V_{OHL}		8.0			8.0		Volts typ.
V_{OL} @ I_{OL}	1.6	1.5	1.5	1.6	1.5	1.5	Volts max.
V_{OL} @ I_{OL}		1.2			1.2		Volts typ.
I_{IL}	−1.9	−1.7	−1.5	−1.9	−1.7	−1.6	mA max.
I_{IL}		−1.2			−1.2		mA typ.
I_L	1.0	1.0	100	1.0	1.0	100	μA max.
I_L		0.05			0.05		μA typ.
T_{PD} (2, 5−1+)	120	160	250	130	160	220	nsec typ.
T_{PD} (2, 5+1−)	130	100	80	120	100	85	nsec typ.
I_{PS} (inputs open)		8.0			8.0		mA max.

CONDITIONS							
V_{CC}	12	12	12	12	12	12	Volts
V_{HO}	6.5	6.5	6.5	6.5	6.5	6.5	Volts
V_{IL}	5.0	5.0	5.0	5.0	5.0	5.0	Volts
V_{IN}	1.6	1.5	1.5	1.6	1.5	1.5	Volts
I_{OH}	−5.0	−5.0	−5.0	−5.0	−5.0	−5.0	mA
I_{OL}	9.5	8.5	7.5	9.5	8.5	8.0	mA

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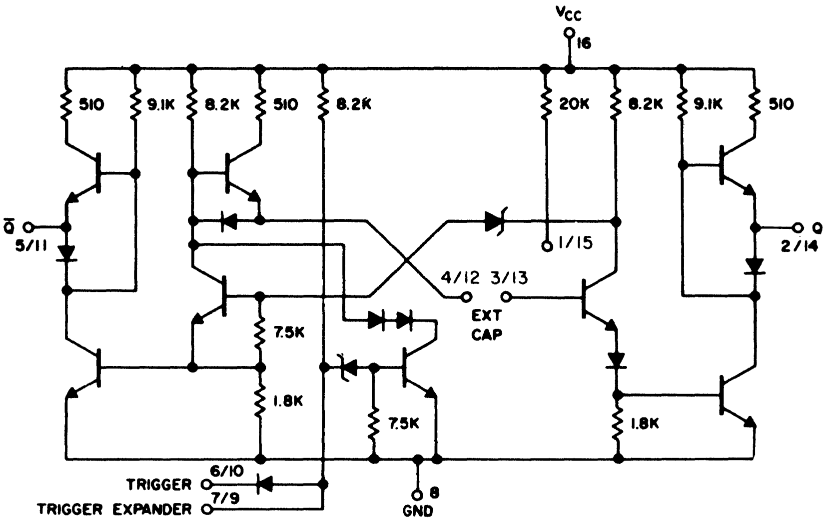
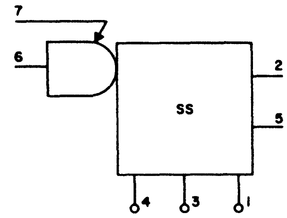
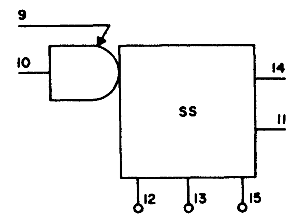
DUAL ONE SHOT

342





EXT. TIMING CONNECTIONS



EXT. TIMING CONNECTIONS

LIMITS	342 B			342 C			
	−55°C	+25°C	+125°C	−30°C	+25°C	+100°C	
V_{OH}	10.5	10.5	10.5	10.5	10.5	10.5	Volts min.
V_{OH}		11.3			11.3		Volts typ.
V_{OHL}	7.0	7.0	7.0	7.0	7.0	7.0	Volts min.
V_{OHL}		8.0			8.0		Volts typ.
V_{OL} @ I_{OL}	1.6	1.5	1.5	1.6	1.5	1.5	Volts max.
V_{OL} @ I_{OL}		1.2			1.2		Volts typ.
I_{IL}	−1.9	−1.7	−1.5	−1.9	−1.7	−1.6	mA max.
I_{IL}		−1.2			−1.2		mA typ.
I_L	1.0	1.0	100	1.0	1.0	100	μA max.
I_L		0.05			0.05		μA typ.
T_{PD} (6+2+)	80	100	150	80	100	140	nsec typ.
T_{PD} (6+5−)	70	75	75	70	75	75	nsec typ.
I_{PS} (Pin 1 connected to Pin 3) (Pin 13 connected to Pin 15)		15			15		mA max.

CONDITIONS							
V_{CC}	12	12	12	12	12	12	Volts
V_{IH}	6.5	6.5	6.5	6.5	6.5	6.5	Volts
V_{IL}	5.0	5.0	5.0	5.0	5.0	5.0	Volts
V_{IN}	1.6	1.5	1.5	1.6	1.5	1.5	Volts
I_{OH}	−5.0	−5.0	−5.0	−5.0	−5.0	−5.0	mA
I_{OL}	9.5	8.5	7.5	9.5	8.5	8.0	mA

The dual one shot is useful for timing and pulse generation over the range of 100 nsec to several seconds. The trigger input (triggers on a positive going input) is a standard HNIL gate input with the expander node brought out for added flexibility. The trigger input is completely isolated from the timing circuitry allowing trigger pulse width to be greater than or less than the output pulse width, and limited only by duty cycle considerations. The output pulse width ($P_w \simeq 0.7$ RC) is determined by an external capacitor, and, for precision applications, an external timing resistor which should not exceed 62 KΩ or less than 500Ω. An internal resistor with a nominal value of 20 KΩ is provided for normal applications. The allowable duty cycle can be calculated from $T_{width}/T_{recovery} = .23\, R_T$ where R_T is the timing resistor in KΩ and $T_{recovery}$ is the time required to charge the timing capacitor to greater than 99% of its final value. For normal applications the capacitor is placed between 3 and 4 (12 & 13) and pin 1 (15) is shorted to pin 3 (13).

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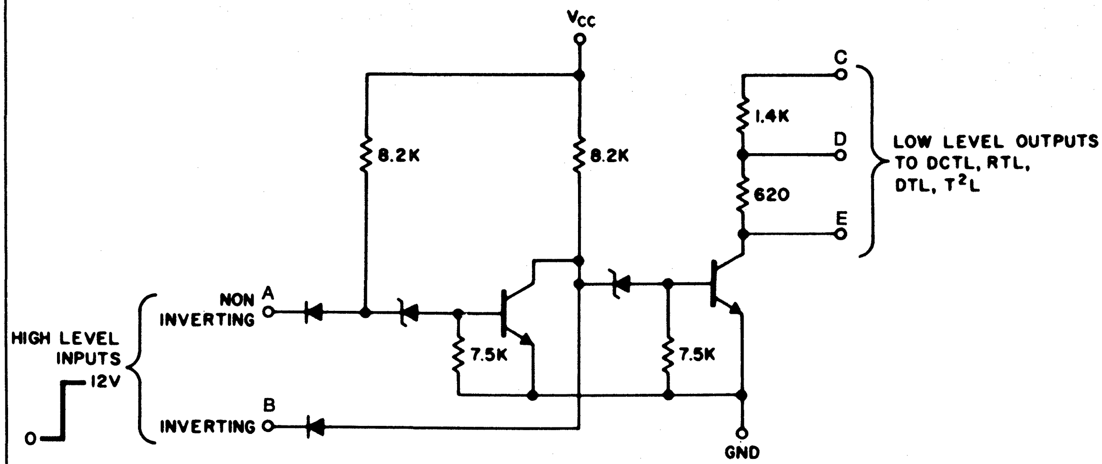
DUAL INPUT INTERFACE

CONVERTS HIGH LEVEL LOGIC TO LOW LEVEL LOGIC

361



361 TERMINAL IDENTIFICATION	G & J PACKAGE	H PACKAGE
A1	5	6
B1	4	5
C1	1	2
D1	2	3
E1	3	4
A2	11	9
B2	12	10
C2	15	13
D2	14	12
E2	13	11
V_{CC}	16	14
GND	8	7

LIMITS	361 B			361 C			
	−55°C	+25°C	+125°C	−30°C	+25°C	+100°C	
V_{OH} @ V_I	4.8	4.8	4.8	4.8	4.8	4.8	Volts min.
V_{OH} @ V_I		5.0			5.0		Volts typ.
V_{OL} @ I_{OL1}	350	300	330	350	300	330	mV max.
V_{OL} @ I_{OL2}		500			500		mV max.
I_{IL}	−2.2	−2.0	−1.8	−2.2	−2.0	−1.9	mA max.
I_{IL}		−1.4			−1.4		mA typ.
I_L	1.0	1.0	100	1.0	1.0	100	μA max.
I_L		0.05			0.05		μA typ.
I_O @ V_2 & V_3	−2.5	−2.5	−2.3	−2.3	−2.2	−2.0	mA min.
T_{PD} (5+3+)	85	110	160	90	110	145	nsec typ.
T_{PD} (5−3−)	65	85	125	70	85	115	nsec typ.
T_{PD} (4+3−)	65	75	115	65	75	100	nsec typ.
T_{PD} (4−3+)	60	75	110	65	75	95	nsec typ.
I_{PS} (inputs open)		6.5			6.5		mA max.

CONDITIONS							
V_{CC}	12	12	12	12	12	12	Volts
V_{IH}	6.5	6.5	6.5	6.5	6.5	6.5	Volts
V_{IL}	5.0	5.0	5.0	5.0	5.0	5.0	Volts
V_{IN}	0.5	0.5	0.5	0.5	0.5	0.5	Volts
V_1 @ (Pins 1 and 15)	5.0	5.0	5.0	5.0	5.0	5.0	Volts
V_2 @ (Pins 2 and 14)	3.0	3.0	3.0	3.0	3.0	3.0	Volts
V_3 @ (Pins 3 and 13)	1.01	0.85	0.675	0.9	0.85	0.76	Volts
I_{OL1}	6.0	6.0	6.0	6.0	6.0	6.0	mA
I_{OL2}		10			10		mA

Pins in ( ) for G package.

I_O The output (drive) current available when terminated at a specific voltage (V).

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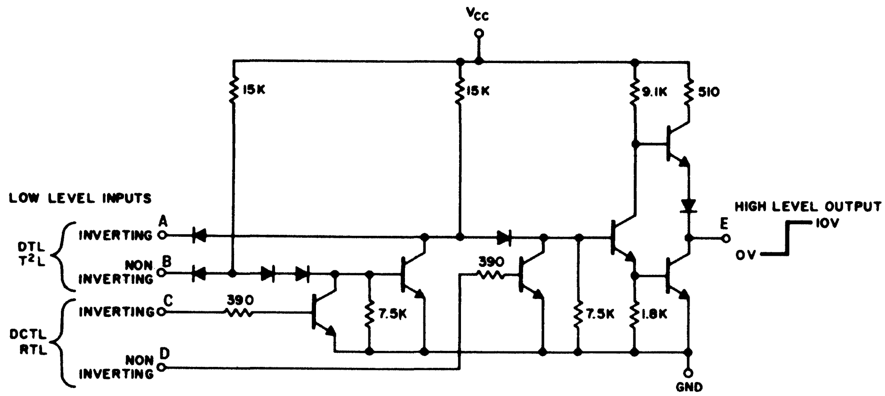
DUAL OUTPUT INTERFACE

CONVERTS LOW LEVEL LOGIC TO HIGH LEVEL LOGIC

362



362 TERMINAL IDENTIFICATION	G & J PACKAGE	H PACKAGE
A1	4	4
B1	6	6
C1	5	5
D1	3	3
E1	2	2
A2	12	11
B2	10	9
C2	11	10
D2	13	12
E2	14	13
V_{CC}	16	14
GND	8	7

LIMITS	362 B			362 C			
	−55°C	+25°C	+125°C	−30°C	+25°C	+100°C	
V_{OH}	9.5	9.5	9.5	9.5	9.5	9.5	Volts min.
V_{OH}		10.7			10.7		Volts typ.
V_{OHL}	7.0	7.0	7.0	7.0	7.0	7.0	Volts min.
V_{OHL}		8.0			8.0		Volts typ.
V_{OL}	0.5	0.5	0.5	0.5	0.5	0.5	Volts min.
V_{OL}		0.3			0.3		Volts typ.
$I_{IN(S)}$	−1.3	−1.2	−1.1	−1.3	−1.2	−1.1	mA max.
$I_{IN(D)}$	495	440	470	460	440	470	μA max.
$I_{L(S)}$	1.0	1.0	100	1.0	1.0	100	μA max.
$I_{L(D)}$	−1.0	−1.0	−100	−1.0	−1.0	−100	μA max.
T_D (4+2−)	40	60	110	45	60	100	nsec typ.
(4−2+)	40	20	15	35	20	15	nsec typ.
(6+2+)	55	50	40	55	50	45	nsec typ.
(6−2−)	40	50	105	45	50	90	nsec typ.
(5−2+)	70	50	45	60	50	45	nsec typ.
(5+2−)	80	110	190	85	110	170	nsec typ.
(3+2+)	90	100	160	90	100	140	nsec typ.
(3−2−)	35	55	100	40	55	90	nsec typ.
I_{PS} (Pin 6 & Pin 10 = Gnd)		8.0			8.0		mA max.

CONDITIONS							
V_{CC}	12	12	12	12	12	12	Volts
$V_{IH(S)}$	1.9	1.7	1.5	2.1	2.0	1.8	Volts
$V_{IL(S)}$	0.9	0.9	0.7	0.8	0.8	0.7	Volts
$V_{IN(S)}$	350	350	350	350	350	350	mV
$V_{IH(D)}$	1.01	0.85	0.675	0.95	0.85	0.70	Volts
$V_{IL(D)}$	0.71	0.5	0.32	0.6	0.5	0.38	Volts
$V_{IN(D)}$	1.01	8.5	0.675	0.95	0.85	0.70	Volts
I_{OL}	11	10	9.0	10.5	10	9.5	mA
I_{OH}	−3.0	−3.0	−3.0	−3.0	−3.0	−3.0	mA
$V_{L(D)}$	−4.0	−4.0	−4.0	−4.0	−4.0	−4.0	Volts
$V_{L(S)}$	4.0	4.0	4.0	4.0	4.0	4.0	Volts

Pins in ( ) for G package.

$I_{IN(S)}$ same definition as I_{IL}, measured on DTL inputs.

$I_{IN(D)}$ that current which flows into the RTL inputs with $V_{IN(D)}$ applied to that terminal.
$I_{L(S)}$ same definition as I_L, measured on DTL inputs with $V_{L(S)}$ applied.
$I_{L(D)}$ that current which flows from the RTL inputs with $V_{L(D)}$ applied to that terminal.

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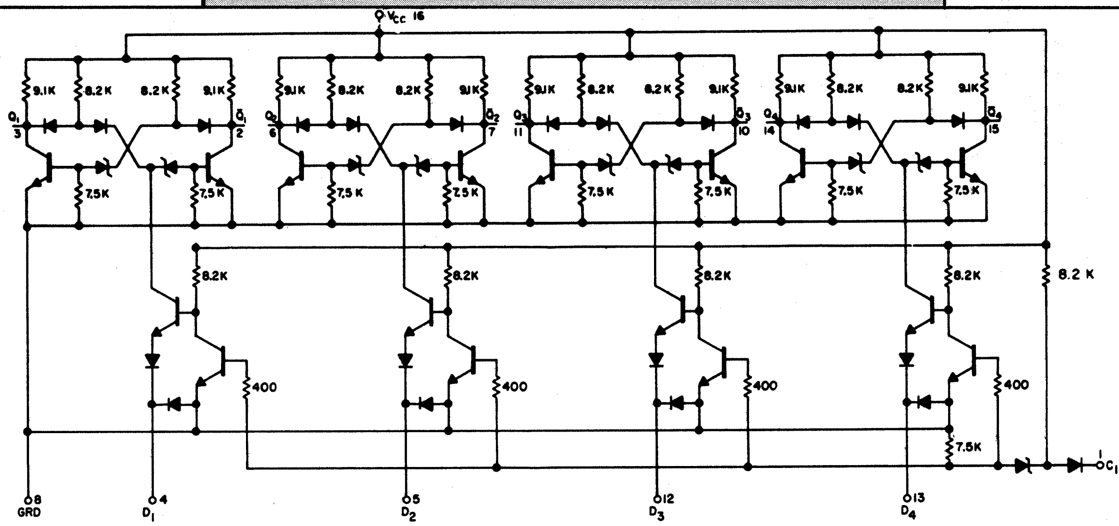
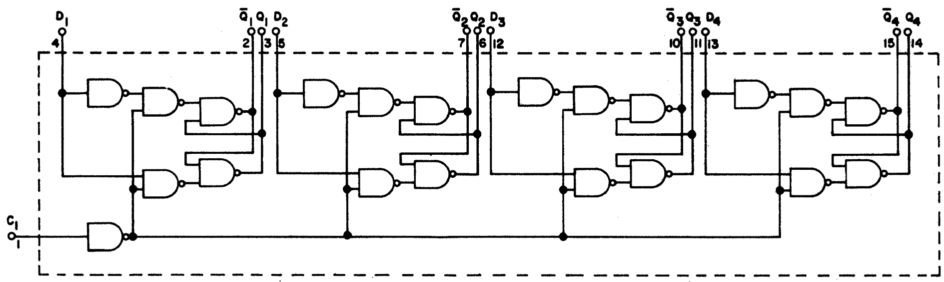
QUAD D FLIP-FLOP

370





TRUTH TABLE

C_1	D^n	Q^{n+1}
1	1	Q^n
1	0	Q^n
0	1	1
0	0	0

LIMITS	370 B			370 C			
	−55°C	+25°C	+125°C	−30°C	+25°C	+100°C	
V_{OH}	10.5	10.5	10.5	10.5	10.5	10.5	Volts min.
V_{OH}		12			12		Volts typ.
V_{OHL}	7.0	7.0	7.0	7.0	7.0	7.0	Volts min.
V_{OHL}		8.0			8.0		Volts typ.
V_{OL} @ I_{OL}	0.5	0.5	0.5	0.5	0.5	0.5	Volts max.
V_{OL} @ I_{OL}		0.3			0.3		Volts typ.
I_{IL}		−1.7			−1.7		mA max.
I_{IL}		−1.2			−1.2		mA typ.
I_L	1.0	1.0	100	1.0	1.0	100	μA max.
I_L		0.05			0.05		μA typ.
T_{PD} (4+3+)	120	160	250	130	160	220	nsec typ.
T_{PD} (4−3−)	80	70	75	75	70	70	nsec typ.
I_{PS} (inputs open)		30			30		mA max.

CONDITIONS							
V_{CC}	12	12	12	12	12	12	Volts
V_{IH}	6.5	6.5	6.5	6.5	6.5	6.5	Volts
V_{IL}	5.0	5.0	5.0	5.0	5.0	5.0	Volts
V_{IN}	1.6	1.5	1.5	1.6	1.5	1.5	Volts
I_{OH}	−300	−300	−300	−300	−300	−300	μA
I_{OL}	7.6	6.8	6.0	7.6	6.8	6.4	mA

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DEFINITION OF SYMBOLS AND TERMS

V_{CC} Supply Voltage

V_{IL} Maximum voltage that may be applied to an input without changing the output from a "1" state to a "0" state.

V_{IH} Minimum voltage that may be applied to an input without changing the output from a "0" state to a "1" state.

V_{OL} The output voltage with I_{OL} applied and V_{IH} applied to all inputs.

V_{OH} The output voltage with V_{IL} applied to the input.

V_{OHL} The output voltage with V_{IL} applied to the input and a drive current, I_{OH}, being supplied.

V_{IN} The voltage which is applied to an input for the I_{IL} test measurement, equals V_{OL} for standard diode input.

I_{IL} The input forward current with V_{IN} applied to that input.

I_{L} The maximum reverse current at the input when V_{CC} is applied and the other adjacent inputs are grounded.

I_{OL} Load (Sink) current at which the output voltage is guaranteed for the zero state or V_{OL}.

T_{PD} Propagation delay, (N+, M−), when input pulse at terminal N is going positive (direction of the sign) and the output, Terminal M, is going negative. Propagation time is measured at the 50% levels.

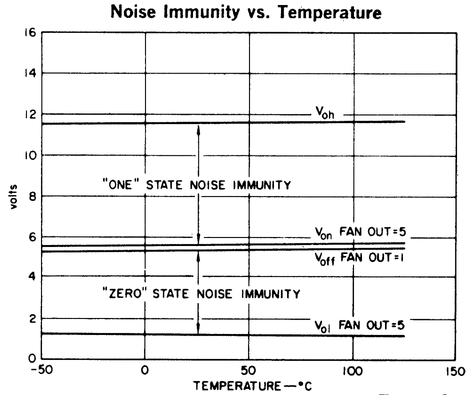
FAN-OUT Minimum number of logic elements that may be driven by one other logic element of the same family, and is determined by the ratio of I_{OL}/I_{IL}.

"Zero" State Noise Immunity The additional amount of positive voltage required at the output of a gate, when in the "zero" state, to raise that voltage to the maximum voltage that may be applied to an input without changing that gate's output state. It is determined by the equation, $NI = V_{IL} - V_{OL}$ (5.0 V−1.5 V = 3.5 Volts).

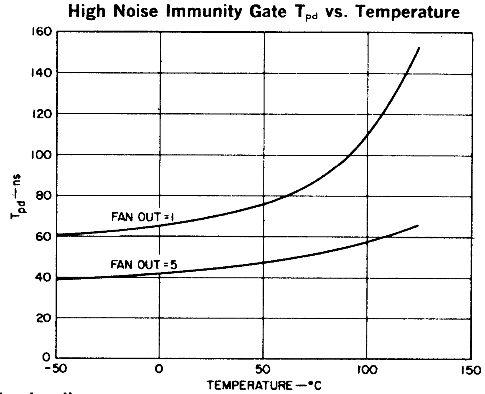
"One" State Noise Immunity The additional amount of negative voltage required at the output of a gate, when in the "one" state, to lower that voltage to the minimum voltage that may be applied to an input without changing that gate's output state. It is determined by the equation, $NI = V_{OH} - V_{IH}$ (10.5 V−6.5 V = 4.0 Volts).

I_{PS} Power Supply Current, no load, $V_{CC} = +12$ Volts.

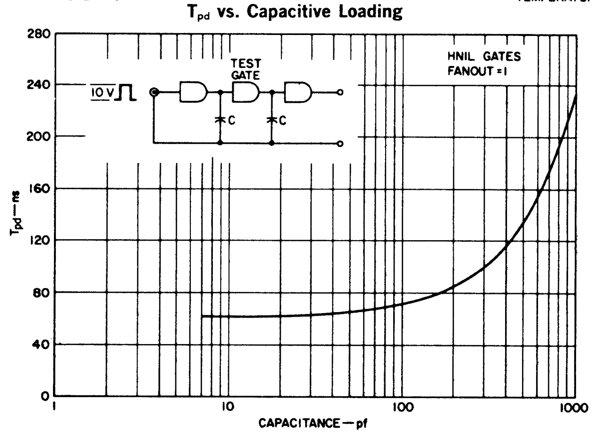
Noise Immunity vs. Temperature



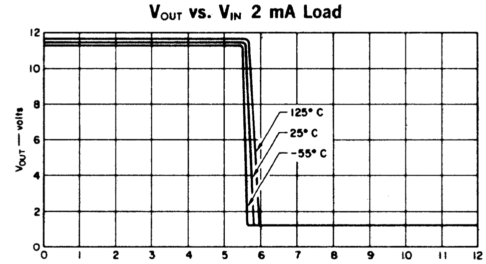
High Noise Immunity Gate T_{pd} vs. Temperature



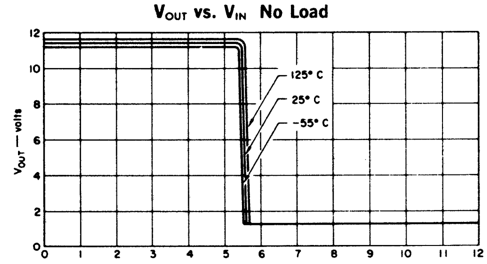
T_{pd} vs. Capacitive Loading



V_{OUT} vs. V_{IN} 2 mA Load



V_{OUT} vs. V_{IN} No Load



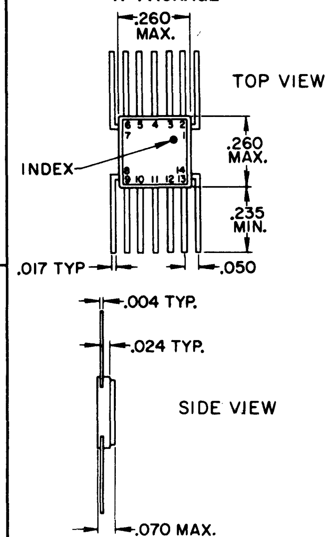
JANUARY 1968

DIGITAL CIRCUIT
TRANSISTOR-TRANSISTOR LOGIC

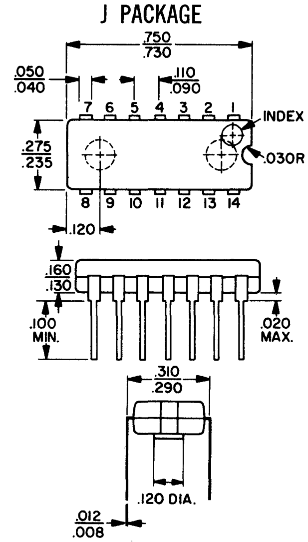
500 SERIES

The Amelco Transistor-Transistor Logic has been designed specifically for use in applications where primary emphasis is placed on low power consumption. The logic family is provided in three compatible and interchangeable power levels, 0.5 mW, 1.2 mW, and 4.0 mW, allowing the Designer to optimize his speed-power trade-off. Most of the gate elements are also available with no pull up resistor, allowing collector "OR"ing.

H PACKAGE



J PACKAGE



TRANSISTOR-TRANSISTOR LOGIC ELEMENTS

- JK Flip-Flop
- Quad-2 Input Gate
- Triple-3 Input Gate
- Dual-4 Input Gate
- Dual-4 Input Power Gate with Expander
- Dual-4 Input Buffer with Expander
- Dual-4 Input Nand/Nor Gate with Inverter
- Dual-4 Input Power Gate and Lamp Driver

ABSOLUTE MAXIMUM RATINGS

	500BH	500CJ
Storage Temperature	−65°C to +150°C	−65°C to +150°C
Operating Temperature	−55°C to +125°C	0°C to 70°C
Maximum Voltage	6.8 V	6.8 V
Operating Voltage	4.0 V to 5.5 V	4.0 V to 5.5 V

NUMBERING SEQUENCE

500-529 Low Power
530-559 Medium Power
570-589 High Power

Complete part number designation consists of three digits and two letters, for example:

500BH
- Package
- Temperature Range
- Circuit

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ELECTRICAL CHARACTERISTICS

	POWER LEVELS									UNITS
	LOW			MEDIUM			HIGH			
	−55°C	+25°C	+125°C	−55°C	+25°C	+125°C	−55°C	+25°C	+125°C	
V_{CC} max.	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	Volts
V_{CC}	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	Volts
V_{OL} at I_{OL}	0.4	0.2	0.25	0.4	0.3	0.35	0.5	0.4	0.4	Volts max.
V_{OH}	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	Volts min.
V_{IL}	1.4	1.0	0.6	1.4	1.0	0.7	1.4	1.0	0.7	Volts max.
V_{IH}	2.0	1.8	1.5	2.0	1.8	1.5	2.0	1.8	1.6	Volts min.
I_{IL}	200	150	120	550	450	400	1100	1100	1100	μA max.
I_{IL} R & S (f/f)	130	100	80	550	450	400	750	750	750	μA max.
I_{IL} C (flip-flop)	400	300	240	1450	1200	1050	2250	2250	2250	μA max.
I_{IL} C_2 R_D	400	300	240	1450	1200	1050	2250	2250	2250	μA max.
I_{IH1}	2.0	2.0	3.0	4.0	4.0	6.0	12	12	18	μA max.
I_{IH2}		10			20			60		μA max.
I_{OH1}		100			100			100		μA max.
I_{OH2} at $V_{CC} = 4.5$ V				0.0	2.5	2.5	2.0	5.0	6.0	mA
I_{OH2} at $V_{CC} = 4.5$ V				2.0	4.0	4.0	4.0	7.0	8.0	mA
I_{OL1}	1.2	0.9	0.72	3.3	2.7	2.4	8.0	8.0	8.0	mA
I_{OL2} med. pwr.				8.0	8.0	8.0				mA
I_{OL3} high pwr.				22	22	22	34	36	32	mA
I_{OL4} high pwr.							36	40	36	mA
I_{OL}SR		0.9		4.4	3.6	3.2	13.5	13.5	13.5	mA
I_A		20			200			375		μA min.
V_{I1}	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	Volts
V_{I2}	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	Volts

DEFINITION OF SYMBOL & TERMS

V_{CC} Supply Voltage

V_{OL} The output voltage with I_{OL} applied and V_{IH} applied to all inputs.

V_{OH} The output voltage with input grounded.

V_{IL} Maximum voltage that may be applied to an input without changing the output from "1" to a "0" state.

V_{IH} Minimum voltage that may be applied to an input without changing the output from a "0" to a "1" state.

I_{IL} The input forward current.

I_{IH1} The maximum reverse current allowable at the input when V_{I1} is applied and the adjacent input is grounded.

I_{IH2} The maximum total reverse current at the input when V_{I2} is applied to all inputs.

I_{OH1} The output high current when V_{max} is applied to the outputs and V_{CC}, with inputs grounded.

I_{OH2} The output current with inputs grounded, and the output voltage at V_{OH} minimum.

I_{OL} Minimum load current at the output of the logic element in the "0" state.

I_A Minimum load current at the output of the logic element in the "1" state.

T_{PD} Propagation delay — average of T_{on} and T_{off}.

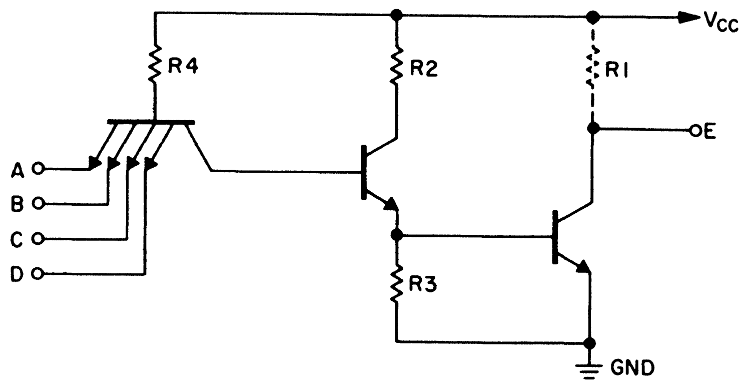
Fan-out Minimum number of logic elements that may be driven by one other logic element and is determined by the ratio of $\frac{I_{OL}}{I_{IL}}$.

JANUARY 1968

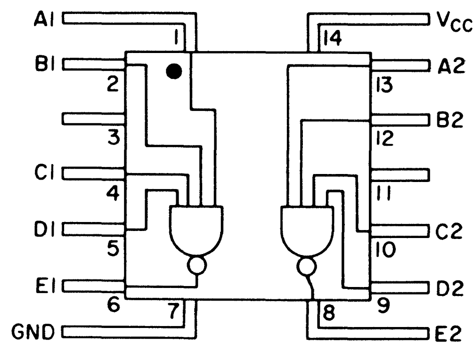
DUAL 4 INPUT GATE

500 504
530 534
570 574

SCHEMATIC (EACH GATE)



LOGIC DIAGRAM AND PIN CONNECTIONS



ELECTRICAL CHARACTERISTICS

PART NO.	POWER LEVEL	RESISTANCE VALUES R_1	R_2	R_3	R_4	R_5	R_6	DISS. PER GATE (mW) TYP.	MAX.	PROPAGATION DELAY (nsec) −55°C TYP.	+25°C TYP.	+25°C MAX.	+125°C TYP.	I_{OL}
500	L	∞	20K	20K	40K			0.5	1.0	225	180	300	215	I_{OL1}
504	L	40K	20K	20K	40K			0.7	1.2	175	140	250	175	I_{OL1}
530	M	∞	10K	10K	10K			1.5	2.2	85	75	100	85	I_{OL1}
534	M	10K	10K	10K	10K			2.0	3.0	75	60	90	75	I_{OL1}
570	H	∞	7.0K	4.0K	3.5K			4.1	5.5	45	25	55	38	I_{OL1}
574	H	6.0K	7.0K	4.0K	3.5K			5.0	6.8	45	25	55	38	I_{OL1}

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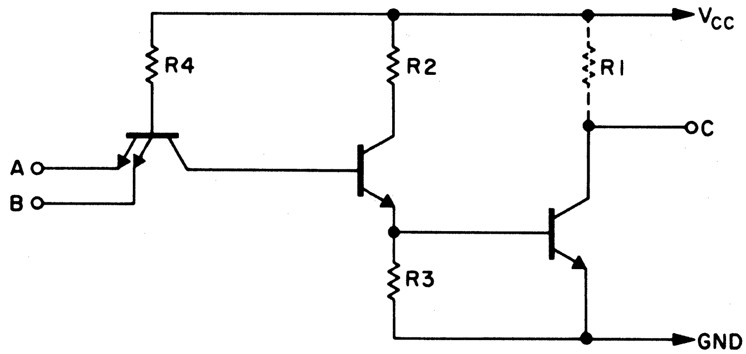
6503

JANUARY 1968

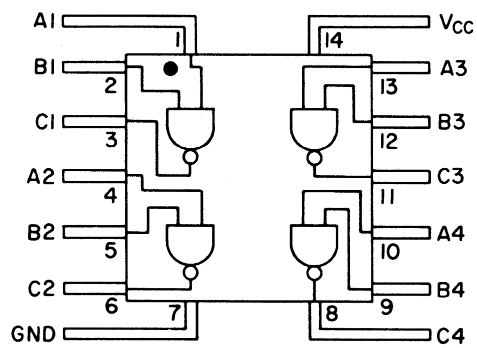
QUAD 2 INPUT GATE

501 505
531 535
571 575

SCHEMATIC (EACH GATE)



LOGIC DIAGRAM AND PIN CONNECTIONS



ELECTRICAL CHARACTERISTICS

PART NO.	POWER LEVEL	RESISTANCE VALUES						DISS. PER GATE (mW)		PROPAGATION DELAY (nsec)				
										−55°C	+25°C		+125°C	
		R_1	R_2	R_3	R_4	R_5	R_6	TYP.	MAX.	TYP.	TYP.	MAX.	TYP.	I_{OL}
501	L	∞	20K	20K	40K			0.5	1.0	225	180	300	215	I_{OL1}
505	L	40K	20K	20K	40K			0.7	1.2	175	140	250	175	I_{OL1}
531	M	∞	10K	10K	10K			1.5	2.2	85	75	100	85	I_{OL1}
535	M	10K	10K	10K	10K			2.0	3.0	75	60	90	75	I_{OL1}
571	H	∞	7.0K	4.0K	3.5K			4.1	5.5	45	25	55	38	I_{OL1}
575	H	6.0K	7.0K	4.0K	3.5K			5.0	6.8	45	25	55	38	I_{OL1}

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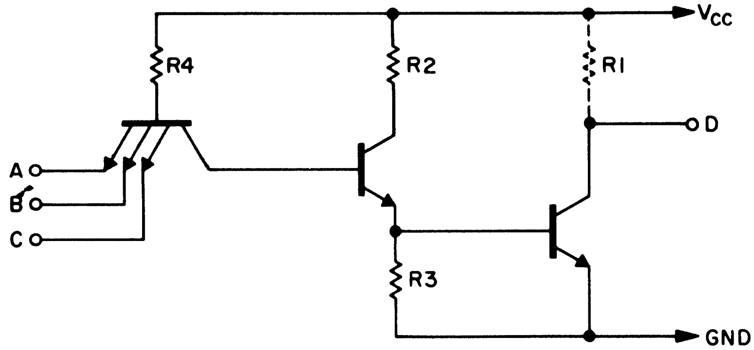
JANUARY 1968

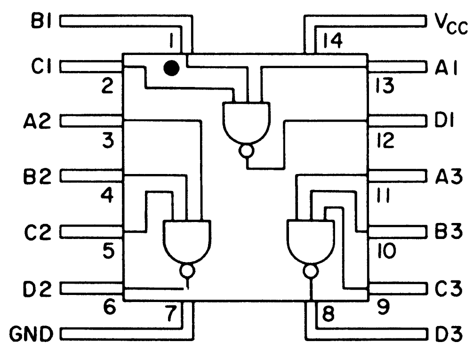
TRIPLE 3 INPUT GATE

503 507
533 537
573 577

SCHEMATIC (EACH GATE)



LOGIC DIAGRAM AND PIN CONNECTIONS



ELECTRICAL CHARACTERISTICS

PART NO.	POWER LEVEL	RESISTANCE VALUES R_1	R_2	R_3	R_4	R_5	R_6	DISS. PER GATE (mW) TYP.	MAX.	PROPAGATION DELAY (nsec) −55°C TYP.	+25°C TYP.	+25°C MAX.	+125°C TYP.	I_{OL}
503	L	∞	20K	20K	40K			0.5	1.0	225	180	300	215	I_{OL1}
507	L	40K	20K	20K	40K			0.7	1.2	175	140	250	175	I_{OL1}
533	M	∞	10K	10K	10K			1.5	2.2	85	75	100	85	I_{OL1}
537	M	10K	10K	10K	10K			2.0	3.0	75	60	90	75	I_{OL1}
573	H	∞	7.0K	4.0K	3.5K			4.1	5.5	45	25	55	38	I_{OL1}
577	H	6.0K	7.0K	4.0K	3.5K			5.0	6.8	45	25	55	38	I_{OL1}

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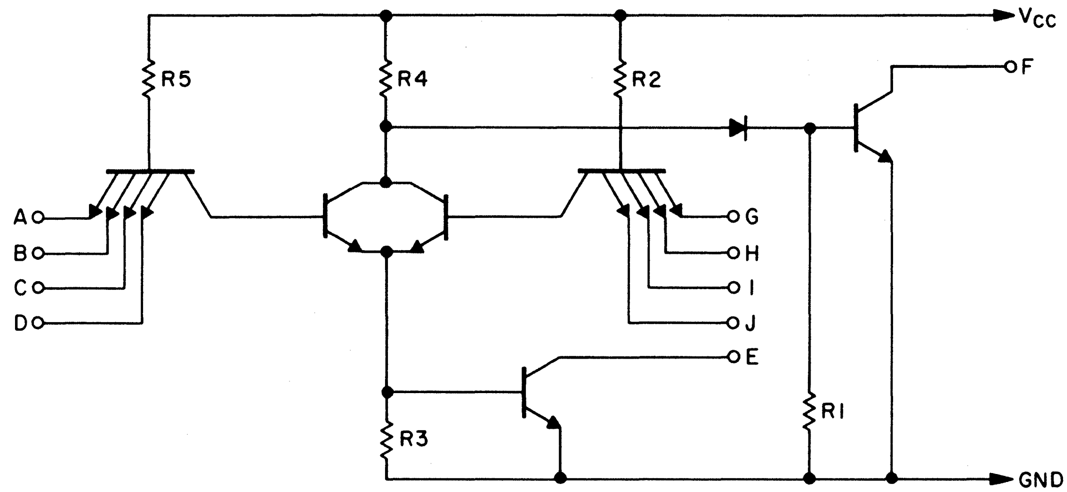
6505

JANUARY 1968

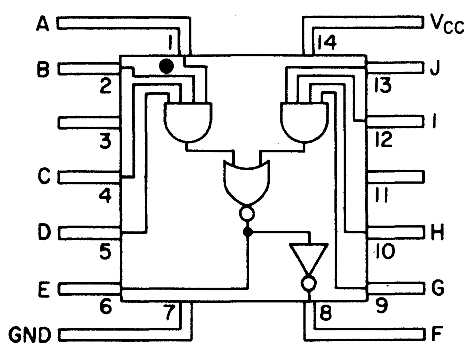
DUAL 4 INPUT
NAND-NOR GATE
WITH INVERTER

508
538
578

SCHEMATIC



LOGIC DIAGRAM AND PIN CONNECTIONS



ELECTRICAL CHARACTERISTICS

PART NO.	POWER LEVEL	RESISTANCE VALUES R_1	R_2	R_3	R_4	R_5	R_6	DISS. PER GATE (mW) TYP.	MAX.	PROPAGATION DELAY (nsec) −55°C TYP.	+25°C TYP.	+25°C MAX.	+125°C TYP.	PIN #6 I_{OL}	PIN #8 I_{OL}
508	L	20K	40K	20K	15K	40K		1.4	2.0	240	200	360	240	I_{OLI}	2/3 I_{OLI}
538	M	10K	10K	10K	7.5K	10K		3.8	4.8	100	85	120	100	I_{OLI}	2/3 I_{OLI}
578	H	4.0K	3.8K	4.0K	3.6K	3.8K		8.9	11.2	55	35	65	45	I_{OLI}	2/3 I_{OLI}

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6506

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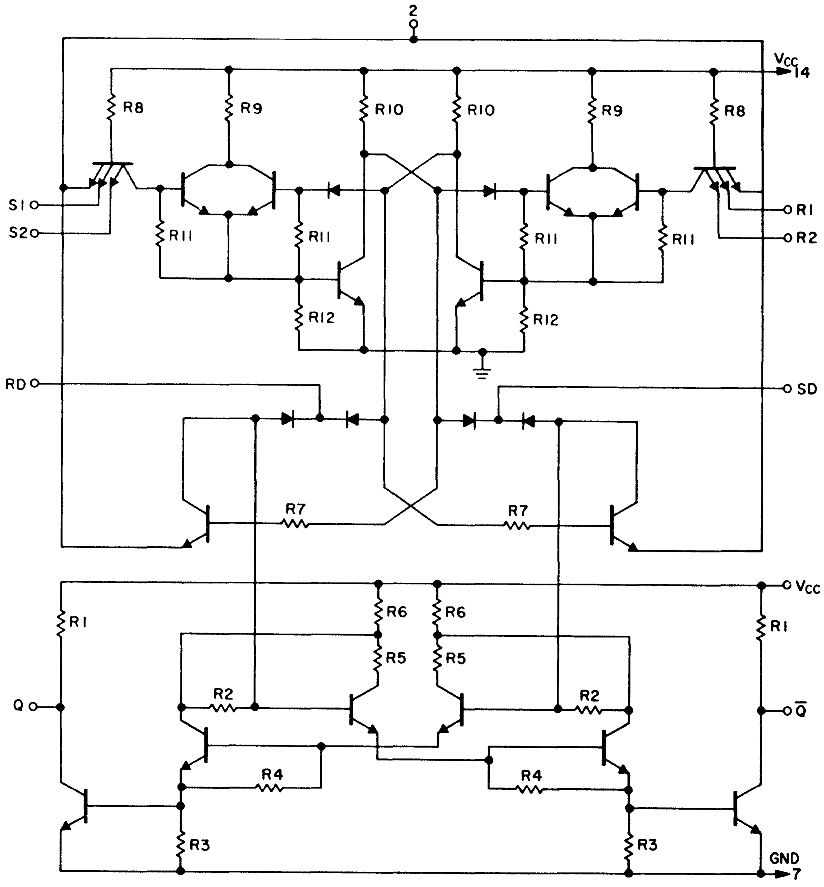
JK FLIP-FLOP

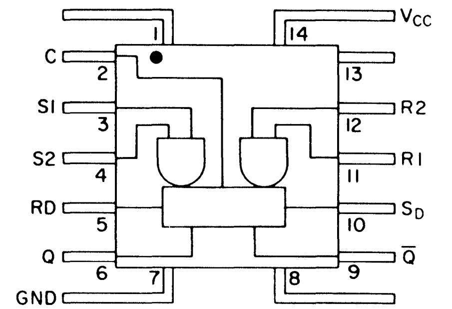
509
539
579

SCHEMATIC



MASTER–SLAVE FLIP-FLOP

LOGIC DIAGRAM AND PIN CONNECTIONS



TRUTH TABLE

R-S MODE					J-K MODE		
S_1^n	S_2^n	R_1^n	R_2^n	Q^{n+1}	J^n	K^n	Q^{n+1}
L	X	L	X	Q^n	L	L	Q^n
L	X	X	L	Q^n	L	H	L
X	L	L	X	Q^n	H	L	H
X	L	X	L	Q^n	H	H	$\overline{Q^n}$
L	X	H	H	L			
X	L	H	H	L			
H	H	L	X	H			
H	H	X	L	H			
H	H	H	H	Ambiguous			

X = don't care
$R_D = S_D = 1$

ELECTRICAL CHARACTERISTICS

PART NO.	POWER LEVEL	RESISTANCE VALUES												POWER DISS. (mW)			PROPAGATION DELAY AND CLOCK RATE					UNITS
																	−55°C	+25°C			+125°C	
		R_1	R_2	R_3	R_4	R_5	R_6	R_7	R_8	R_9	R_{10}	R_{11}	R_{12}	TYP.	MAX.		TYP.	MIN.	TYP.	MAX.	TYP.	
509	L	15K	40K	24K	36K	12K	20K	110K	56K	56K	28K	56K	28K	4.0	6.0	I_{OL}SR	700		550	700	800	T_{pd}(nsec)
																	0.75	0.5	1.0		0.75	Clock Rate MHz
539	M	10K	10K	10K	15K	3.0K	5.0K	20K	10K	20K	5.0K	15K	10K	12	18	I_{OL}SR	180		140	225	200	T_{pd}(nsec)
																	4.0	3.0	4.0		3.0	Clock Rate MHz
579	H	2.0K	3.3K	3.3K	5.0K	1.4K	2.2K	6.6K	6.0K	7.0K	3.2K	8.0K	3.3K	24	32	I_{OL}SR	75		65	75	75	T_{pd}(nsec)
																	12	10	12		10	Clock Rate MHz

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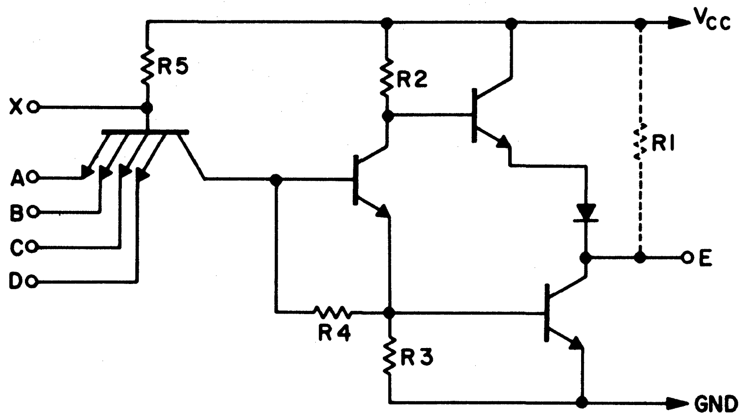
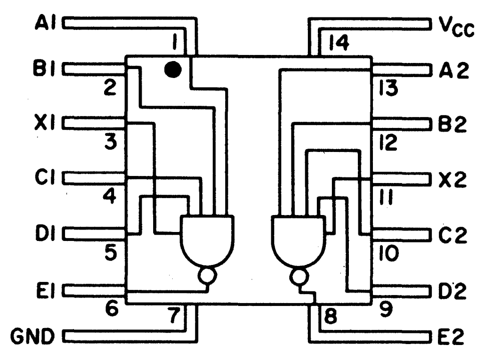
DUAL 4 INPUT BUFFER WITH EXPANDER

540
541

SCHEMATIC (EACH GATE)



LOGIC DIAGRAM AND PIN CONNECTIONS



ELECTRICAL CHARACTERISTICS

PART NO.	POWER LEVEL	RESISTANCE VALUES R_1	R_2	R_3	R_4	R_5	R_6	DISS. PER GATE (mW) TYP.	MAX.	PROPAGATION DELAY (nsec) −55°C TYP.	+25°C TYP.	+25°C MAX.	+125°C TYP.	I_{OL}	I_{OH}
540	M	∞	2.6K	2.0K	20K	11K		6.0	8.0	90	70	100	90	I_{OL2}	I_{OH2}
541	M	5.75K	2.6K	2.0K	20K	11K		4.5	6.0	90	70	100	90	I_{OL2}	

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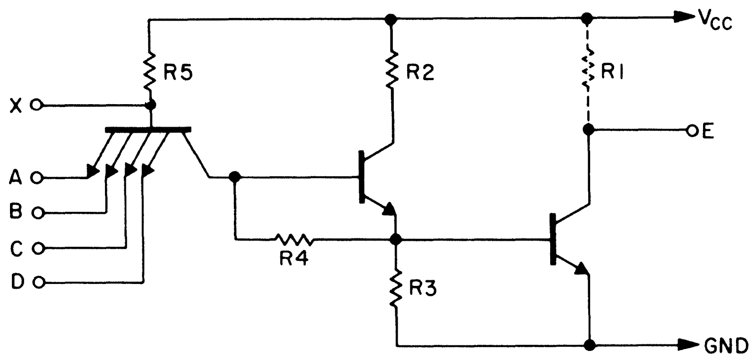
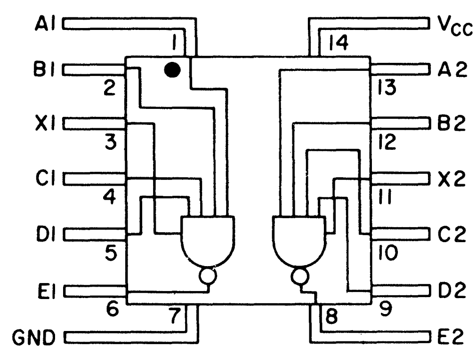
DUAL 4 INPUT GATE WITH EXPANDER

543
544
583
584

SCHEMATIC (EACH GATE)



LOGIC DIAGRAM AND PIN CONNECTIONS



ELECTRICAL CHARACTERISTICS

PART NO.	POWER LEVEL	RESISTANCE VALUES R_1	R_2	R_3	R_4	R_5	R_6	DISS. PER GATE (mW) TYP.	MAX.	PROPAGATION DELAY (nsec) −55°C TYP.	+25°C TYP.	+25°C MAX.	+125°C TYP.	I_{OL}
543	M	∞	10K	10K	20K	10K		1.5	2.3	85	85	120	85	I_{OL1}
544	M	10K	10K	10K	20K	10K		2.0	3.0	75	75	110	75	I_{OL1}
583	H	∞	7.0K	4.0K	5.0K	3.5K		4.1	5.5	50	30	60	45	I_{OL1}
584	H	6.0K	7.0K	4.0K	5.0K	3.5K		5.0	6.8	50	30	60	45	I_{OL1}

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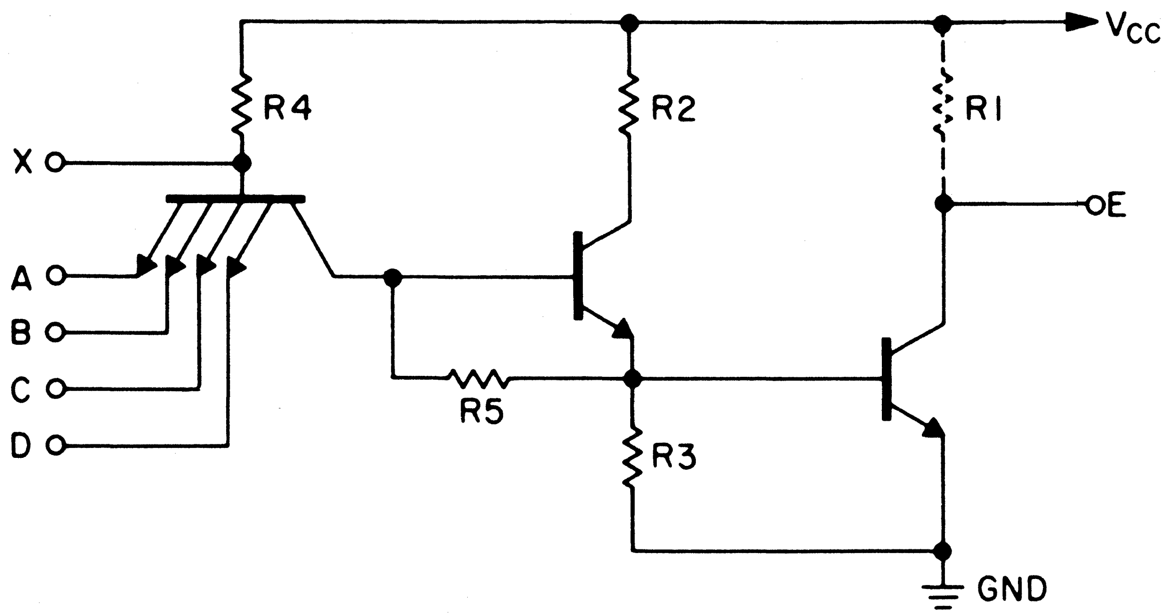
JANUARY 1968

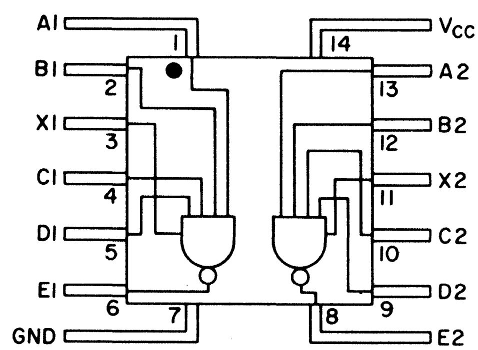
DUAL 4 INPUT POWER GATE AND LAMP DRIVER

547
548

SCHEMATIC (EACH GATE)



LOGIC DIAGRAM AND PIN CONNECTIONS



ELECTRICAL CHARACTERISTICS

PART NO.	POWER LEVEL	RESISTANCE VALUES R_1	R_2	R_3	R_4	R_5	R_6	DISS. PER GATE (mW) TYP.	MAX.	PROPAGATION DELAY (nsec) −55°C TYP.	+25°C TYP.	+25°C MAX.	+125°C TYP.	I_{OL}
547	M	5.0K	1.4K	2.0K	9.0K	20K		7.5	9.6	75	60	90	75	I_{OL3}
548	M	∞	1.4K	2.0K	9.0K	20K		6.2	8.0	75	60	90	75	I_{OL3}

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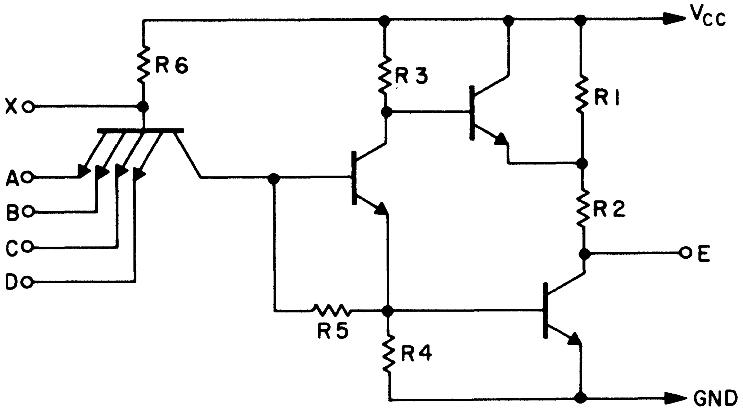
JANUARY 1968

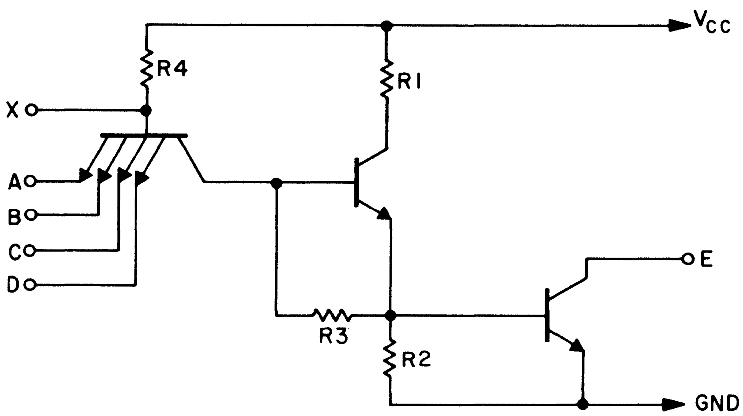
DUAL 4 INPUT BUFFER WITH EXPANDER
DUAL 4 INPUT GATE WITH EXPANDER

580
587

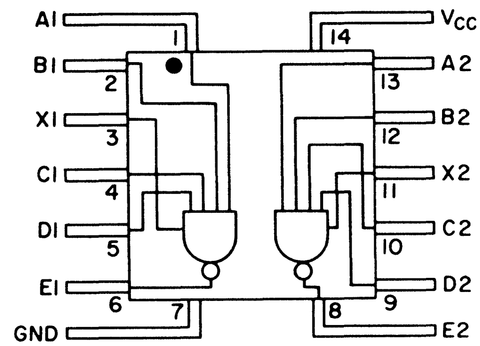
580 SCHEMATIC
DUAL 4 INPUT BUFFER WITH EXPANDER (EACH GATE)



587 SCHEMATIC
DUAL 4 INPUT GATE WITH EXPANDER (EACH GATE)



LOGIC DIAGRAM AND PIN CONNECTIONS



ELECTRICAL CHARACTERISTICS

PART NO.	POWER LEVEL	RESISTANCE VALUES R_1	R_2	R_3	R_4	R_5	R_6	DISS. PER GATE (mW) TYP.	MAX.	PROPAGATION DELAY (nsec) −55°C TYP.	+25°C TYP.	+25°C MAX.	+125°C TYP.	I_{OL}	I_{OH}
580	H	1.85K	150	850	630	5.0K	3.8K	17	22	60	45	60	60	I_{OL3}	I_{OH2}
587	H	850	630	5.0K	3.8K			13	17	60	55	60	60	I_{OL4}	

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6511

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TEST CIRCUITS

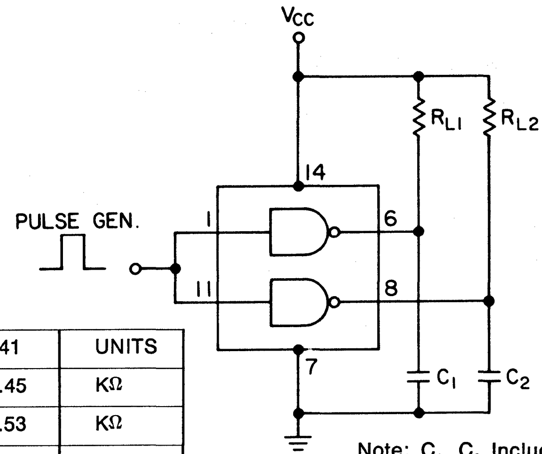
500 SERIES

T_{ON}, T_{OFF}
504, 534, 574, 580, 540, 541

$V_{threshold}$:

−55°C	25°C	125°C
1.8 V	1.5 V	1.2 V

V_{CC} = 4.0 Volt
Clock Freq: 1.0 MHz
Clock Amplitude: 4.0 Volt
Clock Duty Cycle: 50%
$T_r = T_f = 25 \pm 5$ nsec



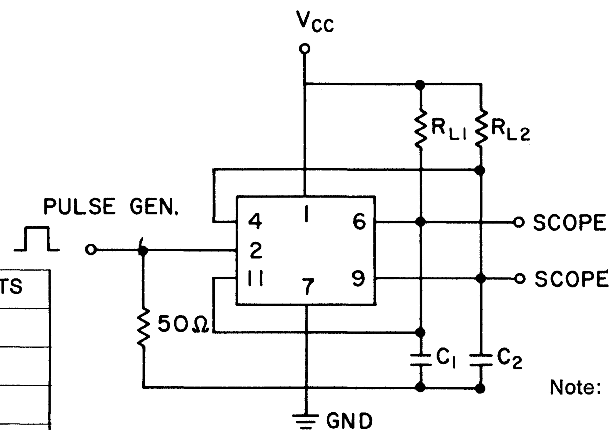
	504	534	574	580	540	541	UNITS
R_{L1}	4.2	1.4	0.47	0.15	0.45	0.45	KΩ
R_{L2}	40	10	3.9	0.51	1.53	1.53	KΩ
C_1	10	10	50	500	500	500	pf
C_2	10	10	30	500	500	500	pf

Note: C_1, C_2 Include Probe & Jig Capacitance
Allocate 10 pf for Probe & Jig Capacitance

T_{ON}, T_{OFF}
509, 539, 579

$V_{threshold}$:

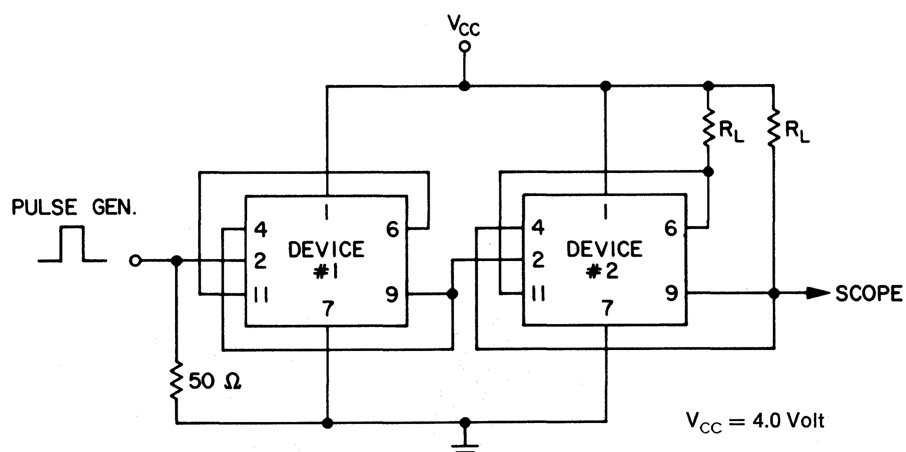
−55°C	25°C	125°C
1.8 V	1.5 V	1.2 V



	509	539	579	UNITS
R_{L1}	4.2	1.4	0.4	KΩ
R_{L2}	60	10	3.9	KΩ
C_1	10	10	30	pf
C_2	10	10	30	pf

Note: C_1, C_2 Include Probe & Jig Capacitance
Allocate 10 pf for Probe & Jig Capacitance

CLOCK RATE
509, 539, 579



	R_L
509	10 KΩ
539	3 KΩ
579	1 KΩ

V_{CC} = 4.0 Volt

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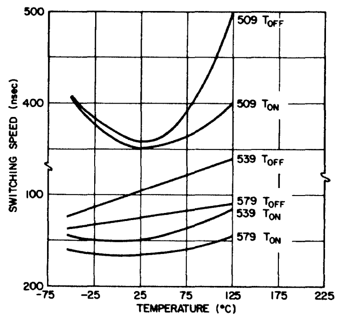
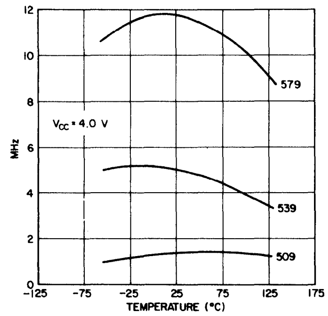
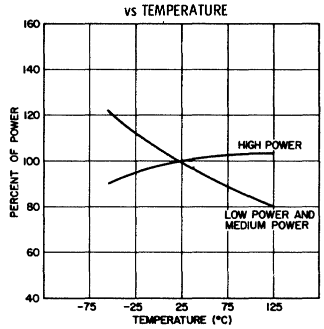
SWITCHING SPEEDS vs TEMPERATURE



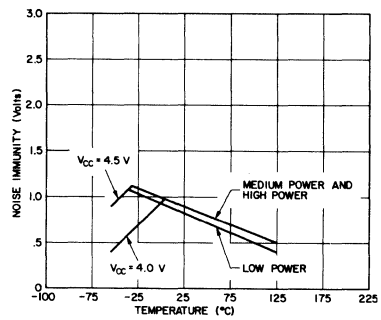
FLIP-FLOP CLOCK RATE vs TEMPERATURE



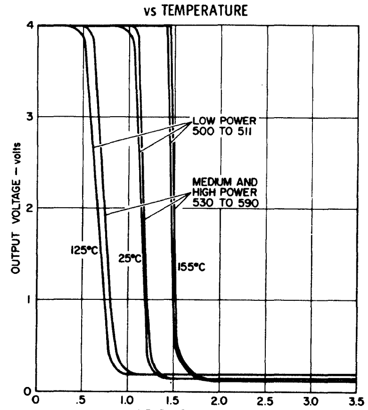
VARIATION OF POWER REQUIREMENTS vs TEMPERATURE



NOISE IMMUNITY vs TEMPERATURE



INPUT/OUTPUT TRANSFER CHARACTERISTICS vs TEMPERATURE

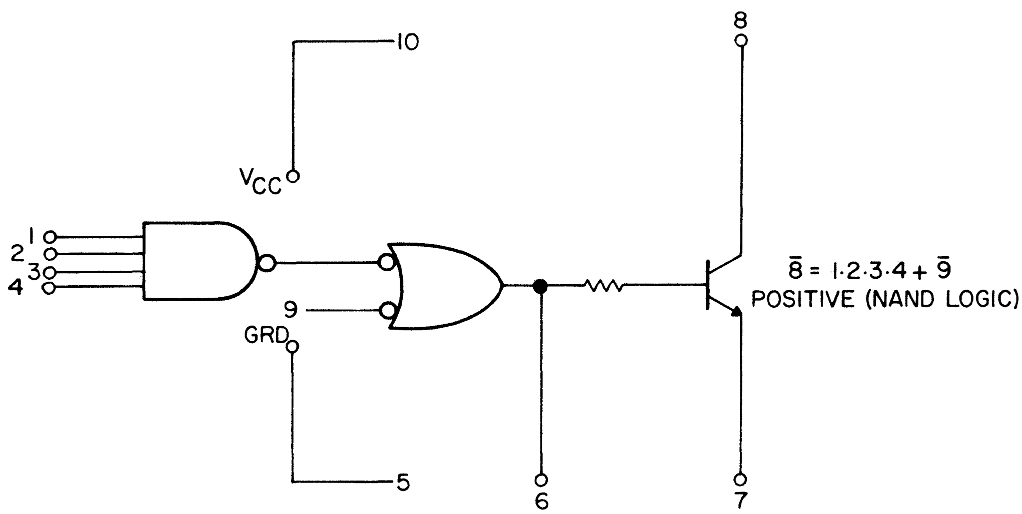


JANUARY 1968

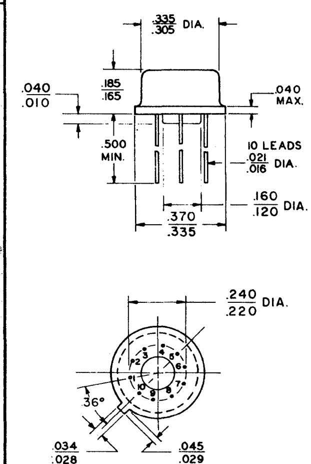
HYBRID CIRCUIT

2001BE

- INPUTS DTL COMPATIBLE (USES T²L 580)
- USE FOR CORE, CABLE, AND LAMP DRIVER
- HIGH CURRENT CAPABILITY—UP TO 250 mA
- HIGH VOLTAGE CAPABILITY—40 VOLTS LV_{CEO}
- LOGIC FLEXIBILITY—4 INPUT NAND WITH INHIBIT (NOR) INPUT



E PACKAGE



PIN 5 IS INTERNALLY CONNECTED TO CASE

ABSOLUTE MAXIMUM RATINGS

(25°C Free Air Temperature unless otherwise noted)

Maximum Voltage Applied to Pin 8	40 Volts
Maximum Voltage Applied to Pin 10	6.8 Volts
Power Operating	150 mW
Operating Temperature	−55°C to +125°C
Storage Temperature	−65°C to +150°C

Complete part number designation consists of four digits and two letters, for example:

2001BE
- Package
- Grade
- Type

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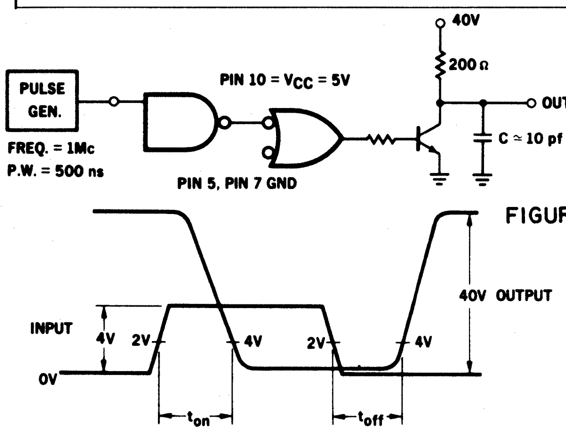
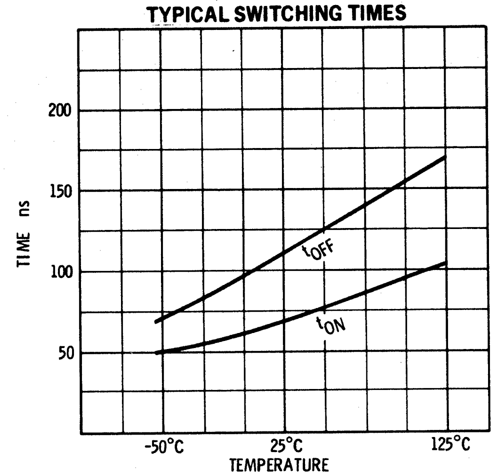
ELECTRICAL CHARACTERISTICS (V_{CC} = +5.0 Volts, Pins 5 and 7 Grounded)

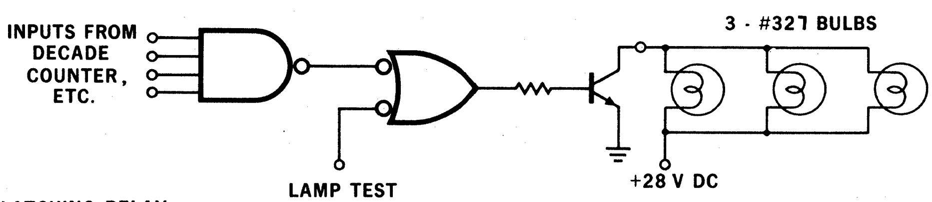
CHARACTERISTICS	PIN MEASURED	MIN.	TYP.	MAX.	UNITS
V_{OL} (Output Low) with $V_1 = V_2 = V_3 = V_4 = V_9 = 2.0$ Volts, $I_8 = 250$ mA	V_8			350	mV
I_{CEX} (Output High) with V_1 or V_2 or V_3 or $V_4 = 1.0$ Volts, V_9 open, $V_8 = 40$ Volts	I_8			5.0	μA
V_{OHB} (Buffer Output High) with $V_1 = V_2 = V_3 = V_4 = V_9 = 2.0$ Volts	V_6	2.1			Volts
V_{OLB} (Buffer Output Low) with V_1 or V_2 or V_3 or $V_4 = 1.0$ Volts, V_9 open	V_6			100	mV
I_F (Input Current of Pin 1, 2, 3, 4, or 9) Pin under test at 0 Volts, other inputs open	$I_{1-4\,9}$			−1.6	mA
t_{on} (Switch Turn-On Time) (See test conditions Figure 1)			70		ns
t_{off} (Switch Turn-Off Time) (See test conditions Figure 1)			110		ns



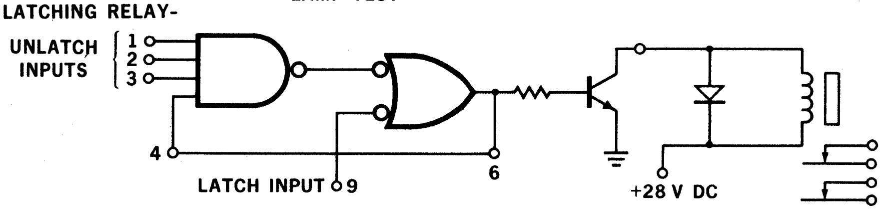
TYPICAL SWITCHING TIMES



LAMP DRIVER-

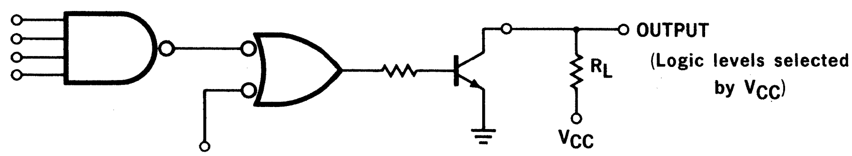


LATCHING RELAY-



Relay will unlatch if any input (1, 2, 3) goes low.

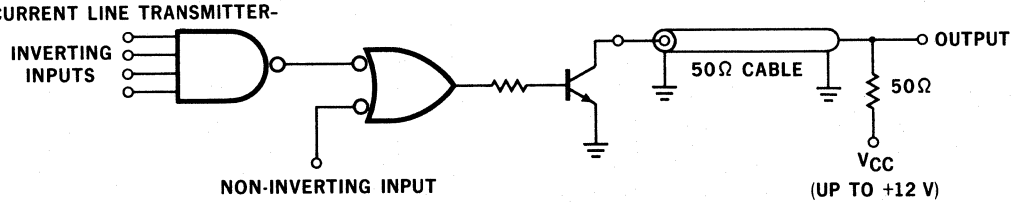
DTμL INTERFACE DRIVER-



$R_L \geq 160\Omega$ at V_{CC} = 40 VOLTS

$R_L \geq 80\Omega$ at V_{CC} = 20 VOLTS

HIGH-CURRENT LINE TRANSMITTER-



NOTE: If only non-inverting input is used, one of the inverting inputs must be grounded.

JANUARY 1968

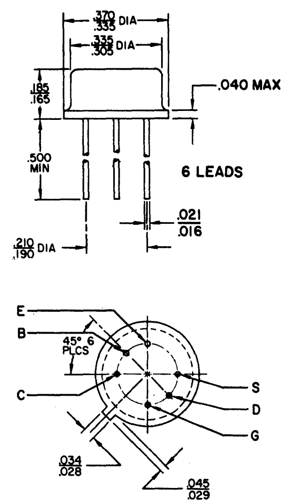
HYBRID CIRCUIT SWITCH
SINGLE POLE SINGLE THROW

2107BE
2110BE

These gates are designed for general purpose high level signal switching, scanning, multiplexing, A/D conversion, telemetry and chopper applications. They feature high switching speed plus the capability of handling high level AC signals at frequencies in excess of 1 MHz.

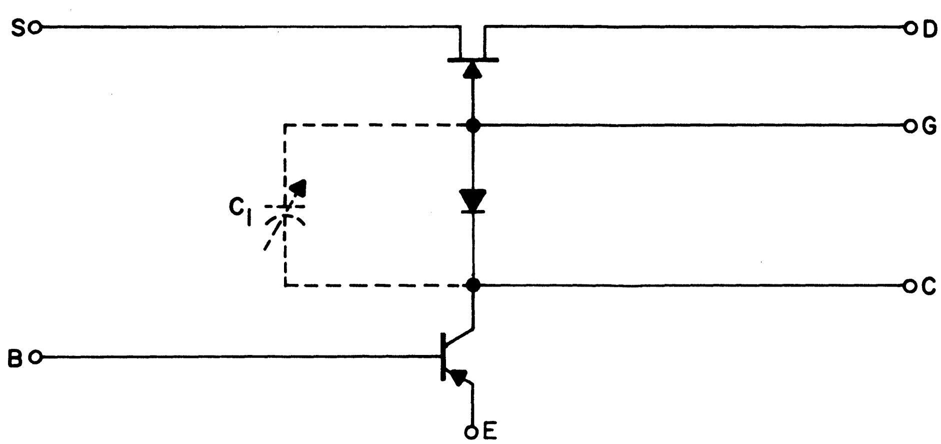
The elements provide the necessary isolation between the data signal and the drive signal without the use of a transformer and have zero offset voltage. Internal diode requires no external capacitor for switching application.

E PACKAGE



ABSOLUTE MAXIMUM RATINGS

Storage Temperature Range	−65°C to +165°C
Operating Temperature Range	−55°C to +125°C
Power Dissipation at $T_A = 25°C$ $T_C = 25°C$	0.8 Watt 2.0
Derating factors θ_{JA} θ_{JC}	 4.0 mW/°C 20



ELECTRICAL CHARACTERISTICS AT +25°C (Unless Otherwise Specified)

PARAMETER	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNITS
DC Output Voltage Range	V_{OUT}				
2107BE		See Figure 1	±5		Volts
2110BE		See Figure 1	±10		
Drain-Source On Resistance	r_{ds}				
2107BE		$I_D = 1.0$ mA, $V_{GS} = 0$		100	Ω
2110BE				50	
2107BE		$I_D = 1.0$ mA, $V_{GS} = 0$, $T_A = 85°C$		140	
2110BE				90	

Complete part number designation consists of three digits and two letters, for example:

2107BE
- Package
- Temperature Range
- Circuit

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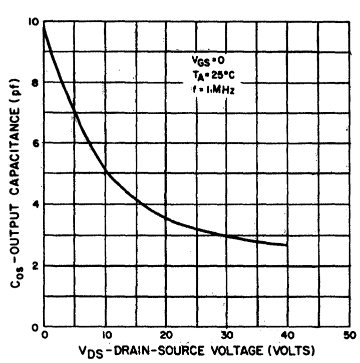
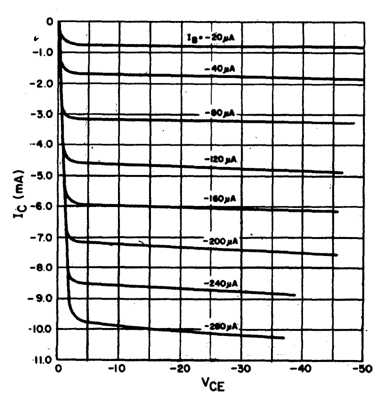
PARAMETER	SYMBOL	TEST CONDITIONS	MIN.	TYP.	MAX.	UNITS
Turn-On Time	t_{on}	See Figure 1		350	700	nsec
Turn-Off Time	t_{off}	See Figure 1		350	700	nsec
Drain-Gate Capacitance	C_{dgo}	$V_{DG} = 10\ V$ $I_S = 0$ $f = 1.0\ MHz$			5.0	pf
Source-Gate Capacitance	C_{sgo}	$V_{SG} = 10\ V$ $I_D = 0$ $f = 1.0\ MHz$			5.0	pf
Drain Cutoff Current	$I_{D(OFF)}$	$V_{DS} = 20\ V$ $V_{GS} = -7.0\ V$ $V_{DS} = 20\ V$ $V_{GS} = -7.0\ V, T_A = 85°C$		0.2 20	1.0	nA
Gate-Channel Breakdown Voltage	BV_{GSS}	$I_G = 1.0\ \mu A$ $V_{DS} = 0$	30.			Volts
Collector-Base Cutoff Current	I_{CBO}	$V_{CB} = 30\ V$ $I_E = 0$			10	nA
Collector-Gate Breakdown Voltage	BV_{CBO}	$I_C = 10\ \mu A$ $I_E = 0$	40			Volts
Collector-Emitter Sustaining Voltage	V_{CEO}		40			Volts
Emitter-Base Breakdown Voltage	BV_{EBO}	$I_E = 0.1\ \mu A$ $I_C = 0$	5.0			Volts
DC Current Gain	h_{FE}	$I_C = 10\ mA$ $V_{CE} = 10\ V$	40			
AC Output Voltage Range 2107BE 2110BE	e_{OUT}	See Figure 2		5.6 10		V_{p-p}

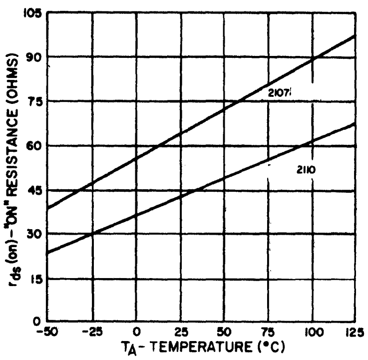
Output Capacitance vs Drain-Source Voltage



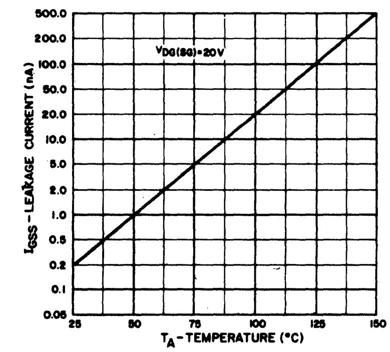
PNP Transfer Characteristics



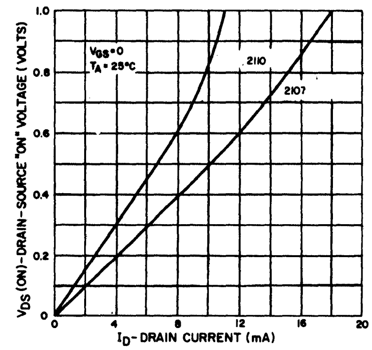
On Resistance vs Ambient Temperature



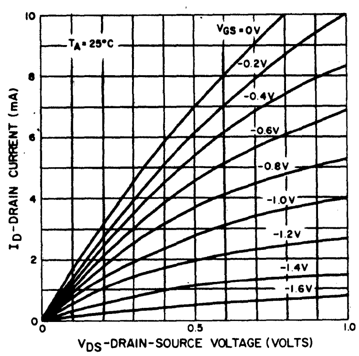
Drain Cutoff Current and Source Cutoff Current vs Ambient Temperature



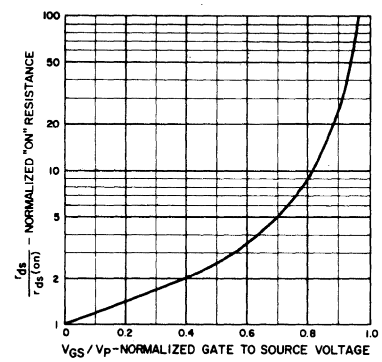
Drain-Source "ON" Voltage vs Drain Current



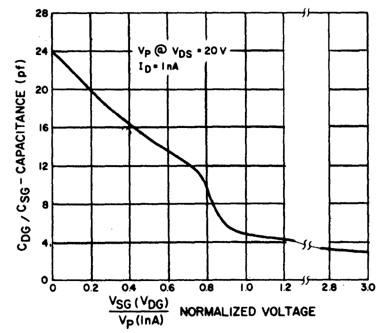
FET Transfer Characteristics 2107 BE



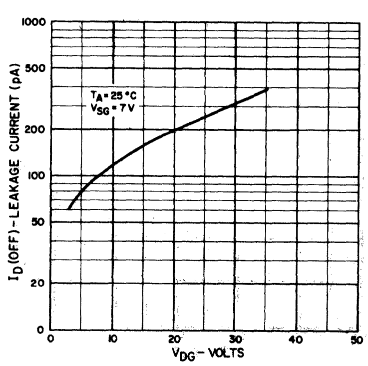
NORMALIZED V_{DS} vs. V_{GS}



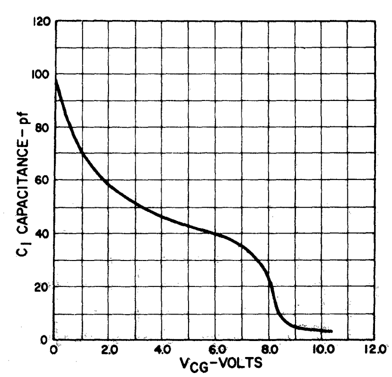
Junction Capacitance vs Normalized Bias



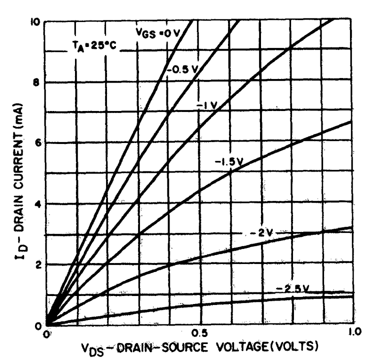
Leakage Current vs Voltage



C_1 Capacitance vs V_{CG}



FET Transfer Characteristics 2110 BE



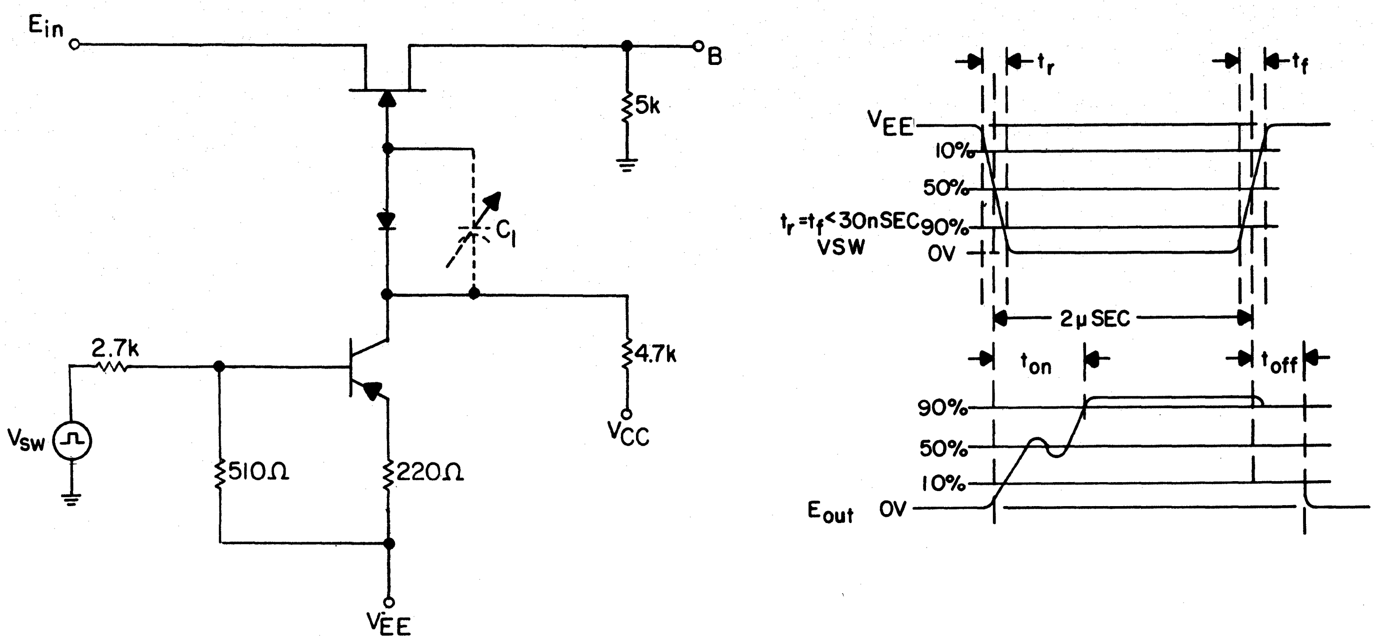


Figure 1. DC Input Test Circuit

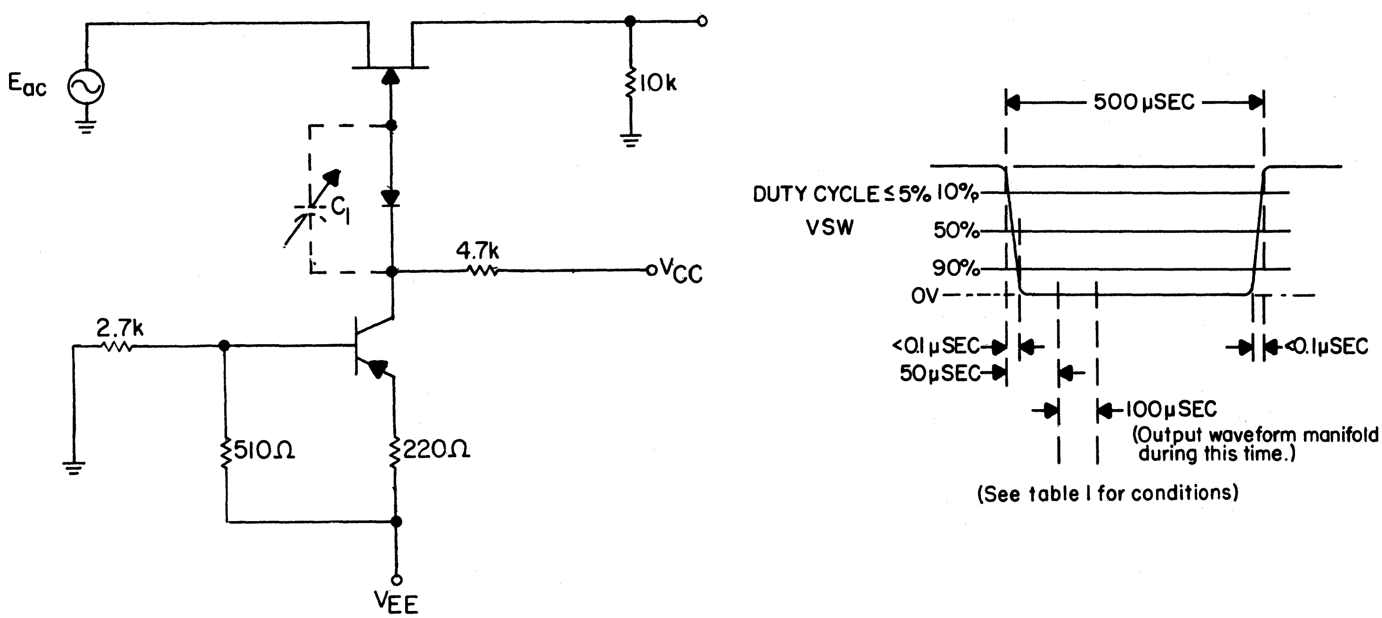


Figure 2. AC Clipping Test Circuit

TABLE 1

GATE	2107BE	2110BE
V_{EE}	+12 V	+18 V
V_{CC}	−12 V	−18 V

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JANUARY 1968

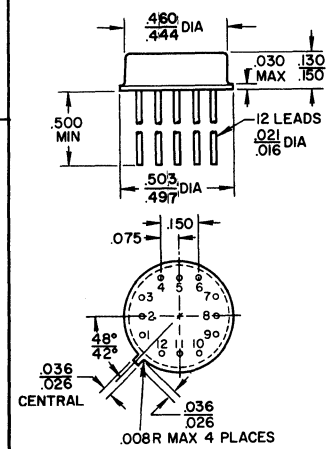
HYBRID CIRCUIT SWITCH

DOUBLE THROW SINGLE POLE

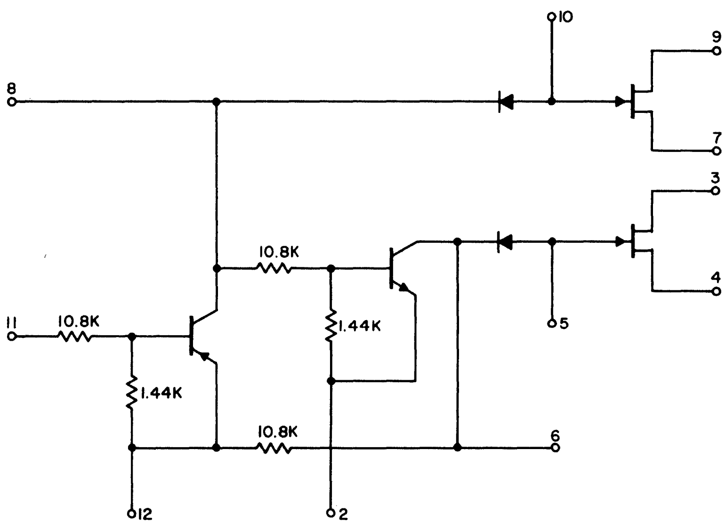
2114BF

This Analog Switch is used for high level multiplexing, A/D conversion, telemetry, and chopper applications. It features high switching speeds and has the capability of handling ac signals with frequencies in excess of one megahertz.

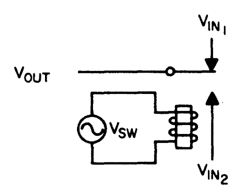
F Package



PIN 6 COMMON TO CASE



Circuit Schematic



(Mechanical Equivalent)

ABSOLUTE MAXIMUM RATINGS

Storage Temperature	−65°C to +150°C
Operating Temperature	−55°C to +125°C
Power Dissipation @ $T_A = 25°C$	1.36 W
Thermal Resistance @ $T_A = 25°C$ θ_{JC} θ_{JA}	 50°C/Watt 110°C/Watt

Complete part number designation consists of four digits and two letters, for example:

2114BF
- Package
- Temperature Range
- Circuit

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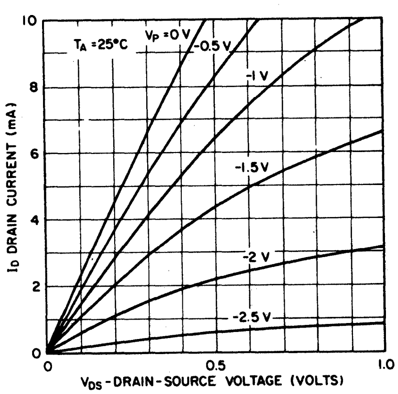
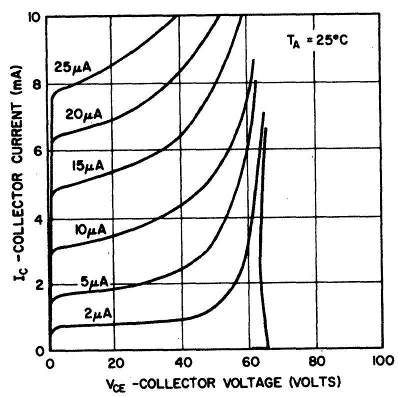
ELECTRICAL CHARACTERISTICS AT +25°C (Unless Otherwise Specified)

PARAMETER	SYMBOL	TEST CONDITIONS	LIMIT MIN.	LIMIT MAX.	UNITS
Static Drain-Source "ON" Resistance	r_{DS}	$I_D = 1.0$ mA, $V_{GS} = 0$ $I_D = 1.0$ mA, $V_{GS} = 0$, $T_A = 85°C$		100 150	Ω
Drain-Source "OFF" Resistance	$R_{(OFF)}$	$V_{DS} = 10$ V, $V_{GS} = -7.0$ V	10^8		Ω
Drain-Gate Leakage Current	$I_{D(OFF)}$	$V_{DS} = 20$ V, $V_{GS} = -7.0$ V $V_{DS} = 20$ V, $V_{GS} = -7.0$ V, $T_A = 85°C$		1.0 60	nA
FET Gate-Source Breakdown Voltage	$V_{(BR)GSS}$	$I_G = 1.0\ \mu A$, $V_{DS} = 0$	35		Volts
Diode Breakdown Voltage	V_R	$I_R = 1.0\ \mu A$	40		Volts
Transistor Collector-Emitter Breakdown Voltage	LV_{CEO}	$I_C = 10$ mA, $I_B = 0$	40		Volts
Drain-Gate Capacitance	C_{dgo}	$V_{DC} = 20$ V, $I_S = 0$ f = 1.0 MHz		5.0	pf
Source-Gate Capacitance	C_{sgo}	$V_{GS} = 20$ V, $I_D = 0$ f = 1.0 MHz		5.0	pf
Turn-On Time	t_{on}	See Figure 1		900	nsec
Turn-Off Time	t_{off}	See Figure 1		900	nsec
DC Voltage Range	V_{OUT}	See Figure 2	±9.0		Volts
AC Peak Voltage Range	E_{OUT}	See Figure 2	±9.0		Volts

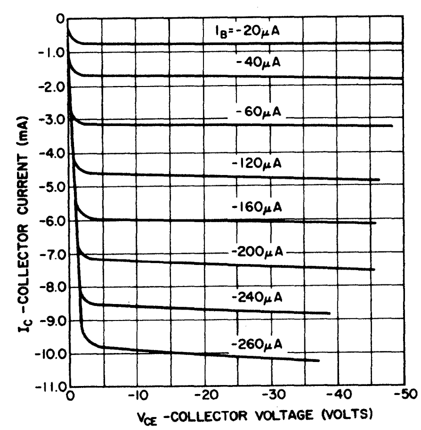
FET
Common Source-
Drain Characteristics



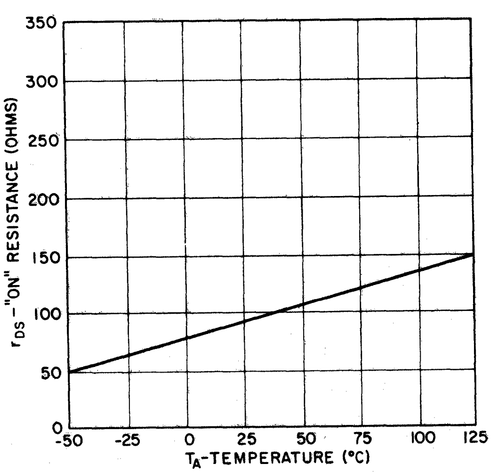
NPN
Transfer
Characteristics



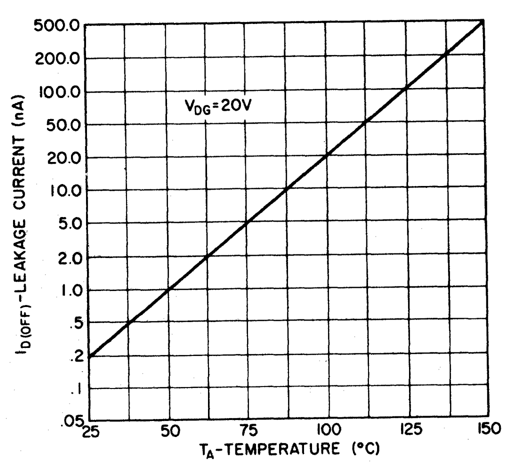
PNP
Transfer
Characteristics



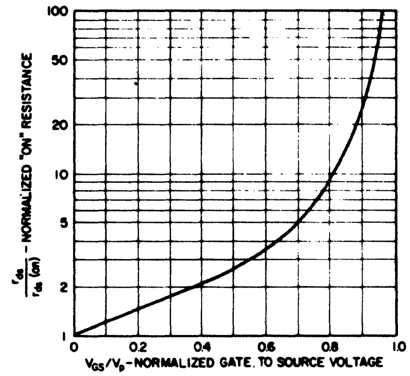
Drain-Source "ON" Resistance
vs
Ambient Temperature



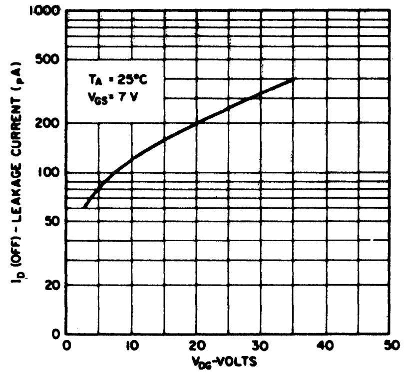
Drain-Gate Leakage Current
vs
Ambient Temperature



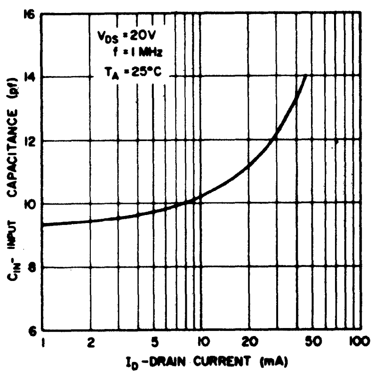
Normalized r_{ds} vs V_{GS}



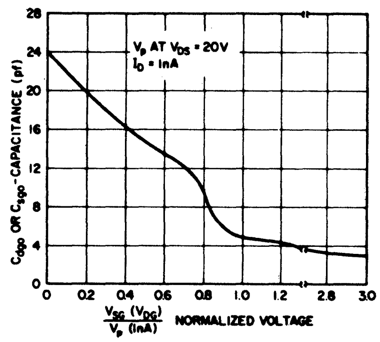
Drain-Gate Leakage Current vs Drain-Gate Voltage



Input Capacitance vs Drain Current



Junction Capacitance vs Normalized Bias



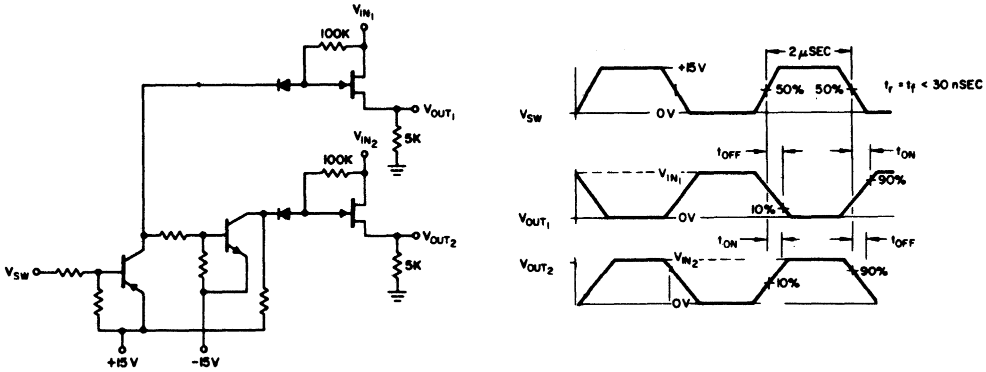


Figure 1. Switching Time & DC Voltage Test

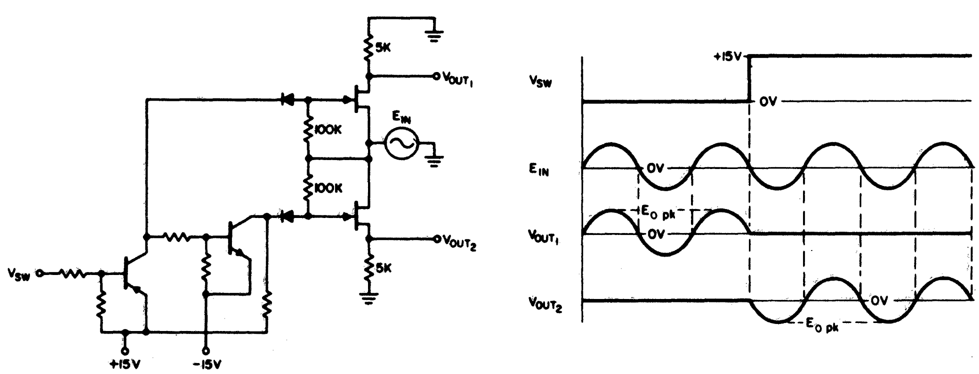


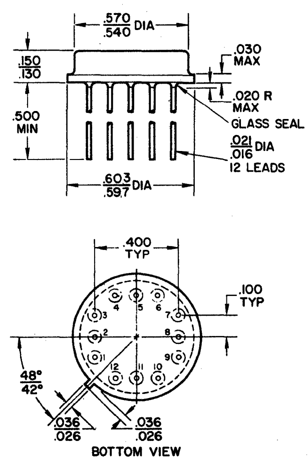
Figure 2. AC Clipping Level Test

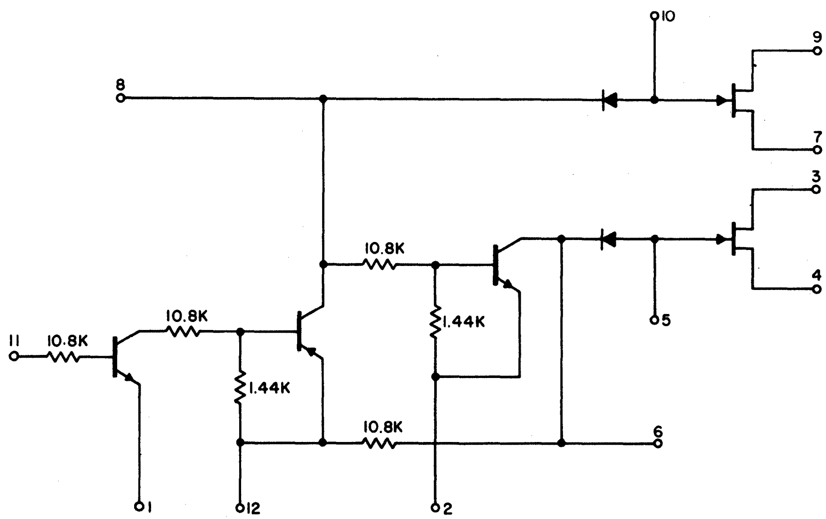
HYBRID CIRCUIT SWITCH
DOUBLE THROW SINGLE POLE

2126BG

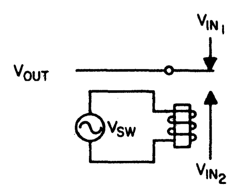
This Analog Switch is used for high level multiplexing, A/D conversion, telemetry, and chopper applications and may be driven from TTL, DTL, RTL, or SHUL logic. It features high switching speeds and has the capability of handling ac signals with frequencies in excess of one megahertz.

G PACKAGE





Circuit Schematic



(Mechanical Equivalent)

ABSOLUTE MAXIMUM RATINGS

Storage Temperature	−65°C to +150°C
Operating Temperature	−55°C to +125°C
Operating Voltages	±18 Volts
Thermal Resistance @ $T_A = 25°C$ θ_{JA} θ_{JC}	 110°C/Watt 50°C/Watt

Complete part number designation consists of four digits and two letters, for example:

2126 BG
- Package
- Temperature Range
- Circuit

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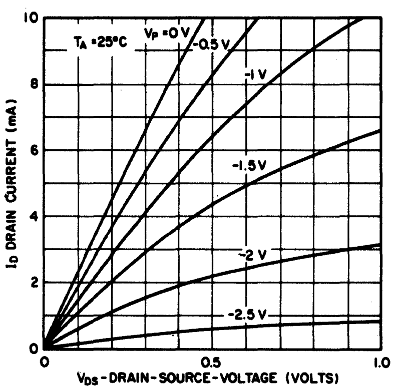
Printed in U.S.A.

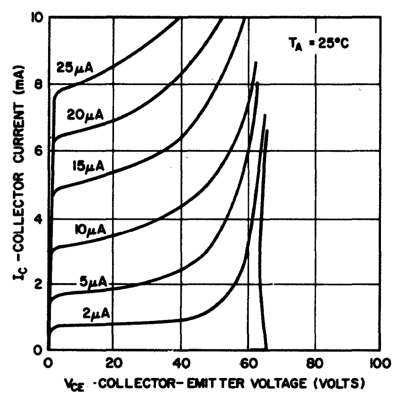
ELECTRICAL CHARACTERISTICS AT +25°C (Unless Otherwise Specified)

PARAMETER	SYMBOL	TEST CONDITIONS	LIMIT MIN.	LIMIT MAX.	UNITS
Static Drain-Source "ON" Resistance	r_{DS}	$I_D = 1.0$ mA, $V_{GS} = 0$ $I_D = 1.0$ mA, $V_{GS} = 0$, $T_A = 85°C$		65 95	Ω
Drain-Source "OFF" Resistance	$R_{(off)}$	$V_{DS} = 10$ V, $V_{GS} = -7.0$ V	10^8		Ω
Drain-Gate Leakage Current	$I_{D(off)}$	$V_{DS} = 20$ V, $V_{GS} = -7.0$ V $V_{DS} = 20$ V, $V_{GS} = -7.0$ V, $T_A = 85°C$		1.0 60	nA
FET Gate-Source Breakdown Voltage	$V_{(BR)GSS}$	$I_G = 1.0\ \mu A$, $V_{DS} = 0$	35		Volts
Diode Breakdown Voltage	V_R	$I_R = 1.0\ \mu A$	40		Volts
Transistor Collector-Emitter Breakdown Voltage	LV_{CEO}	$I_C = 10$ mA, $I_B = 0$	40		Volts
Drain-Gate Capacitance	C_{dgo}	$V_{DC} = 20$ V, $I_S = 0$ f = 1.0 MHz		7.0	pf
Source-Gate Capacitance	C_{sgo}	$V_{GS} = 20$ V, $I_D = 0$ f = 1.0 MHz		7.0	pf
Turn-On Time	t_{on}	See Fig. 1		1.5	μsec
Turn-Off Time	t_{off}	See Fig. 1		1.5	μsec
DC Voltage Range	V_{OUT}	See Fig. 2	±8.0		Volts
AC Peak Voltage Range	E_{OUT}	See Fig. 2	±8.0		Volts

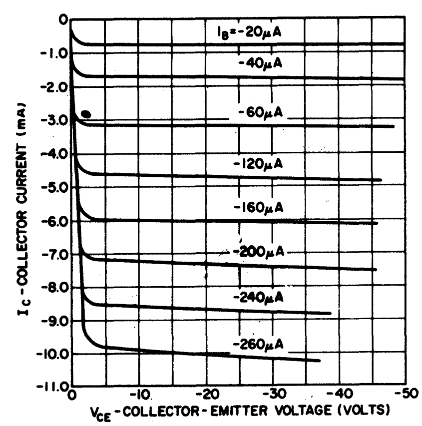
FET Common Source-Drain Characteristics



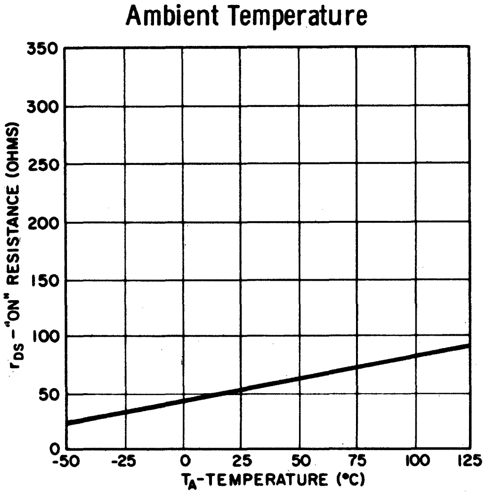
NPN Transfer Characteristics



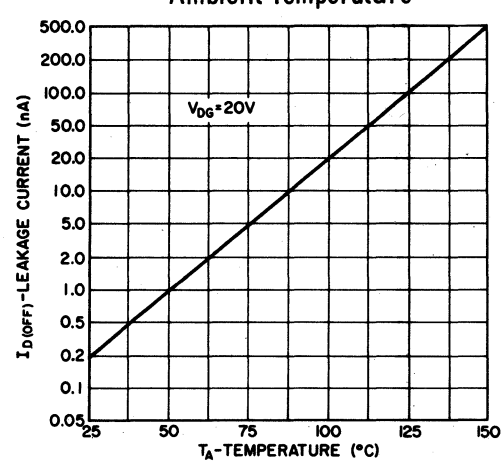
PNP Transfer Characteristics



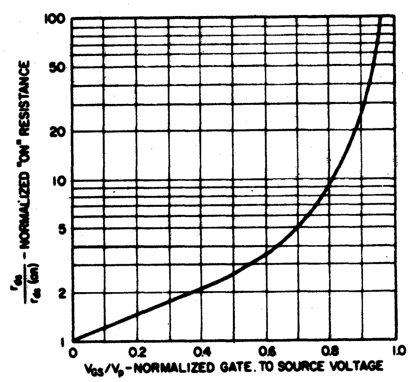
Drain-Source "ON" Resistance vs Ambient Temperature



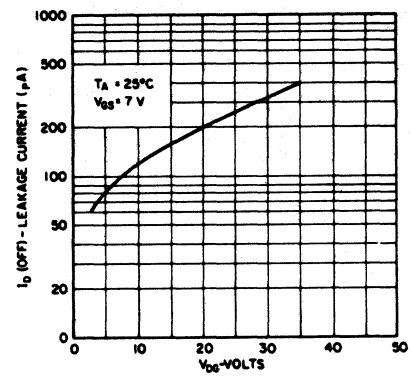
Drain-Gate Leakage Current vs Ambient Temperature



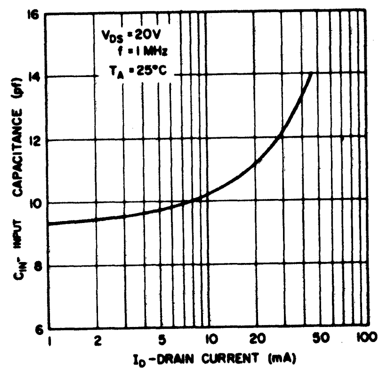
Normalized r_{ds} vs V_{GS}



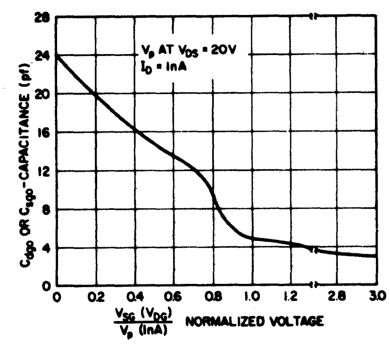
Drain-Gate Leakage Current vs Drain-Gate Voltage



Input Capacitance vs Drain Current



Junction Capacitance vs Normalized Bias



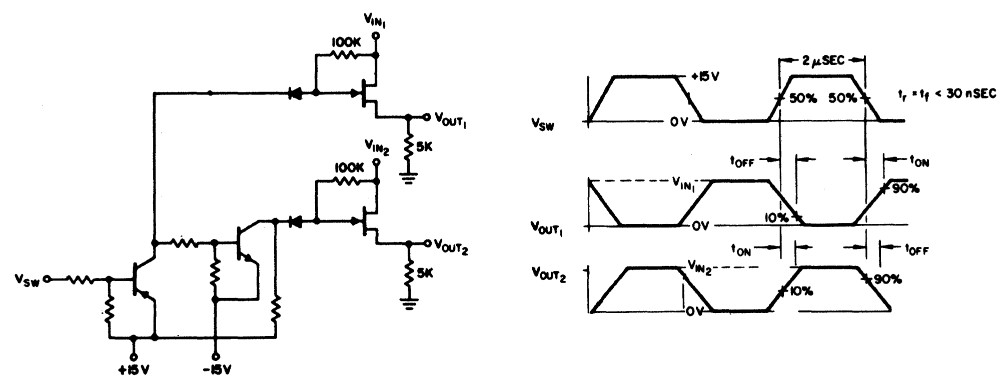


Figure 1. Switching Time & DC Voltage Test

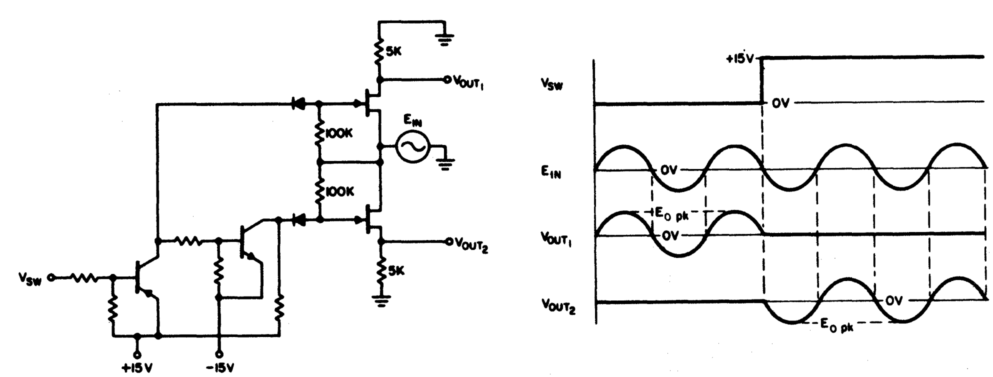


Figure 2. AC Clipping Level Test

JANUARY 1968

HYBRID CIRCUIT SWITCH

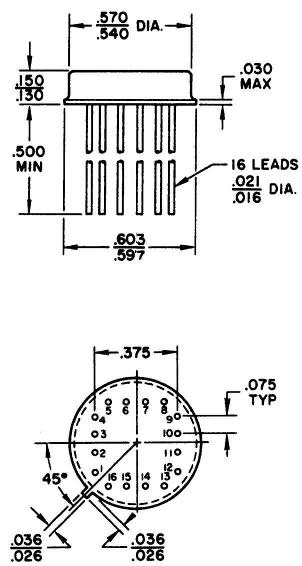
QUAD SINGLE POLE SINGLE THROW

2128BG

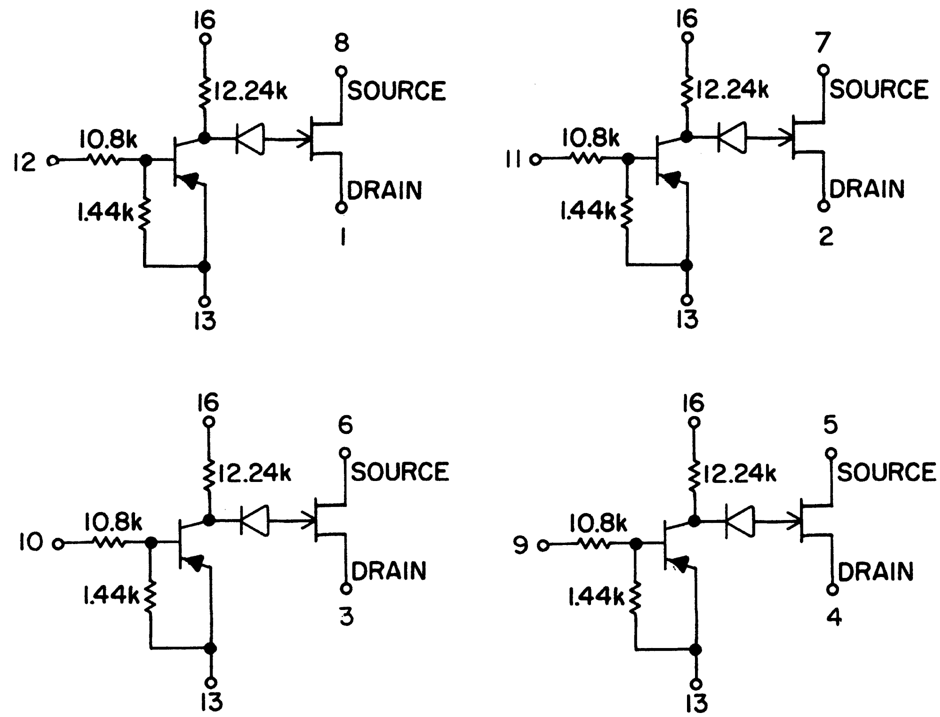
The Amelco 2128BG is a quad analog switch for multiplexing, sample and hold, A/D conversion and chopper applications.

Thin film techniques were used to combine four FET diodes, twelve thin-film tantalum resistors, four 2N2907 pnp transistors and four 2N4092 FET's in one low profile TO-8 header. As a result, a quad analog gate is available for military and industrial applications where more reliability, added performance, and more package density are required.

G PACKAGE



BOTTOM VIEW



ABSOLUTE MAXIMUM RATINGS

Storage Temperature	−65°C to +150°C
Operating Temperature	−55°C to +125°C
Thermal Resistance	θ_{JA} = 50°C/Watt θ_{JC} = 110°C/Watt
Operating Voltages	$+V_{CC}$ = +18 Volts $-V_{CC}$ = −18 Volts

Complete part number designation consists of four digits and two letters, for example:

2128BG
- Package
- Grade
- Type

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7104

ELECTRICAL CHARACTERISTICS at 25°C (Unless Otherwise Specified)

PARAMETER	SYMBOL	TEST CONDITIONS	LIMITS		UNITS
			MIN.	MAX.	
Static Drain-Source "ON" Resistance	r_{ds}	$I_D = 1.0$ mA		50	Ohms
		$I_D = 1.0$ mA, $T_A = 105°C$		90	Ohms
Drain-Source "OFF" Resistance	$R_{(off)}$	$V_{DS} = 10$ V, $V_{GS} = -7.0$ V	10^8		Ohms
Drain-Gate Leakage Current	$I_{D(off)}$	$V_{DS} = 20$ V, $V_{GS} = -7.0$ V		1.0	nA
		$V_{DS} = 20$ V, $V_{GS} = -7.0$ V, $T_A = 105°C$		0.3	μA
Turn-On Time	t_{on}	Figure 1		1.0	μsec
Turn-Off Time	t_{off}	Figure 1		1.0	μsec
DC Output Voltage Range	$\pm E_{out}$	Figure 1	±7.0		Volts
AC Output Voltage Range	e_{out}	Figure 1	8.0		V_{p-p}

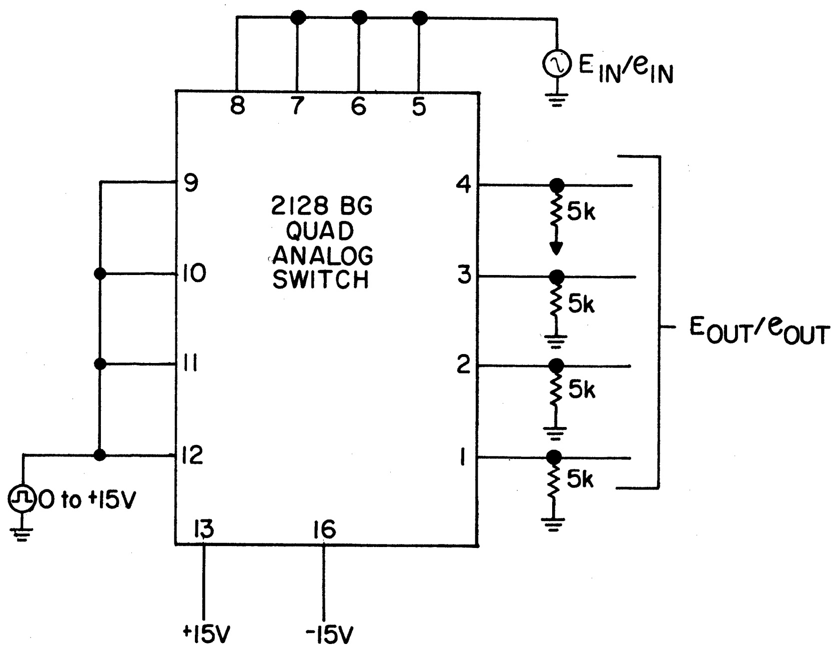


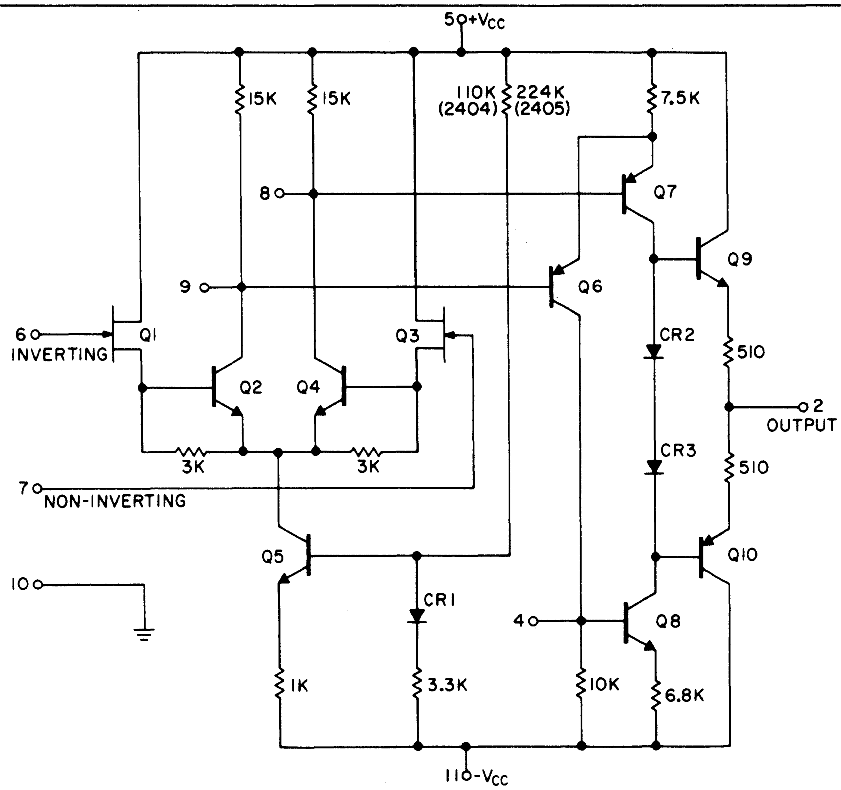
FIGURE 1, TEST CONFIGURATION FOR TURN-ON TIME, TURN-OFF TIME DC OUTPUT VOLTAGE RANGE. AND AC OUTPUT VOLTAGE RANGE.

JANUARY 1968

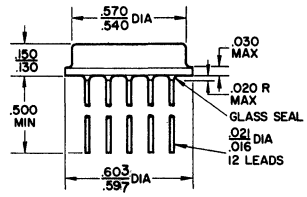
HYBRID CIRCUIT
OPERATIONAL AMPLIFIER
- LOW POWER
- HIGH VOLTAGE

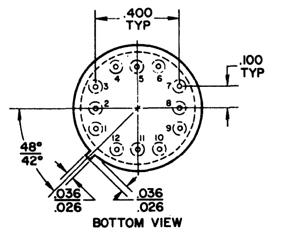
2404BG
2405BG

These Hybrid Operational Amplifiers are designed specifically for applications requiring very high input impedance and extremely low power consumption. Other outstanding electrical characteristics include extremely low offset currents and drifts, high open loop gains, and short-circuit protected output.



G PACKAGE





ABSOLUTE MAXIMUM RATINGS

Storage Temperature Range	−65°C to +150°C
Operational Temperature Range	−55°C to +125°C
Maximum Supply Voltage 2404BG 2405BG	 ±18 V ±35 V
Thermal Resistance @ $T_A = 25°C$ θ_{JC} θ_{JA}	 50°C/W 110°C/W

Complete part number designation consists of four digits and two letters, for example:

2404BG
- Package
- Temperature Range
- Circuit

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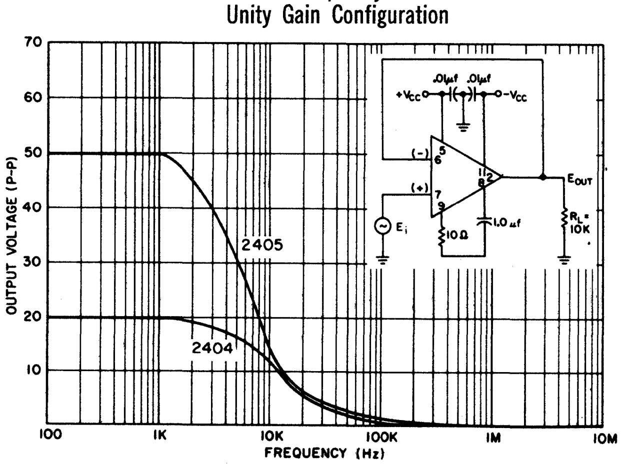
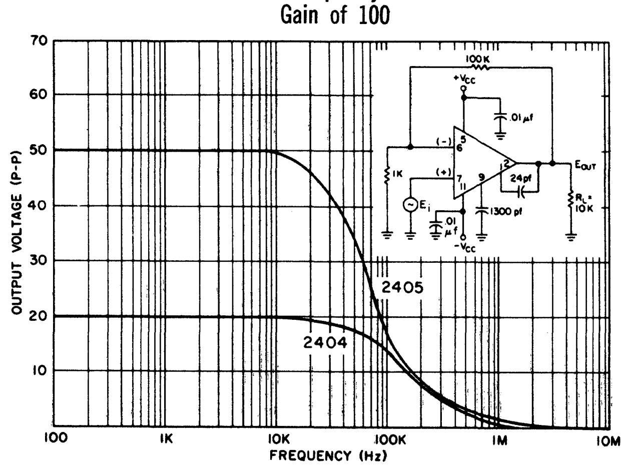
ELECTRICAL CHARACTERISTICS AT +25°C (Unless Otherwise Specified)

PARAMETER	MIN.	TYP.	MAX.	UNITS
Open Loop Voltage Gain	90	100		db
Input Resistance	10k	100k		MΩ
Input Bias Current		20		pA
Input Bias Current $T_A = 125°C$		15	40	nA
Input Offset Current		2.0		pA
Input Offset Current $T_A = 125°C$		1.0	5.0	nA
Input Offset Current Drift $T_A = -55°C$ to $+85°C$ $T_A = -55°C$ to $+125°C$		 5.0 20	 10 90	pA/°C
Input Offset Voltage		3.0	10	mV
Input Offset Voltage Drift $T_A = -55°C$ to $+125°C$		5.0	25	μV/°C
Common Mode Voltage Range (2404) (2405)	 8.0 16	 10 25		±V
Common Mode Rejection Ratio		−90	−74	db
Input Noise (See Figure 1)		3.0		μV_{rms}
Slew Rate (See Figure 2)		2.0		V/μsec
Power Dissipation (2404) $V_{CC} = \pm 15$ V (2405) $V_{CC} = \pm 30$ V			 55 110	mW
Power Supply Rejection Ratio		−90	−74	db
Output Voltage Swing $R_L = 10k$ (2404) (2405)	 20 40	 22 50		V_{p-p}

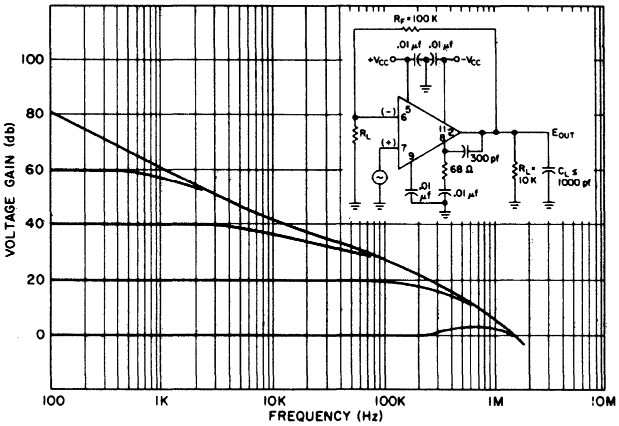
Output Voltage Swing
vs.
Frequency
Unity Gain Configuration



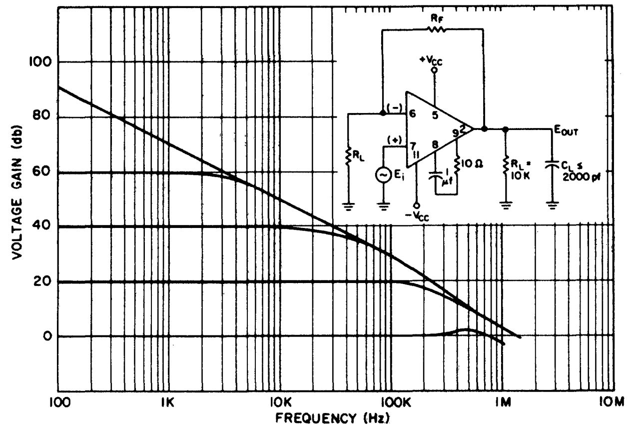
Output Voltage Swing
vs.
Frequency
Gain of 100



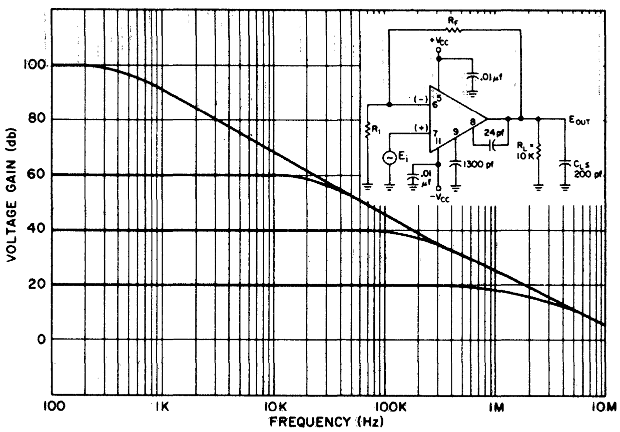
Voltage Gain
vs
Frequency



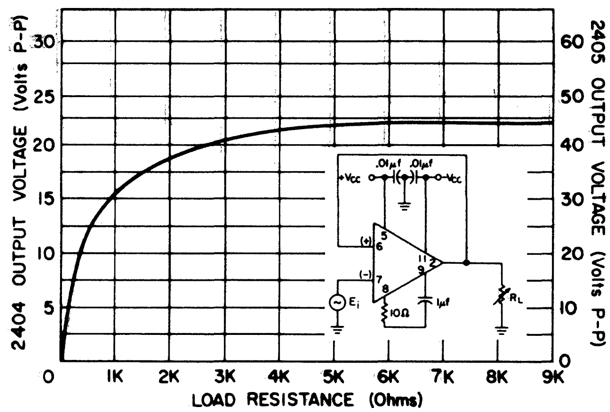
Voltage Gain
vs
Frequency



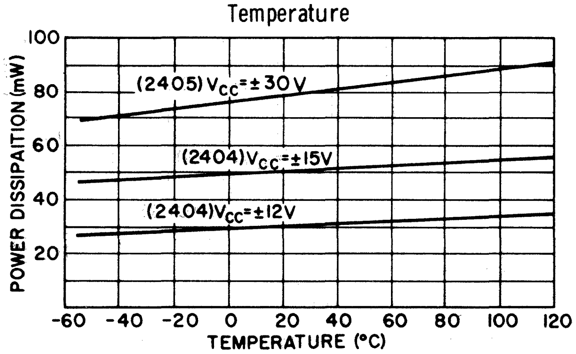
Voltage Gain
vs
Frequency



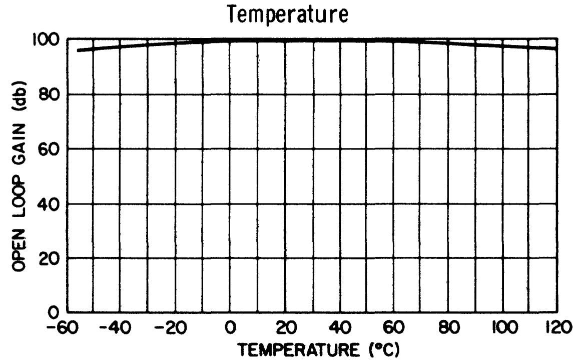
Output Voltage
vs
Load Resistance for
Unity Gain

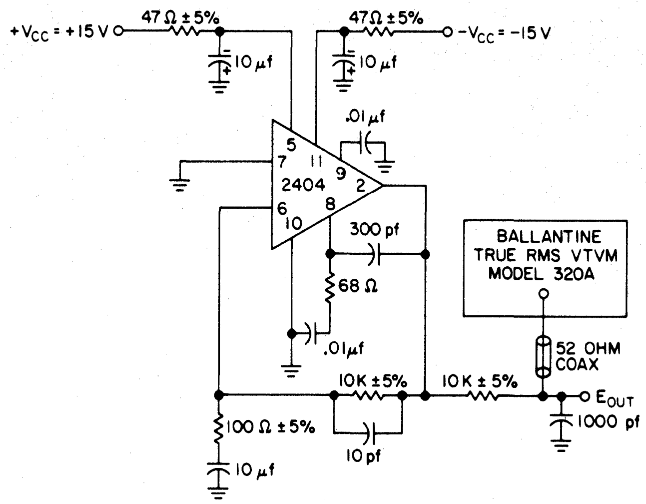


Power Dissipation
vs
Temperature

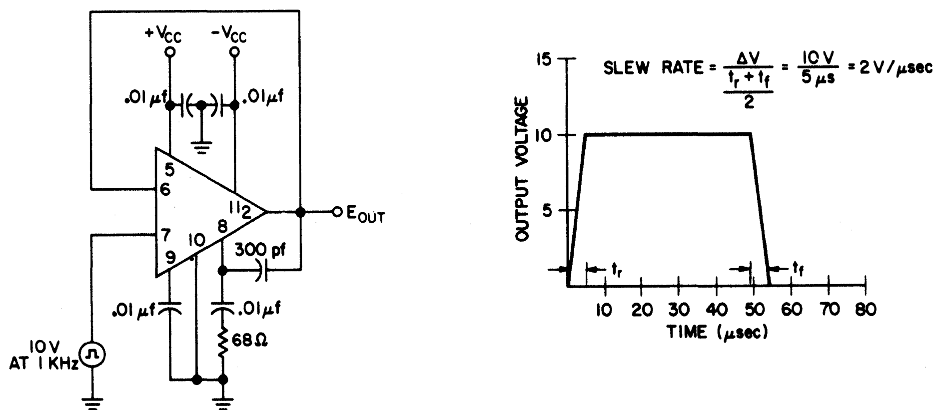


Open Loop Voltage Gain
vs
Temperature

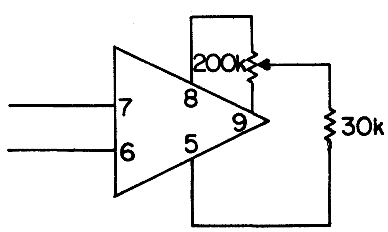




Noise Test Setup, Wide Band Noise 160 Hz to 16 kHz



Slew Rate Test Configuration



Offset Voltage Adjustment

JANUARY 1968

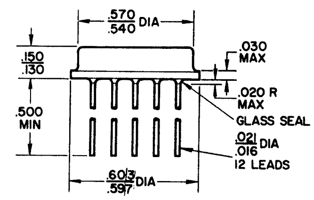
HYBRID CIRCUIT
VOLTAGE REGULATOR

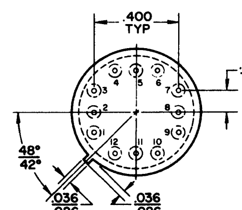
2802BG
2803BG

The 2802, positive voltage regulator, and the 2803, negative voltage regulator, are designed to be used with linear and digital circuits. Both regulators are packaged in low profile TO8 headers. Important features are:

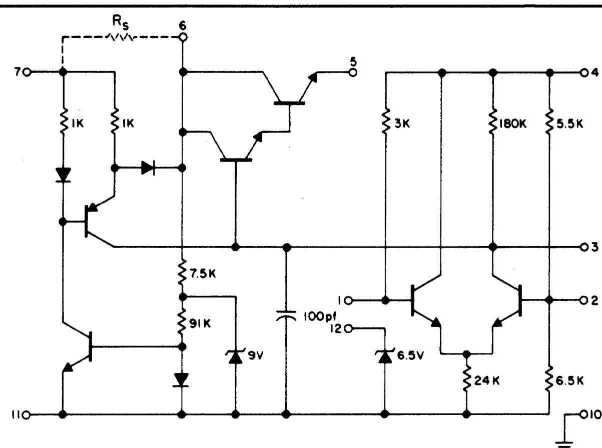
- One-Tenth percent load and line regulation
- One-Half percent stability over full military temperature range
- Current limiting adjustable with external sampling resistor, (R_S).
- Compensation included in package.
- Output currents of 200 mA without external transistor and 10 Amps with external transistor.
- Output voltage adjustable from 4.5 V to 40 V. Adjustment not necessary for 12 V.

G PACKAGE

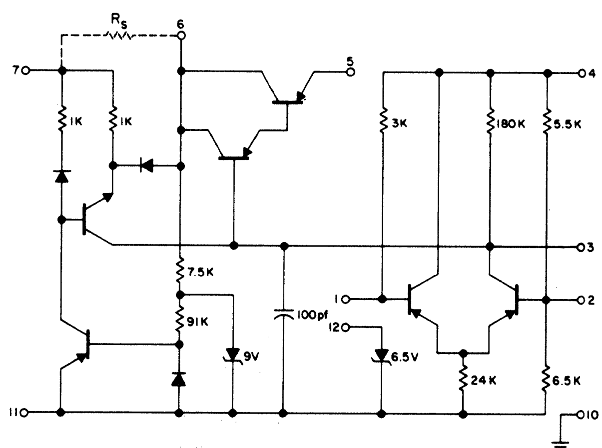




BOTTOM VIEW



ELECTRICAL SCHEMATIC OF 2802 REGULATOR



ELECTRICAL SCHEMATIC OF 2803 REGULATOR

Complete part number designation consists of four digits and two letters, for example:

2802 BG
- Package
- Temperature Range
- Circuit

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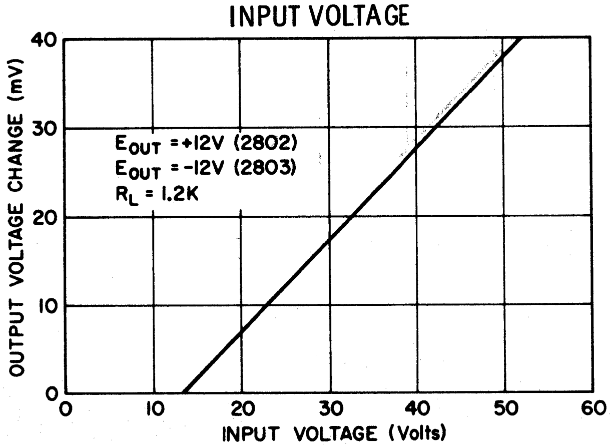
ABSOLUTE MAXIMUM RATINGS

Storage Temperature:	−65°C to +150°C
Operating Temperature:	−55°C to +125°C
Power Dissipation $T_A = 25°C$: $T_C = 25°C$:	1.8 Watts 3.5
Thermal Resistance θ_{JA}: θ_{JC}:	100°C/Watt 50°
Input Voltage:	55 Volts
Input-Output Voltage Differential:	40 Volts

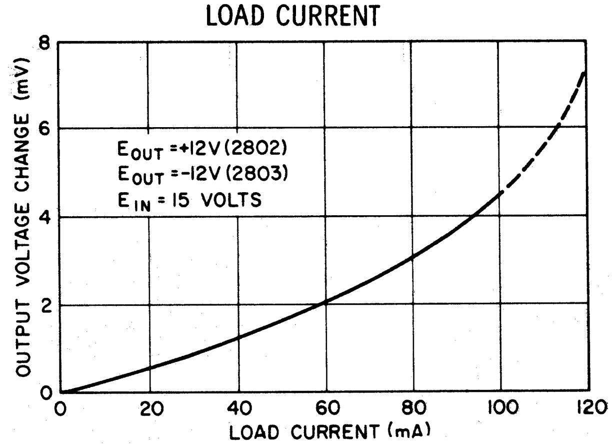
ELECTRICAL CHARACTERISTICS AT +25°C (Unless Otherwise Specified)

CHARACTERISTIC	MIN.	TYP.	MAX.	UNITS
Input Voltage Range (2802) (2803)	+12 −12		+55 −55	Volts
Initial Output Voltage (Internal Divider, $V_{in} = 15$ Volts) (2802) (2803)	+11.5 −11.5	+12.0 −12.0	+12.5 −12.5	Volts
Output Voltage Range (externally adjusted) (2802) (2803)	+4.5 −4.5		+40 −40	Volts
Output-Input Voltage Differential	2.5		40	Volts
Load Regulation (0 to 100 mA) (See Figure 1)		0.03	0.1	%
Line Regulation (Line change = 38 V) (See Figure 2)		0.005	0.01	%/V
Temperature Stability, $T_A = -55°C$ to +125°C (See Figure 3)		0.1	0.5	%
Long Term Stability (168 Hrs.)		0.05	0.5	%
Recovery Time (See Figure 4) Load Line		1.0 1.0		μsec
Ripple Rejection ($e_{in} = 3.0\ V_{pp}$ at 1.0 kHz) (See Figure 5)		−65	−60	db
Output Impedance (f = 1.0 kHz) (See Figure 6)		0.5	1.0	Ω
Load Current (See Figure 7) $T_A = 25°C$ $T_C = 25°C$			100 200	mA
Current Drain (no load, $V_{in} = 20$ V, $V_{out} = 12$ V)		4.0	5.0	mA

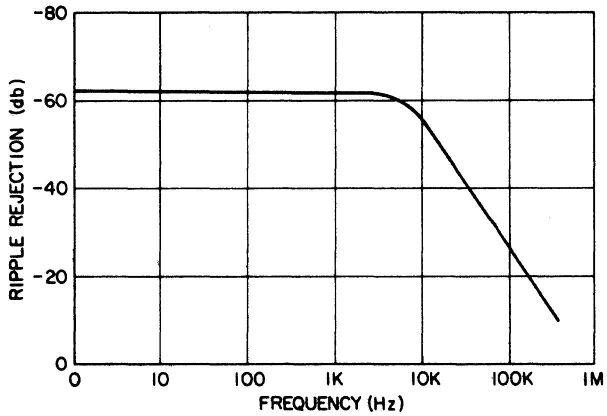
OUTPUT VOLTAGE CHANGE VS INPUT VOLTAGE



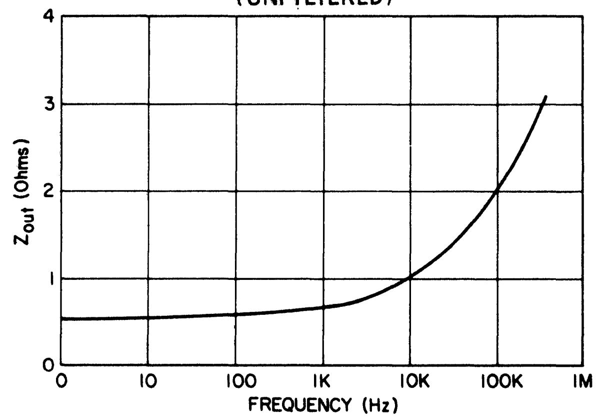
OUTPUT VOLTAGE CHANGE VS LOAD CURRENT



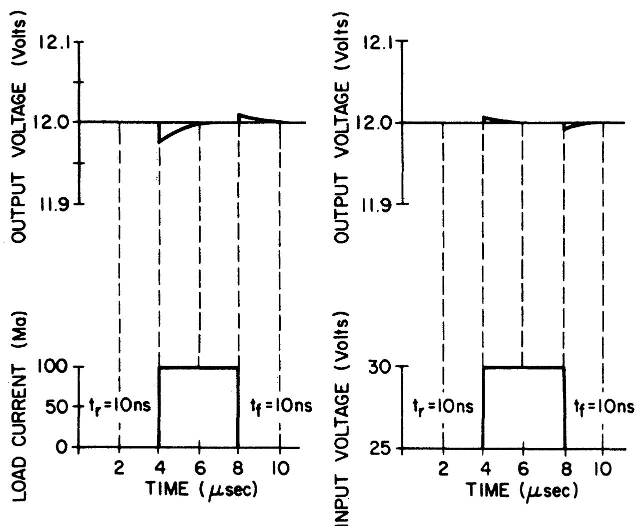
RIPPLE REJECTION VS FREQUENCY



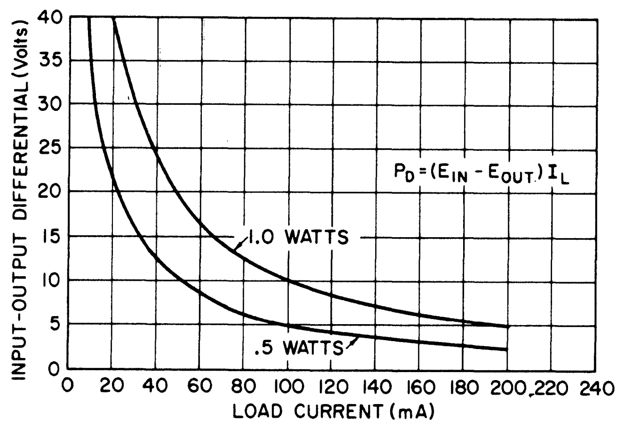
OUTPUT IMPEDANCE VS FREQUENCY (UNFILTERED)



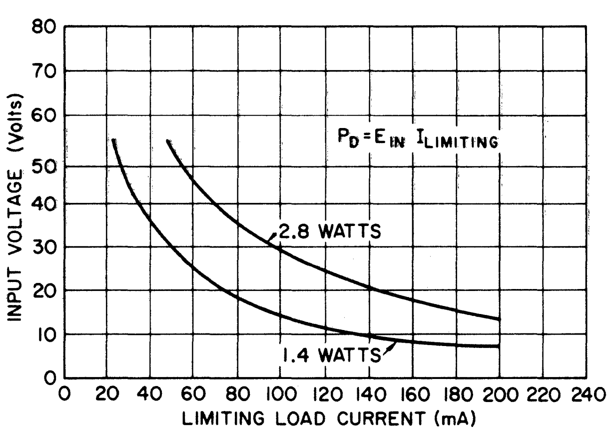
LOAD AND LINE RECOVERY TIMES



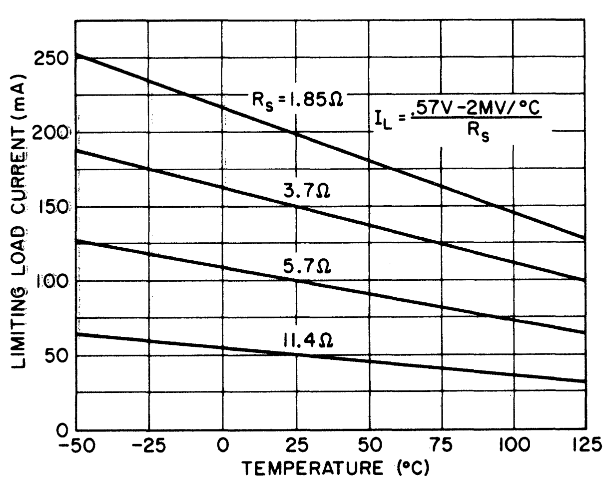
INPUT OUTPUT DIFFERENTIAL VS LOAD CURRENT (OPERATING CONDITION)



INPUT VOLTAGE VS LOAD CURRENT (SHORT CIRCUIT CONDITION)



LIMITING LOAD CURRENT VS TEMPERATURE



TEST CONFIGURATIONS

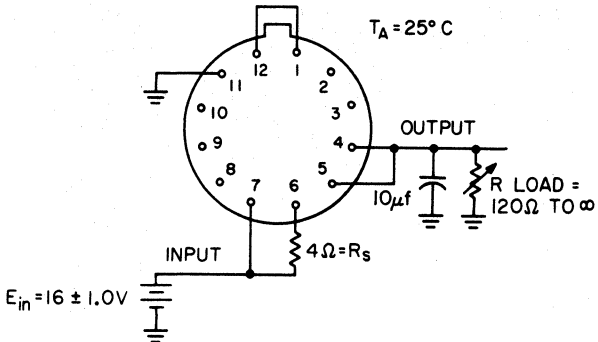


Figure 1. Load Regulation

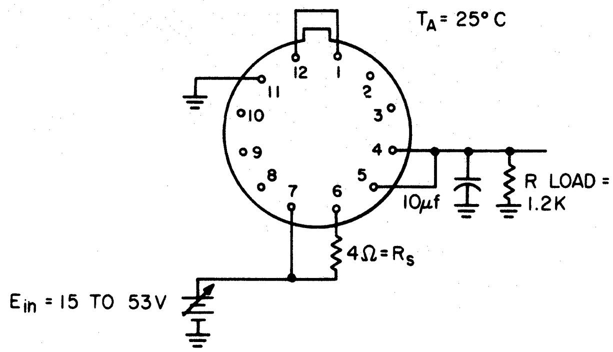


Figure 2. Line Regulation

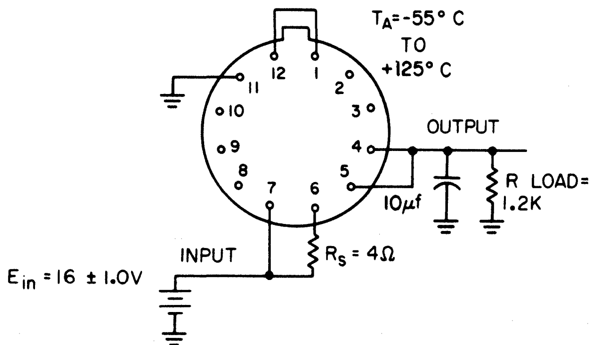


Figure 3. Temperature Stability

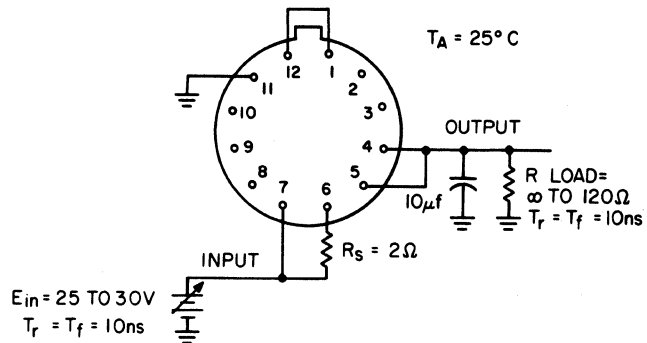


Figure 4. Response Times

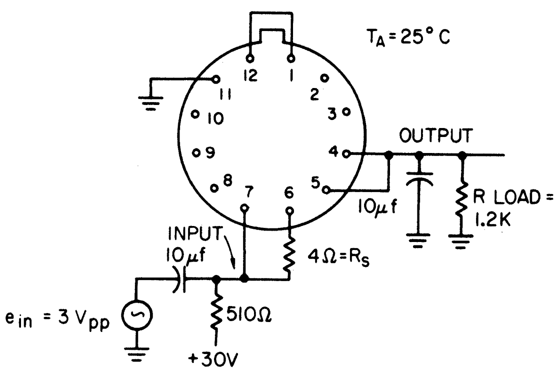


Figure 5. Ripple Rejection

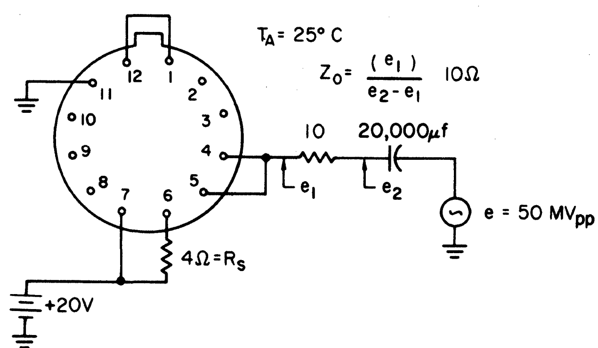


Figure 6. Output Impedance

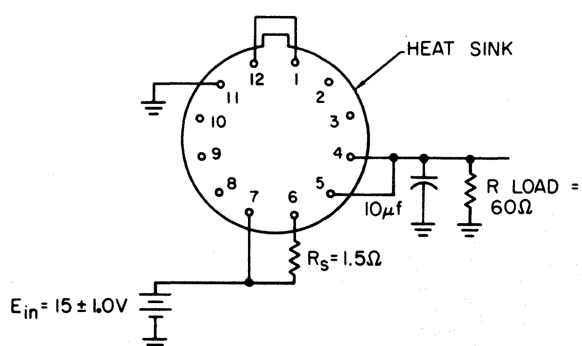


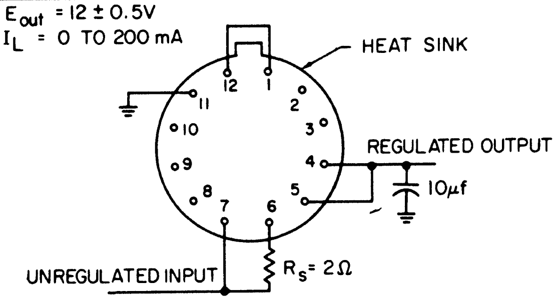
Figure 7. Maximum Load Current

TYPICAL APPLICATIONS

OPERATING CONDITIONS

E_{out} = 12 ± 0.5V

I_L = 0 TO 200 mA

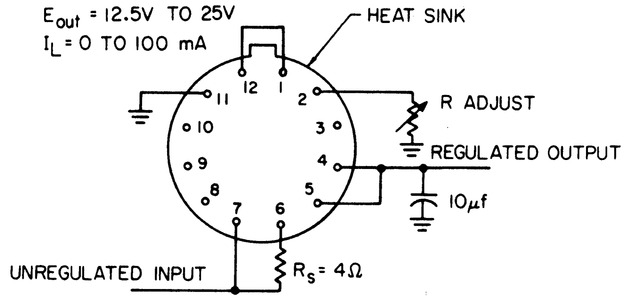


Configuration #1

OPERATING CONDITIONS

E_{out} = 12.5V TO 25V

I_L = 0 TO 100 mA

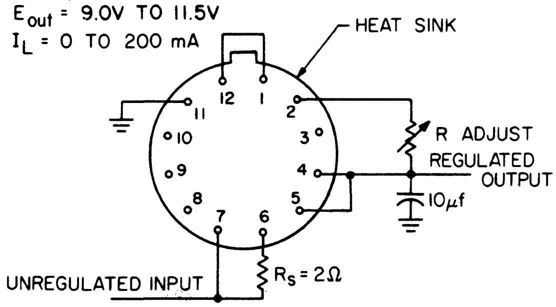


Configuration #2

OPERATING CONDITIONS

E_{out} = 9.0V TO 11.5V

I_L = 0 TO 200 mA



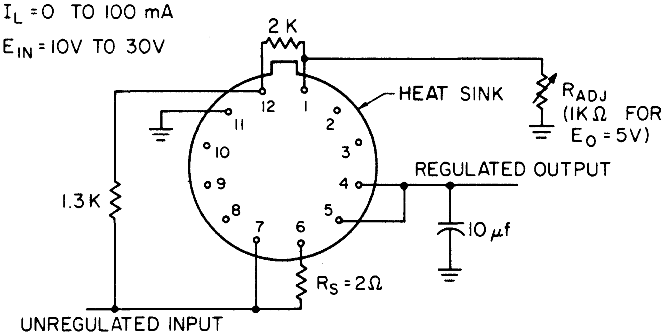
Configuration #3

OPERATING CONDITIONS

E_{OUT} = 4.5V TO 12V

I_L = 0 TO 100 mA

E_{IN} = 10V TO 30V



Configuration #4

OPERATING CONDITIONS

E_{out} = 25V TO 40V

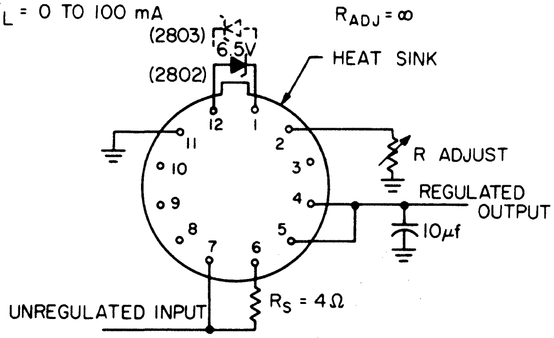
I_L = 0 TO 100 mA

E_{OUT} = 24 ± 0.5V

TERMINALS 2 AND 3

ARE NOT USED

$R_{ADJ} = \infty$

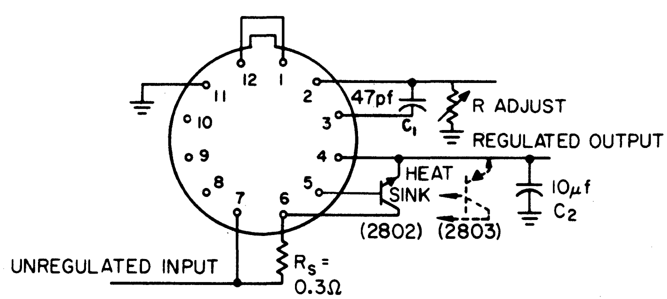


Configuration #5

OPERATING CONDITIONS

E_{out} = 12.5V TO 25V

I_L = 0 TO 2 AMP

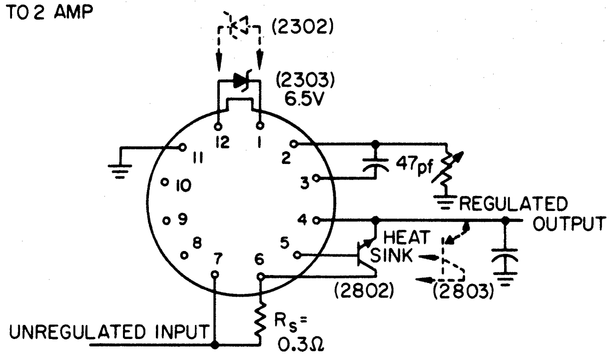


Configuration #6

OPERATING CONDITIONS

E_{out} = 25V TO 40V

I_L = 0 TO 2 AMP



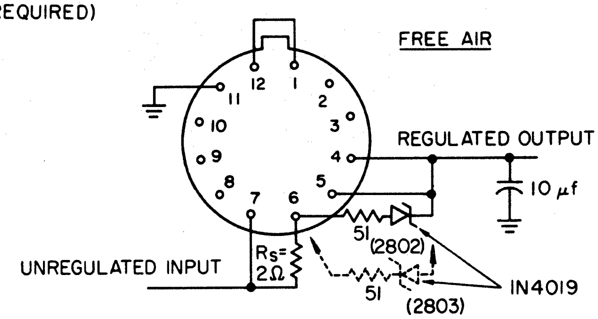
Configuration #7

OPERATING CONDITIONS

E_{OUT} = 12 ± .5V

I_L = 0 TO 100 mA

(NOTE: NO HEAT SINK REQUIRED)



Configuration #8

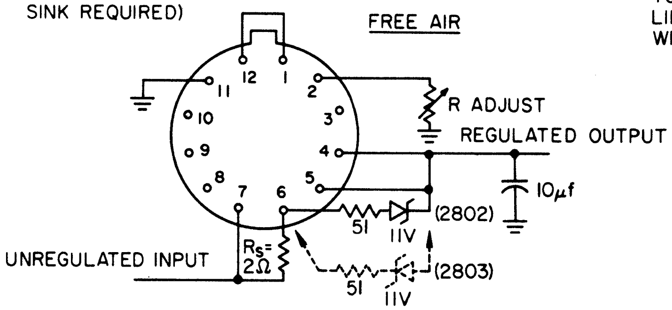
OPERATING CONDITIONS

E_{OUT} = 12.5 TO 25V

$E_{IN}-E_{OUT}$ (MAX) = 8.0V

I_L = 0 TO 100 mA

(NOTE: NO HEAT SINK REQUIRED)



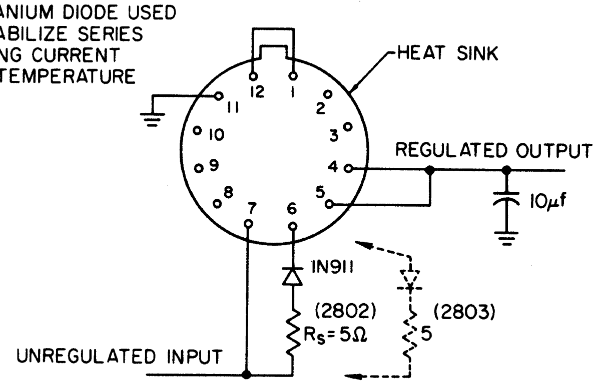
Configuration #9

OPERATING CONDITIONS

E_{OUT} = 12 ± .5V

I_L = 0 TO 100 mA

GERMANIUM DIODE USED TO STABILIZE SERIES LIMITING CURRENT WITH TEMPERATURE



Configuration #10

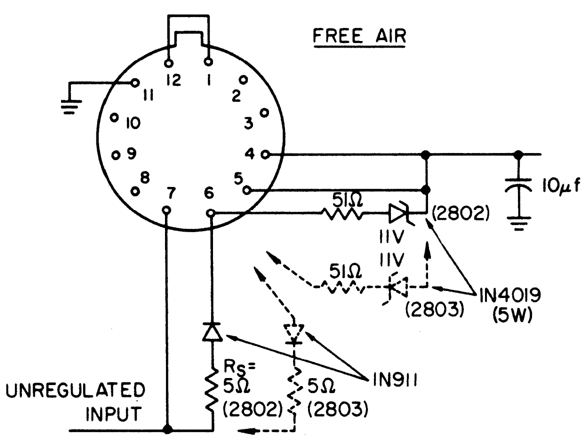
OPERATING CONDITIONS

E_{OUT} = 12 ± .5V

$E_{IN}-E_{OUT}$ = 8 0V (MAX)

I_L = 0 TO 100 mA

(NOTE: NO HEAT SINK REQUIRED)



Configuration #11

100% PROCESSING

TEST NO.	MIL-STD-750 REF. PARA.	EXAMINATION OR TEST	CONDITIONS
1		Fine Hermetic Seal Test (Helium)	10^{-8} cc/Sec (Max)
2		High Temperature Stabilization	150°C for 60 hrs. (Min)
3	1051 Cond. C	Temperature Cycling	5 cycles —65°C to +150°C
4	2006	Constant Acceleration	10,000 g (Minimum) Y_1 Axis only
5		Gross Hermetic Seal Leak Test (High Pressure) (Alcohol and water)	70 psig, 15 Minutes
6		Electrical Functional Test	See Test Configurations

JANUARY 1968

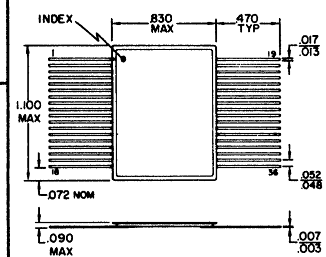
MEMA SHIFT REGISTER

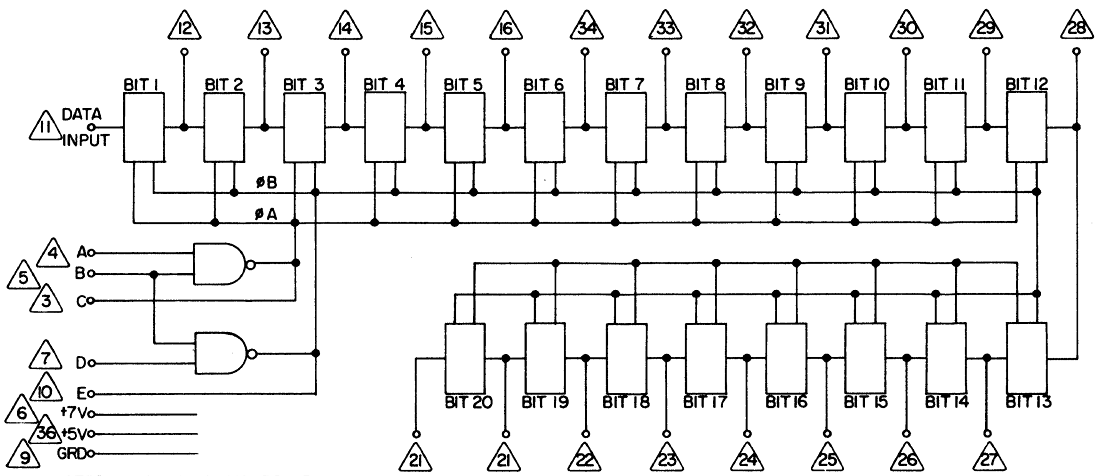
- 16 BIT
- 20 BIT

5551
5552

This MEMA (Micro-Electronic Modular Assembly) consists of dual binary elements interconnected to be used as a 16 or 20 Bit serial or parallel Shift Register. Two operating temperature ranges are available, for each configuration.

MEMA (M) PACKAGE





NOTES:
1. ALL PIN NUMBERS ARE WITHIN TRIANGLES.
2. 5552-16 BIT REGISTER–USE BITS 1 THRU 16.
3. SINGLE PHASE OPERATION: INPUT AT A IS $\overline{ØA}$ AND TIE C TO D.
4. TWO PHASE OPERATION: INPUT AT A IS $\overline{ØA}$ AND INPUT AT D IS $\overline{ØB}$.
5. DATA SHIFT OCCURS WHEN ØA IS LOW AND ØB IS HIGH.
6. REGISTER WILL BE RESET BY PROPAGATING STATE OF BIT 1 THROUGH REGISTER WHEN ØA AND ØB ARE HIGH.

ABSOLUTE MAXIMUM RATINGS

	5551BM 5552BM	5551CM 5552CM
Storage Temperature	−65°C to +150°C	−65°C to +150°C
Operating Temperature	−55°C to +125°C	0°C to 70°C
Maximum Input Voltage	6.8 V	6.8 V
Operating Voltage (V_{CC1})	4.5 V to 5.5 V	4.75 V to 5.25 V
Operating Voltage (V_{CC2})	6.5 V to 7.5 V	6.75 V to 7.25 V

Complete part number designation consists of four digits and two letters, for example:

5551BM
- Package
- Temp. Range
- Circuit

AMELCO SEMICONDUCTOR 1300 Terra Bella Ave. • Mountain View • Calif. 94040

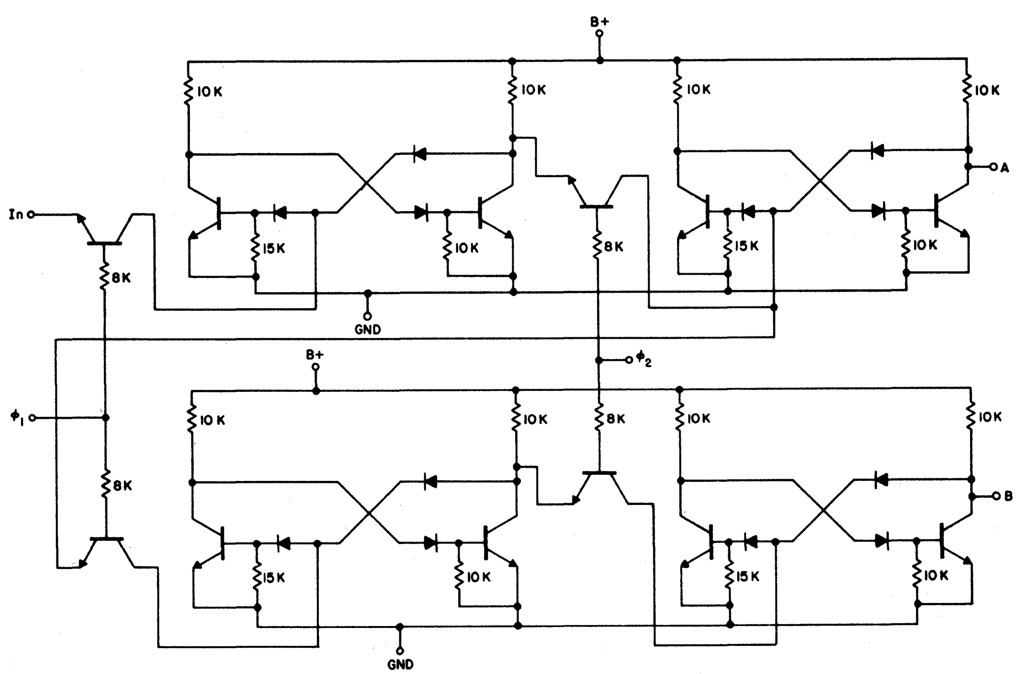
A TELEDYNE COMPANY PHONE: (415) 968-9241

Printed in U.S.A.

8101

ELECTRICAL SPECIFICATIONS @ $V_{CC1} = 5.0$ V, $V_{CC2} = 7.0$ V Over Operating Temperature Range

PARAMETER	SYMBOL	TEST CONDITIONS	P/N 5551	P/N 5552	UNITS
Number of Bits			20	16	
V_{CC1} Supply Current V_{CC2} Supply Current	I_{VCC1} I_{VCC2}		60 30	50 25	mA max.
Clock Rate	f_C		1.0		MHz max.
Clock Width	t_C		200		nsec min.
Output Voltage "Zero"	V_{OL}	I_{OL} Applied (Sink)	0.35		Volts max.
Output Current "Zero" Data Outputs Clock Outputs	I_{OL}		 1.5 1.0		mA max.
Output Voltage "One" Data Outputs Clock Outputs (C or E)	V_{OH}	Hi Temp. Limit Only Low Temp. Limit Only	2.0 2.5 3.5		Volts min.
Input Current "Zero" Clock Input (A or D) Reset (B) Data Inputs	I_{inL}	Input Grounded	 1.0 2.0 1.0		mA max.
Input Current "One" Clock Input (A or D) Reset (B) Data Inputs	I_{inH}	V_{inH} Applied	 30 60 30		μA max.
Minimum Voltage "One"	V_{inH}	Hi Temp. Limit Only Low Temp. Limit Only	1.5 2.0		Volts max.
Maximum Voltage "Zero"	V_{inHL}		0.7		Volts max.



Dual Shift Register

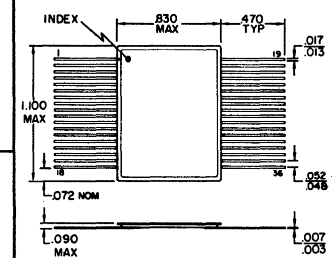
JANUARY 1968

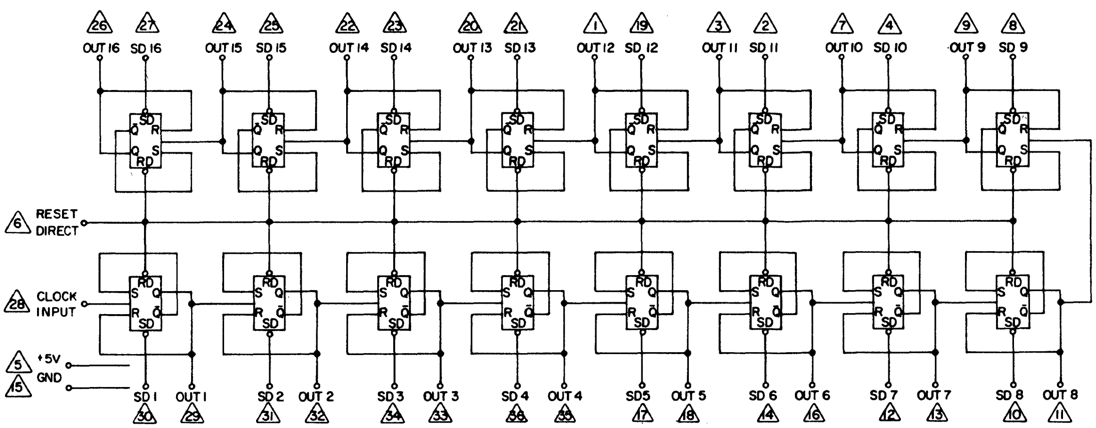
5598
5605
5625
5645

MEMA
16 BIT RIPPLE COUNTER

This MEMA (Micro Electronic Modular Assembly) is a sixteen (16) Bit Ripple Counter. A common direct reset and individual set inputs are provided. Three choices of maximum counting rate and power dissipation are provided by employing the 579, 539, or 509 Master-Slave Flip Flops from the 500 Series T²L Logic Family. A fourth choice uses two 579's, two 539's and twelve 509 Master-Slave Flip Flops to accomplish maximum input rate with minimum power dissipation. Two operating temperature ranges are available for each power level.

MEMA (M) PACKAGE





NOTE:
1. ALL PIN NUMBERS ARE WITHIN TRIANGLES.

ABSOLUTE MAXIMUM RATINGS

	5598BM 5605BM 5625BM 5645BM	5598CM 5605CM 5625CM 5645CM
Storage Temperature	−65°C to +150°C	−65°C to +150°C
Operating Temperature	−55°C to +125°C	0°C to 70°C
Maximum Voltage	6.8 V	6.8 V
Operating Voltage	4.5 V to 5.5 V	4.75 V to 5.25 V

Complete part number designation consists of four digits and two letters, for example:

5605BM
- Package
- Temp. Range
- Circuit

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A TELEDYNE COMPANY PHONE: (415) 968-9241

Printed in U.S.A. 8102

ELECTRICAL SPECIFICATIONS at $V_{CC} = 5.0$ V Over Operating Temperature Range

PARAMETER	SYMBOL	TEST CONDITIONS	5598			5605	5625	5645	UNITS
Counting Rate	F_C			5.0		0.3	1.5	5.0	MHz max.
Propagation Time 16 Bits	T_p			8.0		10	2.4	1.0	μsec Typ.
Power Supply Current	I_{VCC}			60		36	110	180	mA max.
Output Voltage "Zero"	V_{OL}	I_{OL} applied (sink)		0.3		0.3	0.35	0.35	Volts max.
Output Current "Zero"	I_{OL}		Bits 1-2 9.0	3-4 1.8	5-16 1.2	1.2	1.8	10.5	mA min.
Output Voltage "One"	V_{OH}	No external load	4.4	4.4	4.4	4.4	4.4	4.4	Volts min.
Output Current "One"	I_A	Output Voltage $= V_{inH}$	600	100	50	50	100	600	μA min.
Input Current "Zero" Clock/Set Input Reset Input	I_{inL}		 3.0 15	 1.8 15	 0.35 15	 0.35 6.0	 1.8 22	 3.0 36	mA max.
Input Current "One" Clock/Set Input Reset Input	I_{inH}	Input Voltage $= V_{inH}$	 120 400	 60 400	 8.0 400	 8.0 100	 60 750	 120 1500	μA max.
Minimum Voltage "One"	V_{inH}			2.0		2.0	2.0	2.0	Volts min.
Maximum Voltage "Zero"	V_{inL}			0.6		0.6	0.7	0.7	Volts max.

JANUARY 1968

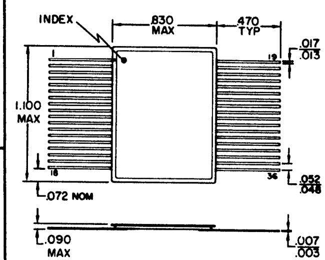
MEMA COUNTER

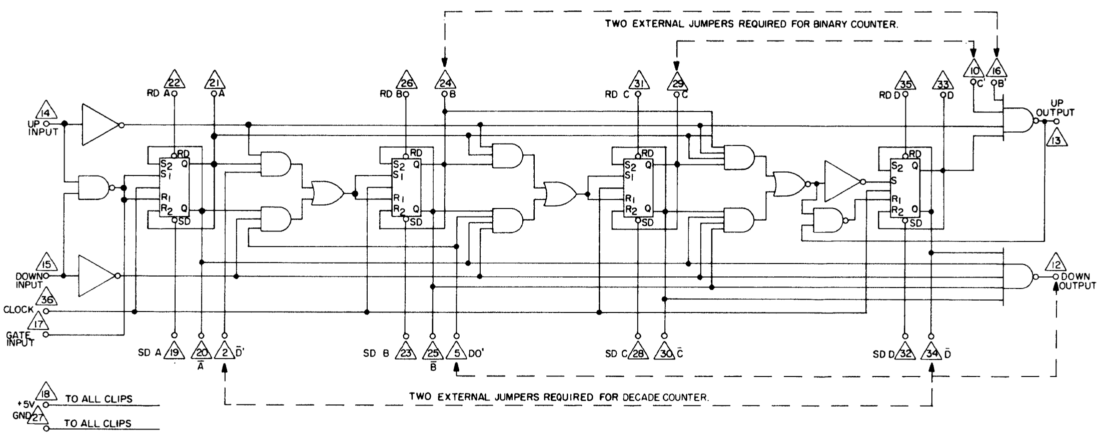
- **REVERSIBLE**
- **SYNCHRONOUS**
- **BINARY OR DECADE**

5603
5623
5643

This MEMA (Microelectronic Modular Assembly) can be used as a reversible synchronous counter. Operation as a four (4) bit binary or a decade counter can be achieved by two (2) external pin connections. Both "one" and "zero" outputs and direct set and reset inputs of each bit are provided. The counter state changes when the clock input changes from "one" to "zero" and either the up or down input is in the "zero" state. Three (3) choices of maximum counting rate and power levels, plus two (2) choices of operating temperature range are available.

MEMA (M) PACKAGE





NOTE: 1. ALL PIN NUMBERS ARE WITHIN TRIANGLES.

ABSOLUTE MAXIMUM RATINGS

	5603BM 5623BM 5643BM	5603CM 5623CM 5643CM
Storage Temperature	−65°C to +150°C	−65°C to +150°C
Operating Temperature	−55°C to +125°C	0°C to 70°C
Maximum Voltage	6.8 V	6.8 V
Operating Voltage	4.5 V to 5.5 V	4.75 V to 5.25 V

Complete part number designation consists of four digits and two letters, for example:

5603BM
- Package
- Temp. Range
- Circuit

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A TELEDYNE COMPANY PHONE: (415) 968-9241

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8401

ELECTRICAL SPECIFICATIONS at $V_{CC} = 5.0$ V Over Operating Temperature Range

MEMA TYPE			5603	5623	5643	
PARAMETER	SYMBOL	TEST CONDITIONS				UNITS
Counting Rate	f_C		0.2	1.0	3.0	MHz max.
Power Supply Current	I_{VCC}		14	36	72	mA max.
Output Voltage "Zero"	V_{OL}	I_{OL} applied (sink)	0.3	0.35	0.35	Volts max.
Output Current "Zero" Up/Down Outputs Counter Outputs	I_{OL}	With decade or binary connections made	2.4 0.7	2.4 1.8	4.5 9.0	mA min.
Output Voltage "One"	V_{OH}		4.4	4.4	4.4	Volts min.
Output Current "One" Up/Down Outputs Counter Outputs	I_A	V_{inH} applied to output	100 50	100 100	200 600	μA min.
Input Current "Zero" Set/Reset Inputs Up/Down Inputs Clock Input	I_{inL}	Input grounded	0.35 0.35 1.4	1.8 1.4 8.4	3.0 3.0 12	mA max.
Input Current "One" Set/Reset Inputs Up/Down Inputs Clock Input	I_{inH}	V_{inH} applied to input	6.0 6.0 36	60 12 90	120 40 240	μA max.
Minimum Voltage "One"	V_{inH}		2.0	2.0	2.0	Volts min.
Maximum Voltage "Zero"	V_{inL}		0.6	0.7	0.7	Volts max.

JANUARY 1968

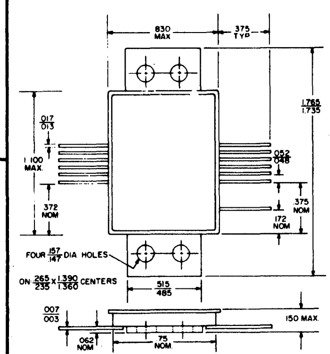
MEMA
RF POWER AMPLIFIER

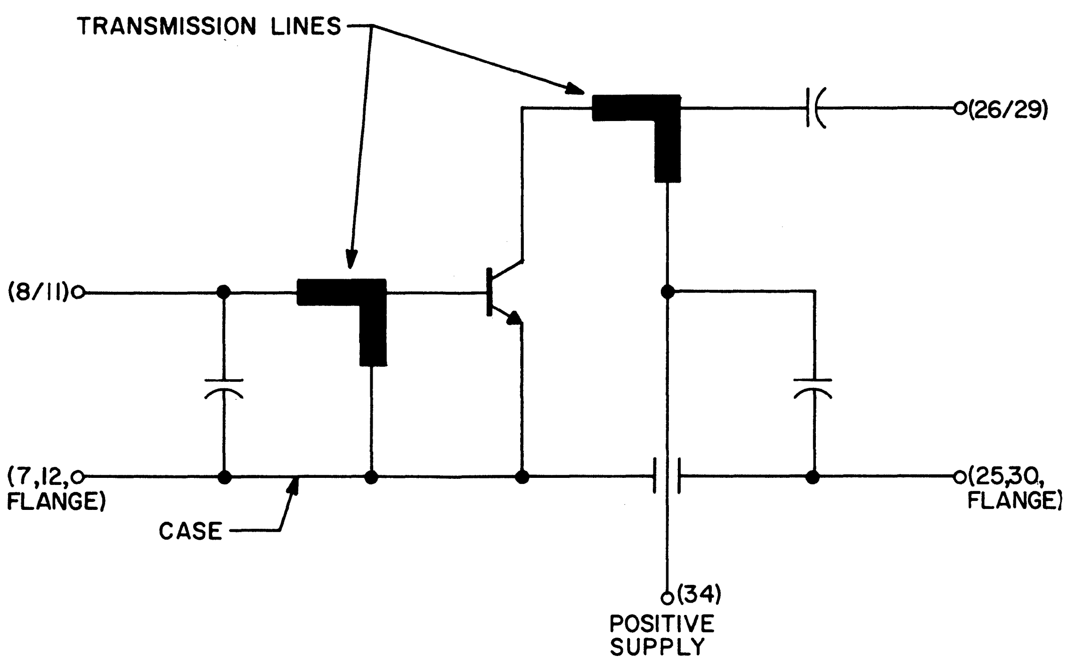
5670BM

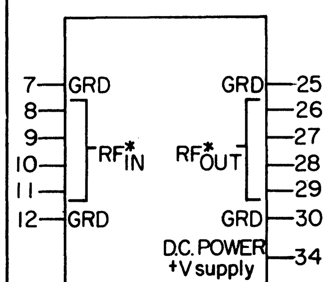
This MEMA (Micro Electronic Modular Assembly) contains all the rf circuitry for a 1 watt, 500 MHz power amplifier. The input and output terminals are matched to 50Ω microstrip transmission line. Gain is typically 7 db. Since the amplifier performs well with input signals between 30 and 200 milliwatts, it is suitable as a driver for itself in a two stage system.

The MEMA is a hermetic package utilizing the highest quality metal to ceramic sealing techniques. The transistor is wired directly to the microstrip matching circuit thereby minimizing spurious effects.

(M) PACKAGE





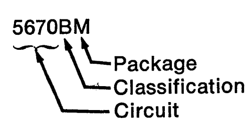


*INTERNALLY CONNECTED

ABSOLUTE MAXIMUM RATINGS

Storage Temperature	−65°C to +150°
Operating Temperature	−55°C to +125°C
Maximum Dissipation @ $T_C = 25°C$	2.5 W
Dissipation Derating from 25°C Case	15 mW/°C
Maximum Supply Voltage	40 V
Maximum Current	130 mA
Output Load Max. VSWR at Full Power	3.0

Complete part number designation consists of four digits and two letters, for example:



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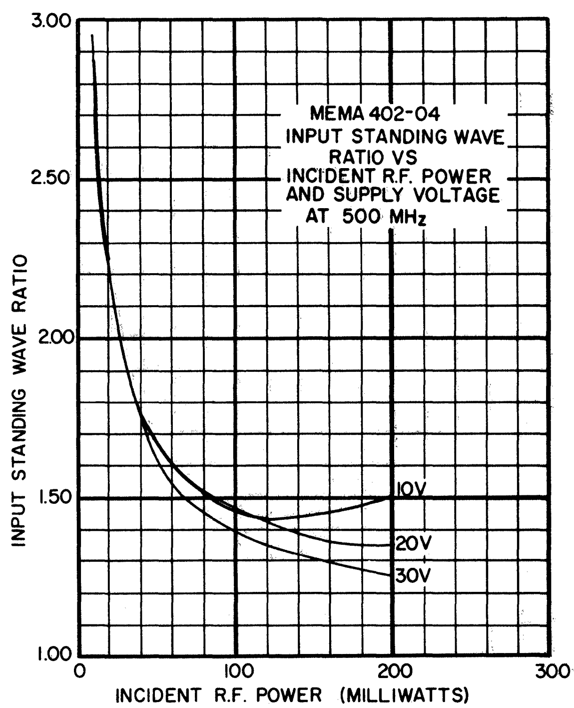
8402

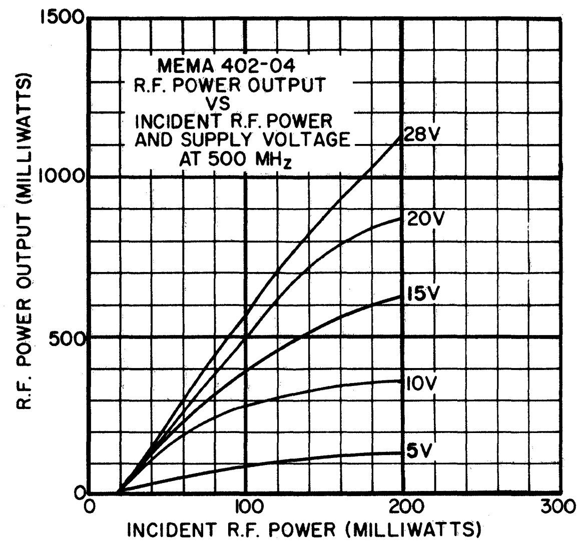
ELECTRICAL SPECIFICATIONS AT 25°C CASE TEMPERATURE

PARAMETER	TEST CONDITIONS	MIN.	TYP.	MAX.	UNITS
RF Power Input	$V_S = 28$ V $P_O = 1$ W f = 500 MHz			250	mW
Input VSWR	Same as Above			2.0	ratio
Efficiency	Same as Above	35			%
Max. Change in Incident Power Output for Mismatched Load as a Percent of Power Output with Matched Load	VSWR = 1.0 VSWR = 1.5 VSWR = 2.0 VSWR = 3.0 Worst Case Phase $V_S = 25$ V $P_O = 0.75$ W f = 500 MHz		±0 ±5.0 ±9.0 ±13		%

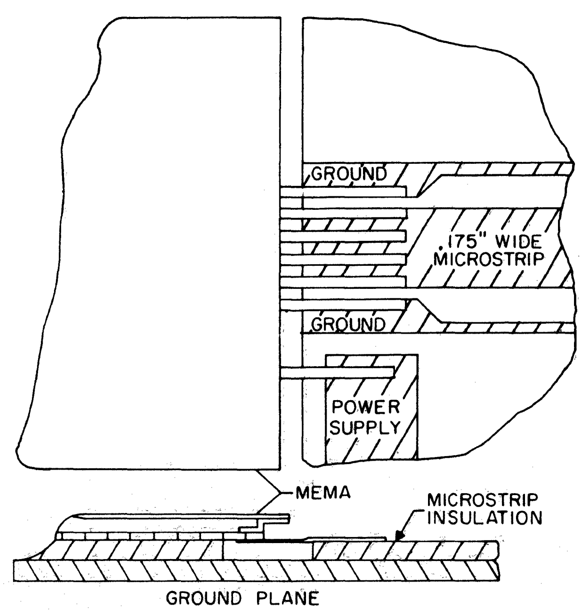
INCIDENT RF POWER (mW)



INCIDENT RF POWER



SUGGESTED MOUNTING



Credits

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