



the full spectrum / NIXIE® Indicator Tubes and Accessories



F. Steiner #128/67

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INTRODUCTION

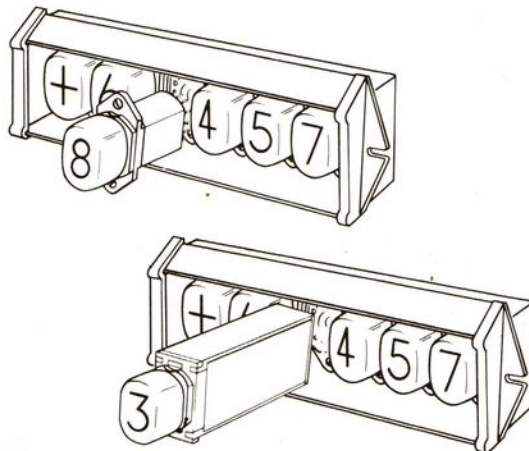
NIXIE® Indicator Tubes, available in either numeric or alphanumeric configurations, are all-electronic, gas-filled, cold-cathode display devices. The numeric tubes consist of a common anode and ten individual metallic cathodes which are formed in the shape of numerals (0-9), alphabetic characters, or special symbols. The alphanumeric tubes consist of a common anode and 13 or 15 individual cathode segments which can be energized alone or in combination with one another to form the numerals 0 through 9, the letters A through Z and many special symbols.

Both devices operate on the principle of the simple gas discharge diode. Application of a negative voltage to the selected cathode element with respect to the common anode causes the gas around the element to ionize and glow. In the case of the numeric display, where the various elements are stacked on top of each other, only the selected character is visible in the common viewing area because the visual glow discharge is considerably larger than its metallic source. This same characteristic is a feature of the alphanumeric tube type in that the glow overlap between segments gives characters a continuous line look and eliminates the need for notched or foreshortened segments so common in most other segmented type display devices.

Typical features which have made NIXIE Tubes industry's most popular readout are:

1. All electronic design providing high speed operation and low power requirements.
2. All dc operation making simple drive circuits possible.
3. Smallest volume and lightest weight making possible simple and reliable packaging.
4. Low cost—both to buy and operate.
5. Highest brightness — up to 200 footlamberts under normal operating conditions. No degradation of light output throughout life. Color is neon red.
6. Best readability for character size at any distance—any viewing angle.
7. Temperature, shock and vibration characteristics which meet military standards.
8. Longest life and greatest reliability of any readout device.

Available either in component form or in completely packaged display systems, NIXIE Tubes offer the ultimate in readout performance.



GUIDE TO READOUT TUBE SELECTION AND IDENTIFICATION

NIXIE Indicator Tubes are available in a variety of character sizes each of which is designed to meet a specific viewing distance requirement. The tabulation at the right is designed to serve as a guide to the proper character size for application.

Tube identification by type number: Each NIXIE tube is assigned a 4 or 5 digit type number preceded by the letter B, e.g., B-4081, B-5092, B-6091, B-7094, B-8091, B-50117, etc. As these tubes are registered with Electronic Industries Association, EIA numbers are assigned. For example, the B-5092 has become the type 8421 and the B-4032 has become the 7977. In these cases the EIA number is used as the principle identification number while the Burroughs number is shown in parenthesis.

When selecting a NIXIE tube, care should be taken that all factors are considered. Most important for new designs is the life and reliability of long life tube types. The life of the regular NIXIE tube is only about 2% of the long life types. For this reason the regular tubes B-4081, 7009, B4021, 6844A and 7153 are recommended for special applications or for replacement purposes only.




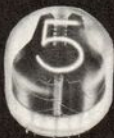




Readout selection should be based on many parameters, therefore, it should be remembered that a comparison arbitrarily limited to any single attribute may not give a true picture. Some readout parameters to be taken into consideration are:

Character Height	Available Drivers
Viewing Angle	Power
Packaging Economy	Cost
Weight Economy	Life and Reliability

The following NIXIE tubes have been approved per MIL-E-1:

Burroughs P/N	MIL-E-1 Specification	Tube Size
7009	1500	Miniature
7977	1497	Miniature
6844A	1266	Standard
8421	1454	Standard
8422	1519	Standard
8423	1518	Super

See Bulletin 1095

TUBE GROUP	NUMERAL HEIGHT	MAXIMUM VIEWING DISTANCE	FOR DETAILED SPECIFICATIONS SEE
NUMERIC  MINIATURE ROUND AND RECTANGULAR	0.3"	14'	Page 5
 STANDARD ROUND, RECTANGULAR, SIDE-VIEWING	0.6"	30'	Pages 7, 10 & 11
 SUPER	0.8"	38'	Page 7
 LARGE	1.4"	65'	Page 12
 JUMBO	2.0"	100'	Page 12
ALPHANUMERIC  STANDARD	0.6"	30'	Page 14
 LARGE MEDIUM	2.5/1.5"	100'/65'	Page 14
POSITION  PIXIE INDICATOR	0.125"	8'	Page 17

MINIATURE TUBES



The miniature NIXIE Tube types have been developed for specialized applications. This smallest of all electronic readouts is particularly suitable where equipment space is at a premium, such as in airplane panel displays, desk electronic calculators, real time control displays or manned space vehicles. Most of these applications demand the high reliability characteristics found in all NIXIE Indicator Tubes, and testify to the growing range of military and commercial applications for Burroughs NIXIE Tubes.

OUTLINE DRAWINGS

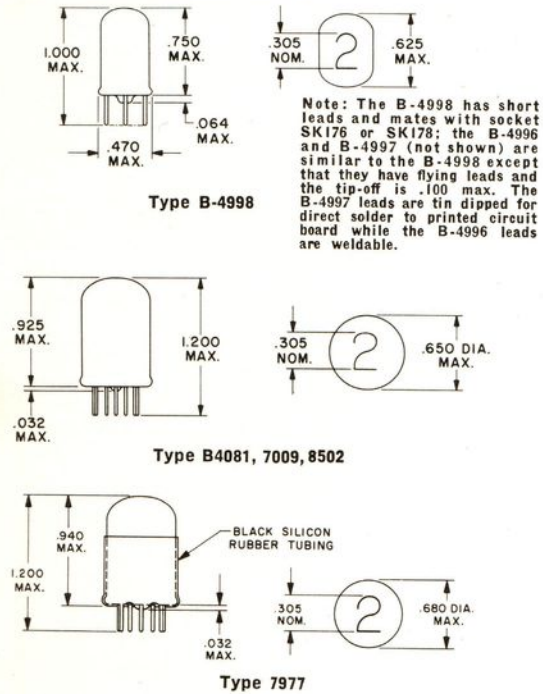


Fig. 1

ENVIRONMENTAL DESIGN DATA

1. Altitude 70,000 Ft.
2. Temperature (1)... -20°C to +55°C
(2)... -65°C to +85°C (Reduced life)
3. Acceleration 20 G's
4. Vibration (1)..... 10-50-10 cps at .08" D.A. for 5 min. ea. in X, Y, and Z axis.
(2)..... 50-500-50 cps at 10 G's for 5 min. in X, Y, and Z axis.
5. Shock (1) 50 G's, 11 millisecond.
(2) 250 G's, 1 millisecond.
6. Salt Spray MIL Std. 202, Method 101, Cond. A
7. Humidity MIL Std. 202, Method 103, Cond. B
8. Vibration Fatigue MIL-E-1E, Method 1031
9. Expected Life (Dynamic) 200,000 hrs. (ultra long life)

PIN CONNECTIONS

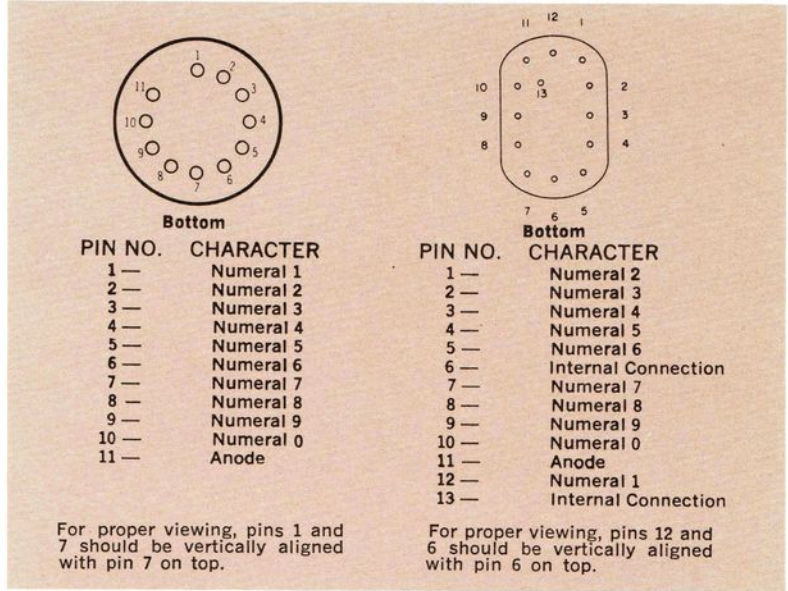


Fig. 2

All round miniature NIXIE Tubes are available in both short and long lead versions. Short lead types are shown in figure 1. Long lead tubes have 1.400" leads and are designed for direct solder connections to printed circuit boards. The tubes can be ordered by adding suffix L to regular part numbers (e.g. 7977L, B4021L, 7009L, etc.).

PIN STRAIGHTENER

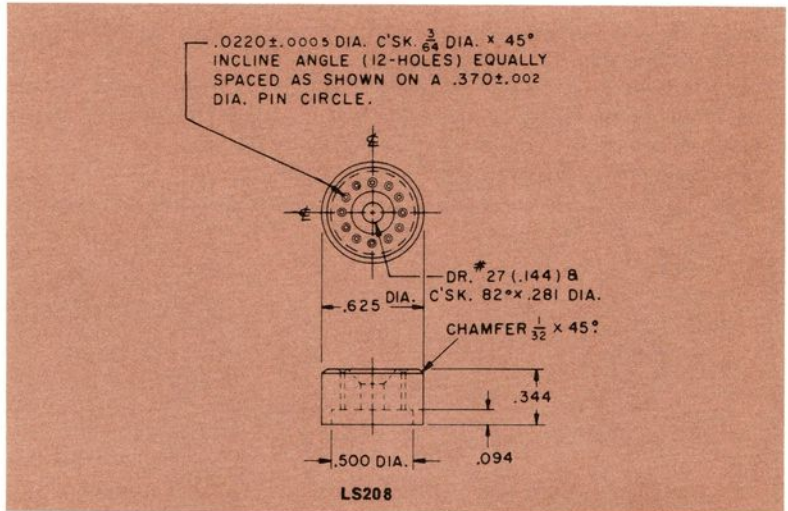


Fig. 3

BASIC CIRCUIT

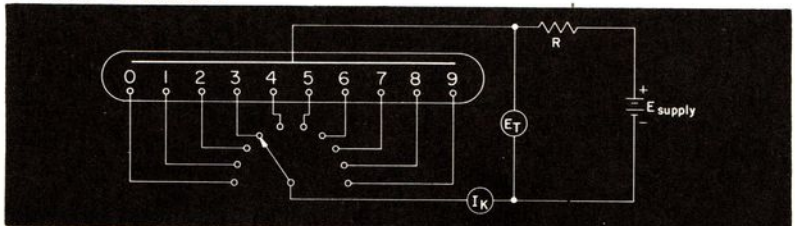


Fig. 4

ELECTRICAL DATA FOR MINIATURE TUBES

	B4996/7/8* Long Life Rectangular			B4081 Wide Viewing Angle			7977 (B4032) Long Life			7009 Regular			8502 (B4021) Low Voltage	
Absolute Ratings (Note 5) Ionization Voltage (Maximum)	170 Vdc			170 Vdc			170 Vdc			170 Vdc			120 Vdc	
Supply Voltage (Minimum) (Note 2)	170 Vdc			170 Vdc			170 Vdc			170 Vdc			120 Vdc	
Cathode Current (Peak) (Note 1)	2.5 ma			2.0 ma			2.0 ma			2.0 ma			2.0 ma	
Test Conditions (Basic Circuit Fig. 4)														
Supply Voltage	170 Vdc			170 Vdc			170 Vdc			170 Vdc			120 Vdc	
Series Resistor (Note 4)	15K			68K			15K			68K			20K	
Cathode Current: (Minimum) (Maximum) (Note 3)	1.0 ma 2.0 ma			0.7 ma 1.4 ma			0.7 ma 1.4 ma			0.7 ma 1.2 ma			0.7 ma 1.4 ma	
Recommended Operating Conditions (Basic Circuit, Fig. 4)														
Supply Voltage (E) (Note 2)	200V	250V	300V	200V	250V	300V	200V	250V	300V	200V	250V	300V	120V	
Series Resistor (R)	36K	75K	110K	100K	150K	200K	43K	91K	150K	100K	150K	200K	20K	

Note 1. Due to life considerations only long life NIXIE tubes are recommended for pulsed operation.

Note 2. The minimum supply voltage should be as stated for each tube type. However, the use of the highest voltage available, with the appropriate series resistor is recommended.

Note 3. No glow is permitted on any tube part other than the numeral under test.

Note 4. All resistance values are $\pm 1\%$.

Note 5. Maximum ionization voltage is the highest voltage necessary to assure breakdown.

Note 6. Minimum supply voltage is the lowest voltage necessary to assure full cathode glow.

* Preferred type for long life, low cost, packaging and readability.

SOCKETS—MINIATURE SIZE TUBES

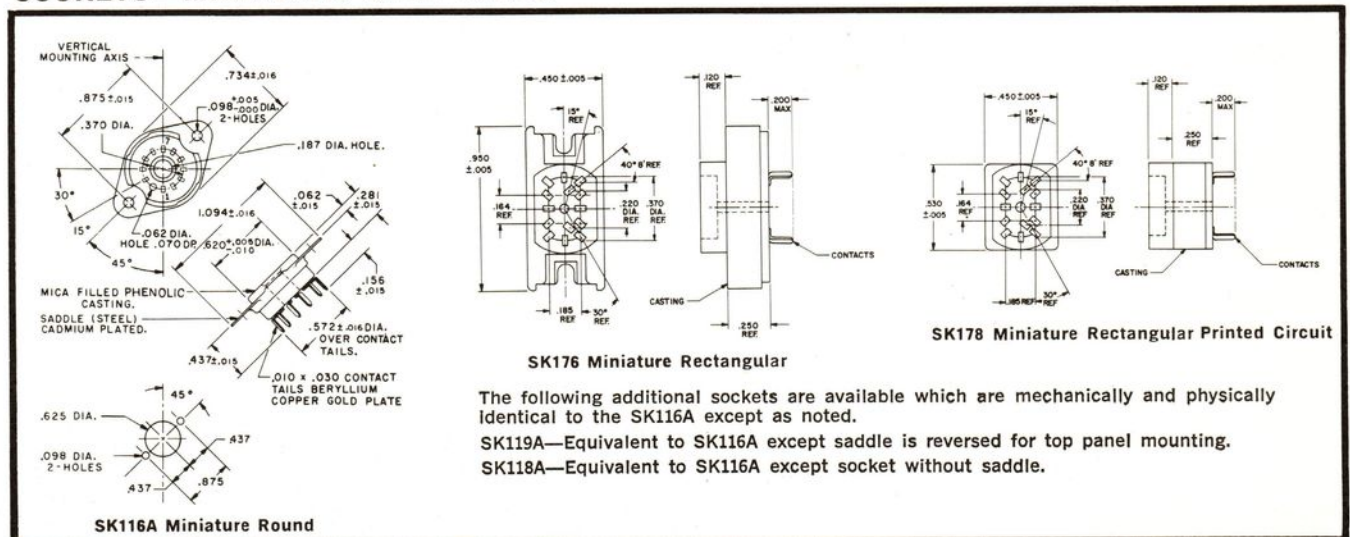


Fig. 5

STANDARD AND SUPER TUBES



Year after year, NIXIE Indicator Tubes remain industry's most popular readout. More manufacturers choose NIXIE Tubes over all other readouts for their equipment designs because they have • longest life (more than 200,000 hours) • constant brightness • best readability from every angle • lowest cost • smallest size • most rugged construction • availability of JAN types. NIXIE Tube characters are human engineered, making them easier to read.

The Rectangular NIXIE Tube offers dramatic dimensional reduction, but the same character size is maintained. And they provide major user benefits, since equipment size is not dictated by the demands of readout space requirements.

There's a NIXIE Tube for every readout application. From jumbo to standard to miniature size; from special character to numerical display, the outstanding performance remains the same.

OUTLINE DRAWINGS

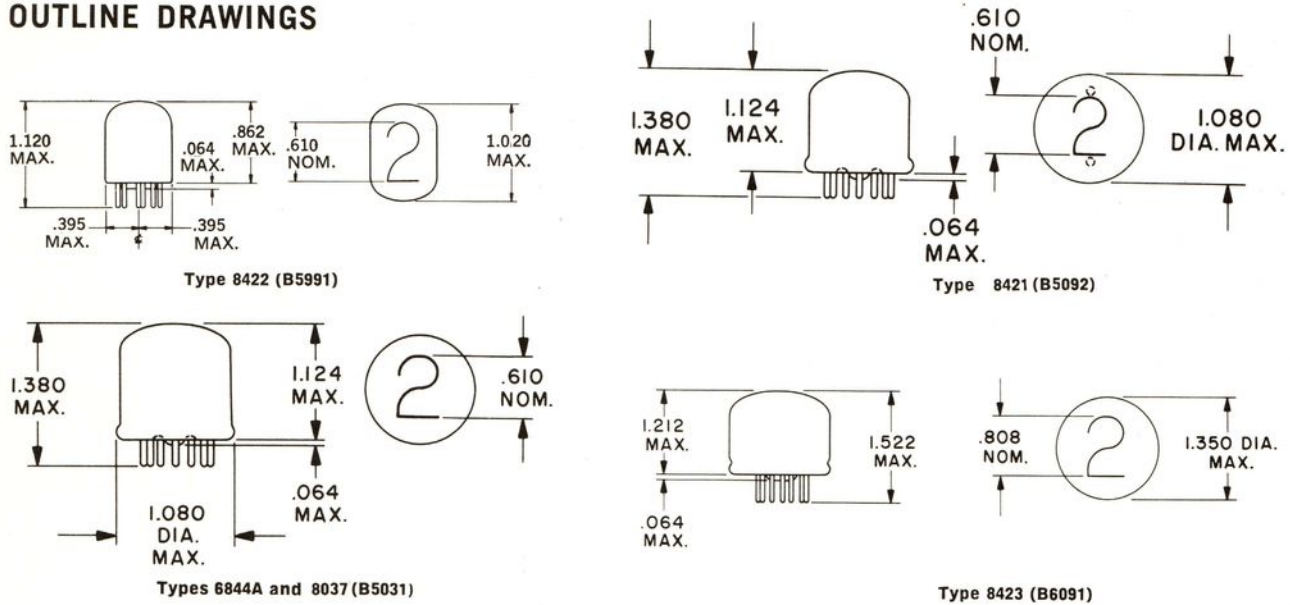


Fig. 6

ENVIRONMENTAL DESIGN DATA

STANDARD AND SUPER TUBES

1. Altitude70,000 Ft.
2. Temperature (1) - 20°C to +55°C
 (2) - 65°C to +85°C (Reduced Life) (Type 8422, to +70°C)
3. Acceleration20 G's
4. Vibration (1)10-50-10 cps at .08" D.A., 5 min. ea. in X, Y, and Z axis.
 (2)50-2000-50 cps at 10 G's, 5 min. in X, Y, and Z axis.
5. Shock (1)50 G's, 11 millisecc.
 (2)200 G's, 1 millisecc., (Type 8422; 250G's, 1.0 millisecc.)
6. Salt SprayMIL Std. 202, Method 101 Cond. A
7. HumidityMIL Std. 202, Method 103 Cond. B
8. Vibration FatigueMIL-E-1E, Method 1031
9. Expected Life (Dynamic)200,000 hours (ultra long life)

ELECTRICAL DATA

STANDARD

SUPER

	8422 (B-5991) Long Life*,** Rectangular			8421 (B5092) Long Life Wide Angle			8037 (B5031) Long Life			6844A Regular			8423 (B6091) Long Life Wide Angle			7153 Regular	
Absolute Ratings (Note 5) Ionization Voltage (Maximum)	170 Vdc			170 Vdc			170 Vdc			170 Vdc			170 Vdc			250 Vdc	
Supply Voltage (Minimum) (Note 2)	170 Vdc			170 Vdc			170 Vdc			170 Vdc			170 Vdc			250 Vdc	
Cathode Current (Peak) (Note 1)	3.5 ma			3.5 ma			3.5 ma			4.0 ma			4.5 ma			5.0 ma	
Test Conditions (Basic Circuit Fig. 4)																	
Supply Voltage	170 Vdc			170 Vdc			170 Vdc			170 Vdc			170 Vdc			250 Vdc	
Series Resistor (Note 4)	8.2K			10K			10K			15K			6.8K			43K	
Cathode Current: (Minimum) (Maximum) (Note 3)	1.5 ma 3.0 ma			1.5 ma 3.0 ma			1.5 ma 3.0 ma			1.5 ma 3.0 ma			1.5 ma 4.0 ma			2.0 ma 3.0 ma	
Recommended Operating Conditions (Basic Circuit Fig. 4)																	
Supply Voltage (E) (Note 2)	200V	250V	300V	200V	250V	300V	200V	250V	300V	200V	250V	300V	200V	250V	300V	250V	300V
Series Resistor (R)	22 K	47K	68K	22K	47 K	68 K	22K	47 K	68 K	27K	51 K	75 K	18K	36 K	56K	43K	62K

Note 1. Due to life considerations only long life NIXIE tubes are recommended for pulsed operation.

Note 2. The minimum supply voltage should be as stated for each tube type. However, the use of the highest voltage available, with the appropriate series resistor is recommended.

Note 3. No glow is permitted on any tube part other than the numeral under test.

Note 4. All resistance values are $\pm 1\%$.

Note 5. Maximum ionization voltage is the highest voltage necessary to assure breakdown.

Note 6. Minimum supply voltage is the lowest voltage necessary to assure full cathode glow.

* Preferred type for long life, low cost, packaging and readability.

** The B59956 is identical to the type 8422 except it contains an internal decimal point (See Bulletin 1103).

PIN CONNECTIONS

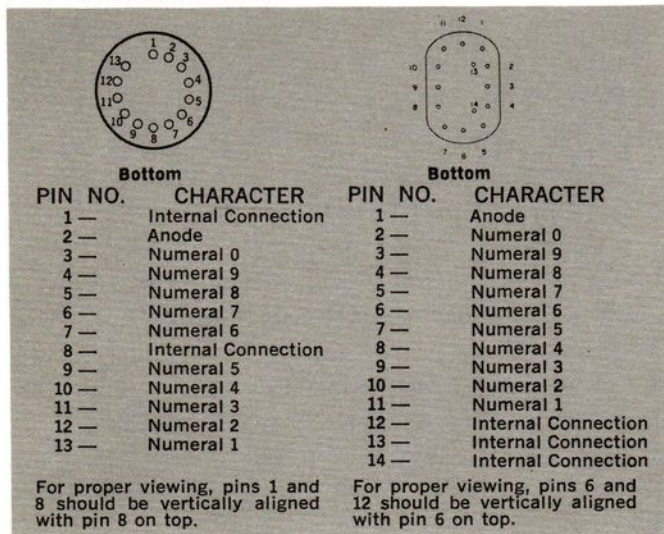


Fig. 7

PIN STRAIGHTENERS

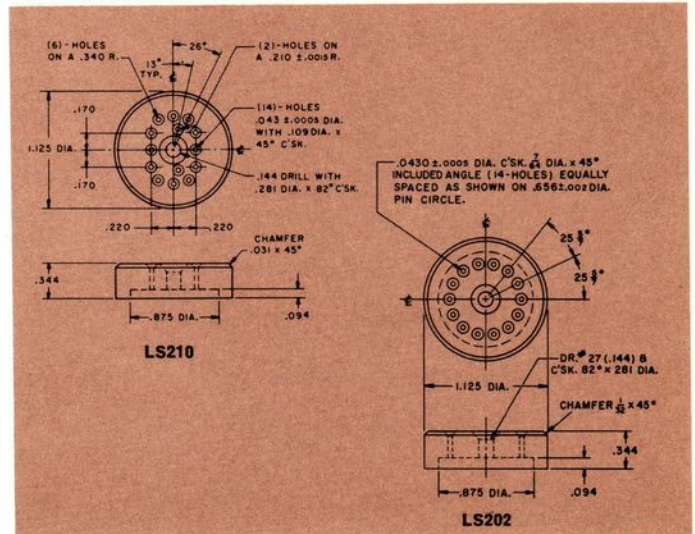
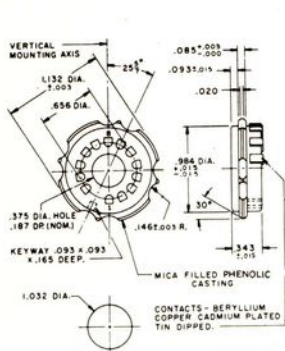
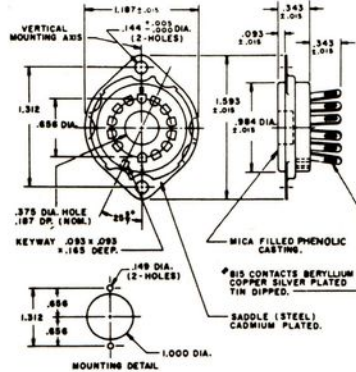


Fig. 8

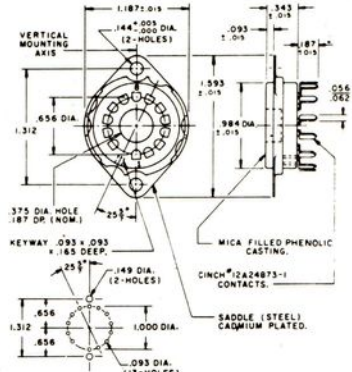
SOCKETS—STANDARD AND SUPER SIZE TUBES



SK109 Butt Type Printed Circuit Socket



SK112 (See Note)



SK130 Standoff Printed Circuit Socket

Note: The following additional sockets are available which are mechanically and physically identical to the SK112 except as noted.—

SK106—General Purpose Angle Mount Socket. Mechanically and physically the same as SK112 except saddle is rotated 25-5/7° clockwise from vertical.

SK120—Commercial Socket. Mechanically and physically same as SK112 except casting is general purpose black phenolic and contacts are brass-cadmium plated finish.

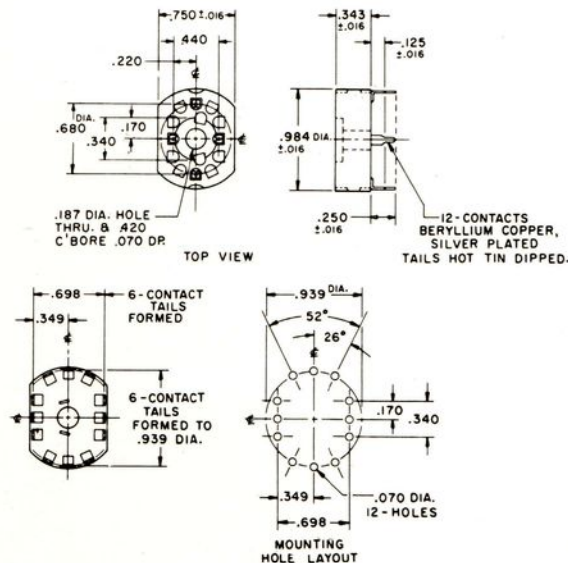
SK124—Mechanically and physically same as SK112 except supplied without saddle.

SK129—Mechanically and physically same as SK112 except saddle is nickel plated brass.

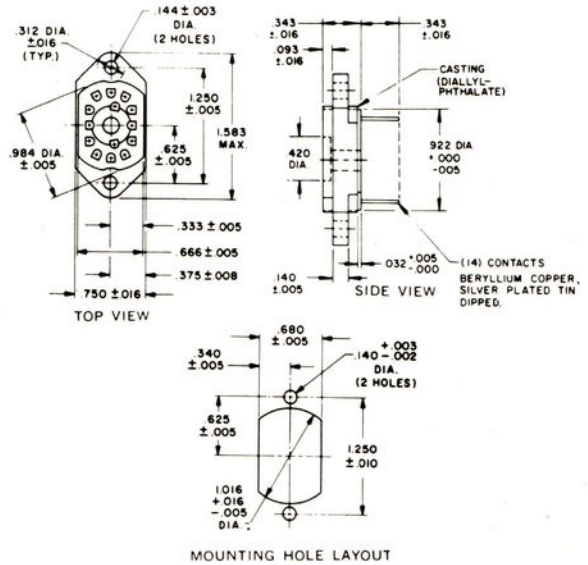
SK127—Mechanically and physically same as SK106 except saddle is nickel plated brass.

SK128—Commercial Socket. Mechanically and physically same as SK106 except casting material is general purpose black phenolic and contacts are brass-cadmium plated finish.

SK134—Mechanically and physically same as SK106 except saddle is brass, bronze iridite cadmium plated per QQP416 Type II Class 1.



SK144A Rectangular Printed Circuit Socket



SK169 Rectangular General Purpose Socket

Fig. 9



BIQUINARY INDICATOR TUBES

TENTATIVE DATA

The B-5025 and B-5030 Biquinary NIXIE tubes are cold-cathode, gas-filled, side-viewing numerical indicator tubes containing the numerals 0 through 9. The numeral cathodes are connected internally in five pairs (0-1, 2-3, 4-5, 6-7, 8-9). The cathodes are grouped with the odd numbers separated from the even numbers by a screen. Two anodes, one for each group of cathodes, are used to allow the illumination of any one numeral by applying the specified voltage between the appropriate anode and the cathode pair containing the desired numeral. (See Note 2)

The B-5030 is a long life tube (200,000 hours life). The B-5025 is a non-mercury tube having greater than 10,000 hours of useful life under dynamic operating conditions. MTBF for the B-5025 is 40,000 hours at 95% confidence level.

OUTLINE DRAWING

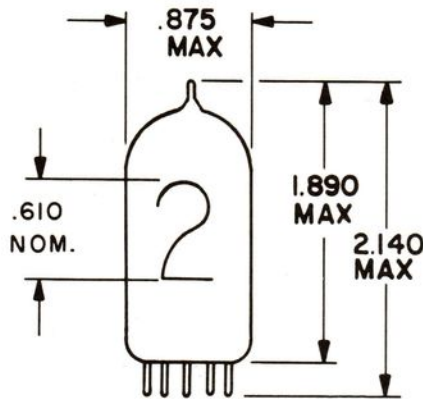


Fig. A

PIN CONNECTIONS

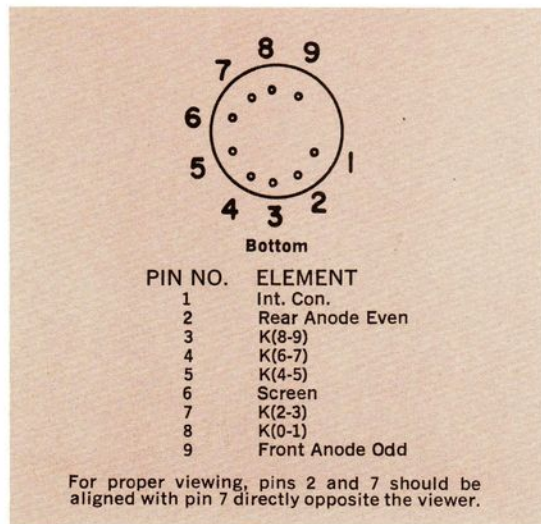


Fig. B

ENVIRONMENTAL DESIGN DATA—B-5025, B-5030

1. Salt Spray: MIL-STD 202C, method 101B, Cond. A.
2. Shock: 50 G 11 ± 1 millisecc duration 1/2 sine wave pulse.
3. Vibration: 10-50-10 CPS. .08 D.A., 5 minutes in each of 3 planes.
4. Altitude: 70,000 ft.
5. Temperature: -65°C to 70°C (B-5025); -20°C to +55°C (B-5030).
6. Humidity: MIL-STD 202C, Method 103B, Condition B
7. Expected Life (Dynamic): 10,000 hours (B-5025); 200,000 hours (B-5030).

ELECTRICAL DATA—B-5025, B-5030

Absolute Ratings	B-5025		B-5030			
	Min.	Max.	Min.	Max.		
Breakdown Voltage (Note 1) (Ez) Vdc	—	130	—	160		
Anode Current (Ia) ma	—	4	—	5		
Cathode Prebias Voltage (Ekk) Vdc	40	70	40	110		
"Off" Anode Voltage (Eb') Vdc	65	80	90	110		
Screen Voltage (Esh) Vdc	40	55	40	65		
Test Limits (Notes 6 & 7)	Min.	Max.	Min.	Max.		
Anode Current (Ia) ma	1.8	3.8	2.8	4.8		
Typical Operating Conditions						
"Off" Anode Supply Voltage (Ebb') Vdc	70		100			
Nominal Tube Voltage Drop (Notes 4 & 5)	100		142			
Cathode Prebias Voltage (Ekk) Vdc (Note 3)	50		50			
Screen Voltage (Esh) Vdc	50		50			
"On" Anode Supply Voltage (Ebb) (Note 2) Vdc	150	200	180	220	250	300
Anode Series Resistor (Rp) (Notes 4 & 5)	18	36	10	20	27	39

NOTES

1. Voltage necessary for breakdown between anode and cathode.
2. E_{bb} may be as stated; however, the use of the highest voltage available with an appropriate series resistor is recommended.
3. Cathode prebias voltage is defined as the potential difference which must be maintained between "on" and "off" cathodes to avoid objectionable background glow.
4. For B-5025 "On" Anode Supply Voltages other than those shown, the series limiting resistor should be calculated on the basis of an anode current design center of 2.8 ma and a nominal tube voltage drop of 100 volts.
5. For B-5030 "On" Anode Supply Voltages other than those shown, the series limiting resistor should be calculated on the basis of an anode current design center of 3.8 ma and a nominal tube voltage drop of 142 volts.
6. B-5025 Test Conditions are the same as typical operating conditions for "On" anode supply voltage of 150 volts.
7. B-5030 Test Conditions are the same as typical operating conditions for "On" anode supply voltage of 180 volts.

TEST CIRCUIT — B-5025, B-5030

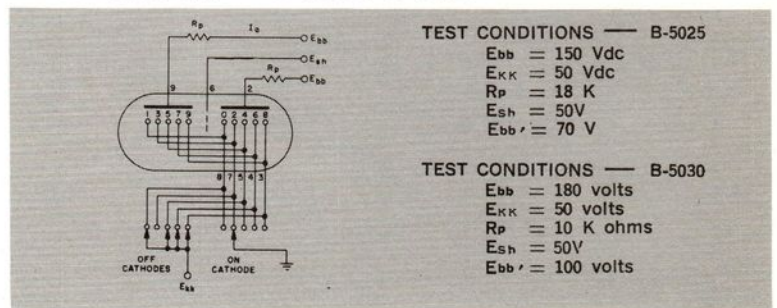


Fig. C

SIDE-VIEW INDICATOR TUBE

TENTATIVE DATA



The B-5440 NIXIE tube is a gas filled, cold cathode, ultra long life, decimal input, side viewing numerical (0-9) indicator tube having a common anode. The B-5441 is identical to the B-5440 except it has two decimal points (right and left of the numeral) inside the tube, which are independently operable (Note 2). The narrow width of the tubes (.750" max.) permit 0.80" center-to-center spacing for multi-tube assemblies and its short seated height (1.8") allows minimal instrument panel height. Printed circuit and wiring type sockets are available. The B-5442 is available for plus-minus indication. Bulletin 1104.

OUTLINE DRAWING

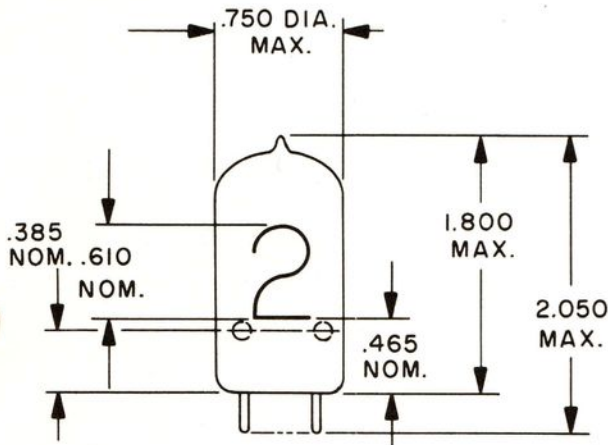
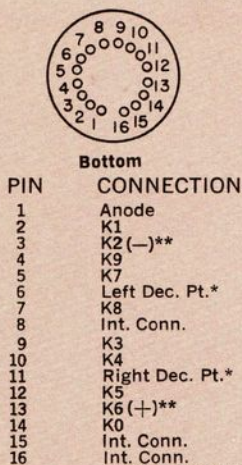


Fig. D

PIN CONNECTIONS



Bottom

*With B-5441 only.
** B-5442 only (Anode is Pin 1)

For proper viewing, the tube should be oriented so that the keyway is directly opposite the viewer.

Fig. E

ELECTRICAL DATA—B-5440, B-5441

Absolute Ratings

Ionization Voltage	+170 Vdc max.
Supply Voltage	+170 Vdc min. (Note 1)
Cathode Current	3.5 ma max.
Decimal Point Current (B-5441)	0.7 ma max.
Cathode Pre-bias Voltage	+65V to +120V

Typical Operating Conditions

Supply Voltage	+170 Vdc (Note 1)
Series Resistor	10K ohm (Note 1)
Numeral Cathode Current (B-5440)	2.5 ma nom. (1.5 to 3.0 ma)
Numeral Cathode Current (B-5441)	2.3 ma nom. (2.0 to 3.5 ma)
Decimal Point Cathode Current (B-5441)	0.5 ma nom. (Note 2)
Cathode Pre-bias Voltage	+65V

MECHANICAL CHARACTERISTICS—B-5440, B-5441

Outline Drawing	Figure D
Pin Connections	Figure E
Wiring Type	SK-182, SK-197 (Diallylphthalate), SK-184, SK-199 (Phenolic)
Printed Circuit	SK-183, SK-194, SK-198 (Diallylphthalate), SK-185, SK-196, SK-200 (Phenolic)

NOTES

- The minimum supply voltage should be 170 Vdc, however, the use of the highest voltage available with an appropriate series resistor is recommended.

SUPPLY VOLTAGE (Vdc)	170	200	250	300
Anode Resistor B-5440 (K Ω)	10	22	43	62
Anode Resistor B-5441 (K Ω)	10	20	39	56

Table 1.

- The decimal points in the B-5441 should be used as follows:
 - When a numeral is always "on"—use an anode resistor as specified in Table 2.
 - When a numeral and a decimal point will not be lighted at the same time (numeral and decimal point is lighted alone)—use an anode resistor specified in Table 1 and insert a resistor in series with the decimal point cathode, as specified in Table 2. Note: in this mode of operation, the Supply Voltage cannot exceed 200V and the Pre-bias voltage is 100V minimum.

SUPPLY VOLTAGE (Vdc)	170	200
Decimal Point Resistor (K Ω)	47	100

Table 2. Decimal Point Cathode Resistor (See Note 2b)

TEST CIRCUIT—B-5440, B-5441

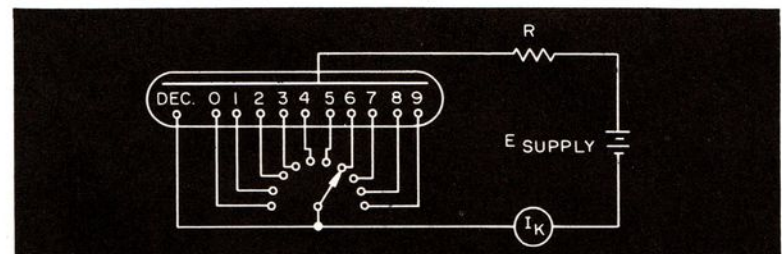


Fig. F

LARGE AND JUMBO TUBES

The large and jumbo size NIXIE Tubes are used in flat panel wall type displays. These tubes are ideal for applications involving group viewing and large room displays where viewing distances demand large character size and a high degree of readability. Both the wide angle viewing and the consistent brightness of NIXIE Tubes contribute to their suitability for applications in terminal schedule boards and status control boards.

OUTLINE DRAWINGS

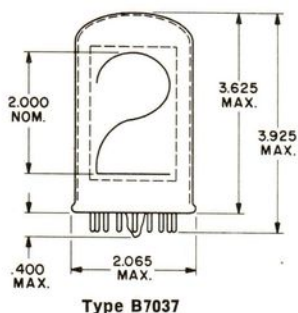
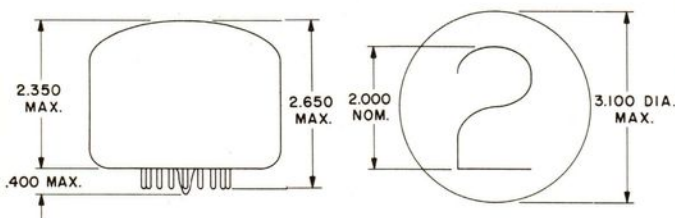
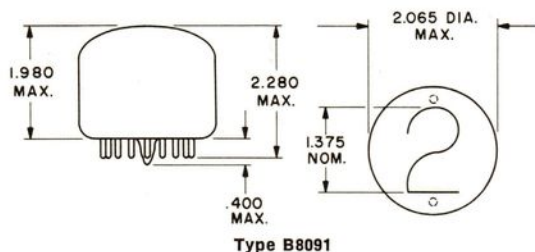


Fig. 10

ENVIRONMENTAL DESIGN DATA

LARGE AND JUMBO TUBES

- Altitude 70,000 Ft.
- Temperature (1) -20°C to +55°C
(2) -65°C to +85°C (Reduced Life)
- Vibration 10-50-10 cps at .08" D.A.,
5 min. ea. in X₁, X₂, & Y₁ axis.
- Shock 30 G's, 11 millise.
- Humidity MIL-STD. 202, Method 103,
Cond. B
- Salt Spray MIL-STD. 202, Method 101,
Cond. A
- Expected Life 200,000 hours (ultra long life)
(Dynamic)

ELECTRICAL DATA

	JUMBO SIDE VIEW	
	LARGE	B7037 Long Life Wide Angle
Absolute Ratings (Note 5)		
Ionization Voltage (Max.)	170 Vdc	200 Vdc
Supply Voltage (Minimum) (Note 2)	170 Vdc	200 Vdc
Cathode Current (Peak) (Note 1)	6.5 ma	7.5 ma
Test Conditions (Basic Circuit, Fig. 4)		
Supply Voltage	170 Vdc	200 Vdc
Series Resistor (Note 4)	5.6 K	9.1 K
Cathode Current: (Minimum) (Maximum) (Note 3)	3.0 ma 6.0 ma	4.0 ma 7.0 ma
Recommended Operating Conditions (DC) (See Basic Circuit, Fig. 4)		
Supply Voltage (E) (Note 2)	200V 250V 300V	300V 250V
Series Resistor (R)	12K 22K 33K	27K 18K

Note 1. Due to life considerations only long life NIXIE tubes are recommended for pulsed operation.

Note 2. The minimum supply voltage should be as stated for each tube type. However, the use of the highest voltage available, with the appropriate series resistor is recommended.

Note 3. No glow is permitted on any tube part other than the numeral under test.

Note 4. All resistance values are $\pm 1\%$.

Note 5. Maximum ionization voltage is the highest voltage necessary to assure breakdown.

Note 6. Minimum supply voltage is the lowest voltage necessary to assure full cathode glow.

PIN CONNECTIONS

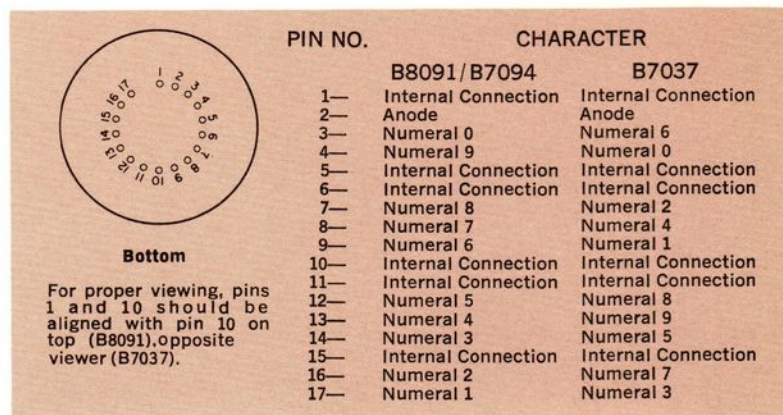


Fig. 11



SOCKETS—LARGE AND JUMBO TUBES

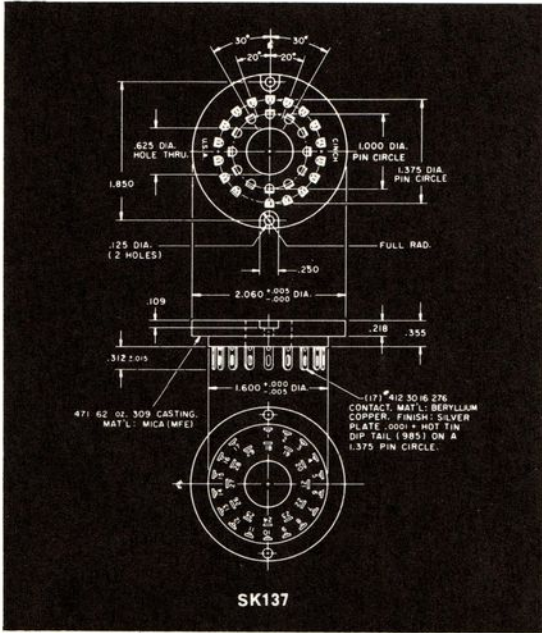


Fig. 12

PIN STRAIGHTENER

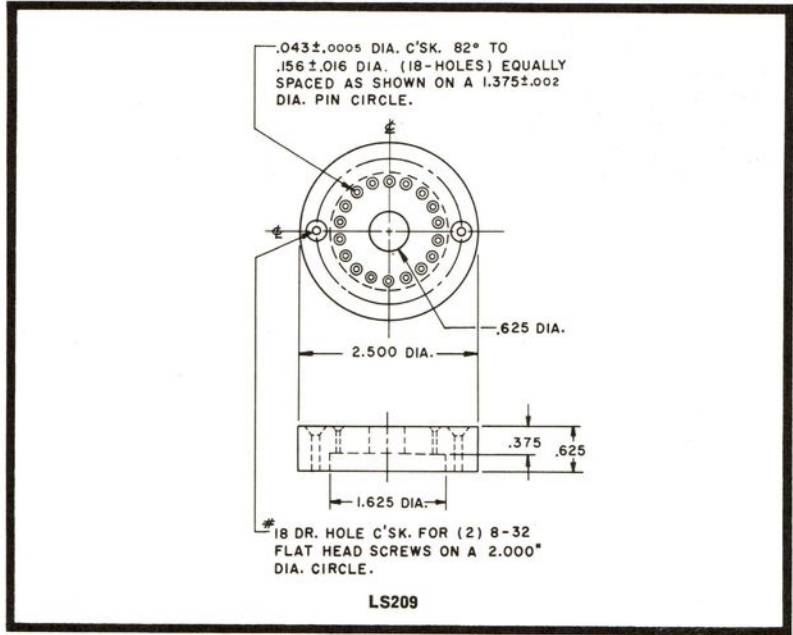


Fig. 13

SPECIAL NIXIE TUBES (SEE BULLETIN 1110 FOR MORE TYPES AND DETAILS)

NIXIE tubes which contain special characters are available in all five sizes. Typical of the characters displayed are:

1. All letters of the alphabet
2. Plus and Minus signs
3. Ω , $<$, $>$, \sim , θ , μ , ϕ , Arrows, $\%$, \div , Fractions (eg: $\frac{1}{8}$, $\frac{1}{4}$, $\frac{1}{2}$)
4. Multiple Symbols (see note below)

In all cases, as many as ten of these characters can be contained in one tube without difficulty. In special cases, it is sometimes possible to employ as many as twelve characters in a single tube. In addition, characters can be combined with digits to form alpha-numerical displays in all tube sizes.

Due to the particularly heavy demand for plus and minus and alphabet tubes, certain types are maintained in stock for immediate delivery. They are contained in the table below. To order special tubes not contained in the table, simply specify the regular part number for the tube type desired and call out the special characters to be included.

NOTE: Additional examples of special tubes that can be designed and fabricated include:



B5094

Two stacks of three miniature characters in a standard size bulb.
Left side N, M, μ
Right side, S, V, A
Such combinations as nanosecond (NS), millisecond (MS), millivolt (MV), microvolt (μ V), microsecond (μ S), can be obtained with this tube.



B6037

Two stacks of standard size digits in a super size bulb.
0-9 on the right side with an additional number 1 digit on the left providing indication from 0 through 19.

MINIATURE SIZE		
TYPE	DESCRIPTION	USED WITH NUMERICAL TUBE TYPES
B4022 (BD-255)	Plus and minus	7009
B4026	Plus and minus (low voltage type)	B4021
B4031*	Plus and minus (long life type)	7977 (B4032)
STANDARD SIZE		
TYPE	DESCRIPTION	USED WITH NUMERICAL TUBE TYPES
B5016 (BD-214)	Plus and minus	6844A
B5032	Plus and minus (long life type)	B5031
B50911*	Plus and minus (long life type)	8421(B5092)
B5018 (BD-216)	A through K less I	6844A
B50113 (BD-221)	L through X less O, Q, and U	6844A
B5992*	Plus and minus Rectangular	8422(B5991)
SUPER SIZE		
TYPE	DESCRIPTION	USED WITH NUMERICAL TUBE TYPES
B6012 (BD-214)	Plus and minus	7153
B6034*	Plus and minus (long life type)	B6033, B6091

Electrical and mechanical characteristics of special character tubes are generally the same as those for the regular lines of NIXIE tubes to which they correspond.

*Preferred type for long life, low cost, packaging and reliability.

Special NIXIE Tubes containing a minute quantity of radioactive gas are available for use in dark ambient conditions. The small amount of radioactive gas assures rapid ionization.

ALPHANUMERIC DISPLAYS

STANDARD, MEDIUM AND LARGE TUBES



The alphanumeric NIXIE Tube represents an outstanding addition to Burroughs readout product line. The new tube has the ability to display all the letters of the alphabet, numerals 0 thru 9 and special characters in a single tube.

From the standpoint of both readability and electrical characteristics, the alphanumeric NIXIE Tube provides many unique benefits including:

- All DC operation.
- Uniform, continuous line characters of equal height.
- Memory with simple solid state drive circuits.
- Readability in high ambient light . . . 200 footlamberts brightness.
- Maintenance-free operation . . . long life with no loss of brightness.

The tube consists of 13 or 15 cathode segments and a common anode mounted within a rectangular shaped glass envelope. Alphanumeric characters are formed by the application of a negative voltage (with respect to the common anode) to the appropriate combination of cathode segments. The characters appear as a bright "continuous line" red neon glow which can be easily read under high ambient light conditions from distances of 25 to 100 feet and at angles exceeding 150°. The tube's rectangular shape provides maximum readout density in multi-character displays.

The alphanumeric NIXIE Tube's DC operating characteristics make it compatible with conventional, low cost, transistorized drive circuitry. Electrical memory can be provided by means of an SCS latch circuit which conserves power and simplifies the input circuitry.

ENVIRONMENTAL DESIGN DATA B-5971

1. Altitude70,000 Ft.
2. Temperature (1)....-20°C to +55°C
(2)....-65°C to +85°C (Reduced Life)
3. Vibration10-50-10 cps at .08" D.A.
5 min. ea. in X₁, X₂ & Y₁
axis.
4. Shock50 G's, 11 millisecc.
350 G's, 1 millisecc.
5. Expected Life50,000 hours
(Dynamic)

OUTLINE DRAWINGS

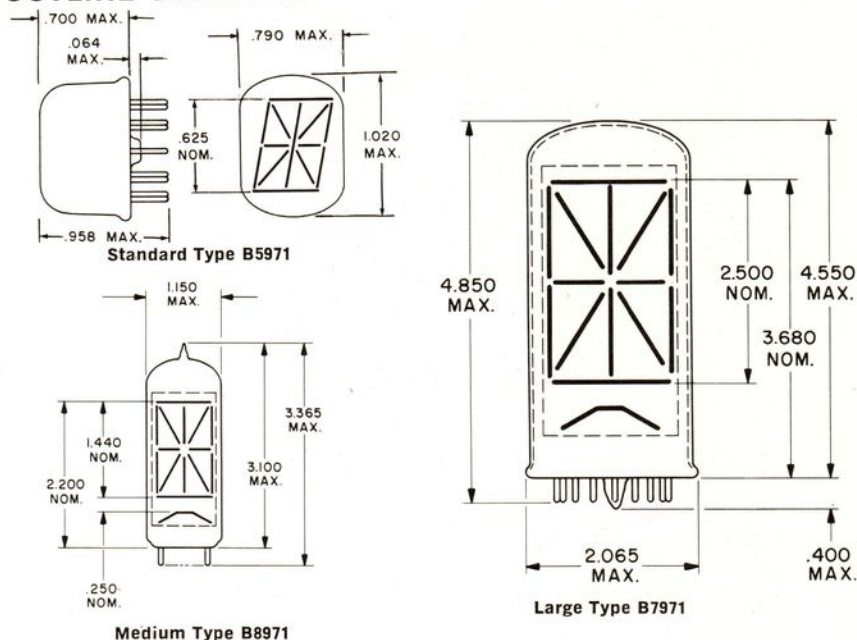


Fig. 14

SEGMENT DESIGNATIONS

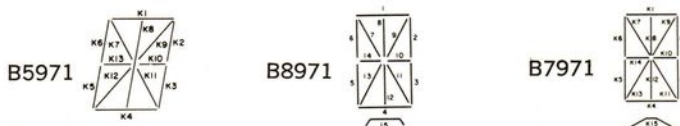


Fig. 15

PIN CONNECTIONS

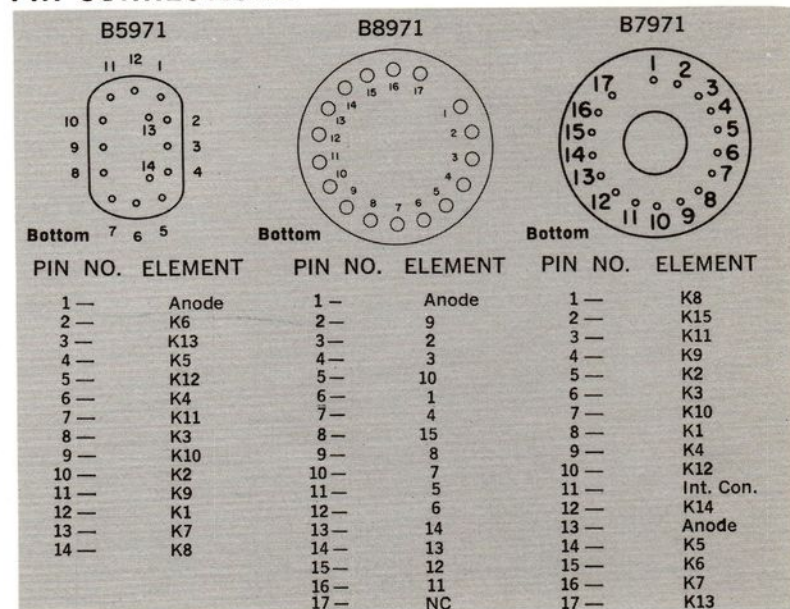


Fig. 16



SOCKETS—ALPHANUMERIC TUBES

ELECTRICAL DATA

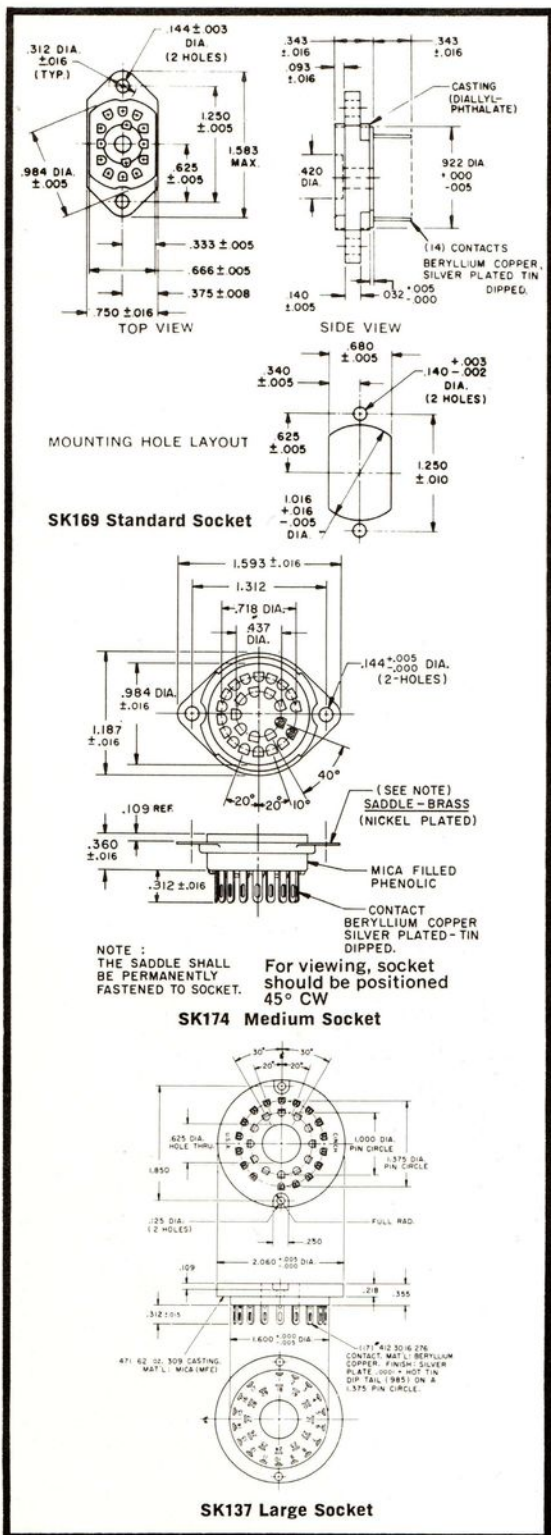


Fig. 17

Absolute Ratings

Supply Voltage (Ebb)	170 Vdc Min.
Cathode Current	
Ik (Total all cathodes)	12 ma max.
Ik (Individual cathodes, K1 through K12 (except K8, K10))	4 ma max.
Ik (Individual cathodes, K10, K13)	3 ma max.
Ik (Individual cathode, K8)	6 ma max.

Test Conditions (See Notes 1 and 2)

Supply Voltage (Ebb)	170 Vdc
Series Anode Resistor (R _p)	6.8 K ± 1%

Test Limits

Individual Cathode Current	Value	Notes
Minimum	50 μa	2
Maximum	4.5 ma	4
Anode Current (Max.)	7.0 ma	2, 3
Ionization Voltage (Max.)	170 Vdc	
Leakage Current (Max.)	5.0 μa	5

TYPE B8971, B7971

Absolute Ratings

	B8971	B7971
Supply Voltage (Ebb) (Vdc min.)	170	170
Individual Cathode Current (Ik) (ma max)		
K1, K4, K15	6.0	6.0
K7, K9, K11, K13	5.0	5.5
K10, K14	3.5	4.0
K2, K3, K5, K6, K8, K12	4.5	5.0
Total All Cathodes	14.0	21.0

Test Conditions (See Notes 1 & 2)

Supply Voltage (Ebb) (Vdc)	170	170
Series Anode Resistor (R _p) (Ohms)	4.3K ± 1%	1.8K ± 1%

Test Limits

Individual Cathode Current		
Minimum (Note 2)	75 ua	75 ua
Maximum (Note 4)	6.0 ma	6.0 ma
Anode Current (max) (Notes 2, 3)	13.5 ma	19.0 ma
Ionization Voltage (max)	170 Vdc	170 Vdc
Leakage Current (max) (Note 5)	5.0 ua	5.0 ua

NOTES:

1. These conditions are also recommended for operation. Higher values of supply voltage and series resistor limit the ability of the tube's dynamic impedance to compensate for different numbers (1 to 15) of cathodes being ionized.
2. These tests are conducted with all cathodes ionized as shown in Figure 21 except as noted (See notes 4 and 5)
3. Under the specified conditions, all cathodes will exhibit uniform glow over their entire surface.
4. Maximum cathode current is measured with the following cathodes energized: B-5971—K₈; B-8971 and B-7971—K₁, K₄ or K₁₅ (all other cathodes floating).
5. Leakage current is measured from one element to all others under the following conditions: Ebb = 50Vdc and R_p = 2.6 megohms.
6. Power requirements for the tubes depend to a large extent upon the application; i.e., the maximum number of cathodes required to be ionized at any one time. The graph shown in Fig. 20 gives the normalized anode current as a function of the number of cathodes ionized.

ALPHANUMERIC TUBES, CON'T.

PIN STRAIGHTENERS

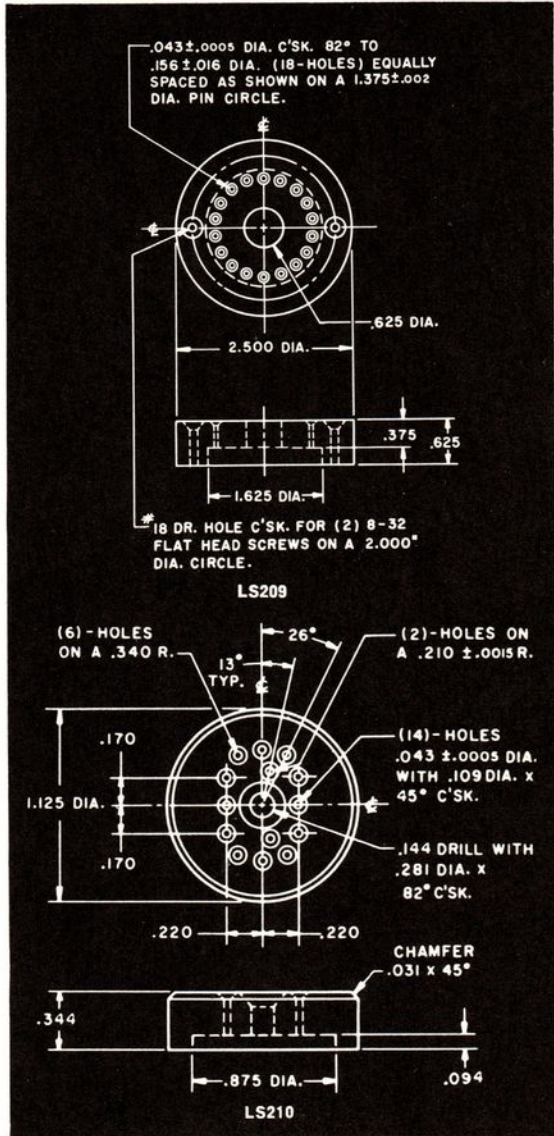


Fig. 18

SYSTEM BLOCK DIAGRAM

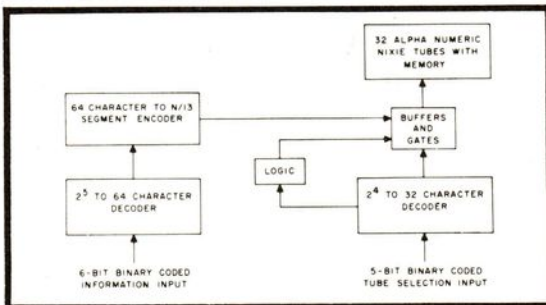


Fig. 19

ANODE CURRENT DISTRIBUTION

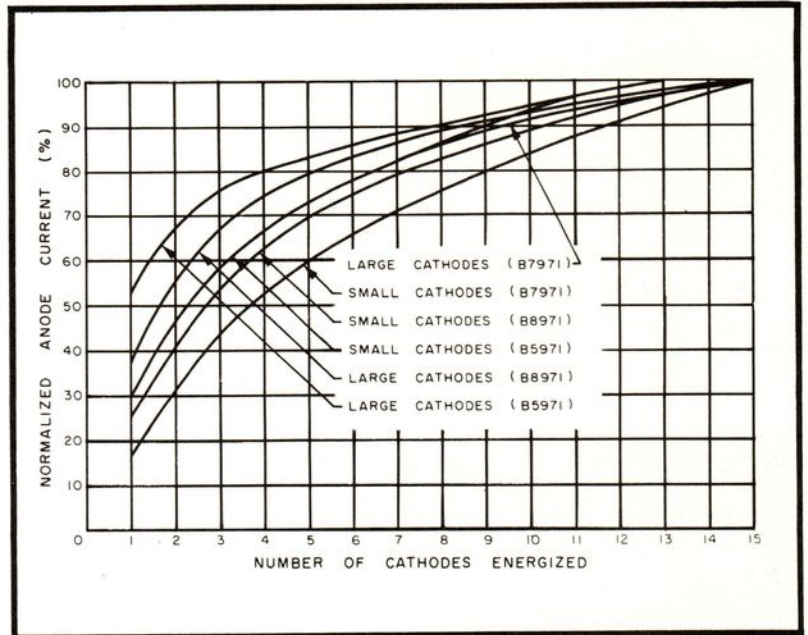


Fig. 20

TEST CIRCUIT FOR ALPHANUMERIC TUBES

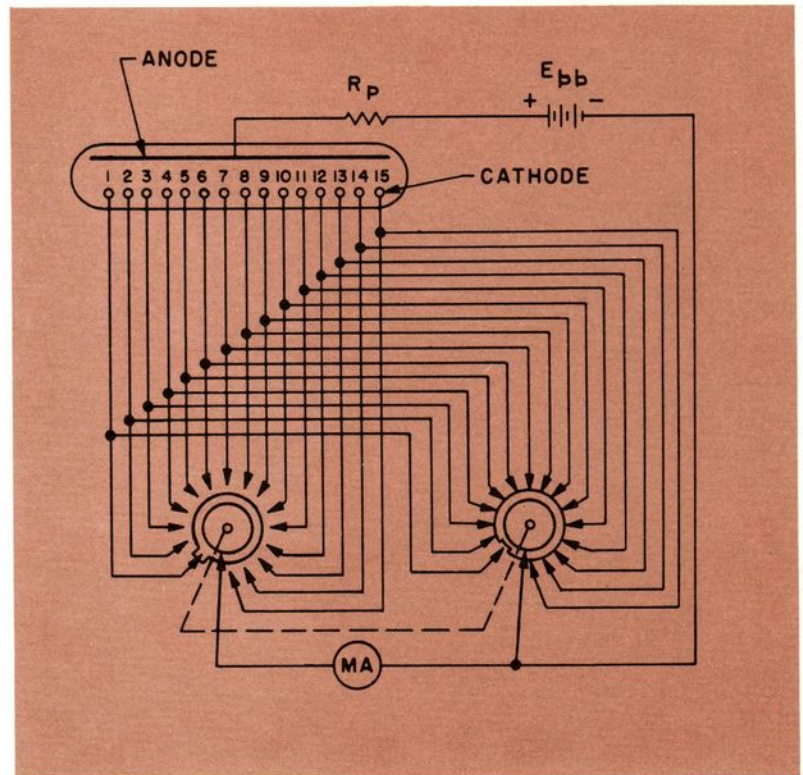


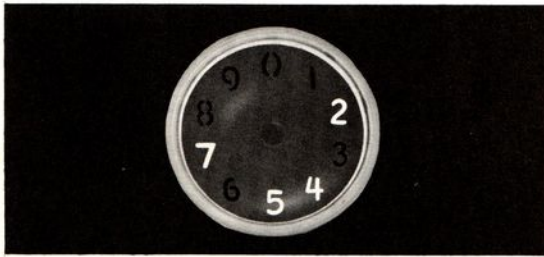
Fig. 21

PIXIE® TUBES



The B-9012 is a gas-filled, cold cathode, indicator tube. It contains ten glow positions or cathodes located 36° apart which are visible through numerical perforations in a plate located above the cathodes. The plate serves as a common anode and functions in the manner of an internal bezel with the indicated number determined by the position of the glow discharge. A twelfth electrode functions as a "keep alive" to obtain rapid ionization for those applications in which this property is desirable.

The PIXIE Indicator Tube is an extremely low cost device which has the ability to display up to ten independent bits of information simultaneously. It is ideal for counting or status displays and requires very low power. It has the same long life characteristics as Burroughs NIXIE Indicator Tubes.



OUTLINE DRAWING

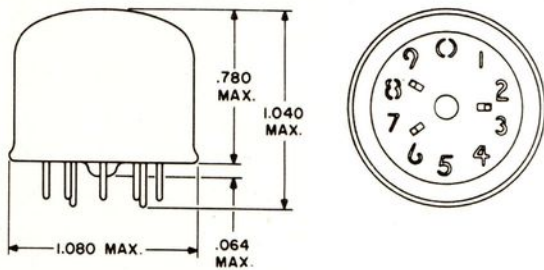


Fig. 22

ENVIRONMENTAL DESIGN DATA

- Altitude 70,000 Ft.
- Temperature -65°C to +85°C
- Vibration 50-2000-50 cps at 10 G's and 10-50-10 cps at .08 D.A. in X₁, X₂ & Y₁ axis.
- Shock 250 G's, 1 millisc. 50 G's, 11 millisc.
- Expected Life (Dynamic) 100,000 hours

ELECTRICAL DATA

Absolute Ratings

Individual Cathode Ionization Voltage 150 Vdc max.
 Individual Cathode Current 600 μ Adc max.
 Keep Alive Ionization Voltage 170 Vdc max.

Test Conditions (Basic Circuit Fig. 4)

Anode to Cathode Supply Voltage 150 Vdc
 Anode Series Resistor 82 K ± 1%
 Cathode Current 400 ua max.
 250 ua min.

Recommended Operating Conditions

Supply Voltage Vdc 170 . . . 200 . . . 250
 Numeral Cathode Resistor 150K . . . 240K . . . 390K
 Keep Alive Cathode Resistor 4.7M . . . 6.8M . . . 10M

PIN CONNECTION

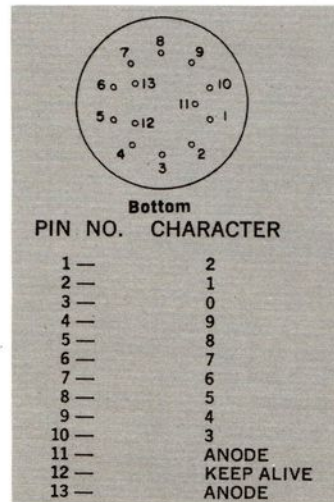


Fig. 23

PIN STRAIGHTENER

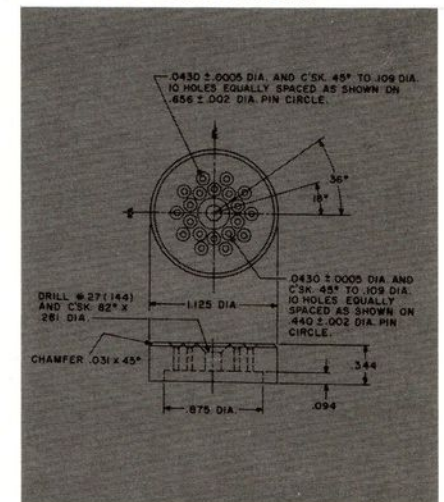


Fig. 24

SOCKETS—PIXIE TUBES

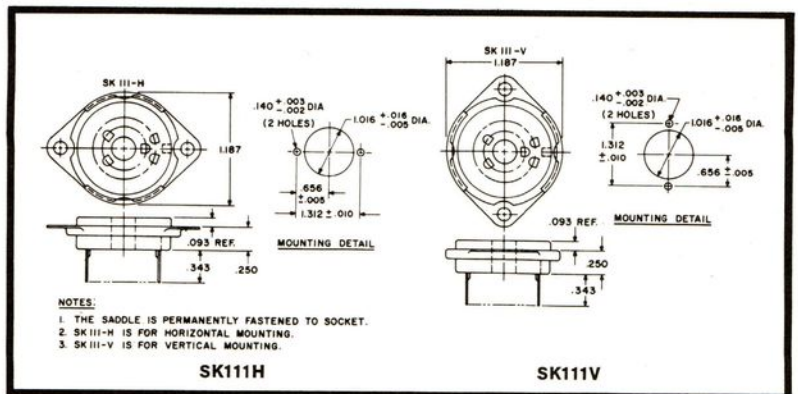


Fig. 25

TECHNICAL MEMORANDUM

SUMMARY

This section contains an explanation of the basic characteristics and operation of NIXIE Indicator Tubes. Ionization and operating voltages as well as full-glow current requirements are defined. Methods for selecting best values of supply voltage, series resistance, pre-bias voltage and switching voltages are discussed. In general, the following discussion applies to both numeric and alphanumeric tube types; however, differences are described wherever necessary.

ELECTRICAL CHARACTERISTICS

The NIXIE Tube is a gas-filled, cold-cathode display device consisting of a common anode and some number of individual metallic cathode elements. Application of a negative voltage to a selected element or combination of elements with respect to the common anode makes these elements the cathode of a simple gas discharge diode.

The equivalent circuit of a NIXIE Tube is shown in Figure 26.

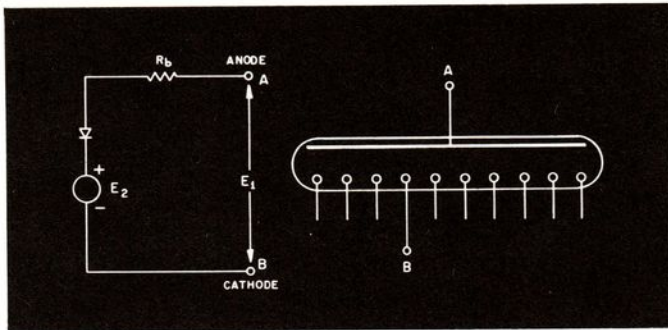


Fig. 26—NIXIE Tube and Its Equivalent Circuit

This circuit represents the NIXIE Tube when considering the anode and only one of the tube's cathodes. Looking into terminals A and B, the device appears as a constant voltage source, E_2 , in series with an internal impedance (approximately 10K ohm) and a diode. The diode represents the nonlinear characteristic of the NIXIE Tube in that current flow ceases when E_1 drops below E_2 .

E_2 is equal to $E_1 - IR$ where E_1 is the average sustaining voltage under average current conditions. If E_2 were constant for each NIXIE Tube, then all tubes would exhibit the same tube voltage drop and cathode current. However, variations exist in

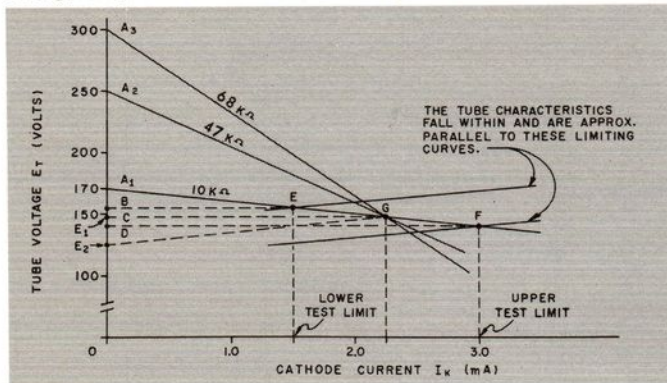


Fig. 27—Electrical Characteristics—Type B5092 NIXIE Tube

E_2 between different tube types and to a lesser extent from tube to tube within a given type. Therefore, corresponding variations will exist in the tube voltage drop and cathode current of individual NIXIE Tubes. Figure 27 shows the limits of tube voltage vs. cathode current (E vs. I) characteristic curves for the type 8421 (B5092) NIXIE Tube. For this tube type, a 170-volt, 10 K ohm load line intersects the characteristic curves at points E and F corresponding to the cathode current limits of 1.5 ma and 3.0 ma.

Points E and F projected onto the ordinate establish points B and D. The distances OB and OD represent the limits of the tube voltage drop as the operating point moves along the 10 K ohm load line from E to F. The voltage represented by the distance OC is the average tube voltage drop under average current conditions of E_1 . These limiting curves constitute the product variation in the volt-amp characteristics for this type. Increasing cathode current results in greater intensity, but shortens tube life. To obtain sufficient brilliance and insure maximum tube life, drive circuits should be designed for a nominal cathode current of 2.25 ma (for the B-5092).

SUPPLY, IONIZATION AND SUSTAINING VOLTAGES

NIXIE Indicator Tubes require a minimum cathode current density to assure complete glow and a maximum cathode current to provide maximum life. Sufficient B+ voltage and appropriate series limiting resistance are the means for assuring full ionization and control of the cathode current within these limits.

As shown in the specification section of this brochure, the recommended minimum supply voltage is the same as the maximum ionization voltage. This assures full ionization of the particular tube type. For example, the maximum ionization voltage and minimum supply voltage for the type 8421 tube is 170 volts. Figure 27 shows that although many type 8421 tubes will ionize below point B, the ionization voltage range must be considered to extend up to A_1 (170 volts). If a B+ voltage less than 170 volts were used, a series resistor smaller than 10 K ohms would be required to establish an average cathode current of 2.25 ma. The resulting load line would extend the cathode current limits which could produce dullness of glow at the lower end and extraneous glow and short life at the upper end.

SERIES RESISTOR

For most 8421 applications, the results obtained by using a 170 volt supply in conjunction with a 10 K ohm load resistor are satisfactory. However, in many cases, such as operation with unregulated supplies or at elevated temperatures, it is preferable to keep the cathode current and glow intensity range to a minimum. One way of accomplishing this is to select a higher supply voltage and use an appropriately high value of load resistance. The higher the B+ and series resistor, the more nearly a constant current is approached and the better the tube operates. (This discussion applies to numeric NIXIE Tubes only. See page 20 for special alphanumeric tube considerations.)

The method of selecting the series load resistance for a particular supply voltage is:

1. Select the center value of cathode current, e.g., 2.25 ma for the type 8421 (Figure 27).
2. Multiply this cathode current by the value of the anode

load resistor to get the IR drop under standard test conditions. In the case of the 8421, it is $2.25 \times 10^{-3} \times 10^4 = 22.5V$.

3. Subtract this IR drop from the supply voltage given under standard test conditions. The result represents the average voltage drop across the tube; point G in Figure 27. For the 8421 this value is $170 - 22.5 = 147.5V$.
4. Subtract the tube drop from the new, higher, supply voltage and divide by the current determined in step (1). This will give the new value of anode load resistor. For the 8421 with a 250V supply: $\frac{250 - 147.5}{2.25 \times 10^{-3}} = 47K \text{ ohm}$.

It should be noted that in the above calculations, the anode current was assumed to be equal to the ON cathode current. This is true only if the remaining nine OFF cathodes are either disconnected or are at or near anode potential. As noted in the section on pre-bias, the OFF cathodes are normally held at a potential of 60 to 80 volts above ON cathode potential. Under these conditions, the OFF cathodes will conduct a small amount of current which must be added to the ON cathode current in step 4 above. Also note that the cathode limits specified for a tube under standard test conditions are given for open circuited OFF cathodes.

The following chart has been prepared to simplify the selection of series resistors for the various NIXIE tube types. The approximate value of the required series resistor (R_L) can be obtained by substituting the selected operating voltage (B^+), the average tube voltage drop, E_1 , and the average cathode current, I_k (av), in the formula:

$$R_L = \frac{B^+ - E_1}{I_k \text{ (av)}}$$

TABLE 1

Tube Group	Tube Type	E_1	I_k (av) ma
Miniature	7009	100	1.0
	8502	100	1.0
	7977	154	1.05
	B-4998	150	1.35
Standard	8422	151	2.3
	8421	147	2.25
	8037	147	2.25
	6844A	135	2.25
	B-5440	145	2.5
	Super	8423	151
7153		143	2.5
Large	B-8091	145	4.5
Jumbo	B-7094	150	5.5
	B-7037	150	5.5

Note: No latitude in series resistance or supply voltage is permissible with alphanumeric tubes except as described on page 16.

PRE-BIAS

In the preceding discussion, the NIXIE Tube has been operated by connecting a high positive voltage in series with a current limiting resistor to the anode of the tube and grounding the appropriate cathode. Although this method serves well for explanation purposes it is not used in most practical applications since it requires a signal equal in amplitude to the minimum supply voltage to turn on the selected NIXIE Tube number. Instead, the OFF cathodes are held at a potential of 55 to 120 volts above the ON cathode making it necessary to switch only the smaller pre-bias voltage, as it is called, to ionize the selected cathode.

The pre-bias voltage is defined as the potential difference be-

tween "on" and "off" cathodes. It should be sufficiently high to avoid objectionable background glow and yet not too high as to cause the "off" cathodes to function as anodes. The curves in Figure 28 show the range of currents which the OFF cathode will draw as its potential changes with respect to the ON cathode. It can be seen that if the OFF cathode voltage is raised above the sustaining voltage (E_1), the OFF cathode will take over as the anode and accept electron current. And if the OFF cathode voltage is lowered, the OFF cathode will begin to accept ion current. If this ion current is excessive, the OFF cathode will become ionized and produce a background haze. Therefore, the pre-bias voltage is limited on the high side by the lowest sustaining voltage for the tube (point D, figure 27 for the type 8421) and on the low side by the objection of the eye to the background haze caused by the ionization of OFF cathodes.

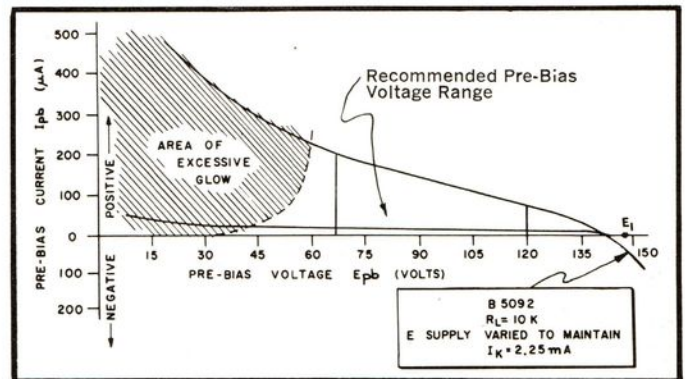


Fig. 28—Pre-bias Voltage vs. Current Characteristics of the Type B5092 NIXIE Tube

The curves shown in Figure 28 were obtained by using a circuit such as that shown in Figure 29. In this circuit one cathode is grounded and therefore ionized while another cathode is connected to the pre-bias supply E_{pb} . As pointed out in the Series Resistor Section, the circuit should be used for illustrative purposes only. Under actual conditions, all cathodes with the exception of the one that is ionized would be connected to the pre-bias supply. Figure 30 shows a set of curves for the 8421 tube which were obtained by using a circuit similar to figure 29 except the pre-bias current meter I_{pb} was connected to all nine OFF cathodes simultaneously. The spread of curves results from the differing effects of pre-bias from one combination of ON and OFF cathodes to the next.

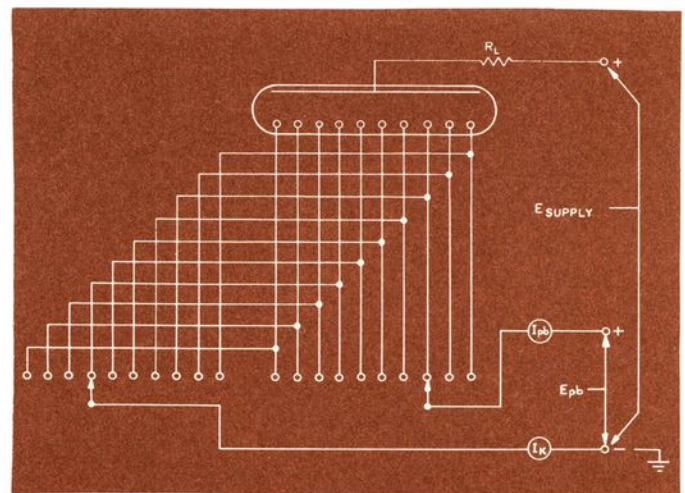


Fig. 29—Basic NIXIE Tube Pre-bias Circuit

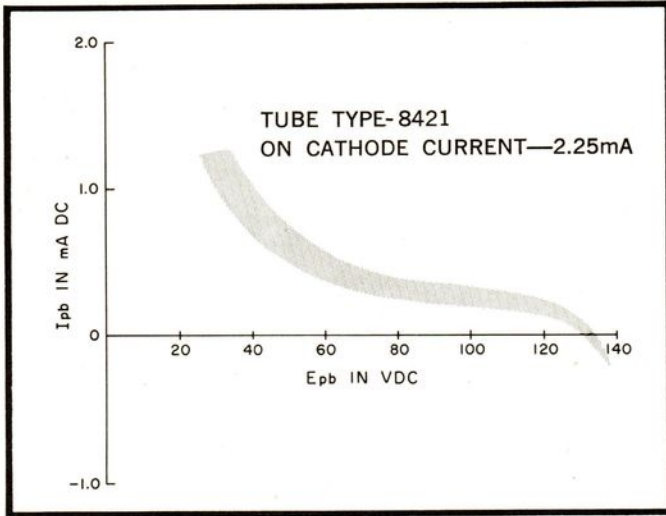


Fig. 30—Pre-bias Voltage vs. Pre-bias Current for Type 8421 NIXIE Tube with Pre-bias Voltage connected to all nine Off Cathodes simultaneously

The table below contains pre-bias voltage limits for the various NIXIE Tube types:

TABLE II		
Tube Group	Tube Type	Pre-Bias Voltage Limits Referenced to the ON Cathode
Miniature	7009	55 V to 75 V
	B4081	55 V to 75 V
	8502 (B4021)	55 V to 75 V
	7977 (B4032)	65 V to 120 V
Standard	All Types	65 V to 120 V
Standard A/N	B5971	55 V to 120 V
Super	All Types	65 V to 120 V
Large	All Types	65 V to 120 V
Medium A/N	B8971	55 V to 120 V
Jumbo	All Types	65 V to 120 V
Large A/N	B7971	55 V to 120 V

SPECIAL ALPHANUMERIC TUBE CHARACTERISTICS

The alphanumeric or segmented NIXIE tube is similar to the numeric type in that both are cold cathode glow discharge devices. Their difference lies in the method of character formation. Unlike the numeric tube, the alpha numeric tube must have a combination of cathode elements ionized to form a character.

Two basic methods may be used to accomplish this. The preferred method (Figure 31A) uses a common anode resistor while other (Figure 31B) uses individual cathode resistors.

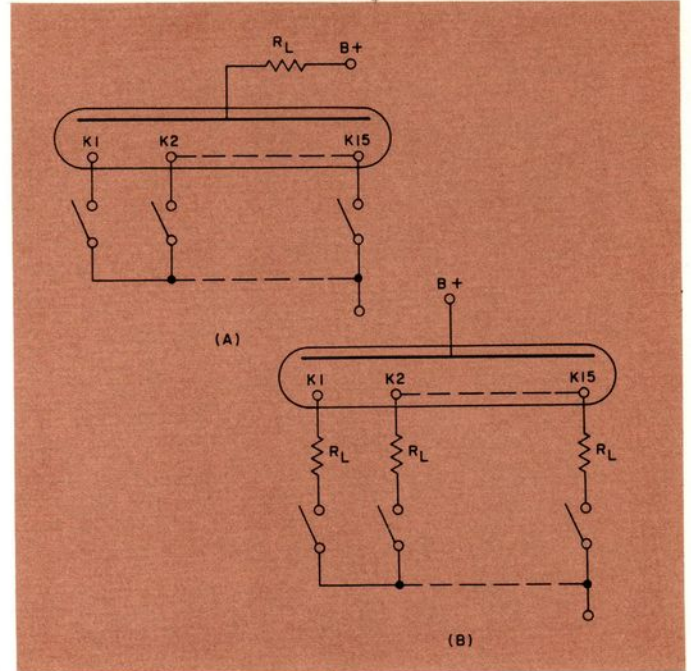


Fig. 31—Basic Circuits for Alphanumeric Tube Types

The advantage of the common anode resistor circuit is in the use of one resistor instead of 13 or 15 required in the individual cathode resistor circuit. Not only does this circuit use fewer components but the drop in current per segment as more segments are ionized makes all tubes appear equal in light output regardless of the number of segments on. The only limitation of this method is the restriction on the power supply. Voltages higher than 170V are not recommended with this technique and value of the load resistor is somewhat critical if the tube is not to be over dissipated. (See page 15 for recommended resistance values.)

With the individual cathode resistor circuit, there are no restrictions on the power supply or resistor value other than those normally imposed by NIXIE Tubes, but the constant current operation causes apparent light output variation from tube to tube depending on the number of segments ionized. This method, however, does have the advantage of isolating the driving elements from the tube so that loading is not a problem and more than one tube can be operated from a single driver.

The method for determining cathode resistor values is not trivial. For applications assistance on the use of cathode resistors, contact Applications Department, Burroughs Corporation, Electronic Components Division, P. O. Box 1226, Plainfield, N. J.

APPLICATIONS INFORMATION

SUMMARY

Typical applications of NIXIE tubes are discussed. Specific methods of operating NIXIE tubes are described, including electromechanical switches, transistors, and BEAM-X® switches. Typical power supply circuits and specialized circuit techniques such as dimming and blanking are discussed. Typical display systems and applications are described.

NIXIE TUBE APPLICATIONS

NIXIE tubes have found application in literally every type of equipment from elevators to electronic instruments, from process control flowmeters to missile count-down displays. The following is a brief listing of some typical applications which indicate the scope, versatility and capabilities of these unique readout devices:

- Digital Clocks
- Aircraft Channel Indicators
- Computer Console Readouts
- Airline Displays
- Frequency Counters
- Direct Readout Oscilloscopes
- Digital Tachometers
- Flight Simulators
- Teaching Machines
- Stock Quotation Displays
- Digital Voltmeters
- Flowmeters
- Tank Level Indicators

In each of these applications, a particular set of conditions exists which dictates the manner in which the tubes will be operated. On the following pages, various methods of operation are described to assist the design engineer in his specific application.

NIXIE TUBE DRIVER CIRCUITS

TRANSISTOR CIRCUITS

The availability of low cost high breakdown NPN transistors has made transistor driver circuits the most popular method for operating NIXIE Tubes. Originally it was felt transistors used with NIXIE tubes would have to be able to switch voltages approaching 100 volts. But, experience showed that the pre-bias voltage necessary to operate the NIXIE tube reliably is only about 40% (approximately 60 volts) of the sustaining voltage for the tube being used. This fact as implemented by the TRIXIE® driver technique makes transistor drivers competitive with other techniques.

In the TRIXIE driver technique, the ON transistor is operated in a saturated condition.

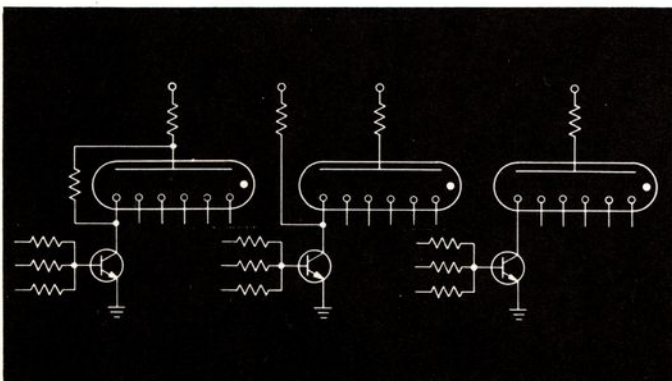


Fig. 32—Typical TRIXIE Circuit Configuration

The "off" transistors are usually operated in a back bias BVCEX condition with a base resistor or a combination of base resistors. The electrical characteristics of the NIXIE tube's "off" cathodes are important because they help determine the operating point of the transistor associated with the "off" cathode. The "off" cathode looks like a current source to the transistor associated with this cathode. The source current is a function of the leakage currents between the NIXIE tube "off" cathode and the anode, and the "off" cathode and the "on" cathode. This current is dependent upon the physical position within the tube of the "off" cathode with respect to the "on" number. The following graph shows a typical V-I plot of this characteristic.

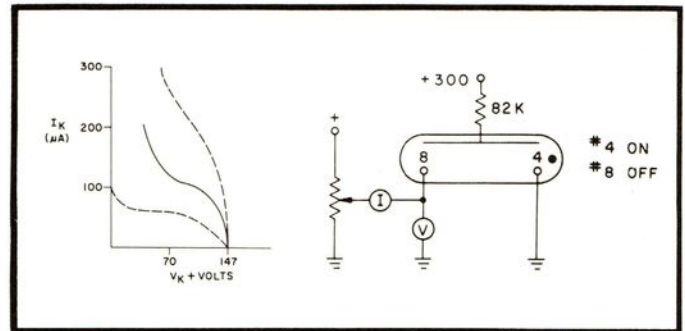


Fig. 33—Characteristics of NIXIE Tube "off" Cathodes

This curve is similar to that shown as Figure 28 in the discussion of pre-bias (page 19).

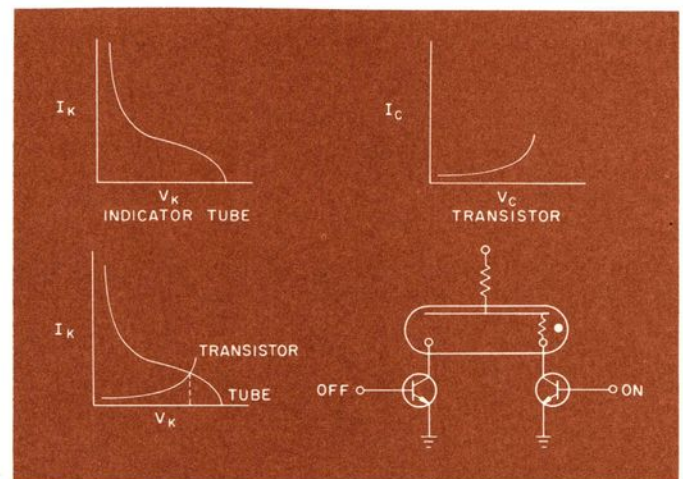


Fig. 34—Combination of NIXIE Tube and Transistor Curves

The exact shape of the curve depends on the number selected, the ambient temperature, and the characteristics of the NIXIE tube used. If the operating voltage of the "off" cathode is less than about 50 volts and the current greater than 100μA, there will be a glow forming on the "off" cathode. This is an undesirable operating condition and reduces the resolution of the "on" number. The amount of leakage current is dependent upon the voltage breakdown characteristics of the transistor used. The operating point of the transistor-NIXIE tube combination is that point where the NIXIE tube characteristic intersects

the transistor voltage breakdown curve. Figure 34 shows the combination of a typical transistor characteristic curve and an average NIXIE tube V-1 curve similar to that in Figure 28. This point establishes the voltage of the "off" cathodes.

General circuit configurations in use at the present time are illustrated below:

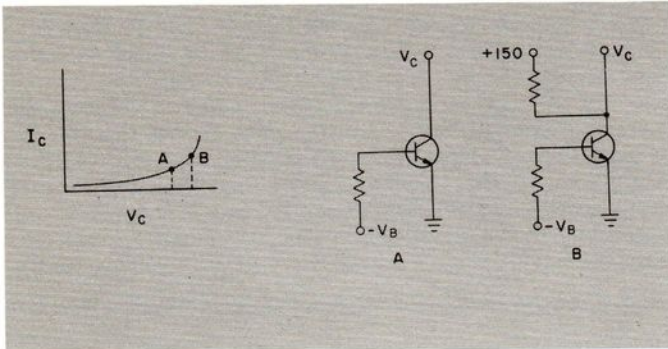


Fig. 35—General Circuit Configuration

The purpose of the extra resistor connected to the collector of the transistor is to cause the transistor to operate at a higher voltage level than if the resistor was not present. This resistor should not be necessary with transistors having low leakage currents. Operating conditions for the transistor when used as a switch with the ultra long life NIXIE tube are as follows:

OFF: The NIXIE tube "off" cathode looks like 140 volts in series with approx. 600 kilohms. This together with any external resistor is the current source for the transistor. The transistor is usually operated in a BVCEX condition. Back bias ranges from -5 volts to -10 volts, base resistance ranges from 10 to 20,000 ohms.

ON: The NIXIE tube in the "on" condition looks like 140 volts in series with 8,000 ohms. The current ranges from 1.5 milliamperes to 3 milliamperes maximum. The absolute values of voltage and current depend on the supply voltage used and the operating point chosen by the designer.

Important facts to consider in the choice of a transistor for use as a NIXIE tube driver are:

1. The breakdown voltage under conditions of back bias and base resistance should be high enough so that under worst case conditions there will be no glow on an "off" number (see table II Pre-bias Limits, page 20).
2. The dc beta must be high enough to keep the transistor in the saturated condition under minimum base drive.
3. The high temperature leakage should be low enough to be insignificant (less than $5\mu\text{a}$).
4. The transistor should not exhibit avalanche breakdown within the operating conditions (see Figure 36A). This is an important consideration when silicon transistors are used. Collector currents as low as 100 microamperes may cause a unit to "fire" to a lower voltage. This lower voltage may be called the sustaining voltage. If the transistor will fire under the operating conditions, the switch may act as a free running sawtooth generator (see Figure 36A, B, & C). The amplitude of the sawtooth will depend on the difference between BVCEX and LVCEX. To avoid this condition, transistors should be selected to have firing currents higher than 500 microamperes.

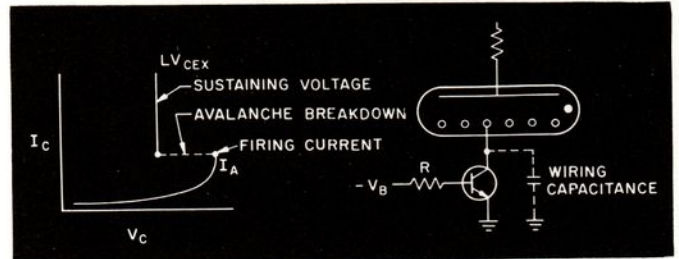


Fig. 36A—Typical Voltage Breakdown Characteristic Triple-Diffused Silicon Transistor

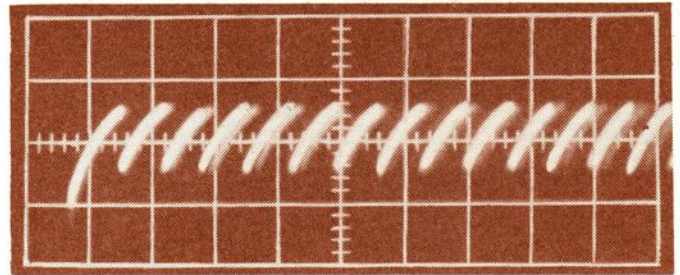


Fig. 36B—Photo of Waveform 500 $\mu\text{sec}/\text{div}$.

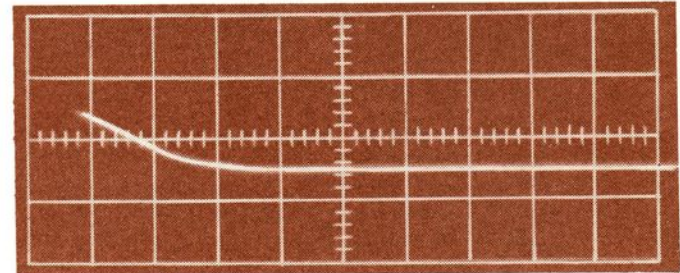


Fig. 36C—Photo of Waveform 0.1 $\mu\text{sec}/\text{div}$.

Typical specifications for transistors used as NIXIE tube drivers are illustrated in Figure 37. The circuit can be used to drive NIXIE tubes and is available packaged as shown.

Description: NPN Silicon Transistor Dissipation Rating at 25°C Free Air: 120 MW min.

CUT OFF CHARACTERISTICS AT 25°C:

Parameter	Condition at 25°C	Value at 25°C
V_{CBO}	$I_{CBO} = 50 \mu\text{a}$	70 V min.
V_{CEX}	$I_{CEX} = 50 \mu\text{a}$ $X = 1.0\text{V}$	70 V min.
V_{EBO}	$I_{EBO} = 50 \mu\text{a}$	6 V min.
I_{CBO}	$V_{CBO} = 50\text{V}$	0.4 μa max.
I_{EBO}	$V_{CEX} = 50\text{V}$ $X = 1.0\text{V}$	0.8 μa max.
I_{CEX}	$V_{EBO} = 5\text{V}$	0.4 μa max.
η_{FE}	$V_{CE} = 3\text{V}$ $I_C = 3\text{ma}$	32 min.
$V_{CE}(\text{sat.})$	$I_C = 2\text{ma}, I_B = .1\text{ma}$	0.45 V max.
$V_{BE}(\text{sat.})$	$I_C = 2\text{ma}, I_B = .1\text{ma}$	0.88 V max.
C_{OB}	$V_{CB} = 15\text{V}, f = 1\text{mc}$	6.8 pf
Temperature		
Operating, Junction		-65°C to +150°C
Storage, Junction		-65°C to +150°C

Fig. 37A—Typical Specifications for NIXIE Tube Driver Transistors

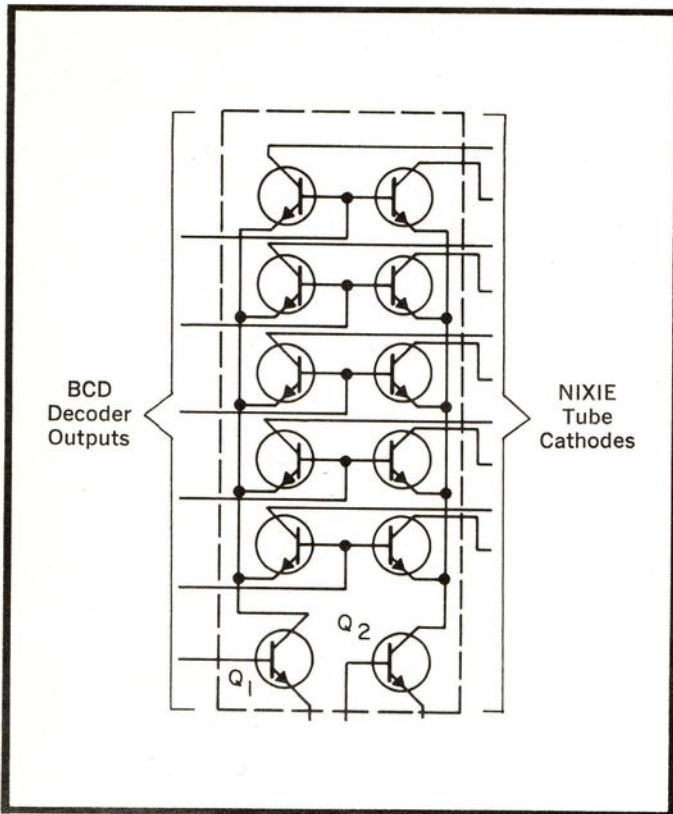


Fig. 37B—Typical Transistor Driver Circuitry

TABLE III

SILICON		GERMANIUM	
Company	Type	Company	Type
Burroughs Corporation	BIP-2003	General Transistor Corp.	2N1310, 2N1311, 2N1672A
G.E.	2N 3877	Motorola	2N4409 2N4410
Fairchild Semiconductor	2N 3568		
	2N 1990 B5888		

SOLID STATE READOUT DRIVER MODULES

The Burroughs Corporation has developed a series of solid-state readout driver packages to operate NIXIE tubes from a wide variety of input signals. General package types currently available are as follows:

- TRIXIE Transistor Drivers BCD-Decimal Decoders with Memory
- Decimal Memory Drivers Uni-Directional Counters
- BCD-Decimal Decoders Bi-Directional Counters

The TRIXIE transistor drivers and the BCD-to-decimal decoders feature molded socket pack construction and are designed to operate standard rectangular NIXIE tubes from low-level decimal or binary-coded-decimal information. The memory drivers and decoders also provide decimal readout from low-level decimal or BCD inputs, but they use a sheet metal enclosure and incorporate the special feature of latching storage which makes it possible to sample the data being presented at the inputs and to hold the sampled data for

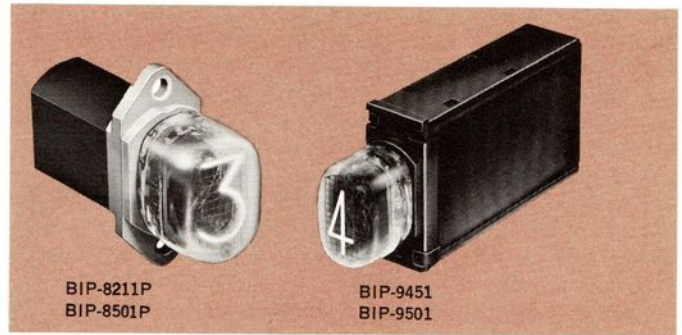


Fig. 38—Binary Decoder Series

convenient visual observation. Figure 38 shows both package versions either of which is available to operate from decimal or bipolar 8-4-2-1 BCD inputs. Decoder modules can also be made available to decode 4-2-2-1, 2-4-2-1, 5-3-1-1, Watts, Cyclic 20 Gray and other commonly used BCD codes.

The transistor drivers contain ten NPN silicon planar transistors connected in common emitter configuration; each transistor base is made available for the input signal. Each transistor collector is connected internally to the appropriate tube socket terminal. The decoder units contain passivated, highly reliable, silicon planar diodes and transistors in micro-miniature subassemblies. Both module types have plug type termination designed to mate with the SK-169 receptacle.

The memory drivers and decoder memory drivers use Burroughs new hybrid microcircuits featuring the glassivated, single-sided, silicon controlled switch as the main memory element. Use of the glass-encapsulated, single-sided devices in conjunction with screened resistive and conductive networks eliminates the need for individually sealed devices and makes possible highly reliable functional packages at low cost. Figure 39 shows a hybrid microcircuit module containing two complete memory latch circuits such as one used in the driver and decoder modules. The new driver modules incorporate the hybrid circuits in a unique sheet metal package which is capable of accommodating from 10 to 36 square inches of printed circuit in units 2 to 6 inches in length with 17 or 34 pin connectors.

Two decade counters, the BIP-8054 and BIP-8055 (See Figure 40), using the SCS as the basic active element are available for a wide variety of counting applications. The BIP-8054

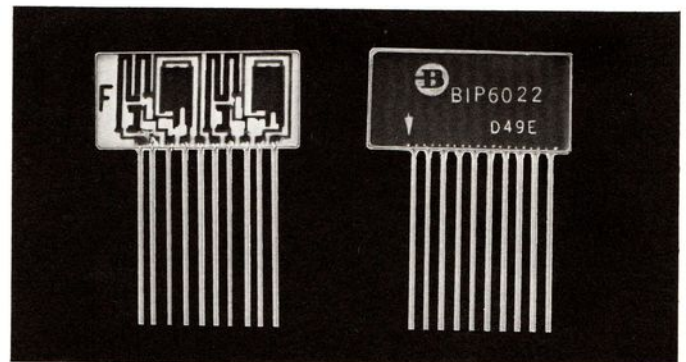


Fig. 39—Dual Latch Hybrid Circuit Module, BIP-6022

is a bi-directional counter capable of counting at rates up to 110 KC while the BIP-8055 is a uni-directional unit capable of counting at rates up to 150 KC. Both counters incorporate an integrally mounted NIXIE tube type 8422, for readout of information and both have ten auxiliary high current outputs

for preset counting or to operate auxiliary equipment such as printers, logic control circuitry or remote displays. In addition, support modules are available for use with the counters. For the BIP-8054 these modules are a preamplifier, a preset/reset module, a polarity detector and an output buffer. With these units a fully reversible, presettable, resettable, bi-directional accumulator which will operate from one, two or three line inputs can be assembled. For the BIP-8055 a preset/reset module capable of accommodating up to six counter decades is available for uni-directional level predetermination.

Table IV contains a complete list of modules available off-the-shelf. Unless otherwise specified, all units listed are designed for use with the standard rectangular NIXIE tube, type 8422; however, units designed to operate with other NIXIE tube types or to perform other functions, such as the decoding of some of the other commonly used BCD codes, can be made available on special order.

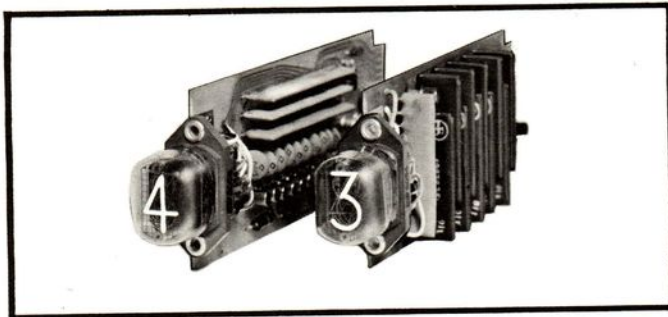


Fig. 40—SCS Decade Counters, BIP-8054 and BIP-8055

TABLE IV (SEE BULLETIN 1108 FOR OTHER TYPES)	
MODULE FUNCTION	PART NO.
Decimal Driver for B-9012 PIXIE Tube	BIP-8506P
Dual Latch Circuit for NIXIE Tubes	BIP-6022
Driver for Plus/Minus NIXIE Tube	BIP-8507P
Decimal Driver	BIP-8501P
Decimal Driver with Memory	BIP-9501
13-bit Driver with Memory for B5971 NIXIE Tube	BIP-9502
8421 BCD-D Decoder—8 Lines	BIP-8211P
8421 BCD-D Decoder—4 Lines (+ Logic)	BIP-8229P
8421 BCD-D Decoder—4 Lines (- Logic)	BIP-8224P
8421 BCD-D Decoder with Memory (+ logic)	BIP-9451
8421 BCD-D Decoder with Memory (- logic)	BIP-8404
110 KC Bi-Directional Decade Counter	BIP-8054
150 KC Uni-Directional Counter	BIP-8055
Preamplifier for BIP-8054 (1, 2, & 3 lines)	BIP-8606
	BIP-8617
Preset/Reset Module for BIP-8054	BIP-8609
Polarity Detector Module for BIP-8054	BIP-8006
Preset/Reset Module for BIP-8055	BIP-8613
Buffer Amplifier for Counters	BIP-8611
8421 BCD-D Decoder/ Memory for Type B-4998	BIP-9401A
8421 BCD-D Decoder—4 Lines for Type B-4998	BIP-9201/03

BEAM-X[®] SWITCH CIRCUITS

Since the NIXIE Indicator tube is a current operated device, a constant current source such as the BEAM-X Switch is an ideal driver for the tube. Having been designed as companion units, their operating voltages and currents are such that optimum performance of the NIXIE tube readout is assured.

The BEAM-X Switch is a high-speed, ten-position, electronic switching device. Within the device are ten arrays of independent elements positioned around a centrally located cathode. See cross section Figure 41.

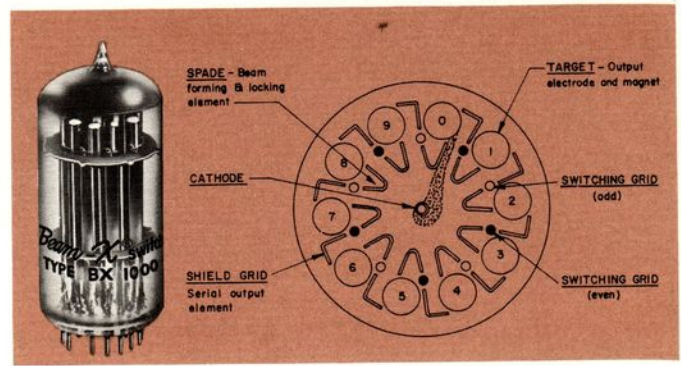


Fig. 41—BEAM-X Switch and Cross Section

An electron beam can be formed from the cathode to any one position and then can be switched sequentially or at random by use of the elements in each array to any of the other nine positions of the tube. When the beam is formed at a given position, the output current available at that position can be used to operate NIXIE tubes, printers and to perform gating or presetting functions.

The versatile design of the BEAM-X Switch allows it to perform the two most common functions in a readout system. It can count pulses reliably at both low and high frequencies, and it can decode binary coded decimal information to decimal form.

DECADE COUNTING WITH THE BEAM-X SWITCH

A number of different techniques can be used to operate the BEAM-X Switch as a counting device. Typical are 100 KC and 1 MC flip-flop circuits which use transistors, vacuum tubes or Nuvistors to drive the switching grids of the BEAM-X Switch and advance the electron beam through the ten positions of the device. A cascade output pulse from the ninth or tenth position of the BEAM-X Switch is normally used to drive succeeding decades. At lower frequencies (below 10 KC), flip-flop drive circuits can be eliminated and the switching grids can be pulsed directly. In either case, the ten constant current outputs operate remote or local NIXIE tube readouts directly without the need for decoder, buffer, or amplifier circuits. BEAM-X Switch/NIXIE tube circuit design criteria is discussed in detail in the BEAM-X Switch brochure (BX-535). In the following sections, typical BEAM-X Switch circuits are shown.

TRANSISTOR BEAM-X COUNTER CIRCUITS

Figure 42 shows the schematic diagram of a 1 MC Transistorized BEAM-X Counter. A total of only eleven active components (three silicon transistors, seven diodes and one BEAM-X Switch) are required to perform the counting function. In addition to operating the NIXIE tube directly, ten electrical outputs are available to drive gates and printers.

This circuit is commercially available as a plug-in module which is designed for front panel mounting in direct readout counting systems (see Figure 43). A second module, the DC-118, is available for counting applications requiring 110 KC maximum pulse resolution. This circuit is electrically compatible with the 1 MC circuit shown below so that complete high-speed systems can be designed using the two units together.

Each unit contains an integral NIXIE Tube (standard long life Type B5092) and BEAM-X Switch which is magnetically shielded to facilitate side-by-side mounting. In addition, a 110 KC unit is available without integral NIXIE Tube for those applications in which remote readout is desired. Table V lists the various BEAM-X Modules by function. Complete specifica-

tions for the units can be found in the BEAM-X Modules Brochure #405.

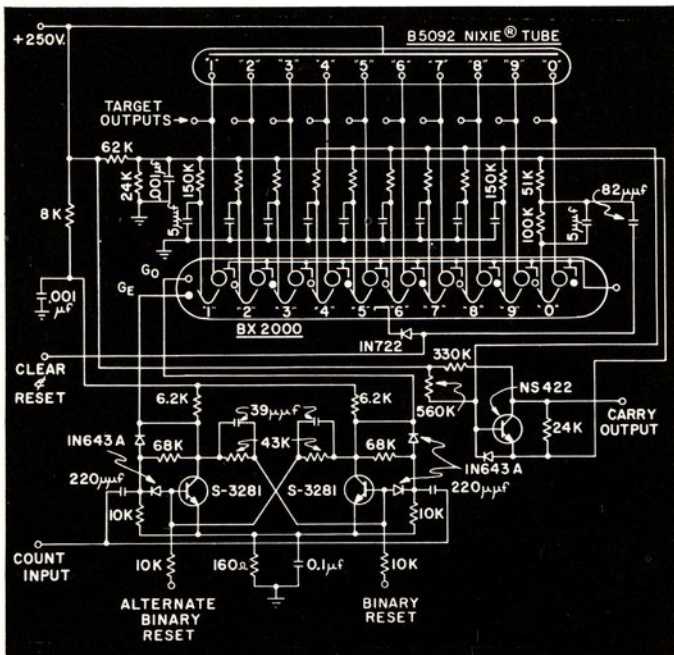


Fig. 42—DC-116 Schematic

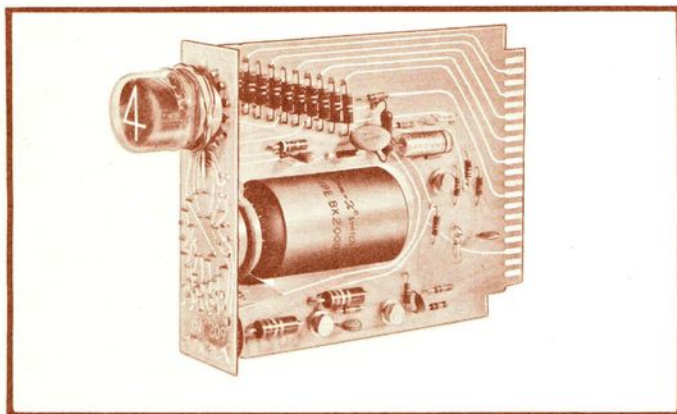


Fig. 43—DC-116 Module

TABLE V

Module Type	Function
DC-111	110 KC General Purpose Decade Counter
DC-112	Distributor
DC-113	Low Cost General Purpose Decade Counter
DC-115	BCD-D Decoder
DC-116	1 MC Counter with Integral NIXIE Tube
DC-118	110 KC Counter with Integral NIXIE Tube

DECODING WITH THE BEAM-X SWITCH

One of the most common circuit requirements in readout systems is the need for conversions of binary coded data to decimal form. In almost every case, the information is available for only a short period of time so that a decoding device which has both data storage and high speed operation capabilities is required. A typical example is the activation of computer console displays from binary coded decimal information.

The BEAM-X Switch is a device which satisfies all of the basic requirements of a decoding system. It has high access

speed (ten microseconds or less) and provides electronic storage in decimal form for the data. It can be combined with transistors to decode 8-4-2-1 BCD to decimal form with four-line access and single line read gate control.

In performing the decoding function, the ten-position BEAM-X Switch operates as a homing switch. A read gate pulse, amplified by a transistor, clears the previously stored information from the BEAM-X Switch and then resets the switch to the "zero" position. As the BEAM-X Switch resets, a second transistor generates an information access gate pulse which turns on four binary information input transistors. Depending upon the binary information at the input to these transistors during the access gate time, voltage levels are established within the BEAM-X Switch so that the beam switches to the decimal output position corresponding to the binary input. Upon termination of the information access gate, four binary input transistors are turned off. The BEAM-X Switch retains the information stored in it until the next conversion cycle begins.

This type of decoder operation is commercially available in a series of BEAM-X decoder modules (Types DC-115-A, DC-115-B, DC-115-C, etc). The modules are designed to decode various BCD codes to decimal form.

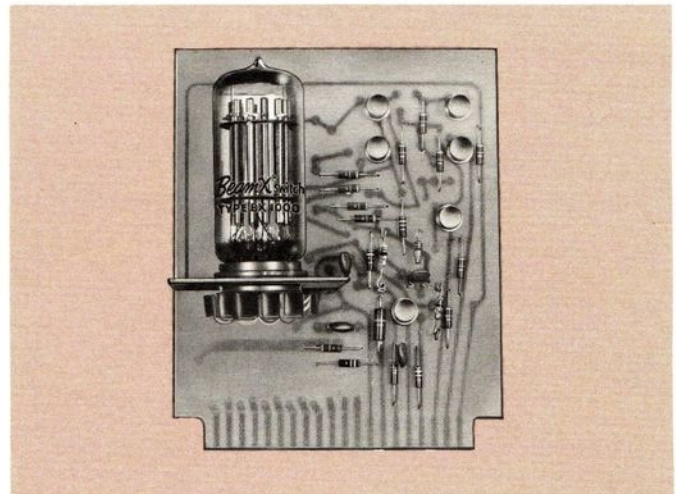


Figure 44—DC-115 Module

A photograph of a typical DC-115 module is shown in Figure 44. Each unit is designed to operate remotely located NIXIE Tubes directly. The table below lists the various modules and the code which they convert. Detailed technical specifications can be obtained by referring to the BEAM-X Modules Brochure #405. Other codes can also be converted and modules can be prepared to your specifications.

TABLE VI

DECODER TYPE #	CODE CONVERTED
DC-115-A	8-4-2-1
DC-115-B	8-4-2-1 (constant current read gate)
DC-115-C	4-2-2-1
DC-115-D	2-4-2-1
DC-115-F	5-3-1-1

ELECTRO-MECHANICAL DRIVE CIRCUITS

In addition to the relatively sophisticated types of drive circuits described above (SCS, BEAM-X Switch, transistor), a NIXIE tube may be operated in a simple electro-mechanical circuit in which each cathode is turned "on" by operating a

mechanical switch. A typical circuit of this type is shown in the figure below:

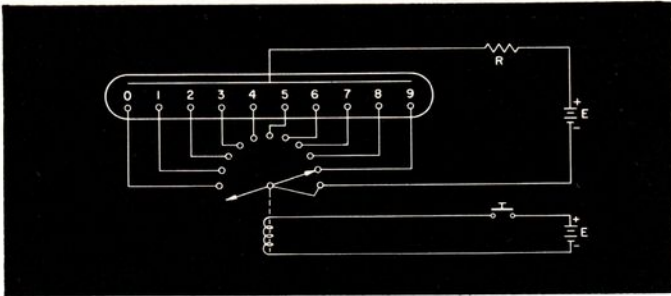


Fig. 45—Electro-mechanical Drive Circuit

Typical applications of this technique would be: status boards, data loggers, cable testers, and automatic system checkout equipment. In these applications the relatively slow speed of the switch is not prohibitive.

POWER SUPPLY CIRCUITS

The power supplies required to drive NIXIE tubes are simple and inexpensive. The circuits illustrated below show how several power supplies can be designed.

AC TO DC CONVERSION

A closely regulated supply is not required, since relatively large amounts of ripple in the power supply will not cause a noticeable flicker or change in brightness in the NIXIE tube. Typical circuits are shown in Figure 46 and 47.

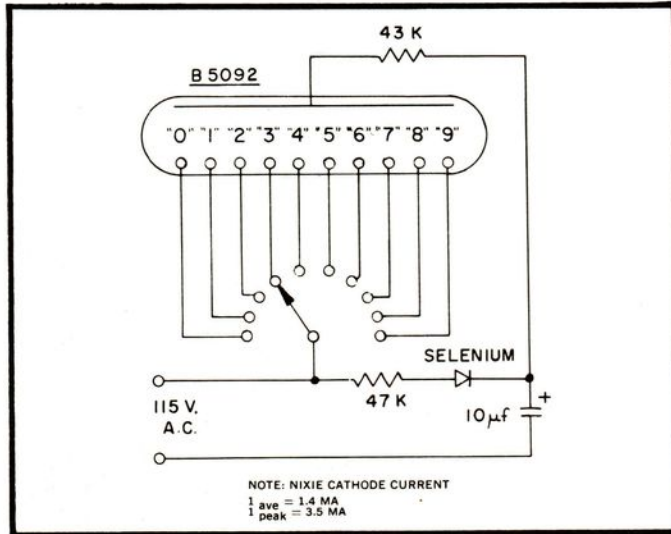


Fig. 46—NIXIE Tube Operation from 115 VAC

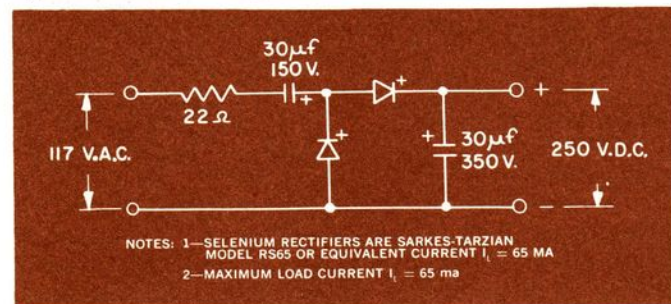


Fig. 47—Power Supply (250 volts)

DC TO DC CONVERSION

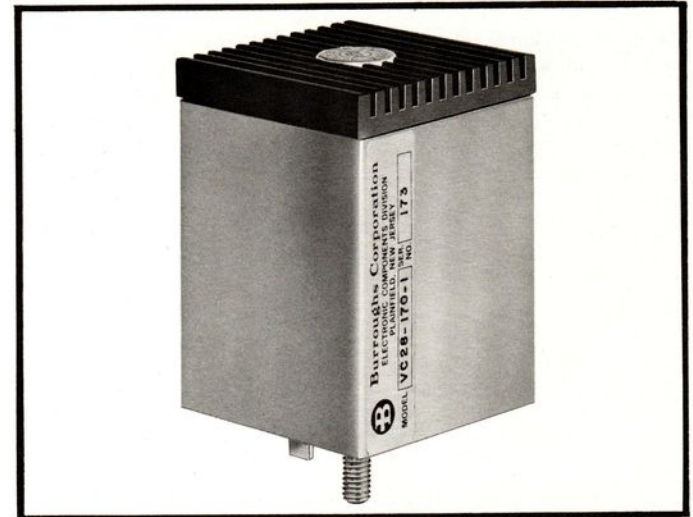


Fig. 48—VC 28-170-1 DC/DC Converter Module

In some equipments, AC power is not available. For these applications, the Burroughs Corporation has developed a line of DC/DC Converter Modules which are capable of converting either 12 or 28 volts DC to 170 volt DC for operating NIXIE tubes. The circuits for the 12 and 28 volt converters are given below. The dimensions for the units are approximately 1.6" wide, 1.6" deep, 2.8" high. When used in conjunction with TRIXIE Modules (Transistorized drivers for NIXIE tubes), these units provide a perfect combination for use in fully transistorized systems. (See Bulletin 1087)

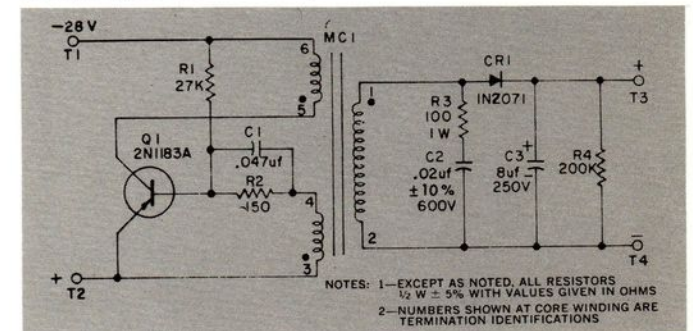


Fig. 49—Circuit Diagram, Voltage Converter Type VC 28-170-1

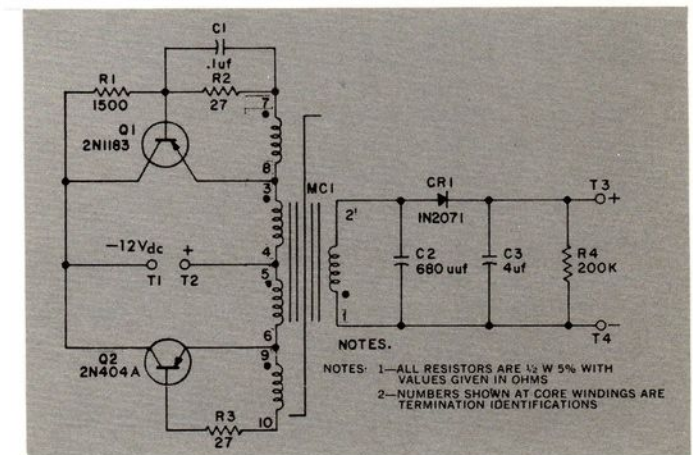


Fig. 50—Circuit Diagram, Voltage Converter Type VC 12-170-1

DIMMING:

Under normal conditions the NIXIE tubes exhibit a constant intensity glow. When the NIXIE tube is to be used in areas where the ambient light is subdued, such as in radar rooms, its intensity can be diminished by using dimming circuits which turn the tube on and off. The duration of the off part of the on-off cycle controls the degree of dimming. The on-off cycle rate should be fast enough to prevent visible flicker. Several circuits illustrating how this may be done are given below.

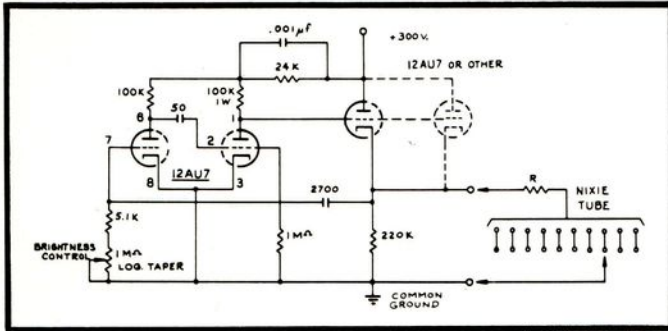


Fig. 51—NIXIE Tube Dimming Circuit

Figure 51 shows a low cost method of controlling the brightness of a NIXIE tube display. The circuit consists of a free-running multivibrator, one output of which is directly coupled to a cathode follower. The multivibrator produces positive pulses of 200 volts amplitude and 100 microseconds duration at variable repetition rates. The high output impedance of the multivibrator is transformed by the cathode follower to a low impedance source driving the NIXIE tube or tubes.

The cathode follower is also made a functional part of the multivibrator charging the large 2700 μf capacitor by its output. Plate one of the multivibrator is thereby allowed quickly to recover to its positive buss, being loaded only by the high impedance input of the cathode follower.

The 1.0 megohm potentiometer is part of the time constant that determines the repetition rate of positive pulses appearing at the output and is therefore used as a brightness control. Potentiometers having a logarithmic or similar taper will allow the brightness of the NIXIE tube to be a nearly linear function of the control shaft's displacement.

The cathode follower swings between approximately 50 volts and 250 volts above ground in accordance with the output of the multivibrator. It must be capable of handling the total current required for the number of NIXIE tubes used. The type 12AU7 tube can handle several NIXIE tubes and is, therefore, sufficient for most applications of this circuit. The average cathode current for various types of NIXIE tubes is tabulated in the specifications section of this brochure and can be used to calculate the total current drain through the cathode follower.

Figure 52 illustrates a transistorized dimming circuit. This is basically a free running multivibrator driving an amplifier Q_1 . An emitter follower, Q_3 , is added to enable the rapid discharging of capacitor C_3 . The brightness control potentiometer carries only D.C. and therefore is well suited for remote control applications. The duty cycle ratio is such that transistor Q_1 is turned "on" for approximately 100 μ seconds and turned off" for 20 μ seconds to 2.5 milliseconds over the range of the control.

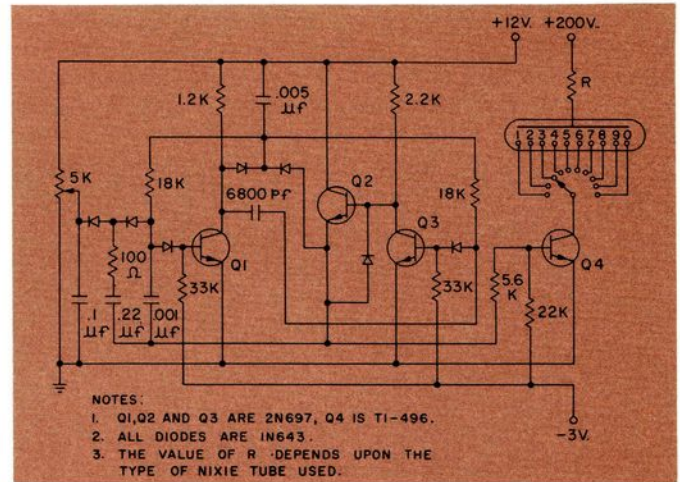


Fig. 52—Transistorized Dimming Circuit

Every NIXIE tube should have a separate current limiting resistor (R). Resistor values for the various tube types are presented in table VII.

Tube Group	Tube Type	Value of R
Miniature	7009	100 K ohm
	7977 (B4032)	82 K ohm
	B4021	100 K ohm
	B4081	100 K ohm
Standard	6844A	39 K ohm
	8037 (B4031)	36 K ohm
	8421 (B5092)	36 K ohm
Super	7153	33 K ohm
	8423 (B6091)	27 K ohm

Figure 53 shows a NIXIE tube dimming circuit using unijunction transistor which yields an excellent dimming ratio with a minimum of components. The unijunction transistor is used as a relaxation oscillator which generates a fixed pulse width at a variable repetition rate. The repetition rate is controlled by the potentiometer. This change in duty cycle determines the amount of light output, changing it from full brilliance to nearly extinction.

The pulse generated by the unijunction is amplified by transistors Q_2 and Q_3 and is used to control the NIXIE tube current.

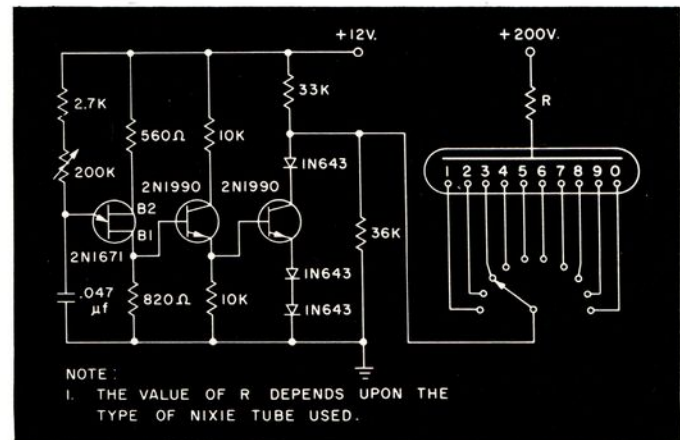


Fig. 53—Unijunction Dimming Circuit

Both circuits (Figures 52 and 53) are capable of operating either TRIXIE modules or NIXIE tubes directly as shown in Figure 54. The values of R in these circuits will be determined by the type of NIXIE tube used and can be found in the specifications section of this brochure.

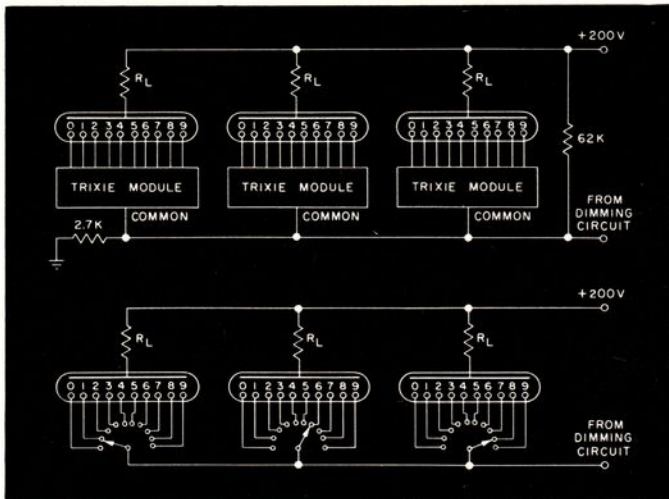


Fig. 54—Dimming Circuit Applications

Another unique dimming circuit has been developed using DC to DC converters similar to those described under Power Sources. Not only does this circuit allow the NIXIE Tubes to be operated from a low voltage supply (12 volts in this case), but it also provides for a wide range of brightness control. Two blocking oscillators form a triggerable multivibrator which, in conjunction with a specially wound tape core, convert 12VDC to high voltage. A full wave bridge rectifier converts the high voltage AC to high voltage DC.

Brightness control is achieved by varying the ratio of on-time to off-time of the NIXIE Tubes. This is accomplished by the variable resistor R_1 . When R_1 is adjusted to zero value, the multivibrator oscillation is essentially symmetrical and the volt-

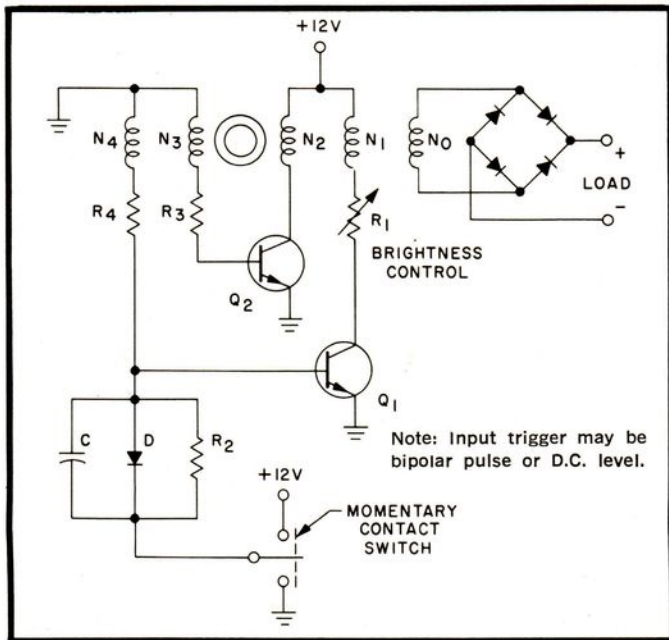


Fig. 55—Magnetic Core Dimming Circuit

age swings across winding N_0 due to conduction of Q_1 and Q_2 are approximately equal in amplitude and duration. Two factors influence the brightness of the NIXIE tubes as R_1 is made larger. First, the voltage swings across N_0 due to conduction of Q_1 become smaller until they are no longer sufficient to fire the NIXIE tubes. Second, the repetition rate of voltage swings induced in N_0 by the conduction of Q_2 becomes lower. These factors then determine the ratio of on-time to off-time and hence the brightness of the NIXIE tubes.

Inherent features of this design are very wide input power tolerances ($\pm 20\%$) and full short circuit protection. Multivibrator oscillation simply stops in event of secondary overload or short circuit.

BLANKING

In some readout applications, it is desirable to have the NIXIE tubes lighted (ionized) only when data is to be observed. At all other times the display is darkened even though the peripheral circuitry may still be accumulating new data.

Blanking can be accomplished most simply by merely inserting a mechanical switch in the anode circuit of the tube. When the switch is closed, the full supply voltage is applied to the NIXIE tube anode. Assuming that input information is present on one of the cathodes of the tube, the corresponding data will be displayed.

Electronic methods of blanking are also readily achieved. Figure 56 shows several variations of a transistorized blanking technique which is applicable to the TRIXIE modules. In each circuit the blanking current drive is $800 \mu\text{a}$ per TRIXIE module.

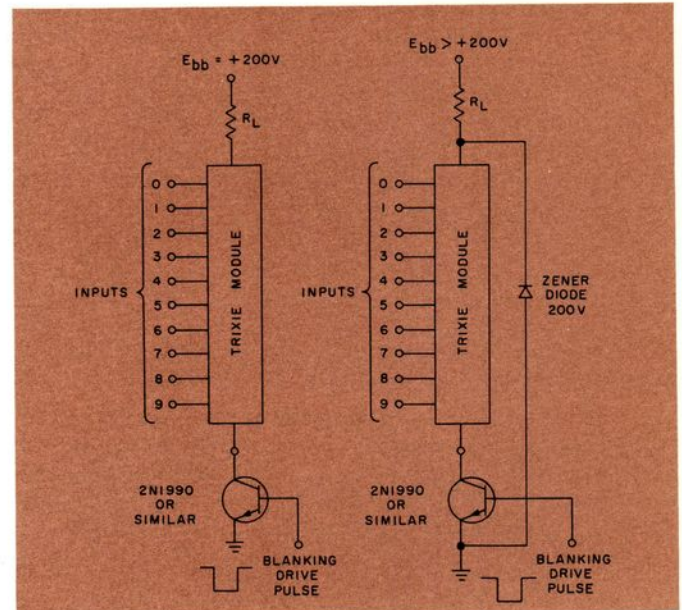


Fig. 56—Blanking circuit for TRIXIE Modules

Values of R_L (anode series resistor) to be used in the blanking circuit for various NIXIE tube types are the same as those contained in TRIXIE module specifications. Power ratings for R_L and the Zener diode can be calculated by use of the following formulas:

$$P_{R_L} = \frac{(E_{bb} - E_z)^2}{R_L} \quad P_z = \frac{(E_{bb} - E_z)E_z}{R_L}$$

where E_z is the Zener Voltage drop of the diode.

Blanking circuits can also be incorporated in BEAM-X Switch

—NIXIE Tube circuits. For example, on page 25 of this brochure, the circuit of a 1 MC Decade Counter was shown (Type DC-116, Figures 42 and 43) and reference was made to other BEAM-X Counters. These circuits can be adapted for blanking by merely connecting the target output terminals through diodes to a common blanking input pulse of 90 volt amplitude. Figure 57 shows how the connections are made between the input, the target outputs of the BEAM-X Switch circuit, and the NIXIE Tube cathodes. This circuit should be used in conjunction with Figure 42, the DC-116 circuit.

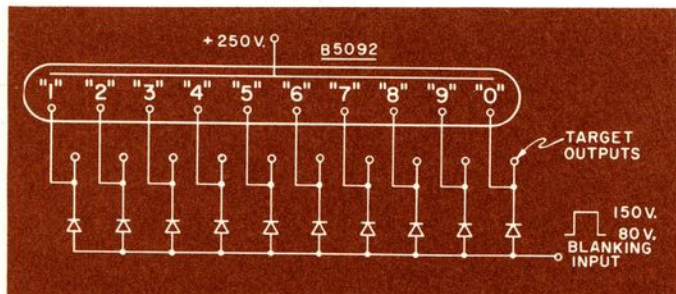


Fig. 57—BEAM-X Switch Blanking Circuit

The operation is as follows: The targets of the BEAM-X Switch would normally fall to a +100 volt potential when the NIXIE tube is ionized. However, when the blanking pulse is present, the targets are held at a +150 volt level which limits the amount of voltage which can develop across the NIXIE tube. Under these conditions, the NIXIE tube will not ionize and the display will be dark.

IONIZATION TIME

When the NIXIE tubes are to be photographed for data recording purposes, the ionization time is generally of interest. Tests results indicate that the ionization time is quite variable and depends on several factors. One of the most important factors is the ambient light in the vicinity of the NIXIE tubes. When a strong ambient light is available in the vicinity, ionization may occur in intervals ranging from twenty microseconds to 300 microseconds. Where strong ambient light is not available, ionization times tend to be considerably longer. Under conditions where no ambient light is available, ionization times may be very long; on the order of several seconds. This can normally be overcome by using a relatively large voltage and series resistance with the NIXIE tube. The larger voltage across the tube causes ionization to occur more readily and speeds up the ionization once it occurs.

Ionization time is also influenced by the previous history of the tube. If the tube was stored for a long period of time, the initial ionization delay will tend to be longer than subsequent ones. Even under repetitive pulsed conditions, the ionization time will tend to be shorter if the "off" time is reduced. Tests have shown that dark ionization can be improved by putting small amounts of radioactive material inside the tube.

There are several established tube types having a minute quantity of radioactive gas to assure ionization under dark ambient conditions.

STANDARD RADIOACTIVE TUBE TYPES

B4021A—Miniature Round	B5092A—Standard Round
7009A—Miniature Round	B5991A—Standard Rectangular

Note: The B4021A tube has a maximum ionization time limit specified.

READABILITY AND MOUNTING INFORMATION

The appearance of an electronic instrument or other piece of equipment in which a digital display is used can be greatly enhanced by careful attention to the way in which the readout device is mounted and by giving consideration to the factors which are discussed in the following paragraphs.

The NIXIE tube is a relatively bright indicator, and can be read easily under normal ambient lighting conditions at distances approximating 40 feet per inch of character height. For example, the commonly used ultra long life, wide angle NIXIE tube, type 8421, can be read at distances of about 27 feet by people with normal eyesight. When ambient light conditions are either very bright or very dim, the maximum viewing distance is somewhat reduced. The included viewing angle for all NIXIE tube types is greater than 100°. The wide angle series of NIXIE tubes has an especially broad viewing angle of 160°.

Generally speaking, it is desirable to mount NIXIE tubes in an enclosure which has been painted with a dull black paint so that reflected light is minimized. The coating will eliminate reflections both from ambient light sources and from the glow generated in the NIXIE tubes themselves. A piece of circular polarizing material or an ordinary red or amber plastic filter is useful. Both the Polaroid filter and plastic filter will reduce the amount of ambient light reflected from the glass surface of the NIXIE tubes, and from the numbers within the tube. This serves to improve the contrast and consequently, the readability of the display. Red or amber filters are recommended since the glow of the NIXIE tubes is in this sector of the color spectrum. The ultra long life series of NIXIE tubes has a characteristic bluish halo. This bluish haze is eliminated by using red or amber filters.

The density of the filter used with the NIXIE tube is not critical, but should be related to the ambient light condition anticipated. If the NIXIE tube is to be used in a darkened area, such as a radar room, it is desirable to use a relatively dense filter so that the brightness of the display is compatible with the other illumination area. Polaroid filters are generally preferred in all readout applications and are particularly useful when high ambient light levels are encountered. Polaroid filters are constructed so that ambient light entering the display through the filter will be polarized into a single plane. The filter material is approximately $\frac{1}{4}$ wave length thick and will impart a 45° rotation to the ambient light which passes through the filter. When the ambient light is reflected from the surface of the NIXIE tube, it is given a further 45° rotation so that when it reaches the inner surface of the filter, it is now 90° out of phase with the polarizing layer. By this means, nearly all of the ambient light which would ordinarily be reflected off the surface of the NIXIE tube is eliminated and consequently, the contrast between the glow generated by the NIXIE tubes and the background around the NIXIE tubes is greatly enhanced. Further information on polaroid filters may be obtained by writing The Polaroid Corporation, Cambridge 39, Massachusetts. Information on bezel assemblies designed to accomplish the effects described above is contained in Bulletin #1020.

Filters to eliminate Radio Frequency Interference (RFI) are also available. These filters can be used with Burroughs NIXIE tube bezel assemblies and they meet the requirements of MIL-I-6181D and MIL-I-26600.

NIXIE TUBE ASSEMBLIES AND DISPLAY SYSTEMS

NIXIE Tube assemblies and display systems fall into two distinct categories; numeric and alphanumeric. The numeric types are generally used in applications such as digital voltmeters, frequency counters, and other devices where digital information, which is largely of a decimal nature, must be displayed; i.e., the application does not require that more than ten different characters be displayed. Alphanumeric applications are such that a minimum of 36 different characters (ten numbers and 26 letters) be displayed. Since the number of characters which must be displayed to satisfy numeric applications requirements is small, the standard NIXIE Tube with preformed numbers mounted in a stack, is the most reasonable solution. This is not the case with alphanumeric applications where the large number of characters which must be displayed makes stacking of the characters impossible and where use of a segmented character type is an absolute necessity.

Because of these basic differences in the method of character formation, the alphanumeric and numeric tube systems are quite different. Generally speaking, the alphanumeric system is more complex in that some method of retaining information supplied to each tube is necessary if duplication of decoding and segment selection circuitry is to be avoided. Normally, information is supplied in 6-bit binary form to the decoder where it is decoded to one out of 64 possible outputs or characters. The output of the decoder is then encoded to some number out of 13 or 15 segments and fed to the memory driver module to form the desired character. The block diagram in Figure 58 shows a typical single-line system in which the information is received at the decoder in a bit-parallel, character-serial fashion. Each character is gated to the desired tube or



Fig. 59—Bezel Assembly

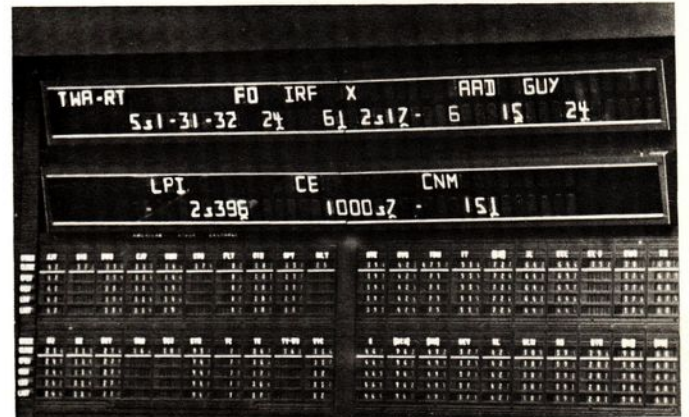


Fig. 60—Stock Quotation Display Application

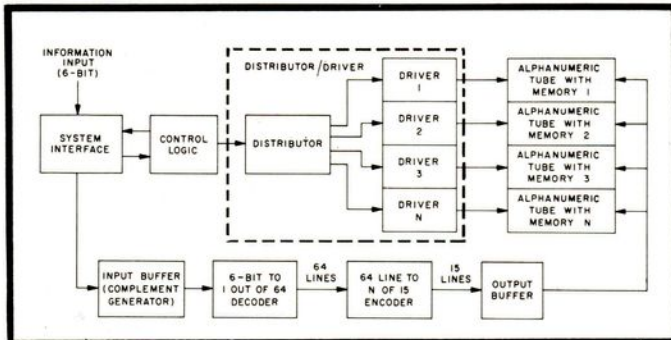


Fig. 58—Typical Alphanumeric Display System

display position by synchronizing the information input with the tube selection input. This system can handle almost any number of tubes requiring only that the distribution system be enlarged to accommodate the larger number of display positions.

Straight numeric display systems are usually much simpler in nature than the alphanumeric type described above. In most cases, memory is not required since information is fed individually to each tube. However, memory drivers which operate from straight decimal or BCD inputs are available if required by the application. Examples of numeric applications requiring memory drivers include event per unit time measurement, gated display counters, etc.

The display formats to which NIXIE Tubes may be adapted can vary anywhere from simple arrangements of tubes mounted in a bezel (figure 59) to complex schedule boards, arrival-departure displays, computer readout panels, stock quotation systems (figure 60), etc. In any case, many different display

formats can be accommodated using standard driver modules described on page 24 of this brochure.

Use of these standard driver modules makes possible the design of completely modular display systems. That is, all display system components are standard production items so that the only item which must be custom designed is the interface between the output of the information source and the display system input.

The interface requirements may be simple or complex depending upon the nature of the information. One commonly used information source is punched paper tape. The system shown in Figure 58 could be readily adapted to such a source. Since all the necessary synchronization information can be picked up from the tape sprocket holes, all that is required is a tape reader control to make up a complete display system.

The distributor to be used depends upon the display format required. In a one-line display, it can be a simple counter with the outputs turning on the display drivers sequentially in synchronization with the character-serial input. With more complex formats, the distributor function becomes more complicated. For example, on large flat panel displays consisting of many rows and columns of information, more sophisticated X-Y selection schemes may be necessary.

For applications assistance on particular display requirements, write Applications Department, Burroughs Corporation, Electronic Components Division, P. O. Box 1226, Plainfield, New Jersey 07061.

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