PROTECTION DEVICES

DATABOOK

1st EDITION

GS-THOMSON
ROELECTRONICS

PROTECTION DEVICES

PROTECTION DEVICES

DATABOOK

1st EDITION

MAY 1989

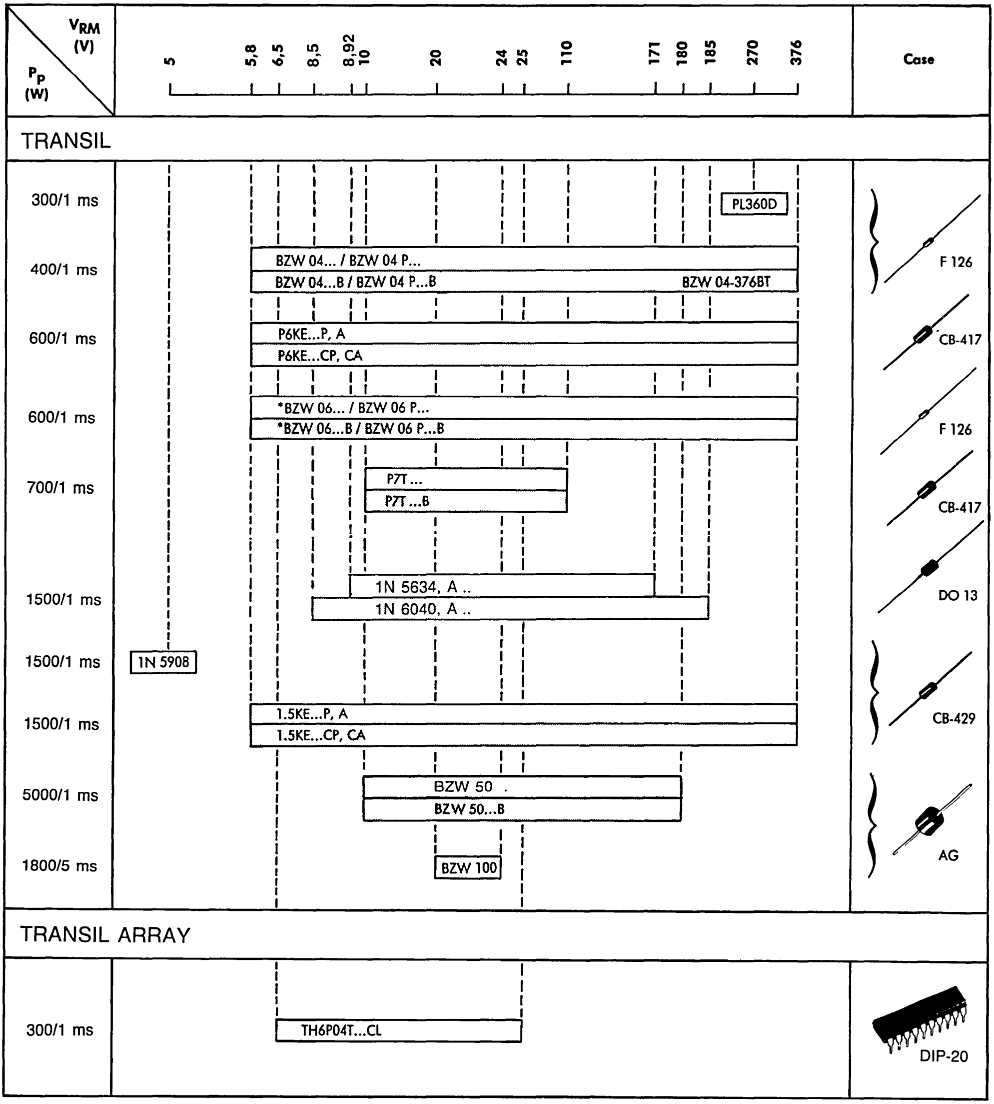
TABLE OF CONTENTS

ALPHANUMERICAL INDEX

PRODUCT GUIDE

C	Capacitance
C_O	Junction capacitance (Transil)
dv/dt	Critical rate of rise of off-state voltage (Trisil)
f, F	Frequency
$I_{(BO)}$	Breakover current (Trisil)
I_{FM}	Peak forward current
I_{FSM}	Surge non repetitive forward current (Transil)
I_{GN}	Firing gate N current (Trisil)
I_{GP}	Firing gate P current (Trisil)
I_H	Continuous holding current (Trisil)
I_{PP}	Surge non repetitive reverse current
I_R	Continuous reverse current
I_{RM}	Peak reverse current
I_T	On-state current
I_{TSM}	Surge non repetitive on-state current (Trisil)
P	Power dissipation
P_p	Peak pulse power
P_{tot}	Total power dissipation
R_{th}	Thermal resistance
T_{amb}	Ambient temperature
T_{case}	Case temperature
T_j	Junction temperature
T_L	Maximum lead temperature for soldering
T_{oper}	Operating temperature (at zero dissipation)
t_P	Pulse width
T_{stg}	Storage temperature
$V_{(BO)}$	Breakover voltage (Trisil)
$V_{(BR)}$	Breakdown voltage
$V_{(CL)}$	Clamping voltage
V_{DRM}	Repetitive peak off-state voltage (Transil)
V_F	Forward voltage
V_{FM}	Forward transient voltage
V_{GN}	Gate voltage (Trisil)
V_R	Continuous reverse voltage
V_{RGN}	Reverse gate N voltage (Trisil)
V_{RM}	Maximum recommended stand-off voltage
V_T	On-state voltage
Z_{th}	Thermal impedance
αT	Temperature coefficient of $V_{(BR)}$ (Transil)
δ	Duty cycle of pulse

TRANSIENT VOLTAGE SUPPRESSOR "TRANSIL"

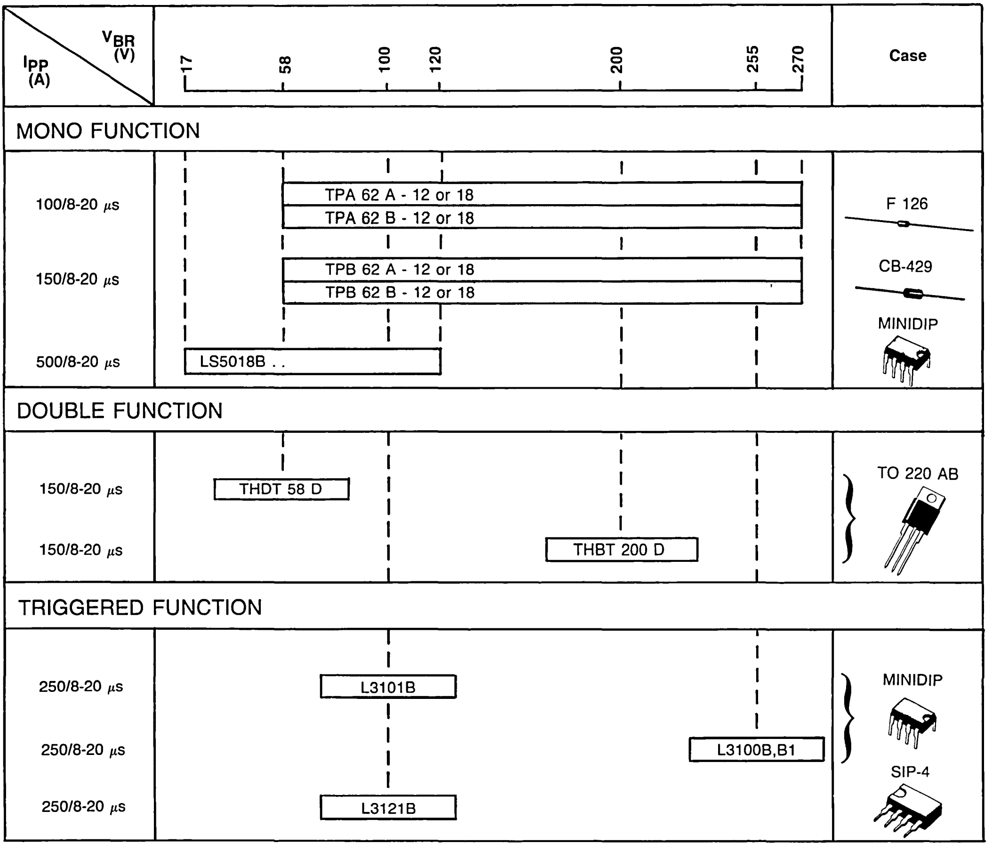


Unidirectional

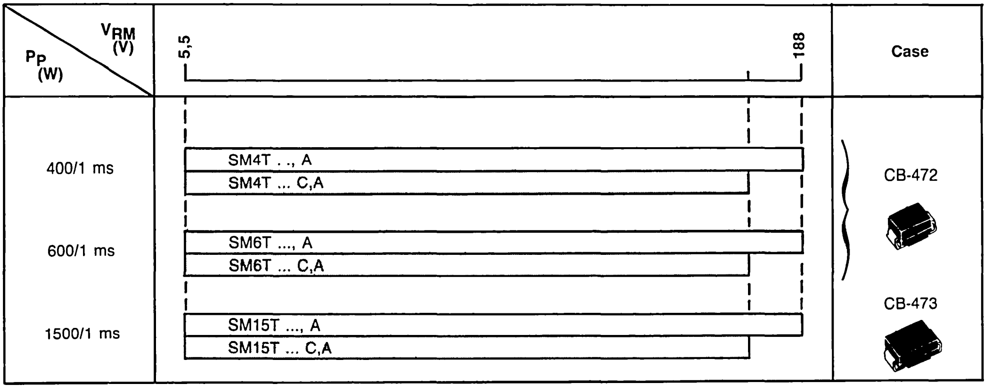
Bidirectional

* Non preferred devices

TRISIL



SURFACE MOUNT DEVICES



☐ Unidirectional ☐ Bidirectional

INDUSTRY PART NUMBER	SGS-THOMSON SIMILAR REPLACEMENT
1N 5634,A	1N 5634,A
↓	↓
1N 5665,A	1N 5665,A
1N 5908	1N 5908
1N 6040,A	1N 6040,A
↓	↓
1N 6072,A	1N 6072,A
1N 6267	1.5KE 6V8 P
1N 6267A	1.5KE 6V8 A
1N 6268	1.5KE 7V5 P
1N 6268A	1.5KE 7V5 A
1N 6269	1.5KE 8V2 P
1N 6269 A	1.5KE 8V2 A
1N 6270	1.5KE 9V1 P
1N 6270A	1.5KE 9V1 A
1N 6271	1.5KE 10 P
1N 6271A	1.5KE 10 A
1N 6272	1.5KE 11 P
1N 6272A	1.5KE 11 A
1N 6273	1.5KE 12 P
1N 6273A	1.5KE 12 A
1N 6274	1.5KE 13 P
1N 6274A	1.5KE 13 A
1N 6275	1.5KE 15 P
1N 6275A	1.5KE 15 A
1N 6276	1.5KE 16 P
1N 6276A	1.5KE 16 A
1N 6277	1.5KE 18 P
1N 6277A	1.5KE 18 A
1N 6278	1.5KE 20 P
1N 6278A	1.5KE 20 A
1N 6279	1.5KE 22 P
1N 6279A	1.5KE 22 A
1N 6280	1.5KE 24 P
1N 6280A	1.5KE 24 A
1N 6281	1.5KE 27 P
1N 6281A	1.5KE 27 A
1N 6282	1.5KE 30 P
1N 6282A	1.5KE 30 A
1N 6283	1.5KE 33 P
1N 6283A	1.5KE 33 A
1N 6284	1.5KE 36 P
1N 6284A	1.5KE 36 A
1N 6285	1.5KE 39 P
1N 6285A	1.5KE 39 A
1N 6286	1.5KE 43 P
1N 6286A	1.5KE 43 A
1N 6287	1.5KE 47 P
1N 6287A	1.5KE 47 A
1N 6288	1.5KE 51 P
1N 6288A	1.5KE 51 A
1N 6289	1.5KE 56 P
1N 6289A	1.5KE 56 A

INDUSTRY PART NUMBER	SGS-THOMSON SIMILAR REPLACEMENT
1N 6290	1.5KE 62 P
1N 6290A	1.5KE 62 A
1N 6291	1.5KE 68 P
1N 6291A	1.5KE 68 A
1N 6292	1.5KE 75 P
1N 6292A	1.5KE 75 A
1N 6293	1.5KE 82 P
1N 6293A	1.5KE 82 A
1N 6294	1.5KE 91 P
1N 6294A	1.5KE 91 A
1N 6295	1.5KE 100 P
1N 6295A	1.5KE 100 A
1N 6296	1.5KE 110 P
1N 6296A	1.5KE 110 A
1N 6297	1.5KE 120 P
1N 6297A	1.5KE 120 A
1N 6298	1.5KE 130 P
1N 6298A	1.5KE 130 A
1N 6299	1.5KE 150 P
1N 6299A	1.5KE 150 A
1N 6300	1.5KE 160 P
1N 6300A	1.5KE 160 A
1N 6301	1.5KE 170 P
1N 6301A	1.5KE 170 A
1N 6302	1.5KE 180 P
1N 6302A	1.5KE 180 A
1N 6303	1.5KE 200 P
1N 6303A	1.5KE 200 A
1N 6404	P6KE 7V5 P
1N 6404A	P6KE 7V5 A
1N 6405	P6KE 8V2 P
1N 6405A	P6KE 8V2 A
1N 6408	P6KE 10 P
1N 6408A	P6KE 10 A
1N 6410	P6KE 12 P
1N 6410A	P6KE 12 A
1N 6411	P6KE 13 P
1N 6411A	P6KE 13 A
1N 6413	P6KE 15 P
1N 6413A	P6KE 15 A
1N 6417	P6KE 20 P
1N 6417A	P6KE 20 A
1N 6419	P6KE 24 P
1N 6419A	P6KE 24 A
1N 6422	P6KE 30 P
1N 6422A	P6KE 30 A
1N 6423	P6KE 33 P
1N 6423A	P6KE 33 A
1N 6425	P6KE 39 P
1N 6425A	P6KE 39 A
1N 6427	P6KE 47 P
1N 6427A	P6KE 47 A
1N 6428	P6KE 51 P
1N 6428A	P6KE 51 A
1N 6430	P6KE 56 P

INDUSTRY PART NUMBER	SGS-THOMSON SIMILAR REPLACEMENT
1N 6430A	P6KE 56 A
1N 6433	P6KE 68 P
1N 6433A	P6KE 68 A
1N 6435	P6KE 75 P
1N 6435A	P6KE 75 A
1N 6436	P6KE 82 P
1N 6436A	P6KE 82 A
1N 6439	P6KE 100 P
1N 6439A	P6KE 100 A
1N 6442	P6KE 130 P
1N 6442A	P6KE 130 A
1N 6444	P6KE 150 P
1N 6444A	P6KE 150 A
1N 6445	P6KE 180 P
1N 6445A	P6KE 180 A
1N 6447	P6KE 200 P
1N 6447A	P6KE 200 A
1N 6452	P6KE 300 P
1N 6452A	P6KE 300 A
1N 6454	P6KE 350 P
1N 6454A	P6KE 350 A
1N 6456	P6KE 400 P
1N 6456A	P6KE 400 A
1.5K 11	1N 5634
1.5K 11A	1N 5634 A
1.5K 12	1N 5635
1.5K 12A	1N 5635 A
1.5K 13	1N 5636
1.5K 13A	1N 5636 A
1.5K 15	1N 5637
1.5K 15A	1N 5637 A
1.5K 16	1N 5638
1.5K 16A	1N 5638 A
1.5K 18	1N 5639
1.5K 18A	1N 5639 A
1.5K 20	1N 5640
1.5K 20A	1N 5640 A
1.5K 22	1N 5641
1.5K 22A	1N 5641 A
1.5K 24	1N 5642
1.5K 24A	1N 5642 A
1.5K 27	1N 5643
1.5K 27A	1N 5643 A
1.5K 30	1N 5644
1.5K 30A	1N 5644 A
1.5K 33	1N 5645
1.5K 33A	1N 5645 A
1.5K 36	1N 5646
1.5K 36A	1N 5646 A
1.5K 39	1N 5647
1.5K 39A	1N 5647 A
1.5K 43	1N 5648
1.5K 43A	1N 5648 A
1.5K 47	1N 5649
1.5K 47A	1N 5649 A

INDUSTRY PART NUMBER	SGS-THOMSON SIMILAR REPLACEMENT
1.5K 51	1N 5650
1.5K 51A	1N 5650 A
1.5K 56	1N 5651
1.5K 56A	1N 5651 A
1.5K 62	1N 5652
1.5K 62A	1N 5652 A
1.5K 68	1N 5653
1.5K 68A	1N 5653 A
1.5K 75	1N 5654
1.5K 75A	1N 5654 A
1.5K 82	1N 5655
1.5K 82A	1N 5655 A
1.5K 91	1N 5656
1.5K 91A	1N 5656 A
1.5K 100	1N 5657
1.5K 100A	1N 5657 A
1.5K 110	1N 5658
1.5K 110A	1N 5658 A
1.5K 120	1N 5659
1.5K 120A	1N 5659 A
1.5K 130	1N 5660
1.5K 130A	1N 5660 A
1.5K 150	1N 5661
1.5K 150A	1N 5661 A
1.5K 160	1N 5662
1.5K 160A	1N 5662 A
1.5K 170	1N 5663
1.5K 170A	1N 5663 A
1.5K 180	1N 5664
1.5K 180A	1N 5664 A
1.5K 200	1N 5665
1.5K 200A	1N 5665 A
1.5KE 6V8,A,C,CA	1.5KE 6V8 A,CA,CP,P
↓	↓
1.5KE 440,A,C,CA	1.5KE 440 A,CA,CP,P
1.5SE 6.8,A,C,CA	1.5KE 6V8 A,CA,CP,P
↓	↓
1.5SE 440,A,C,CA	1.5KE 440 A,CA,CP,P
5KP 10	BZW 50-10
5KP 10C	BZW 50-10 B
5KP 12	BZW 50-12
5KP 12C	BZW 50-12 B
5KP 15	BZW 50-15
5KP 15C	BZW 50-15 B
5KP 18	BZW 50-18
5KP 18C	BZW 50-18 B
5KP 22	BZW 50-22
5KP 22C	BZW 50-22 B
5KP 26	BZW 50-27
5KP 26C	BZW 50-27 B
5KP 33	BZW 50-33
5KP 33C	BZW 50-33 B
5KP 48	BZW 50-47

INDUSTRY PART NUMBER	SGS-THOMSON SIMILAR REPLACEMENT
5KP 48C	BZW 50-47 B
5KP 100	BZW 50-100
5KP 100C	BZW 50-100 B
BZW 04-5V5	BZW 04P5V8
BZW 04-5V5B	BZW 04P5V8B
BZW 04-6V0	BZW 04P6V4
BZW 04-6V0B	BZW 04P6V4B
BZW 04-6V6	BZW 04P7V0
BZW 04-6V6B	BZW 04P7V0B
BZW 04-7V4	BZW 04P7V8
BZW 04-7V4B	BZW 04P7V8B
BZW 04-8V1	BZW 04P8V5
BZW 04-8V1B	BZW 04P8V5B
BZW 04-8V9	BZW 04P9V4
BZW 04-8V9B	BZW 04P9V4B
BZW 04-9V7	BZW 04P10
BZW 04-9V7B	BZW 04P10B
BZW 04-10	BZW 04P11
BZW 04-10B	BZW 04P11B
BZW 04-12	BZW 04P13
BZW 04-12B	BZW 04P13B
BZW 04-13	BZW 04P14
BZW 04-13B	BZW 04P14B
BZW 04-14	BZW 04P15
BZW 04-14B	BZW 04P15B
BZW 04-16	BZW 04P17
BZW 04-16B	BZW 04P17B
BZW 04-18	BZW 04P19
BZW 04-18B	BZW 04P19B
BZW 04-19	BZW 04P20
BZW 04-19B	BZW 04P20B
BZW 04-22	BZW 04P23
BZW 04-22B	BZW 04P23B
BZW 04-24	BZW 04P26
BZW 04-24B	BZW 04P26B
BZW 04-27	BZW 04P28
BZW 04-27B	BZW 04P28B
BZW 04-29	BZW 04P31
BZW 04-29B	BZW 04P31B
BZW 04-32	BZW 04P33
BZW 04-32B	BZW 04P33B
BZW 04-35	BZW 04P37
BZW 04-35B	BZW 04P37B
BZW 04-38	BZW 04P40
BZW 04-38B	BZW 04P40B
BZW 04-41	BZW 04P44
BZW 04-41B	BZW 04P44B
BZW 04-45	BZW 04P48
BZW 04-45B	BZW 04P48B
BZW 04-50	BZW 04P53
BZW 04-50B	BZW 04P53B
BZW 04-55	BZW 04P58
BZW 04-55B	BZW 04P58B
BZW 04-61	BZW 04P64
BZW 04-61B	BZW 04P64B

INDUSTRY PART NUMBER	SGS-THOMSON SIMILAR REPLACEMENT
BZW 04-66	BZW 04P70
BZW 04-66B	BZW 04P70B
BZW 04-74	BZW 04P78
BZW 04-74B	BZW 04P78B
BZW 04-81	BZW 04P85
BZW 04-81B	BZW 04P85B
BZW 04-89	BZW 04P94
BZW 04-89B	BZW 04P94B
BZW 04-97	BZW 04P102
BZW 04-97B	BZW 04P102B
BZW 04-105	BZW 04P111
BZW 04-105B	BZW 04P111B
BZW 04-121	BZW 04P128
BZW 04-121B	BZW 04P128B
BZW 04-130	BZW 04P136
BZW 04-130B	BZW 04P136B
BZW 04-138	BZW 04P145
BZW 04-138B	BZW 04P145B
BZW 04-146	BZW 04P154
BZW 04-146B	BZW 04P154B
BZW 04-162	BZW 04P171
BZW 04-162B	BZW 04P171B
BZW 04-178	BZW 04P188
BZW 04-178B	BZW 04P188B
BZW 04-202	BZW 04P213
BZW 04-202B	BZW 04P213B
BZW 04-227	BZW 04P239
BZW 04-227B	BZW 04P239B
BZW 04-243	BZW 04P256
BZW 04-243B	BZW 04P256B
BZW 04-259	BZW 04P273
BZW 04-259B	BZW 04P273B
BZW 04-283	BZW 04P299
BZW 04-283B	BZW 04P299B
BZW 04-324	BZW 04P342
BZW 04-324B	BZW 04P342B
BZW 04-356	BZW 04P376
BZW 04-356B	BZW 04P376B
BZW 06-5V5	BZW 06P5V8
BZW 06-5V5B	BZW 06P5V8B
BZW 06-6V0	BZW 06P6V4
BZW 06-6V0B	BZW 06P6V4B
BZW 06-6V6	BZW 06P7V0
BZW 06-6V6B	BZW 06P7V0B
BZW 06-7V4	BZW 06P7V8
BZW 06-7V4B	BZW 06P7V8B
BZW 06-8V1	BZW 06P8V5
BZW 06-8V1B	BZW 06P8V5B
BZW 06-8V9	BZW 06P9V4
BZW 06-8V9B	BZW 06P9V4B
BZW 06-9V7	BZW 06P10
BZW 06-9V7B	BZW 06P10B
BZW 06-10V5	BZW 06P11
BZW 06-10V5B	BZW 06P11B
BZW 06-12V1	BZW 06P13

INDUSTRY PART NUMBER	SGS-THOMSON SIMILAR REPLACEMENT
BZW 06-12V1B	BZW 06P13B
BZW 06-13V1	BZW 06P14
BZW 06-13V1B	BZW 06P14B
BZW 06-14V5	BZW 06P15
BZW 06-14V5B	BZW 06P15B
BZW 06-16V2	BZW 06P17
BZW 06-16V2B	BZW 06P17B
BZW 06-17V8	BZW 06P19
BZW 06-17V8B	BZW 06P19B
BZW 06-19V4	BZW 06P20
BZW 06-19V4B	BZW 06P20B
BZW 06-21V8	BZW 06P23
BZW 06-21V8B	BZW 06P23B
BZW 06-24V3	BZW 06P26
BZW 06-24V3B	BZW 06P26B
BZW 06-26V8	BZW 06P28
BZW 06-26V8B	BZW 06P28B
BZW 06-29V1	BZW 06P31
BZW 06-29V1B	BZW 06P31B
BZW 06-31V6	BZW 06P33
BZW 06-31V6B	BZW 06P33B
BZW 06-34V8	BZW 06P37
BZW 06-34V8B	BZW 06P37B
BZW 06-38V1	BZW 06P40
BZW 06-38V1B	BZW 06P40B
BZW 06-41V3	BZW 06P44
BZW 06-41V3B	BZW 06P44B
BZW 06-45V4	BZW 06P48
BZW 06-45V4B	BZW 06P48B
BZW 06-50V2	BZW 06P53
BZW 06-50V2B	BZW 06P53B
BZW 06-55V1	BZW 06P58
BZW 06-55V1B	BZW 06P58B
BZW 06-60V7	BZW 06P64
BZW 06-60V7B	BZW 06P64B
BZW 06-66V4	BZW 06P70
BZW 06-66V4B	BZW 06P70B
BZW 06-73V7	BZW 06P78
BZW 06-73V7B	BZW 06P78B
BZW 06-81	BZW 06P85
BZW 06-81B	BZW 06P85B
BZW 06-89V2	BZW 06P94
BZW 06-89V2B	BZW 06P94B
BZW 06-97V2	BZW 06P102
BZW 06-97V2B	BZW 06P102B
BZW 06-105	BZW 06P111
BZW 06-105B	BZW 06P111B
BZW 06-121	BZW 06P128
BZW 06-121B	BZW 06P128B
BZW 06-130	BZW 06P136
BZW 06-130B	BZW 06P136B
BZW 06-138	BZW 06P145
BZW 06-138B	BZW 06P145B
BZW 06-146	BZW 06P154
BZW 06-146B	BZW 06P154B

INDUSTRY PART NUMBER	SGS-THOMSON SIMILAR REPLACEMENT
BZW 06-162	BZW 06P171
BZW 06-162B	BZW 06P171B
BZW 06-178	BZW 06P188
BZW 06-178B	BZW 06P188B
BZW 06-202	BZW 06P213
BZW 06-202B	BZW 06P213B
BZW 06-227	BZW 06P239
BZW 06-227B	BZW 06P239B
BZW 06-243	BZW 06P256
BZW 06-243B	BZW 06P256B
BZW 06-259	BZW 06P273
BZW 06-259B	BZW 06P273B
BZW 06-283	BZW 06P299
BZW 06-283B	BZW 06P299B
BZW 06-324	BZW 06P342
BZW 06-324B	BZW 06P342B
BZW 06-356	BZW 06P376
BZW 06-356B	BZW 06P376B
BZW 70-5V6	P6KE 6V8A
BZW 70-6V2	P6KE 7V5A
BZW 70-6V8	P6KE 8V2A
BZW 70-7V5	P6KE 9V1A
BZW 70-8V2	P6KE 10A
BZW 70-9V1	P6KE 11A
BZW 70-10	P6KE 12A
BZW 70-11	P6KE 13A
BZW 70-12	P6KE 15A
BZW 70-13	P6KE 16A
BZW 70-15	P6KE 18A
BZW 70-16	P6KE 20A
BZW 70-18	P6KE 22A
BZW 70-20	P6KE 24A
BZW 70-22	P6KE 27A
BZW 70-24	P6KE 30A
BZW 70-27	P6KE 33A
BZW 70-30	P6KE 36A
BZW 70-33	P6KE 39A
BZW 70-36	P6KE 43A
BZW 70-39	P6KE 47A
BZW 70-43	P6KE 51A
BZW 70-47	P6KE 56A
BZW 70-51	P6KE 62A
BZW 70-56	P6KE 68A
BZW 70-62	P6KE 75A
P6KE 6V8,A,C,CA	P6KE 6V8 A,CA,CP,P
↓	
P6KE 440,A,C,CA	P6KE 440 A,CA,CP,P
S5KP 10	BZW 50-10
S5KP 10C	BZW 50-10B
S5KP 12	BZW 50-12
S5KP 12C	BZW 50-12B
S5KP 15	BZW 50-15
S5KP 15C	BZW 50-15B
S5KP 18	BZW 50-18

INDUSTRY PART NUMBER	SGS-THOMSON SIMILAR REPLACEMENT
S5KP 18C	BZW 50-18B
S5KP 22	BZW 50-22
S5KP 22C	BZW 50-22B
S5KP 26	BZW 50-27
S5KP 26C	BZW 50-27B
S5KP 33	BZW 50-33
S5KP 33C	BZW 50-33B
S5KP 48	BZW 50-47
S5KP 48C	BZW 50-47B
S5KP 100	BZW 50-100
S5KP 100C	BZW 50-100B
SA 5.0	BZW 06P5V8
SA 5.0 A	BZW 06-5V8
SA 5.0 C	BZW 06P5V8B
SA 5.0 CA	BZW 06-5V8B
SA 6.0	BZW 06P6V4
SA 6.0 A	BZW 06-6V4
SA 6.0 C	BZW 06P6V4B
SA 6.0 CA	BZW 06-6V4B
SA 7.0	BZW 06P7V0
SA 7.0 A	BZW 06-7V0
SA 7.0 C	BZW 06P7V0B
SA 7.0 CA	BZW 06-7V0B
SA 8.5	BZW 06P8V5
SA 8.5 A	BZW 06-8V5
SA 8.5 C	BZW 06P8V5B
SA 8.5 CA	BZW 06-8V5B
SA 9.0	BZW 06P9V4
SA 9.0 A	BZW 06-9V4
SA 9.0 C	BZW 06P9V4B
SA 9.0 CA	BZW 06-9V4B
SA 10	BZW 06P10
SA 10 A	BZW 06-10
SA 10 C	BZW 06P10B
SA 10 CA	BZW 06-10B
SA 11	BZW 06P11
SA 11 A	BZW 06-11
SA 11 C	BZW 06P11B
SA 11 CA	BZW 06-11B
SA 13	BZW 06P13
SA 13 A	BZW 06-13
SA 13 C	BZW 06P13B
SA 13 CA	BZW 06-13B
SA 14	BZW 06P14
SA 14 A	BZW 06-14
SA 14 C	BZW 06P14B
SA 14 CA	BZW 06-14B
SA 15	BZW 06P15
SA 15 A	BZW 06-15
SA 15 C	BZW 06P15B
SA 15 CA	BZW 06-15B
SA 17	BZW 06P17
SA 17 A	BZW 06-17
SA 17 C	BZW 06P17B
SA 17 CA	BZW 06-17B

INDUSTRY PART NUMBER	SGS-THOMSON SIMILAR REPLACEMENT
SA 20	BZW 06P20
SA 20 A	BZW 06-20
SA 20 C	BZW 06P20B
SA 20 CA	BZW 06-20B
SA 26	BZW 06P26
SA 26 A	BZW 06-26
SA 26 C	BZW 06P26B
SA 26 CA	BZW 06-26B
SA 28	BZW 06P28
SA 28 A	BZW 06-28
SA 28 C	BZW 06P28B
SA 28 CA	BZW 06-28B
SA 33	BZW 06P33
SA 33 A	BZW 06-33
SA 33 C	BZW 06P33B
SA 33 CA	BZW 06-33B
SA 40	BZW 06P40
SA 40 A	BZW 06-40
SA 40 C	BZW 06P40B
SA 40 CA	BZW 06-40B
SA 48	BZW 06P48
SA 48 A	BZW 06-48
SA 48 C	BZW 06P48B
SA 48 CA	BZW 06-48B
SA 58	BZW 06P58
SA 58 A	BZW 06-58
SA 58 C	BZW 06P58B
SA 58 CA	BZW 06-58B
SA 64	BZW 06P64
SA 64 A	BZW 06-64
SA 64 C	BZW 06P64B
SA 64 CA	BZW 06-64B
SA 70	BZW 06P70
SA 70 A	BZW 06-70
SA 70 C	BZW 06P70B
SA 70 CA	BZW 06-70B
SA 78	BZW 06P78
SA 78 A	BZW 06-78
SA 78 C	BZW 06P78B
SA 78 CA	BZW 06-78B
SA 85	BZW 06P85
SA 85 A	BZW 06-85
SA 85 C	BZW 06P85B
SA 85 CA	BZW 06-85B
SA 100	BZW 06P102
SA 100 A	BZW 06-102
SA 100 C	BZW 06P102B
SA 100 CA	BZW 06-102B
SA 110	BZW 06P111
SA 110 A	BZW 06-111
SA 110 C	BZW 06P111B
SA 110 CA	BZW 06-111B
SA 130	BZW 06P128
SA 130 A	BZW 06-128
SA 130 C	BZW 06P128B

INDUSTRY PART NUMBER	SGS-THOMSON SIMILAR REPLACEMENT
SA 130 CA	BZW 06-128B
SA 150	BZW 06P154
SA 150 A	BZW 06-154
SA 150 C	BZW 06P154B
SA 150 CA	BZW 06-154B
SA 170	BZW 06P171
SA 170 A	BZW 06-171
SA 170 C	BZW 06P171B
SA 170 CA	BZW 06-171B
SBL 10	P7T-10
SBL 10 C	P7T-10 B
SBL 25	P7T-27
SBL 25 C	P7T-27 B
SBL 43	P7T-43
SBL 43 C	P7T-43 B
SBL 100	P7T-110
SBL 100 C	P7T-110 B
TVS 505	P6KE 6V8 A
TVS 510	P6KE 12 A
TVS 512	P6KE 15 A
TVS 515	P6KE 18 A
TVS 518	P6KE 22 A
TVS 524	P6KE 30 A
TVS 528	P6KE 33 A
TZB 6.8 A	BZW 04P5V8
TZB 6.8 B	BZW 04-5V8
TZB 6.8 CA	BZW 04P5V8B
TZB 6.8 CB	BZW 04-5V8B
TZB 7.5 A	BZW 04P6V4
TZB 7.5 B	BZW 04-6V4
TZB 7.5 CA	BZW 04P6V4B
TZB 7.5 CB	BZW 04-6V4B
TZB 8.2 A	BZW 04P7V0
TZB 8.2 B	BZW 04-7V0
TZB 8.2 CA	BZW 04P7V0B
TZB 8.2 CB	BZW 04-7V0B
TZB 9.1 A	BZW 04P7V8
TZB 9.1 B	BZW 04-7V8
TZB 9.1 CA	BZW 04P7V8B
TZB 9.1 CB	BZW 04-7V8B
TZB 10 A	BZW 04P8V5
TZB 10 B	BZW 04-8V5
TZB 10 CA	BZW 04P9V5B
TZB 10 CB	BZW 04-8V5B
TZB 11 A	BZW 04P9V4
TZB 11 B	BZW 04-9V4
TZB 11 CA	BZW 04P9V4B
TZB 11 CB	BZW 04-9V4B
TZB 12 A	BZW 04P10
TZB 12 B	BZW 04-10
TZB 12 CA	BZW 04P10B
TZB 12 CB	BZW 04-10B
TZB 13 A	BZW 04P11
TZB 13 B	BZW 04-11
TZB 13 CA	BZW 04P11B
TZB 13 CB	BZW 04-11B
TZB 15 A	BZW 04P13
TZB 15 B	BZW 04-13
TZB 15 CA	BZW 04P13B
TZB 15 CB	BZW 04-13B
TZB 16 A	BZW 04P14
TZB 16 B	BZW 04-14
TZB 16 CA	BZW 04P14B
TZB 16 CB	BZW 04-14B
TZB 18 A	BZW 04P15
TZB 18 B	BZW 04-15
TZB 18 CA	BZW 04P15B
TZB 18 CB	BZW 04-15B
TZB 20 A	BZW 04P17
TZB 20 B	BZW 04-17
TZB 20 CA	BZW 04P17B
TZB 20 CB	BZW 04-17B
TZB 22 A	BZW 04P19
TZB 22 B	BZW 04-19
TZB 22 CA	BZW 04P19B
TZB 22 CB	BZW 04-19B
TZB 24 A	BZW 04P20
TZB 24 B	BZW 04-20
TZB 24 CA	BZW 04P20B
TZB 24 CB	BZW 04-20B
TZB 27 A	BZW 04P23
TZB 27 B	BZW 04-23
TZB 27 CA	BZW 04P23B
TZB 27 CB	BZW 04-23B
TZB 30 A	BZW 04P26
TZB 30 B	BZW 04-26
TZB 30 CA	BZW 04P26B
TZB 30 CB	BZW 04-26B
TZB 33 A	BZW 04P28
TZB 33 B	BZW 04-28
TZB 33 CA	BZW 04P28B
TZB 33 CB	BZW 04-28B
TZB 36 A	BZW 04P31
TZB 36 B	BZW 04-31
TZB 36 CA	BZW 04P31B
TZB 36 CB	BZW 04-31B
TZB 39 A	BZW 04P33
TZB 39 B	BZW 04-33
TZB 39 CA	BZW 04P33B
TZB 39 CB	BZW 04-33B
TZB 43 A	BZW 04P37
TZB 43 B	BZW 04-37
TZB 43 CA	BZW 04P37B
TZB 43 CB	BZW 04-37B
TZB 47 A	BZW 04P40
TZB 47 B	BZW 04-40
TZB 47 CA	BZW 04P40B
TZB 47 CB	BZW 04-40B
TZB 51 A	BZW 04P44
TZB 51 B	BZW 04-44

INDUSTRY PART NUMBER	SGS-THOMSON SIMILAR REPLACEMENT
TZB 51 CA	BZW 04P44B
TZB 51 CB	BZW 04-44B
TZB 56 A	BZW 04P48
TZB 56 B	BZW 04-48
TZB 56 CA	BZW 04P48B
TZB 56 CB	BZW 04-48B
TZB 62 A	BZW 04P53
TZB 62 B	BZW 04-53
TZB 62 CA	BZW 04P53B
TZB 62 CB	BZW 04-53B
TZB 68 A	BZW 04P58
TZB 68 B	BZW 04-58
TZB 68 CA	BZW 04P58B
TZB 68 CB	BZW 04-58B
TZB 75 A	BZW 04P64
TZB 75 B	BZW 04-64
TZB 75 CA	BZW 04P64B
TZB 75 CB	BZW 04-64B
TZB 82 A	BZW 04P70
TZB 82 B	BZW 04-70
TZB 82 CA	BZW 04P70B
TZB 82 CB	BZW 04-70B
TZB 91 A	BZW 04P78
TZB 91 B	BZW 04-78
TZB 91 CA	BZW 04P78B
TZB 91 CB	BZW 04-78B
TZB 100 A	BZW 04P85
TZB 100 B	BZW 04-85
TZB 100 CA	BZW 04P85B
TZB 100 CB	BZW 04-85B
TZB 110 A	BZW 04P94
TZB 110 B	BZW 04-94
TZB 110 CA	BZW 04P94B
TZB 110 CB	BZW 04-94B
TZB 120 A	BZW 04P102
TZB 120 B	BZW 04-102
TZB 120 CA	BZW 04P102B
TZB 120 CB	BZW 04-102B
TZB 130 A	BZW 04P111
TZB 130 B	BZW 04-111
TZB 130 CA	BZW 04P111B
TZB 130 CB	BZW 04-111B
TZB 150 A	BZW 04P128
TZB 150 B	BZW 04-128
TZB 150 CA	BZW 04P128B
TZB 150 CB	BZW 04-128B
TZB 160 A	BZW 04P136
TZB 160 B	BZW 04-136
TZB 160 CA	BZW 04P136B
TZB 160 CB	BZW 04-136B
TZB 170 A	BZW 04P145
TZB 170 B	BZW 04-145
TZB 170 CA	BZW 04P145B
TZB 170 CB	BZW 04-145B
TZB 180 A	BZW 04P154
TZB 180 B	BZW 04-154
TZB 180 CA	BZW 04P154B
TZB 180 CB	BZW 04-154B
TZB 200 A	BZW 04P171
TZB 200 B	BZW 04-171
TZB 200 CA	BZW 04P171B
TZB 200 CB	BZW 04-171B
TZB 220 A	BZW 04P188
TZB 220 B	BZW 04-188
TZB 220 CA	BZW 04P188B
TZB 220 CB	BZW 04-188B
TZB 250 A	BZW 04P213
TZB 250 B	BZW 04-213
TZB 250 CA	BZW 04P213B
TZB 250 CB	BZW 04-213B
TZB 300 A	BZW 04P256
TZB 300 B	BZW 04-256
TZB 300 CA	BZW 04P256B
TZB 300 CB	BZW 04-256B
TZB 350 A	BZW 04P299
TZB 350 B	BZW 04-299
TZB 350 CA	BZW 04P299B
TZB 350 CB	BZW 04-299B
TZB 400 A	BZW 04P342
TZB 400 B	BZW 04-342
TZB 400 CA	BZW 04P342B
TZB 400 CB	BZW 04-342B
ZZ 16	P6KE 16 CA
ZZ 36	P6KE 36 CA
ZZ 62	P6KE 62 CA
ZZ 160	P6KE 160 CA
ZZY 16	P6KE 16 CA
ZZY 36	P6KE 36 CA
ZZY 62	P6KE 62 CA
ZZY 160	P6KE 160 CA

INDUSTRY PART NUMBER	SGS-THOMSON SIMILAR REPLACEMENT		
	AXIAL LEAD	DIL/SIP	TO 220
3A120 (1)	TPB100A18		
3A133 (1)	TPB200A18		
3A138 (1)	TPB62A18	LS5060B	
BR210-120	TPB110A18		
BR210-140	TPB130A18	LS5120B	
BR210-220	TPB200A18		
BR210-260	TPB220A18		
BR210-280	TPB270A18		
BR220-260			THBT200D
P2702AB	TPB220A18		
P3002AB	TPB240A18		
P3403AB	TPB270A18		
SGT06U13 (1)	TPB62A18		
SGT23B13	TPB240A18		
SGT23U13 (1)	TPB240A18		
SGT27813	TPB270A18		
TISP10B2			THDT58D
TISP5160	TPB120A18		
TISP5290	TPB200A18		
TISP8290			
TISP9290	TPB220A18		THBT200D

(1) UNIDIRECTIONAL PRODUCT ONLY

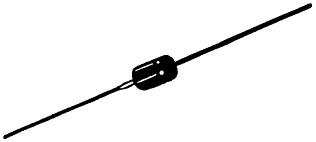
TRANSIL DATASHEETS

SGS-THOMSON
MICROELECTRONICS

1N 5634,A → 1N 5665,A

UNIDIRECTIONAL TRANSIENT VOLTAGE SUPPRESSORS

- HIGH SURGE CAPABILITY :
  1.5 kW/1 ms EXPO
- VERY FAST CLAMPING TIME : 1 ps
- LARGE VOLTAGE RANGE :
  8.9 V → 171 V



DO 13
(Metal)

DESCRIPTION

Transient voltage suppressor diodes especially useful in protecting integrated circuits. MOS, hybrids and other voltage-sensitive semiconductors and components.

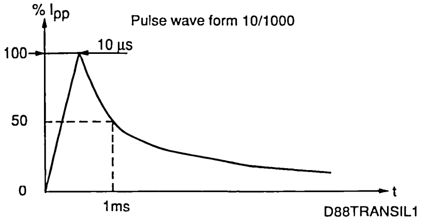
ABSOLUTE RATINGS (limiting values)

Symbol	Parameter		Value	Unit
P_p	Peak Pulse Power for 1 ms Exponential Pulse	T_j Initial = 25 °C See note 1	1500	W
P	Power Dissipation on Infinite Heatsink	T_{amb} = 75 °C	5	W
I_{FSM}	Non Repetitive Surge Peak Forward Current	T_j Initial = 25 °C t = 10 ms	250	A
T_{stg} T_j	Storage and Junction Temperature Range		– 65 to 175 175	°C °C
T_L	Maximum Lead Temperature for Soldering During 10 s at 4 mm from Case		230	°C

THERMAL RESISTANCE

Symbol	Parameter	Value	Unit
$R_{th(j-l)}$	Junction-leads on Infinite Heatsink for L_{lead} = 10 mm	20	°C/W

Note : 1. For surges upper than the maximum values, the diode will present a short-circuit anode-cathode.



ELECTRICAL CHARACTERISTICS (T_j = 25°C)

Symbol	Parameter	Value
V_{RM}	Stand-off Voltage	See table
$V_{(BR)}$	Breakdown Voltage	
$V_{(CL)}$	Clamping Voltage	
I_{pp}	Peak Pulse Current	
α_T	Temperature Coefficient of $V_{(BR)}$	
C	Capacitance	
$t_{clamping}$	Clamping Time (0 volt to $V_{(BR)}$)	1 ps max.
V_F	Peak Forward Voltage Drop (I_{FM} = 100 A)	3.5 V max.

Types	I_{RM}@ V_{RM} max.		$V_{(BR)}$* @ (V)			I_R	$V_{(CL)}$@ I_{pp} max. 1 ms expo.		V_{CL} @ I_{pp} max. 8-20 µs expo.		α_T max.	C typ. V_R = 0 f = 1 MHz
	(µA)	(V)	min.	nom.	max.	(mA)	(V)	(A)	(V)	(A)	(10^{-4}/°C)	(pF)
1N 5634	5	8.92	9.9	11	12.1	1	16.2	93	21.2	849	7.5	6400
1N 5634 A	5	9.4	10.5	11	11.6	1	15.6	96	20.3	887	7.5	6400
1N 5635	5	9.72	10.8	12	13.2	1	17.3	87	22.7	793	7.8	6000
1N 5635 A	5	10.2	11.4	12	12.6	1	16.7	90	21.7	829	7.8	6000
1N 5636	5	10.5	11.7	13	14.3	1	19	79	24.6	732	8.1	5500
1N 5636 A	5	11.1	12.4	13	13.7	1	18.2	82	23.6	763	8.1	5500
1N 5637	5	12.1	13.5	15	16.5	1	22	68	28.4	634	8.4	5000
1N 5637 A	5	12.8	14.3	15	15.8	1	21.2	71	27.2	662	8.4	5000
1N 5638	5	12.9	14.4	16	17.6	1	23.5	64	30.3	594	8.6	4700
1N 5638 A	5	13.6	15.2	16	16.8	1	22.5	67	28.9	623	8.6	4700
1N 5639	5	14.5	16.2	18	19.8	1	26.5	56.5	34	529	8.8	4300
1N 5639 A	5	15.3	17.1	18	18.9	1	25.2	59.5	32.5	554	8.8	4300
1N 5640	5	16.2	18	20	22	1	29.1	51.5	37.8	476	9	4000
1N 5640 A	5	17.1	19	20	21	1	27.7	54	36.1	498	9	4000
1N 5641	5	17.8	19.8	22	24.2	1	31.9	47	41.2	437	9.2	3700
1N 5641 A	5	18.8	20.9	22	23.1	1	30.6	49	39.3	458	9.2	3700
1N 5642	5	19.4	21.6	24	26.4	1	34.7	43	44.9	401	9.4	3500
1N 5642 A	5	20.5	22.8	24	25.2	1	33.2	45	42.8	421	9.4	3500
1N 5643	5	21 8	24.3	27	29.7	1	39.1	38.5	50.5	356	9.6	3200
1N 5643 A	5	23.1	25.7	27	28.4	1	37.5	40	48.3	373	9.6	3200
1N 5644	5	24.3	27	30	33	1	43.5	34.5	56.1	321	9.7	2900
1N 5644 A	5	25.6	28.5	30	31.5	1	41.4	36	53.5	336	9.7	2900
1N 5645	5	26.8	29.7	33	36.3	1	47.7	31.5	61.7	292	9.8	2700
1N 5645 A	5	28.2	31.4	33	34.7	1	45.7	33	59	305	9.8	2700
1N 5646	5	29.1	32.4	36	39.6	1	52	29	67.3	267	9.9	2500
1N 5646 A	5	30.8	34.2	36	37.8	1	49.9	30	64.3	280	9.9	2500
1N 5647	5	31.6	35.1	39	42.9	1	56.4	26.5	73	246	10	2400
1N 5647 A	5	33.3	37.1	39	41	1	53.9	28	69.7	258	10	2400
1N 5648	5	34.8	38.7	43	47.3	1	61.9	24	80.4	224	10.1	2200
1N 5648 A	5	36.8	40.9	43	45.2	1	59.3	25.3	76.8	234	10.1	2200
1N 5649	5	38.1	42.3	47	51.7	1	67.8	22.2	88	204	10.1	2050
1N 5649 A	5	40.2	44.7	47	49.4	1	64.8	23.2	84	214	10.1	2050
1N 5650	5	41.3	45.9	51	56.1	1	73.5	20.4	95.5	188	10.2	1950
1N 5650 A	5	43.6	48.5	51	53.6	1	70.1	21.4	91	198	10.2	1950
1N 5651	5	45.4	50.4	56	61.6	1	80.5	18.6	105	171	10.3	1800
1N 5651 A	5	47.8	53.2	56	58.8	1	77	19.5	100	180	10.3	1800

* Pulse test $t_p \leq 50ms$ $\delta < 2\%$

(continued)

Types	I_{RM}@ V_{RM} max.		$V_{(BR)}$* @ (V)			I_R	$V_{(CL)}$@ I_{pp} max. 1 ms expo.		V_{CL} @ I_{pp} max. 8-20 µs expo.		α T max.	C typ. V_R = 0 f = 1 MHz
	(µA)	(V)	min.	nom.	max.	(mA)	(V)	(A)	(V)	(A)	(10^{-4}/°C)	(pF)
1N 5652	5	50.2	55.8	62	68.2	1	89	16.9	116	155	10.4	1700
1N 5652 A	5	53	58.9	62	65.1	1	85	17.7	111	162	10.4	1700
1N 5653	5	55.1	61.2	68	74.8	1	98	15.3	127	142	10.4	1550
1N 5653 A	5	58.1	64.6	68	71.4	1	92	16.3	121	148	10.4	1550
1N 5654	5	60.7	67.5	75	82.5	1	108	13.9	140	128	10.5	1450
1N 5654 A	5	64.1	71.3	75	78.8	1	103	14.6	134	134	10.5	1450
1N 5655	5	66.4	73.8	82	90.2	1	118	12.7	153	117	10.5	1350
1N 5655 A	5	70.1	77.9	82	86.1	1	113	13.3	146	123	10.5	1350
1N 5656	5	73.7	81.9	91	100	1	131	11.4	170	106	10.6	1250
1N 5656 A	5	77.8	86.5	91	95.5	1	125	12	162	111	10.6	1250
1N 5657	5	81	90	100	110	1	144	10.4	187	96	10.6	1150
1N 5657 A	5	85.5	95	100	105	1	137	11	178	101	10.6	1150
1N 5658	5	89.2	99	110	121	1	158	9.5	203	89	10.7	1050
1N 5658 A	5	94	105	110	116	1	152	9.9	195	92	10.7	1050
1N 5659	5	97.2	108	120	132	1	173	8.7	222	81	10.7	1000
1N 5659 A	5	102	114	120	126	1	165	9.1	212	85	10.7	1000
1N 5660	5	105	117	130	143	1	187	8	240	75	10.7	950
1N 5660 A	5	111	124	130	137	1	179	8.4	230	78	10.7	950
1N 5661	5	121	135	150	165	1	215	7	277	65	10.8	850
1N 5661 A	5	128	143	150	158	1	207	7.2	265	68	10.8	850
1N 5662	5	130	144	160	176	1	230	6.5	296	61	10.8	800
1N 5662 A	5	136	152	160	168	1	219	6.8	282	64	10.8	800
1N 5663	5	138	153	170	187	1	244	6.2	314	57.5	10.8	750
1N 5663 A	5	145	161	170	179	1	234	6.4	301	60	10.8	750
1N 5664	5	146	162	180	198	1	258	5.8	333	54	10.8	725
1N 5664 A	5	154	171	180	189	1	246	6.1	317	57	10.8	725
1N 5665	5	162	180	200	220	1	287	5.2	370	48.5	10.8	675
1N 5665 A	5	171	190	200	210	1	274	5.5	353	51	10.8	675

* Pulse test $t_p \le 50$ms δ< 2%

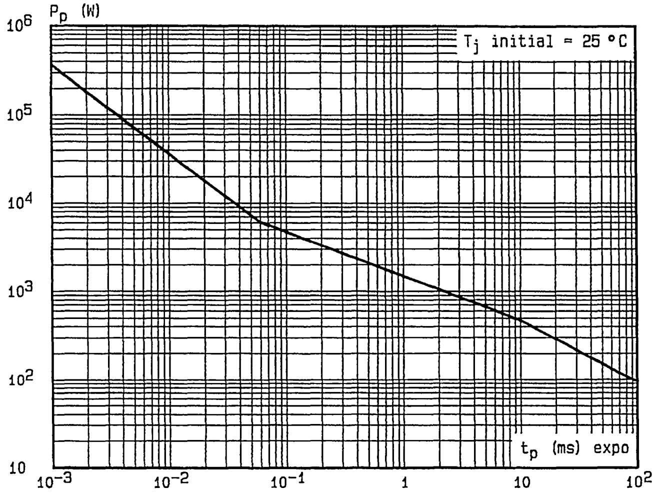


Fig.1 - Peak pulse power versus exponential pulse duration.

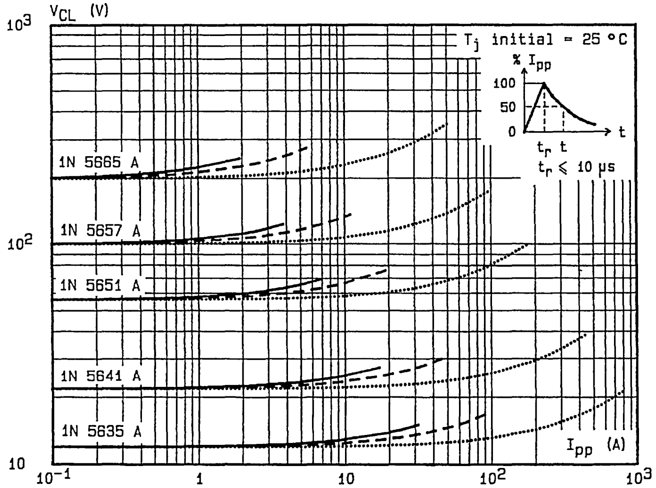


Fig.2 - Clamping voltage versus peak pulse current.
exponential waveform t = 20 µs ···········
t = 1 ms - - - -
t = 10 ms ———

Note : The curves of the figure 2 are specified for a junction temperature of 25 °C before surge. The given results may be extrapolated for other junction temperatures by using the following formula : $\Delta V_{(BR)} = \alpha_{T(V(BR))} \times [T_j - 25] \times V_{(BR)}$
For intermediate voltages, extrapolate the given results.

D891N5634AP4

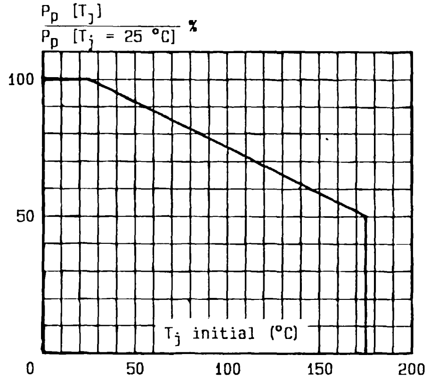


Fig.3 - Allowable power dissipation versus junction temperature.

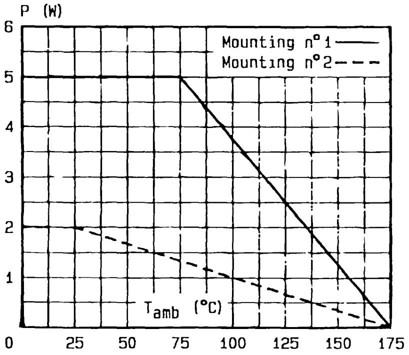


Fig.4 - Power dissipation versus ambient temperature.

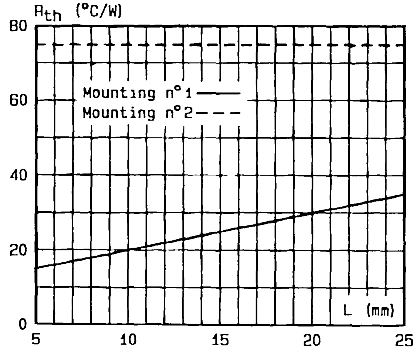
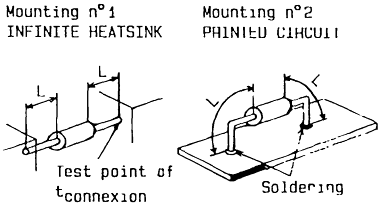


Fig.5 - Thermal resistance versus lead length.



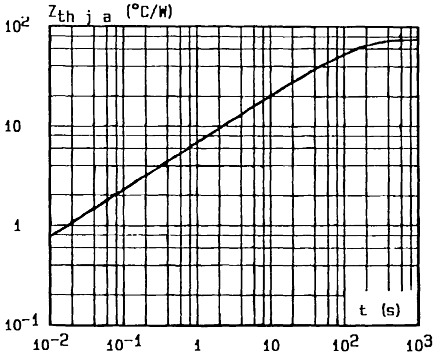


Fig.6 - Transient thermal impedance junction-ambient for mounting n°2 versus pulse duration (L = 10 mm).

D891N5634AP5

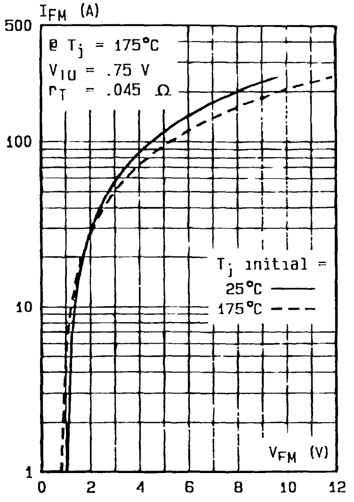


Fig.7 - Peak forward current versus peak forward voltage drop (typical values for unidirectional types).

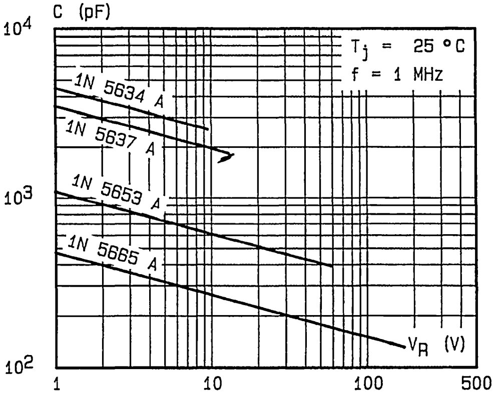
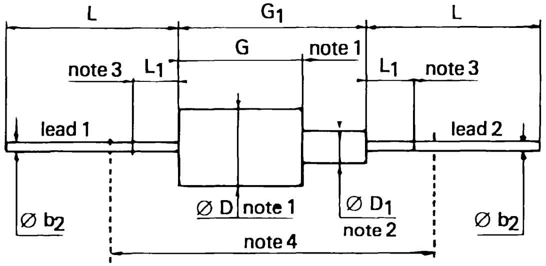


Fig.8 - Capacitance versus reverse applied voltage (typical values).

D891N5634AP6

PACKAGE MECHANICHAL DATA

DO 13 Metal



Ref.	Millimeters		Inches		Notes
	Min.	Max.	Min.	Max.	
Ø b_2	0.64	0.88	0.025	0.035	1 - Ø D is substantially constant along the length G. 2 - This dimension limits any pinch or seal deformation along the tubulation. 3 - The lead diameter Ø b_2 is not controlled over zone L_1. 4 - The minimum axial length within which the device may be placed with its leads bent at right angles is 1.00" (25.4 mm).
Ø D	5.47	5.96	0.215	0.235	
Ø D_1	1.15	2.54	0.045	0.100	
G	7.45	9.06	0.293	0.357	
G_1	–	14.47	–	0.570	
L	25.4	41.2	1.000	1.625	
L_1	–	4.77	–	0.188	
Code IEC : A 19 Code France : DO 13/F 61 Code USA : DO 13					

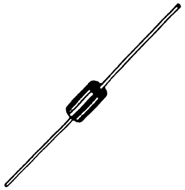
Cooling method : by convection (method A).
Marking type number.
Weight . 1.5 g
Lead 1 connected electrically to case.

SGS-THOMSON
MICROELECTRONICS

1N5908

UNIDIRECTIONAL TRANSIENT VOLTAGE SUPPRESSOR

- HIGH SURGE CAPABILITY :
  1.5 kW/1 ms EXPO
- VERY FAST CLAMPING TIME : 1 ps



CB-429
(Plastic)

DESCRIPTION

Transient voltage suppressor diode especially useful in protecting integrated circuits, MOS, hybrids and other voltage-sensitive semiconductors and components.

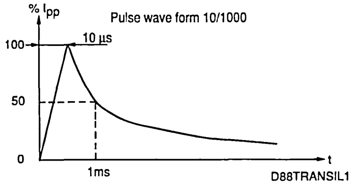
ABSOLUTE RATINGS (limiting values)

Symbol	Parameter		Value	Unit
P_p	Peak Pulse Power for 1 ms Exponential Pulse	T_j Initial = 25 °C See note 1	1500	W
P	Power Dissipation on Infinite Heatsink	T_{amb} = 75 °C	5	W
I_{FSM}	Non Repetitive Surge Peak Forward Current	T_j Initial = 25 °C t = 10 ms	250	A
T_{stg} T_j	Storage and Junction Temperature Range		– 65 to 175 175	°C °C
T_L	Maximum Lead Temperature for Soldering During 10 s at 4 mm from Case		230	°C

THERMAL RESISTANCE

Symbol	Parameter	Value	Unit
$R_{th(j-l)}$	Junction-leads on Infinite Heatsink for L_{lead} = 10 mm	20	°C/W

Note : 1. For surges upper than the maximum values, the diode will present a short-circuit anode-cathode.



ELECTRICAL CHARACTERISTICS (T_j = 25°C)

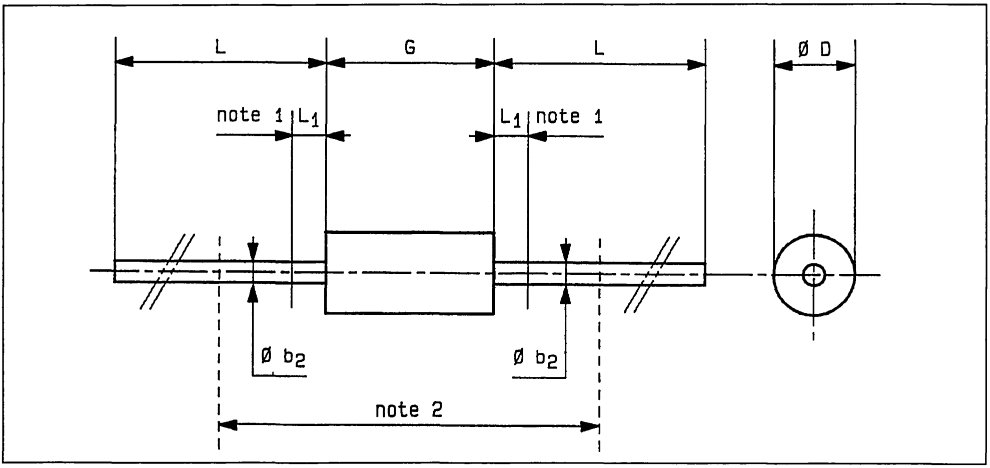
Symbol	Parameter	Value
V_{RM}	Stand-off Voltage	See table
$V_{(BR)}$	Breakdown Voltage	
$V_{(CL)}$	Clamping Voltage	
I_{pp}	Peak Pulse Current	
α_T	Temperature Coefficient of $V_{(BR)}$	
C	Capacitance	
$t_{clamping}$	Clamping Time (0 volt to $V_{(BR)}$)	1 ps max.

Type	I_{RM} @ V_{RM} max.		$V_{(BR)}$* @ I_R min.		V_{CL} @ I_{pp} max. 1 ms expo.		V_{CL} @ I_{pp} max. 1 ms expo.		V_{CL} @ I_{pp} max. 1 ms expo.		α T max.	C typ. V_R = 0 f = 1 MHz
	(µA)	(V)	(V)	(mA)	(V)	(A)	(V)	(A)	(V)	(A)	(10^{-4}/°C)	(pF)
1N 5908	300	5	6.0	1	7.6	30	8.0	60	8.5	120	5.7	10000

* Pulse test $t_p \leq 50$ ms $\delta < 2\%$.

PACKAGE MECHANICHAL DATA

CB-429 Plastic



Ref.	Millimeters		Inches		Notes
	Min.	Max.	Min.	Max.	
∅ b_2	–	1.06	–	0.042	1 - The lead diameter ∅ b_2 is not controlled over zone L_1. 2 - The minimum axial lengh within which the device may be placed with its leads bent at right angles is 0.70" (18 mm).
∅ D	–	5.1	–	0.20	
G	–	9.8	–	0.386	
L	26	–	1.024	–	
L_1	–	1.27	–	0.050	

Cooling method : by convection (method A).
Marking : type number ; white band indicates cathode for unidirectional types.
Weight : 0.9 g

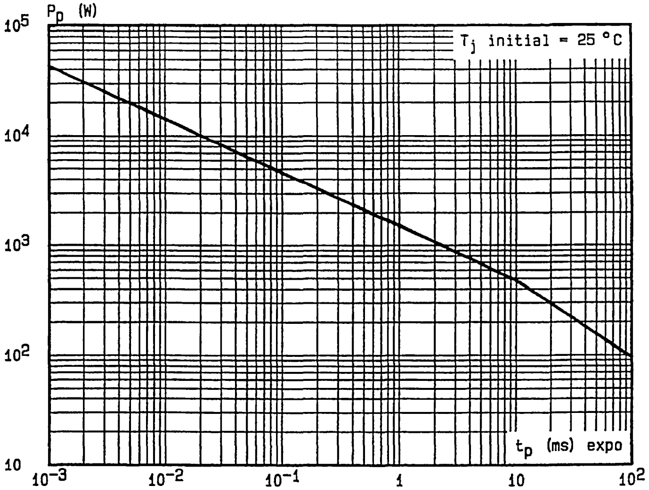


Fig.1 - Peak pulse power versus exponential pulse duration.

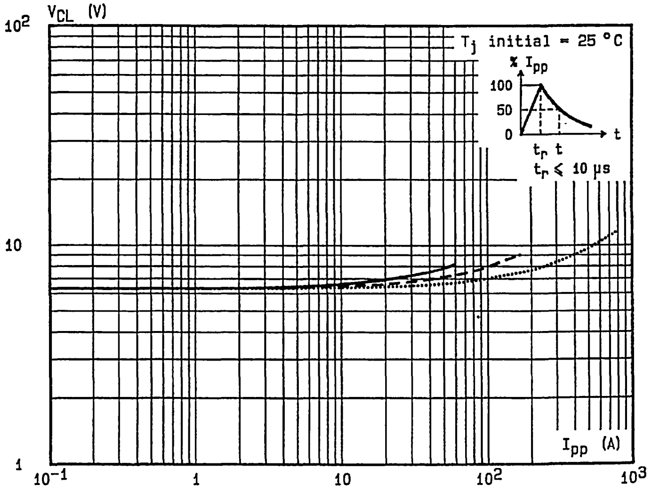


Fig.2 - Clamping voltage versus peak pulse current.
exponential waveform t = 20 µs ··········
t = 1 ms — — —
t = 10 ms ———

Note : The curves of the figure 2 are specified for a junction temperature of 25 °C before surge. The given results may be extrapolated for other junction temperatures by using the following formula : $\Delta V_{(BR)} = \alpha_{T(V(BR))}$ X $[T_j - 25]$ X $V_{(BR)}$
For intermediate voltages, extrapolate the given results.

D891N5908P3

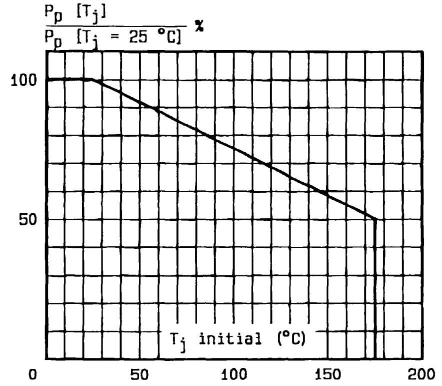


Fig.3 - Allowable power dissipation versus junction temperature.

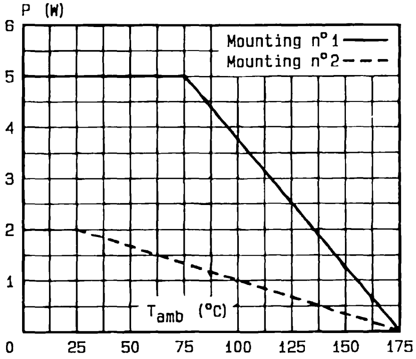


Fig.4 - Power dissipation versus ambient temperature.

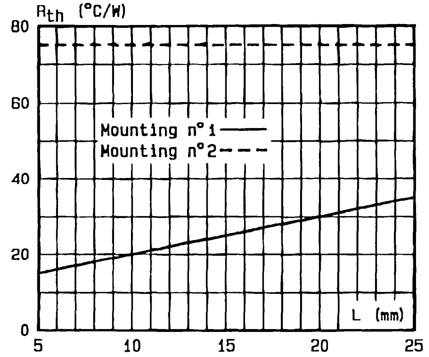
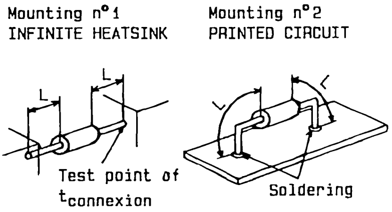


Fig.5 - Thermal resistance versus lead length.



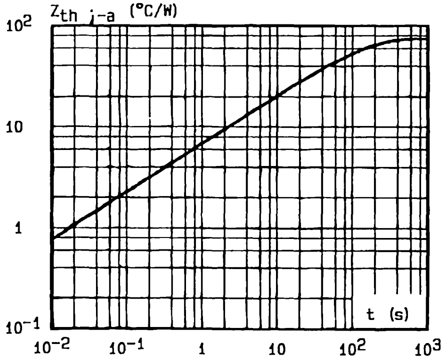


Fig.6 - Transient thermal impedance junction-ambient for mounting n° 2 versus pulse duration (L = 10 mm).

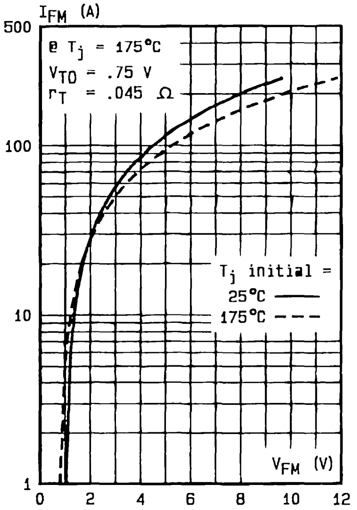


Fig.7 - Peak forward current versus peak forward voltage drop (typical values for unidirectional types).

D891N5908P4

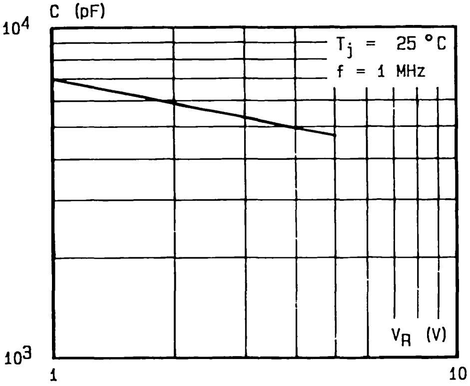


Fig.8 - Capacitance versus reverse applied voltage (typical values).

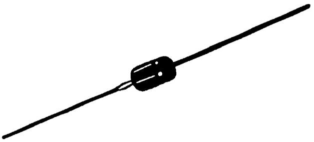
D891N5908P5

SGS-THOMSON
MICROELECTRONICS

1N 6040,A → 1N 6072,A

BIDIRECTIONAL TRANSIENT VOLTAGE SUPPRESSORS

- HIGH SURGE CAPABILITY :
  1.5 kW/1 ms EXPO
- VERY FAST CLAMPING TIME : 5 ns
- LARGE VOLTAGE RANGE :
  8.5 V → 185 V



DO 13
(Metal)

DESCRIPTION

Transient voltage suppressor diodes especially useful in protecting integrated circuits, MOS, hybrids and other voltage-sensitive semiconductors and components.

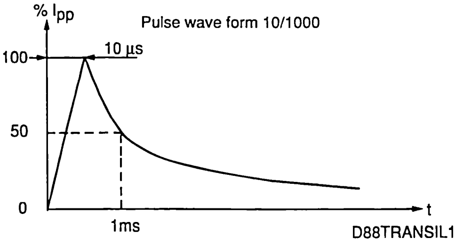
ABSOLUTE RATINGS (limiting values)

Symbol	Parameter		Value	Unit
P_p	Peak Pulse Power for 1 ms Exponential Pulse	T_j Initial = 25 °C See note 1	1500	W
P	Power Dissipation on Infinite Heatsink	T_{amb} = 75 °C	5	W
T_{stg} T_j	Storage and Junction Temperature Range		– 65 to 175 175	°C °C
T_L	Maximum Lead Temperature for Soldering During 10 s at 4 mm from Case		230	°C

THERMAL RESISTANCE

Symbol	Parameter	Value	Unit
$R_{th(j-l)}$	Junction-leads on Infinite Heatsink for L_{lead} = 10 mm	20	°C/W

Note : 1. For surges upper than the maximum values, the diode will present a short-circuit anode-cathode.



Pulse wave form 10/1000

D88TRANSIL1

ELECTRICAL CHARACTERISTICS (T_j = 25°C)

Symbol	Parameter	Value
V_{RM}	Stand-off Voltage	See table
$V_{(BR)}$	Breakdown Voltage	
$V_{(CL)}$	Clamping Voltage	
I_{pp}	Peak Pulse Current	
α_T	Temperature Coefficient of $V_{(BR)}$	
C	Capacitance	
$t_{clamping}$	Clamping Time (0 volt to $V_{(BR)}$)	5 ns max.

Types	I_{RM}@ V_{RM} max.		$V_{(BR)}$* @ (V)			I_R	$V_{(CL)}$@ I_{pp} max. 1 ms expo.		V_{CL} @ I_{pp} max. 8-20 µs expo.		α_T max.	C typ. V_R = 0 f = 1 MHz
	(µA)	(V)	min.	nom.	max.	(mA)	(V)	(A)	(V)	(A)	(10^{-4}/°C)	(pF)
1N 6040	10	8.5	9.9	11	12.1	1	16.2	93	21.2	849	7.5	3200
1N 6040 A	10	9.0	10.5	11	11.6	1	15.6	96	20.3	887	7.5	3200
1N 6041	5	9.0	10.8	12	13.2	1	17.3	87	22.7	793	7.8	3000
1N 6041 A	5	10.0	11.4	12	12.6	1	16.7	90	21.7	829	7.8	3000
1N 6042	5	10.0	11.7	13	14.3	1	19	79	24.6	732	8.1	2750
1N 6042 A	5	11.0	12.4	13	13.7	1	18.2	82	23.6	763	8.1	2750
1N 6043	5	11.0	13.5	15	16.7	1	22	68	28.7	627	8.4	2500
1N 6043 A	5	12.0	14.3	15	15.8	1	21.2	71	27.2	662	8.4	2500
1N 6044	5	12.0	14.4	16	17.6	1	23.5	64	30.3	594	8.6	2350
1N 6044 A	5	13.0	15.2	16	16.8	1	22.5	67	28.9	623	8.6	2350
1N 6045	5	14.0	16.2	18	19.8	1	26.5	56.5	34	529	8.8	2150
1N 6045 A	5	15.0	17.1	18	18.9	1	25.2	59.5	32.5	554	8.8	2150
1N 6046	5	16.0	18	20	22	1	29.1	51.5	37.8	476	9	2000
1N 6046 A	5	17.0	19	20	21	1	27.7	54	36.1	498	9	2000
1N 6047	5	17.0	19.8	22	24.2	1	31.9	47	41.1	438	9.2	1850
1N 6047 A	5	18.0	20.9	22	23.1	1	30.6	49	39.3	458	9.2	1850
1N 6048	5	19.0	21.6	24	26.4	1	34.7	43	44.9	401	9.4	1750
1N 6048 A	5	20.0	22.8	24	25.2	1	33.2	45	42.8	421	9.4	1750
1N 6049	5	21.0	24.3	27	29.7	1	39.1	38.5	50.5	356	9.6	1600
1N 6049 A	5	22.0	25.7	27	28.4	1	37.5	40	48.3	373	9.6	1600
1N 6050	5	24.0	27	30	33	1	43.5	34.5	56.1	321	9.7	1450
1N 6050 A	5	25.0	28.5	30	31.5	1	41.4	36	53.6	336	9.7	1450
1N 6051	5	26.0	29.7	33	36.3	1	47.7	31.5	61.7	292	9.8	1350
1N 6051 A	5	28.0	31.4	33	34.7	1	45.7	33	59	305	9.8	1350
1N 6052	5	29.0	32.4	36	39.6	1	52	29	67	269	9.9	1250
1N 6052 A	5	30.0	34.2	36	37.8	1	49.9	30	64	281	9.9	1250
1N 6053	5	31.0	35.1	39	42.9	1	56.4	26.5	73	246	10	1200
1N 6053 A	5	33.0	37.1	39	41	1	53.9	28	70	257	10	1200
1N 6054	5	34.0	38.7	43	47.3	1	61.9	24	80	225	10.1	1100
1N 6054 A	5	36.0	40.9	43	45.2	1	59.3	25.3	77	234	10.1	1100
1N 6055	5	38.0	42.3	47	51.7	1	67.8	22.2	88	204	10.1	1025
1N 6055 A	5	40.0	44.7	47	49.4	1	64.8	23.2	84	214	10.1	1025
1N 6056	5	41.0	45.9	51	56.1	1	73.5	20.4	95	189	10.2	975
1N 6056 A	5	43.0	48.5	51	53.6	1	70.1	21.4	91	198	10.2	975
1N 6057	5	45.0	50.4	56	61.6	1	80.5	18.6	105	171	10.3	900
1N 6057 A	5	47.0	53.2	56	58.8	1	77	19.5	100	180	10.3	900
1N 6058	5	48.0	55.8	62	68.2	1	89	16.9	116	155	10.4	850
1N 6058 A	5	53.0	58.9	62	65.1	1	85	17.7	111	162	10.4	850

* Pulse test $t_p \leq 50ms$ $\delta < 2$ %.

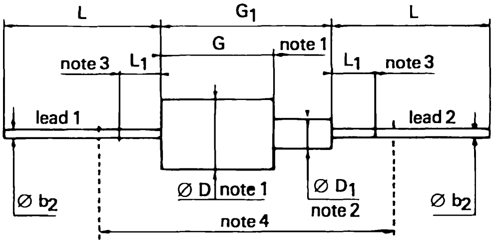
(continued)

Types	I_{RM} @ V_{RM} max.		$V_{(BR)}$* @ (V)			I_R	$V_{(CL)}$ @ I_{pp} max. 1 ms expo.		V_{CL} @ I_{pp} max. 8-20 µs expo.		α_T max.	C typ. $V_R = 0$ f = 1 MHz
	(µA)	(V)	min.	nom.	max.	(mA)	(V)	(A)	(V)	(A)	(10^{-4}/°C)	(pF)
1N 6059	5	55.0	61.2	68	74.8	1	98	15.3	127	142	10.4	775
1N 6059 A	5	58.0	64.6	68	71.4	1	92	16.3	121	148	10.4	775
1N 6060	5	60.0	67.5	75	82.5	1	108	13.9	140	128	10.5	725
1N 6060 A	5	64.0	71.3	75	78.8	1	103	14.6	134	134	10.5	725
1N 6061	5	66.0	73.8	82	90.2	1	118	12.7	153	117	10.5	675
1N 6061 A	5	70.0	77.9	82	86.1	1	113	13.3	146	123	10.5	675
1N 6062	5	73.0	81.9	91	100.1	1	131	11.4	170	106	10.6	625
1N 6062 A	5	75.0	86.5	91	95.5	1	125	12	162	111	10.6	625
1N 6063	5	81.0	90	100	110	1	144	10.4	187	96	10.6	575
1N 6063 A	5	82.0	95	100	105	1	137	11	178	101	10.6	575
1N 6064	5	90.0	99	110	121	1	158	9.5	203	89	10.7	525
1N 6064 A	5	94.0	105	110	116	1	152	9.9	195	92	10.7	525
1N 6065	5	95.0	108	120	132	1	176	8.5	222	81	10.7	500
1N 6065 A	5	100	114	120	126	1	168	8.9	212	85	10.7	500
1N 6066	5	105	117	130	143	1	191	7.8	240	75	10.7	475
1N 6066 A	5	110	124	130	137	1	182	8.2	230	78	10.7	475
1N 6067	5	121	135	150	165	1	223	6.7	277	65	10.8	425
1N 6067 A	5	128	143	150	158	1	213	7.0	265	68	10.8	425
1N 6068	5	137	153	170	187	1	258	5.8	314	57.5	10.8	375
1N 6068 A	5	145	162	170	179	1	245	6.1	301	60	10.8	375
1N 6069	5	145	162	180	198	1	274	5.5	332	54	10.8	362
1N 6069 A	5	150	171	180	189	1	261	5.7	317	57	10.8	362
1N 6070	5	155	171	190	210	1	292	5.1	353	51	10.8	350
1N 6070 A	5	160	181	190	200	1	278	5.4	336	53.5	10.8	350
1N 6071	5	165	180	200	220	1	308	4.9	370	48.5	10.8	337
1N 6071 A	5	170	190	200	210	1	294	5.1	353	51	10.8	337
1N 6072	5	175	198	220	242	1	344	4.3	406	44.5	10.8	312
1N 6072 A	5	185	209	220	231	1	328	4.6	388	46.5	10.8	312

* Pulse test $t_p \leq 50$ms $\delta < 2$ %.

PACKAGE MECHANICHAL DATA

DO13 Metal



Ref.	Millimeters		Inches		Notes
	Min.	Max.	Min.	Max.	
Ø b_2	0.64	0.88	0.025	0.035	1 - Ø D is substantially constant along the length G.
Ø D	5.47	5.96	0.215	0.235	2 - This dimension limits any pinch or seal deformation along the tubulation.
Ø D_1	1.15	2.54	0.045	0.100	3 - The lead diameter Ø b_2 is not controlled over zone L_1.
G	7.45	9.06	0.293	0.357	4 - The minimum axial length within which the device may be placed with its leads bent at right angles is 1.00" (25.4 mm).
G_1	–	14.47	–	0.570	
L	25.4	41.2	1.000	1.625	
L_1	–	4.77	–	0.188	
Code IEC : A 19 Code France : DO 13/F 61 Code USA : DO 13					

Cooling method : by convection (method A).
Marking : type number.
Weight : 1.5 g.
Lead 1 connected electrically to case.

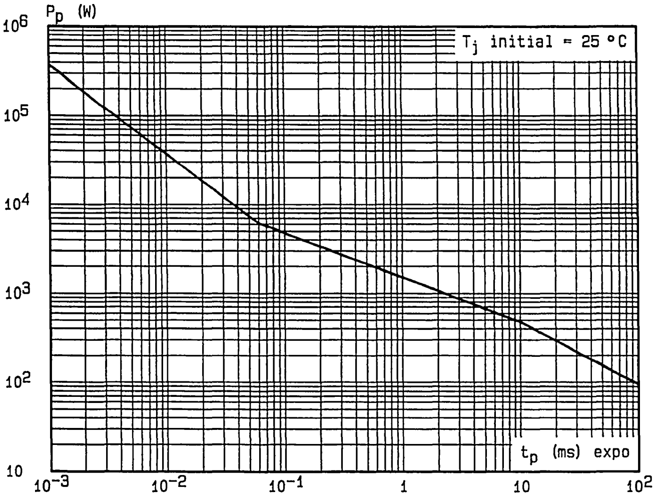


Fig.1 - Peak pulse power versus exponential pulse duration.

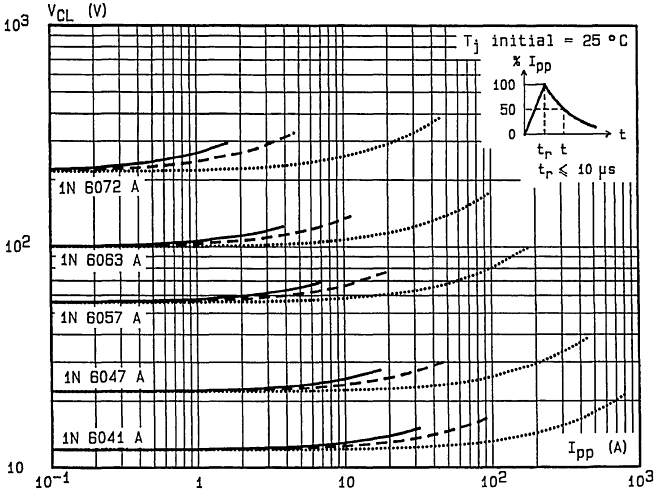


Fig.2 - Clamping voltage versus peak pulse current.
exponential waveform t = 20 µs ··············
t = 1 ms – – – –
t = 10 ms ———

Note : The curves of the figure 2 are specified for a junction temperature of 25 °C before surge. The given results may be extrapolated for other junction temperatures by using the following formula : $\Delta V_{(BR)} = \alpha_{T(V(BR))} \times [T_j - 25] \times V_{(BR)}$
For intermediate voltages, extrapolate the given results.

D891N6040AP4

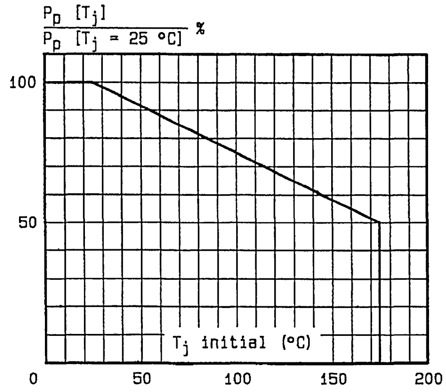


Fig.3 - Allowable power dissipation versus junction temperature.

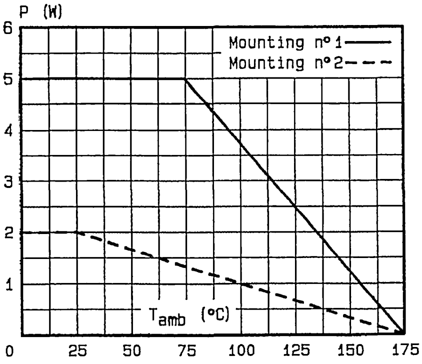


Fig.4 - Power dissipation versus ambient temperature.

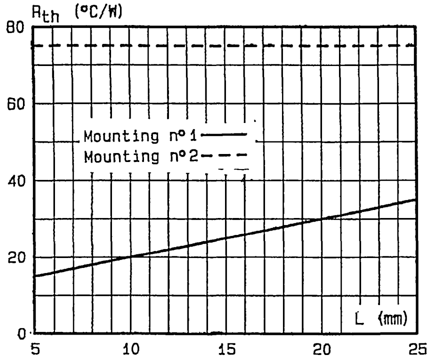
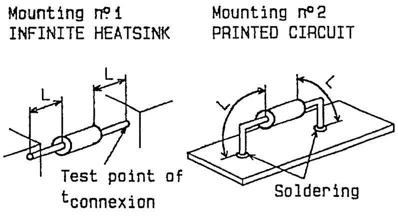


Fig.5 - Thermal resistance versus lead length.



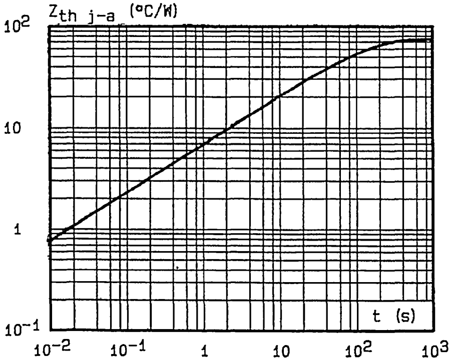


Fig.6 - Transient thermal impedance junction-ambient for mounting n°2 versus pulse duration (L = 10 mm).

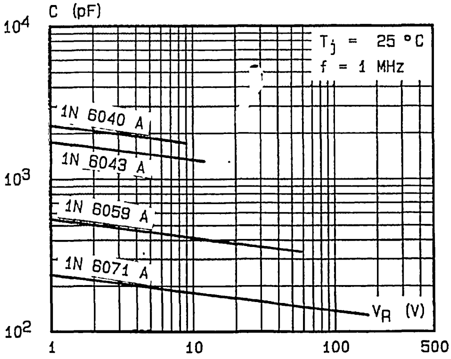


Fig.7 - Capacitance versus reverse applied voltage (typical values).

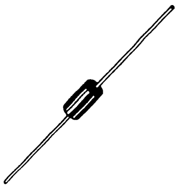
D891N6040P5

SGS-THOMSON
MICROELECTRONICS

1.5KE6V8P,A → 440P,A
1.5KE6V8CP,CA → 440CP,CA

UNI-AND BIDIRECTIONAL TRANSIENT VOLTAGE SUPPRESSORS

- HIGH SURGE CAPABILITY :
  1.5 kW / 1 ms EXPO
- VERY FAST CLAMPING TIME :
  1 ps FOR UNIDIRECTIONAL TYPES
  5 ns FOR BIDIRECTIONAL TYPES
- LARGE VOLTAGE RANGE :
  5.8 V → 376 V
- ORDER CODE :
  TYPE NUMBER FOR UNIDIRECTIONAL TYPES, TYPE NUMBER + SUFFIX C FOR BIDIRECTIONAL TYPES



CB-429
(Plastic)

DESCRIPTION

Transient voltage suppressor diodes especially useful in protecting integrated circuits, MOS, hybrids and other voltage-sensitive semiconductors and components.

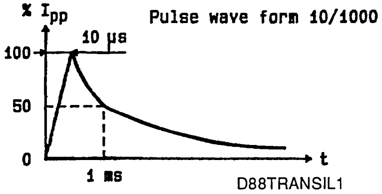
ABSOLUTE RATINGS (limiting values)

Symbol	Parameter		Value	Unit
P_p	Peak Pulse Power for 1 ms Exponential Pulse	T_j Initial = 25 °C See note 1	1.5	kW
P	Power Dissipation on Infinite Heatsink	T_{amb} = 75 °C	5	W
I_{FSM}	Non Repetitive Surge Peak Forward Current for Unidirectional Types	T_j Initial = 25 °C t = 10 ms	250	A
T_{stg} T_j	Storage and Operating Junction Temperature Range		– 65 to 175 175	°C °C
T_L	Maximum Lead Temperature for Soldering During 10 s at 4 mm from Case		230	°C

THERMAL RESISTANCE

Symbol	Parameter	Value	Unit
$R_{th(j-l)}$	Junction-leads on Infinite Heatsink for L_{lead} = 10 mm	20	°C/W

Note : 1 For surges upper than the maximum values, the diode will present a short-circuit anode-cathode



ELECTRICAL CHARACTERISTICS (T_j = 25 °C)

Symbol	Parameter		Value
V_{RM}	Stand-off Voltage		See tables
$V_{(BR)}$	Breakdown Voltage		
$V_{(CL)}$	Clamping Voltage		
I_{pp}	Peak Pulse Current		
α_T	Temperature Coefficient of $V_{(BR)}$		
C	Capacitance		
$t_{clamping}$	Clamping Time (0 volt to $V_{(BR)}$)	Unidirectional Types	1 ps max.
		Bidirectional Types	5 ns max.

Types		I_{RM} @ V_{RM} max.		$V_{(BR)}$* (V)	@		I_R	$V_{(CL)}$ @ I_{pp} max. 1 ms expo		$V_{(CL)}$ @ I_{pp} max. 8-20 µs expo		α_T max.	C** typ. V_R=0 f=1 MHz
Unidirectional	Bidirectional	(µA)	(V)	min.	nom.	max.	(mA)	(V)	(A)	(V)	(A)	(10^{-4}/°C)	(pF)
P 1.5KE6V8P	P 1.5KE6V8CP	1000§	5.8	6.45	6.8	7.48	10	10.5	143	13.4	746	5.7	9500
1.5KE6V8A	1.5KE6V8CA	1000§	5.8	6.45	6.8	7.14	10	10.5	143	13.4	746	5.7	9500
P 1.5KE7V5P	1.5KE7V5CP	500§	6.4	7.13	7.5	8.25	10	11.3	132	14.5	690	6.1	8500
1.5KE7V5A	1.5KE7V5CA	500§	6.4	7.13	7.5	7.88	10	11.3	132	14.5	690	6.1	8500
1.5KE8V2P	1.5KE8V2CP	200§	7.02	7.79	8.2	9.02	10	12.1	124	15.5	645	6.5	8000
1.5KE8V2A	1.5KE8V2CA	200§	7.02	7.79	8.2	8.61	10	12.1	124	15.5	645	6.5	8000
1.5KE9V1P	1.5KE9V1CP	50§	7.78	8.65	9.1	10	1	13.4	112	17.1	585	6.8	7500
1.5KE9V1A	1.5KE9V1CA	50§	7.78	8.65	9.1	9.55	1	13.4	112	17.1	585	6.8	7500
P 1.5KE10P	1.5KE10CP	10§	8.55	9.5	10	11	1	14.5	103	18.6	968	7.3	7000
1.5KE10A	1.5KE10CA	10§	8.55	9.5	10	10.5	1	14.5	103	18.6	968	7.3	7000
1.5KE11P	1.5KE11CP	5§	9.4	10.5	11	12.1	1	15.6	96	20.3	887	7.5	6400
1.5KE11A	1.5KE11CA	5§	9.4	10.5	11	11.6	1	15.6	96	20.3	887	7.5	6400
P 1.5KE12P	P 1.5KE12CP	5	10.2	11.4	12	13.2	1	16.7	90	21.7	829	7.8	6000
1.5KE12A	1.5KE12CA	5	10.2	11.4	12	12.6	1	16.7	90	21.7	829	7.8	6000
P 1.5KE13P	1.5KE13CP	5	11.1	12.4	13	14.3	1	18.2	82	23.6	763	8.1	5500
1.5KE13A	1.5KE13CA	5	11.1	12.4	13	13.7	1	18.2	82	23.6	763	8.1	5500
1.5KE15P	1.5KE15CP	5	12.8	14.3	15	16.5	1	21.2	71	27.2	662	8.4	5000
1.5KE15A	1.5KE15CA	5	12.8	14.3	15	15.8	1	21.2	71	27.2	662	8.4	5000
P 1.5KE16P	1.5KE16CP	5	13.6	15.2	16	17.6	1	22.5	67	28.9	623	8.6	4700
1.5KE16A	1.5KE16CA	5	13.6	15.2	16	16.8	1	22.5	67	28.9	623	8.6	4700
P 1.5KE18P	P 1.5KE18CP	5	15.3	17.1	18	19.8	1	25.2	59.5	32.5	554	8.8	4300
1.5KE18A	1.5KE18CA	5	15.3	17.1	18	18.9	1	25.2	59.5	32.5	554	8.8	4300
P 1.5KE20P	P 1.5KE20CP	5	17.1	19	20	22	1	27.7	54	36.1	498	9.0	4000
1.5KE20A	1.5KE20CA	5	17.1	19	20	21	1	27.7	54	36.1	498	9.0	4000
P 1.5KE22P	1.5KE22CP	5	18.8	20.9	22	24.2	1	30.6	49	39.3	458	9.2	3700
1.5KE22A	1.5KE22CA	5	18.8	20.9	22	23.1	1	30.6	49	39.3	458	9.2	3700
1.5KE24P	1.5KE24CP	5	20.5	22.8	24	26.4	1	33.2	45	42.8	421	9.4	3500
1.5KE24A	1.5KE24CA	5	20.5	22.8	24	25.2	1	33.2	45	42.8	421	9.4	3500
P 1.5KE27P	1.5KE27CP	5	23.1	25.7	27	29.7	1	37.5	40	48.3	373	9.6	3200
1.5KE27A	1.5KE27CA	5	23.1	25.7	27	28.4	1	37.5	40	48.3	373	9.6	3200
P 1.5KE30P	P 1.5KE30CP	5	25.6	28.5	30	33	1	41.5	36	53.5	336	9.7	2900
1.5KE30A	1.5KE30CA	5	25.6	28.5	30	31.5	1	41.5	36	53.5	336	9.7	2900
P 1.5KE33P	P 1.5KE33CP	5	28.2	31.4	33	36.3	1	45.7	33	59	305	9.8	2700
1.5KE33A	1.5KE33CA	5	28.2	31.4	33	34.7	1	45.7	33	59	305	9.8	2700
P 1.5KE36P	P 1.5KE36CP	5	30.8	34.2	36	39.6	1	49.9	30	64.3	280	9.9	2500
1.5KE36A	1.5KE36CA	5	30.8	34.2	36	37.8	1	49.9	30	64.3	280	9.9	2500
P 1.5KE39P	P 1.5KE39CP	5	33.3	37.1	39	42.9	1	53.9	28	69.7	258	10.0	2400

* Pulse test $t_p \leq 50$ ms $\delta < 2$ %.

** Divide these values by 2 for bidirectional types

§ For bidirectional types 1.5KE6V8CP → 11CA, I_{RM} must be double that specified for unidirectional types.

For bidirectional types, electrical characteristics apply in both directions.

P : Preferred device.

Types		I_{RM} @ V_{RM} max.		$V_{(BR)}$* @ I_R (V)				$V_{(CL)}$ @ I_{pp} max. 1 ms expo		$V_{(CL)}$ @ I_{pp} max. 8-20 µs expo		α_T max.	C** typ $V_R=0$ f=1 MHz
Unidirectional	Bidirectional	(µA)	(V)	min.	nom.	max.	(mA)	(V)	(A)	(V)	(A)	(10^{-4}/°C)	(pF)
1.5KE39A	1.5KE39CA	5	33.3	37.1	39	41	1	53.9	28	69.7	258	10.0	2400
P 1.5KE43P	1.5KE43CP	5	36.8	40.9	43	47.3	1	59.3	25.3	76.8	234	10.1	2200
1.5KE43A	1.5KE43CA	5	36.8	40.9	43	45.2	1	59.3	25.3	76.8	234	10.1	2200
P 1.5KE47P	P 1.5KE47CP	5	40.2	44.7	47	51.7	1	64.8	23.2	84	214	10.1	2050
1.5KE47A	1.5KE47CA	5	40.2	44.7	47	49.4	1	64.8	23 2	84	214	10.1	2050
P 1.5KE51P	1.5KE51CP	5	43.6	48.5	51	56.1	1	70.1	21.4	91	198	10.2	1950
1.5KE51A	1.5KE51CA	5	43.6	48.5	51	53 6	1	70.1	21.4	91	198	10.2	1950
1.5KE56P	1.5KE56CP	5	47.8	53.2	56	61 6	1	77	19.5	100	180	10 3	1800
1.5KE56A	1.5KE56CA	5	47.8	53.2	56	58.8	1	77	19.5	100	180	10.3	1800
1.5KE62P	1.5KE62CP	5	53	58.9	62	68.2	1	85	17.7	111	162	10.4	1700
1.5KE62A	1.5KE62CA	5	53	58.9	62	65.1	1	85	17.7	111	162	10.4	1700
P 1.5KE68P	P 1.5KE68CP	5	58.1	64.6	68	74.8	1	92	16.3	121	148	10.4	1550
1.5KE68A	1.5KE68CA	5	58.1	64.6	68	71.4	1	92	16.3	121	148	10.4	1550
1.5KE75P	1.5KE75CP	5	64.1	71.3	75	82.5	1	103	14.6	134	134	10.5	1450
1.5KE75A	1.5KE75CA	5	64 1	71.3	75	78.8	1	103	14.6	134	134	10.5	1450
P 1.5KE82P	P 1.5KE82CP	5	70.1	77.9	82	90.2	1	113	13.3	146	123	10.5	1350
1.5KE82A	1.5KE82CA	5	70.1	77.9	82	86.1	1	113	13.3	146	123	10 5	1350
1.5KE91P	1.5KE91CP	5	77.8	86.5	91	100	1	125	12	162	111	10.6	1250
1.5KE91A	1.5KE91CA	5	77.8	86.5	91	95.5	1	125	12	162	111	10.6	1250
1.5KE100P	1.5KE100CP	5	85.5	95	100	110	1	137	11	178	101	10.6	1150
1.5KE100A	1.5KE100CA	5	85.5	95	100	105	1	137	11	178	101	10.6	1150
1.5KE110P	P 1.5KE110CP	5	94	105	110	121	1	152	9.9	195	92	10.7	1050
1.5KE110A	1.5KE110CA	5	94	105	110	116	1	152	9.9	195	92	10.7	1050
1.5KE120P	1.5KE120CP	5	102	114	120	132	1	165	9.1	212	85	10.7	1000
1.5KE120A	1.5KE120CA	5	102	114	120	126	1	165	9.1	212	85	10.7	1000
1.5KE130P	P 1.5KE130CP	5	111	124	130	143	1	179	8 4	230	78	10 7	950
1.5KE130A	1.5KE130CA	5	111	124	130	137	1	179	8.4	230	78	10.7	950
1.5KE150P	1.5KE150CP	5	128	143	150	165	1	207	7.2	265	68	10.8	850
1.5KE150A	1.5KE150CA	5	128	143	150	158	1	207	7.2	265	68	10.8	850
1.5KE160P	1.5KE160CP	5	136	152	160	176	1	219	6.8	282	64	10.8	800
1.5KE160A	1.5KE160CA	5	136	152	160	168	1	219	6.8	282	64	10.8	800
P 1.5KE170P	1.5KE170CP	5	145	161	170	187	1	234	6.4	301	60	10.8	750
1.5KE170A	1.5KE170CA	5	145	161	170	179	1	234	6.4	301	60	10.8	750
P 1.5KE180P	P 1.5KE180CP	5	154	171	180	198	1	246	6 1	317	57	10.8	725
1.5KE180A	1.5KE180CA	5	154	171	180	189	1	246	6.1	317	57	10 8	725
P 1.5KE200P	P 1.5KE200CP	5	171	190	200	220	1	274	5.5	353	51	10.8	675
1.5KE200A	1.5KE200CA	5	171	190	200	210	1	274	5.5	353	51	10.8	675
1.5KE220P	P 1.5KE220CP	5	188	209	220	242	1	328	4.6	388	46.5	10.8	625
1.5KE220A	1.5KE220CA	5	188	209	220	231	1	328	4.6	388	46.5	10.8	625
P 1.5KE250P	P 1.5KE250CP	5	213	237	250	275	1	344	5.0	442	47	11	560
1.5KE250A	1.5KE250CA	5	213	237	250	263	1	344	5.0	442	47	11	560
1.5KE280P	1.5KE280CP	5	239	266	280	308	1	384	5.0	494	47	11	520
1.5KE280A	1.5KE280CA	5	239	266	280	294	1	384	5.0	494	47	11	520
P 1.5KE300P	P 1.5KE300CP	5	256	285	300	330	1	414	5.0	529	47	11	500
1.5KE300A	1.5KE300CA	5	256	285	300	315	1	414	5 0	529	47	11	500
1.5KE320P	1.5KE320CP	5	273	304	320	352	1	438	4.5	564	42	11	460
1.5KE320A	1.5KE320CA	5	273	304	320	336	1	438	4.5	564	42	11	460
P 1.5KE350P	P 1.5KE350CP	5	299	332	350	385	1	482	4.0	618	37	11	430
1.5KE350A	1.5KE350CA	5	299	332	350	368	1	482	4.0	618	37	11	430
P 1.5KE400P	P 1.5KE400CP	5	342	380	400	440	1	548	4.0	706	37	11	390
1.5KE400A	1.5KE400CA	5	342	380	400	420	1	548	4.0	706	37	11	390
P 1.5KE440P	P 1.5KE440CP	5	376	418	440	484	1	603	3.5	776	33	11	360
1.5KE440A	1.5KE440CA	5	376	418	440	462	1	603	3.5	776	33	11	360

* Pulse test $t_p \leq 50$ ms $\delta < 2$ %.
** Divide these values by 2 for bidirectional types.
For bidirectional types, electrical characteristics apply in both directions
P : Preferred device.

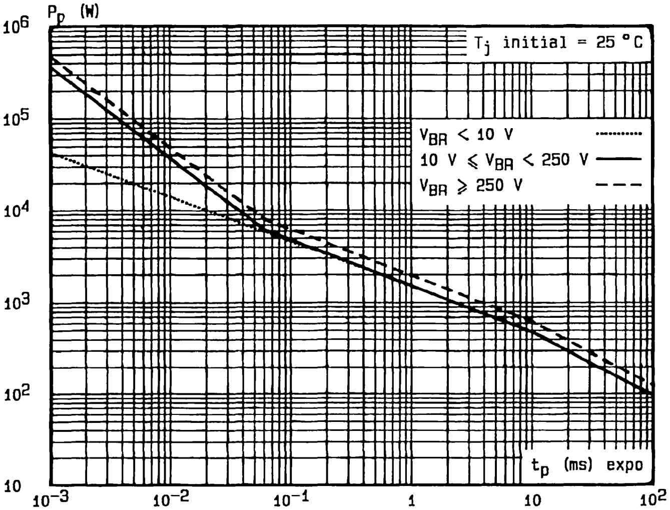


Fig.1 - Peak pulse power versus exponential pulse duration.

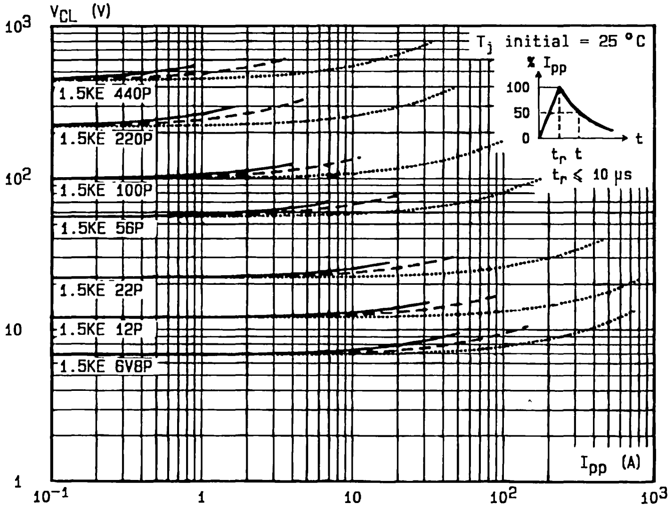


Fig.2 - Clamping voltage versus peak pulse current.
exponential waveform t = 20 µs ··········
t = 1 ms - - -
t = 10 ms ——

Note : The curves of the figure 2 are specified for a junction temperature of 25 °C before surge. The given results may be extrapolated for other junction temperatures by using the following formula : $\Delta V_{(BR)} = \alpha_{T(V(BR))} \times [T_j - 25] \times V_{(BR)}$
For intermediate voltages, extrapolate the given results.

D881.5KEP4

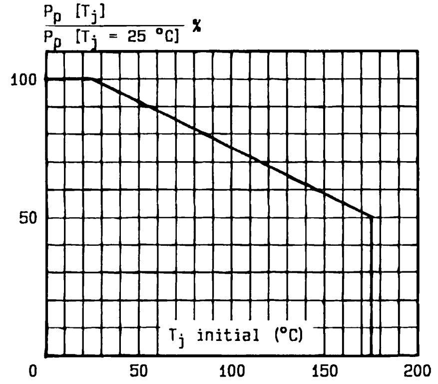


Fig.3 - Allowable power dissipation versus junction temperature.

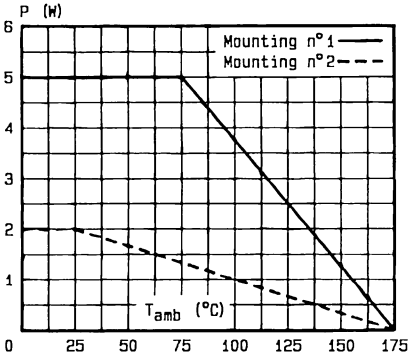


Fig.4 - Power dissipation versus ambient temperature.

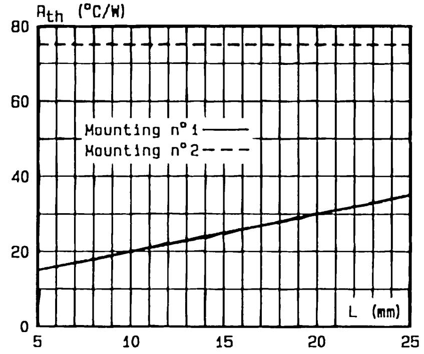
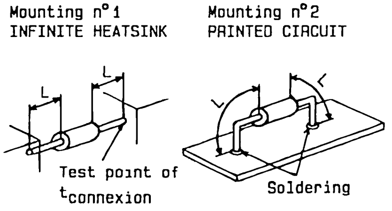


Fig.5 - Thermal resistance versus lead length.



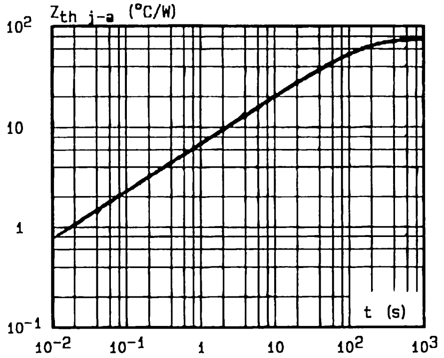


Fig.6 - Transient thermal impedance junction-ambient for mounting n°2 versus pulse duration (L = 10 mm).

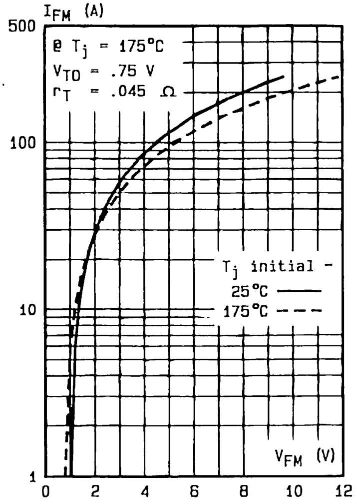


Fig.7 - Peak forward current versus peak forward voltage drop (typical values for unidirectional types).

D881.5KEP5

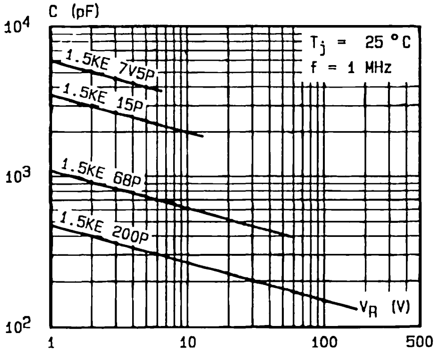


Fig.8a - Capacitance versus reverse applied voltage for unidirectional types (typical values).

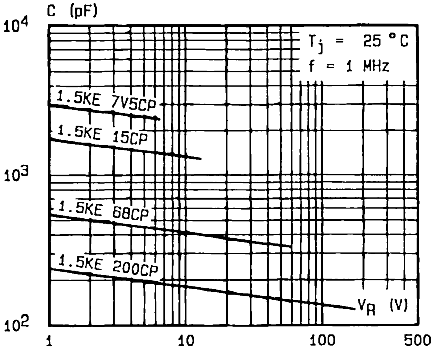
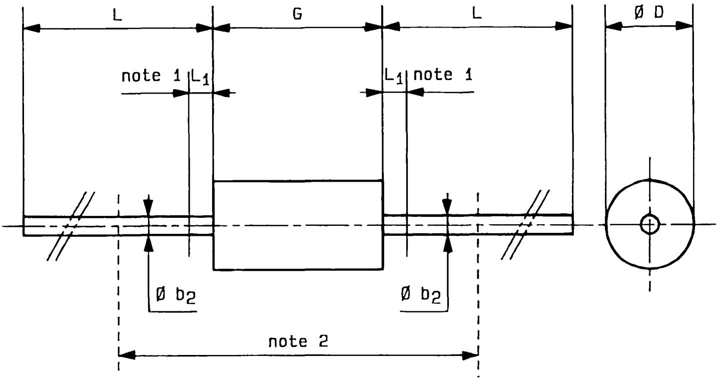


Fig.8b - Capacitance versus reverse applied voltage for bidirectional types (typical values).

D881.5KEP6

PACKAGE MECHANICAL DATA

CB-429 Plastic



Ref.	Millimeters		Inches		Notes
	Min.	Max.	Min.	Max.	
Ø b_2	–	1.06	–	0.042	1 - The lead diameter Ø b_2 is not controlled over zone L_1. 2 - The minimum axial lengh within which the device may be placed with its leads bent at right angles is 0.70" (18 mm).
Ø D	–	5.1	–	0.20	
G	–	9.8	–	0.386	
L	26	–	1.024	–	
L_1	–	1.27	–	0.050	

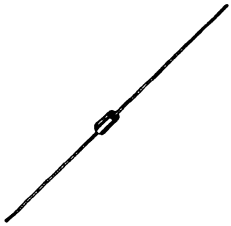
Cooling method . by convection (method A).
Marking : type number ; white band indicates cathode for unidirectional types.
Weight : 0.9 g.

SGS-THOMSON
MICROELECTRONICS

BZW04-5V8, B → 376, B
BZW04P5V8, B → 376, B

UNI-AND BIDIRECTIONAL TRANSIENT VOLTAGE SUPPRESSORS

- HIGH SURGE CAPABILITY :
  400 W / 1 ms EXPO
- VERY FAST CLAMPING TIME :
  1 ps FOR UNIDIRECTIONAL TYPES
  5 ns FOR BIDIRECTIONAL TYPES
- LARGE VOLTAGE RANGE :
  5.8 V → 376 V
- ORDER CODE :
  TYPE NUMBER FOR UNIDIRECTIONAL TYPES, TYPE NUMBER + SUFFIX B FOR BIDIRECTIONAL TYPES



F 126
(Plastic)

DESCRIPTION

Transient voltage suppressor diodes especially useful in protecting integrated circuits, MOS, hybrids and other voltage-sensitive semiconductors and components.

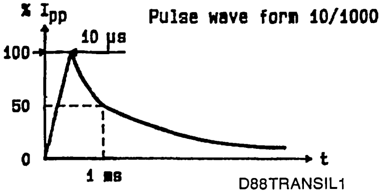
ABSOLUTE MAXIMUM RATINGS (limiting values)

Symbol	Parameter		Value	Unit
P_p	Peak Pulse Power for 1 ms Exponential Pulse	T_j Initial = 25 °C See note 1	400	W
P	Power Dissipation on Infinite Heatsink	T_{amb} = 50 °C	1.7	W
I_{FSM}	Non Repetitive Surge Peak Forward Current for Unidirectional Types	T_j Initial = 25 °C t = 10 ms	50	A
T_{stg} T_j	Storage and Operating Junction Temperature Range		– 55 to 150 150	°C °C
T_L	Maximum Lead Temperature for Soldering During 10 s at 4 mm from Case		230	°C

THERMAL RESISTANCE

Symbol	Parameter	Value	Unit
$R_{th(j-l)}$	Junction-leads on Infinite Heatsink for L_{lead} = 10 mm	60	°C/W

Note : 1. For surges upper than the maximum values, the diode will present a short-circuit anode-cathode.



ELECTRICAL CHARACTERISTICS (T_j = 25 °C)

Symbol	Parameter		Value
V_{RM}	Stand-off Voltage		See tables
$V_{(BR)}$	Breakdown Voltage		
$V_{(CL)}$	Clamping Voltage		
I_{pp}	Peak Pulse Current		
α_T	Temperature Coefficient of $V_{(BR)}$		
C	Capacitance		
$t_{clamping}$	Clamping Time (0 volt to $V_{(BR)}$)	Unidirectional Types	1 ps max.
		Bidirectional Types	5 ns max.

Types		I_{RM} @ V_{RM} max.		$V_{(BR)}$* (V)	@		I_R	$V_{(CL)}$ @ I_{pp} max. 1ms expo		$V_{(CL)}$ @ I_{pp} max. 8-20µs expo		α_T max.	C** typ. $V_R=0$ f=1MHz
Unidirectional	Bidirectional	(µA)	(V)	min.	nom.	max.	(mA)	(V)	(A)	(V)	(A)	(10^{-4}/°C)	(pF)
P BZW04P5V8	P BZW04P5V8B	1000	5.8	6.45	6.8	7.48	10	10.5	38	13.4	174	5.7	3500
BZW04-5V8	BZW04-5V8B	1000	5.8	6.45	6.8	7.14	10	10.5	38	13 4	174	5.7	3500
BZW04P6V4	P BZW04P6V4B	500	6.4	7.13	7.5	8.25	10	11.3	35.4	14.5	160	6.1	3100
BZW04-6V4	BZW04-6V4B	500	6.4	7.13	7.5	7.88	10	11.3	35.4	14.5	160	6.1	3100
BZW04P7V0	P BZW04P7V0B	200	7.02	7.79	8.2	9.02	10	12.1	33	15.5	148	6.5	2700
BZW04-7V0	BZW04-7V0B	200	7.02	7.79	8.2	8.61	10	12.1	33	15.5	148	6.5	2700
BZW04P7V8	BZW04P7V8B	50	7.78	8.65	9.1	10.0	1	13.4	30	17.1	134	6.8	2300
BZW04-7V8	BZW04-7V8B	50	7.78	8.65	9.1	9.55	1	13.4	30	17.1	134	6.8	2300
BZW04P8V5	BZW04P8V5B	10	8.55	9.50	10	11.0	1	14.5	27.6	18.6	258	7.3	2000
BZW04-8V5	BZW04-8V5B	10	8.55	9.50	10	10.50	1	14.5	27.6	18.6	258	7.3	2000
P BZW04P9V4	P BZW04P9V4B	5	9.4	10.5	11	12.1	1	15.6	25.7	20.3	236	7.5	1750
BZW04-9V4	BZW04-9V4B	5	9.4	10.5	11	11.6	1	15.6	25.7	20.3	236	7.5	1750
BZW04P10	BZW04P10B	5	10.2	11.4	12	13.2	1	16.7	24	21.7	221	7.8	1550
BZW04-10	BZW04-10B	5	10.2	11.4	12	12.6	1	16.7	24	21.7	221	7.8	1550
P BZW04P11	P BZW04P11B	5	11.1	12 4	13	14.3	1	18.2	22	23 6	203	8.1	1450
BZW04-11	BZW04-11B	5	11.1	12.4	13	13.7	1	18.2	22	23.6	203	8.1	1450
P BZW04P13	P BZW04P13B	5	12.8	14.3	15	16.5	1	21.2	19	27.2	176	8.4	1200
BZW04-13	BZW04-13B	5	12.8	14.3	15	15.8	1	21.2	19	27.2	176	8.4	1200
P BZW04P14	P BZW04P14B	5	13.6	15.2	16	17.6	1	22.5	17.8	28.9	166	8.6	1100
BZW04-14	BZW04-14B	5	13.6	15.2	16	16.8	1	22.5	17.8	28.9	166	8.6	1100
P BZW04P15	P BZW04P15B	5	15.3	17.1	18	19.8	1	25.2	16	32.5	148	8.8	975
BZW04-15	BZW04-15B	5	15.3	17.1	18	18.9	1	25.2	16	32.5	148	8.8	975
BZW04P17	BZW04P17B	5	17.1	19	20	22	1	27.7	14.5	36 1	133	9.0	850
BZW04-17	BZW04-17B	5	17.1	19	20	21	1	27.7	14.5	36.1	133	9.0	850
BZW04P19	BZW04P19B	5	18.8	20.9	22	24.2	1	30.6	13	39.3	122	9.2	800
BZW04-19	BZW04-19B	5	18.8	20.9	22	23.1	1	30.6	13	39.3	122	9.2	800
BZW04P20	P BZW04P20B	5	20.5	22.8	24	26.4	1	33.2	12	42.8	112	9.4	725
BZW04-20	BZW04-20B	5	20.5	22.8	24	25.2	1	33.2	12	42.8	112	9.4	725
P BZW04P23	BZW04P23B	5	23.1	25.7	27	29.7	1	37.5	10.7	48.3	99	9.6	625
BZW04-23	BZW04-23B	5	23.1	25.7	27	28.4	1	37.5	10.7	48.3	99	9.6	625
P BZW04P26	P BZW04P26B	5	25.6	28.5	30	33	1	41.5	9.6	53.5	90	9.7	575
BZW04-26	BZW04-26B	5	25.6	28.5	30	31.5	1	41.5	9.6	53.5	90	9.7	575
BZW04P28	P BZW04P28B	5	28.2	31.4	33	36.3	1	45.7	8.8	59	81.5	9.8	510
BZW04-28	BZW04-28B	5	28.2	31.4	33	34.7	1	45.7	8.8	59	81.5	9.8	510
P BZW04P31	P BZW04P31B	5	30.8	34.2	36	39.6	1	49.9	8	64.3	74.5	9.9	480
BZW04-31	BZW04-31B	5	30.8	34.2	36	37.8	1	49.9	8	64.3	74.5	9.9	480
P BZW04P33	BZW04P33B	5	33.3	37.1	39	42.9	1	53.9	7.4	69.7	69	10.0	450

* Pulse test $t_p \leq 50$ ms $\delta < 2$ %.

** Divide these values by 2 for bidirectional types.

For bidirectional types, electrical characteristics apply in both directions.

P : Preferred device.

Types		I_{RM} @ V_{RM} max.		$V_{(BR)}$* @ I_R (V)				$V_{(CL)}$ @ I_{pp} max. 1ms expo		$V_{(CL)}$ @ I_{pp} max. 8-20µs expo		α_T max.	C** typ. $V_R=0$ f=1MHz
Unidirectional	Bidirectional	(µA)	(V)	min.	nom.	max.	(mA)	(V)	(A)	(V)	(A)	(10^{-4}/°C)	(pF)
BZW04-33	BZW04-33B	5	33.3	37.1	39	41	1	53.9	7.4	69.7	69	10.0	450
BZW04P37	P BZW04P37B	5	36.8	40.9	43	47.3	1	59.3	6.7	76.8	62.5	10.1	400
BZW04-37	BZW04-37B	5	36.8	40.9	43	45.2	1	59.3	6.7	76.8	62.5	10.1	400
BZW04P40	BZW04P40B	5	40.2	44.7	47	51.7	1	64.8	6.2	84	57	10.1	370
BZW04-40	BZW04-40B	5	40.2	44.7	47	49.4	1	64.8	6.2	84	57	10.1	370
BZW04P44	BZW04P44B	5	43.6	48.5	51	56.1	1	70.1	5.7	91	52.5	10.2	350
BZW04-44	BZW04-44B	5	43.6	48.5	51	53.6	1	70.1	5.7	91	52.5	10.2	350
BZW04P48	BZW04P48B	5	47.8	53.2	56	61.6	1	77	5.2	100	48	10.3	320
BZW04-48	BZW04-48B	5	47.8	53.2	56	58.8	1	77	5.2	100	48	10.3	320
BZW04P53	BZW04P53B	5	53	58.9	62	68.2	1	85	4.7	111	43	10.4	290
BZW04-53	BZW04-53B	5	53	58.9	62	65.1	1	85	4.7	111	43	10.4	290
BZW04P58	BZW04P58B	5	58.1	64.6	68	74.8	1	92	4 3	121	39.5	10.4	270
BZW04-58	BZW04-58B	5	58.1	64 6	68	71.4	1	92	4 3	121	39.5	10.4	270
BZW04P64	BZW04P64B	5	64.1	71.3	75	82.5	1	103	3.9	134	36	10.5	250
BZW04-64	BZW04-64B	5	64.1	71.3	75	78.8	1	103	3.9	134	36	10.5	250
BZW04P70	P BZW04P70B	5	70.1	77.9	82	90.2	1	113	3.5	146	33	10.5	230
BZW04-70	BZW04-70B	5	70.1	77.9	82	86.1	1	113	3.5	146	33	10.5	230
BZW04P78	BZW04P78B	5	77.8	86.5	91	100	1	125	3.2	162	29.5	10.6	210
BZW04-78	BZW04-78B	5	77.8	86.5	91	95.5	1	125	3.2	162	29.5	10.6	210
P BZW04P85	BZW04P85B	5	85.5	95	100	110	1	137	2.9	178	27	10.6	200
BZW04-85	BZW04-85B	5	85.5	95	100	105	1	137	2.9	178	27	10.6	200
BZW04P94	BZW04P94B	5	94	105	110	121	1	152	2.6	195	24.5	10.7	185
BZW04-94	BZW04-94B	5	94	105	110	116	1	152	2.6	195	24.5	10.7	185
BZW04P102	BZW04P102B	5	102	114	120	132	1	165	2.4	212	22.5	10.7	170
BZW04-102	BZW04-102B	5	102	114	120	126	1	165	2.4	212	22.5	10.7	170
P BZW04P111	BZW04P111B	5	111	124	130	143	1	179	2.2	230	20.8	10.7	165
BZW04-111	BZW04-111B	5	111	124	130	137	1	179	2.2	230	20.8	10.7	165
P BZW04P128	P BZW04P128B	5	128	143	150	165	1	207	2.0	265	18.1	10.8	145
BZW04-128	BZW04-128B	5	128	143	150	158	1	207	2.0	265	18.1	10.8	145
P BZW04P136	P BZW04P136B	5	136	152	160	176	1	219	1.8	282	17	10.8	140
BZW04-136	BZW04-136B	5	136	152	160	168	1	219	1.8	282	17	10.8	140
P BZW04P145	BZW04P145B	5	145	161	170	187	1	234	1.7	301	16	10.8	135
BZW04-145	BZW04-145B	5	145	161	170	179	1	234	1 7	301	16	10.8	135
BZW04P154	BZW04P154B	5	154	171	180	198	1	246	1.6	317	15.1	10.8	125
BZW04-154	BZW04-154B	5	154	171	180	189	1	246	1.6	317	15.1	10.8	125
BZW04P171	BZW04P171B	5	171	190	200	220	1	274	1.5	353	13.6	10.8	120
BZW04-171	BZW04-171B	5	171	190	200	210	1	274	1.5	353	13.6	10.8	120
BZW04P188	P BZW04P188B	5	188	209	220	242	1	301	1.4	388	12.4	10.8	110
BZW04-188	BZW04-188B	5	188	209	220	231	1	301	1.4	388	12.4	10.8	110
P BZW04P213	BZW04P213B	5	213	237	250	275	1	344	1.5	442	12	11	100
BZW04-213	BZW04-213B	5	213	237	250	263	1	344	1.5	442	12	11	100
P BZW04P239	BZW04P239B	5	239	266	280	308	1	384	1.5	494	12	11	95
BZW04-239	BZW04-239B	5	239	266	280	294	1	384	1.5	494	12	11	95
BZW04P256	BZW04P256B	5	256	285	300	330	1	414	1.2	529	10	11	90
BZW04-256	BZW04-256B	5	256	285	300	315	1	414	1.2	529	10	11	90
BZW04P273	BZW04P273B	5	273	304	320	352	1	438	1.2	564	10	11	85
BZW04-273	BZW04-273B	5	273	304	320	336	1	438	1.2	564	10	11	85
P BZW04P299	BZW04P299B	5	299	332	350	385	1	482	0.9	618	9	11	80
BZW04-299	BZW04-299B	5	299	332	350	368	1	482	0.9	618	9	11	80
BZW04P342	BZW04P342B	5	342	380	400	440	1	548	0.9	706	8	11	75
BZW04-342	BZW04-342B	5	342	380	400	420	1	548	0.9	706	8	11	75
BZW04P376	BZW04P376B	5	376	418	440	484	1	603	0.8	776	8	11	70
BZW04-376	BZW04-376B	5	376	418	440	462	1	603	0.8	776	8	11	70

* Pulse test $t_p \leq 50$ ms $\delta < 2$ %.
** Divide these values by 2 for bidirectional types.
For bidirectional types, electrical characteristics apply in both directions.
P : Preferred device.

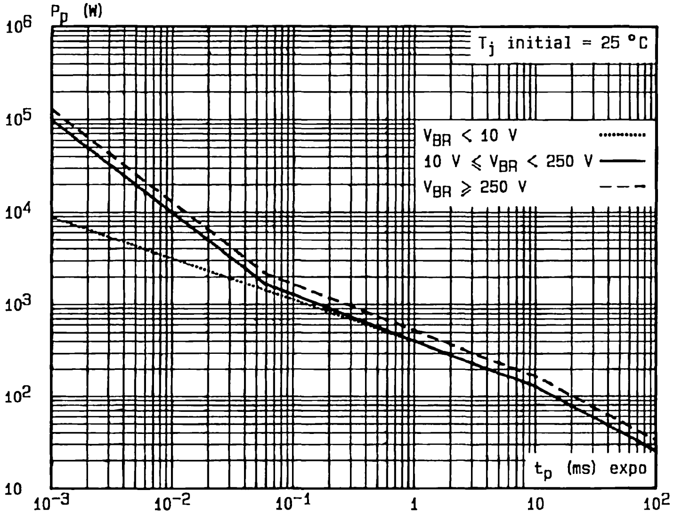


Fig.1 - Peak pulse power versus exponential pulse duration.

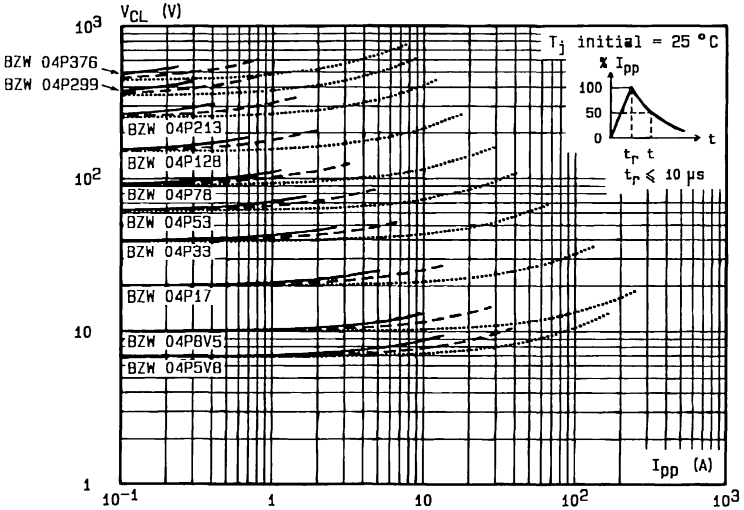


Fig.2 - Clamping voltage versus peak pulse current.
exponential waveform t = 20 µs ....
t = 1 ms - - -
t = 10 ms ———

Note : The curves of the figure 2 are specified for a junction temperature of 25 °C before surge. The given results may be extrapolated for other junction temperatures by using the following formula : $\Delta V_{(BR)} = \alpha_{T(V(BR))} \times [T_j - 25] \times V_{(BR)}$
For intermediate voltages, extrapolate the given results.

D88BZW04P4

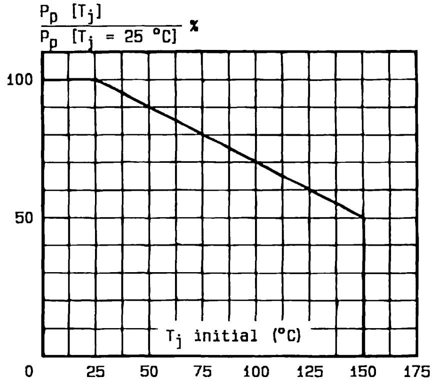


Fig.3 - Allowable power dissipation versus junction temperature.

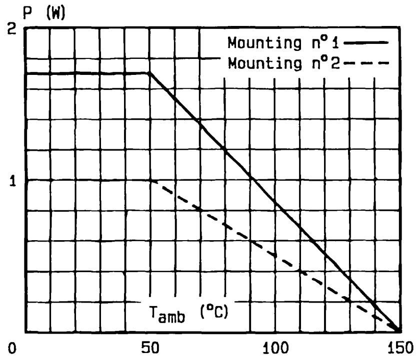


Fig.4 - Power dissipation versus ambient temperature.

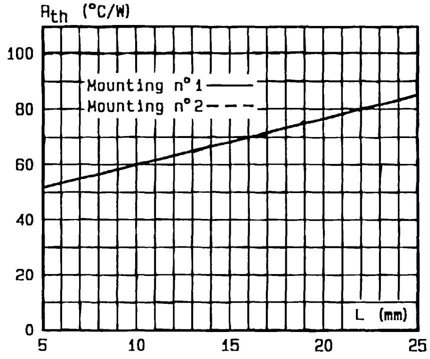
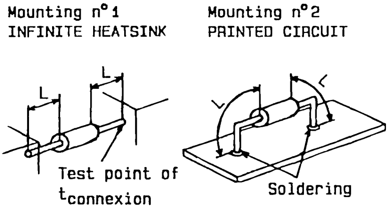


Fig.5 - Thermal resistance versus lead length.



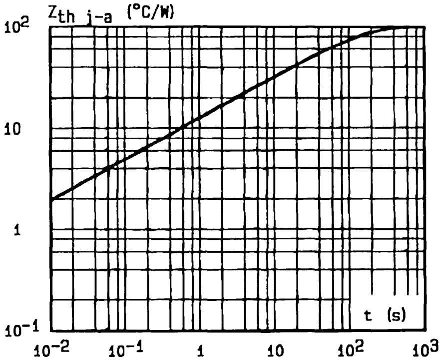


Fig.6 - Transient thermal impedance junction-ambient for mounting n°2 versus pulse duration (L = 10 mm).

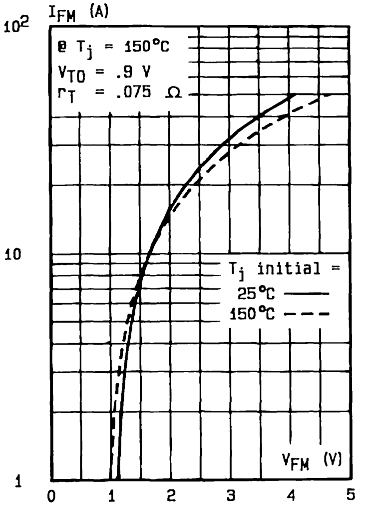


Fig.7 - Peak forward current versus peak forward voltage drop (typical values for unidirectional types).

D88BZW04P5

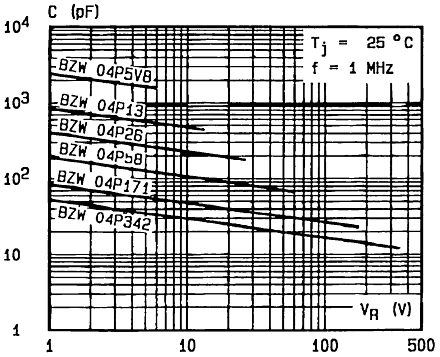


Fig.8a - Capacitance versus reverse applied voltage for unidirectional types (typical values).

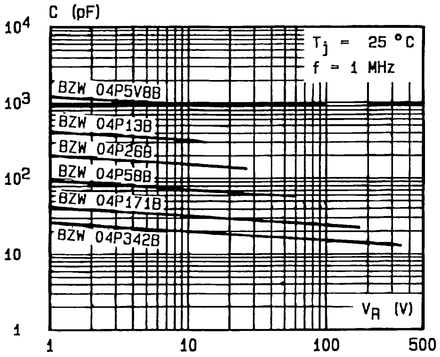
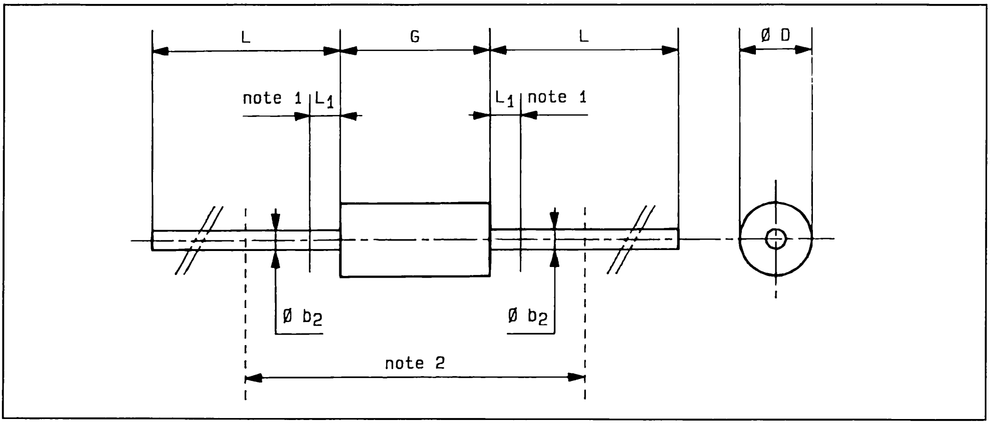


Fig.8b - Capacitance versus reverse applied voltage for bidirectional types (typical values).

D88BZW04P6

PACKAGE MECHANICAL DATA

F 126 Plastic



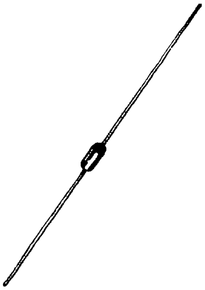
Ref.	Millimeters		Inches		Notes
	Min.	Max.	Min.	Max.	
Ø b_2	0.76	0.86	0.029	0.034	1 - The lead diameter Ø b_2 is not controlled over zone L_1. 2 - The minimum axial lengh within which the device may be placed with its leads bent at right angles is 0.59" (15 mm).
Ø D	2.95	3.05	0.116	0.120	
G	6 05	6.35	0.238	0.250	
L	26	–	1.024	–	
L_1	–	1.27	–	0.050	

Cooling method : by convection (method A).
Marking : type number ; white band indicates cathode for unidirectional types.
Weight : 0.4 g.

SGS-THOMSON
MICROELECTRONICS

BZW04-376BT

BIDIRECTIONAL TRANSIENT VOLTAGE SUPPRESSOR



F126
(Plastic)

DESCRIPTION

Transient voltage suppressor diode especially useful in protecting triacs.
When occurs an overvoltage, the transil induces a triggering current inside the triac. That avoids any damaging over shoot of its breakover voltage.

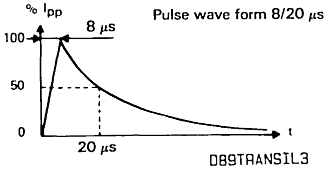
ABSOLUTE RATINGS (limiting values)

Symbol	Parameter		Value	Unit
I_{pp}	Peak Pulse Current for 8-20 µs Exponential Pulse	T_j Initial = 25 °C See note 1	1	A
P	Power Dissipation on Infinite Heatsink	T_{amb} = 50 °C	1.7	W
T_{stg} T_j	Storage and Junction Temperature Range		– 55 to 150 150	°C °C
T_L	Maximum Lead Temperature for Soldering During 10 s at 4 mm from Case		230	°C

THERMAL RESISTANCE

Symbol	Parameter	Value	Unit
$R_{th(j-l)}$	Junction-leads on Infinite Heatsink for L_{lead} = 10 mm	60	°C/W

Note : 1. For surges upper than the maximum values, the diode will present a short-circuit anode-cathode.

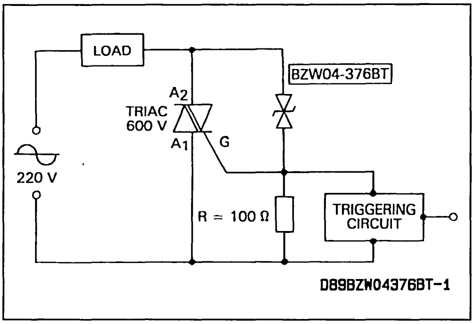


ELECTRICAL CHARACTERISTICS (T_j = 25°C)

Symbol	Parameter	Value
V_{RM}	Stand-off Voltage	See table
$V_{(BR)}$	Breakdown Voltage	
$V_{(CL)}$	Clamping Voltage	
I_{pp}	Peak Pulse Current	
α_T	Temperature Coefficient of $V_{(BR)}$	
C	Capacitance	
$t_{clamping}$	Clamping Time (0 volt to $V_{(BR)}$)	5 ns max.

Bidirectional Type	**I_{RM} @ V_{RM} max.**		**$V_{(BR)}$ typ. @ I_R**		**V_{CL} @ I_{pp} max. 8-20 µs expo.**		**α_T max.**	**C typ. V_R = 0 f = 1 MHz**
	(µA)	**(V)**	**(V)**	**(mA)**	**(V)**	**(A)**	**(10^{-4}/°C)**	**(pF)**
BZW04-376BT	5	376	480	1	600	1	11	35

WAY OF USING



Without TRANSIL, an overvoltage can turn on the triac by exceeding its breakover voltage and can damage it with the TRANSIL, when the overvoltage reaches its breakdown voltage a gate current turns on the triac safety.

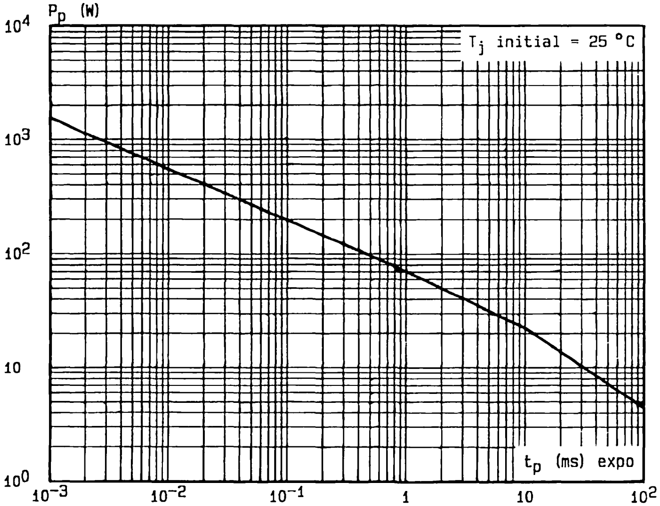


Fig.1 - Peak pulse power versus exponential pulse duration.

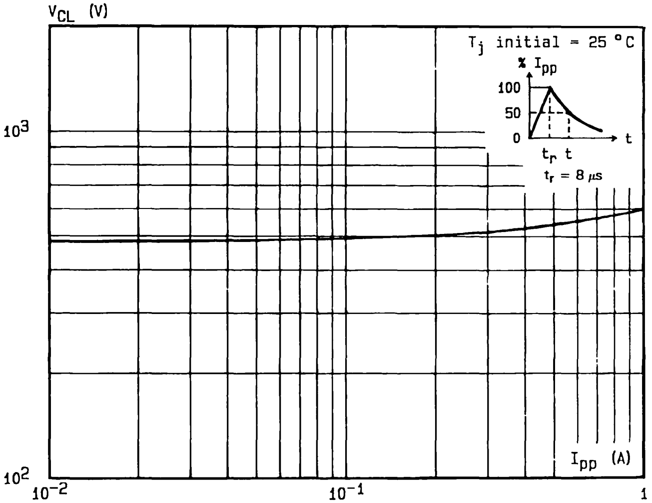


Fig.2 - Clamping voltage versus peak pulse current
exponential waveform t = 20 µs.

Note : The curves of the figure 2 are specified for a junction temperature of 25 °C before surge. The given results may be extrapolated for other junction temperatures by using the following formula : $\Delta V_{(BR)} = \alpha_{T(V(BR))} \times [T_j - 25] \times V_{(BR)}$
For intermediate voltages, extrapolate the given results.

D89BZW04376BTP3

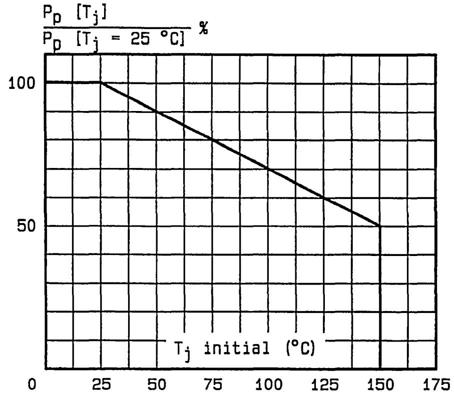


Fig.3 - Allowable power dissipation versus junction temperature.

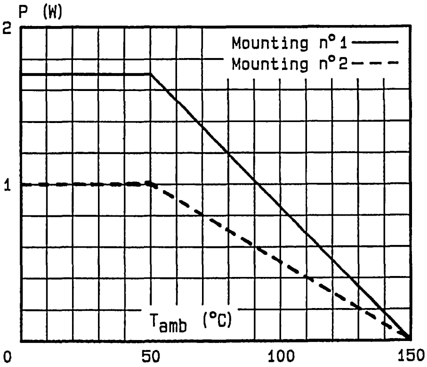


Fig.4 - Power dissipation versus ambient temperature.

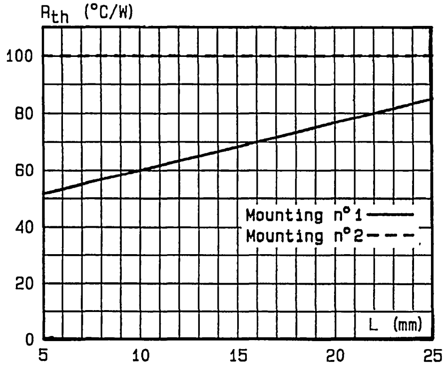
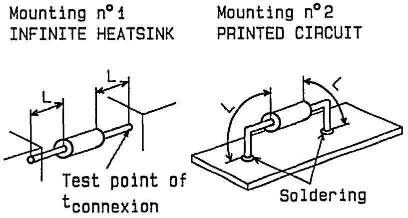


Fig.5 - Thermal resistance versus lead length.



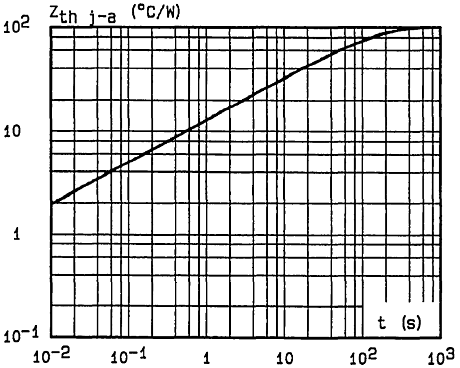


Fig.6 - Transient thermal impedance junction-ambient for mounting n°2 versus pulse duration (L = 10 mm).

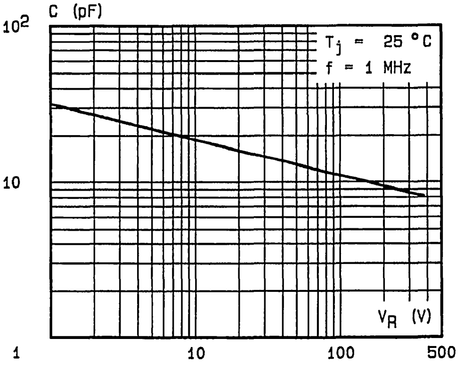
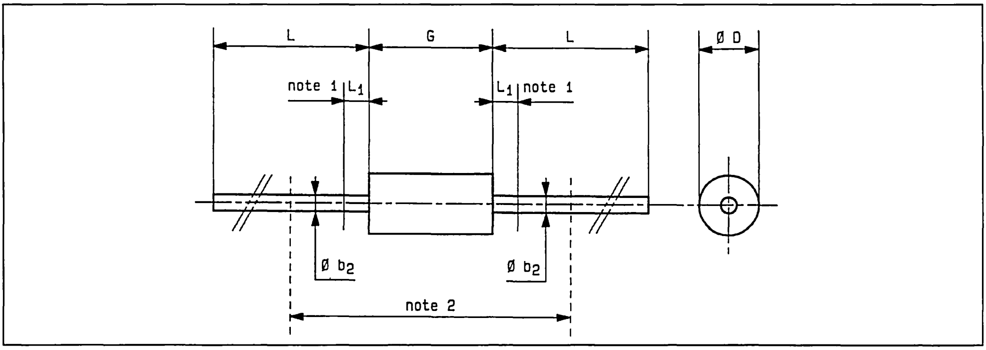


Fig.7 - Capacitance versus reverse applied voltage (typical values).

D89BZW04376BTP4

PACKAGE MECHANICAL DATA

F126 Plastic



Ref.	Millimeters		Inches		Notes
	Min.	Max.	Min.	Max.	
∅ b_2	0.76	0.86	0.029	0.034	1 - The lead diameter ∅ b_2 is not controlled over zone L_1. 2 - The minimum axial lengh within which the device may be placed with its leads bent at right angles is 0.59" (15 mm).
∅ D	2.95	3.05	0.116	0.120	
G	6.05	6.35	0.238	0.250	
L	26	–	1.024	–	
L_1	–	1.27	–	0.050	

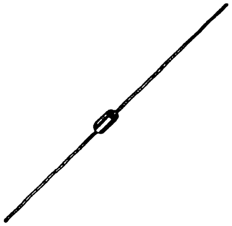
Cooling method : by convection (method A)
Marking : type number
Weight : 0.4 g

SGS-THOMSON
MICROELECTRONICS

BZW06-5V8, B → 376, B
BZW06P5V8, B → 376, B

UNI-AND BIDIRECTIONAL TRANSIENT VOLTAGE SUPPRESSORS

- HIGH SURGE CAPABILITY :
  600 W / 1 ms EXPO
- VERY FAST CLAMPING TIME :
  1 ps FOR UNIDIRECTIONAL TYPES
  5 ns FOR BIDIRECTIONAL TYPES
- LARGE VOLTAGE RANGE :
  5.8 V → 376 V
- ORDER CODE :
  TYPE NUMBER FOR UNIDIRECTIONAL TYPES, TYPE NUMBER + SUFFIX B FOR BIDIRECTIONAL TYPES



F 126
(Plastic)

DESCRIPTION

Transient voltage suppressor diodes especially useful in protecting integrated circuits, MOS, hybrids and other voltage-sensitive semiconductors and components.

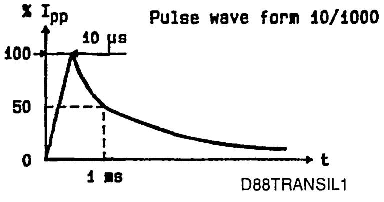
ABSOLUTE RATINGS (limiting values)

Symbol	Parameter		Value	Unit
P_p	Peak Pulse Power for 1 ms Exponential Pulse	T_j Initial = 25 °C See note 1	600	W
P	Power Dissipation on Infinite Heatsink	T_{amb} = 50 °C	1.7	W
I_{FSM}	Non Repetitive Surge Peak Forward Current for Unidirectional Types	T_j Initial = 25 °C t = 10 ms	100	A
T_{stg} T_j	Storage and Operating Junction Temperature Range		– 55 to 150 150	°C °C
T_L	Maximum Lead Temperature for Soldering During 10 s at 4 mm from Case		230	°C

THERMAL RESISTANCE

Symbol	Parameter	Value	Unit
$R_{th(j-l)}$	Junction-leads on Infinite Heatsink for L_{lead} = 10 mm	60	°C/W

Note : 1. For surges upper than the maximum values, the diode will present a short-circuit anode-cathode.



ELECTRICAL CHARACTERISTICS (T_j = 25 °C)

Symbol	Parameter		Value
V_{RM}	Stand-off Voltage		See tables
$V_{(BR)}$	Breakdown Voltage		
$V_{(CL)}$	Clamping Voltage		
I_{pp}	Peak Pulse Current		
α_T	Temperature Coefficient of $V_{(BR)}$		
C	Capacitance		
$t_{clamping}$	Clamping Time (0 volt to $V_{(BR)}$)	Unidirectional Types	1 ps max.
		Bidirectional Types	5 ns max.

Types		I_{RM} @ V_{RM} max.		$V_{(BR)}$* @ I_R (V)				$V_{(CL)}$ @ I_{pp} max. 1 ms expo		$V_{(CL)}$ @ I_{pp} max. 8-20 µs expo		α_T max.	C** typ. V_R=0 f=1 MHz
Unidirectional	Bidirectional	(µA)	(V)	min.	nom.	max.	(mA)	(V)	(A)	(V)	(A)	(10^{-4}/°C)	(pF)
BZW06P5V8	BZW06P5V8B	1000	5.8	6.45	6.8	7.48	10	10.5	57	13.4	261	5.7	4000
BZW06-5V8	BZW06-5V8B	1000	5.8	6.45	6.8	7.14	10	10.5	57	13.4	261	5.7	4000
BZW06P6V4	BZW06P6V4B	500	6.4	7.13	7.5	8.25	10	11.3	53	14.5	241	6.1	3700
BZW06-6V4	BZW06-6V4B	500	6.4	7.13	7.5	7.88	10	11.3	53	14.5	241	6.1	3700
BZW06P7V0	BZW06P7V0B	200	7.02	7.79	8.2	9.02	10	12.1	50	15.5	226	6.5	3400
BZW06-7V0	BZW06-7V0B	200	7.02	7.79	8.2	8.61	10	12.1	50	15.5	226	6.5	3400
BZW06P7V8	BZW06P7V8B	50	7.78	8.65	9.1	10	1	13.4	45	17.1	205	6.8	3100
BZW06-7V8	BZW06-7V8B	50	7.78	8.65	9.1	9.55	1	13.4	45	17.1	205	6.8	3100
BZW06P8V5	BZW06P8V5B	10	8.55	9.5	10	11	1	14.5	41	18.6	387	7.3	2800
BZW06-8V5	BZW06-8V5B	10	8.55	9.5	10	10.5	1	14.5	41	18.6	387	7.3	2800
BZW06P9V4	BZW06P9V4B	5	9.4	10.5	11	12.1	1	15.6	38	20.3	355	7.5	2500
BZW06-9V4	BZW06-9V4B	5	9.4	10.5	11	11.6	1	15.6	38	20.3	355	7.5	2500
BZW06P10	BZW06P10B	5	10.2	11.4	12	13.2	1	16.7	36	21.7	332	7.8	2300
BZW06-10	BZW06-10B	5	10.2	11.4	12	12.6	1	16.7	36	21.7	332	7.8	2300
BZW06P11	BZW06P11B	5	11.1	12.4	13	14.3	1	18.2	33	23.6	305	8.1	2150
BZW06-11	BZW06-11B	5	11.1	12.4	13	13.7	1	18.2	33	23.6	305	8.1	2150
BZW06P13	BZW06P13B	5	12.8	14.3	15	16.5	1	21.2	28	27.2	265	8.4	1900
BZW06-13	BZW06-13B	5	12.8	14.3	15	15.8	1	21.2	28	27.2	265	8.4	1900
BZW06P14	BZW06P14B	5	13.6	15.2	16	17.6	1	22.5	27	28.9	249	8.6	1800
BZW06-14	BZW06-14B	5	13.6	15.2	16	16.8	1	22.5	27	28.9	249	8.6	1800
BZW06P15	BZW06P15B	5	15.3	17.1	18	19.8	1	25.2	24	32.5	222	8.8	1600
BZW06-15	BZW06-15B	5	15.3	17.1	18	18.9	1	25.2	24	32.5	222	8.8	1600
BZW06P17	BZW06P17B	5	17.1	19	20	22	1	27.7	22	36.1	199	9.0	1500
BZW06-17	BZW06-17B	5	17.1	19	20	21	1	27.7	22	36.1	199	9.0	1500
BZW06P19	BZW06P19B	5	18.8	20.9	22	24.2	1	30.6	20	39.3	183	9.2	1350
BZW 06-19	BZW06-19B	5	18.8	20.9	22	23.1	1	30.6	20	39.3	183	9.2	1350
BZW06P20	BZW06P20B	5	20.5	22.8	24	26.4	1	33.2	18	42.8	168	9.4	1250
BZW06-20	BZW06-20B	5	20.5	22.8	24	25.2	1	33.2	18	42.8	168	9.4	1250
BZW06P23	BZW06P23B	5	23.1	25.7	27	29.7	1	37.5	16	48.3	149	9.6	1150
BZW06-23	BZW06-23B	5	23.1	25.7	27	28.4	1	37.5	16	48.3	149	9.6	1150
BZW06P26	BZW06P26B	5	25.6	28.5	30	33	1	41.4	14.5	53.5	134	9.7	1075
BZW06-26	BZW06-26B	5	25.6	28.5	30	31.5	1	41.4	14.5	53.5	134	9.7	1075
BZW06P28	BZW06P28B	5	28.2	31.4	33	36.3	1	45.7	13.1	59	122	9.8	1000
BZW06-28	BZW06-28B	5	28.2	31.4	33	34.7	1	45.7	13.1	59	122	9.8	1000
BZW06P31	BZW06P31B	5	30.8	34.2	36	39.6	1	49.9	12	64.3	112	9.9	950
BZW06-31	BZW06-31B	5	30.8	34.2	36	37.8	1	49.9	12	64.3	112	9.9	950
BZW06P33	BZW06P33B	5	33.3	37.1	39	42.9	1	53.9	11.1	69.7	103	10.0	900

* Pulse test $t_p \leq 50$ ms $\delta < 2$ %.

** Divide these values by 2 for bidirectional types.

For bidirectional types, electrical characteristics apply in both directions.

Types		I_{RM} @ V_{RM} max.		$V_{(BR)}$* @ I_R (V)				$V_{(CL)}$ @ I_{pp} max. 1 ms expo		$V_{(CL)}$ @ I_{pp} max. 8-20 µs expo		α_T max.	C** typ. $V_R=0$ f=1 MHz
Unidirectional	Bidirectional	(µA)	(V)	min.	nom.	max.	(mA)	(V)	(A)	(V)	(A)	(10^{-4}/°C)	(pF)
BZW06-33	BZW06-33B	5	33.3	37.1	39	41	1	53.9	11.1	69.7	103	10.0	900
BZW06P37	BZW06P37B	5	36.8	40.9	43	47.3	1	59.3	10.1	76.8	94	10.1	850
BZW06-37	BZW06-37B	5	36.8	40.9	43	45.2	1	59.3	10.1	76.8	94	10.1	850
BZW06P40	BZW06P40B	5	40.2	44.7	47	51.7	1	64.8	9.3	84	86	10.1	800
BZW06-40	BZW06-40B	5	40.2	44.7	47	49.4	1	64.8	9.3	84	86	10.1	800
BZW06P44	BZW06P44B	5	43 6	48.5	51	56.1	1	70.1	8.6	91	79	10.2	750
BZW06-44	BZW06-44B	5	43.6	48.5	51	53.6	1	70.1	8.6	91	79	10.2	750
BZW06P48	BZW06P48B	5	47.8	53.2	56	61.6	1	77	7.8	100	72	10.3	700
BZW06-48	BZW06-48B	5	47.8	53.2	56	58.8	1	77	7.8	100	72	10.3	700
BZW06P53	BZW06P53B	5	53	58 9	62	68.2	1	85	7.1	111	65	10.4	650
BZW06-53	BZW06-53B	5	53	58.9	62	65.1	1	85	7.1	111	65	10.4	650
BZW06P58	BZW06P58B	5	58 1	64.6	68	74.8	1	92	6 5	121	59 5	10.4	625
BZW06-58	BZW06-58B	5	58.1	64.6	68	71.4	1	92	6.5	121	59.5	10.4	625
BZW06P64	BZW06P64B	5	64.1	71.3	75	82.5	1	103	5.8	134	53.5	10.5	575
BZW06-64	BZW06-64B	5	64.1	71.3	75	78.8	1	103	5.8	134	53.5	10.5	575
BZW06P70	BZW06P70B	5	70.1	77.9	82	90.2	1	113	5.3	146	49	10.5	550
BZW06-70	BZW06-70B	5	70.1	77.9	82	86.1	1	113	5.3	146	49	10.5	550
BZW06P78	BZW06P78B	5	77 8	86.5	91	100	1	125	4.8	162	44.5	10.6	525
BZW06-78	BZW06-78B	5	77.8	86 5	91	95.5	1	125	4.8	162	44.5	10.6	525
BZW06P85	BZW06P85B	5	85.5	95	100	110	1	137	4.4	178	40.5	10.6	500
BZW06-85	BZW06-85B	5	85.5	95	100	105	1	137	4.4	178	40.5	10.6	500
BZW06P94	BZW06P94B	5	94	105	110	121	1	152	3.9	195	37	10.7	470
BZW06-94	BZW06-94B	5	94	105	110	116	1	152	3.9	195	37	10.7	470
BZW06P102	BZW06P102B	5	102	114	120	132	1	165	3.6	212	34	10.7	450
BZW06-102	BZW06-102B	5	102	114	120	126	1	165	3.6	212	34	10.7	450
BZW06P111	BZW06P111B	5	111	124	130	143	1	179	3.4	230	31.5	10.7	420
BZW06-111	BZW06-111B	5	111	124	130	137	1	179	3.4	230	31.5	10.7	420
BZW06P128	BZW06P128B	5	128	143	150	165	1	207	2 9	265	27.2	10.8	400
BZW06-128	BZW06-128B	5	128	143	150	158	1	207	2.9	265	27.2	10.8	400
BZW06P136	BZW06P136B	5	136	152	160	176	1	219	2.7	282	25.5	10.8	380
BZW06-136	BZW06-136B	5	136	152	160	168	1	219	2.7	282	25.5	10.8	380
BZW06P145	BZW06P145B	5	145	161	170	187	1	234	2.6	301	24	10 8	370
BZW06-145	BZW06-145B	5	145	161	170	179	1	234	2.6	301	24	10.8	370
BZW06P154	BZW06P154B	5	154	171	180	198	1	246	2.4	317	22.7	10.8	360
BZW06-154	BZW06-154B	5	154	171	180	189	1	246	2.4	317	22.7	10.8	360
BZW06P171	BZW06P171B	5	171	190	200	220	1	274	2.2	353	20.4	10.8	350
BZW06-171	BZW06-171B	5	171	190	200	210	1	274	2.2	353	20.4	10.8	350
BZW06P188	BZW06P188B	5	188	209	220	242	1	301	2	388	18 6	10.8	330
BZW06-188	BZW06-188B	5	188	209	220	231	1	301	2	388	18.6	10.8	330
BZW06P213	BZW06P213B	5	213	237	250	275	1	344	2	442	19	11	310
BZW06-213	BZW06-213B	5	213	237	250	263	1	344	2	442	19	11	310
BZW06P239	BZW06P239B	5	239	266	280	308	1	384	2	494	18	11	300
BZW06-239	BZW06-239B	5	239	266	280	294	1	384	2	494	18	11	300
BZW06P256	BZW06P256B	5	256	285	300	330	1	414	1.6	529	14	11	290
BZW06-256	BZW06-256B	5	256	285	300	315	1	414	1.6	529	14	11	290
BZW06P273	BZW06P273B	5	273	304	320	352	1	438	1.6	564	14	11	280
BZW06-273	BZW06-273B	5	273	304	320	336	1	438	1.6	564	14	11	280
BZW06P299	BZW06P299B	5	299	332	350	385	1	482	1.6	618	14	11	270
BZW06-299	BZW06-299B	5	299	332	350	368	1	482	1.6	618	14	11	270
BZW06P342	BZW06P342B	5	342	380	400	440	1	548	1.3	706	11	11	360
BZW06-342	BZW06-342B	5	342	380	400	420	1	548	1.3	706	11	11	360
BZW06P376	BZW06P376B	5	376	418	440	484	1	603	1.3	776	11	11	350
BZW06-376	BZW06-376B	5	376	418	440	462	1	603	1.3	776	11	11	350

* Pulse test $t_p \leq 50$ ms $\delta < 2$ %.

** Divide these values by 2 for bidirectional types.

For bidirectional types, electrical characteristics apply in both directions.

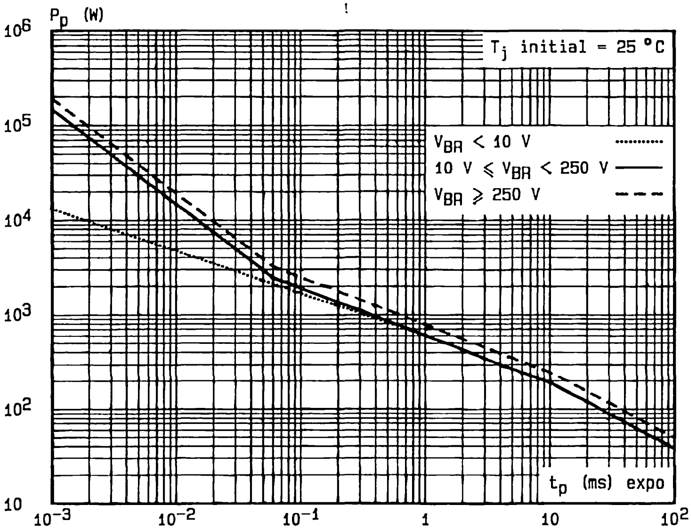


Fig.1 - Peak pulse power versus exponential pulse duration.

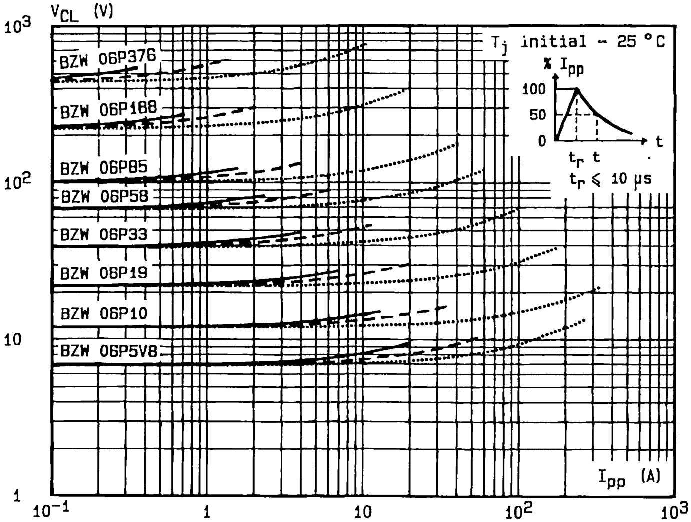


Fig.2 - Clamping voltage versus peak pulse current.
exponential waveform t = 20 µs ⋯⋯
t = 1 ms – – –
t = 10 ms ——

Note : The curves of the figure 2 are specified for a junction temperature of 25 °C before surge. The given results may be extrapolated for other junction temperatures by using the following formula : $\Delta V_{(BR)} = \alpha_{T(V(BR))} \times [T_j - 25] \times V_{(BR)}$
For intermediate voltages, extrapolate the given results.

D88BZW06P4

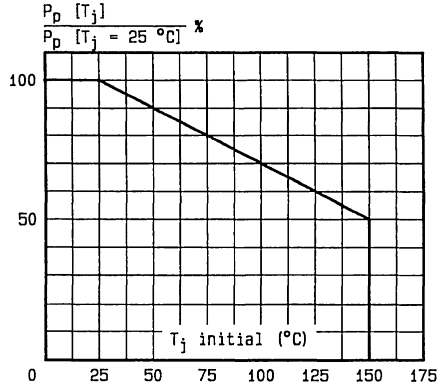


Fig.3 - Allowable power dissipation versus junction temperature.

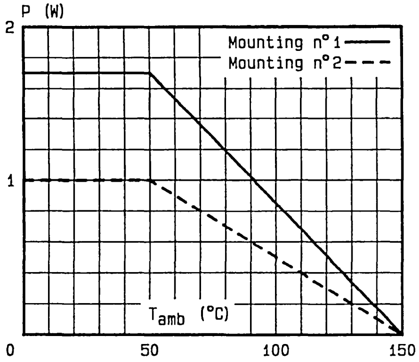


Fig.4 - Power dissipation versus ambient temperature.

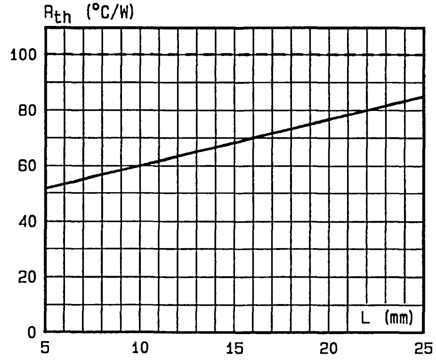
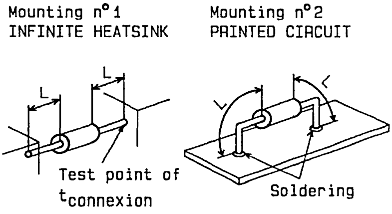


Fig.5 - Thermal resistance versus lead length.



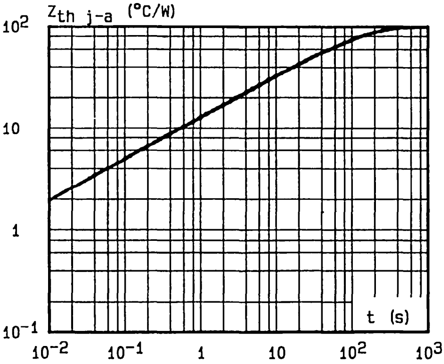


Fig.6 - Transient thermal impedance junction-ambient for mounting n°2 versus pulse duration (L = 10 mm).

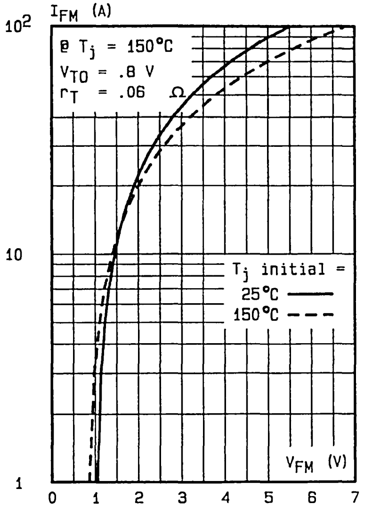


Fig.7 - Peak forward current versus peak forward voltage drop (typical values for unidirectional types).

D88BZW06P5

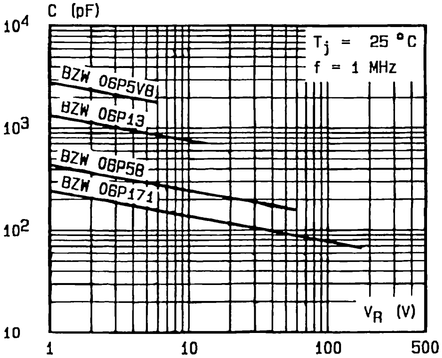


Fig.8a - Capacitance versus reverse applied voltage for unidirectional types (typical values) .

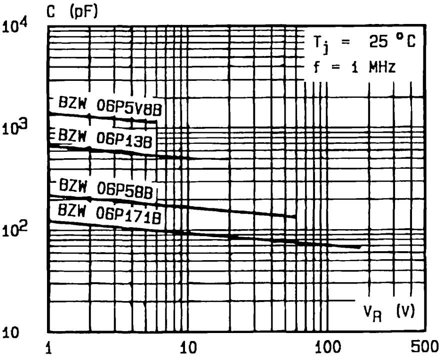
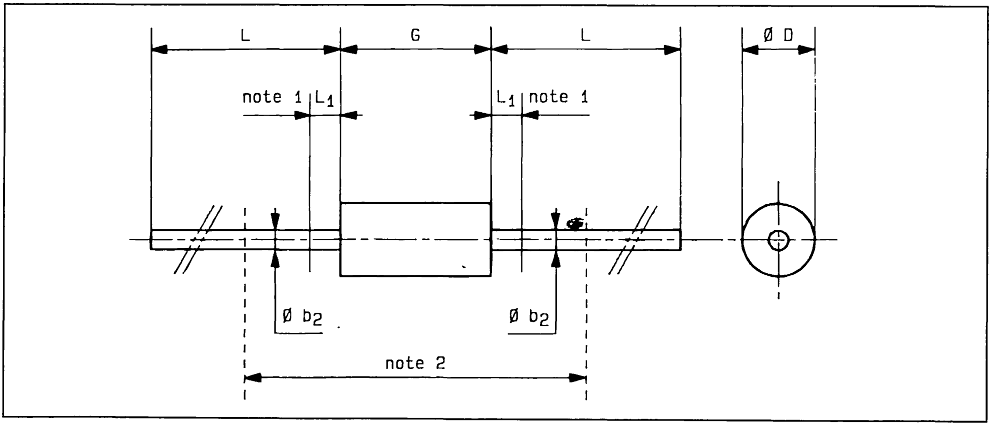


Fig.8b - Capacitance versus reverse applied voltage for bidirectional types (typical values) .

D88BZW06P6

PACKAGE MECHANICAL DATA

F 126 Plastic



Ref.	Millimeters		Inches		Notes
	Min.	Max.	Min.	Max.	
Ø b2	0.76	0.86	0.029	0.034	1 - The lead diameter Ø b2 is not controlled over zone L1. 2 - The minimum axial lengh within which the device may be placed with its leads bent at right angles is 0.59" (15 mm).
Ø D	2.95	3.05	0 116	0.120	
G	6.05	6.35	0.238	0.250	
L	26	–	1.024	–	
L1	–	1.27	–	0.050	

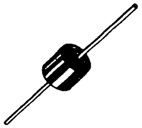
Cooling method : by convection (method A)
Marking : type number ; white band indicates cathode for unidirectional types
Weight : 0.4 g.

SGS-THOMSON
MICROELECTRONICS

BZW50-10,B → 180, B

UNI-AND BIDIRECTIONAL TRANSIENT VOLTAGE SUPPRESSORS

- HIGH SURGE CAPABILITY :
  5 kW / 1 ms EXPO
- VERY FAST CLAMPING TIME :
  1 ps FOR UNIDIRECTIONAL TYPES
  5 ns FOR BIDIRECTIONAL TYPES
- LARGE VOLTAGE RANGE :
  10 V → 180 V
- ORDER CODE :
  TYPE NUMBER FOR UNIDIRECTIONAL TYPES, TYPE NUMBER + SUFFIX B FOR BIDIRECTIONAL TYPES


AG
(Plastic)

DESCRIPTION

Transient voltage suppressor diodes especially useful in protecting integrated circuits, MOS, hybrids and other voltage-sensitive semiconductors and components.

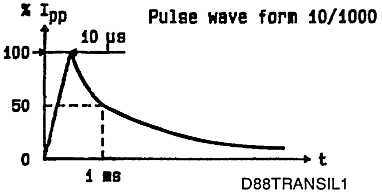
ABSOLUTE RATINGS (limiting values)

Symbol	Parameter		Value	Unit
P_p	Peak Pulse Power for 1 ms Exponential Pulse	T_j Initial = 25 °C See note 1	5	kW
P	Power Dissipation on Infinite Heatsink	T_{amb} = 75 °C	5	W
I_{FSM}	Non Repetitive Surge Peak Forward Current for Unidirectional Types	T_j Initial = 25 °C t = 10 ms	500	A
T_{stg} T_j	Storage and Operating Junction Temperature Range		– 65 to 150 150	°C °C
T_L	Maximum Lead Temperature for Soldering During 10 s at 4 mm from Case		230	°C

THERMAL RESISTANCE

Symbol	Parameter	Value	Unit
$R_{th(j-l)}$	Junction-leads on Infinite Heatsink for L_{lead} = 10 mm	15	°C/W

Note : 1. For surges upper than the maximum values, the diode will present a short-circuit anode-cathode.



ELECTRICAL CHARACTERISTICS (T_j = 25 °C)

Symbol	Parameter		Value
V_{RM}	Stand-off Voltage		See tables
$V_{(BR)}$	Breakdown Voltage		
$V_{(CL)}$	Clamping Voltage		
I_{pp}	Peak Pulse Current		
α_T	Temperature Coefficient of $V_{(BR)}$		
C	Capacitance		
$t_{clamping}$	Clamping Time (0 volt to $V_{(BR)}$)	Unidirectional Types	1 ps max.
		Bidirectional Types	5 ns max.

Types		I_{RM} @ V_{RM} max.		$V_{(BR)}$* (V)			@ I_R	$V_{(CL)}$ @ I_{pp} max. 1 ms expo		$V_{(CL)}$ @ I_{pp} max. 8-20 µs expo		α_T max.	C** typ. V_R=0 f=1 MHz
Unidirectional	**Bidirectional**	(µA)	(V)	min.	nom.	max.	(mA)	(V)	(A)	(V)	(A)	(10^{-4}/°C)	(pF)
BZW50-10	BZW50-10B	5	10	11.1	12.4	13.6	1	18.8	266	23.4	2564	7.8	24000
BZW50-12	BZW50-12B	5	12	13.3	14.8	16.3	1	22	227	28	2143	8.4	18500
BZW50-15	BZW50-15B	5	15	16.6	18.5	20.4	1	26.9	186	35	1714	8.8	13500
BZW50-18	BZW50-18B	5	18	20	22.2	24.4	1	32.2	155	41.5	1446	9.2	11500
BZW50-22	BZW50-22B	5	22	24.4	27.1	29.8	1	39.4	127	51	1177	9.6	8500
BZW50-27	BZW50-27B	5	27	30	33.3	36.6	1	48.3	103	62	968	9.8	7000
BZW50-33	BZW50-33B	5	33	36.6	40.7	44.7	1	59	85	76	789	10	5750
BZW50-39	BZW50-39B	5	39	43.3	48.1	53	1	69.4	72	90	667	10.1	4800
BZW50-47	BZW50-47B	5	47	52	57.8	63.6	1	83.2	60.1	108	556	10.3	4100
BZW50-56	BZW50-56B	5	56	62.2	69.1	76	1	99.6	50	129	465	10.4	3400
BZW50-68	BZW50-68B	5	68	75.6	84	92.4	1	121	41	157	382	10.5	3000
BZW50-82	BZW50-82B	5	82	91	101.2	111	1	145	34	189	317	10.6	2600
BZW50-100	BZW50-100B	5	100	111	123.5	136	1	179	28	228	263	10.7	2300
BZW50-120	BZW50-120B	5	120	133	148.1	163	1	215	23	274	219	10.8	1900
BZW50-150	BZW50-150B	5	150	166	185.2	204	1	269	19	343	175	10.8	1700
BZW50-180	BZW50-180B	5	180	200	222	244	1	322	16	410	146	10.8	1500

* Pulse test $t_p \leq 50$ ms $\delta < 2$ %.
** Divide these values by 2 for bidirectional types.
For bidirectional types, electrical characteristics apply in both directions.

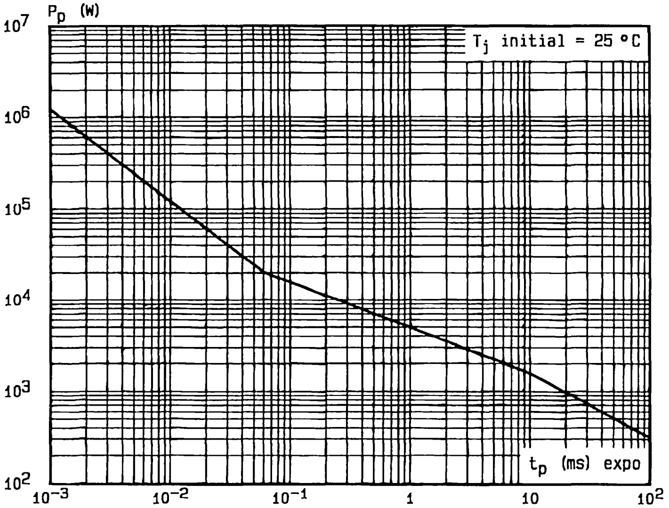


Fig.1 - Peak pulse power versus exponential pulse duration.

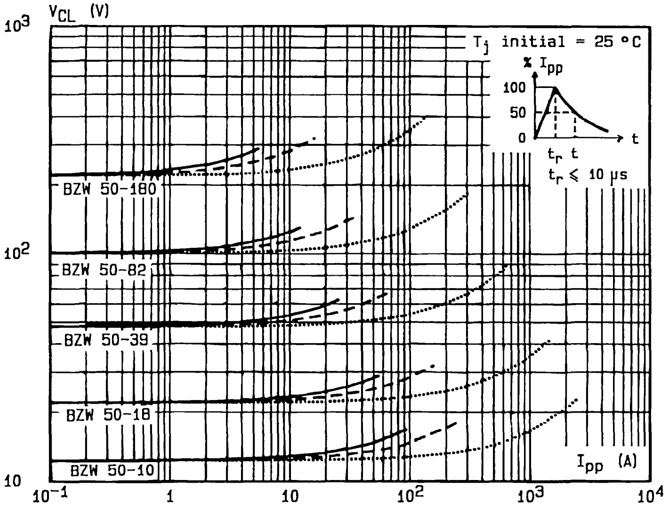


Fig.2 - Clamping voltage versus peak pulse current.
exponential waveform t = 20 µs ·
t = 1 ms – – – –
t = 10 ms ———

Note : The curves of the figure 2 are specified for a junction temperature of 25 °C before surge. The given results may be extrapolated for other junction temperatures by using the following formula : $\Delta V_{(BR)} = \alpha_{T\,(V\,(BR))} \times [T_j - 25] \times V_{(BR)}$
For intermediate voltages, extrapolate the given results.

D88BZW50P3

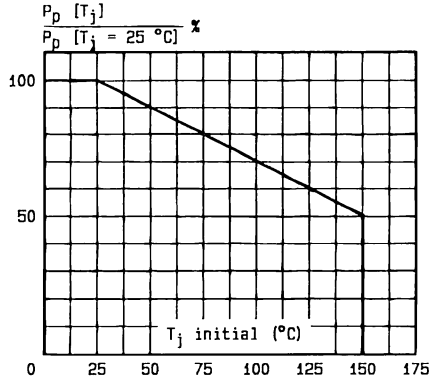


Fig.3 - Allowable power dissipation versus junction temperature.

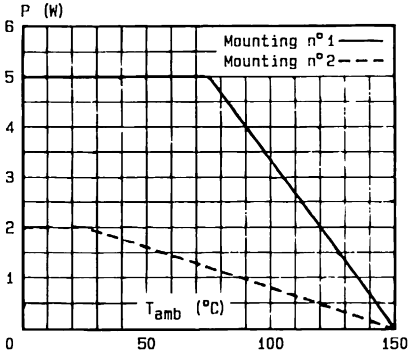


Fig.4 - Power dissipation versus ambient temperature.

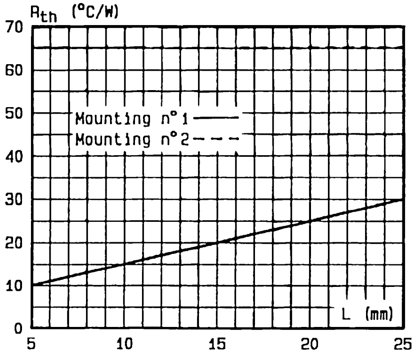
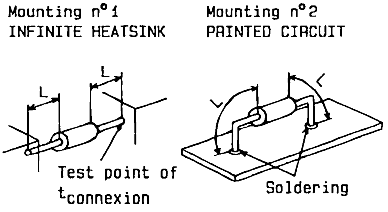


Fig.5 - Thermal resistance versus lead length.



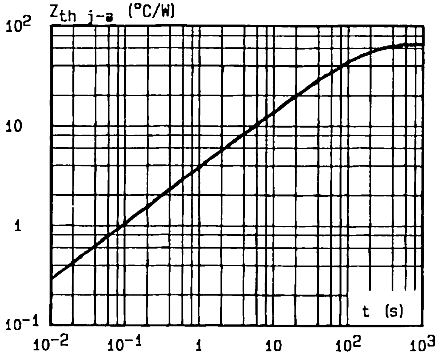


Fig.6 - Transient thermal impedance junction-ambient for mounting n°2 versus pulse duration (L = 10 mm).

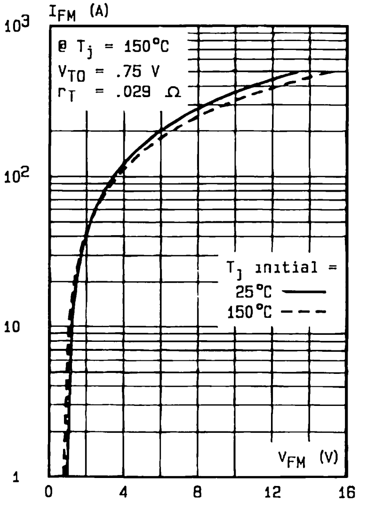


Fig.7 - Peak forward current versus peak forward voltage drop (typical values for unidirectional types).

D88BZW50P4

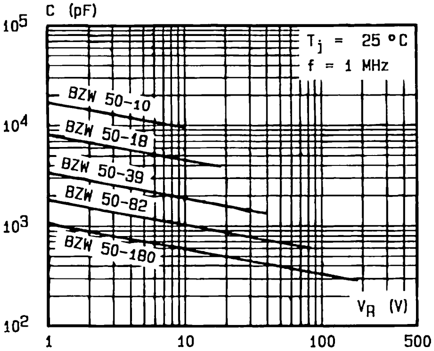


Fig.8a - Capacitance versus reverse applied voltage for unidirectional types (typical values).

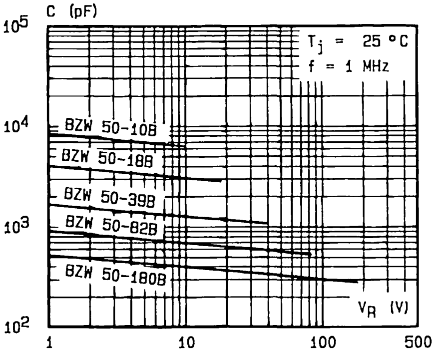
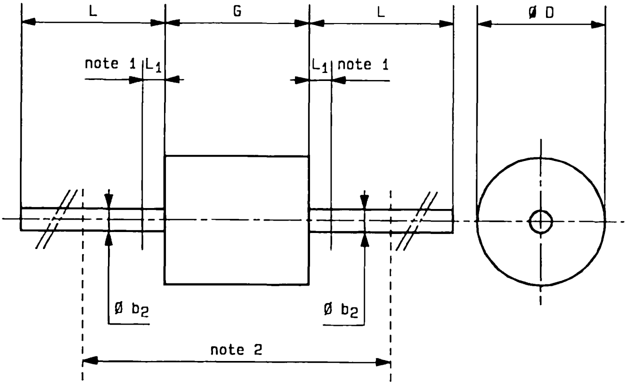


Fig.8b - Capacitance versus reverse applied voltage for bidirectional types (typical values).

D88BZW50P5

PACKAGE MECHANICAL DATA

AG Plastic



<table>
<tr><th rowspan="2">Ref.</th><th colspan="2">Millimeters</th><th colspan="2">Inches</th><th rowspan="2">Notes</th></tr>
<tr><th>Min.</th><th>Max.</th><th>Min.</th><th>Max.</th></tr>
<tr><td>Ø b_2</td><td>1.35</td><td>1.45</td><td>0.053</td><td>0.057</td><td rowspan="5">1 - The lead diameter Ø b_2 is not controlled over zone L_1.
2 - The minimum axial lengh within which the device may be placed with its leads bent at right angles is 0.79" (20 mm).</td></tr>
<tr><td>Ø D</td><td>–</td><td>8</td><td>–</td><td>0.315</td></tr>
<tr><td>G</td><td>–</td><td>9</td><td>–</td><td>0.354</td></tr>
<tr><td>L</td><td>20</td><td>–</td><td>0.787</td><td>–</td></tr>
<tr><td>L_1</td><td>–</td><td>1.27</td><td>–</td><td>0.050</td></tr>
</table>

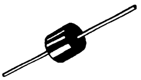
Cooling method : by convection (method A).
Marking : type number ; white band indicates cathode for unidirectional types.
Weight : 1 g.

SGS-THOMSON
MICROELECTRONICS

BZW 100-20
BZW 100-24

UNIDIRECTIONAL TRANSIENT VOLTAGE SUPPRESSORS

- HIGH SURGE CAPABILITY :
  1.8 kW / 15 ms EXPO
- VERY FAST CLAMPING TIME : 1 ps



AG
(Plastic)

DESCRIPTION

Transient voltage suppressor diodes especially designed for load dump effect protection.

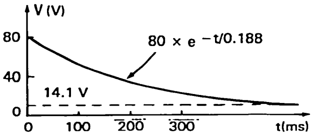
ABSOLUTE RATINGS (limiting values)

Symbol	Parameter		Value	Unit
P_p	Peak Pulse Power for 15 ms Exponential Pulse	T_j Initial = 25 °C See note 1	1800	W
P	Power Dissipation on Infinite Heatsink	T_{amb} = 75 °C	5	W
I_{FSM}	Non Repetitive Surge Peak Forward Current	T_j Initial = 25 °C t = 10 ms	200	A
T_{stg} T_j	Storage and Operating Junction Temperature Range		– 65 to 150 150	°C °C
T_L	Maximum Lead Temperature for Soldering During 10 s at 4 mm from Case		230	°C

THERMAL RESISTANCE

Symbol	Parameter	Value	Unit
$R_{th(j-l)}$	Junction-leads on Infinite Heatsink for L_{lead} = 10 mm	15	°C/W

Note : 1. For surges upper than the maximum values, the diode will present a short-circuit anode-cathode.



LOAD DUMP TRANSIENT (standard SAE J1113A).

D88TRANSIL2

ELECTRICAL CHARACTERISTICS (T_J = 25°C)

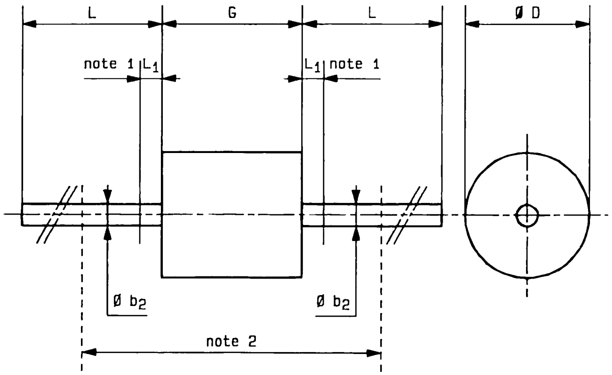
Symbol	Parameter	Value
V_{RM}	Stand-off Voltage	See table
$V_{(BR)}$	Breakdown Voltage	
$V_{(CL)}$	Clamping Voltage	
I_{pp}	Peak Pulse Current	
α_T	Temperature Coefficient of $V_{(BR)}$	
C	Capacitance	
$t_{clamping}$	Clamping Time (0 volt to $V_{(BR)}$)	1 ps max.
V_F	Peak Forward Voltage Drop (I_{FM} = 10 A)	1.9 V max.

Unidirectional Types	I_{RM} @ V_{RM} max.		$V_{(BR)}$* @ I_R (V)		V_{CL} @ I_{pp} max. 15 ms expo.		α_T max.	C typ. V_R = 0 f = 1 MHz
	(µA)	(V)	min.	(mA)	(V)	(A)	(10^{-4}/°C)	(pF)
BZW100-20	50	20	24	1	36	50	9.6	4250
BZW100-24	50	24	29	1	40	45	9.8	3500

* Pulse test $t_p \leq 50$ ms $\delta < 2$ %.

PACKAGE MECHANICAL DATA

AG Plastic



Ref.	Millimeters		Inches		Notes
	Min.	Max.	Min.	Max.	
Ø b_2	1.35	1.45	0.053	0.057	1 - The lead diameter Ø b_2 is not controlled over zone L_1. 2 - The minimum axial lengh within which the device may be placed with its leads bent at right angles is 0.79" (20 mm).
Ø D	–	8	–	0.315	
G	–	9	–	0.354	
L	20	–	0.787	–	
L_1	–	1.27	–	0.050	

Cooling method : by convection (method A).
Marking : type number ; white band indicates cathode.
Weight : 1 g.

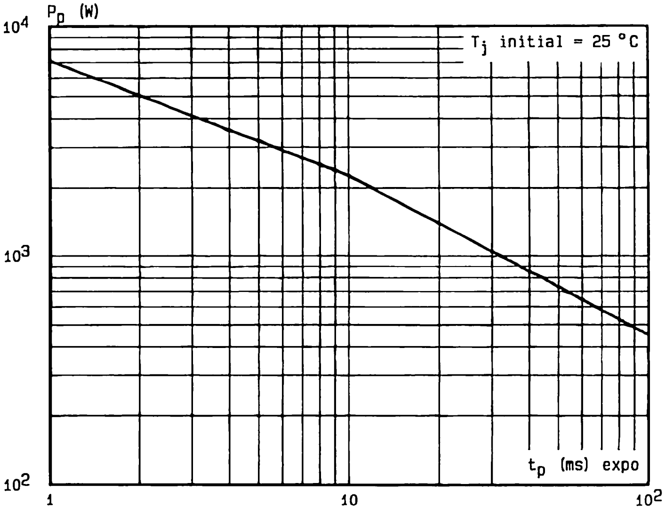


Fig.1 - Peak pulse power versus exponential pulse duration.

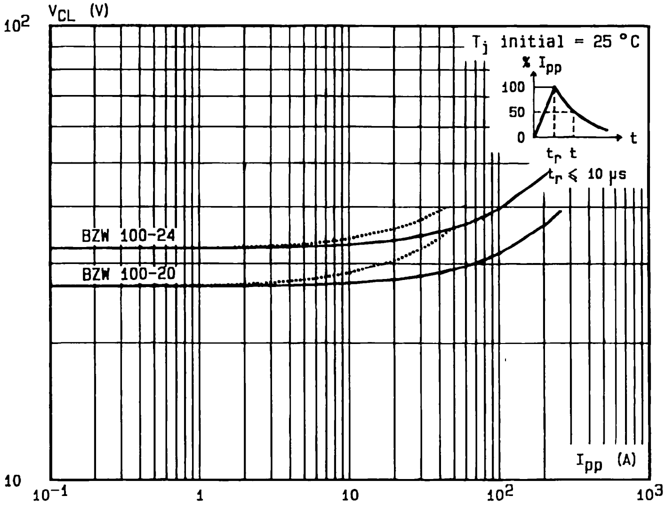


Fig.2 - Clamping voltage versus peak pulse current
exponential waveform t = 15 ms ··········
t = 1 ms ———

Note : The curves of the figure 2 are specified for a junction temperature of 25 °C before surge. The given results may be extrapolated for other junction temperatures by using the following formula : $\Delta V_{(BR)} = \alpha_{T(V(BR))} \times [T_j - 25] \times V_{(BR)}$
For intermediate voltages, extrapolate the given results.

DBBBZW100P3

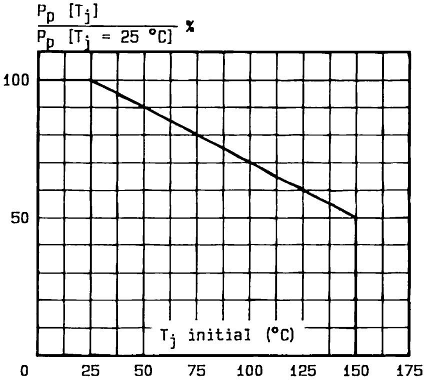


Fig.3 - Allowable power dissipation versus junction temperature.

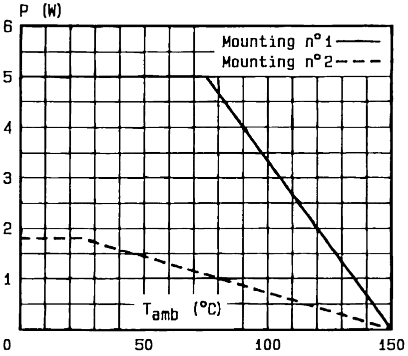


Fig.4 - Power dissipation versus ambient temperature.

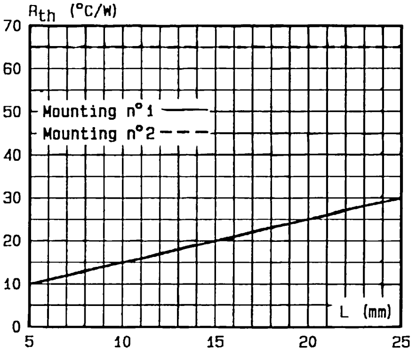
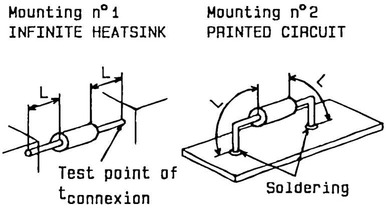


Fig.5 - Thermal resistance versus lead length.



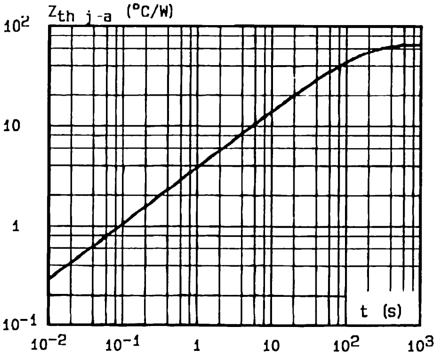


Fig.6 - Transient thermal impedance junction-ambient for mounting n°2 versus pulse duration (L = 10 mm).

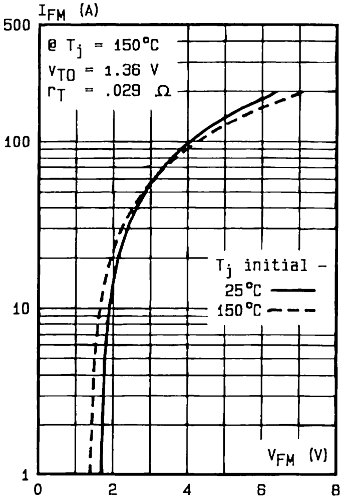


Fig.7 - Peak forward current versus peak forward voltage drop (maximum values).

D88BZW100P4

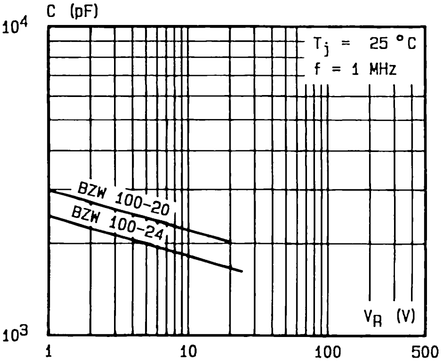


Fig.8 - Capacitance versus reverse aplied voltage (typical values).

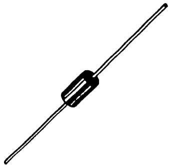
D88BZW100P5

SGS-THOMSON
MICROELECTRONICS

P6KE6V8P, A → 440P, A
P6KE6V8CP, CA → 440CP, CA

UNI-AND BIDIRECTIONAL TRANSIENT VOLTAGE SUPPRESSORS

- HIGH SURGE CAPABILITY :
  600 W / 1 ms EXPO
- VERY FAST CLAMPING TIME :
  1 ps FOR UNIDIRECTIONAL TYPES
  5 ns FOR BIDIRECTIONAL TYPES
- LARGE VOLTAGE RANGE :
  5.8 V → 376 V
- ORDER CODE :
  TYPE NUMBER FOR UNIDIRECTIONAL TYPES, TYPE NUMBER + SUFFIX C FOR BIDIRECTIONAL TYPES



CB-417
(Plastic)

DESCRIPTION

Transient voltage suppressor diodes especially useful in protecting integrated circuits, MOS, hybrids and other voltage-sensitive semiconductors and components.

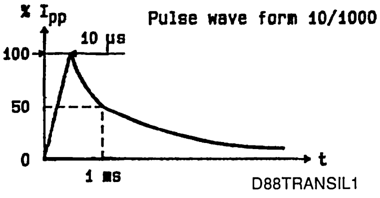
ABSOLUTE RATINGS (limiting values)

Symbol	Parameter		Value	Unit
P_p	Peak Pulse Power for 1 ms Exponential Pulse	T_j Initial = 25 °C See note 1	600	W
P	Power Dissipation on Infinite Heatsink	T_{amb} = 75 °C	5	W
I_{FSM}	Non Repetitive Surge Peak Forward Current for Unidirectional Types	T_j Initial = 25 °C t = 10 ms	100	A
T_{stg} T_j	Storage and Operating Junction Temperature Range		– 55 to 175 175	°C °C
T_L	Maximum Lead Temperature for Soldering During 10 s at 4 mm from Case		230	°C

THERMAL RESISTANCE

Symbol	Parameter	Value	Unit
$R_{th(j-l)}$	Junction-leads on Infinite Heatsink for L_{lead} = 10 mm	20	°C/W

Note : 1. For surges upper than the maximum values, the diode will present a short-circuit anode-cathode.



ELECTRICAL CHARACTERISTICS (T_J = 25 °C)

Symbol	Parameter		Value
V_{RM}	Stand-off Voltage		See tables
$V_{(BR)}$	Breakdown Voltage		
$V_{(CL)}$	Clamping Voltage		
I_{pp}	Peak Pulse Current		
α_T	Temperature Coefficient of $V_{(BR)}$		
C	Capacitance		
$t_{clamping}$	Clamping Time (0 volt to $V_{(BR)}$)	Unidirectional Types	1 ps max.
		Bidirectional Types	5 ns max.
V_{FM}	Forward Voltage Drop for Unidirectional Types (I_{FM} = 50 A)		3.5 V max.

Types		I_{RM} @ V_{RM} max.		$V_{(BR)}$* (V)		@	I_R	$V_{(CL)}$ @ I_{pp} max. 1 ms expo		$V_{(CL)}$ @ I_{pp} max. 8-20 µs expo		α_T max.	C** typ V_R=0 f=1 MHz
Unidirectional	Bidirectional	(µA)	(V)	min.	nom.	max.	(mA)	(V)	(A)	(V)	(A)	$(10^{-4}/°C)$	(pF)
P P6KE6V8P	P P6KE6V8CP	1000§	5.8	6.45	6.8	7.48	10	10.5	57	13.4	261	5.7	4000
P6KE6V8A	P6KE6V8CA	1000§	5.8	6.45	6.8	7.14	10	10.5	57	13.4	261	5.7	4000
P P6KE7V5P	P P6KE7V5CP	500§	6.4	7.13	7.5	8.25	10	11.3	53	14.5	241	6.1	3700
P6KE7V5A	P6KE7V5CA	500§	6.4	7.13	7.5	7.88	10	11.3	53	14.5	241	6.1	3700
P P6KE8V2P	P6KE8V2CP	200§	7.02	7.79	8.2	9.02	10	12.1	50	15.5	226	6.5	3400
P6KE8V2A	P6KE8V2CA	200§	7.02	7.79	8.2	8.61	10	12.1	50	15.5	226	6.5	3400
P6KE9V1P	P6KE9V1CP	50§	7.78	8.65	9.1	10	1	13.4	45	17.1	205	6 8	3100
P6KE9V1A	P6KE9V1CA	50§	7.78	8.65	9 1	9.55	1	13.4	45	17.1	205	6.8	3100
P6KE10P	P6KE10CP	10§	8.55	9.5	10	11	1	14.5	41	18.6	387	7.3	2800
P6KE10A	P6KE10CA	10§	8.55	9.5	10	10.5	1	14.5	41	18.6	387	7.3	2800
P6KE11P	P6KE11CP	5§	9.4	10.5	11	12.1	1	15.6	38	20.3	355	7.5	2500
P6KE11A	P6KE11CA	5§	9.4	10.5	11	11.6	1	15.6	38	20.3	355	7.5	2500
P P6KE12P	P P6KE12CP	5	10.2	11.4	12	13.2	1	16.7	36	21.7	332	7.8	2300
P6KE12A	P6KE12CA	5	10.2	11.4	12	12.6	1	16.7	36	21.7	332	7.8	2300
P P6KE13P	P P6KE13CP	5	11.1	12.4	13	14.3	1	18.2	33	23.6	305	8.1	2150
P6KE13A	P6KE13CA	5	11.1	12.4	13	13.7	1	18.2	33	23.6	305	8.1	2150
P P6KE15P	P P6KE15CP	5	12.8	14.3	15	16.5	1	21.2	28	27.2	265	8.4	1900
P6KE15A	P6KE15CA	5	12.8	14.3	15	15.8	1	21.2	28	27.2	265	8.4	1900
P6KE16P	P6KE16CP	5	13.6	15.2	16	17.6	1	22.5	27	28.9	249	8.6	1800
P6KE16A	P6KE16CA	5	13.6	15.2	16	16.8	1	22.5	27	28 9	249	8.6	1800
P P6KE18P	P P6KE18CP	5	15.3	17.1	18	19.8	1	25.2	24	32.5	222	8.8	1600
P6KE18A	P6KE18CA	5	15.3	17.1	18	18.9	1	25.2	24	32.5	222	8.8	1600
P P6KE20P	P6KE20CP	5	17.1	19	20	22	1	27.7	22	36.1	199	9.0	1500
P6KE20A	P6KE20CA	5	17.1	19	20	21	1	27.7	22	36.1	199	9.0	1500
P6KE22P	P P6KE22CP	5	18.8	20.9	22	24.2	1	30.6	20	39.3	183	9.2	1350
P6KE22A	P6KE22CA	5	18.8	20.9	22	23.1	1	30.6	20	39.3	183	9.2	1350
P6KE24P	P6KE24CP	5	20.5	22.8	24	26.4	1	33.2	18	42.8	168	9.4	1250
P6KE24A	P6KE24CA	5	20.5	22.8	24	25.2	1	33.2	18	42.8	168	9.4	1250
P P6KE27P	P6KE27CP	5	23.1	25.7	27	29.7	1	37.5	16	48.3	149	9.6	1150
P6KE27A	P6KE27CA	5	23.1	25.7	27	28.4	1	37.5	16	48.3	149	9.6	1150
P P6KE30P	P6KE30CP	5	25.6	28.5	30	33	1	41.5	14.5	53.5	134	9.7	1075
P6KE30A	P6KE30CA	5	25.6	28.5	30	31.5	1	41.5	14.5	53.5	134	9.7	1075
P P6KE33P	P P6KE33CP	5	28.2	31.4	33	36.3	1	45.7	13.1	59	122	9.8	1000
P6KE33A	P6KE33CA	5	28.2	31.4	33	34.7	1	45.7	13.1	59	122	9.8	1000
P P6KE36P	P6KE36CP	5	30.8	34.2	36	39.6	1	49.9	12	64.3	112	9.9	950
P6KE36A	P6KE36CA	5	30.8	34.2	36	37.8	1	49.9	12	64.3	112	9.9	950

* Pulse test $t_p \leq 50$ ms $\delta < 2$ %.

** Divide these values by 2 for bidirectional types.

For bidirectional types P6KE6V8CP → 11CA, IRM must be double that specified for unidirectional types.

For bidirectional types, electrical characteristics apply in both directions.

P : Preferred device.

Types		I_{RM} @ V_{RM} max.		$V_{(BR)}$* @ I_R (V)				$V_{(CL)}$ @ I_{pp} max. 1 ms expo		V_{CL} @ I_{pp} max. 8-20 µs expo		α_T max.	C** typ. $V_R=0$ f=1 MHz
Unidirectional	Bidirectional	(µA)	(V)	min.	nom.	max.	(mA)	(V)	(A)	(V)	(A)	(10^{-4}/°C)	(pF)
P P6KE39P	P P6KE39CP	5	33.3	37.1	39	42.9	1	53.9	11.1	69.7	103	10.0	900
P6KE39A	P6KE39CA	5	33 3	37.1	39	41	1	53.9	11.1	69.7	103	10.0	900
P6KE43P	P6KE43CP	5	36.8	40.9	43	47.3	1	59.3	10.1	76.8	94	10.1	850
P6KE43A	P6KE43CA	5	36.8	40.9	43	45.2	1	59.3	10.1	76.8	94	10.1	850
P6KE47P	P P6KE47CP	5	40.2	44.7	47	51.7	1	64.8	9.3	84	86	10.1	800
P6KE47A	P6KE47CA	5	40.2	44.7	47	49.4	1	64.8	9.3	84	86	10.1	800
P P6KE51P	P6KE51CP	5	43.6	48.5	51	56.1	1	70.1	8.6	91	79	10.2	750
P6KE51A	P6KE51CA	5	43.6	48.5	51	53.6	1	70.1	8.6	91	79	10.2	750
P P6KE56P	P6KE56CP	5	47.8	53.2	56	61.6	1	77	7.8	100	72	10.3	700
P6KE56A	P6KE56CA	5	47.8	53.2	56	58.8	1	77	7.8	100	72	10.3	700
P6KE62P	P6KE62CP	5	53	58.9	62	68 2	1	85	7 1	111	65	10.4	650
P6KE62A	P6KE62CA	5	53	58.9	62	65.1	1	85	7.1	111	65	10.4	650
P P6KE68P	P6KE68CP	5	58.1	64.6	68	74.8	1	92	6.5	121	59.5	10.4	625
P6KE68A	P6KE68CA	5	58.1	64.6	68	71.4	1	92	6.5	121	59.5	10.4	625
P6KE75P	P6KE75CP	5	64.1	71.3	75	82.5	1	103	5.8	134	53.5	10.5	575
P6KE75A	P6KE75CA	5	64.1	71.3	75	78.8	1	103	5.8	134	53.5	10.5	575
P P6KE82P	P6KE82CP	5	70.1	77.9	82	90.2	1	113	5.3	146	49	10.5	550
P6KE82A	P6KE82CA	5	70.1	77.9	82	86.1	1	113	5.3	146	49	10.5	550
P6KE91P	P6KE91CP	5	77.8	86.5	91	100	1	125	4.8	162	44.5	10.6	525
P6KE91A	P6KE91CA	5	77.8	86.5	91	95.5	1	125	4.8	162	44.5	10.6	525
P6KE100P	P6KE100CP	5	85.5	95	100	110	1	137	4.4	178	40.5	10.6	500
P6KE100A	P6KE100CA	5	85.5	95	100	105	1	137	4.4	178	40.5	10.6	500
P6KE110P	P6KE110CP	5	94	105	110	121	1	152	3.9	195	37	10.7	470
P6KE110A	P6KE110CA	5	94	105	110	116	1	152	3.9	195	37	10.7	470
P6KE120P	P6KE120CP	5	102	114	120	132	1	165	3.6	212	34	10.7	450
P6KE120A	P6KE120CA	5	102	114	120	126	1	165	3.6	212	34	10.7	450
P P6KE130P	P6KE130CP	5	111	124	130	143	1	179	3.4	230	31.5	10.7	420
P6KE130A	P6KE130CA	5	111	124	130	137	1	179	3.4	230	31.5	10.7	420
P6KE150P	P6KE150CP	5	128	143	150	165	1	207	2.9	265	27.2	10.8	400
P6KE150A	P6KE150CA	5	128	143	150	158	1	207	2.9	265	27.2	10.8	400
P6KE160P	P P6KE160CP	5	136	152	160	176	1	219	2.7	282	25.5	10.8	380
P6KE160A	P6KE160CA	5	136	152	160	168	1	219	2.7	282	25.5	10.8	380
P6KE170P	P6KE170CP	5	145	161	170	187	1	234	2.6	301	24	10.8	370
P6KE170A	P6KE170CA	5	145	161	170	179	1	234	2.6	301	24	10.8	370
P P6KE180P	P6KE180CP	5	154	171	180	198	1	246	2.4	317	22.7	10.8	360
P6KE180A	P6KE180CA	5	154	171	180	189	1	246	2.4	317	22.7	10.8	360
P P6KE200P	P6KE200CP	5	171	190	200	220	1	274	2.2	353	20.4	10.8	350
P6KE200A	P6KE200CA	5	171	190	200	210	1	274	2.2	353	20.4	10.8	350
P6KE220P	P6KE220CP	5	188	209	220	242	1	301	2	388	18.6	10.8	330
P6KE220A	P6KE220CA	5	188	209	220	231	1	301	2	388	18 6	10.8	330
P P6KE250P	P6KE250CP	5	213	237	250	275	1	344	2	442	19	11	310
P6KE250A	P6KE250CA	5	213	237	250	263	1	344	2	442	19	11	310
P6KE280P	P6KE280CP	5	239	266	280	308	1	384	2	494	18	11	300
P6KE280A	P6KE280CA	5	239	266	280	294	1	384	2	494	18	11	300
P6KE300P	P6KE300CP	5	256	285	300	330	1	414	1.6	529	14	11	290
P6KE300A	P6KE300CA	5	256	285	300	315	1	414	1.6	529	14	11	290
P6KE320P	P6KE320CP	5	273	304	320	352	1	438	1.6	564	14	11	280
P6KE320A	P6KE320CA	5	273	304	320	336	1	438	1.6	564	14	11	280
P6KE350P	P6KE350CP	5	299	332	350	385	1	482	1.6	618	14	11	270
P6KE350A	P6KE350CA	5	299	332	350	368	1	482	1.6	618	14	11	270
P P6KE400P	P P6KE400CP	5	342	380	400	440	1	548	1.3	706	11	11	360
P6KE400A	P6KE400CA	5	342	380	400	420	1	548	1.3	706	11	11	360
P P6KE440P	P6KE440CP	5	376	418	440	484	1	603	1.3	776	11	11	350
P6KE440A	P6KE440CA	5	376	418	440	462	1	603	1.3	776	11	11	350

* Pulse test $t_p \leq 50$ ms $\delta < 2$ %.

** Divide these values by 2 for bidirectional types.

For bidirectional types, electrical characteristics apply in both directions.

P : Preferred device.

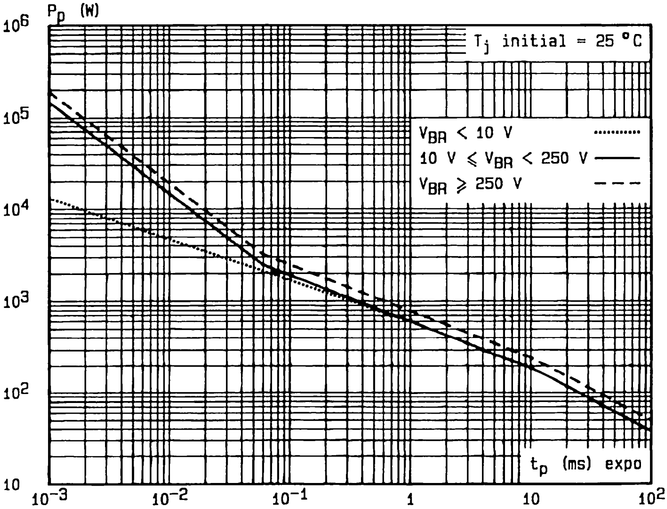


Fig.1 - Peak pulse power versus exponential pulse duration.

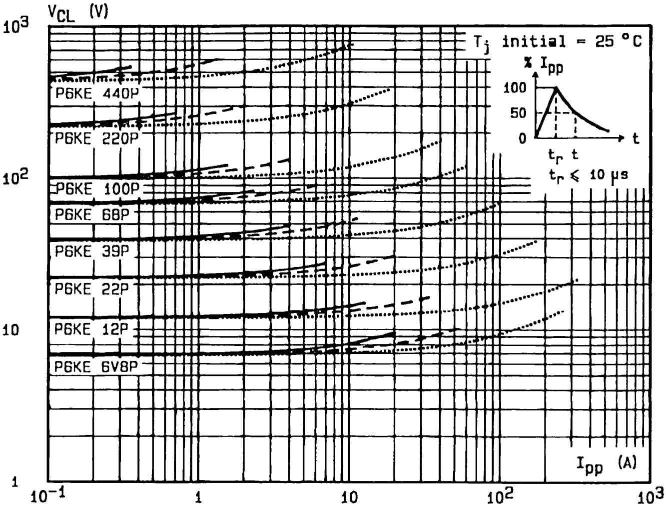


Fig.2 - Clamping voltage versus peak pulse current.
exponential waveform t = 20 µs ....
t = 1 ms – – –
t = 10 ms ——

Note : The curves of the figure 2 are specified for a junction temperature of 25 °C before surge. The given results may be extrapolated for other junction temperatures by using the following formula : $\Delta V_{(BR)} = \alpha_{T\,(V\,(BR))} \times [T_j - 25] \times V_{(BR)}$
For intermediate voltages, extrapolate the given results.

D88P6KEP4

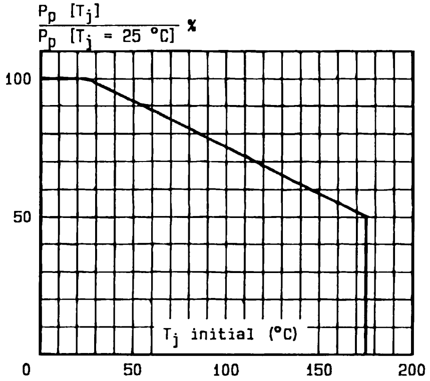


Fig.3 - Allowable power dissipation versus junction temperature.

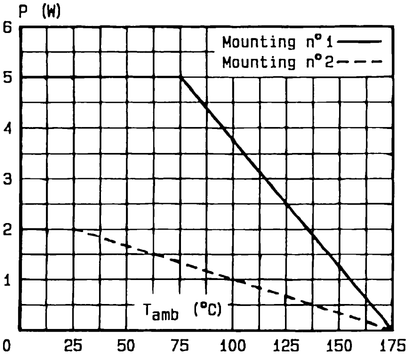


Fig.4 - Power dissipation versus ambient temperature.

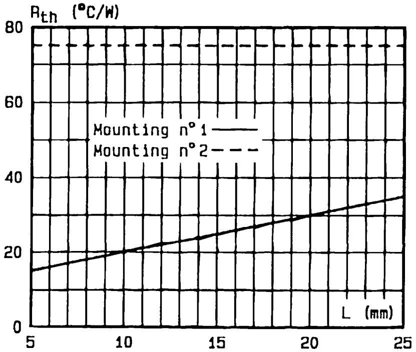
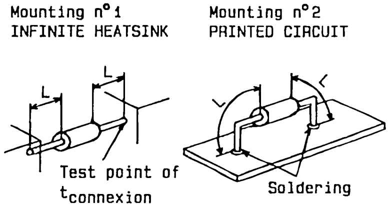


Fig.5 - Thermal resistance versus lead length.



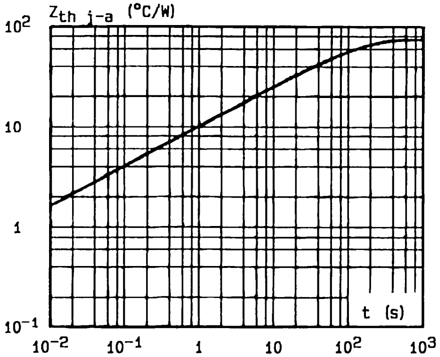


Fig.6 - Transient thermal impedance junction-ambient for mounting n°2 versus pulse duration (L = 10 mm).

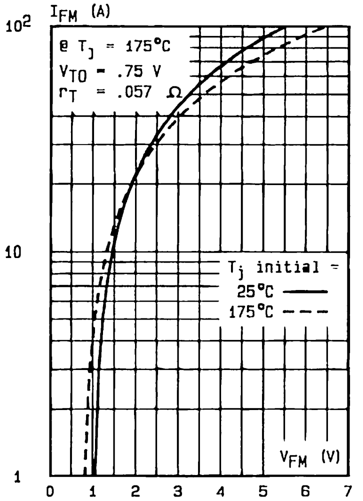


Fig.7 - Peak forward current versus peak forward voltage drop (typical values for unidirectional types).

D88P6KEP5

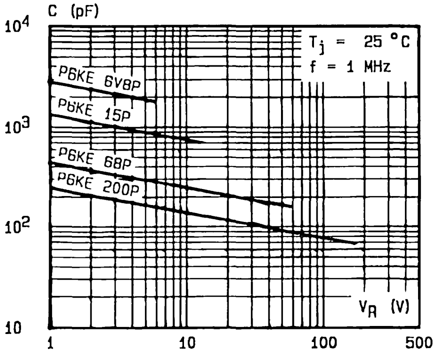


Fig.8a - Capacitance versus reverse applied voltage tor unidirectional types (typical values).

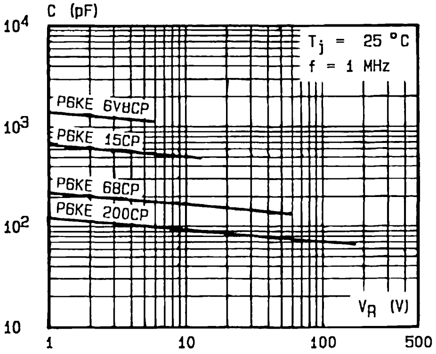
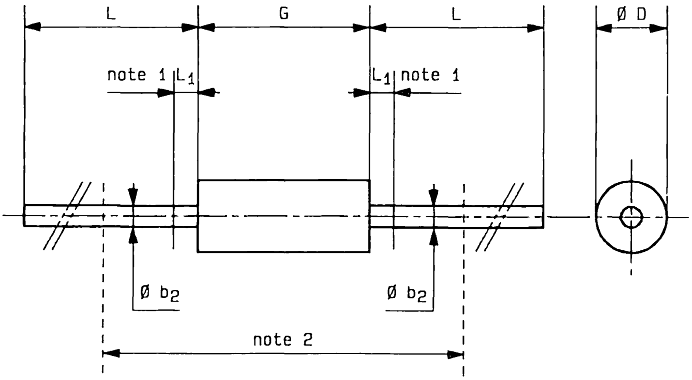


Fig.8b - Capacitance versus reverse applied voltage for bidirectional types (typical values).

D88P6KEP6

PACKAGE MECHANICAL DATA

CB-417 Plastic



Ref.	Millimeters		Inches		Notes
	Min.	Max.	Min.	Max.	
Ø b_2	–	1.092	–	0.043	1 - The lead diameter Ø b_2 is not controlled over zone L_1. 2 - The minimum axial lengh within which the device may be placed with its leads bent at right angles is 0 59" (15 mm).
Ø D	–	3 683	–	0.145	
G	–	8.89	–	0.350	
L	25 4	–	1 000	–	
L_1	–	1.25	–	0.049	

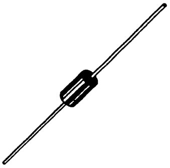
Cooling method : by convection (method A).
Marking : type number ; white band indicates cathode for unidirectional types
Weight : 0.6 g

SGS-THOMSON
MICROELECTRONICS

P7T-10, B → 110, B

UNI-AND BIDIRECTIONAL TRANSIENT VOLTAGE SUPPRESSORS

- HIGH SURGE CAPABILITY :
  700 W / 1 ms EXPO
- VERY FAST CLAMPING TIME :
  1 ps FOR UNIDIRECTIONAL TYPES
  5 ns FOR BIDIRECTIONAL TYPES
- LARGE VOLTAGE RANGE :
  10 V → 110 V
- ORDER CODE :
  TYPE NUMBER FOR UNIDIRECTIONAL TYPES, TYPE NUMBER + SUFFIX B FOR BIDIRECTIONAL TYPES



CB-417
(Plastic)

DESCRIPTION

Transient voltage suppressor diodes especially useful in protecting integrated circuits, MOS, hybrids and other voltage-sensitive semiconductors and components.

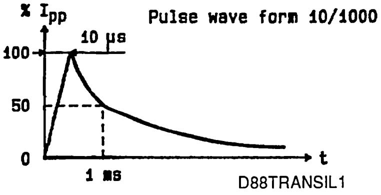
ABSOLUTE RATINGS (limiting values)

Symbol	Parameter		Value	Unit
P_p	Peak Pulse Power for 1 ms Exponential Pulse	T_j Initial = 25 °C See note 1	700	W
P	Power Dissipation on Infinite Heatsink	T_{amb} = 50 °C	5	W
I_{FSM}	Non Repetitive Surge Peak Forward Current for Unidirectional Types	T_j Initial = 25 °C t = 10 ms	120	A
T_{stg} T_j	Storage and Operating Junction Temperature Range		– 55 to 150 150	°C °C
T_L	Maximum Lead Temperature for Soldering During 10 s at 4 mm from Case		230	°C

THERMAL RESISTANCE

Symbol	Parameter	Value	Unit
$R_{th(j-l)}$	Junction-leads on Infinite Heatsink for L_{lead} = 10 mm	20	°C/W

Note : 1. For surges upper than the maximum values, the diode will present a short-circuit anode-cathode.



ELECTRICAL CHARACTERISTICS (T_j = 25 °C)

Symbol	Parameter		Value
V_{RM}	Stand-off Voltage		See tables
$V_{(BR)}$	Breakdown Voltage		
$V_{(CL)}$	Clamping Voltage		
I_{pp}	Peak Pulse Current		
α_T	Temperature Coefficient of $V_{(BR)}$		
C	Capacitance		
$t_{clamping}$	Clamping Time (0 volt to $V_{(BR)}$)	Unidirectional Types	1 ps max.
		Bidirectional Types	5 ns max.

Types		I_{RM} @ V_{RM} max.		$V_{(BR)}$* @ I_R (V)				$V_{(CL)}$ @ I_{pp} max. 1 ms expo		$V_{(CL)}$ @ I_{pp} max. 8-20 µs expo		α_T max.	C** typ. $V_R=0$ f=1 MHz
Unidirectional	Bidirectional	(µA)	(V)	min.	nom.	max.	(mA)	(V)	(A)	(V)	(A)	(10^{-4}/°C)	(pF)
P7T-10	P7T-10B	5	10	13	18	20	5	25	30	32	265	8.4	2600
P7T-27	P7T-27B	5	27	29.6	36	43.5	5	53	13	68	125	9.6	1100
P7T-43	P7T-43B	5	43	50	62	75	5	90	8	115	74	10.3	620
P7T-110	P7T-110B	5	110	130	160	200	5	235	3	300	28	10.8	370

* Pulse test $t_p \leq 50$ ms $\delta < 2$ %.

** Divide these values by 2 for bidirectional types.

For bidirectional types, electrical characteristics apply in both directions.

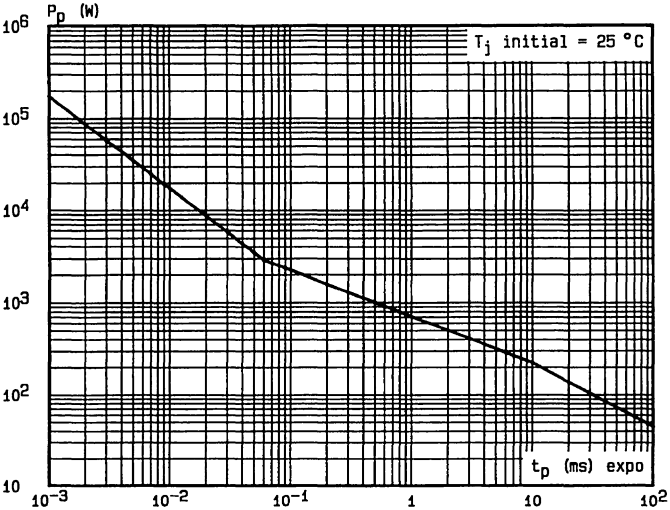


Fig.1 - Peak pulse power versus exponential pulse duration.

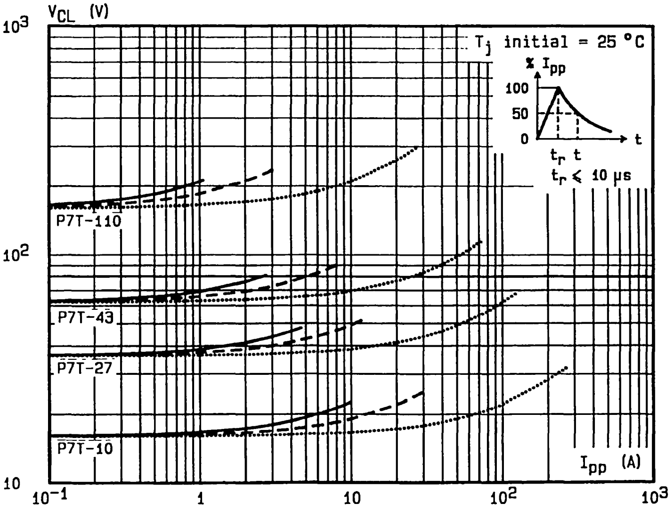


Fig.2 - Clamping voltage versus peak pulse current.
exponential waveform t = 20 µs ··········
t = 1 ms – – –
t = 10 ms ———

Note : The curves of the figure 2 are specified for a junction temperature of 25 °C before surge. The given results may be extrapolated for other junction temperatures by using the following formula : $\Delta V_{(BR)} = \alpha_{T(V(BR))} \times [T_j - 25] \times V_{(BR)}$
For intermediate voltages, extrapolate the given results.

D88P7TP3

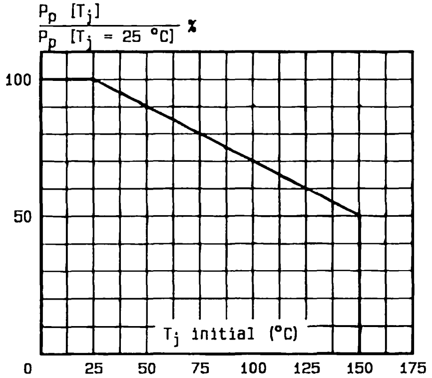


Fig.3 - Allowable power dissipation versus junction temperature.

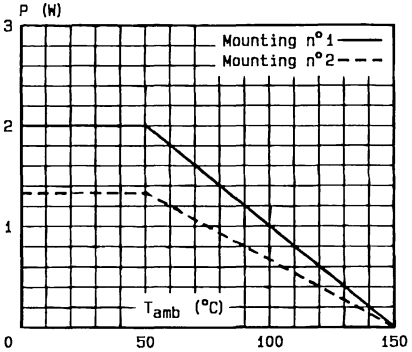


Fig.4 - Power dissipation versus ambient temperature.

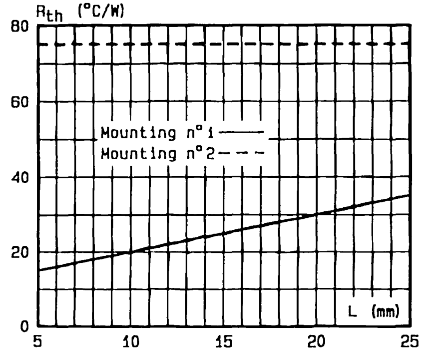
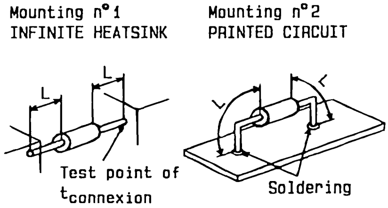


Fig.5 - Thermal resistance versus lead length.



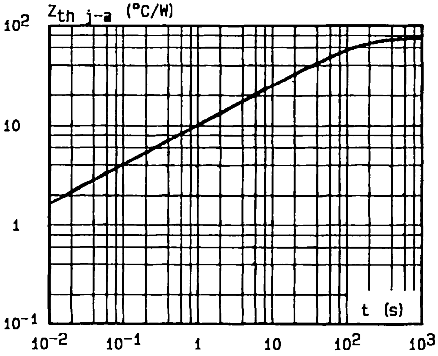


Fig.6 - Transient thermal impedance junction-ambient for mounting n°2 versus pulse duration (L = 10 mm).

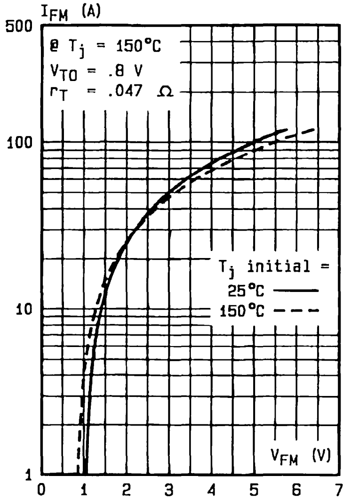


Fig.7 - Peak forward current versus peak forward voltage drop (typical values for unidirectional types).

D88P7TP4

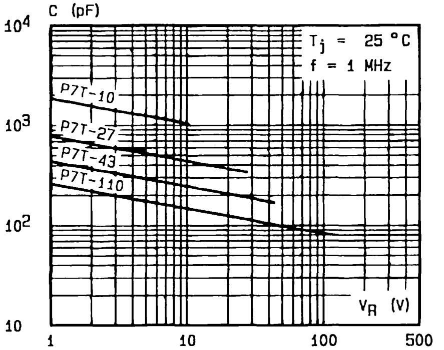


Fig.8a - Capacitance versus reverse applied voltage for unidirectional types (typical values).

D88P7TP5

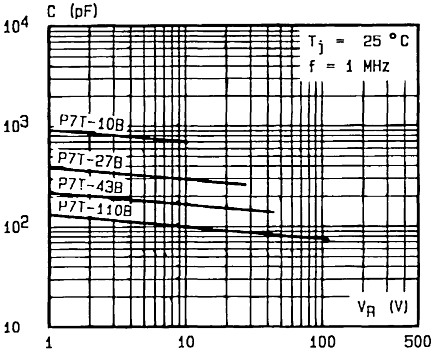
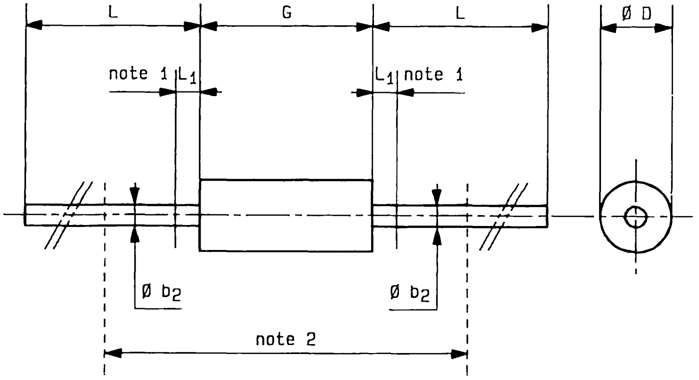


Fig.8b - Capacitance versus reverse applied voltage for bidirectional types (typical values).

PACKAGE MECHANICAL DATA

CB-417 Plastic



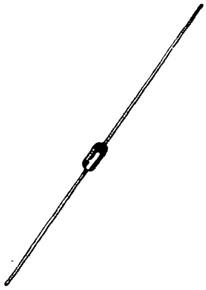
Ref.	Millimeters		Inches		Notes
	Min.	Max.	Min.	Max.	
Ø b_2	–	1.092	–	0.043	1 - The lead diameter Ø b_2 is not controlled over zone L_1. 2 - The minimum axial lengh within which the device may be placed with its leads bent at right angles is 0.59" (15 mm)
Ø D	–	3.683	–	0.145	
G	–	8.89	–	0.350	
L	25 4	–	1.000	–	
L_1	–	1.25	–	0.049	

Cooling method : by convection (method A).
Marking : type number ; white band indicates cathode for unidirectional types.
Weight : 0.6 g.

SGS-THOMSON
MICROELECTRONICS

PL360D

UNIDIRECTIONAL TRANSIENT VOLTAGE SUPPRESSOR



F126
(Plastic)

DESCRIPTION

Transient voltage suppressor diode especially designed for transistor protection in electronic ignition circuit.
Connected accross collector and base it avoids any transistor damage when spark plug is fouled or disconnected.

ABSOLUTE RATINGS (limiting values)

Symbol	Parameter		Value	Unit
P_{tot}	DC Power Dissipation	T_{amb} = 50 °C	1.7	W
I_{ZM}	Continuous Reverse Current	T_{amb} = 50 °C	3.5	mA
P_{RSM}	Non Repetitive Surge Peak Power Dissipation	T_J Initial = 25 °C t = 1 ms	300	W
T_{oper}	Operating Temperature		– 55 to 150	°C
T_{stg} T_J	Storage and Junction Temperature Range		– 55 to 150 150	°C °C
T_L	Maximum Lead Temperature for Soldering During 3 s at 5 mm from Case		300	°C

THERMAL RESISTANCE

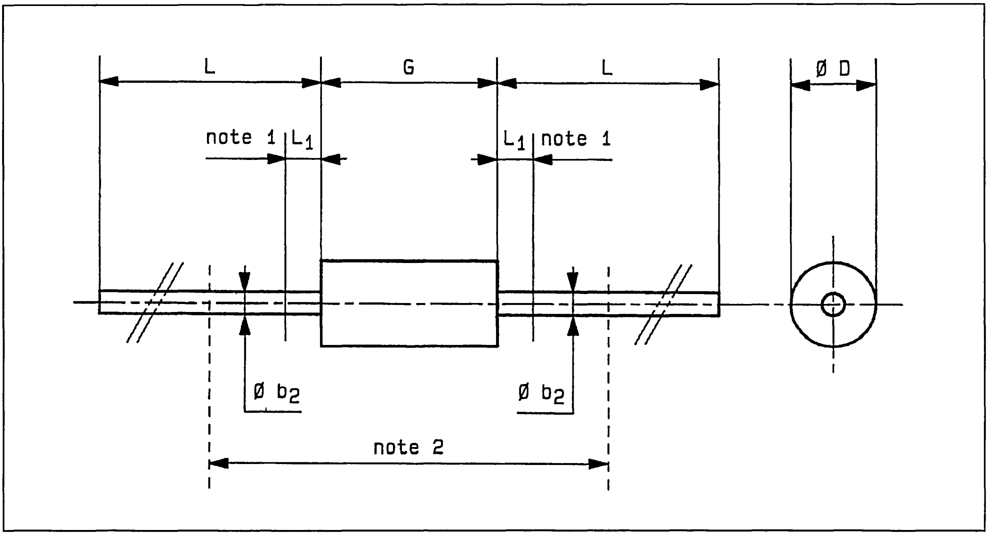
Symbol	Parameter	Value	Unit
$R_{th(j-l)}$	Junction-leads on Infinite Heatsink for L_{lead} = 10 mm	60	°C/W

ELECTRICAL CHARACTERISTICS

Type	V_{BR} @ T_j = 25 °C min.	max.	V_{BR} @ T_j = 120 °C min.	max.	I_R	α_T typ.	I_{RM}/V_{RM} max.	V_{RM}	I_{ZM}
	(V)		(V)		(mA)	(10^{-4}/°C)	(µA)	(V)	(mA)
PL 360 D	330	370	358	416	2	11	0.35	270	3.5

PACKAGE MECHANICAL

F 126 Plastic



Ref.	Millimeters		Inches		Notes
	Min.	Max.	Min.	Max.	
Ø b_2	0.76	0.86	0.029	0.034	1 - The lead diameter Ø b_2 is not controlled over zone L_1. 2 - The minimum axial lengh within which the device may be placed with its leads bent at right angles is 0.59" (15 mm).
Ø D	2.95	3.05	0.116	0.120	
G	6.05	6.35	0.238	0.250	
L	26	–	1.024	–	
L_1	–	1.27	–	0.050	

Cooling method : by convection (method A).
Marking : type number ; white band indicates cathode.
Weight : 0.4 g.

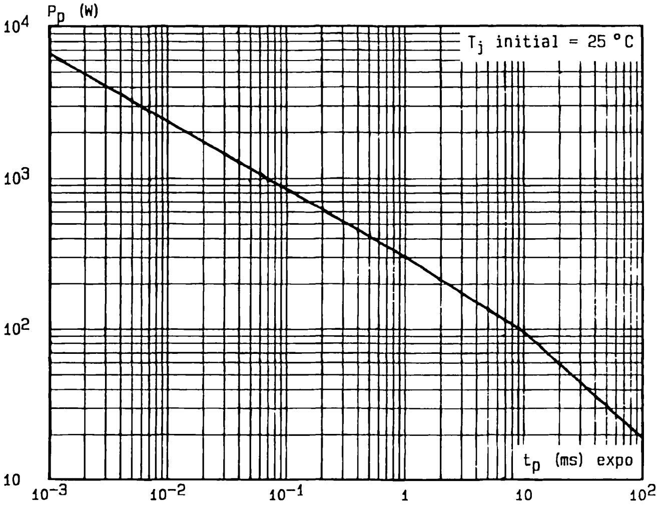


Fig.1 - Peak pulse power versus exponential pulse duration.

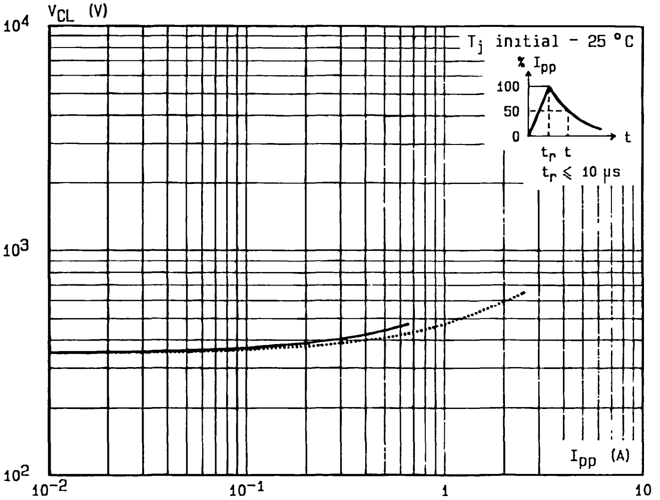


Fig.2 - Clamping voltage versus peak pulse current
exponential waveform t = 20 µs ··········
t = 1 ms ———

Note : The curves of the figure 2 are specified for a junction temperature of 25 °C before surge. The given results may be extrapolated for other junction temperatures by using the following formula : $\Delta V_{(BR)} = \alpha_{T(V(BR))} \times [T_j - 25] \times V_{(BR)}$
For intermediate voltages, extrapolate the given results.

D89PL360DP3

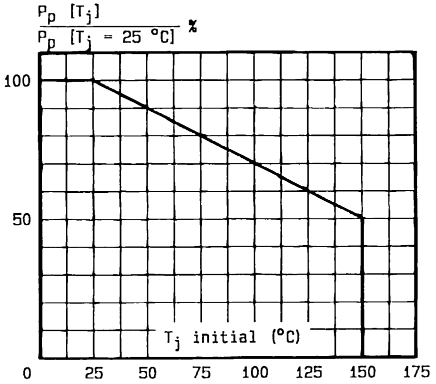


Fig.3 - Allowable power dissipation versus junction temperature.

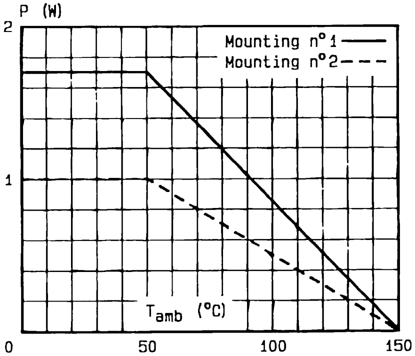


Fig.4 - Power dissipation versus ambient temperature.

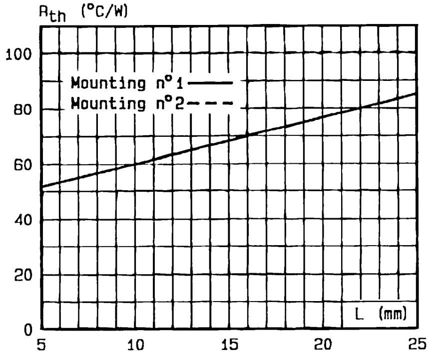
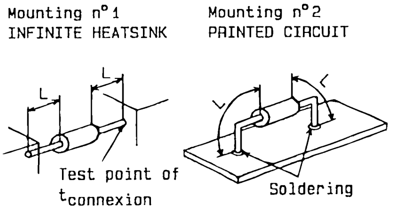


Fig.5 - Thermal resistance versus lead length.



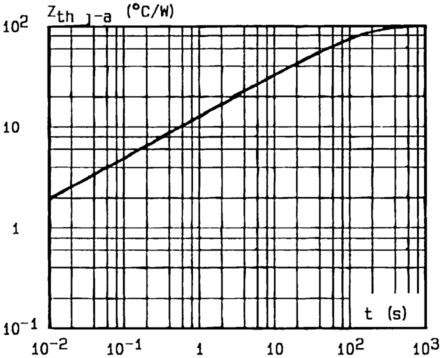


Fig.6 - Transient thermal impedance junction-ambient for mounting n°2 versus pulse duration (L = 10 mm).

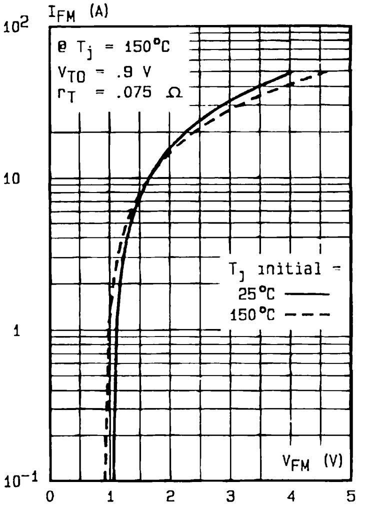


Fig.7 - Peak forward current versus peak forward voltage drop (typical values for unidirectional types).

DB9PL360DP4

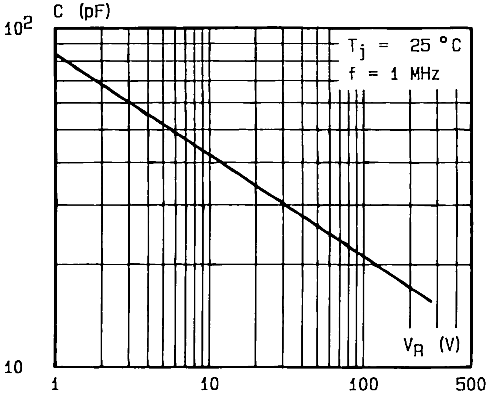


Fig.8 - Capacitance versus reverse aplied voltage (typical values).

D89PL360DP5

SGS-THOMSON
MICROELECTRONICS

TH6P04T6V5CL
TH6P04T25CL

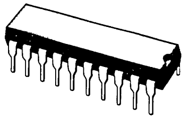
TRANSIL ARRAY FOR DATA LINE PROTECTION

DESCRIPTION

Developed specially for data line protection at the PC Board Level, the component offers 8 protective Bidirectionnal devices with common bus connections per package.

In addition to the parallel protection given by the Transils ®, the pin-die connection wires provide a serie protection in case of short circuit on the line. Therefore this device is a feature of 8 serie/parallel protection elements.

The dual in line design allows compatible packaging for microprocessors, memories and controllers.



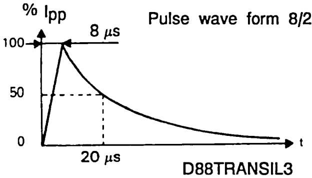
DIP-20
(Plastic)

ABSOLUTE RATINGS (limiting values) (0°C ≤ T_{amb} ≤ 70 °C)

Symbol	Parameter		Value	Unit
I_{pp}	Peak Pulse Power for 8.20 µs Exponential Pulse	See note 1	40	A
I^2t	Wire I^2t Value	See note 1	0.6	A^2s
ESD	Electrostatic Overstress	See note 2	25	kV
T_{stg} T_j	Storage and Junction Temperature Range		– 55 to 150 125	°C °

Notes : 1. For surges upper than the maximum value specified, the input/output will present first a short circuit to the common bus line and after an open circuit caused by the wire

2. According to MIL STD 883C method 3015-2



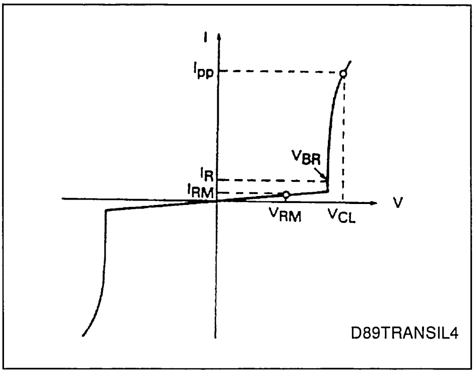
Pulse wave form 8/20 µS

D88TRANSIL3

ELECTRICAL CHARACTERISTICS

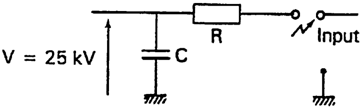
0 °C ≤ $T_{amb} = T_j$ ≤ 70 °C

Symbol	Parameter
V_{RM}	Stand-off Voltage
V_{BR}	Breakdown Voltage
V_{CL}	Clamping Voltage
I_{RM}	Leakage Current @ V_{RM}
I_{pp}	Surge Current
C	Input Capacitance



Symbol	Test Conditions	Types	Min.	Typ.	Max.	Unit
V_{BR}	I_R = ± 1 mA	TH6P04T6V5CL	± 6.5			V
		TH6P04T25CL	± 25			
I_{RM}	V_{RM} = ± 6 V	TH6P04T6V5CL			± 50	µA
	V_{RM} = ± 24 V	TH6P04T25CL			± 10	
C1	Each Input Pin to Ground at 0 V Bias	TH6P04T6V5CL			700	pF
		TH6P04T25CL			500	
C2	Each Input Pin to Ground at 5 V Bias	TH6P04T6V5CL			500	pF
		TH6P04T25CL			300	
$V_{CL}1$	I_{pp} = 40 A 8-20 µs to all Inputs Sequentially (see note 1)	TH6P04T6V5CL			± 12	V
		TH6P04T25CL			± 38	
$V_{CL}2$	8-20 µs Simultaneously 80 A peak pulse current to all inputs with a 10 Ω resistor in serie. (see note 1)	TH6P04T6V5CL			± 12	V
		TH6P04T25CL			± 35	
$V_{CL}3$	25 kV ESD Overstress (see notes 1-2)	TH6P04T6V5CL			± 12	V
		TH6P04T25CL			± 35	

Notes : 1 V_{CL} mesured on outputs.
2 According to MIL STD 883C method 3015-2.
C = 150 pF R = 150 Ω F = 10 Hz Exposure = 5 secs



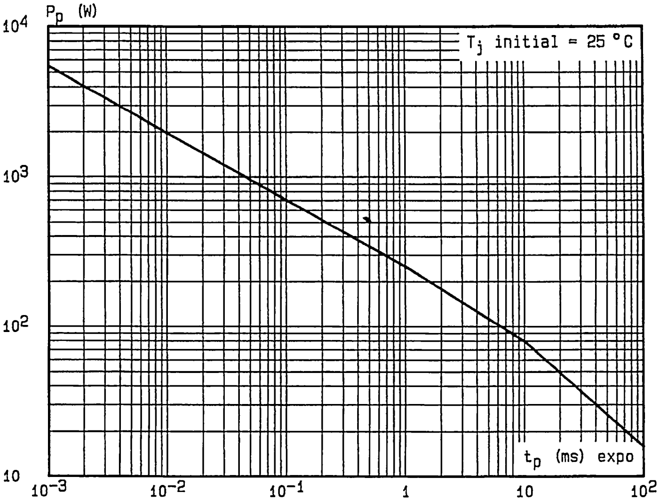


Fig.1 - Peak pulse power versus exponential pulse duration.

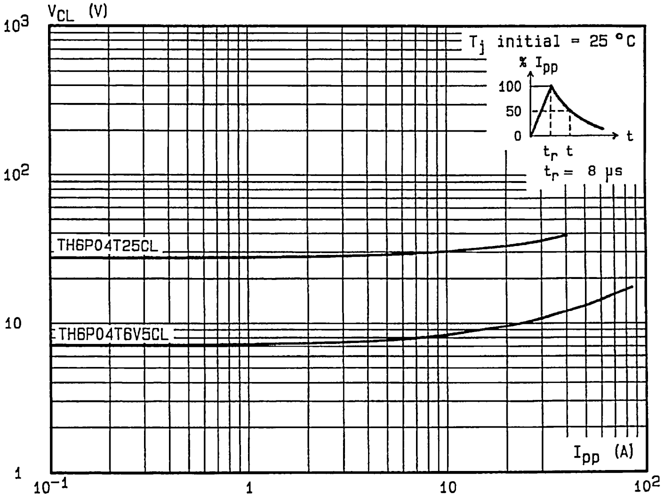


Fig.2 - Clamping voltage versus peak pulse current
exponential waveform t = 20 µs.

Note : The curves of the figure 2 are specified for a junction temperature of 25 °C before surge. The given results may be extrapolated for other junction temperatures by using the following formula : $\Delta V_{(BR)} = \alpha_{T(V(BR))} \times [T_j - 25] \times V_{(BR)}$
For intermediate voltages, extrapolate the given results.

D89TH6P04TP3

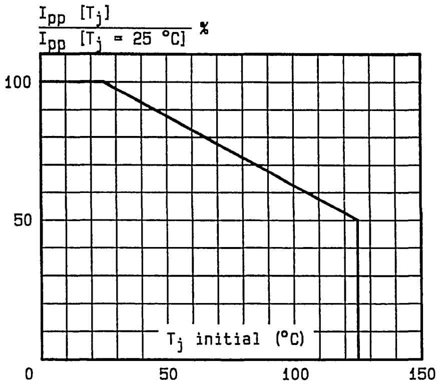


Fig.3 - Allowable peak pulse current versus junction temperature.

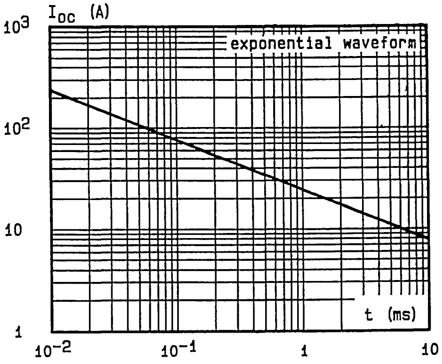


Fig.4 - Peak current I_{oc} inducing open circuit of the wire for one input/output versus pulse duration (typical values).

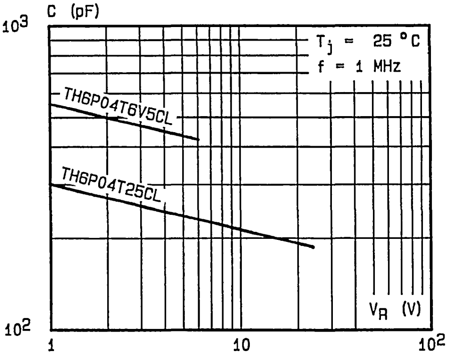


Fig.5 - Junction capacitance versus reverse applied voltage for one input/output (typical values).

D89TH6P04TP4

ORDER CODE

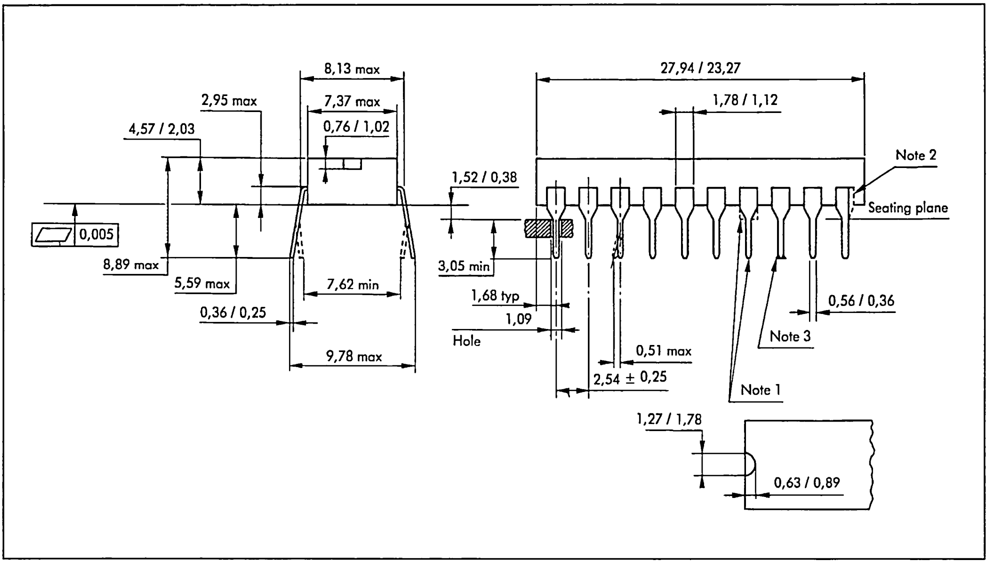
TH 6 P 04 T 25 C L

Working temperature : 0 to 70°C
20 pin DIL
C : Bidirectional
P : Plastic
Breakdown voltage
Peak pulse current 04 : 40 A
T : Transil

D89TH6P04T-2

PACKAGE MECHANICAL DATA

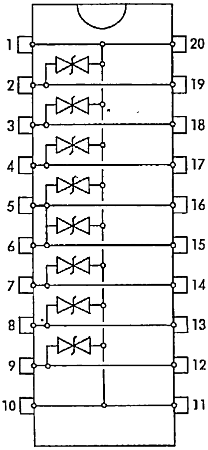
DIP-20 Plastic



Notes : 1. Tapered leads are strongly preferred Squared off is acceptable.
2. Half shoulders are acceptable on four end leads only.
3. On blunt tips, allowable burr or spur is .003 in max on either sude of lead.

Packaging : Products supplied in antistatic tubes. Each tubes contains 18 products.

FUNCTIONNAL DIAGRAM



Pinout configuration :
1 - 20 - 10 - 11 : GND
2 → 19 : Inputs/outputs

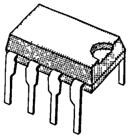
TRISIL DATASHEETS

SGS-THOMSON
MICROELECTRONICS

L3100B
L3100B1

TRISIL
UNIDIRECTIONAL PROGRAMMABLE VOLTAGE AND CURRENT SUPPRESSOR

- HIGH CURRENT CAPABILITY
- PROGRAMMABILITY BOTH IN VOLTAGE AND CURRENT
- AUTOMATIC RECOVERY



Minidip
(Plastic)

DESCRIPTION

The L3100B/B1 is a transient overvoltage suppressor/overcurrent arrester designed to protect sensitive components in electronic telephones and telecommunication equipments against transients caused by lightning, induction from power lines, etc.

The L3100B/B1 characteristic, that is its firing voltage and current, can be easily programmed by means of inexpensive external components ; more over, since this device recoveres automatically when the surge current falls below a fixed holding current, it may be used on remotely supplied lines. Finally, if destroyed, it becomes a permanent short circuit.

ABSOLUTE RATINGS (limiting values) (T_j = 25 °C)

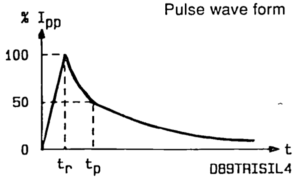
Symbol	Parameter		Value	Unit
I_{pp}	Peak Pulse Current	1 ms expo	150	A
		8-20 µs expo*	250	
I_{TSM}	Non Repetitive Surge Peak on-state Current	t_p = 10 ms – Sinus	50	A
di/dt	Critical Rate of Rise of on-state Current	Non repetitive	100	A/µs
T_{stg} T_j	Storage and Junction Temperature Range		– 40 to 150 150	°C °C

THERMAL RESISTANCE

Symbol	Parameter	Value	Unit
$R_{th(j-a)}$	Junction to Ambient	80	°C/W

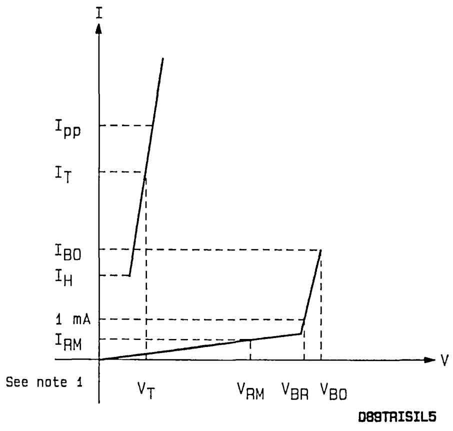
* ANSI STD C62.

Pulse wave form



ELECTRICAL CHARACTERISTICS
(T_j = 25 °C)

Symbol	Parameter
V_{RM}	Stand-off Voltage
V_{BR}	Breakdown Voltage
V_{BO}	Clamping Voltage
I_H	Holding Current
V_T	On-state Voltage @ I_T
I_{BO}	Breakover Current
I_{pp}	Peak-pulse Current
V_{GN}	Gate Voltage
I_{GN}	Firing Gate N Current
V_{RGN}	Reverse Gate N Voltage
I_{GP}	Firing Gate P Current



OPERATION WITHOUT GATE

Type	I_{RM} @ V_{RM} max.		V_{BR} min.	max.	@ I_R	V_{BO}@ max.	I_{BO} min.	max. See note 2	I_H min.	V_T typ. I_T = 1 A	C max. V_R = 5 V F = 1 MHz
	(µA)	(V)	(V)	(V)	(mA)	(V)	(mA)	(mA)	(mA)	(V)	(pF)
L3100B/B1	6 40	60 250	255 (3) 265 (4)		1	350	200	500	210 (3) 280 (4)	2	100

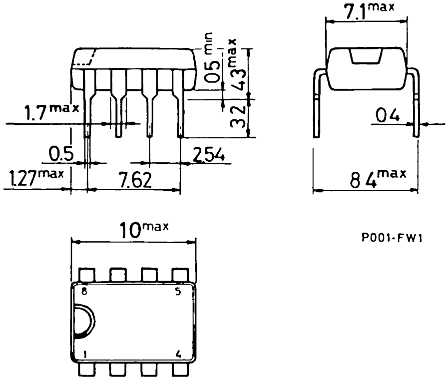
OPERATION WITH GATES

Type	V_{GN} (V) I_G = 200 mA		I_{GN} (mA) $V_A - C$ = 100 V		V_{RGN} (V) I_G = – 1 mA		I_{GP} (mA) $V_A - C$ = 100 V	
	min.	max.	min.	max.	min.	max.	min.	max.
L3100B/B1	0.6	1.8	30	200	0.7			150

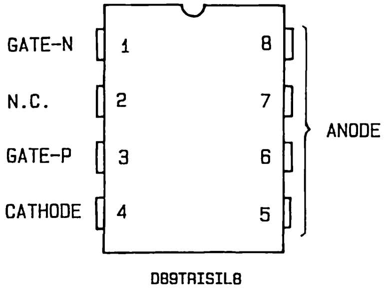
Notes : 1. Reverse characteristic : I_R < 1 mA @ V_R = 0.7V.
2. These devices are not designed to function as zeners ; continuous operation between 1 mA and I_{BO} will damage them.
3. L3100B1
4. L3100B

PACKAGE MECHANICAL DATA

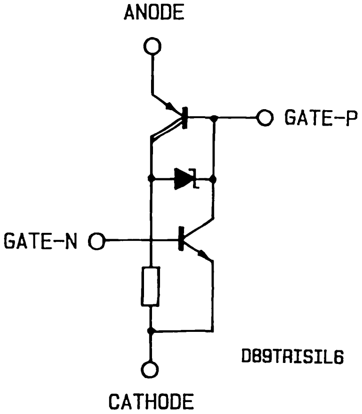
MINIDIP Plastic



CONNECTION DIAGRAM



SCHEMATIC DIAGRAM



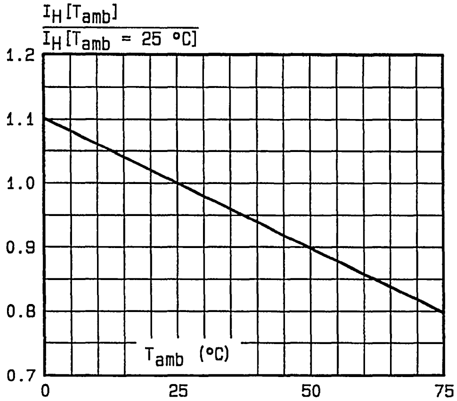


Fig.1 - Relative variation of holding current versus ambient temperature.

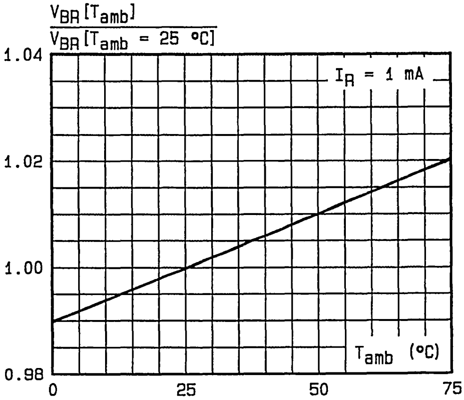


Fig.2 - Relative variation of breakdown voltage versus ambient temperature.

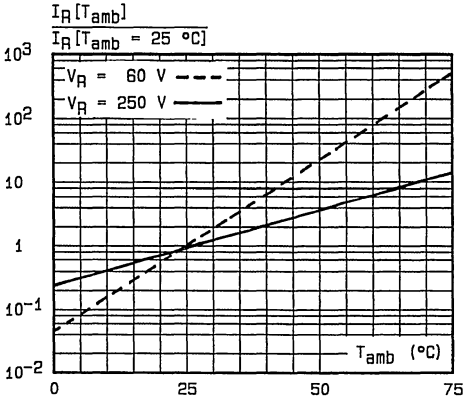


Fig.3 - Relative variation of leakage current versus ambient temperature.

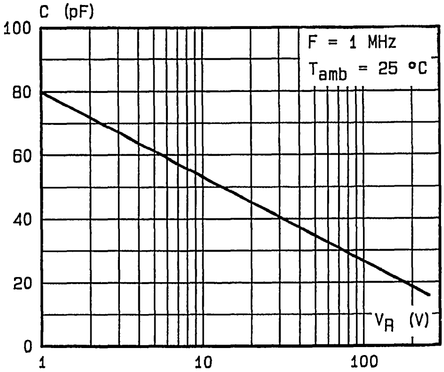


Fig.4 - Junction capacitance versus reverse applied voltage.

D89L3100B1P4

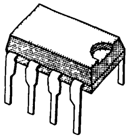
SGS-THOMSON
MICROELECTRONICS

L3101B

TRISIL

UNIDIRECTIONAL PROGRAMMABLE VOLTAGE AND CURRENT SUPPRESSOR

- HIGH CURRENT CAPABILITY
- PROGRAMMABILITY BOTH IN VOLTAGE AND CURRENT
- AUTOMATIC RECOVERY



Minidip
(Plastic)

DESCRIPTION

The L3101B is a transient overvoltage suppressor/overcurrent arrester designed to protect sensitive components in electronic telephones and telecommunication equipments against transients caused by lightning, induction from power lines, etc.

The L3101B characteristic, that is its firing voltage and current, can be easily programmed by means of inexpensive external components ; more over, since this device recoveres automatically when the surge current falls below a fixed holding current, it may be used on remotely supplied lines. Finally, if destroyed, it becomes a permanent short circuit.

ABSOLUTE RATINGS (limiting values) (T_j = 25 °C)

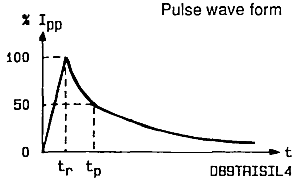
Symbol	Parameter		Value	Unit
I_{pp}	Peak Pulse Current	1 ms expo	150	A
		8-20 µs expo*	250	
I_{TSM}	Non Repetitive Surge Peak on-state Current	t_p = 10 ms – Sinus	50	A
di/dt	Critical Rate of Rise of on-state Current	Non repetitive	100	A/µs
T_{stg} T_j	Storage and Junction Temperature Range		– 40 to 150 150	°C °C

THERMAL RESISTANCE

Symbol	Parameter	Value	Unit
$R_{th(j-a)}$	Junction to Ambient	80	°C/W

* ANSI STD C62.

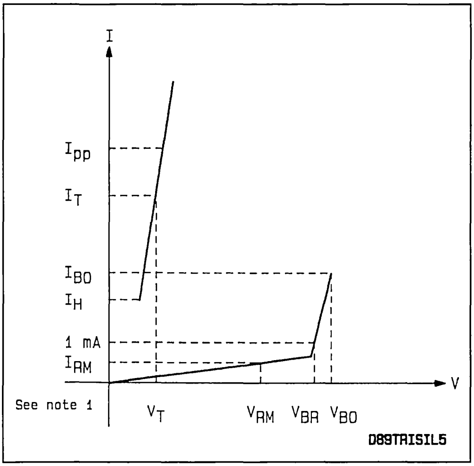
Pulse wave form



ELECTRICAL CHARACTERISTICS

(T_j = 25 °C)

Symbol	Parameter
V_{RM}	Stand-off Voltage
V_{BR}	Breakdown Voltage
V_{BO}	Clamping Voltage
I_H	Holding Current
V_T	On-state Voltage @ I_T
I_{BO}	Breakover Current
I_{pp}	Peak-pulse Current
V_G	Gate Voltage
I_{GN}	Firing Gate N Current
I_{GP}	Firing Gate P Current



OPERATION WITHOUT GATE

Type	I_{RM} @ V_{RM} max.		V_{BR} min.	max.	@ I_R	V_{BO}@ max.	I_{BO} typ.	max. See note 2	I_H min.	V_T typ. I_T = 1 A	C max. V_R = 5 V F = 1 MHz
	(µA)	(V)	(V)	(V)	(mA)	(V)	(mA)	(mA)	(mA)	(V)	(pF)
L3101B	5 8	60 90	100		1	180	200	500	150	2	200

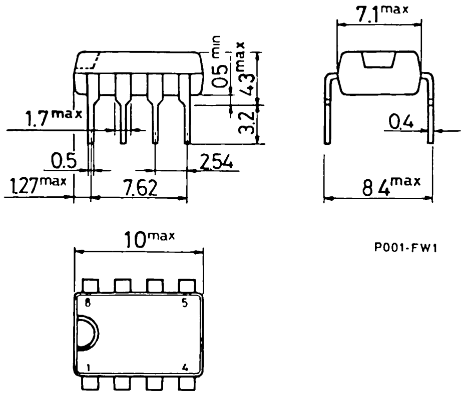
OPERATION WITH GATES

Type	V_G (V) I_G = 200 mA		I_{GN} (mA) $V_A - C$ = 60 V		I_{GP} (mA) $V_A - C$ = 60 V	
	min.	max.	min.	max.	min.	max.
L3101B	0.6	1.8	30	200		180

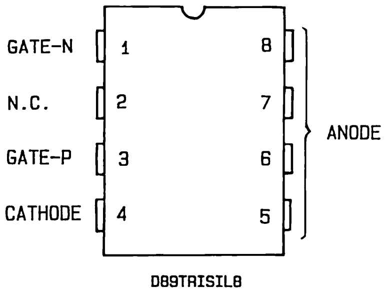
Notes : 1. Reverse characteristic non specified.
2. These devices are not designed to function as zeners ; continuous operation between 1 mA and I_{BO} will damage then.

PACKAGE MECHANICAL DATA

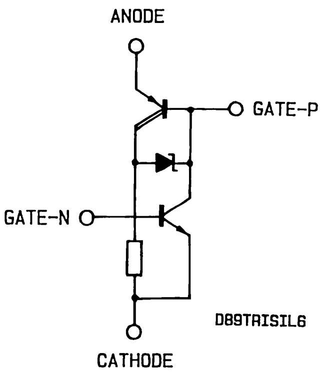
MINIDIP Plastic



CONNECTION DIAGRAM



SCHEMATIC DIAGRAM



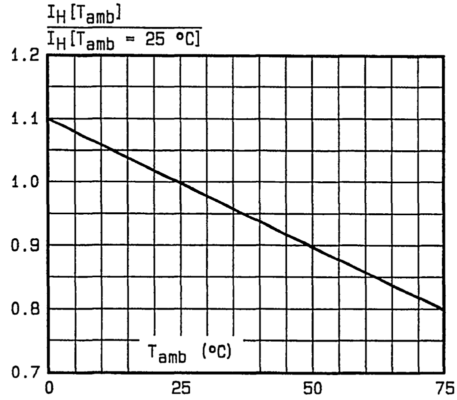


Fig.1 - Relative variation of holding current versus ambient temperature.

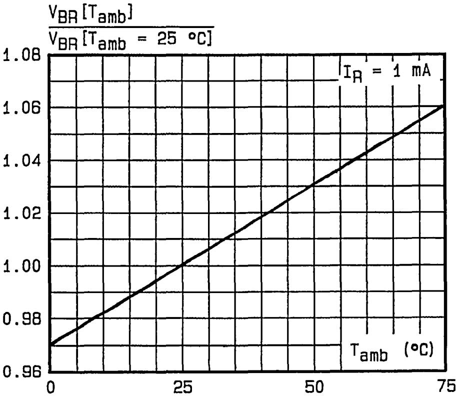


Fig.2 - Relative variation of breakdown voltage versus ambient temperature.

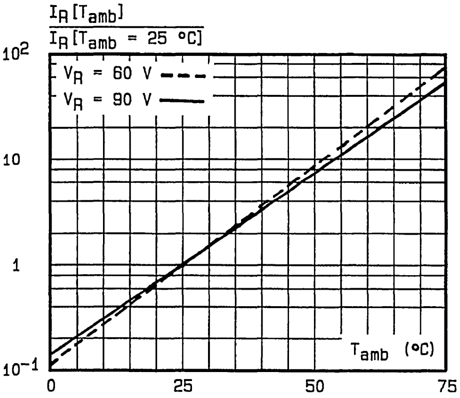


Fig.3 - Relative variation of leakage current versus ambient temperature.

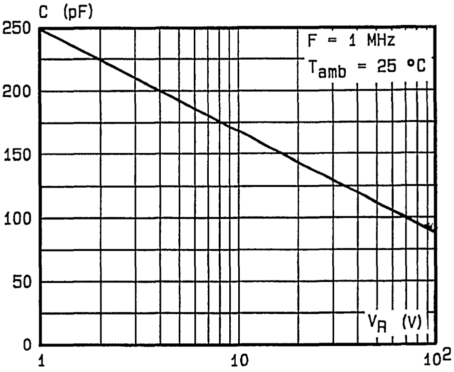


Fig.4 - Junction capacitance versus reverse applied voltage.

D89L3101BP4

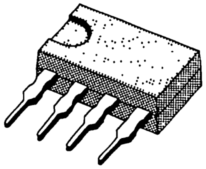
SGS-THOMSON
MICROELECTRONICS

L3121B

TRISIL

BIDIRECTIONAL PROGRAMMABLE VOLTAGE AND CURRENT SUPPRESSOR

- HIGH CURRENT CAPABILITY
- PROGRAMMABILITY BOTH IN VOLTAGE AND CURRENT
- AUTOMATIC RECOVERY



SIP-4
(Plastic)

DESCRIPTION

The L3121B is a bidirectional transient overvoltage/overcurrent protections derived from the programmable L3101B to provide full feature protection for the subscriber line interface.

Full programmability is allowed through access to the triggering gate available on the chips. The L3121B protects the line to ground either against positive or negative transients with external and independent adjustment of the threshold voltages (zener or external battery) in the two directions.

ABSOLUTE RATINGS (limiting values) (T_j = 25 °C)

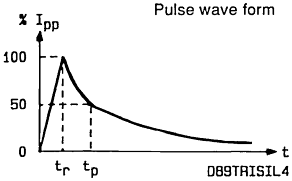
Symbol	Parameter		Value	Unit
I_{pp}	Peak Pulse Current	1 ms expo	150	A
		8-20 µs expo*	250	
I_{TSM}	Non Repetitive Surge Peak on-state Current	t_p = 10 ms Sinus	50	A
di/dt	Critical Rate of Rise of on-state Current	Non repetitive	100	A/µs
T_{stg} T_j	Storage and Junction Temperature Range		– 40 to 150 150	°C °C

THERMAL RESISTANCE

Symbol	Parameter	Value	Unit
$R_{th(j-a)}$	Junction to Ambient	80	°C/W

* ANSI STD C62

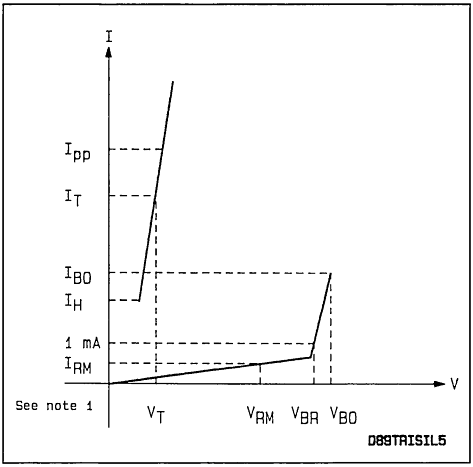
Pulse wave form



ELECTRICAL CHARACTERISTICS

(T_j = 25 °C)

Symbol	Parameter
V_{RM}	Stand-off Voltage
V_{BR}	Breakdown Voltage
V_{BO}	Clamping Voltage
I_H	Holding Current
V_T	On-state Voltage @ I_T
I_{BO}	Breakover Current
I_{pp}	Peak-pulse Current
V_G	Gate Voltage
I_{GN}	Firing Gate N Current
I_{GP}	Firing Gate P Current



OPERATION WITHOUT GATE

Type	I_{RM} @ V_{RM} max.		V_{BR} min. max. @ I_R			V_{BO} @ I_{BO} max. typ. max. See note 2			I_H min.	V_T typ. I_T = 1 A	C max. V_R = 5 V F = 1 MHz
	(µA)	(V)	(V)	(V)	(mA)	(V)	(mA)	(mA)	(mA)	(V)	(pF)
L3121B	5 8	60 90	100		1	180	200	500	150	2	200

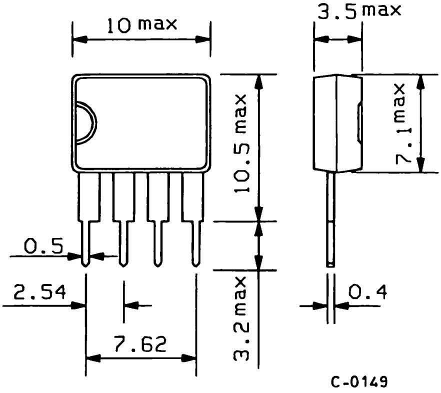
OPERATION WITH GATES

Type	V_G (V) I_G = 200 mA		I_{GN} (mA) $V_A - C$ = 60 V		I_{GP} (mA) $V_A - C$ = 60 V	
	min.	max.	min.	max.	min.	max.
L3121B	0.6	1.8	80	200		180

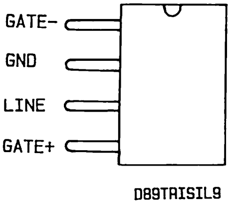
Notes : 1. Same characteristic both sides
2. These devices are not designed to function as zeners ; continuous operation between 1 mA and I_{BO} will damage then.

PACKAGE MECHANICAL DATA

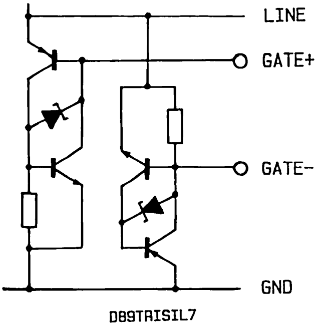
SIP-4 Plastic



CONNECTION DIAGRAM



SCHEMATIC DIAGRAM



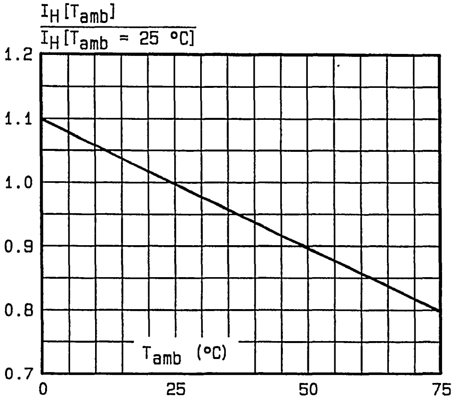


Fig.1 - Relative variation of holding current versus ambient temperature.

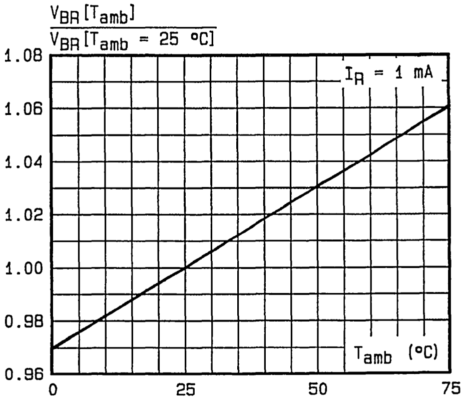


Fig.2 - Relative variation of breakdown voltage versus ambient temperature.

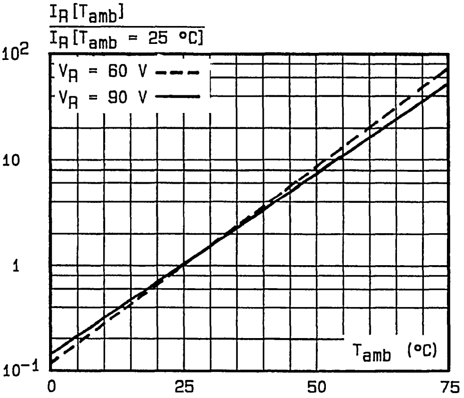


Fig.3 - Relative variation of leakage current versus ambient temperature.

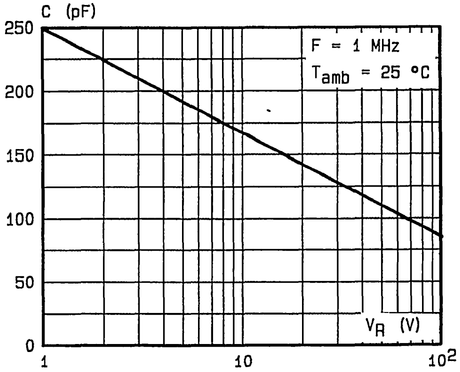


Fig.4 - Junction capacitance versus reverse applied voltage.

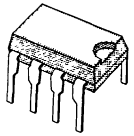
D89L3121BP4

SGS-THOMSON
MICROELECTRONICS

LS5018B/LS5060B
LS5120B/LS5120B1

BIDIRECTIONAL TRISIL

- CHARACTERISTIC OF STAND-OFF AND BREAKDOWN VOLTAGE SIMILAR TO A TRANSIL (V_{off})
- HIGH FLOWOUT CAPABILITY BECAUSE OF ITS BREAKOVER CHARACTERISTICS (V_{on})
- AUTOMATIC RECOVERY AFTER SURGE



Minidip
(Plastic)

DESCRIPTION

The LS5018B, LS5060B and LS5120B/B1 are bidirectional transient overvoltage suppressor designed to protect sensitive components in electronic telephones and telecommunication equipments against transient caused by lightning, induction from power lines, etc.

ABSOLUTE RATINGS (limiting values) (T_j = 25 °C)

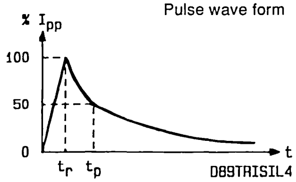
Symbol	Parameter		Value	Unit
I_{pp}	Peak Pulse Current	1 ms expo	100	A
		8-20 µs expo*	500	
I_{TSM}	Non Repetitive Surge Peak on-state Current	t_p = 20 ms – Sinus	50	A
di/dt	Critical Rate of Rise of on-state Current	Non repetitive	100	A/µs
T_{stg} T_j	Storage and Junction Temperature Range		– 40 to 150 150	°C °C

THERMAL RESISTANCE

Symbol	Parameter	Value	Unit
$R_{th(j-a)}$	Junction to Ambient	80	°C/W

* ANSI STD C62.

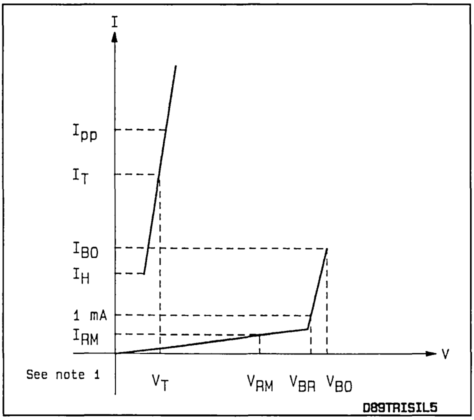
Pulse wave form



ELECTRICAL CHARACTERISTICS

(T_j = 25 °C)

Symbol	Parameter
V_{RM}	Stand-off Voltage
V_{BR}	Breakdown Voltage
V_{BO}	Clamping Voltage
I_H	Holding Current
V_T	On-state Voltage @ I_T
I_{BO}	Breakover Current
I_{pp}	Peak-pulse Current



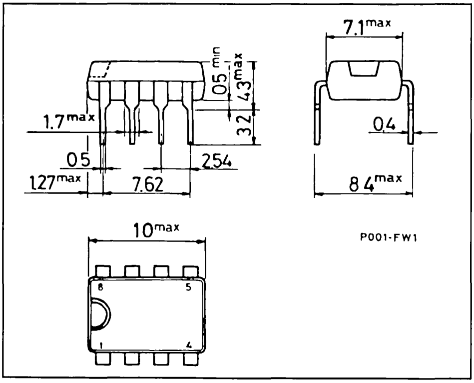
See note 1

Type	I_{RM} @ V_{RM} max.		$V_{(BR)}$ @ I_R min.		V_{BO} @ max.	I_{BO} min.	typ.	max. See note 2	I_H min.	V_T typ. I_T = 1 A	C max. V_R = 5 V F = 1 MHz
	(µA)	(V)	(V)	(mA)	(V)	(mA)	(mA)	(mA)	(mA)	(V)	(pF)
LS5018B	5	16	17	1	22		1300		200	2	150
LS5060B	10	50	60	1	85		1000		200	2	150
LS5120B	20	100	120	1	180	500		1250	250	2	150
LS5120B1	20	100	120	1	180	500		1250	200	2	150

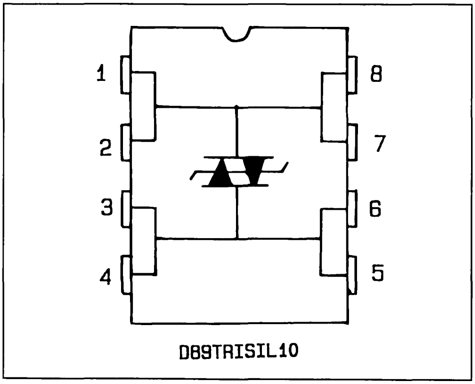
Notes : 1. Same characteristic both sides.
2 These devices are not designed to function as zeners , continuous operation between 1 mA and I_{BO} will damage them.

PACKAGE MECHANICAL DATA

MINIDIP Plastic



CONNECTION DIAGRAM



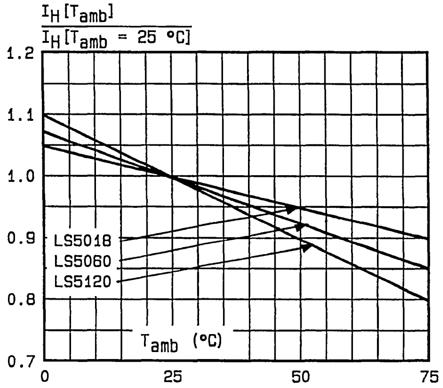


Fig.1 - Relative variation of holding current versus ambient temperature.

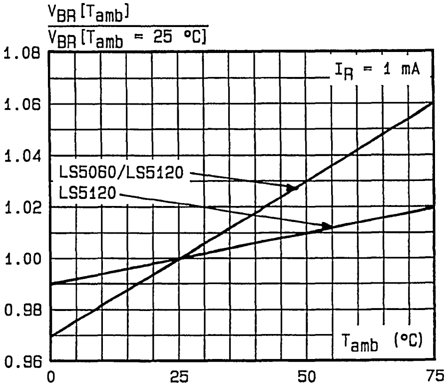


Fig.2 - Relative variation of breakdown voltage versus ambient temperature.

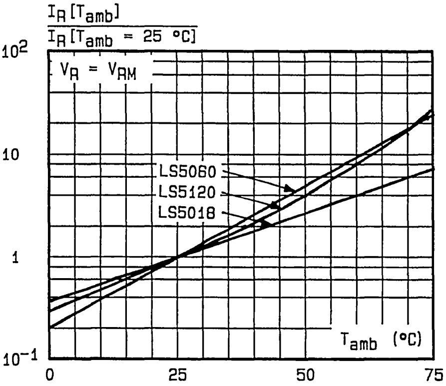


Fig.3 - Relative variation of leakage current versus ambient temperature.

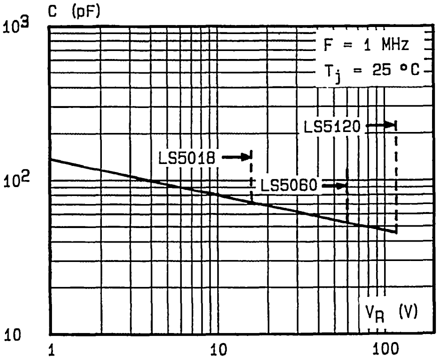


Fig.4 - Junction capacitance versus reverse applied voltage.

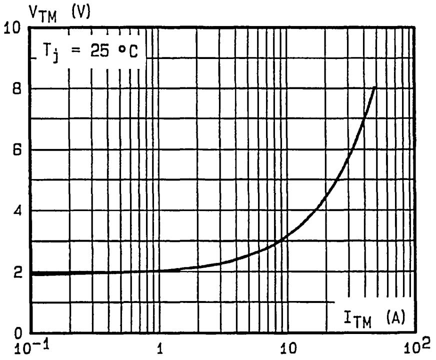


Fig.5 - On-state voltage versus on-state current (typical values).

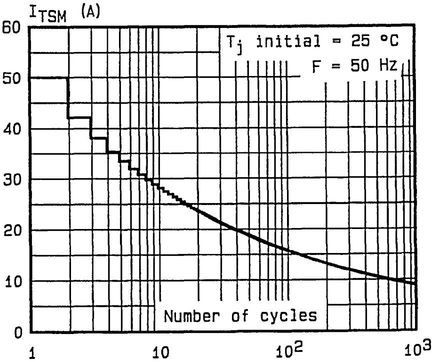


Fig.6 - Non repetitive surge peak on-state current versus number of cycles.

THBT 200 D

TRISIL

DESCRIPTION

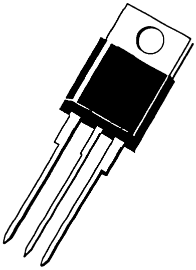
This protection device has been especially designed for subscriber line-card and terminal protection. By itself, it enables to protect integrated SLIC against transient overvoltages. A diode clips positive overloads and breakover device negative overloads.

Its ion-implanted technology confers excellent electrical characteristics on it.

This is why this THBT 200 D easily corresponds to the main protection standard norms which are related to the overvoltages on subscribers lines.

IN ACCORDANCE WITH FOLLOWING STANDARDS :

CCITT K17 - K20	10/700 µs	1.5 kV
	5/310 µs	38 A
VDE 0433	10/700 µs	2 kV
	5/200 µs	50 A
CNET	0.5/700 µs	1.5 kV
	0.2/310 µs	38 A



TO 220 AB
(Plastic)

ABSOLUTE RATINGS (limiting values) (T_j = 25 °C)

Symbol	Parameter		Value	Unit
I_{pp}	Peak Pulse Current	1 ms expo	75	A
		8-20 µs expo*	150	
I_{TSM}	Non Repetitive Surge Peak on-state Current	t_p = 20 ms	30	A
di/dt	Critical Rate of Rise of on-state Current	Non Repetitive	100	A/µs
T_{stg} T_j	Storage and Operating Junction Temperature Range		– 40 to 150 150	°C °C
T_L	Maximum Lead Temperature for Soldering During 10 s at 4 mm from Case		230	°C

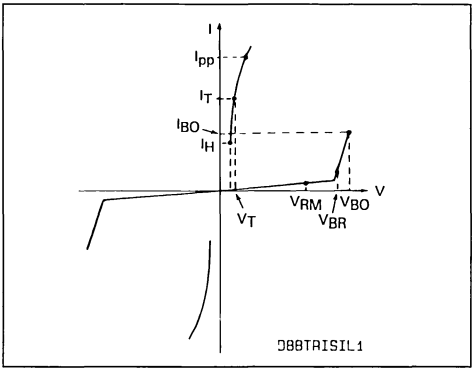
* ANSI STD C62.

THERMAL RESISTANCES

Symbol	Parameter	Value	Unit
$R_{th(j-c)}$	Junction to Case for DC	5	°C/W
$R_{th(j-a)}$	Junction to Ambient	60	°C/W

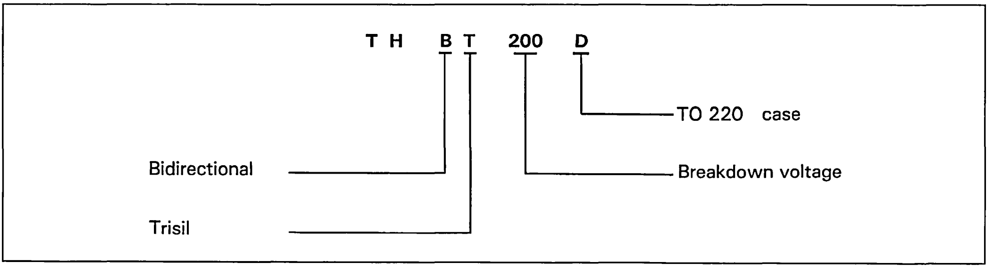
ELECTRICAL CHARACTERISTICS

Symbol	Parameter
V_{RM}	Stand-off Voltage
V_{BR}	Breakdown Voltage
V_{BO}	Clamping Voltage
I_H	Holding Current
V_T	On-state Voltage
I_{BO}	Breakover Current
I_{pp}	Peak-pulse Current



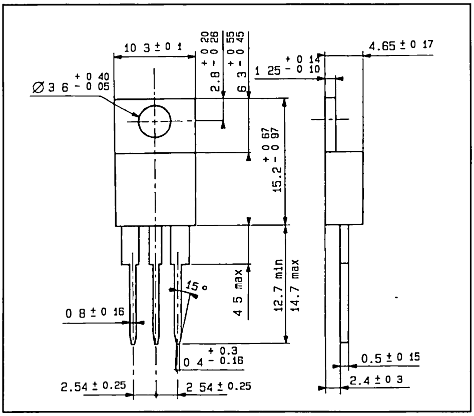
Symbol	Test Conditions			Min.	Typ.	Max.	Unit
I_{RM}	T_j = 25 °C	V_{RM} = 180 V				10	µA
V_{BR}	T_j = 25 °C	I_R = 1 mA		200			V
V_{BO}	T_j = 25 °C	t_p = 100 µs				290	V
I_{BO}	T_j = 25 °C	t_p = 100 µs		150		800	mA
I_H	T_j = 25 °C	I_T = 2 A		150			mA
V_T	T_j = 25 °C	I_T = 5 A	t_p = 100 µs			3	V
α_T					20		10^{-4}/°C
C	T_j = 25 °C	F = 1 MHz	V_R = 5 V			200	pF
dv/dt	T_j = 25 °C	Exponential Ramp 67 % V_{BR}		5000			V/µs

ORDER CODE

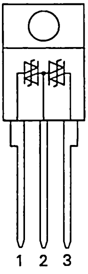


PACKAGE MECHANICAL DATA

TO 220 AB Plastic



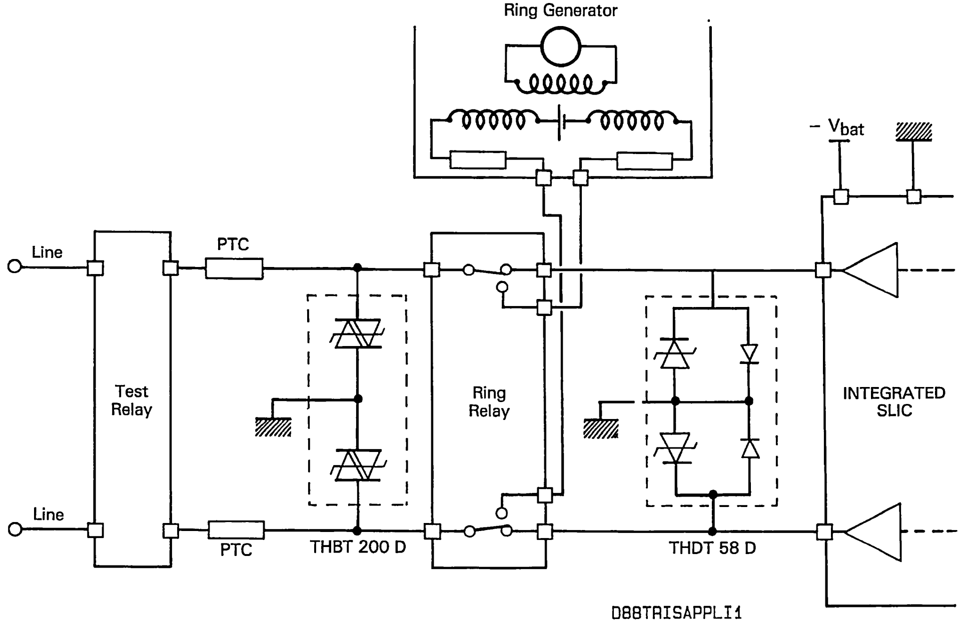
PIN CONNECTIONS



* 1 = Tip or Ring
* 2 = GROUND
* 3 = Tip or Ring
Tab is connected to center pin.

Cooling method : by conduction (Method C)
Marking : type number
Weight : 2 g.

APPLICATION CIRCUIT



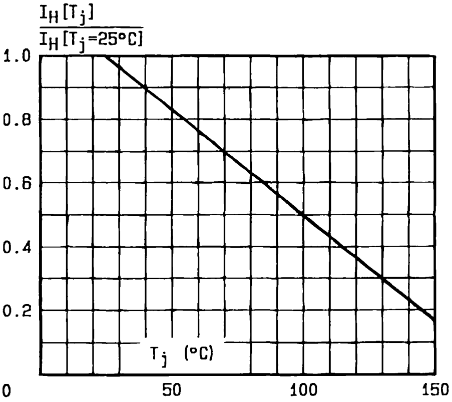


Fig.1 - Relative variation of holding current versus junction temperature.

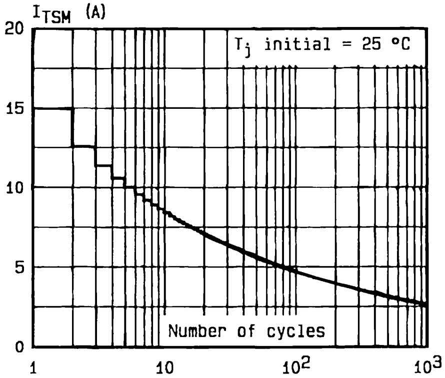


Fig.2 - Non_repetitive surge peak on-state current versus number of cycles (1 cycle = 20 ms).

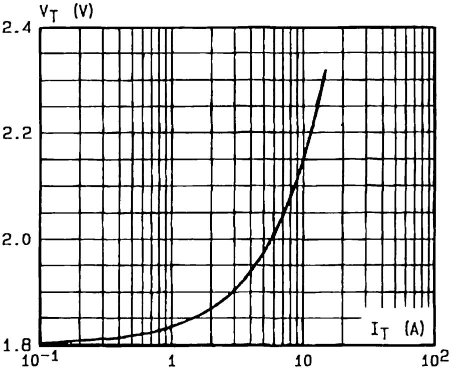


Fig.3 - Peak on-state voltage versus peak on-state current (typical values).

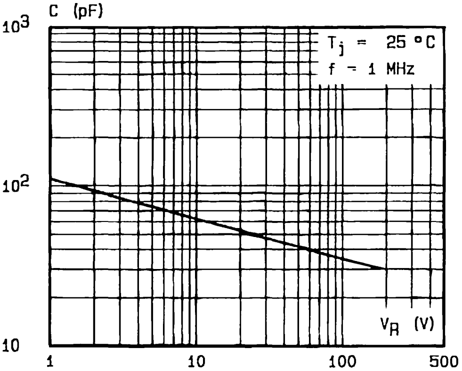


Fig.4 - Capacitance versus reverse applied voltage (typical values).

D89THBT200DP4

SGS-THOMSON
MICROELECTRONICS

THDT 58 D

TRISIL

DESCRIPTION

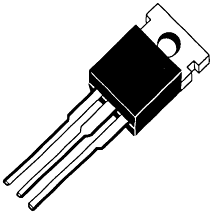
This protection device has been especially designed for subscriber line-card and terminal protection. By itself, it enables to protect integrated SLIC against transient overvoltages. A diode clips positive overloads and breakover device negative overloads.

Its ion-implanted technology confers excellent electrical characteristics on it.

This is why this THDT 58 D easily corresponds to the main protection standard norms which are related to the overvoltages on subscribers lines.

IN ACCORDANCE WITH FOLLOWING STANDARDS :

CCITT K17 - K20	10/700 μs	1.5 kV
	5/310 μs	38 A
VDE 0433	10/700 μs	2 kV
	5/200 μs	50 A
CNET	0.5/700 μs	1.5 kV
	0.2/310 μs	38 A



TO 220 AB
(Plastic)

ABSOLUTE RATINGS (limiting values) (T_j = 25 °C)

Symbol	Parameter		Value	Unit
I_{pp}	Peak Pulse Current	1 ms expo	75	A
		8-20 μs expo*	150	
I_{FSM} I_{TSM}	Non Repetitive Surge Peak on-state Current	t_p = 20 ms	30	A
di/dt	Critical Rate of Rise of on-state Current	Non Repetitive	100	A/μs
T_{stg} T_j	Storage and Operating Junction Temperature Range		– 40 to 150 150	°C °C
T_L	Maximum Lead Temperature for Soldering During 10 s at 4 mm from Case		230	°C

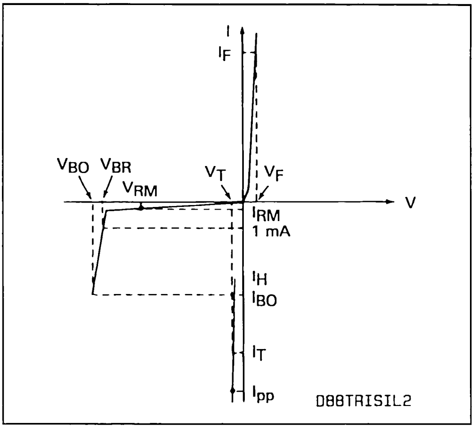
* ANSI STD C62.

THERMAL RESISTANCES

Symbol	Parameter	Value	Unit
$R_{th(j-c)}$	Junction to Case for DC	5	°C/W
$R_{th(j-a)}$	Junction to Ambient	60	°C/W

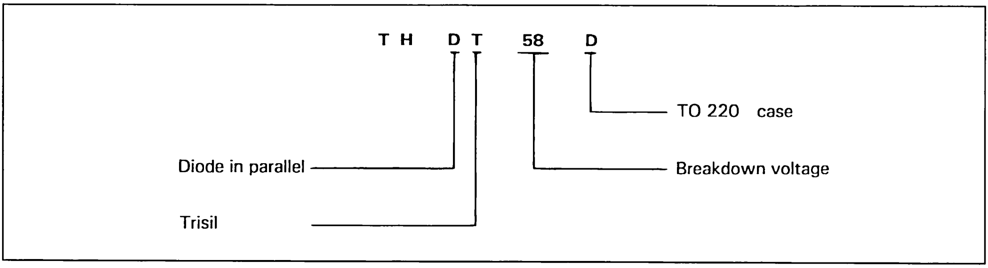
ELECTRICAL CHARACTERISTICS

Symbol	Parameter
V_{RM}	Stand-off Voltage
V_{BR}	Breakdown Voltage
V_{BO}	Clamping Voltage
I_H	Holding Current
V_T	On-state Voltage
V_F	Forward Voltage Drop
I_{BO}	Breakover Current
I_{pp}	Peak-pulse Current



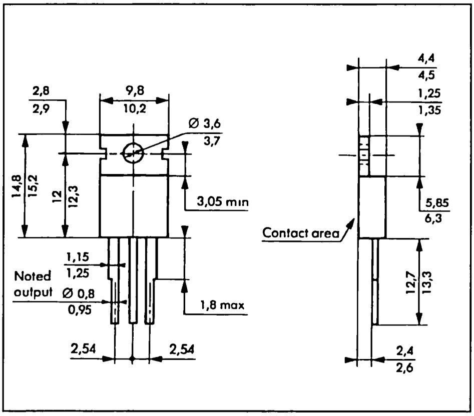
Symbol	Test Conditions			Min.	Typ.	Max.	Unit
I_{RM}	T_j = 25 °C	V_{RM} = – 56 V				– 10	µA
V_{BR}	T_j = 25 °C	I_R = – 1 mA		– 58	– 60		V
V_{BO}	T_j = 25 °C	t_p = 100 µs				– 80	V
I_{BO}	T_j = 25 °C	t_p = 100 µs		– 150		– 800	mA
I_H	T_j = 25 °C	I_T = – 2 A		– 150			mA
V_T	T_j = 25 °C	I_T = – 5 A	t_p = 100 µs			– 3	V
V_F	T_j = 25 °C	I_F = 5 A	t_p = 100 µs			3	V
α_T					10		10^{-4}/°C
C	T_j = 25 °C	F = 1 MHz	V_R = – 5 V			500	pF
dv/dt	T_j = 25 °C	Exponential Ramp 67 % V_{BR}		5000			V/µs

ORDER CODE

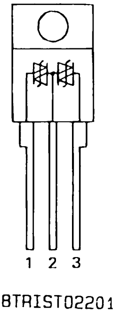


PACKAGE MECHANICAL DATA

TO 220 AB Plastic



PIN CONNECTIONS

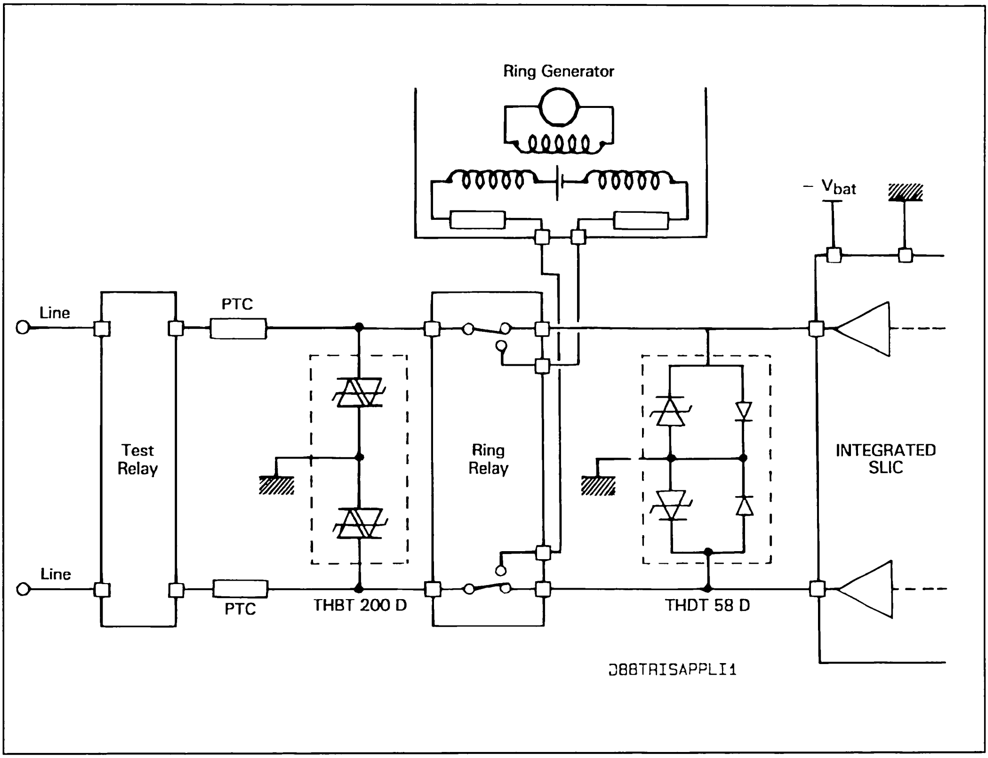


- * 1 = Tip or Ring
- * 2 = GROUND
- * 3 = Tip or Ring

Tab is connected to center pin.

Cooling method : by conduction (Method C)
Marking : type number
Weight : 2 g.

APPLICATION CIRCUIT



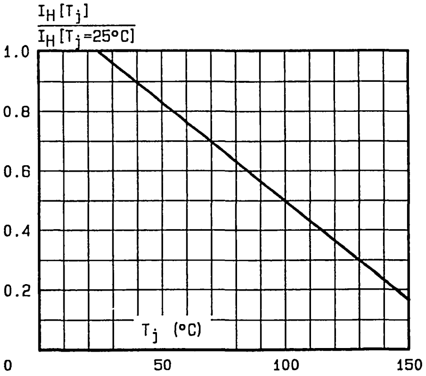


Fig.1 - Relative variation of holding current versus junction temperature.

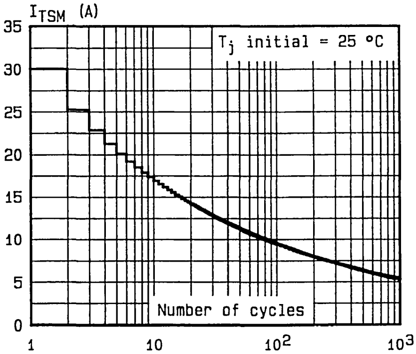


Fig.2 - Non_repetitive surge peak on-state current versus number of cycles (1 cycle = 20 ms).

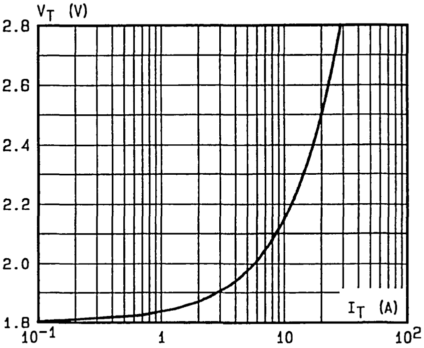


Fig.3 - Peak on-state voltage versus peak on-state current (typical values).

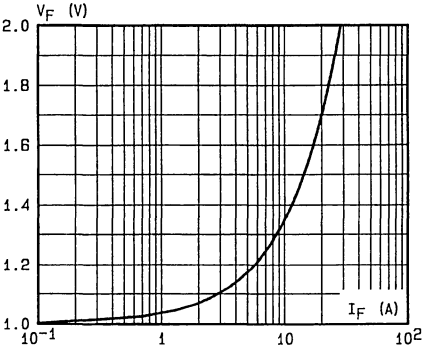


Fig.4 - Peak forward voltage drop versus peak forward current (typical values).

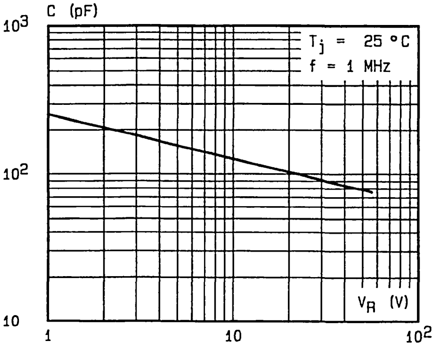


Fig.5 - Capacitance versus reverse applied voltage (typical values).

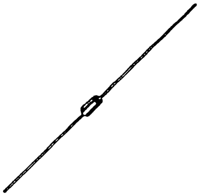
D89THDT58DP4

SGS-THOMSON
MICROELECTRONICS

TPA SERIES

TRISIL

- BIDIRECTIONAL DEVICE USED TO **TELEPHONE PROTECTION**
- CHARACTERISTIC OF STAND-OFF AND BREAKDOWN VOLTAGE SIMILAR TO A TRANSIL (V_{off})
- HIGH FLOWOUT CAPABILITY BECAUSE OF ITS BREAKOVER CHARACTERISTIC (V_{on})



F 126
(Plastic)

ABSOLUTE RATINGS (limiting values) (T_j = 25 °C - L = 10 mm)

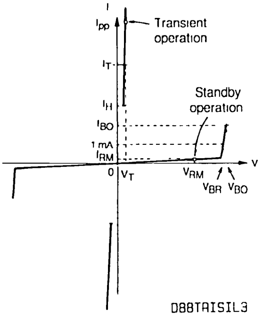
Symbol	Parameter		Value	Unit
P	Power Dissipation on Infinite Heatsink	T_{amb} = 50 °C	1.7	W
I_{pp}	Peak Pulse Current	1 ms expo	50	A
		8-20 µs expo	100	
I_{TSM}	Non Repetitive Surge Peak on-state Current	t_p = 20 ms	30	A
di/dt	Critical Rate of Rise of on-state Current	Non Repetitive	100	A/µs
dv/dt	Critical Rate of Rise of off-state Voltage	67 % $V_{(BR)}$ min	5	kV/µs
T_{stg} T_j	Storage and Operating Junction Temperature Range		– 40 to 150 150	°C °C
T_L	Maximum Lead Temperature for Soldering During 10 s at 4 mm from Case		230	°C

THERMAL RESISTANCES

Symbol	Parameter		Value	Unit
$R_{th\,(j-l)}$ $R_{th\,(j-a)}$	Junction-leads on Infinite Heatsink Junction-ambient on Printed Circuit	L = 10 mm	60 100	°C/W °C/W

ELECTRICAL CHARACTERISTICS
(T_j = 25 °C)

Symbol	Parameter
V_{RM}	Stand-off Voltage
V_{BR}	Breakdown Voltage
V_{BO}	Clamping Voltage
I_H	Holding Current
V_T	On-state Voltage : 2.5 V typ. @ I_T = 1 A (t_p = 300 µs)



Types	I_{RM} @ V_{RM} max.		$V_{(BR)}$ @ I_R min.		V_{BO} max.	I_{BO} max.	I_H min.
	(µA)	(V)	(V)	(mA)	(V)	(mA)	(mA)
TPA62A - 12 or 18	2	56	62	1	82	800	
(1) TPA62B - 12 or 18	2	56	62	1	75	800	
TPA68A - 12 or 18	2	61	68	1	90	800	
(1) TPA68B - 12 or 18	2	61	68	1	82	800	
(1) TPA75A - 12 or 18	2	67	75	1	100	800	
(1) TPA75B - 12 or 18	2	67	75	1	91	800	
(1) TPA82A - 12 or 18	2	74	82	1	109	300	
(1) TPA82B - 12 or 18	2	74	82	1	99	300	
(1) TPA91A - 12 or 18	2	82	91	1	121	300	
(1) TPA91B - 12 or 18	2	82	91	1	110	300	12 Suffix for 120 mA
P TPA100A - 12 or 18	2	90	100	1	133	300	
TPA100B - 12 or 18	2	90	100	1	121	300	
TPA110A - 12 or 18	2	99	110	1	147	300	
TPA110B - 12 or 18	2	99	110	1	133	300	
P TPA120A - 12 or 18	2	108	120	1	160	300	
TPA120B - 12 or 18	2	108	120	1	145	300	
P TPA130A - 12 or 18	2	117	130	1	173	300	
TPA130B - 12 or 18	2	117	130	1	157	300	
(1) TPA150A - 12 or 18	2	135	150	1	200	300	
(1) TPA150B - 12 or 18	2	135	150	1	181	300	18 Suffix for 180 mA
(1) TPA160A - 12 or 18	2	144	160	1	213	300	
(1) TPA160B - 12 or 18	2	144	160	1	193	300	
(1) TPA180A - 12 or 18	2	162	180	1	240	300	
(1) TPA180B - 12 or 18	2	162	180	1	217	300	
(1) TPA200A - 12 or 18	2	180	200	1	267	300	
(1) TPA200B - 12 or 18	2	180	200	1	241	300	
P TPA220A - 12 or 18	2	198	220	1	293	300	
TPA220B - 12 or 18	2	198	220	1	265	300	
P TPA240A - 12 or 18	2	216	240	1	320	300	
TPA240B - 12 or 18	2	216	240	1	289	300	
P TPA270A - 12 or 18	2	243	270	1	360	300	
TPA270B - 12 or 18	2	243	270	1	325	300	

P : Preferred device.
(1) : These volages are on request. Consult us.

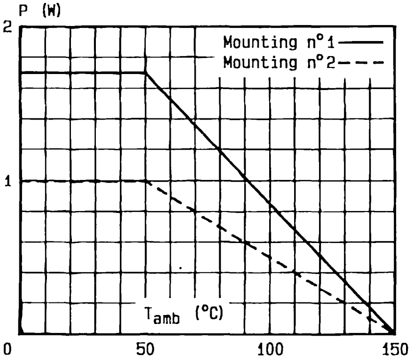


Fig.1 - Power dissipation versus ambient temperature.

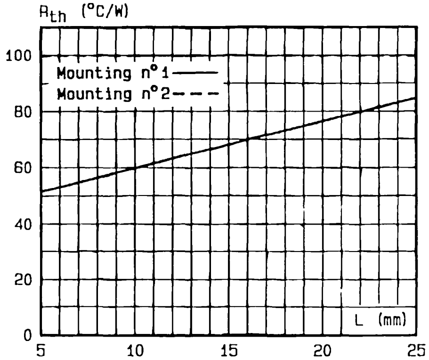


Fig.2 - Thermal resistance versus lead length.

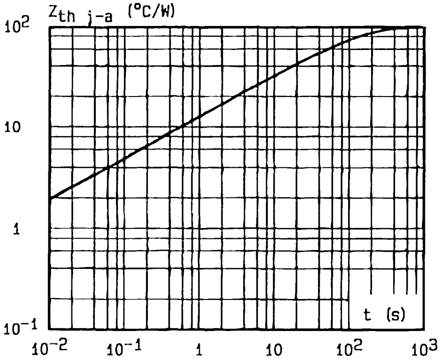
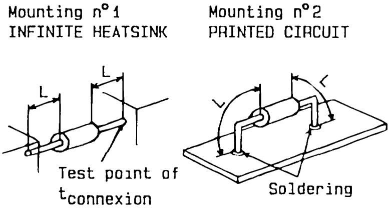


Fig.3 - Transient thermal impedance junction-ambient for mounting n°2 versus pulse duration (L = 10 mm).



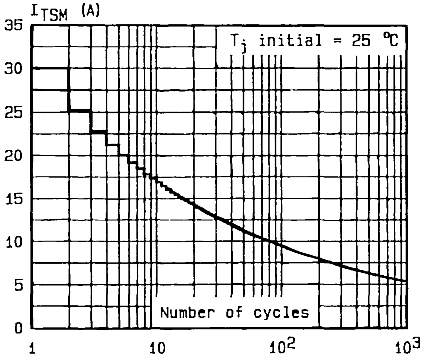


Fig.4 - Non repetitive surge peak on-state current versus number of cycles.

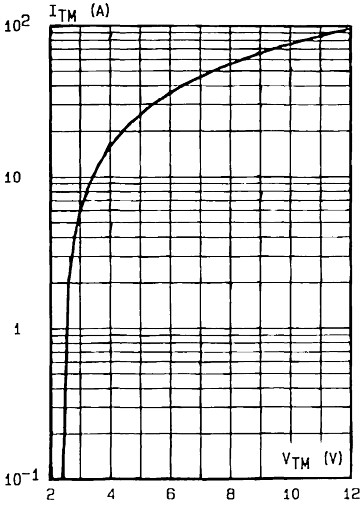


Fig.5 - Peak forward current versus peak forward voltage drop (typical values).

D88TPAP3

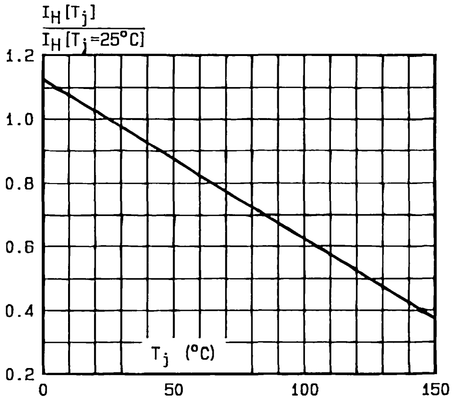


Fig.6 - Relative variation of holding current versus junction temperature.

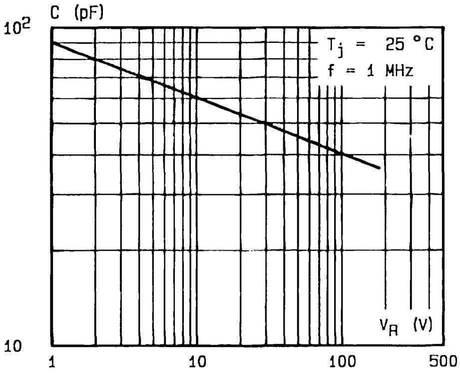
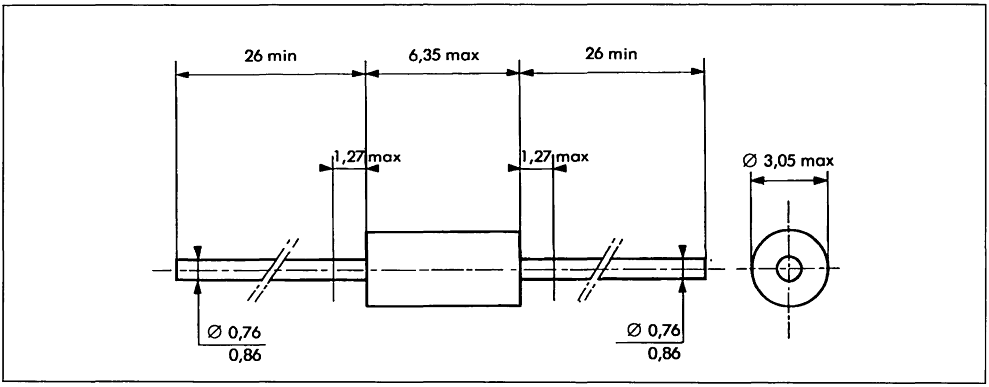


Fig.7 - Capacitance versus reverse applied voltage.

D88TPAP4

PACKAGE MECHANICAL DATA

F 126 Plastic



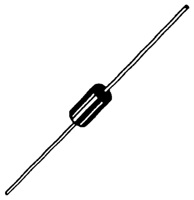
Cooling method : by conduction (method A)
Marking : type number
Weight : 0.4 g

SGS-THOMSON
MICROELECTRONICS

TPB SERIES

TRISIL

- BIDIRECTIONAL DEVICE USED TO **TELEPHONE PROTECTION**
- CHARACTERISTIC OF STAND-OFF AND BREAKDOWN VOLTAGE SIMILAR TO A TRANSIL (V_{off})
- HIGH FLOWOUT CAPABILITY BECAUSE OF ITS BREAKOVER CHARACTERISTIC (V_{on})



CB 429
(Plastic)

ABSOLUTE RATINGS (limiting values) (T_{amb} = 25 °C - L = 10 mm)

Symbol	Parameter		Value	Unit
P	Power Dissipation on Infinite Heatsink	T_{amb} = 50 °C	5	W
I_{pp}	Peak Pulse Current	1 ms expo	100	A
		8-20 μs expo*	150	
I_{TSM}	Non Repetitive Surge Peak on-state Current	t_p = 20 ms	50	A
di/dt	Critical Rate of Rise of on-state Current	Non Repetitive	100	A/μs
dv/dt	Critical Rate of Rise of off-state Voltage	67 % $V_{(BR)}$ min	5	kV/μs
T_{stg}	Storage and Operating Junction Temperature Range		– 40 to 150	°C
T_j			150	°C
T_L	Maximum Lead Temperature for Soldering During 10 s at 4 mm from Case		230	°C

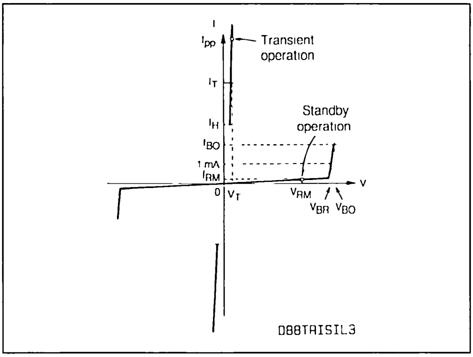
THERMAL RESISTANCES

Symbol	Parameter		Value	Unit
$R_{th(j-l)}$	Junction-leads on Infinite Heatsink	L = 10 mm	20	°C/W
$R_{th(j-a)}$	Junction-ambient on Printed Circuit		75	°C/W

ELECTRICAL CHARACTERISTICS

(T_j = 25 °C)

Symbol	Parameter
V_{RM}	Stand-off Voltage
V_{BR}	Breakdown Voltage
V_{BO}	Clamping Voltage
I_H	Holding Current
V_T	On-state Voltage : 1.6 V typ. @ I_T = 1 A (t_p = 300 µs)



Types	I_{RM} @ V_{RM} max.		$V_{(BR)}$ @ I_R min.		V_{BO} max.	I_{BO} max.	I_H min.
	(µA)	(V)	(V)	(mA)	(V)	(mA)	(mA)
TPB62A - 12 or 18	2	56	62	1	82	800	
(1) TPB62B - 12 or 18	2	56	62	1	75	800	
TPB68A - 12 or 18	2	61	68	1	90	800	
(1) TPB68B - 12 or 18	2	61	68	1	82	800	
(1) TPB75A - 12 or 18	2	67	75	1	100	800	
(1) TPB75B - 12 or 18	2	67	75	1	91	800	
(1) TPB82A - 12 or 18	2	74	82	1	109	300	
(1) TPB82B - 12 or 18	2	74	82	1	99	300	
(1) TPB91A - 12 or 18	2	82	91	1	121	300	
(1) TPB91B - 12 or 18	2	82	91	1	110	300	
P TPB100A - 12 or 18	2	90	100	1	133	300	12 Suffix for 120 mA
TPB100B - 12 or 18	2	90	100	1	121	300	
TPB110A - 12 or 18	2	99	110	1	147	300	
TPB110B - 12 or 18	2	99	110	1	133	300	
P TPB120A - 12 or 18	2	108	120	1	160	300	
TPB120B - 12 or 18	2	108	120	1	145	300	
P TPB130A - 12 or 18	2	117	130	1	173	300	
TPB130B - 12 or 18	2	117	130	1	157	300	
(1) TPB150A - 12 or 18	2	135	150	1	200	300	
(1) TPB150B - 12 or 18	2	135	150	1	181	300	
(1) TPB160A - 12 or 18	2	144	160	1	213	300	18 Suffix for 180 mA
(1) TPB160B - 12 or 18	2	144	160	1	193	300	
(1) TPB180A - 12 or 18	2	162	180	1	240	300	
(1) TPB180B - 12 or 18	2	162	180	1	217	300	
(1) TPB200A - 12 or 18	2	180	200	1	267	300	
(1) TPB200B - 12 or 18	2	180	200	1	241	300	
P TPB220A - 12 or 18	2	198	220	1	293	300	
TPB220B - 12 or 18	2	198	220	1	265	300	
P TPB240A - 12 or 18	2	216	240	1	320	300	
TPB240B - 12 or 18	2	216	240	1	289	300	
P TPB270A - 12 or 18	2	243	270	1	360	300	
TPB270B - 12 or 18	2	243	270	1	325	300	

P : Preferred device.
(1) These voltages are on request Consult us

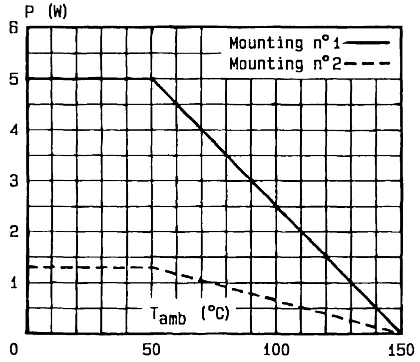


Fig.1 - Power dissipation versus ambient temperature.

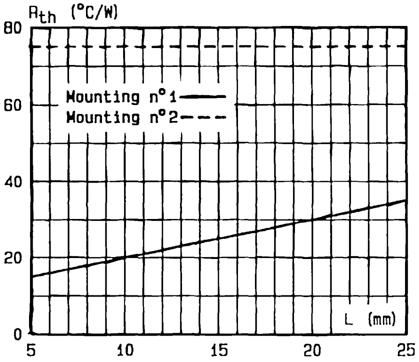


Fig.2 - Thermal resistance versus lead length.

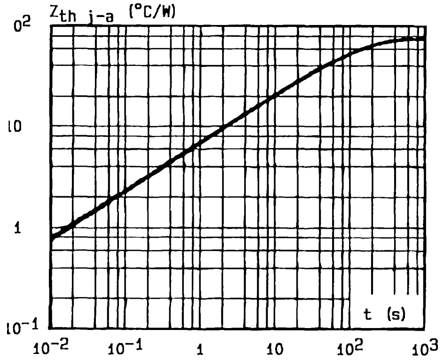
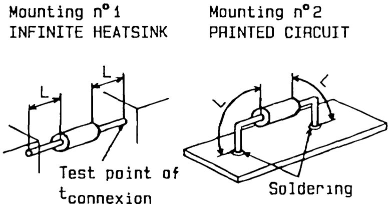


Fig.3 - Transient thermal impedance junction-ambient for mounting n°2 versus pulse duration (L = 10 mm).



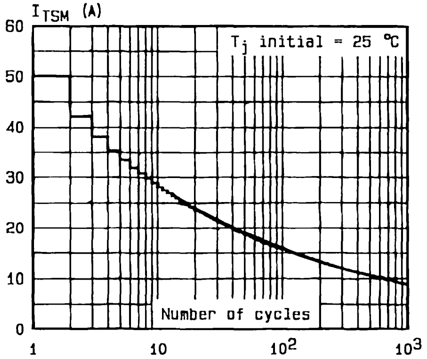


Fig.4 - Non repetitive surge peak on-state current versus number of cycles.

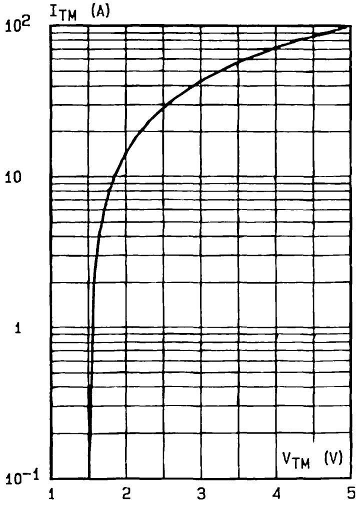


Fig.5 - Peak forward current versus peak forward voltage drop (typical values).

D88TPBP3

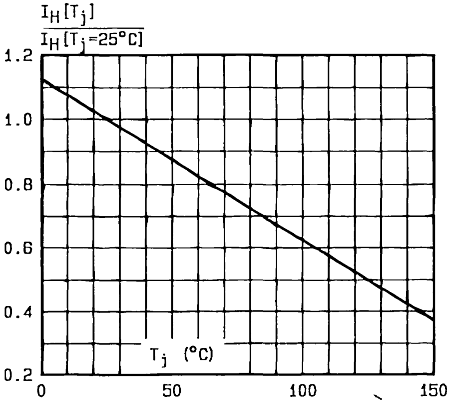


Fig.6 - Relative variation of holding current versus junction temperature

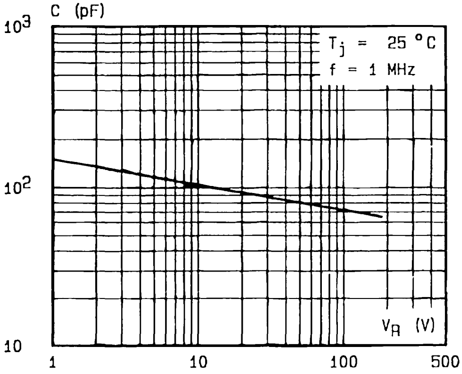
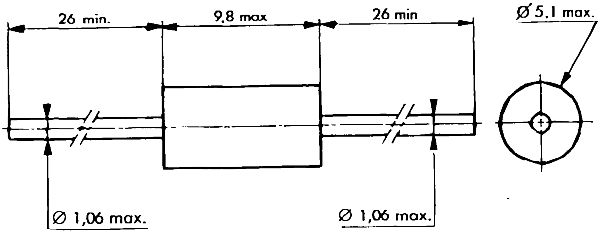


Fig.7 - Capacitance versus reverse applied voltage.

DBBTPBP4

PACKAGE MECHANICAL DATA

CB 429 Plastic



Cooling method · by conduction (method A)
Marking · type number
Weight : 0 9 g

SURFACE MOUNT DEVICE DATASHEETS

SGS-THOMSON
MICROELECTRONICS

SM4T6V8, A → 220, A
SM4T6V8C, A → 200C, A

UNI-AND BIDIRECTIONAL TRANSIENT VOLTAGE SUPPRESSORS

- HIGH SURGE CAPABILITY :
  400 W / 1 ms EXPO
- VERY FAST CLAMPING TIME :
  1 ps FOR UNIDIRECTIONAL TYPES
  5 ns FOR BIDIRECTIONAL TYPES
- LARGE VOLTAGE RANGE :
  5.5 V → 188 V
- ORDER CODE :
  TYPE NUMBER FOR UNIDIRECTIONAL TYPES, TYPE NUMBER + SUFFIX C FOR BIDIRECTIONAL TYPES

SOD 6
(Plastic)

SURFACE MOUNT TRANSIL FEATURES

- A PERFECT PICK AND PLACE BEHAVIOUR
- AN EXCELLENT ON BOARD STABILITY
- A FULL COMPATIBILITY WITH BOTH GLUING AND PASTE SOLDERING TECHNOLOGIES
- BODY MARKED WITH TYPE CODE AND LOGO
- STANDARD PACKAGING : 12 mm TAPE (EIA STD. RS481)
- TINNED COPPER LEADS
- HIGH TEMPERATURE RESISTANT RESIN

DESCRIPTION

Transient voltage suppressor diodes especially useful in protecting integrated circuits, MOS, hybrids and other voltage-sensitive semiconductors and components.

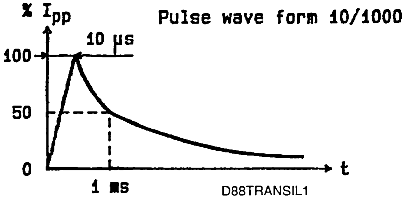
ABSOLUTE RATINGS (limiting values)

Symbol	Parameter		Value	Unit
P_p	Peak Pulse Power for 1 ms Exponential Pulse	T_j Initial = 25 °C See note 1	400	W
P	Power Dissipation on Infinite Heatsink	T_{amb} = 25 °C	1.2	W
I_{FSM}	Non Repetitive Surge Peak Forward Current for Unidirectional Types	T_j Initial = 25 °C t = 10 ms	50	A
T_{stg} T_j	Storage and Operating Junction Temperature Range		– 65 to 175 150	°C °C
T_L	Maximum Lead Temperature for Soldering During 10 s		260	°C

THERMAL RESISTANCE

Symbol	Parameter	Value	Unit
$R_{th(j-l)}$	Junction-leads	20	°C/W

Note : 1. For surges upper than the maximum values, the diode will present a short-circuit anode-cathode.



ELECTRICAL CHARACTERISTICS (T_j = 25 °C)

Symbol	Parameter		Value
V_{RM}	Stand-off Voltage		See tables
$V_{(BR)}$	Breakdown Voltage		
$V_{(CL)}$	Clamping Voltage		
I_{pp}	Peak Pulse Current		
α_T	Temperature Coefficient of $V_{(BR)}$		
C	Capacitance		
$t_{clamping}$	Clamping Time (0 volt to $V_{(BR)}$)	Unidirectional Types	1 ps max.
		Bidirectional Types	5 ns max.

Types		Marking		I_{RM} @ V_{RM} max.		$V_{(BR)}$* @ (V)			I_R	$V_{(CL)}$ @ I_{pp} max. 1ms expo		$V_{(CL)}$ @ I_{pp} max. 8-20µs expo		α_T max.	C** typ. $V_R=0$ f=1MHz
Unidirectional	Bidirectional	Unidirectional	Bidirectional	(µA)	(V)	min.	nom.	max.	(mA)	(V)	(A)	(V)	(A)	(10^{-4}/°C)	(pF)
SM4T6V8	SM4T6V8C	QD	VD	1000	5.5	6.12	6.8	7.48	10	10.8	37	14	164	5.7	3500
SM4T6V8A	SM4T6V8CA	QE	VE	1000	5.8	6.45	6.8	7.14	10	10.5	38	13.4	174	5.7	3500
SM4T7V5	SM4T7V5C	QF	VF	500	6.05	6.75	7.5	8.25	10	11.7	34	15.2	151	6.1	3100
SM4T7V5A	SM4T7V5CA	QG	VG	500	6.4	7.13	7.5	7.88	10	11.3	35.4	14.5	160	6.1	3100
SM4T10	SM4T10C	QN	VN	10	8.1	9	10	11	1	15	27	19.5	246	7.3	2000
SM4T10A	SM4T10CA	QP	VP	10	8.55	9.5	10	10.5	1	14.5	27.6	18.6	258	7.3	2000
SM4T12	SM4T12C	QS	VS	5	9.72	10.8	12	13.2	1	17.3	23.1	22.7	211	7.8	1550
SM4T12A	SM4T12CA	QT	VT	5	10.2	11.4	12	12.6	1	16.7	24	21.7	221	7.8	1550
SM4T15	SM4T15C	QW	VW	5	12.1	13.5	15	16.5	1	22	18.2	28.4	169	8.4	1200
SM4T15A	SM4T15CA	QX	VX	5	12.8	14.3	15	15.8	1	21.2	19	27.2	176	8.4	1200
SM4T18	SM4T18C	RD	UD	5	14.5	16.2	18	19.8	1	26.5	15.1	34	141	8.8	975
SM4T18A	SM4T18CA	RE	UE	5	15.3	17.1	18	18.9	1	25.2	16	32.5	148	8.8	975
SM4T22	SM4T22C	RH	UH	5	17.8	19.8	22	24.2	1	31.9	12.5	41.2	116	9.2	800
SM4T22A	SM4T22CA	RK	UK	5	18.8	20.9	22	23.1	1	30.6	13	39.3	122	9.2	800
SM4T24	SM4T24C	RL	UL	5	19.4	21.6	24	26.4	1	34.7	11.5	44.9	107	9.4	725
SM4T24A	SM4T24CA	RM	UM	5	20.5	22.8	24	25.2	1	33.2	12	42.8	112	9.4	725
SM4T27	SM4T27C	RN	UN	5	21.8	24.3	27	29.7	1	39.1	10.2	50.5	95	9.6	625
SM4T27A	SM4T27CA	RP	UP	5	23.1	25.7	27	28.4	1	37.5	10.7	48.3	99	9.6	625
SM4T30	SM4T30C	RQ	UQ	5	24.3	27	30	33	1	43.5	9.2	56.1	86	9.7	575
SM4T30A	SM4T30CA	RR	UR	5	25.6	28.5	30	31.5	1	41.5	9.6	53.5	90	9.7	575
SM4T33	SM4T33C	RS	US	5	26.8	29.7	33	36.3	1	47.7	8.4	61.7	78	9.8	510
SM4T33A	SM4T33CA	RT	UT	5	28.2	31.4	33	34.7	1	45.7	8.8	59	81.5	9.8	510
SM4T36	SM4T36C	RU	UU	5	29.1	32.4	36	39.6	1	52	7.7	67.3	71	9.9	480
SM4T36A	SM4T36CA	RV	UV	5	30.8	34.2	36	37.8	1	49.9	8	64.3	74.5	9.9	480
SM4T39	SM4T39C	RW	UW	5	31.6	35.1	39	42.9	1	56.4	7.1	73	66	10.0	450
SM4T39A	SM4T39CA	RX	UX	5	33.3	37.1	39	41	1	53.9	7.4	69.7	69	10.0	450
SM4T68	SM4T68C	SN	WN	5	55.1	61.2	68	74.8	1	98	4.1	127	38	10.4	270
SM4T68A	SM4T68CA	SP	WP	5	58.1	64.6	68	71.4	1	92	4.3	121	39.5	10.4	270
SM4T100	SM4T100C	SW	WW	5	81	90	100	110	1	144	2.8	187	25.5	10.6	200
SM4T100A	SM4T100CA	SX	WX	5	85.5	95	100	105	1	137	2.9	178	27	10.6	200
SM4T150	SM4T150C	TH	XH	5	121	135	150	165	1	215	1.9	277	17.3	10.8	145
SM4T150A	SM4T150CA	TK	XK	5	128	143	150	158	1	207	2	265	18.1	10.8	145
SM4T200	SM4T200C	TS	XS	5	162	180	200	220	1	287	1.4	370	13	10.8	120
SM4T200A	SM4T200CA	TT	XT	5	171	190	200	210	1	274	1.5	353	13.6	10.8	120
SM4T220		TU		5	178	198	220	242	1	315	1.3	406	11.8	10.8	110
SM4T220A		TV		5	188	209	220	231	1	301	1.4	388	12.4	10.8	110

* Pulse test $t_p \leq 50$ ms $\delta < 2$ %.

** Divide these values by 2 for bidirectional types.

For bidirectional types, electrical characteristics apply in both directions.

ORDER CODE

SM 4 T 6V8 CA

Surface Mount device — SM

Power range : 4 → 400 W — 4

TRANSIL : T — T

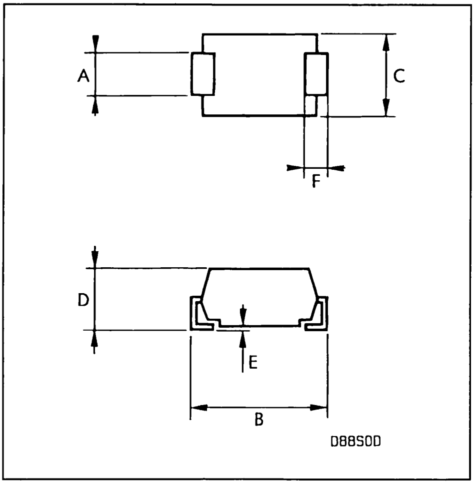
VBR voltage range — 6V8

Products characteristics :
without suffix Unidirectional
with suffix C Bidirectional — C

Tolerances : with suffix A ± 5 %
without suffix ± 10 % — A

PACKAGE MECHANICAL DATA

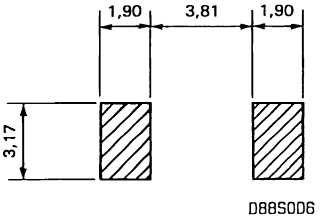
SOD 6 Plastic



Ref.	Millimetres		Inches	
	Min.	Max.	Min.	Max.
A	2.8	3.2	0.110	0.126
B	6.0	6.4	0.236	0.252
C	3.8	4.2	0.150	0.165
D	2.5	3.1	0.098	0.122
E	–	0.1	–	0.004
F	0.9	1.3	0.035	0.051

Laser marking.
The logo indicates cathode for unidirectional types.

FOOT PRINT DIMENSIONS (Millimeters)



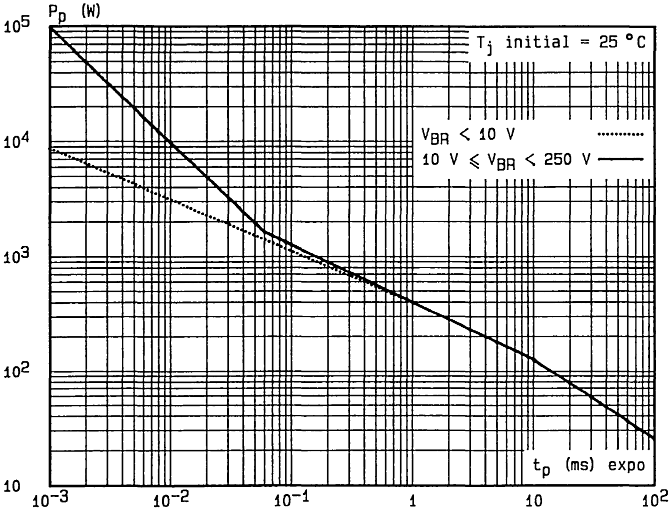


Fig.1 - Peak pulse power versus exponential pulse duration.

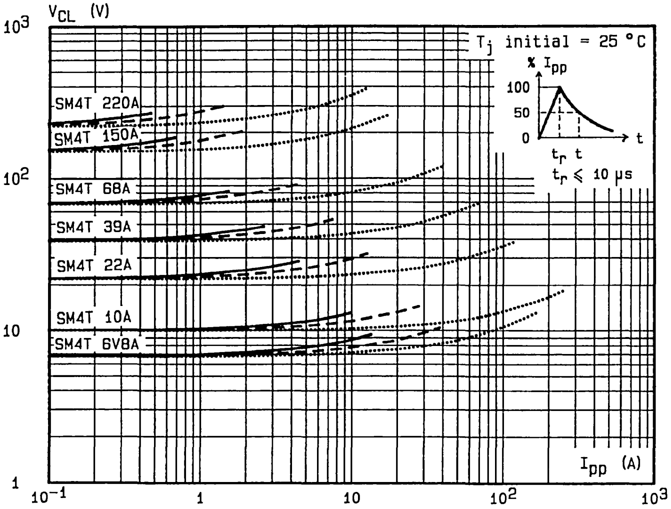


Fig.2 - Clamping voltage versus peak pulse current.
exponential waveform t = 20 µs ··········
t = 1 ms - - -
t = 10 ms ———

Note : The curves of the figure 2 are specified for a junction temperature of 25 °C before surge. The given results may be extrapolated for other junction temperatures by using the following formula : $\Delta V_{(BR)} = \alpha_{T(V(BR))} \times [T_j - 25] \times V_{(BR)}$
For intermediate voltages, extrapolate the given results.

D88SM4TP4

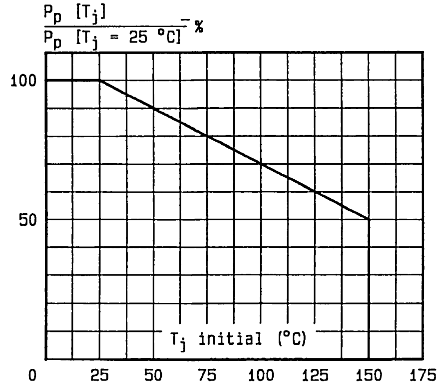


Fig.3 - Allowable power dissipation versus junction temperature.

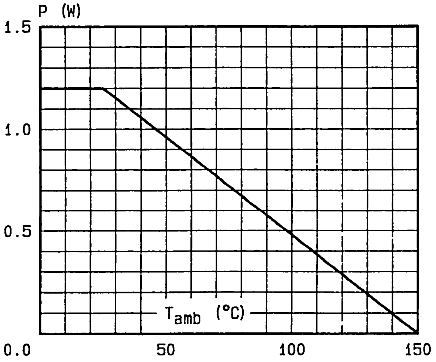


Fig.4 - Power dissipation versus ambient temperature.

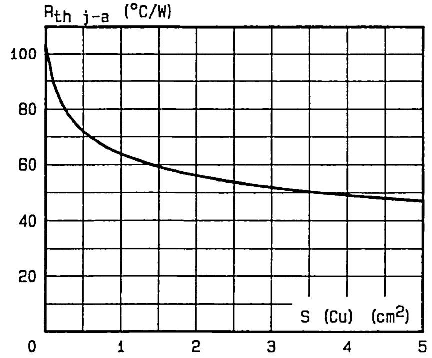


Fig.5 - Thermal resistance junction-ambient versus Cu surface (printed circuit).

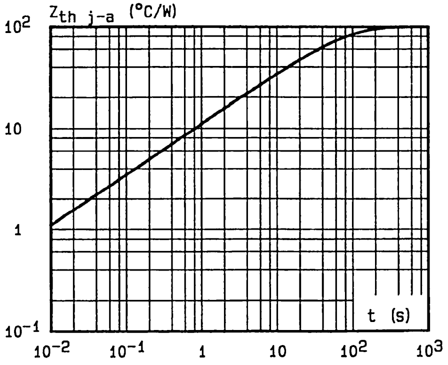


Fig.6 - Transient thermal impedance junction-ambient versus pulse duration.

D88SM4TP5

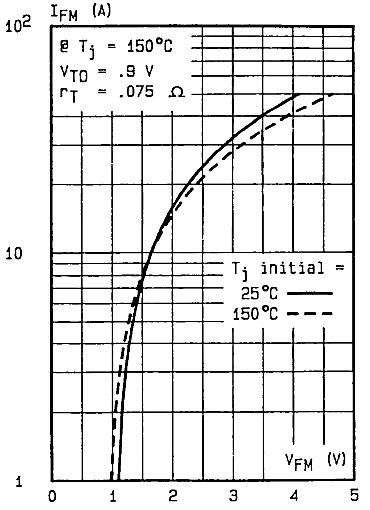


Fig.7 - Peak forward current versus peak forward voltage drop (typical values for unidirectional types).

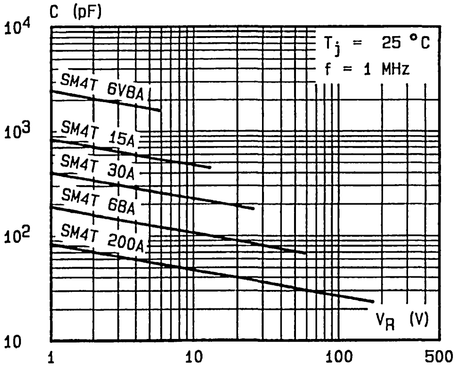


Fig.8a - Capacitance versus reverse applied voltage for unidirectional types (typical values).

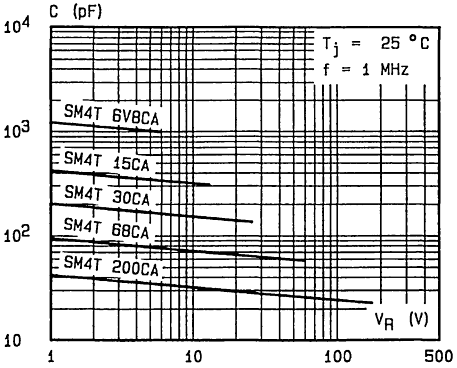


Fig.8b - Capacitance versus reverse applied voltage for bidirectional types (typical values).

D88SM4TP6

SGS-THOMSON
MICROELECTRONICS

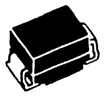
SM6T6V8, A → 220, A
SM6T6V8C, A → 200C, A

UNI-AND BIDIRECTIONAL TRANSIENT VOLTAGE SUPPRESSORS

- HIGH SURGE CAPABILITY :
  600 W / 1 ms EXPO
- VERY FAST CLAMPING TIME :
  1 ps FOR UNIDIRECTIONAL TYPES
  5 ns FOR BIDIRECTIONAL TYPES
- LARGE VOLTAGE RANGE :
  5.5 V → 188 V
- ORDER CODE :
  TYPE NUMBER FOR UNIDIRECTIONAL TYPES, TYPE NUMBER + SUFFIX C FOR BIDIRECTIONAL TYPES

DESCRIPTION

Transient voltage suppressor diodes especially useful in protecting integrated circuits, MOS, hybrids and other voltage-sensitive semiconductors and components.



SOD 6
(Plastic)

SURFACE MOUNT TRANSIL FEATURES

- A PERFECT PICK AND PLACE BEHAVIOUR
- AN EXCELLENT ON BOARD STABILITY
- A FULL COMPATIBILITY WITH BOTH GLUING AND PASTE SOLDERING TECHNOLOGIES
- BODY MARKED WITH TYPE CODE AND LOGO
- STANDARD PACKAGING : 12 mm TAPE (EIA STD. RS481)
- TINNED COPPER LEADS
- HIGH TEMPERATURE RESISTANT RESIN

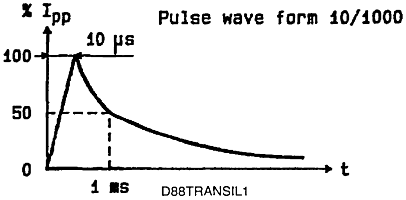
ABSOLUTE RATINGS (limiting values)

Symbol	Parameter		Value	Unit
P_p	Peak Pulse Power for 1 ms Exponential Pulse	T_j Initial = 25 °C See note 1	600	W
P	Power Dissipation on Infinite Heatsink	T_{amb} = 25 °C	1.2	W
I_{FSM}	Non Repetitive Surge Peak Forward Current for Unidirectional Types	T_j Initial = 25 °C t = 10 ms	50	A
T_{stg} T_j	Storage and Operating Junction Temperature Range		– 65 to 175 150	°C °C
T_L	Maximum Lead Temperature for Soldering During 10 s		260	°C

THERMAL RESISTANCE

Symbol	Parameter	Value	Unit
$R_{th(j-l)}$	Junction-leads	20	°C/W

Note : 1. For surges upper than the maximum values, the diode will present a short-circuit anode-cathode.


Pulse wave form 10/1000

ELECTRICAL CHARACTERISTICS (T_j = 25 °C)

Symbol	Parameter		Value
V_{RM}	Stand-off Voltage		See tables
$V_{(BR)}$	Breakdown Voltage		
$V_{(CL)}$	Clamping Voltage		
I_{pp}	Peak Pulse Current		
α_T	Temperature Coefficient of $V_{(BR)}$		
C	Capacitance		
$t_{clamping}$	Clamping Time (0 volt to $V_{(BR)}$)	Unidirectional Types	1 ps max.
		Bidirectional Types	5 ns max.

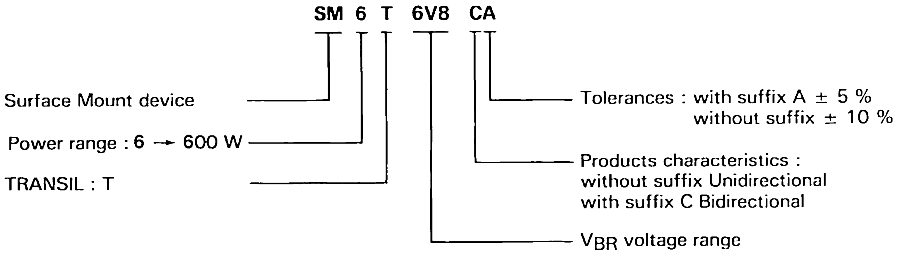
Types		Marking		I_{RM} @ V_{RM} max.		$V_{(BR)}$* (V)			@ I_R	$V_{(CL)}$ @ I_{pp} max. 1ms expo		$V_{(CL)}$ @ I_{pp} max. 8-20μs expo		α_T max.	C** typ. V_R=0 f=1MHz
Unidirectional	Bidirectional	Unidirectional	Bidirectional	(μA)	(V)	min.	nom.	max.	(mA)	(V)	(A)	(V)	(A)	(10^{-4}/°C)	(pF)
SM6T6V8	SM6T6V8C	DD	LD	1000	5.5	6.12	6.8	7.48	10	10.8	55	14	250	5.7	4000
SM6T6V8A	SM6T6V8CA	DE	LE	1000	5.8	6.45	6.8	7.14	10	10.5	57	13.4	261	5.7	4000
SM6T7V5	SM6T7V5C	DF	LF	500	6.05	6.75	7.5	8.25	10	11.7	51	15.2	230	6.1	3700
SM6T7V5A	SM6T7V5CA	DG	LG	500	6.4	7.13	7.5	7.88	10	11.3	53	14.5	241	6.1	3700
SM6T10	SM6T10C	DN	LN	10	8.1	9.0	10	11	1	15	40	19.5	369	7.3	2800
SM6T10A	SM6T10CA	DP	LP	10	8.55	9.5	10	10.5	1	14.5	41	18.6	387	7.3	2800
SM6T12	SM6T12C	DS	LS	5	9.72	10.8	12	13.2	1	17.3	35	22.7	317	7.8	2300
SM6T12A	SM6T12CA	DT	LT	5	10.2	11.4	12	12.6	1	16.7	36	21.7	332	7.8	2300
SM6T15	SM6T15C	DW	LW	5	12.1	13.5	15	16.5	1	22	27.5	28.4	254	8.4	1900
SM6T15A	SM6T15CA	DX	LX	5	12.8	14.3	15	15.8	1	21.2	28	27.2	265	8.4	1900
SM6T18	SM6T18C	ED	MD	5	14.5	16.2	18	19.8	1	26.5	22.5	34	212	8.8	1600
SM6T18A	SM6T18CA	EE	ME	5	15.3	17.1	18	18.9	1	25.2	24	32.5	222	8.8	1600
SM6T22	SM6T22C	EH	MH	5	17.8	19.8	22	24.2	1	31.9	18.5	41.2	175	9.2	1350
SM6T22A	SM6T22CA	EK	MK	5	18.8	20.9	22	23.1	1	30.6	20	39.3	183	9.2	1350
SM6T24	SM6T24C	EL	ML	5	19.4	21.6	24	26.4	1	34.7	17.5	44.9	160	9.4	1250
SM6T24A	SM6T24CA	EM	MM	5	20.5	22.8	24	25.2	1	33.2	18	42.8	168	9.4	1250
SM6T27	SM6T27C	EN	MN	5	21.8	24.3	27	29.7	1	39.1	15.5	50.5	143	9.6	1150
SM6T27A	SM6T27CA	EP	MP	5	23.1	25.7	27	28.4	1	37.5	16	48.3	149	9.6	1150
SM6T30	SM6T30C	EQ	MQ	5	24.3	27	30	33	1	43.5	13.5	56.1	128	9.7	1075
SM6T30A	SM6T30CA	ER	MR	5	25.6	28.5	30	31.5	1	41.4	14.5	53.5	134	9.7	1075
SM6T33	SM6T33C	ES	MS	5	26.8	29.7	33	36.3	1	47.7	12.5	61.7	117	9.8	1000
SM6T33A	SM6T33CA	ET	MT	5	28.2	31.4	33	34.7	1	45.7	13.1	59	122	9.8	1000
SM6T36	SM6T36C	EU	MU	5	29.1	32.4	36	39.6	1	52	11.5	67.3	107	9.9	950
SM6T36A	SM6T36CA	EV	MV	5	30.8	34.2	36	37.8	1	49.9	12	64.3	112	9.9	950
SM6T39	SM6T39C	EW	MW	5	31.6	35.1	39	42.9	1	56.4	10.6	73	99	10.0	900
SM6T39A	SM6T39CA	EX	MX	5	33.3	37.1	39	41	1	53.9	11.1	69.7	103	10.0	900
SM6T68	SM6T68C	FP	NP	5	55.1	61.2	68	74.8	1	98	6.1	127	57	10.4	625
SM6T68A	SM6T68CA	FQ	NQ	5	58.1	64.6	68	71.4	1	92	6.5	121	59.5	10.4	625
SM6T100	SM6T100C	FX	NX	5	81	90	100	110	1	144	4.2	187	38.5	10.6	500
SM6T100A	SM6T100CA	FY	NY	5	85.5	95	100	105	1	137	4.4	178	40.5	10.6	500
SM6T150	SM6T150C	GK	OK	5	121	135	150	165	1	215	2.8	277	26	10.8	400
SM6T150A	SM6T150CA	GL	OL	5	128	143	150	158	1	207	2.9	265	27.2	10.8	400
SM6T200	SM6T200C	GT	OT	5	162	180	200	220	1	287	2.1	370	19.4	10.8	350
SM6T200A	SM6T200CA	GU	OU	5	171	190	200	210	1	274	2.2	353	20.4	10.8	350
SM6T220		GV		5	178	198	220	242	1	316	1.9	406	17.7	10.8	330
SM6T220A		GW		5	188	209	220	231	1	301	2	388	18.6	10.8	330

* Pulse test $t_p \leq 50$ ms $\delta < 2$ %.

** Divide these values by 2 for bidirectional types.

For bidirectional types, electrical characteristics apply in both directions.

ORDER CODE



Surface Mount device

Power range : 6 → 600 W

TRANSIL : T

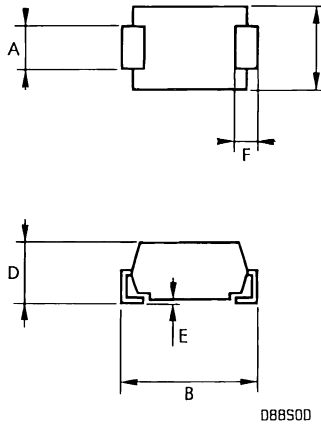
Tolerances : with suffix A ± 5 %
without suffix ± 10 %

Products characteristics :
without suffix Unidirectional
with suffix C Bidirectional

V_{BR} voltage range

PACKAGE MECHANICAL DATA

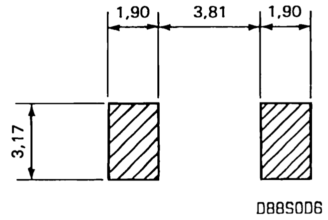
SOD 6 Plastic



Ref.	Millimetres		Inches	
	Min.	Max.	Min.	Max.
A	2.8	3.2	0.110	0.126
B	6.0	6.4	0.236	0.252
C	3.8	4.2	0.150	0.165
D	2.5	3.1	0.098	0.122
E	–	0.1	–	0.004
F	0.9	1.3	0.035	0.051

Laser marking.
The logo indicates cathode for unidirectional types.

FOOT PRINT DIMENSIONS (Millimeters)



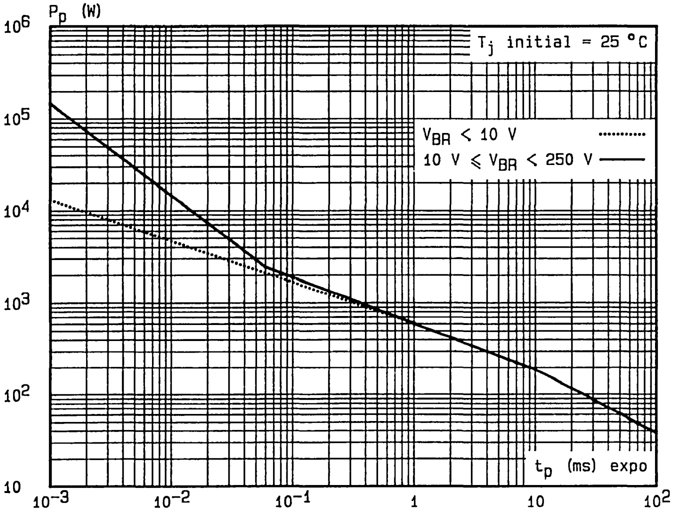


Fig.1 - Peak pulse power versus exponential pulse duration.

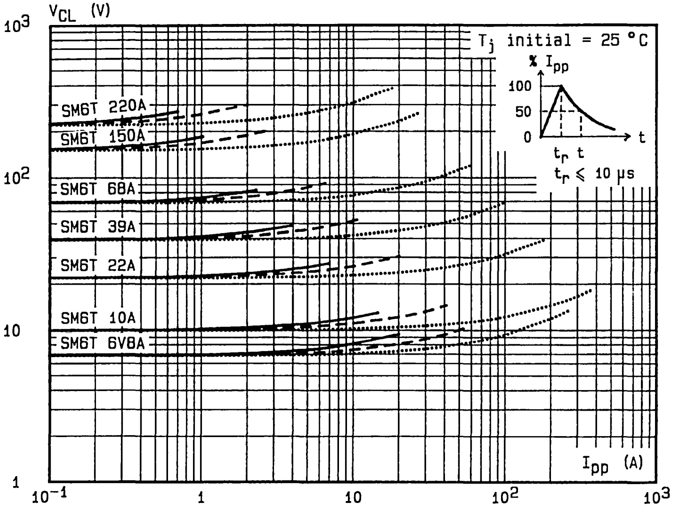


Fig.2 - Clamping voltage versus peak pulse current.
exponential waveform t = 20 µs ··········
t = 1 ms – – –
t = 10 ms ——

Note : The curves of the figure 2 are specified for a junction temperature of 25 °C before surge. The given results may be extrapolated for other junction temperatures by using the following formula : $\Delta V_{(BR)} = \alpha_{T(V(BR))} \times [T_j - 25] \times V_{(BR)}$
For intermediate voltages, extrapolate the given results.

D88SM6TP4

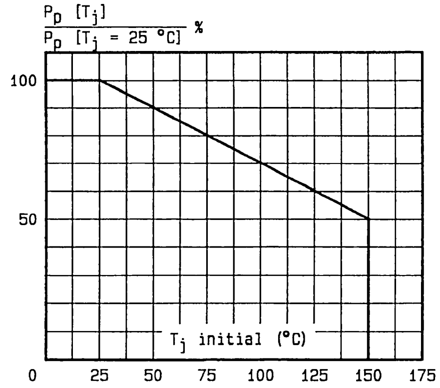


Fig.3 - Allowable power dissipation versus junction temperature.

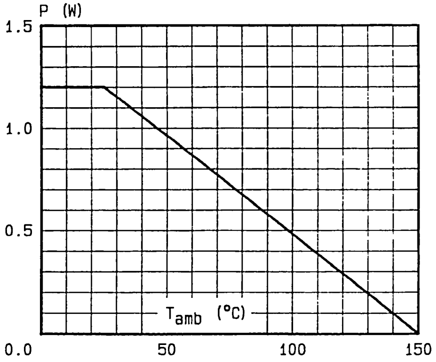


Fig.4 - Power dissipation versus ambient temperature.

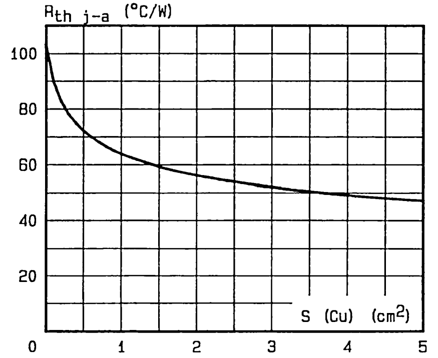


Fig.5 - Thermal resistance junction-ambient versus Cu surface (printed circuit).

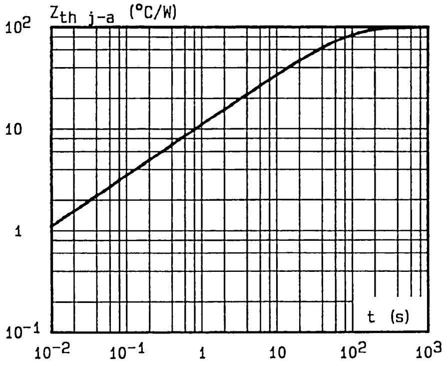


Fig.6 - Transient thermal impedance junction-ambient versus pulse duration.

D88SM6TP5

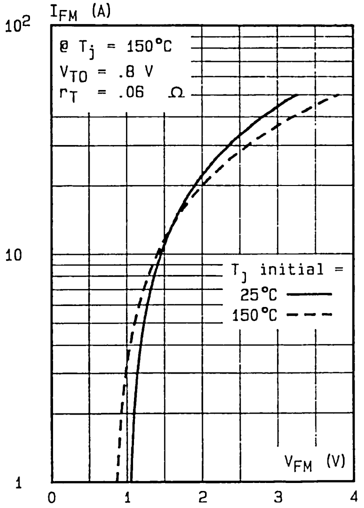


Fig.7 - Peak forward current versus peak forward voltage drop (typical values for unidirectional types).

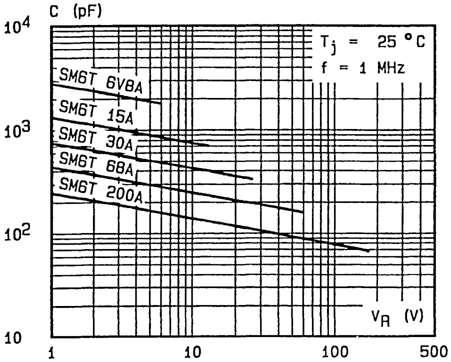


Fig.8a - Capacitance versus reverse applied voltage for unidirectional types (typical values).

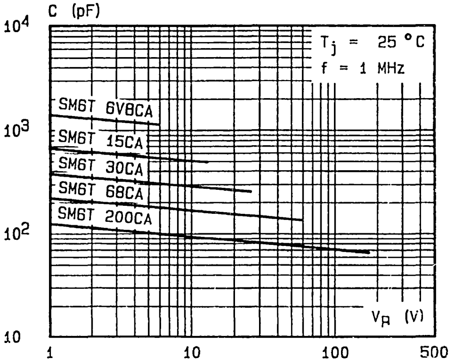


Fig.8b - Capacitance versus reverse applied voltage for bidirectional types (typical values).

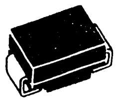
D88SM6TP6

SGS-THOMSON
MICROELECTRONICS

SM15T6V8, A → 220, A
SM15T6V8C, A → 200C, A

UNI-AND BIDIRECTIONAL TRANSIENT VOLTAGE SUPPRESSORS

- HIGH SURGE CAPABILITY :
  1.5 kW / 1 ms EXPO
- VERY FAST CLAMPING TIME :
  1 ps FOR UNIDIRECTIONAL TYPES
  5 ns FOR BIDIRECTIONAL TYPES
- LARGE VOLTAGE RANGE :
  5.5 V → 188 V
- ORDER CODE :
  TYPE NUMBER FOR UNIDIRECTIONAL TYPES, TYPE NUMBER + SUFFIX C FOR BIDIRECTIONAL TYPES



SOD 15
(Plastic)

DESCRIPTION

Transient voltage suppressor diodes especially useful in protecting integrated circuits, MOS, hybrids and other voltage-sensitive semiconductors and components.

SURFACE MOUNT TRANSIL FEATURES

- A PERFECT PICK AND PLACE BEHAVIOUR
- AN EXCELLENT ON BOARD STABILITY
- A FULL COMPATIBILITY WITH BOTH GLUING AND PASTE SOLDERING TECHNOLOGIES
- BODY MARKED WITH TYPE CODE AND LOGO
- STANDARD PACKAGING : 12 mm TAPE (EIA STD. RS481)
- TINNED COPPER LEADS
- HIGH TEMPERATURE RESISTANT RESIN

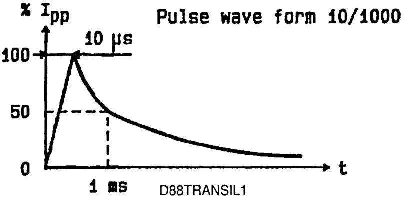
ABSOLUTE RATINGS (limiting values)

Symbol	Parameter		Value	Unit
P_p	Peak Pulse Power for 1 ms Exponential Pulse	T_j Initial = 25 °C See note 1	1500	W
P	Power Dissipation on Infinite Heatsink	T_{amb} = 25 °C	1.7	W
I_{FSM}	Non Repetitive Surge Peak Forward Current for Unidirectional Types	T_j Initial = 25 °C t = 10 ms	150	A
T_{stg} T_j	Storage and Operating Junction Temperature Range		– 65 to 175 150	°C °C
T_L	Maximum Lead Temperature for Soldering During 10 s		260	°C

THERMAL RESISTANCE

Symbol	Parameter	Value	Unit
$R_{th(j-l)}$	Junction-leads	10	°C/W

Note : 1. For surges upper than the maximum values, the diode will present a short-circuit anode-cathode.



ELECTRICAL CHARACTERISTICS (T_j = 25 °C)

Symbol	Parameter		Value
V_{RM}	Stand-off Voltage		See tables
$V_{(BR)}$	Breakdown Voltage		
$V_{(CL)}$	Clamping Voltage		
I_{pp}	Peak Pulse Current		
α_T	Temperature Coefficient of $V_{(BR)}$		
C	Capacitance		
$t_{clamping}$	Clamping Time (0 volt to $V_{(BR)}$)	Unidirectional Types	1 ps max.
		Bidirectional Types	5 ns max.

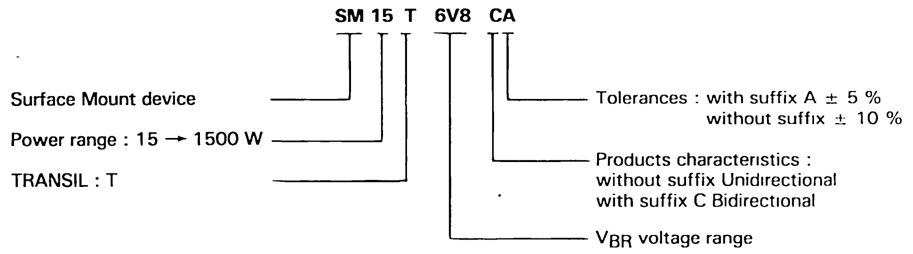
Types		Marking		I_{RM} @ V_{RM} max.		$V_{(BR)}$* (V)	@		I_R	$V_{(CL)}$ @ I_{pp} max. 1ms expo		$V_{(CL)}$ @ I_{pp} max. 8-20µs expo		α_T max.	C** typ. V_R=0 f=1MHz
Unidirectional	Bidirectional	Unidirectional	Bidirectional	(µA)	(V)	min.	nom.	max.	(mA)	(V)	(A)	(V)	(A)	(10^{-4}/°C)	(pF)
SM15T6V8	SM15T6V8C	MDD	BDD	1000	5.5	6.12	6.8	7.48	10	10.8	139	14	714	5.7	9500
SM15T6V8A	SM15T6V8CA	MDE	BDE	1000	5.8	6.45	6.8	7.14	10	10.5	143	13.4	746	5.7	9500
SM15T7V5	SM15T7V5C	MDF	BDF	1000	6.05	6.75	7.5	8.25	10	11.7	128	15.2	660	6.1	8500
SM15T7V5A	SM15T7V5CA	MDG	BDG	1000	6.4	7.13	7.5	7.88	10	11.3	132	14.5	690	6.1	8500
SM15T10	SM15T10C	MDN	BDN	10	8.1	9.0	10	11	1	15	100	19.5	928	7.3	7000
SM15T10A	SM15T10CA	MDP	BDP	10	8.55	9.5	10	10.5	1	14.5	103	18.6	968	7.3	7000
SM15T12	SM15T12C	MDS	BDS	5	9.72	10.8	12	13.2	1	17.3	87	22.7	793	7.8	6000
SM15T12A	SM15T12CA	MDT	BDT	5	10.2	11.4	12	12.6	1	16.7	90	21.7	829	7.8	6000
SM15T15	SM15T15C	MDW	BDW	5	12.1	13.5	15	16.5	1	22	68	28.4	634	8.4	5000
SM15T15A	SM15T15CA	MDX	BDX	5	12.8	14.3	15	15.8	1	21.2	71	27.2	662	8.4	5000
SM15T18	SM15T18C	MED	BED	5	14.5	16.2	18	19.8	1	26.5	56.5	34	529	8.8	4300
SM15T18A	SM15T18CA	MEE	BEE	5	15.3	17.1	18	18.9	1	25.2	59.5	32.5	554	8.8	4300
SM15T22	SM15T22C	MEH	BEH	5	17.8	19.8	22	24.2	1	31.9	47	41.2	437	9.2	3700
SM15T22A	SM15T22CA	MEK	BEK	5	18.8	20.9	22	23.1	1	30.6	49	39.3	458	9.2	3700
SM15T24	SM15T24C	MEL	BEL	5	19.4	21.6	24	26.4	1	34.7	43	44.9	401	9.4	3500
SM15T24A	SM15T24CA	MEM	BEM	5	20.5	22.8	24	25.2	1	33.2	45	42.8	421	9.4	3500
SM15T27	SM15T27C	MEN	BEN	5	21.8	24.3	27	29.7	1	39.1	38.5	50.5	356	9.6	3200
SM15T27A	SM15T27CA	MEP	BEP	5	23.1	25.7	27	28.4	1	37.5	40	48.3	373	9.6	3200
SM15T30	SM15T30C	MEQ	BEQ	5	24.3	27	30	33	1	43.5	34.5	56.1	321	9.7	2900
SM15T30A	SM15T30CA	MER	BER	5	25.6	28.5	30	31.5	1	41.4	36	53.5	336	9.7	2900
SM15T33	SM15T33C	MES	BES	5	26.8	29.7	33	36.3	1	47.7	31.5	61.5	292	9.8	2700
SM15T33A	SM15T33CA	MET	BET	5	28.2	31.4	33	34.7	1	45.7	33	59	305	9.8	2700
SM15T36	SM15T36C	MEU	BEU	5	29.1	32.4	36	39.6	1	52	29	67.3	267	9.9	2500
SM15T36A	SM15T36CA	MEV	BEV	5	30.8	34.2	36	37.8	1	49.9	30	64.3	280	9.9	2500
SM15T39	SM15T39C	MEW	BEW	5	31.6	35.1	39	42.9	1	56.4	26.5	73	246	10.0	2400
SM15T39A	SM15T39CA	MEX	BEX	5	33.3	37.1	39	41	1	53.9	28	69.7	258	10.0	2400
SM15T68	SM15T68C	MFN	BFN	5	55.1	61.2	68	74.8	1	98	15.3	127	142	10.4	1550
SM15T68A	SM15T68CA	MFP	BFP	5	58.1	64.6	68	71.4	1	92	16.3	121	148	10.4	1550
SM15T100	SM15T100C	MFW	BFW	5	81	90	100	110	1	144	10.4	187	96	10.6	1150
SM15T100A	SM15T100CA	MFX	BFX	5	85.5	95	100	105	1	137	11	178	101	10.6	1150
SM15T150	SM15T150C	MGH	BGH	5	121	135	150	165	1	215	7	277	65	10.8	850
SM15T150A	SM15T150CA	MGK	BGK	5	128	143	150	158	1	207	7.2	265	68	10.8	850
SM15T200	SM15T200C	MGU	BGU	5	162	180	200	220	1	287	5.2	370	48.5	10.8	675
SM15T200A	SM15T200CA	MGV	BGV	5	171	190	200	210	1	274	5.5	353	51	10.8	675
SM15T220		MGW		5	175	198	220	242	1	344	4.3	406	44.5	10.8	625
SM15T220A		MGX		5	185	209	220	231	1	328	4.6	388	46.5	10.8	625

* Pulse test $t_p \leq 50$ ms $\delta < 2$ %.

** Divide these values by 2 for bidirectional types.

For bidirectional types, electrical characteristics apply in both directions.

ORDER CODE



SM 15 T 6V8 CA

Surface Mount device

Power range : 15 → 1500 W

TRANSIL : T

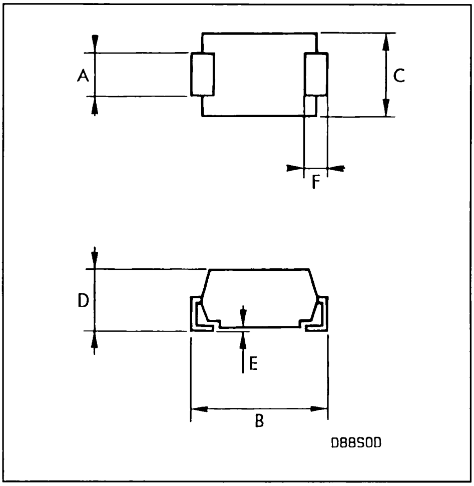
Tolerances : with suffix A ± 5 %
without suffix ± 10 %

Products characteristics :
without suffix Unidirectional
with suffix C Bidirectional

V_{BR} voltage range

PACKAGE MECHANICAL DATA

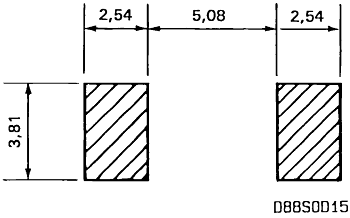
SOD 15 Plastic



Ref.	Millimetres		Inches	
	Min.	Max.	Min.	Max.
A	2.8	3.2	0.110	0.126
B	7.6	8.0	0.300	0.315
C	4.8	5.2	0.190	0.200
D	2.5	3.1	0.098	0.122
E	–	0.1	–	0.004
F	1.3	1.7	0.051	0.067

Laser marking.
The logo indicates cathode for unidirectional types.

FOOT PRINT DIMENSIONS (Millimeters)



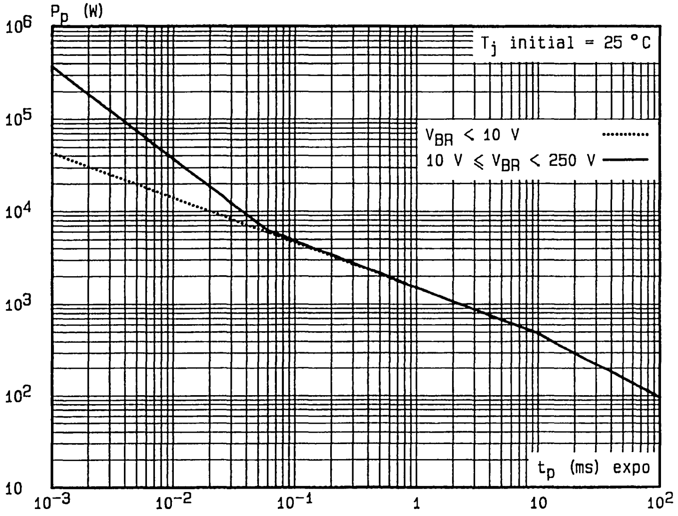


Fig.1 - Peak pulse power versus exponential pulse duration.

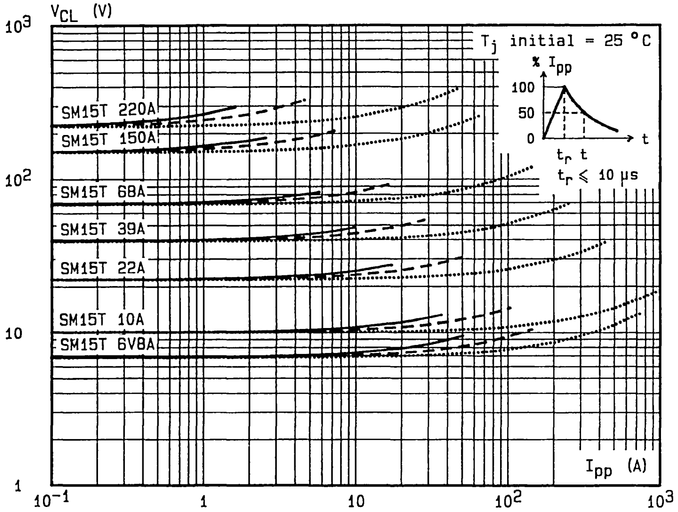


Fig.2 - Clamping voltage versus peak pulse current.
exponential waveform t = 20 µs ··········
t = 1 ms – – –
t = 10 ms ———

Note : The curves of the figure 2 are specified for a junction temperature of 25 °C before surge. The given results may be extrapolated for other junction temperatures by using the following formula : $\Delta V_{(BR)} = \alpha_{T(V(BR))} \times [T_j - 25] \times V_{(BR)}$
For intermediate voltages, extrapolate the given results.

D88SM15TP4

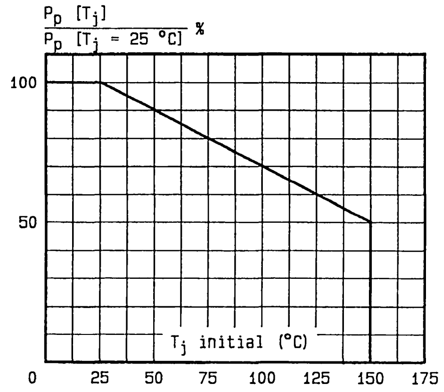


Fig.3 - Allowable power dissipation versus junction temperature.

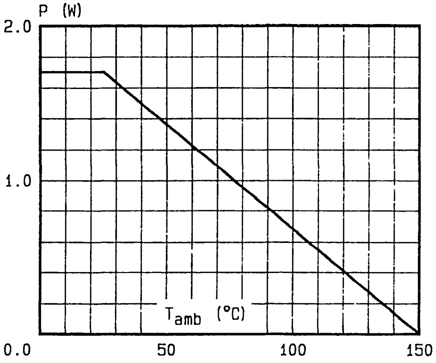


Fig.4 - Power dissipation versus ambient temperature.

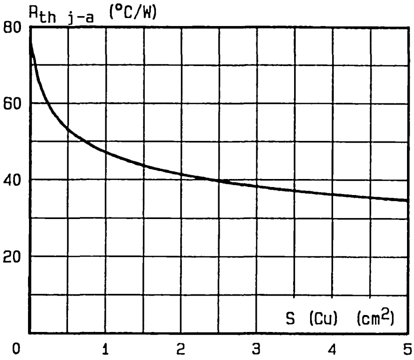


Fig.5 - Thermal resistance junction-ambient versus Cu surface (printed circuit).

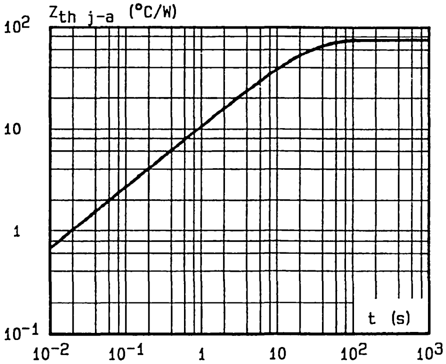


Fig.6 - Transient thermal impedance junction-ambient versus pulse duration.

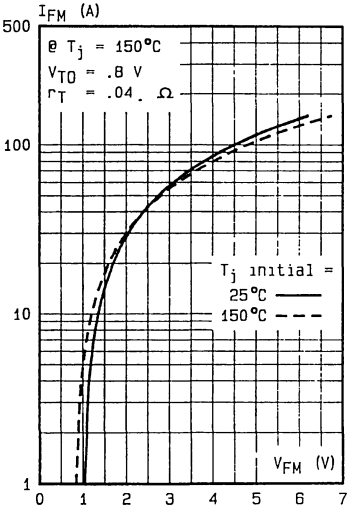


Fig.7 - Peak forward current versus peak forward voltage drop (typical values for unidirectional types).

D88SM15TP5

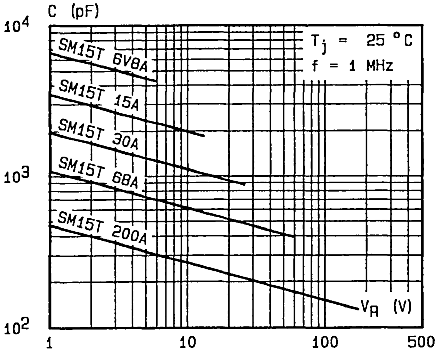


Fig.8a - Capacitance versus reverse applied voltage for unidirectional types (typical values).

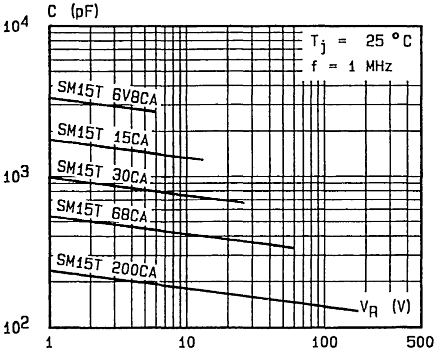


Fig.8b - Capacitance versus reverse applied voltage for bidirectional types (typical values).

D88SM15TP6

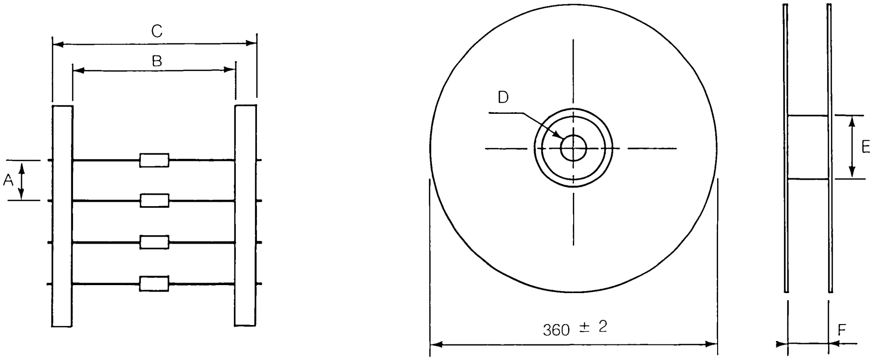
PACKAGING

PACKAGING STANDARD FOR DIODES

TAPE AND REEL

Case	Quantity per reel	Component spacing A	Tape spacing B	Tape spacing C	Reel dimensions D	Reel dimensions E	Reel dimensions F
F 126	6000	5 ± 0.5	53 ± 2	65 ± 2	31.5	86	81
CB-417	5000	5 ± 0.5	53 ± 2	65 ± 2	31.5	86	81
DO 27	1900	10 ± 0.5	53 ± 2	65 ± 2	31.5	86	81
CB-429	1900	10 ± 0.5	53 ± 2	65 ± 2	31.5	86	81

Note: Sizes are given in millimeters.



Note: All polarized components must be oriented in one direction
The cathode lead tape shall be red, and the anode tape shall be whıte.

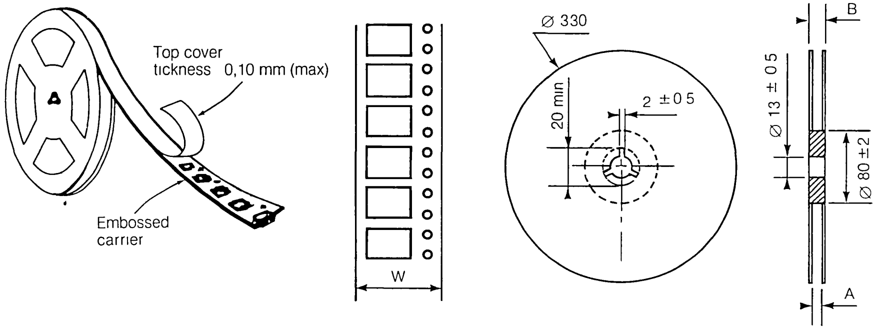
BULK PACKAGING

Case	F 126	CB-417	DO 27	CB-429	AG	DO 13	TO 220
Quantity per box	1000	1000	500	500	1000	100	500

PACKAGING STANDARD FOR DIODES

SURFACE MOUNT

Case	Quantity per reel	Film width	Reel dimensions	
			A	B
SOD 6	2500	12	12.4 ± 2	18.4 ± 2
SOD 15	2500	16	16.4 ± 2	22.4 ± 2



Note: Polarized devices have cathode lead oriented towards the perforated side of the film.

TUBE PACKAGING

- available for TO 220 package.
- quantity standard per tube is 18 units.

LABEL MARKING

Labels on reels, boxes and card board must indicate:

- manufacturer’s name,
- part number type,
- quantity,
- date code,
- lot number.

APPLICATION NOTES

SGS-THOMSON
MICROELECTRONICS

APPLICATION NOTE

HOW TO CHOOSE A TRANSIL

By Jean-Marie PETER

INTRODUCTION

The Transil is an avalanche diode specially designed to clamp over voltages and dissipate high transient power. A Transil has to be selected in two steps :

A). Check that the circuit operating conditions do not exceed the specified limit of the component.

- For non-repetitive "shock" operation,
- For repetitive load operation,
- For continuous operation.

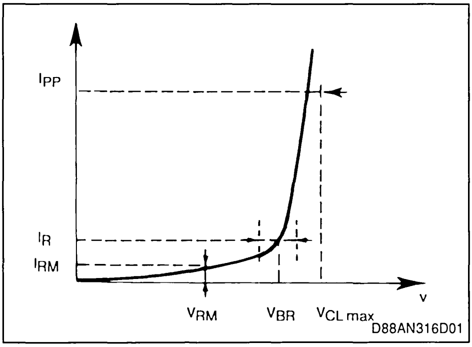
B). Check that the maximum value of the clamped voltage under the most adverse conditions corresponds to the V_C specification of the circuit, i.e. there is no danger for the protected circuits.

REVIEWING THE CHARACTERISTICS OF TRANSIL

1. THE PEAK REVERSE VOLTAGE V_{RM} is the voltage which the Transil can withstand in continuous operation.

2. THE BREAKDOWN VOLTAGE OR KNEE VOLTAGE V_{BR} is the voltage value above which the current in the Transil increases very fast for a slight increase in voltage. The breakdown voltage V_{BR} is specified at 25 °C and its temperature coefficient is positive. The V_{BR} tolerance is normally ± 5 % or – 5 % + 10 % , however it is important to note that Transil technology enables obtaining much lower tolerance in mass production than the other technologies.

Figure 1 : Main Characteristics of a Transil.

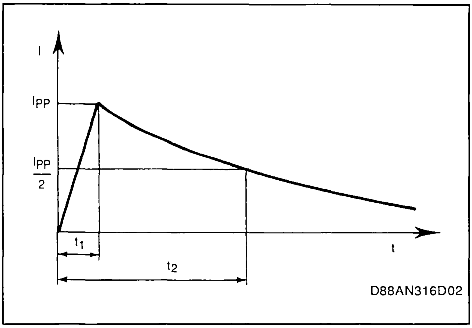


3. THE CLAMPING VOLTAGE V_{CL} as specified in the data-sheets in the maximum value for the "standard" pulse with a peak value of I_{PP}, specified for any type of TRANSIL. (fig. 2).

If the Transil is subjected to a different pulse, the data given in the data-sheets enables calculating the maximum value V_{CL} reached which depends, first of all, on the current level, and then, to a lesser degree, on the duration of the pulse, and finally (by means of the temperature coefficient) on the initial temperature.

The campling factor is represented by V_{CL}/V_{BR}. This ratio between the maximum value of overvoltage for a given current and the maximum voltage which the diode can withstand in continuous operation characterizes the quality of the protection.

Figure 2 : Standard Exponential Pulse. This type of pulse corresponds to most of the standards used for the protection of electronic equipment.



	t_1 µs	t_2 µs
WAVE "8/20µs"	8	20
WAVE "10/1000µs"	10	1000

4. TRANSIL'S POWER DISSIPATION (non-repetitive operation).

A protecting device whose operation is adiabatic can dissipate the very same energy.

$$W = \int_0^{\tau} V_{CL}\, i\, dt$$

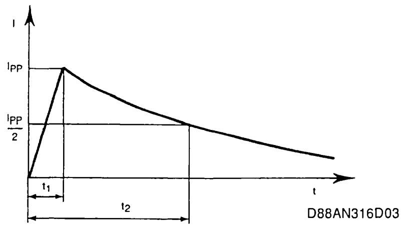
Whatever the duration τ of the surge ; a component of this type is said to be "iso-energetic".

The first protection devices, designed to meet electrotechnical standards, often had an iso-energetic behaviour, and they were mostly used for short over voltages (of the 1/50 µs wave type) encountered on high voltage lines. The research carried out by the CNET (French Telecommunications Agency), confirmed by research abroad, tends to show that low-power electronic equipment is subjected to over voltages of a much longer duration, better represented by 10/1000 µs exponential wave is fig. 2.

Transil are meant to protect electronic equipment and hence have been designed not to be iso-energetic but to perform well for over voltages up to durations of 1 ms.

The performance of Transil has thus been determined with reference to the standard exponential wave 10/1000 µs.

Figure 3 : Maximum Power for an Exponential Pulse of Duration t.



$P_P = V_{BR} - I_{PP}$

The maximum possibilities correspond to non-repetitive operation. If the pulse has a different duration, a curve similar to that in fig. 3, provided in the datasheets, enables determining the specifications of the Transil.

If the initial temperature exceeds 25 °C, the power (P_P) should be reduced in accordance with the curve of fig. 4 which is the same for all the Transil.

If the current surge through the Transil is not exponential, the indications of the table of fig. 5 enable calculating the equivalent exponential pulse.

Figure 4 : Variation of Peak Power as a Function of the Initial Temperature. This curve should only be used for pulse durations of less than 0.01 s.

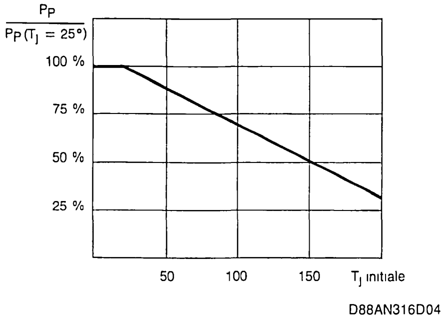
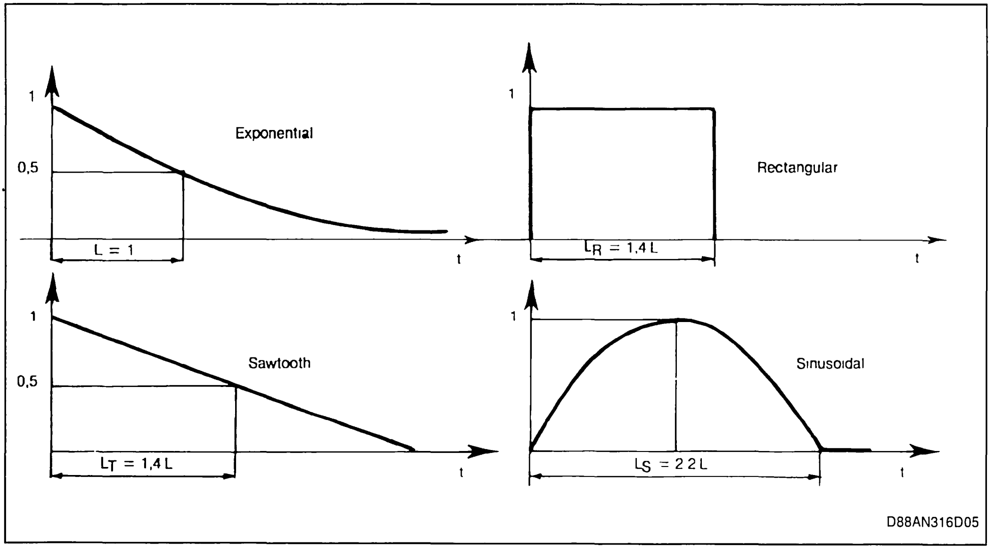


Figure 5 : Above four Pulses of same Peak Value Lead to an Identical Dissipated Power in a Transil. For example : the rectangular pulse which gives the same dissipation than the exponential pulse for a same peak value is 1.4 times longer.



5. POSSIBILITY OF POWER DISSIPATION BY TRANSIL IN MEAN POWER.

In repetitive operation, the specification to be considered is mean power P_{AV}.

$$P_{AV} = f.W$$

(f : frequency, W : energy dissipated at each pulse)

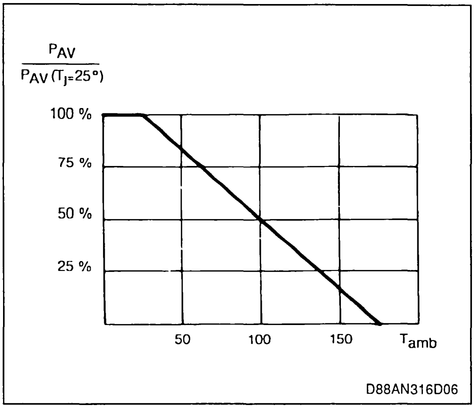
The junction temperature calculated from this power should in no case exceed 175 °C (note that this is the mean temperature).

This temperature is calculated from the thermal resistance, exactly like for a diode. The experience of our application laboratories leads to recommending much lower mean junction temperatures - of about 100 to 110 °C - for repetitive industrial operation.

$T_j = T_{amb} + R_{th} . P_{AV}$

$R_{th} = R_{th\ (j\text{-}a)}$ for axial lead Transil.

Figure 6 : Maximum Average Power as a Function of Ambient Temperature.



6. SPEED.

The first purpose of a Transil is to clamp over voltages produced by current surges.

A conventional lightning arrester system only responds with a certain delay which can reach 2 µs. A metal oxide varistor does not respond immediately either (delay of about 25 ns).

If a current with a very low rise time flows through these components, an over voltage could appear before the device reacts.

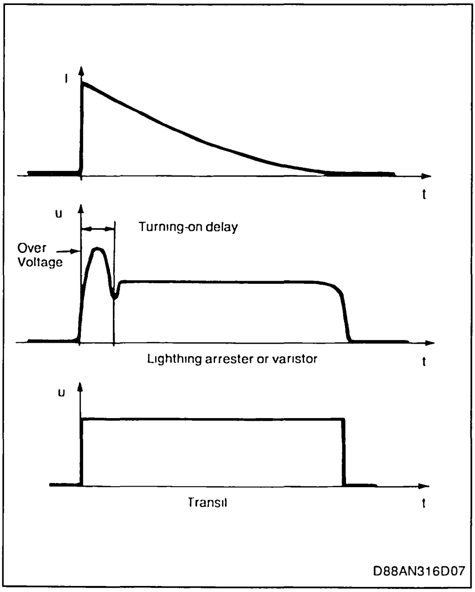
In the case of Transil, the avalanche phenomenon of a silicon diode is extremely fast (theoretical value about one picosecond).

In laboratory tests we have never succeeded in producing over-voltages across Transil, even by using special device producing very steep current gradients (dischargers, mercury relays).

In conclusion it can be said that Transil respond instantaneously in clamping, on condition that di/dt overvoltages are not introduced by connection inductances.

The low capacitance Transil and the bidirectional models have clamping times of about 5 ns. These times remain negligible for practically all applications.

Figure 7 : Voltage Response of a Classical Component used for Protection and of a Transil.



7. SPEED IN "DIODE" OPERATION.

A Transil operating as a rectifier is not a fast recovery diode (it has a high recovered charge). As a result, Transil cannot be used for the rectifier function instead of fast recovery diodes.

On the other hand, a Transil operating as a diode has very low forward recovery time (and a very low forward peak voltage V_{FP}). This property can be used for particular applications since no other existing diode has a lower turn-on time for a given V_{BR} (or V_{RM}) voltage.

Figure 8 : Behaviour of a Transil Operating as a Diode at Turn-off.

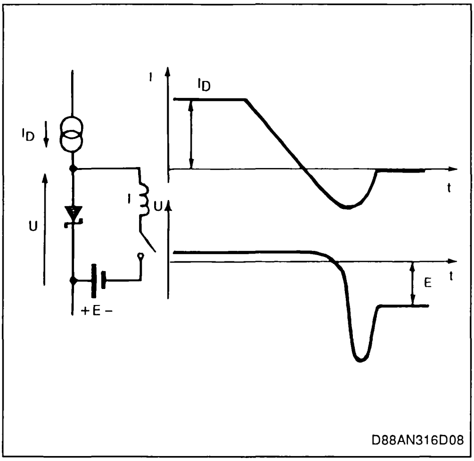
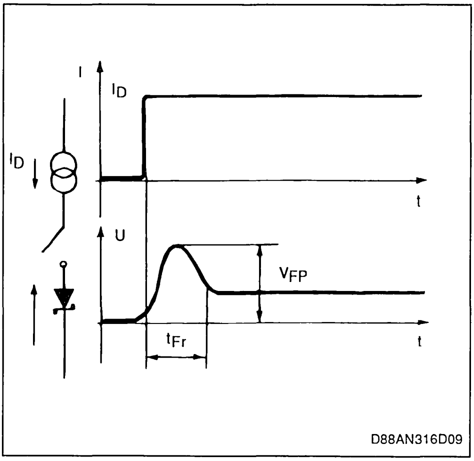


Figure 9 : Behaviour of a Transil Operating as a Diode at Turn-on.



8. CALCULATION OF THE SURGE VOLTAGE. This is a very important step. A Transil is designed for protection, and the user should know the peak voltage after clamping, V_{CL}, in the presence of a current pulse.

When the Transil operates in the avalanche mode, the clamping voltage exceeds the V_{BR} value by a quantity which depends on :

- the peak current,
- the duration of the pulse,
- the initial temperature of the "simplified" Transil.

The data-sheets specify the maximum value of V_{CL} for each type of Transil associated with the maximum current I_{PP} for a standard exponential wave. The curves in the detailed data-sheets (a simplified example is given in fig. 10) give the characteristics for other durations (10 µs and 10 ms) and enable calculating (by interpolation) the maximum clamping voltage if the current surge has a shape other than that of the standard pulse.

Figure 10 : Characteristics given in the Simplified Data-sheets for Calculating the Clamping Voltage V_{CL}.

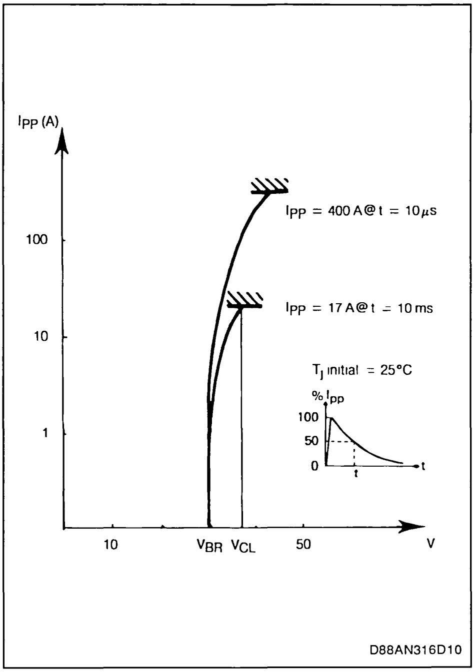
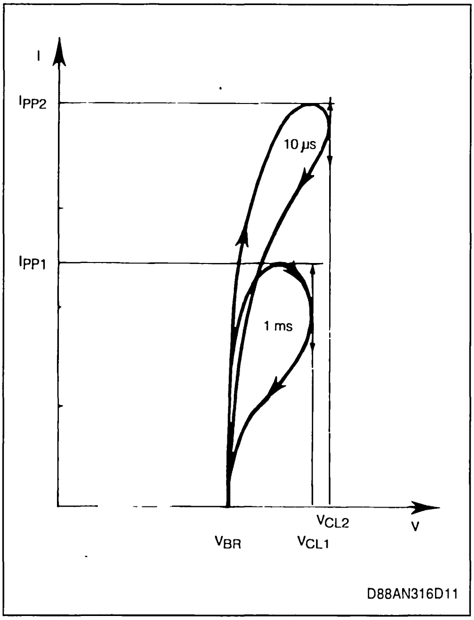


Figure 11 shows the real behaviour of the Transil. The voltage peak is not in phase with the current peak because of heating. The curves $I_{PP} = f(V_{CL})$ thus represent, in reality, the variation of the maximum voltage after clamping.

All the values are given for an initial temperature of 25 °C before the surge and should be corrected as a function of the temperature coefficient as provided in the data-sheets.

Figure 11 : Behaviour of a Transil Subjected to two Pulses of Different Durations.



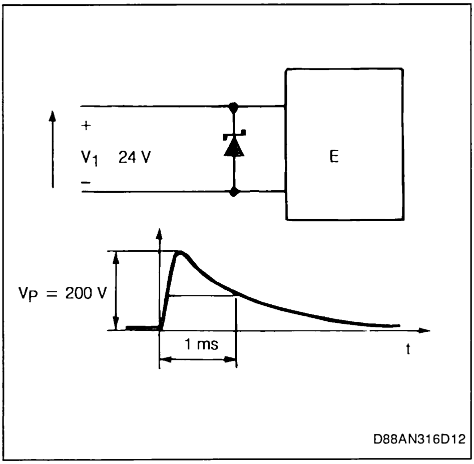
9. CALCULATION EXAMPLE

9.1. NON-REPETITIVE SURGES.

A source (V_1) with a rated voltage of a 24 V supplies equipment E which is to be protected against over voltages. This source is subjected to random non-repetitive exponential over voltages with amplitudes of 200 V and a duration of 1 ms at 50 % (standard wave) (see fig. 12). The equivalent internal impedance Φ of the source with respect to 1 ms exponential waves is 13 Ω.

The maximum ambient temperature is 80 °C. In no case should equipment E be subjected to a voltage higher than 50 V.

Figure 12.



9.1.1. Selection of the protection voltage

In the absence of specific information, we assume that voltage V_1 varies by ± 20 %, ie between 20 V and 29 V.

The protection voltage V_{RM} of the Transil should then be equal or superior to 29 V.

9.1.2. Predetermination of the peak power P_P

The equipment E cannot withstand a voltage above 50 V → $V_{CL} \leq 50$ V.

We assume there is a Transil answering to this criterion, what allows to make a first determination of the power of the Transil we will use.

$$P_P = V_{CL} \text{ x } I_P \text{ where } I_P = \frac{V_P - V_{CL}}{\Phi}$$

$$I_P = \frac{+200 - 50}{13} = 11.5A$$

and $P_p = 50 \text{ x } 11.5 = 577$ W

This power corresponds to an operating temperature of 80 °C. The data sheets indicate power at 25 °C so we have to correct the power according to the curves of admissible power versus initial temperature.

So we obtain :

$$P_P\,(25\,°C) = \frac{P_P\,(80\,°C)}{0.8}$$

$$P_P\,(25\,°C) = \frac{577}{0.8} = 721 \text{ W}$$

9.1.3. Selection of the Transil

We can now establish a first specification of the Transil to use.

$V_{RM} \geq 29$ V

$V_{CL} \leq 50$ V for $I_p = 11.5$ A

P_P (25 °C) = 721 W/1 ms

The type corresponding to these characteristics is the 1.5 KE 36P.

$V_{RM} = 30.8$ V

$V_{BR\,nom} = 36$ V ; min 34.2 V ; max 39.6 V

$V_{CL\,max} = 49.9$ V $I_{PP} = 30$ A

$P_P = 1500$ W/1 ms

$\alpha_T = 9.9 \text{ x } 10^{-3}$

9.1.4. Determination of the clamping voltage V_{CL}.

To determine the voltage V_{CL} at 1.,5 A, we can use the I_{PP}/V_{CL} curves included in the 1.5 KE data sheets.

V_{CL} at $I_P \approx V_{BR\,max} + R_D \cdot I_P$

R_D can be determined from the indications in the data sheets.

$$R_D \leq \frac{V_{CL} - V_{BR}}{I_{PP}}$$

$$V_{CL} \text{ at } 11.5 \text{ A} \approx 39.6 + \frac{49.9 - 36}{30} \text{x } 11.5 = 44.9 \text{ V}$$

9.1.5. Temperature correction

The voltage at 80 °C is :

V_{CL} (80 °C) = V_{CL} (25 °C) [1 + α_T (T_j - 25 °)]

V_{CL} (80 °C) = 44.9 [1 + 9.9 10^{-4} (80 - 25)]

≈ 47.3 V

This value is below the 50 V limit. The Transil insures the protection.

9.2. REPETITIVE SURGE. We have to protect the transistor shown on fig. 13 with a Transil whose clamping voltage, V_{CL}, is not exceeding 85 V.

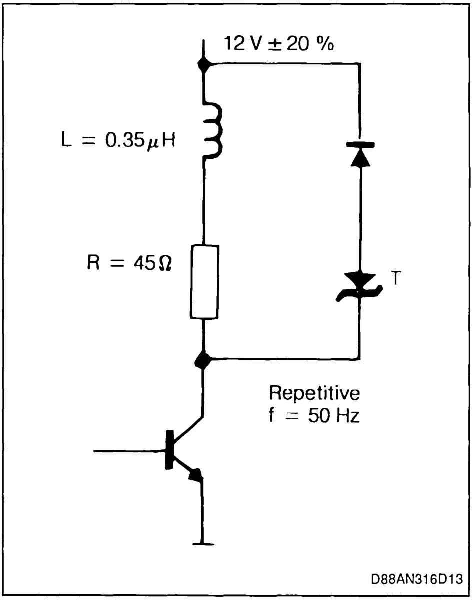
Calculation method

To avoid a long calculation, we assume :

$V_{CL} \approx V_{BR}$ **only true in the case of repetitive surges.**

The experience shows this hypothesis is confirmed in most of the cases with Transil, for we have to choose the Transil considering its thermal resistance first (it is not the same with zeners which have higher dynamical resistance).

Figure 13.



9.2.1. P_{AV}

An approximate value can be obtained by supposing that all the energy contained in the inductance is absorbed by the Transil. This hypothesis is near the reality when the ratio

$\frac{V_{BR}}{V}$ is important

$$PAV = \frac{1}{2}\ LI2f\ \ \frac{1}{2}\ \ 0.35 \left[\frac{12 + 2.4}{45}\right]^2 \ .\ 50$$
$$= 0.9\ W$$

9.2.2. First choice

We choose the type BZW 04P64 $V_{BR\,max}$ = 82.5 V

R_{th} = 100 °C/W

9.2.3. T_j calculation

$T_j = T_{amb} + P_{AV} . R_{th} = 50 + 90 = 140$ °C

This value is compatible with the Transil characteristics, but we consider that the safety coefficient is not sufficient.

9.2.4. Second choice

1.5 KE 75P $V_{BR\,max}$ = 82,5 V R_{th} = 75 °C/W

9.2.5. T_j calculation

$T_j = 50 + 68 = 118$ °C

9.2.6. Determination of V_{CL}

We see on the data sheets that for such a low current level $V_{CL} \approx V_{BR}$

9.2.7. Temperature correction

V_{CL} (118 °C) = V_{CL} (25 °C) [1 + α_T (118 - 25)]

= 90.5 Volts

This value is too high.

9.2.8. Third choice

$$\begin{cases} 1.5KE\ 68P\ V_{BR\,max} = 74.8\ V \\ V_{CL}\ (118\ °C) = 1.098 \times 74.8 = 82.5\ volts \end{cases}$$

The Transil 1.5 KE 68P is suitable.

Remark : This example shows that to the component dispersion we have to add the variation due to the temperature.

Figure 14 : Mounted on a Printed Circuit.

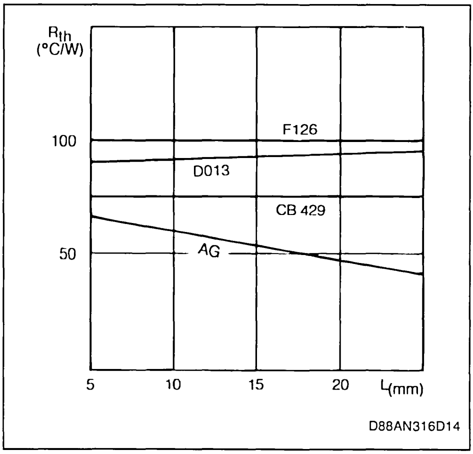
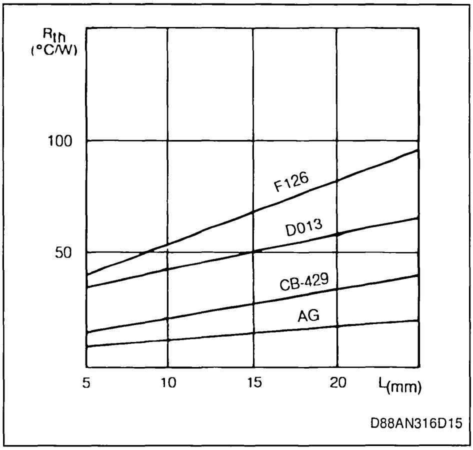
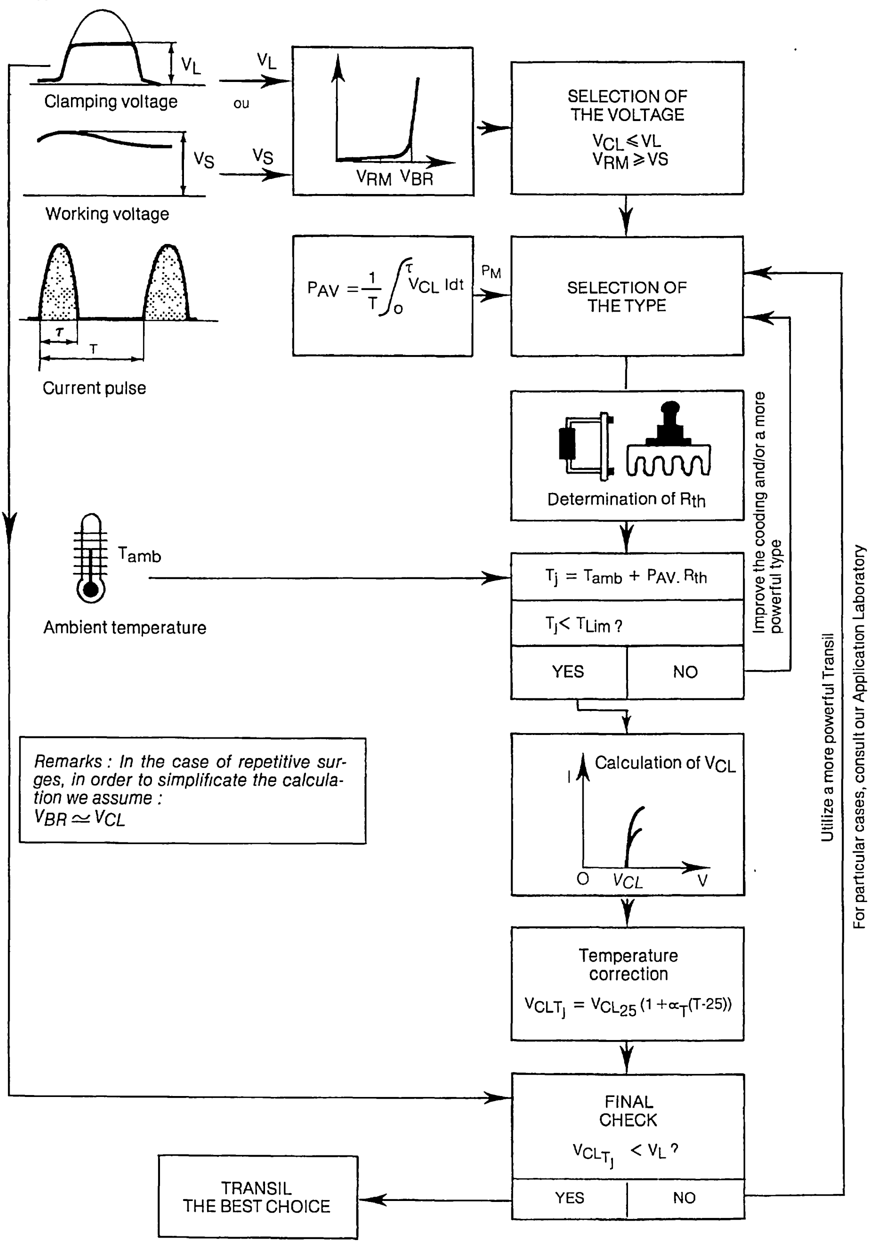


Figure 15 : Mounted on an Infinite Heatsink Thermal Resistance j-a versus Connections Length.



SELECTION OF A TRANSIL

For repetitive surges

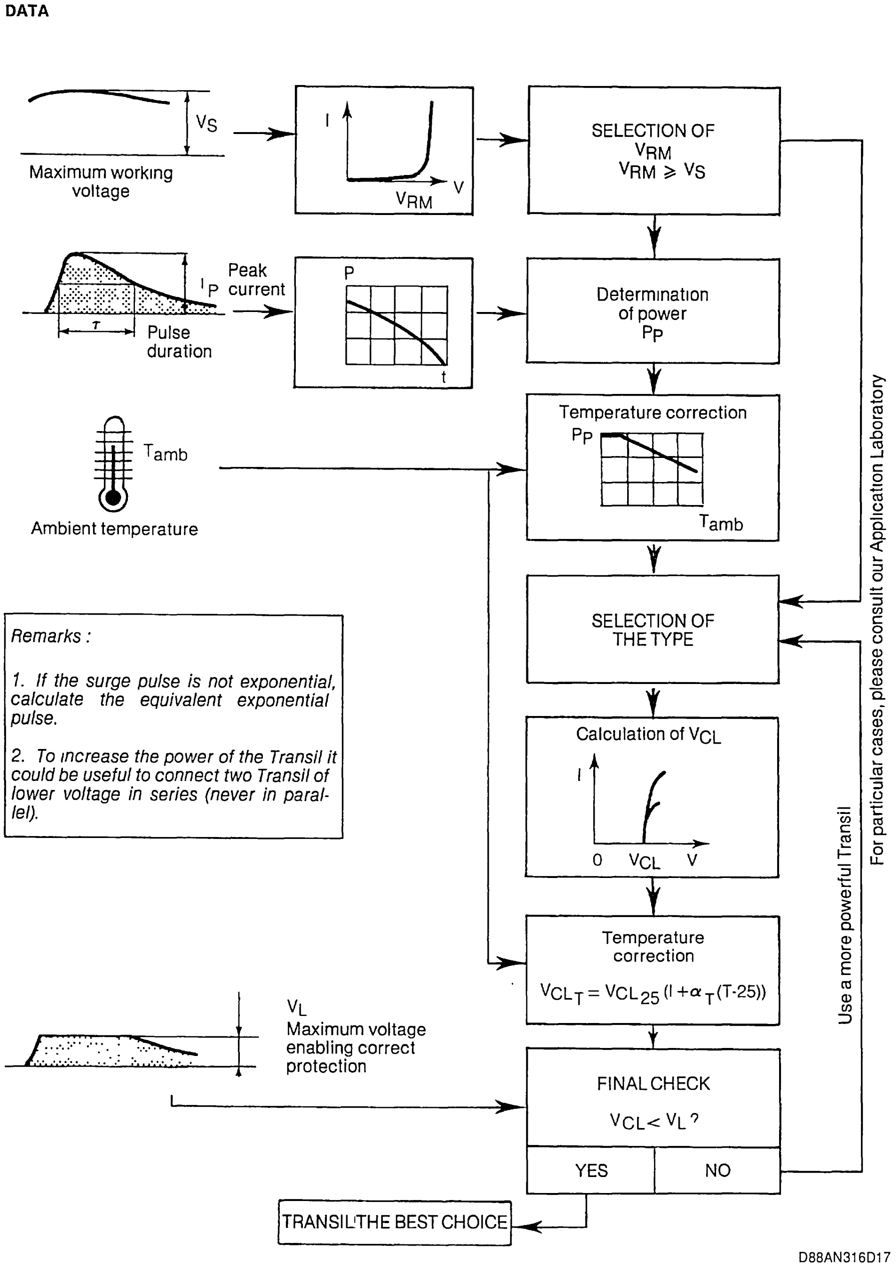


Remarks : In the case of repetitive surges, in order to simplificate the calculation we assume :
$V_{BR} \simeq V_{CL}$

D88AN316D16

SELECTION OF A TRANSIL

For a non-repetitive surge



Remarks :

1. If the surge pulse is not exponential, calculate the equivalent exponential pulse.

2. To increase the power of the Transil it could be useful to connect two Transil of lower voltage in series (never in parallel).

APPLICATIONS OF TRANSIL

Reviewing, Transil are silicon components and hence utilize a technology close to that of diodes. They have been specially designed to protect professional and industrial equipment.

Transil are the only protection components which simultaneously have the following characteristics :

- High operating temperature (175 °C maximum),
- Perfect stability of the characteristics in time, i.e. contrary to most other technologies, Transil do not age,
- Extremely short response time,
- Very narrow tolerances on the characteristics,
- Very low dynamic power impedance this leads to a very good clamping factor.

Transil have high power absorbing characteristics for over voltages with short durations, i.e. over voltages which are encountered mostly in electronic equipment.

Correctly cooled or mounted on a heatsink they can withstand either long duration overloads or non negligible mean powers in repetitive operation.

The purpose of this publication is to complete the previous information by showing some common applications.

UTILIZATION OF TRANSIL FOR RECTIFICATION

1. UTILIZATION OF TRANSIL AS RECTIFIER DIODES.

Transil are diodes specially designed to dissipate considerable power in avalanche operation. In direct conduction they have the properties of very good conventional diodes (with the possibility of handling very high surge currents) and operate as well as rectifiers.

The characteristics given in the data-sheets (I_{FSM}, forward voltage drop characteristic) enable calculating their values for these functions.

Each time this is possible, it is more attractive to use Transil directly as rectifiers instead of protecting the rectifiers with Transil, since the number of components is reduced.

The following table gives the equivalence between Transil and common rectifiers.

TRANSIL	P7T	1N 5634 to 1N 5665	1.5KE	BZW 50
Case	CB-417	DO 13	CB-429	AG
Rating of Equivalent Diode (A)	1	1.2	3	6

2. UTILIZATION OF TRANSIL FOR PROTECTION

2.1. WITH BRIDGE RECTIFIERS.

Considering the most general case, the voltage surge could be due either to the power supply or to the load.

A study of the operation of the bridge rectifier shows that it is sufficient to limit the voltage on the "dc" side to protect the bridge whatever the origin of the over vol-tage is. In all cases, a single Transil is sufficient to protect a single phase or a 3-phase bridge rectifier.

Figure 1 : The Diodes are not Protected from Over Voltages Due to the Load.

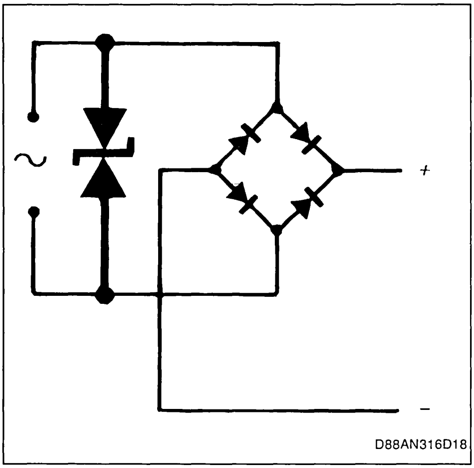


Figure 2 : Mixed Solution which Insures Protection of the Load and of the Rectifier Diodes. The 2 Transil work as rectifiers.

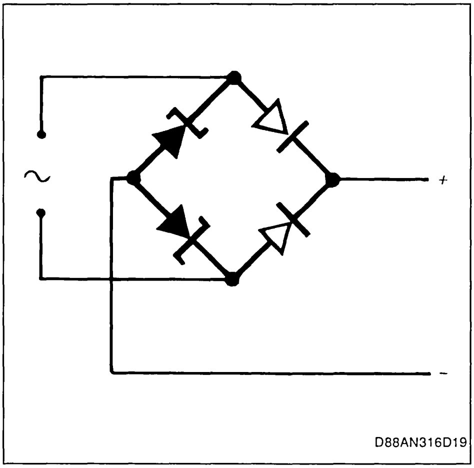
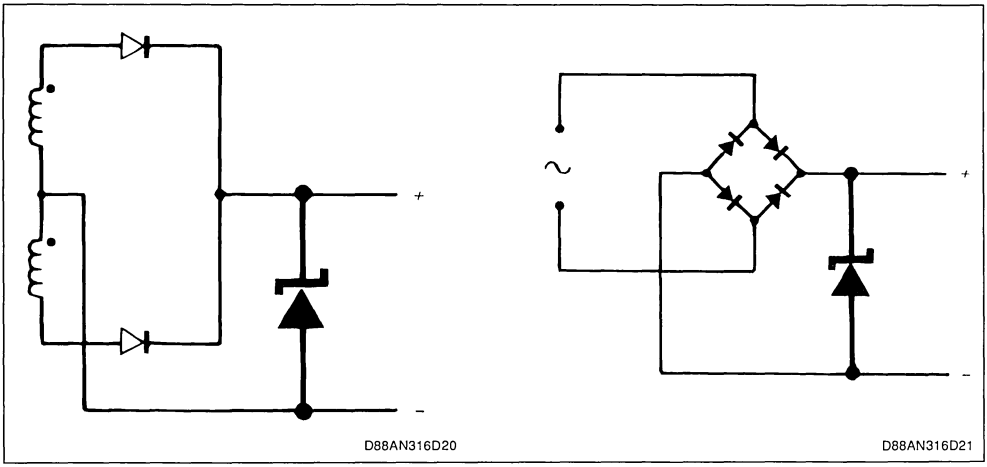


Figure 3 : Optimal Solution. A single Transil protects the rectifying components whatever the origin (power supply or load) of the over voltages.



UTILIZATION OF TRANSIL WITH THYRISTORS AND TRIACS

Figure 4 : Protection for Series Circuits.

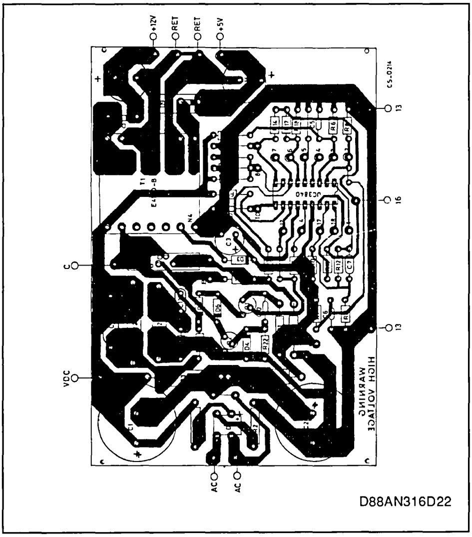


Figure 5 : Protection from False Triggerings.

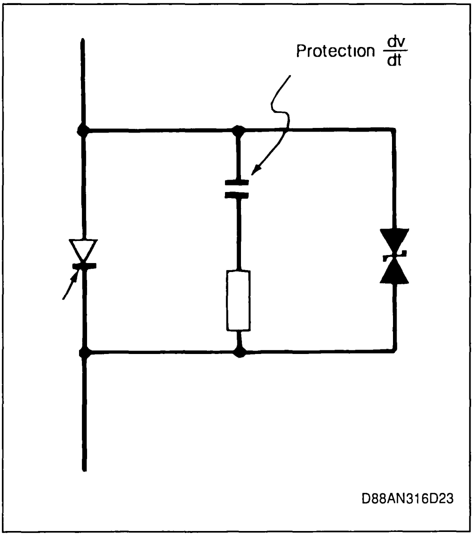


Figure 6 : The Transil as shown in this circuit does not prevent the thyristor from turning on by gate triggering, however it does prevent the thyristor from being triggered by over voltages.

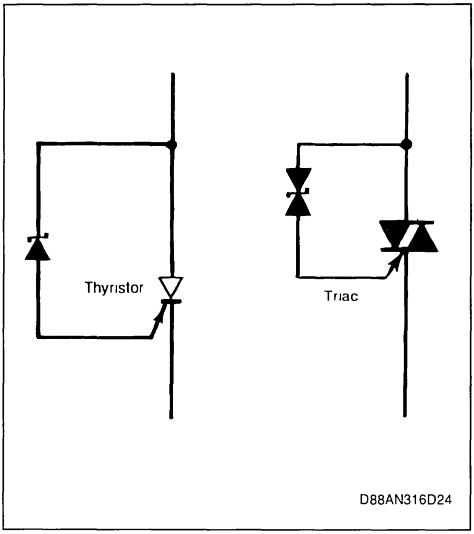
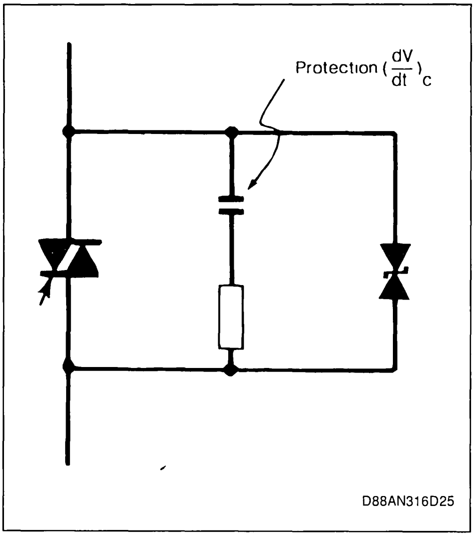


Figure 7 : Protection of Triacs.
a) from false triggering,
b) from over voltages due to an incorrect damping of the RC network.

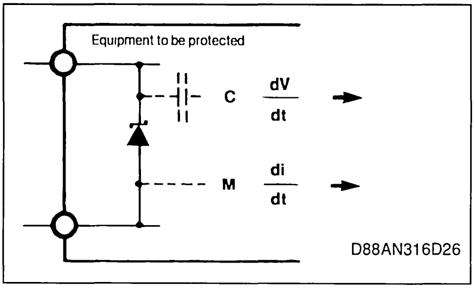


TRANSIL FOR PROTECTING MICROELECTRONIC CIRCUITS

DECENTRALIZED PROTECTION

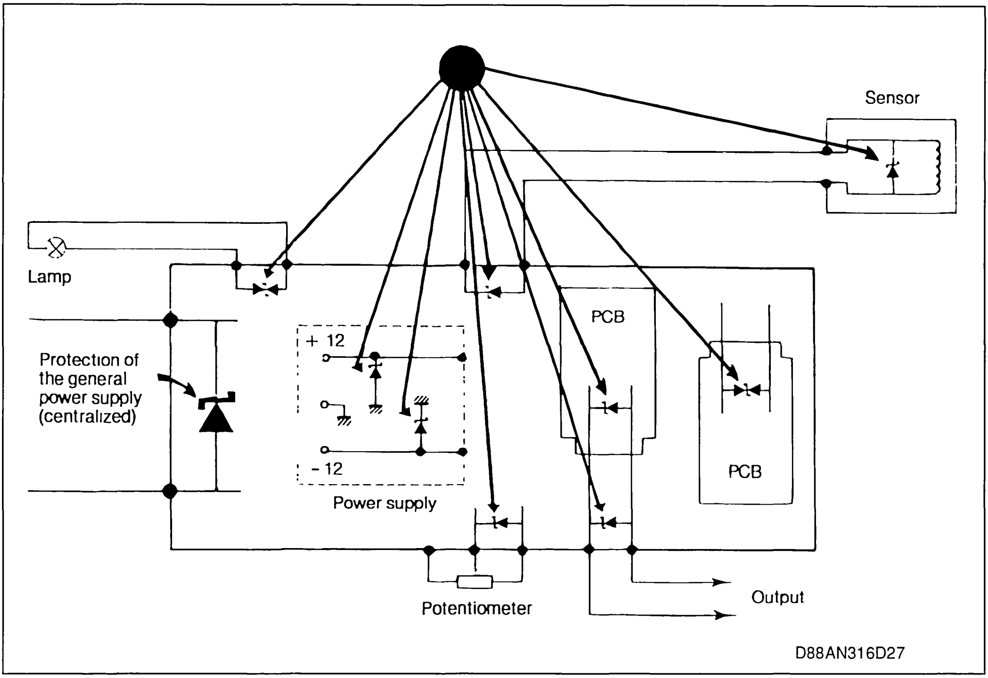
Protection from accidental surges (consequences of lightning, incorrect actuation on a mains network, short circuit or breaking of a cable etc.) cannot generally be carried out in a single place, for example a high-power protection device connected directly accross the power supply input. In reality, the surges are transmitted to the electronic circuits by various paths : unwanted capacitance, inductive coupling, etc. insufficiently known by the designer of the circuit. Experience shows that for adequate protection it is necessary to decentralize the protection, i.e. install the Transil at the exact point which needs to be protected.

Figure 8 : A Local Protection on the Power Supply is Insufficient.



DECENTRALIZED PROTECTION

Figure 9 : Decentralized Protection is Carried out Locally at each spot where the circuit can "communicate" with the exterior.



PROTECTION FROM TRANSIENTS GENERATED BY TRANSFORMERS

When a transformer is off-load the magnetizing current flowing through it is equal to :

$$i_o = \frac{V_1}{L1\omega} \sin(\omega t - \frac{\pi}{2})$$

Where L_1 is the inductance throught to winding n_1.

If the switch is turned off (at the most unfavorable moment $\omega t = \pi/2$), the Transil placed as a protection for the secondary, has to dissipate a power of.

$$W = \frac{1}{2} L(i_o \sqrt{2})^2 = Li_o^2$$

It corresponds to a peak power of :

$$P_P = i_o \sqrt{2}. V_{CL}$$

and this current will decrease as :

$$\frac{di}{dt} = \frac{V_{CL}}{L_2} \approx \frac{V_{BR}}{L_2}$$

If the magnetizing current (off-load current) is unknown, it can be evaluated according to the following table.

Knowledge of the magnetizing current enables determining L_1 and the power to be dissipated. The selection of V_{BR} will fix the duration of the pulse.

Figure 10.

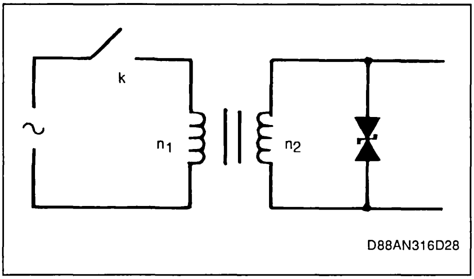
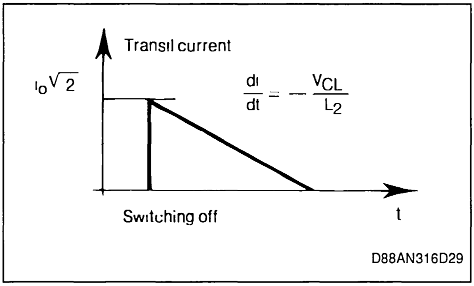


Figure 11: Decrease of the Current in the Transil of fig. 10.



Apparent Power (KVA) of the 50 Hz Transformer	0,1	1	5
Magnetizing Current/nominal Current	10 %	7 %	4 %

SHORT-CIRCUITS

When a short-circuit takes place, the current grows rapidly and the fuse blows, i.e. breaks the circuit only when the value of I_{CC} is sufficiently high (generally the value of I_{CC} is very high compared with the nominal current).

Two phenomena should be considered :

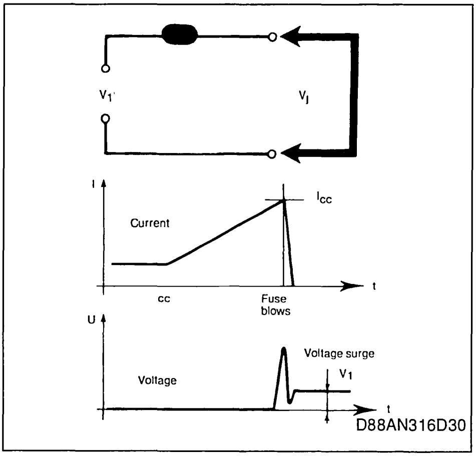
a). "Magnetic" disturbances

Unwanted magnetically induced voltages, follow the formula M. dI_{CC}/dt. Where M is the coupling coefficient. Engineers know how to protect equipment from electrostatic disturbances but as yet cannot offer efficient protection from disturbances caused by magnetic fields. Transil placed at sensitive spots help protect electronic circuits.

b). Electric disturbance caused by arcing of the fuse

Transil placed across fuses (or if not possible, at the input of the equipment) absorb part of these over voltages.

Figure 12 : Current and Voltage Across a Fuse after a Short-circuit.



RELAYS AND CONTACTS

Figure 13A : In Cases whole the contacts are to be protected, configurations A and C enable higher operating safety.

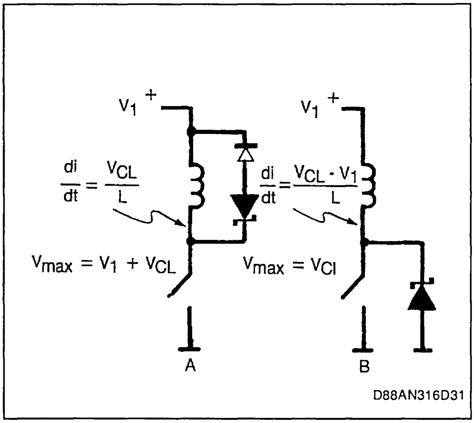
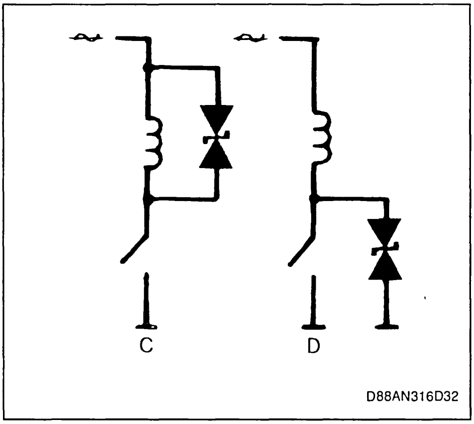
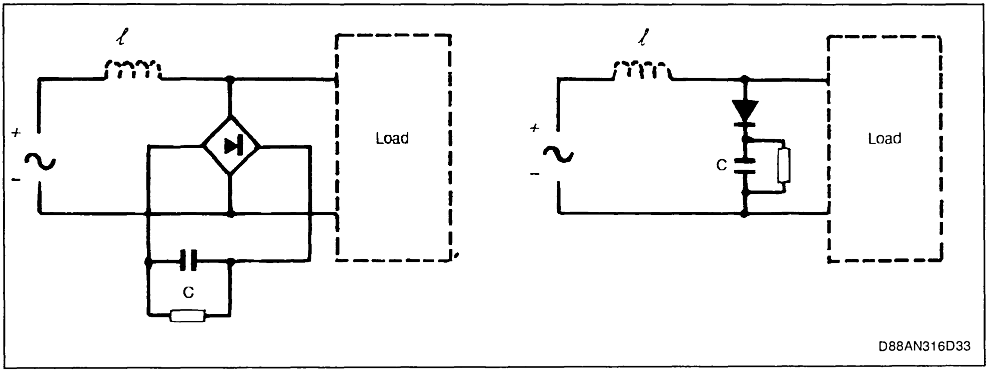


Figure 13B : In the case of a relay, the Transil, while limiting the voltage surge enables cutting off the current in the coil faster than if there was only one free-wheeling diode.



IMPROVEMENT OF A CLAMPING CIRCUITS

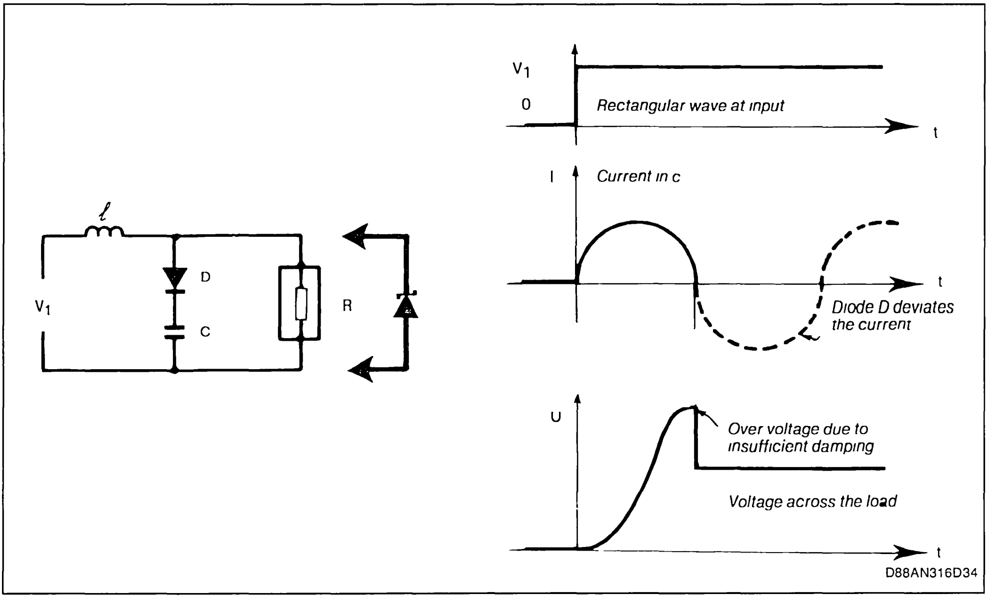
Figure 14 : Clamping circuit with capacitor. *l* represents the unwanted inductance of the power supply network.



The circuits shown in fig. 4 are commonly used in power electronics. Capacitor C can absorb considerable power.

Unfortunately the circuit whose equivalent diagram is represented in fig. 15 has a great disadvantage. The unwanted inductance of a power supply network can never be neglected and it often depends on the installation conditions. If the load, equipment such as a converter, motor, etc., is itself not loaded the system may not be damped, and the off-load equipment could be damaged by an over voltages. **By inserting a Transil the equipment is guaranteed protection under all conditions encountered in practice.**

Figure 15 : Equivalent Diagram of the Clamping Cicuit and Waveforms.



UTILIZATION OF TRANSIL IN TRANSISTORIZED CONVERTERS

Because of their mode of operation, transistorized converters sometimes produce repetitive over voltages which should be limited of absorbed by passive components. A Transil is perfectly suited for this function.

Over voltages are mainly produced by unwanted inductances.

A chopper works very high currents. At the moment transistor T is turned off, the current is deverted by diode D but an over voltages appears across the transistor, produced by the unwanted inductance of the circuit.

The utilization of a Transil across the transistor limits the over voltages and protects it ; overstressing of the transistor can thus be avoided.

In power equipment Transil can be used to discharge circuit generated inductances there by helping switching.

Figure 16 : Utilization of Transil to Limit the over Voltages produced by t he Leakage Inductances of Transformers.

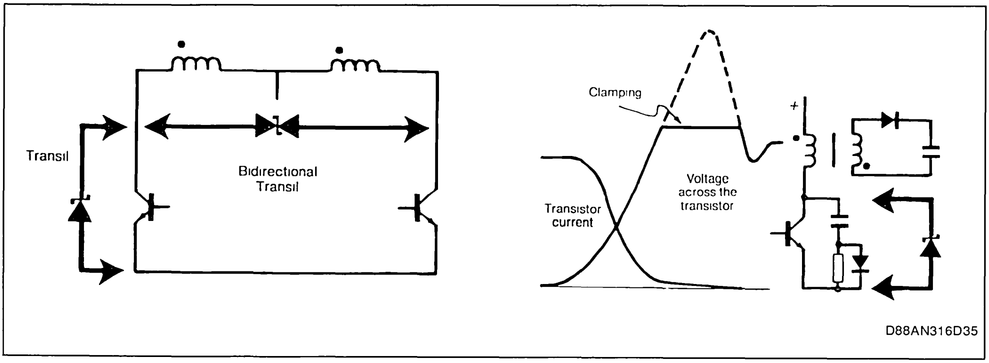
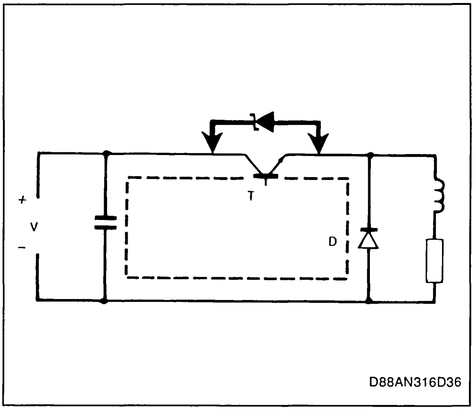


Figure 17 : The Transil Clamps the over Voltages ldi/dt due to the unwanted Inductances 1 of the dotted Circuit.



PROTECTION OF FAST RECTIFIER DIODES

Transil are very quick in avalanche operation, but they are not fast recovery diodes. When a fast rectifier is to be protected, two Transil in series should be used in order to be sure that all the forward current passes effectively through the fast rectifier diode.

Figure 18 : Utilization of a Transil with a Circuit to Help Switching.

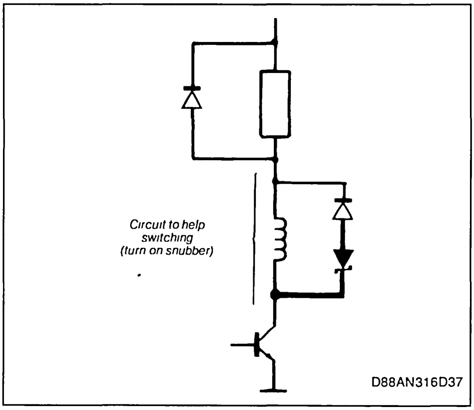
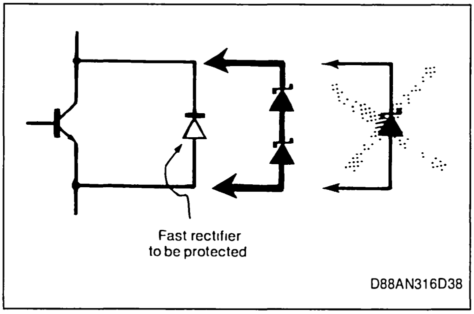


Figure 19 : Protection of a Fast Rectifier by Transil.



EXTENSION OF THE APPLICATION AREA

1. HIGH VOLTAGE

Transil can be connected in series without difficulty. It is unnecessary to balance them by RC networks however it is advisable to connect in series only Transil of the same type in order to distribute the power correctly between the components.

2. HIGH CURRENT

The connection of Transil in parallel is generally not possible. Other methods can be utilized.

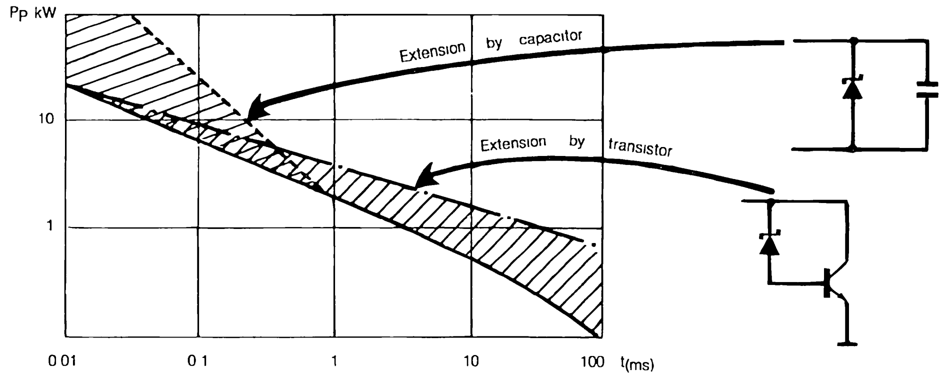
Figure 20 gives the peak power P_P of the Transil as a function of the pulse duration. The utilization of other components with Transil enables extending their area of application.

2.1. The current ratings of a Transil are multiplied by the current gain of the transistors. The transistors ratings, which then operates linearly, should be determined as a function of its "second breakdown" characteristics (determined by the safety area in linear and pulsatory operation). For this type of operation it is advisable to utilize (as soon as the voltage exceeds twenty volts) transistors with a technology suited to linear operation.

2.2. A capacitor previously charged to a voltage V, sees this voltage increasing by a quantity $\Delta V = 1/C\ \Delta Q$, where ΔQ is the quantity of electricity which comes from the surge. The connection of capacitors across Transil enables a considerable increase in their area of utilization, particularly for pulses of short duration and high amplitude.

2.3. The association with other components like lightning arresters also enables extending the application area of Transil.

Figure 20 : Extension of the Application Area.



D88AN316D39

PRACTICAL CONSIDERATION

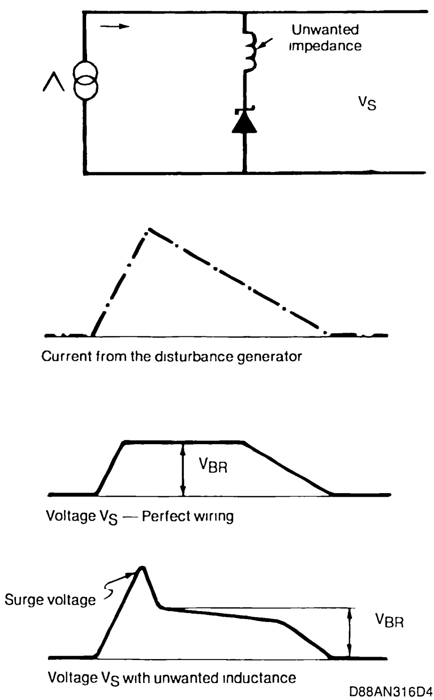
1. CONNECTION OF TRANSIL

A considerable proportion of the over voltages against which equipment is protected, by Transil have short rise times. The wiring of the Transil should thus be considered as "high frequency" wiring if effective protection is to be obtained.

a). Parasitic inductances can introduce considerable over voltages (fig. 21).

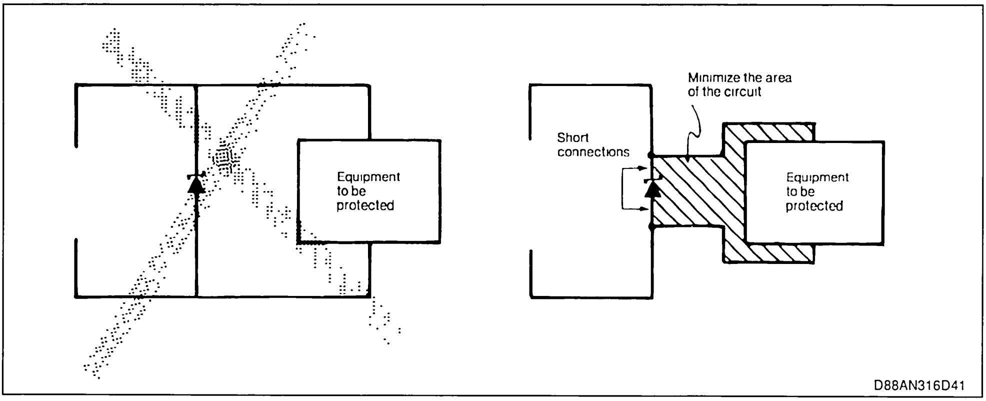
b). Coupling by unwanted capacitances and especially by mutual inductance can produce disturbances in the neighbouring circuit.

Figure 21 : Clamping by Transil.



D88AN316D40

Figure 22 : Connection of a Transil.



2. ESTIMATION OF SURGE CURRENTS

The "energy" aspect is fundamental in the protection against over voltages. The component should :

1 - First be capable of dissipating the energy of the surge.

2 - Then have a sufficiently low dynamic resistance to limit the clamping voltage.

If Transil are compared to other devices offering protection against over voltages, one can observe that Transil are characterized by an excellent clamping factor (i.e. by a low dynamic resistance r_D).

Suppose that V_1 is the maximum value of the over voltages, ρ is the internal impedance of the over voltages source, and r_D the dynamic resistance of the Transil.

$$I_P = \frac{V_S - V_{CL}}{\rho + r_D}$$

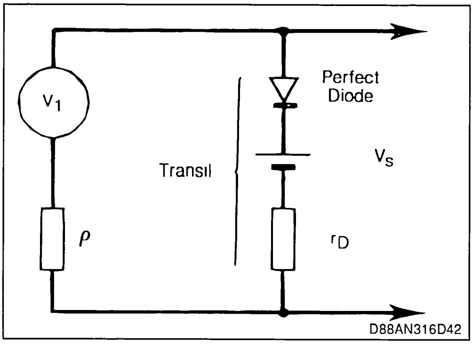
$$V_S = V_{CL} + \frac{r_D}{r_D + \rho} V_1$$

The first parameter to establish in order to determine the right Transil is the peak current I_P (and its duration). Although we begin to know the level of the over voltages encountered in various equipment (an abundant bibliograph exists on this subject), the internal impedance of the various networks is still to a large extent unknown. Nevertheless this is a quantity whose knowledge is fundamental, since it determines the level of power which will have to be dissipated by the Transil.

The determination of the protection level is part of the responsability of the designer : in the absence of accurate data, the following elements discovered from experience, could help to clarify the choices.

The over voltages can be divided into two major categories.

Figure 23.



2.1. OVER VOLTAGES FROM ATMOSPHERIC ORIGIN.

By far the majority of these over voltages are generated by a coupling, generally capacitive, between the source (atmospheric discharge) and the equipment to be protected.

The over voltages are characterized by :

- an amplitude which can be very high,
- dV/dt gradients which are also often high,
- a relatively high internal impedance of the source of the voltage surge.

On power lines, over voltages are generally short and can be simulated by the conventional 1/50 µs exponential wave used in the testing of electrotechnic equipment. In the case of electronic equipment whose power is approximately several kW (or less) it was considered necessary to standardize slightly longer exponential waves (10/1000 µs) since operating conditions differ from those of the power lines.

With respect to this type of over voltages, the following average values can be given to *p* :

	Signaling or communication network	220 V Mains	280 V Mains (p < 10 kW)
p (Ω)	200	50	30

2.2. OVER VOLTAGES FROM ELECTROTECHNICAL ORIGIN.

Sometimes called switching over voltages these over voltages are produced by transients on the mains (coupling of lines or transformers, freeing of energy contained in transformers, inductances, etc.).

Their amplitude is much lower than that of atmospheric over voltages. They are generally somewhat longer and often more dangerous since the equivalent internal impedance of the mains can be low. They produce less disturbance on the level of electronic circuits (lower dV/dt gradient) but lead more easily to the destruction of the power components.

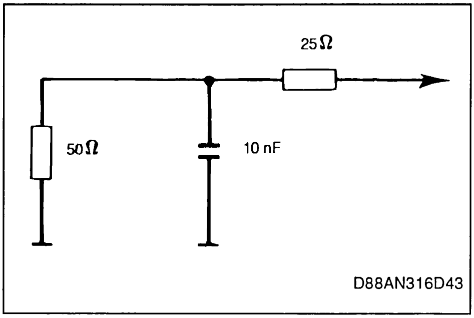
In order to get an idea of the order of magnitude, the following values can be given for the internal impedances of industrial networks.

- For the 220 V single phase mains : $Z = 0.2 + j\ 0.06\ f$
- For 380 V 3-phase mains, P 10 kW : $Z = 0.05 + j\ 0.02\ f$ (where f is the frequency of the disturbance in Hz).

For on-board mains aeronautics, there now are standards fixing values approaching those above.

In general, the rules should be applied prudently and the presence of large transformers on the power mains, liable to be switched when off-load, could produce much more powerful surges.

Figure 24 : Internal Impedance of the Exponential Shock Wave Generator in Accordance with Specification CNET ST/DAS/ PRL/011.



2.3. LONG DURATION OVER VOLTAGES OF ELECTROTECHNICAL ORIGIN.

The amplitude of these over voltages could reach 10 to 25 % that on the main lines and could increase to 40 % or even more for the on-board mains. In all these case it must be considered that the internal impedance of the source is not modified and that the protecting component should withstand the over voltages in continuous operation.

3. BEHAVIOUR OF TRANSIL IN CASE OF ABNORMAL OVERLOADING

If a Transil is subjected to an overload which far exceeds the absolute utilization limits, the temperatures arising locally in the form of hot spots could be sufficiently high to cause lasting damage (localized fusion). This generally destroys the diode which then behaves like a short-circuit. (In certain rare cases, the Transil could be damaged so that it has a high leakage current without a clear short-circuit).

See application note AN317 Protection by Transil - How to ensure absolute safety.

Long-term reliability

Most of the protecting components, lightning arresters, and metal oxide varistors, have their characteristics altered quickly after a certain number of surges. With a Transil, a silicon component, this phenomenon of "ageing" does not exist. The characteristics of Transil, like those of transistors and Zener diodes, etc. remain particularly stable.

SGS-THOMSON
MICROELECTRONICS

APPLICATION NOTE

PROTECTION BY TRANSIL
HOW TO ENSURE ABSOLUTE SAFETY

The function of a protection diode is to limit the voltage across the device being protected in case of accidental overloads. The accidents (atmospheric overvoltages, switching on the mains, failures of the equipment) are defined by standards. But selecting the calibre of a protection diode in accordance with the standards does not always guarantee satisfactory safety. In certain cases accidental overloads higher than those covered by the standards can destroy the protection diode. The user can accept this destruction due to an exceptional accident, but he requires ABSOLUTE SAFETY, i.e. the equipment can stop operating but in no case must it be destroyed. The protection diode should thus remain a short-circuit after the overload. The purpose of this publication is to provide the designer with the elements necessary to define this absolute safety.

Figure 1 gives the values of I^2t for pulse durations less than a second.

BEHAVIOUR OF TRANSIL DIODES IN CASE OF OVERLOADS

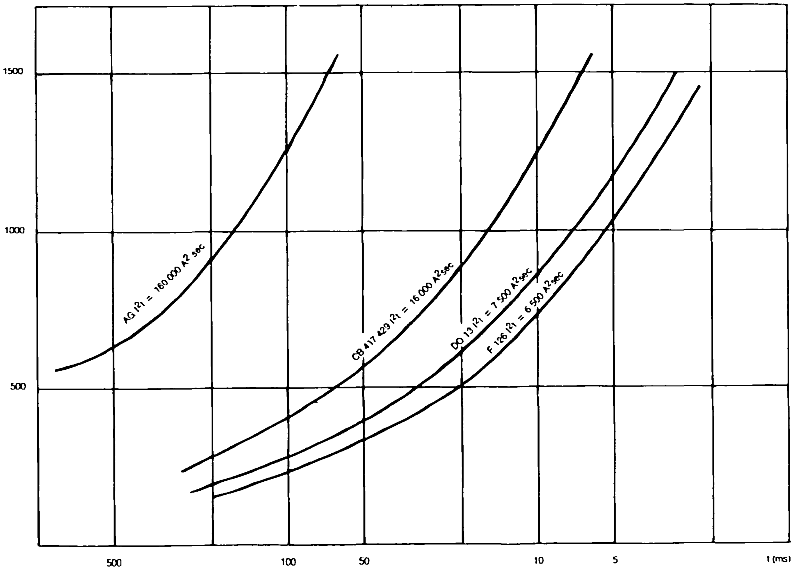
If an overload exceeds the limit I_{PP} specified for the Transil protection diode, it can be destroyed.

- Destruction always begins by an anode-cathode short-circuit.
- If a very high current then flows through the diode, the connections can melt and vaporize and the diode becomes an open circuit.

Numerous tests have been performed at the Characterization Laboratory using current generators (3 to 1800 A) to determine the limits below which the user can be sure that the diode will remain a short-circuit after destruction of the silicon chip. The results of these tests are given for all the TRANSIL diodes in figures 1 and 2.

Figure 2 gives the permanent short-circuit current I_{CP}.

Figure 1 : Limit of the current which does not result in an open circuit for a TRANSIL diode. By analogy with fuses, these limits can be characterized within the 10 µs to 1 s interval by I^2t (A^2sec).



D88AN317D1

It can be noted that Transil diodes withstand very high transient overloads. For example, a diode in a plastic case (CB-429) withstands an "I^2t" of 16000 A^2sec, i.e. more than the chip of a 150 A thyristor ! This is due to the particular technology of Transils in which the silicon chip is mounted between two piston-shaped leads with very high thermal capacity. In continuous operation, on the contrary, the possibilities of Transils are close to those of diodes with the same case.

Figure 2 : Limits of the continuous rms current I_{CP} which does not result in the opening of a TRANSIL diode previously destroyed by an accidental overload

Transils				
Cases	F 126	DO 13	CB 417 CB 429	AG
I_{CP} (A)	3	3.5	4.5	5

PRACTICAL CONSEQUENCES

A/ NON-REPETITIVE PULSE OVERLOADS

In pulse operation (duration < 1 second) the electromechanical capacity of the case is very much higher than that of the silicon chip (figure 1).

For example, if we consider the CB-429 case diodes, of the "1.5 kW" series, the specifications of the maximum values V_{CC} and I_{pp} give an "I^2t" for the silicon chip between 0.1 (high voltage) and 15 A^2s (low voltage). For the case, the value of "I^2t" is 16000 A^2sec, i.e. THOUSAND TIMES higher.

The risk of a TRANSIL diode changing into an open circuit after a pulse overload is thus negligible in practice. The data of figure 1 thus enables the designer to check if his circuit falls within the absolute safety area.

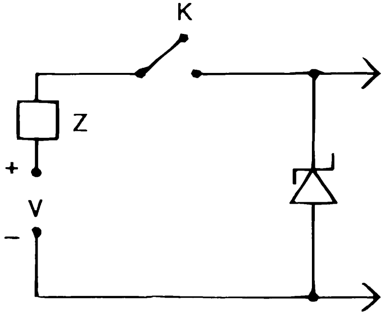
B/ PROTECTION DIODES BEHIND A VOLTAGE SOURCE

After an overload exceeding the limit I_{pp}, the Transil diode whose silicon chip has been destroyed is subjected to a current.

$$I_{CP} = \frac{V}{Z}$$

In many cases this current can result in destruction of the Transil diode contacts, i.e. an open circuit which can have disastrous consequences.

To avoid this, it is necessary to add a device K which breaks the circuit after the failure. This device can be a fuse or a circuit-breaker. The data in figures 1 and 2 will enable the designer to determine the fuse (or circuit-breaker) which will break the circuit before the diode becomes an open circuit.



D88AN317D2

CONCLUSION

The specification of the new I^2t and I_{CC} parameters represents a notable progress in the characterization of TRANSIL diodes. It enables the designer to define his protections with absolute safety. After several years of experience in the field of protection components, this aspect seems particularly important to us since the overloads encountered in practice do not always correspond with the standards, and the building of absolutely safe equipment enables limiting the damage due to unforeseeable accidents.

SGS-THOMSON
MICROELECTRONICS

APPLICATION NOTE

TRANSIL OR VARISTOR

A. BERNABE

The Transils and the metal-oxide Varistors (MOV) are protective components (suppressors).

The following table lists their respective major characteris-tics and fields of application.

COMPARATIVE TABLE

For Varistors (7 to 20 mm dia.) and Transils (F 126 → AG plastic case)

Parameters		M.O.V.		Transil	
Voltage Range (V)	(1)	14 to 1200		5 to 500	
Leakage Current V_{RM} 25 °C	(2)	TYP. 50 µA	MAX. 200 µA	TYP. 0.05 µA	MAX. 5 µA
Capacitance Value		200 to 500 pF Whatever V		V = 0 V = V_{RM}	200 to 500 pF (4) 2 to 5 times less
Temperature Coefficient		– 0.05 % per degree		0.1 % per degree	
Ambient Temperature		– 40 °C < T < + 115 °C		– 40 °C < T < + 150 °C	
Response Time		Some 10 ns		Some ns	
Clamping Factor	(3)	1.7 to 3		1.12 to 1.3	
Dissipation Capacity * 1 overload (20 µs duration) * 10 overloads (20 µs duration) * Permanent Operation		1 to 150 J 0.4 to 60 J 0.3 to 1.3 W		0.1 to 1.7 J 0.1 to 1.7 J 1 to 2 W	

(1) Varistors are available for lower voltages, but their electrical performances are much lower.

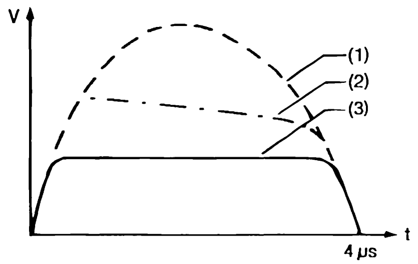
(2) V_{RM} = voltage stand off

(3) Clamping factor = $\dfrac{V_{CL}\text{ clamping voltage (at Transil Ipp)}}{V_{BR}\text{ avalanche voltage (at 1 mA)}}$

(4) These values are to be divided by 2 for bidirectional Transils

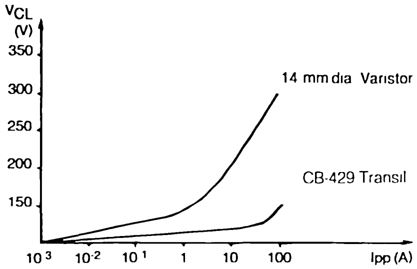
IMPORTANT PARAMETERS

1 - CLAMPING



Clamping diagram
(1) No-load overvoltage
(2) Clamping by Varistor
(3) Clamping by Transil

D88AN318D1



Clamping voltage (V_{CL})
Versus overload current (I_{pp})

D88AN318D2

The clamping factor characterizes the "protection" provided by the component. Owing to its principle (volume avalanche in the silicon), the Transil limits, **for a given current**, the voltage to a lower value than the varistor.

2 - OVERLOAD CURRENT

a) SHORT OVERLOADS (< 100µs) : as a general rule, the varistor can withstand, for a few microseconds, much higher peak currents than the Transil.

b) LONG (> 1 ms) OR REPETITIVE OVERLOADS : Taking into account its structure, mounting and thermal resistance, the Transil is perfectly suited for this type of operation. The varistor is less performing, which is essentially due to its low medium-power dissipation capacity.

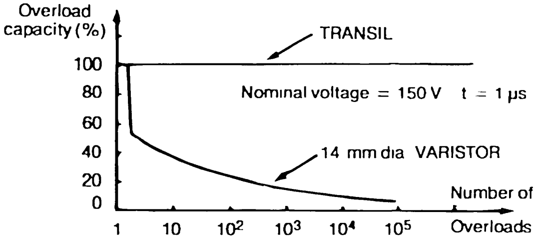
3 - RELIABILITY IN OVERLOAD CONDITIONS

The internal mechanism of structure evolution after each overload (whatever its amplitude) notably modifies the varistor electrical characteristic

(VOLTAGE ↘ ; LEAKAGE CURRENT ↗).

The Transil having a monocrystal structure, its characteristic will not change beyond the limits specified in the data sheets. Whatever the number of overloads of specified amplitude Ipp.

(for inst. : maximum leakage current = 5 µA).

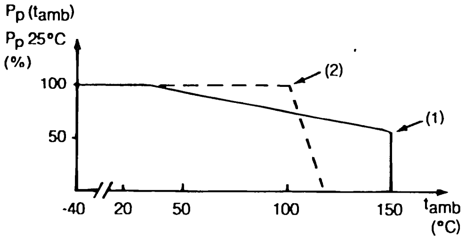


overload capacity (%) versus number of overloads

D88AN318D3

4 - TEMPERATURE RANGE

The varistor fully retains its capacities up to 85 °C. It is no longer usable at 115 °C and above. The Transil still has 50 % of its capacities at 150 °C.



Peak power variation versus ambient temperature
(1) Transil. (2) Varistor

D88AN318D4

CONCLUSION AND FIELDS OF APPLICATION

The Transil is a remarkable clipper. Its excellent reliability ensures a very long service life. Its is better suited for the protection of electronic circuits which require correct clamping (protection of transistors, ICs, microprocessors, etc...).

To sump up :
The Transil is a silicon component for protection of the silicon.

The Varistor is a low-price component capable of withstanding high current peaks during overloads of very short duration. It is better suited for the protection of electrical and electrotechnical equipment against high-level transients. (Protection of electrical mains and of equipment including transformers, motors, to the exclusion of fragile components).

RELAY DRIVES PROTECTION

A fast switch-on in an inductive circuit causes overvoltages and electromagnetic interferences that can damage peripheral elements. Effectively when a relay drive circuit is not protected, it is frequent to find some contacts blacken by the arc due to the overvoltage or destroyed transistors after first used. Different solutions exist which allow to limit the voltage at the terminals of the commutation circuit in order to avoid any damage.

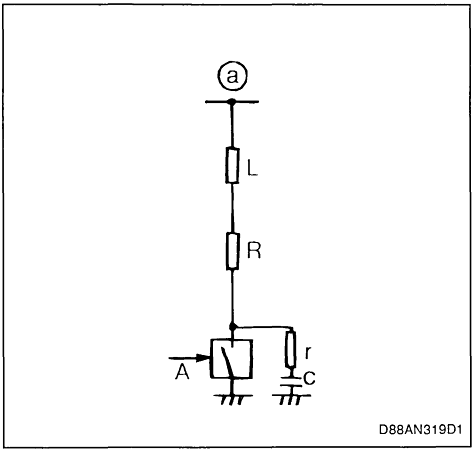
Here after are some examples.

I - PASSIVE COMPONENTS

Resistive network, capacity (Mounting a, fig. 1).

This is an efficient solution in many applications but generates current peaks that can be inconvenient at switch-off.

Figure 1 : Relay Drive Protection by R.C. Network.



II - ELECTRONIC COMPONENTS

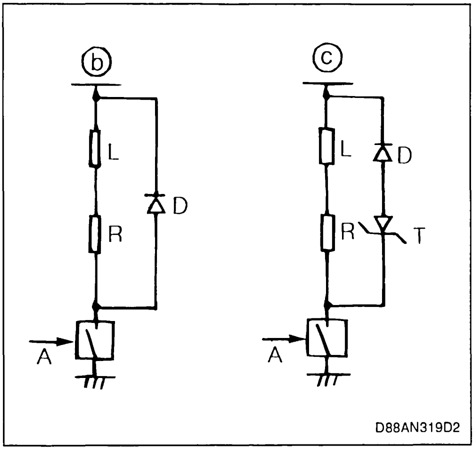
1) FAST DIODES AND TRANSIL

Standard protection which puts in antiparallel a diode on an inductive load (Mounting b, fig. 2) offers many advantages : negligible overvoltage at switch-on (forward voltage of the diode) reduced space, low price, good reliability and negligible permanent losses.

However at switch-on, the current accumulated in the inductance slowly decreases (see paragraph II-3) through the diode and the resistance. This is a disadvantage for some applications. For instance in the case of a relay inductor drive at switch-on (proportional to the time constant L/R) between the drive and the release of the switch. How to decrease the period of current extinction in the inductance while conserving the advantages of the mounting b (fig. 2) witha recovery diode ?

You have to use a Transil diode mounted in serie with the recovery diode (or the bidirectional diode) (Mounting c, fig. 2). The negative voltage which appears at the terminals of the Transil after switch-off accelerates the extinction process.

Figure 2 : Relay Drive Protection by :
b) Recovery Diode
c) Diode and Transil.



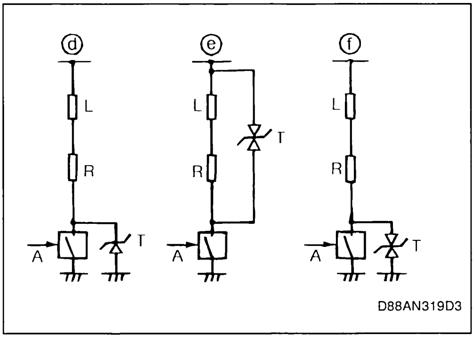
2) TRANSIL

Transil is an avalanche diode specially designed to clamp overvoltages and dissipate power in transistory system. It also gives a good possibility of absorption in mean power. It is available in different cases covering a wide range of voltages (5 to 600 V). Moreover you can find in technical notes all the necessary data to calculate power parameters and temperature evaluation (Z_{th}, R_{th}, etc...). So Transil is perfectly adapted for this application.

In the case of a steady state power supply, we can consider three hypotesis :

- Mounting d (fig. 3). This is an economic solution which requests an unidirectional Transil only but the current released by the inductance goes through the power supply and may change the ground points.
- Mounting c (fig. 2) and mounting e (fig. 3). The inductive discharge current only goes through the LRD loop, thus it does not create disturbances in the ground points. This is a more expensive solution since two diodes or one bidirectional Transil are necessary. In the case of an alternative sinusoidal supply for low power, mountings e and f (fig. 3) are well adapted to limit inductive overvoltages.

Figure 3 : Relay Drive Protection by :
d) Unidirectional Transil
e) Bidirectional Transil
f) Bidirectional Transil.



3) COMPARISON OF THE CURRENT DECREASING PERIOD IN THE INDUCTIVE LOAD BETWEEN THE RECOVERY DIODE SCHEMA AND THE TRANSIL DIODE ONE (fig. 4).

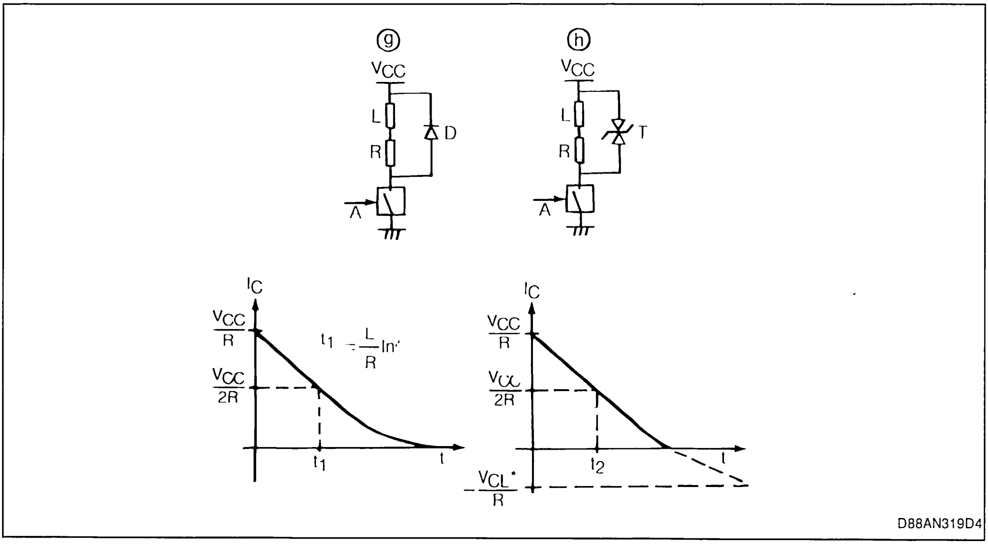
t_2/t_1 ratio characterizes the reduction of time spent by the current to decrease when we use a Transil.

$$t_2/t_1 = \frac{1}{1+1{,}4\ V_{CL}/V_{CC}}$$

V_{CL} is the voltage (measured) at the terminals of the Transil when the load current goes through it.

If you take $V_{CL} \approx V_{CC}$, you limit the overvoltage to a reasonable value and thus t_2 period represents 0.4 x t_1 only. Choosing V_{CL} you can reduce t_2 to very low values and reach the mechanical limit given by the relay.

Figure 4 : At switch-on, current in the inductance :
g) Recovery diode, current slowly decreases to 0
h) Transil, current suddenly decreases (asymptote $-\frac{V_{CL}^*}{R}$)



III - CONCLUSION

Transil is a must in the relay drive circuits. It guarantees a reliable and efficient protection while reducing the delay between the drive and the contact release.

IV - EXAMPLE OF APPLICATION : Calculation and choice of a Transil

You wish to protect the transistor in figure 5 by a Transil which clamping voltage must not in any case exceed $V_{CL} = 85$ V.

Calculation method : To avoid boring calculations we'll take as hypotesis V_{CL} - V_{BR} only valid in the case of repetitive overload (V_{BR} Transil voltage at 1 mA).

Experience shows that this hypotesis is confirmed with Transils in most of the cases, because we are to select the Transil according to its thermal resistance (it is not the same with Zeners which have higher dynamic resistances).

1 - MEAN POWER DETERMINATION : P_{AV}

A rough value can be obtained supposing that all the energy contained in the inductance is absorbed by the Transil (this hypotesis is even more true than $\frac{VBR}{V_{alim}}$ ratio is high).

$$P_{AV} = \frac{1}{2} LI^2 f = \frac{1}{2} 0.35\left(\frac{12 + 2,4}{45} \right)^2 50 = 0.9 \text{ W}$$

2 - STAND OFF VOLTAGE SELECTION

The supplying voltage varies between 9.6 V and 14.4 V.

The stand off voltage of the diode V_{RM} will be so higher or equal to 14.4 V.

3 - V_{CL} DETERMINATION

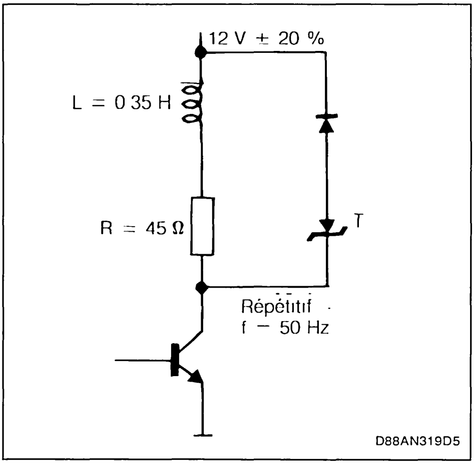
On the data sheets we can see that for a so low current $V_{CL} = V_{BR}$.

4 - Tj CALCULATION

$Tj = T_{amb} + P_{AV} \times R_{th} = 50 + 90 = 140$ C < Tj max (150˚C)

This value is coherent with the characteristics of BZWO4-61 Transil (F 126 case) but we think that the safety margin is a bit low, so we prefer the 1500 W serie (first selection).

Figure 5 : Diagram of the Example with Real Values.



{ 1.5KE 75P (CB-429 case) V_{BR} max = 82.5 V,
R_{th} = 75 ˚C/W, V_{RM} = 60.7 V > 14.4 V

Tj = 50 + 68 = 118 ˚C < Tj max = 175 ˚C

5 - TEMPERATURE CORRECTION

Voltage at 118 ˚C is :

V_{CL} (118 ˚C) = V_{CL} (25 ˚C) [1 + a_T (11 = – 25)] = [1 + 10.5 x 10^{-4} (93)] .82 = 90.5 V.

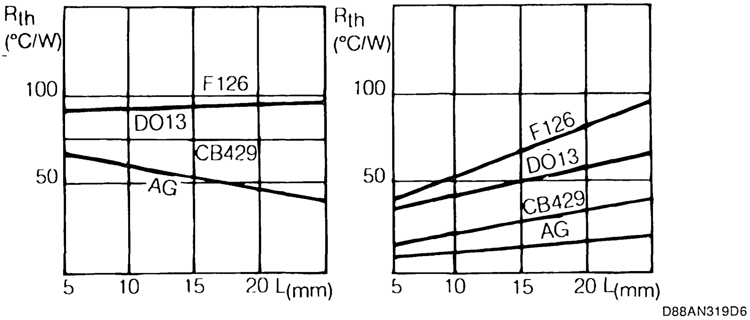
This value is too high.

6 - DEFINITIVE CHOICE

1.5KE 68P $V_{BR\,max}$ = 74.8 V, V_{RM} = 55.1 V > 14.4 V
V_{CL} (118 ˚C) = 1.098 x 74.8 = 82.5 V
1.5KE 68P is suitable.

Comment : this example shows that to the component dissipation you must add the derivative resulting to the change in temperature. We also note that this derivative is much higher than the differrence V_{CL} - V_{BR}.

Figure 6 : Thermal Resistance Junction-ambient According to Connections Length.
Left : Assembly on Printed Circuit.
Right : Assembly on Infinite Heatsink.



SGS-THOMSON
MICROELECTRONICS

APPLICATION NOTE

«TRISIL»
CROWBAR TYPE PROTECTION DIODE

By A. BERNABE - J.P. NOGUIER - P. RAULT

I - INTRODUCTION

In the field of parallel protection, the devices used have two main functions in transit operation : **to limit the voltage and to deviate the surge current.**

If the first function is perfectly carried out by an avalanche junction, confirmed by the success of the TRANSIL series, the second is limited by voltage permanently present across the diode terminals.

Utilization of increasingly sophisticated but fragile electronic components and publication of new standards do not allow the use of diodes TRANSIL in certain applications.

This recent problem is solved by the use of a **semiconductor device** with **two conducting states** such as the thyristor (or the triac in the bidirectional version).

From 1983, we have developed this type of component under the trade name of **TRISIL.**

This booklet is meant to explain its operation and applications and help to choose the model which is most suitable to each ones specific requirements.

II - TRISIL CHARACTERISTICS

II.1 - ELECTRICAL CHARACTERISTIC

The electrical characteristic of the TRISIL is similar to that of a TRIAC (figure 1) except that the component has only two outputs. Triggering in this case is not done via a gate but by **an internal mechanism dependent on the current flowing through it.**

II.2 - OPERATION SEEN FROM THE OUTSIDE

At rest, the TRISIL is biased at a voltage lower than or equal to the standby voltage (V_{RM}). At that point of the characteristic, the leakage current is about ten nanoamperes and the presence of the TRISIL connected across the equipment to be protected does not disturb its operation.

The characteristic data at this point includes : **the leakage current, the electrical capacity and the reliability of the component in blocking.**

During the increase in voltage, the TRISIL impedance drops from practically infinite to a few ohms. The TRISIL remains biased at its avalanche vol-

Figure 1 : I / V Characteristic of a Trisil.

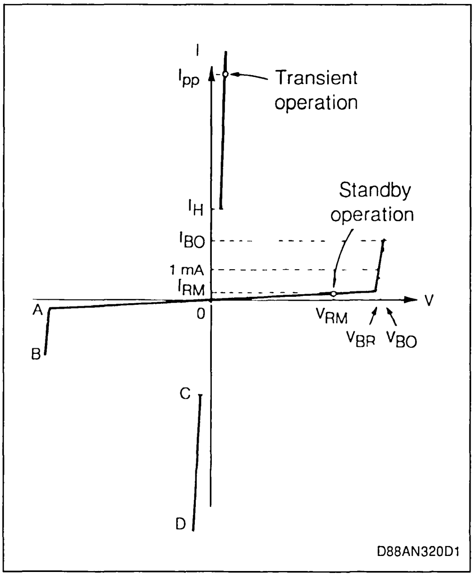
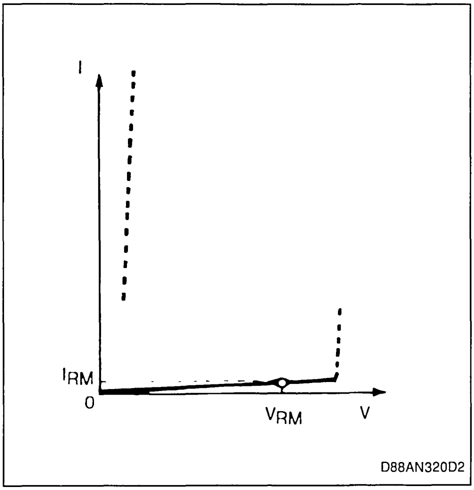


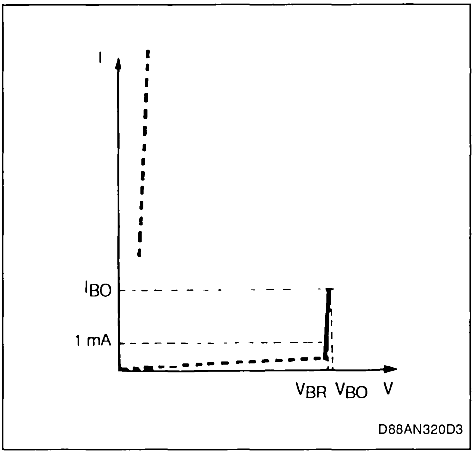
Figure 2 : Low Level Characteristics.



tage and its operation is then identical to that of a TRANSIL diode.

The characteristic parameters at this level are **the limiting voltage** (breakover voltage of the component, V_{BO}) **and the response time for switching between the blocked and conducting states.**

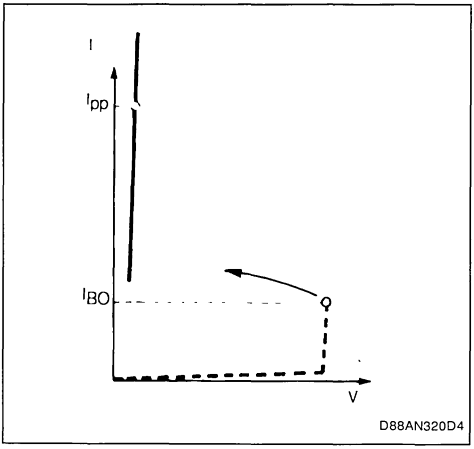
Figure 3 : Avalanche Characteristic of the Trisil.



For current values higher than I_{BO}, the voltage across the TRISIL drops to a few volts and the high currents permitted without damage are possible due to the low value of this voltage, since the physical limit is dependent on the dissipated power.

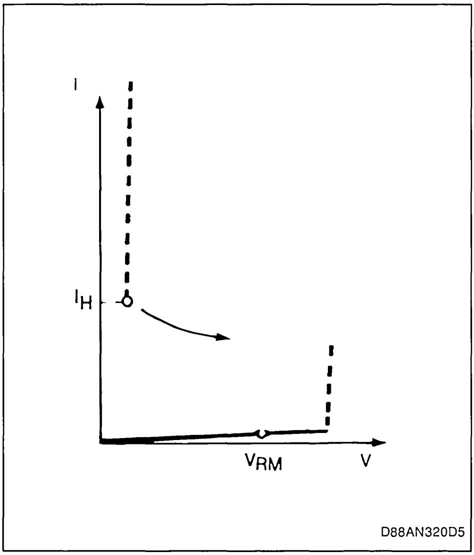
The characteristic parameters are then the possibility **of withstanding surge currents** (peak-point current, I_{PP}).

Figure 4 : Triggering Characteristics.



Return to standby operation by turning off the TRISIL takes place when the current flowing through it drops below the **hold current** (I_H) which is the characteristic parameter for switching from the conducting to the blocked state.

Figure 5 : Return to Standby Operation.



The surge current associated with the disturbance is deviated to the TRISIL as soon as it begins to operate in the avalanche mode (figure 3) and the limiting results from the electrical characteristic at this point. The behaviour of the TRISIL is thus identical to that of the TRANSIL. The difference depends on the level of the breakover current, I_{BO}, where the triggering proper to the thyristor structures take place. This phenomenon results in absolute limiting independent of the current level, on one hand, and a capacity to deviate currents much higher than those possible for an avalanche diode (TRANSIL), and on the other hand, this is done independently of its voltage.

II.3 - LIMITING PROPERTY

Because of its operating mode, the TRISIL results in **absolute limiting, independent of the surge current level** (figure 6) **and of the slope of the applied voltage ramp** (figure 7).

Figure 6 : Correlation Between the Voltage and the Surge Current.

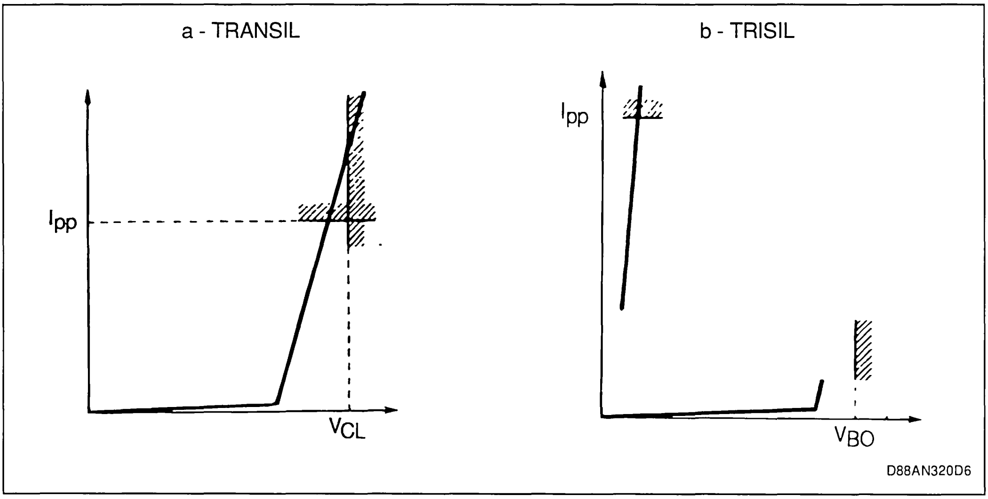
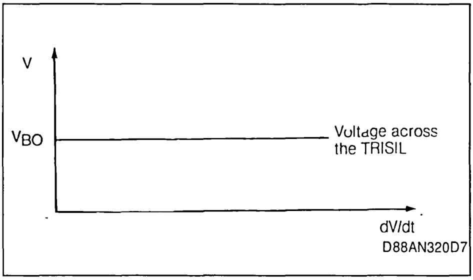


Figure 7 : Correlation Between the Limiting Voltage and the Surge Voltage Ramp.



In particular, if the surge current is higher than the guaranteed value in the catalogue, without however exceeding the physical limits of the component, the voltage across the TRANSIL could reach the critical value destroying the equipment to be protected where as for the TRISIL this risk is excluded.

Finally, for a surge current much higher than the guaranteed value, destruction of the TRISIL always results in a short-circuit thus providing absolute protection for the equipment located downstream.

II.4 - BEHAVIOUR IN CASE OF CURRENT SURGES

The ability of semiconductor components to withstand high currents in transient operation is limited for pulses longer than 10 nano-seconds by a second breakdown due to heat. This phenomenon, although not destructive, is considered as the normal utilization limit in so far as the behaviour of the component depends on the external circuit.

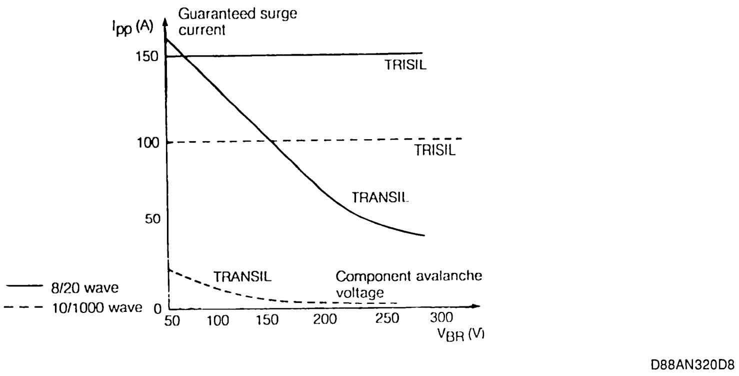
The temperature rise within the semiconductor is thus the parameter which defines the behaviour of the component and its capacity to withstand current surges. It is given by equation (1) :

$$\boxed{T_j = T_a + Z_{th}\, V_{on} \times I_{RS}} \qquad (1)$$

With T_j : instant temperature at the junction level
T_a : ambient temperature
Z_{th} : transient thermal impedance (as a function of the duration of the pulse)
V_{on} : voltage across the terminals of the component in the conducting state
I_{RS} : transient current flowing through the component.

This equation clearly shows the advantage of the TRISIL : decrease in the voltage across its terminals enables it to conduct a **much higher current** than the avalanche diode, for example, for the same junction temperature. Besides, since the voltage to be taken into consideration for the calculation is that in the conducting state, the permitted current levels in transient operation are independent of the avalanche voltage and the **guaranteed values are identical for all the types of a given series** (figure 8).

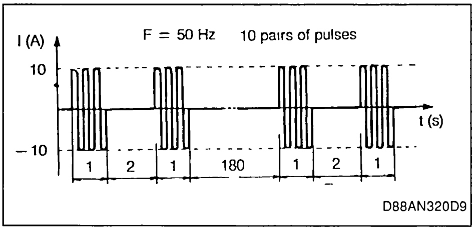
Figure 8 : Comparison of the Limit Transient Currents for a Transil and a Trisil in the Same Case (CB-429).



The maximum junction temperature taken into account in transient operation is not that given in the catalogues (junction temperature in operation or in storage) but corresponds, with a certain safety margin, to the second breakdown due to thermal causes, i.e. about 350 - 400 °C.

This high current capacity can be applied in AC operation at the 50 Hz industrial frequency (figure 9), a field which is particularly interesting in telephony where equipment should be protected against overvoltages resulting from accidental coupling of the telephone line with the power distribution network. This type of protection is required by certain standards used in telecommunications (Standard RLM 88 - Type II).

Figure 9 : Long Duration Overload Test (Standard RLM 88 - Type II).



II.5 - RESPONSE SPEED

The response speed of the component is the time **required by it to limit the voltage.** From this point of view the TRISIL has exactly the same behaviour as a TRANSIL. The time is that required to switch from the standby operating point to the avalanche voltage. This is **quasi instantaneous.**

This time should not be confused with that required to pass from the breakover point (V_{BO}) to the conducting characteristic. This time is longer but does not influence the limiting.

II.6 - OPERATION WITHIN THE AVALANCHE AREA

This paragraph concerns the segment AB (figure 1) of the TRISIL characteristic between the blocked state and the conducting state at low V_{on}.

This portion of the characteristic is identical to that of an avalanche diode. Thus within this area, DC, AC or pulse-type operation are permitted. The currents are limited depending on the possibilities of junction-ambient air heat dissipation. The maximum current is defined by the following inequality (2) :

$$\boxed{T_j = T_a + R_{th}\, V_{BO}\, I_{max} \leq T_{jmax} = 150\ ^\circ\mathrm{C}} \qquad (2)$$

and inequality (3) defining when the TRISIL is not triggered :

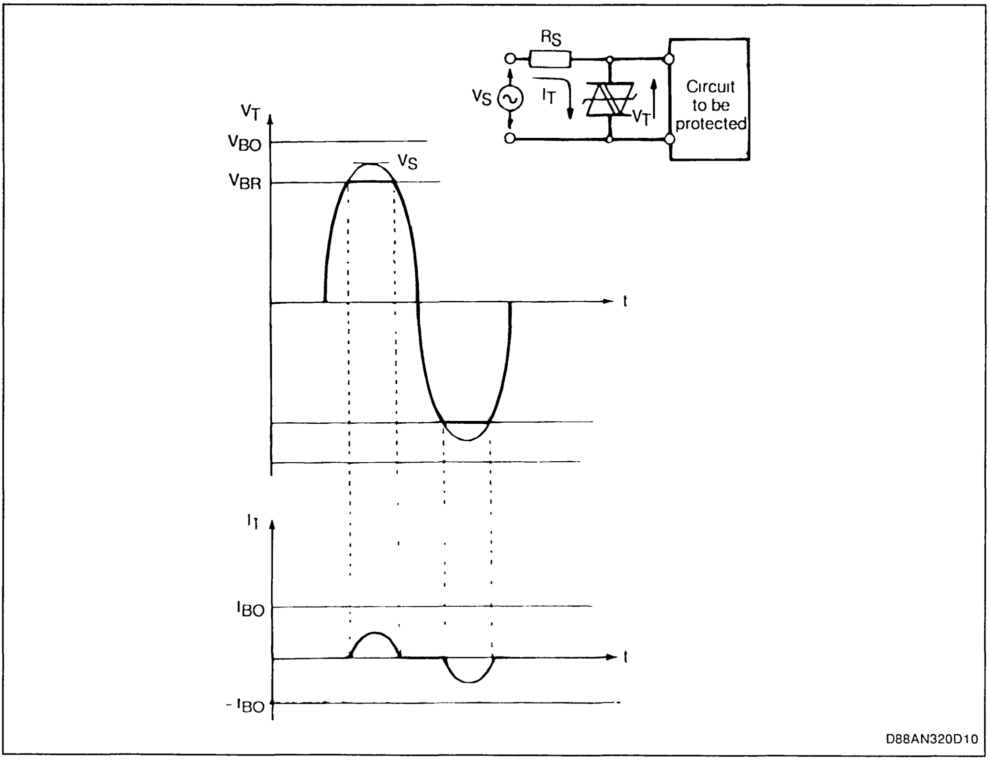
$$\boxed{I_{max} < I_{BO}} \qquad (3)$$

The main differences from equation (1) are the maximum junction temperature which is now that given by the catalogue, i.e. 150 °C, the voltage which is that of the avalanche mechanism and the continuous thermal resistance replacing the transient thermal impedance.

In AC operation, although the equation holds good, the voltage-current diagram as a function of the time (figure 10) is more clear.

The value of the breakover current (I_{BO}) plays an important part in the capacity of the device in avalanche operation.

Figure 10 : AC Operation in the Avalanche Mode.

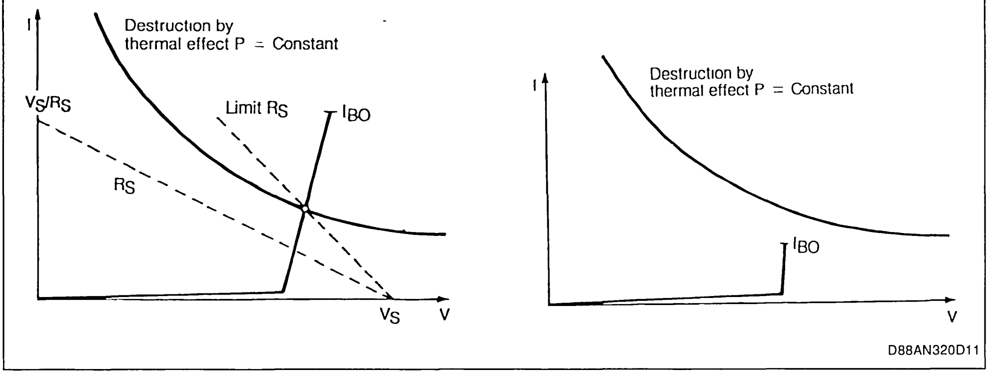


If this value is high (figure 11.a), the current in the component must be limited by a suitable series resistor. For lower values, avalanche operation takes place without destruction whatever the external circuit.

Figure 11 : Conditions for non Destructive Operation in the Avalanche Mode.

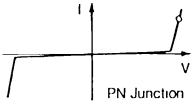
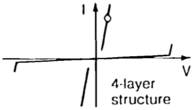
a - Case in which the current should be limited by the external circuit RS > limit RS.

b - Correct operation whatever the external circuit.



II.7 . TRANSIL . TRISIL COMPARISON

Table 1 : Transil - Trisil Comparison

<table>
<tr><th>Component</th><th>Transil</th><th>Trisil</th></tr>
<tr><td rowspan="6">IDENTICAL CRITERIA</td><td colspan="2">Semiconductor component based on PN junctions.</td></tr>
<tr><td colspan="2">I by V Characteristic at Low Level ($I \leq I_{BO}$)</td></tr>
<tr><td colspan="2">Limiting Time</td></tr>
<tr><td colspan="2">Destruction by short-circuiting for values much higher than those guaranteed.</td></tr>
<tr><td colspan="2">Reliability depending on the PN junctions.</td></tr>
<tr><td colspan="2">Bi-directional component</td></tr>
<tr><td rowspan="4">DIFFERENT CRITERIA</td><td>I by V Characteristic at High Level

D88AN320D12</td><td>
D88AN320D13</td></tr>
<tr><td>Limiting Power
Limiting as a function of the current level.</td><td>Absolute Limiting at V_{BO}</td></tr>
<tr><td>Permitted Surge Current
Decreases as a function of the avalanche voltage.
$V_{cl} \times I_{pp} = \text{Constant}$</td><td>Independent of the Avalanche Voltage
Greater for the Same Area of Silicon</td></tr>
<tr><td>Voltage Range
Larger Range of Voltages, from 6.2V to 400V and Higher</td><td>Limited Range with the Lower Values Missing, 62V to 270V</td></tr>
</table>

II.8 . TRISIL . LIGHTNING ARRESTER COMPARISON

<table>
<tr><th>Component</th><th>Lightning Arrester</th><th>Trisil</th></tr>
<tr><td>IDENTICAL CRITERIA</td><td colspan="2">Bi-directional component with two states, one blocked and the other conducting «Crowbar» type protection</td></tr>
<tr><td rowspan="5">DIFFERENT CRITERIA</td><td>Technology
Gas Type Arrester</td><td>Semiconductor component</td></tr>
<tr><td>Limiting Power
Limiting depends on the slope of the disturbance voltage</td><td>Absolute Limiting at V_{BO}</td></tr>
<tr><td>Limiting Time
About 1 Microsecond</td><td>About 1 Nanosecond</td></tr>
<tr><td>Reliability
Problem of Ageing</td><td>High reliability due to semiconductor properties</td></tr>
<tr><td>Permitted Surge Current
Higher for Any Given Volume</td><td>Limited today to 150 A for a standard 8/20 wave</td></tr>
</table>

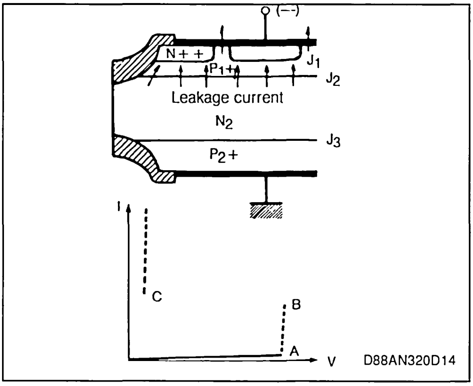
III - FUNCTIONMENT

The TRISIL in fact consists of two thyristors connected in parallel head-to-tail. It is enough to explain the operation of one. The other operates in the same way if the voltage across the component is reversed.

Application of a negative voltage on cathode N + + results in direct biasing of junctions J_1 and J_3 and reverse biasing of J_2.

The current observed is thus the leakage current of junction J_2.

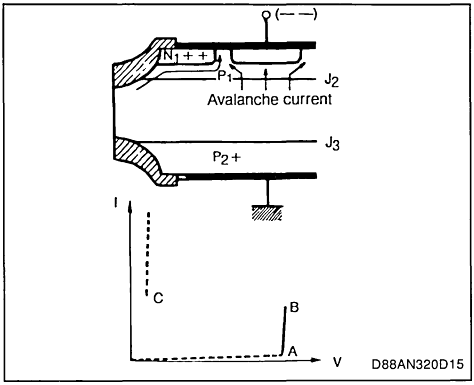
Figure 12 : Operation in the Blocked Mode.



When the voltage exceeds a certain value, junction J_2, which is reverse biased, begins to operate in the avalanche mode. Because of the profile of the groove associated with the type of passivation, this mechanism operates by priority in the area around the junction.

The structure up to this current level operates like a diode (junction J_2).

Figure 13 : Operation in the Avalanche Mode.

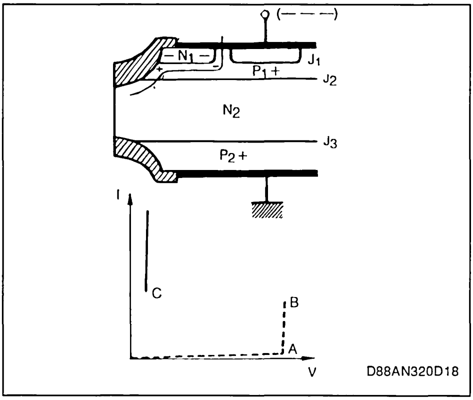


The side current biases the P_1 layer next to the N_1 part of the emitter. The highly dopped N_1 layer has the same potential.

The P_1 area coming to the surface is placed at the same potential as the N1 region by metallization. The J_1 junction around the groove is biased by the lateral current.

While increasing the avalanche current this difference of potential can reach the threshold of 0.6 V, a value which is sufficient to create injection of electrons from the cathode towards the P_1 area and then trigger thyristor N_1 P_1 N_2 P_2.

Figure 14 : Thyristor Effect of the Trisil.



The electrons thus injected into P_1 in fact will reach J_2 by diffusion, and cross it under the effect of the electrical field operating in the space charge of the reverse biased J_2 junction.

In N_2, the electrons help to reduce the potential of this area compared with P_2 and as a result inject holes from P_2 towards N_2. These holes travel in the reverse direction because of their polarity. When they arrive at P_2 they help to increase the potential of P_1 with respect to N_1, this time resulting in the injection of electrons from N_1 to P_1.

The procedure is cumulative. The excess electrons in N_2 and the holes in P_1 will compensate the fixed charges of the space charge and will thus suppress it. Junction J_2 will act as a directly biased junction and the voltage across the component will drop.

IV - APPLICATIONS

IV.1 - APPLICATIONS IN TELEPHONY

The Trisil was initially developed to meet the problems of protecting new telephone equipment.

A - PERIPHERAL PROTECTION

Telephone set

First, it is necessary to distinguish the type of telephone set that is being protected.

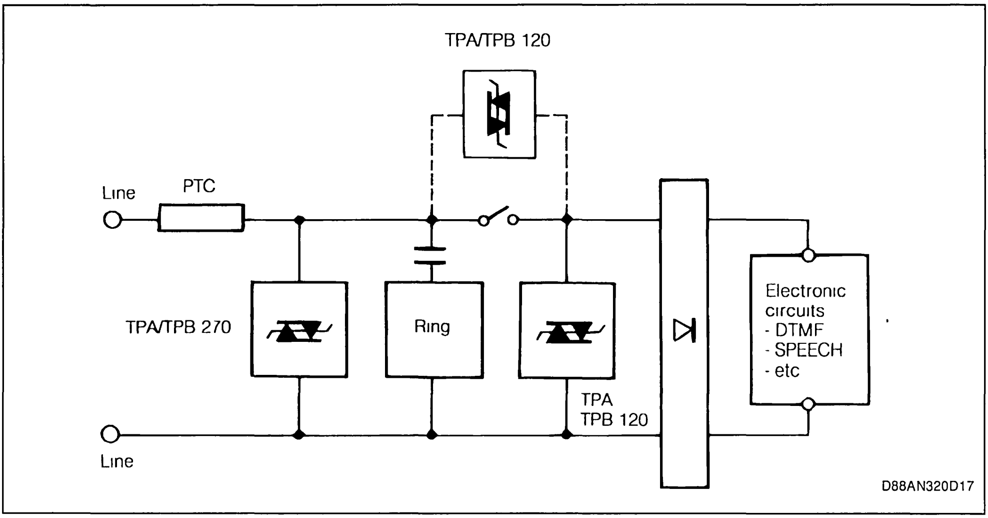
The telephone set connected to a public network that must be able to withstand to standards as CCITT K17, UDE0433, RLM88, etc.

The telephone set connected to a private network for which the constraints of surge are much less severe.

- **Telephone set connected to a public line.**

The typical schema of protection is represented figure 15.

Figure 15.



- **On hook position**

When the set is in ON-HOOK position, the only on-line device is the ringer circuitry, and must therefore be protected against external disturbances.

Nowadays, the implemented electronic ringers are based on integrated circuits ; some of which are self-protected (integrated zener diode, impedance of several k in series, and so on...).

However, this protection is not sufficient. In fact, an overvoltage of several thousand volts will, at p.c. board level, cause a FLASH between the tracks of the components and consequently destroy the device.

The value of the voltage of the Trisil used to protect ON-HOOK position must be higher than the telecom line DC voltage added to the ring voltage signal.

i.e. $V_{TRISIL} > V_{DC} + V_{RING}$

$V_{TRISIL} > 54 + 90\sqrt{2} = 181$ V

$104 + 90\sqrt{2} = 231$ V (over supply)

According to the different countries, the voltage range which is used is between 200 V and 270 V.

Off-hook protection

The set can be also protected against overvoltages by a Trisil. The mainly used voltages are from 100 V up to 130 V.

The TPA with 50 A, 10/1000 µs wave shows a large security margin compared to the preceeding standards.

- **Protection for long duration**

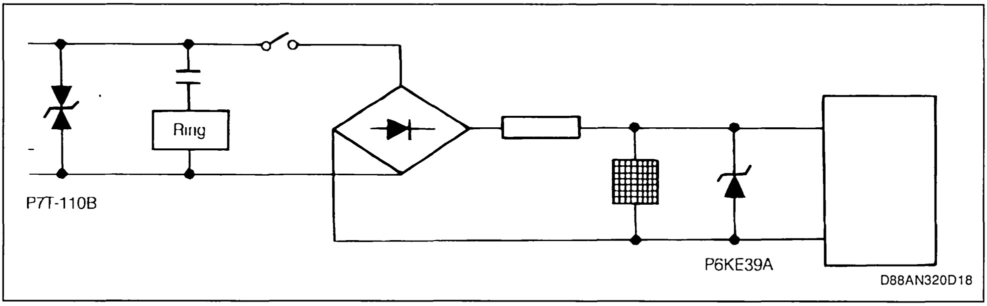
In this case, the standards can by very different from one country to another one and the duration of the superimposed mains on telecom line can reach more than 10 minutes with a current of around 8 A. Obviously, it is not possible to withstand such surges with a plastic component. An economical and reliable solution is to use a PTC (positive temperature coefficient thermistor). These PTC with 10 Ω resistivity (at 25 °C) can reach few kΩ, during the surge. The switching time depends on the surge current and the PTC. Nevertheless, most of PTC tested with an alternative surge current of 8 A reacts in 100 to 150 ms. The TPA Trisil is able to withstand 8 A during 150 ms without any problem (see data sheet). In case of higher current the TPB versions should be used.

In conclusion, TPA Trisil + PTC thermistor is the best performance/cost compromise for the subscriber telephone set protection.

Telephone set connected to private line

Since constraints are far less severe in this case, the Transil solution is often envisaged. For example, it is possible to protect this telephone set in the same way as it is presented (figure 16).

Figure 16.



- **Surge capability**

Concerning overvoltages on telecom equipment, a lot of standards are available today. The mainly known are :

- CCITT K17 - K20
- VDE04-33
- NFC98-010
- RLM88, etc.

All these standards cover two types of disturbances :

- Disturbances caused by atmospheric discharge phenomenon (short duration pulses).
- Disturbances due to local or remote power distribution network (long duration surges).

- **Protection for short duration pulses**

The standards define a test circuit. It also gives values and duration of the overvoltage.

In order to select the right Trisil it is necessary to translate the open circuit surge voltage value in a current surge value through the Trisil.

The values are the following :

Standard	Open Circuit	Under Trisil Test
CCITT K17	1.5 kV 10/700 µs	38 A 5/310 µs
VDE04-33	2 kV 10/700 µs	50 A 5/200 µs
RLM88	1.5 kV 0.5/700 µs	38 A 0.2/310 µs

Two types of Trisil are available, their surge capability are the following :

	10/1000 µs Wave
TPA	50A
TPB	100A

A bidirectional Transil protects the ring whereas unidirectional Transil protects the electronic key-board.

B - SWITCHING EXCHANGE PROTECTION

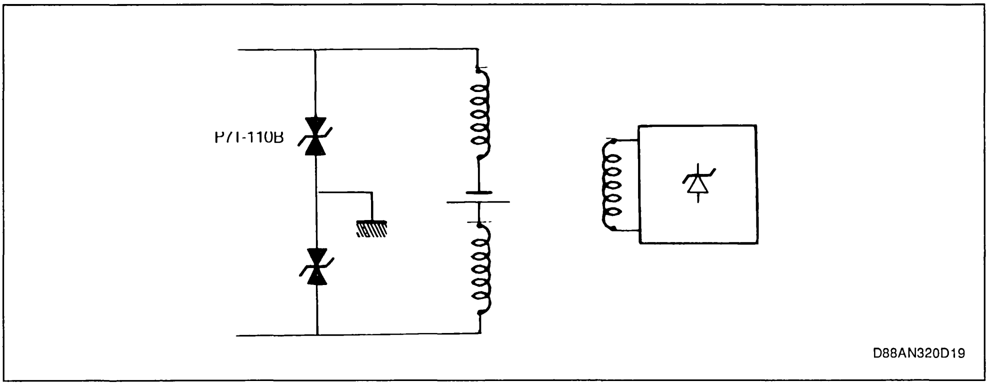
The «old generation»

The first generation of electronic telecom switching exchange presents a transformer in entry.

The protection of these centrals is generally made by Transils : this is the case, for example, of private centrals type PABX. A typical application is represented figure 17 :

- Two Transils assembled in common mode and in relation to the ground avoid any pulling of the transformer.
- Through the transformer assures a galvanic insulation, the parasite capacities can let transients pass. It is sometimes necessary to put a centralized protection on the most sensitive element of the card.

Figure 17 : PABX Protection.



Integrated «SLIC»

Interface circuit on the telephone line (SLIC) is at present realized with one or two silicium chips. Consequently these circuits are much more sensitive to the parasite overvoltages.

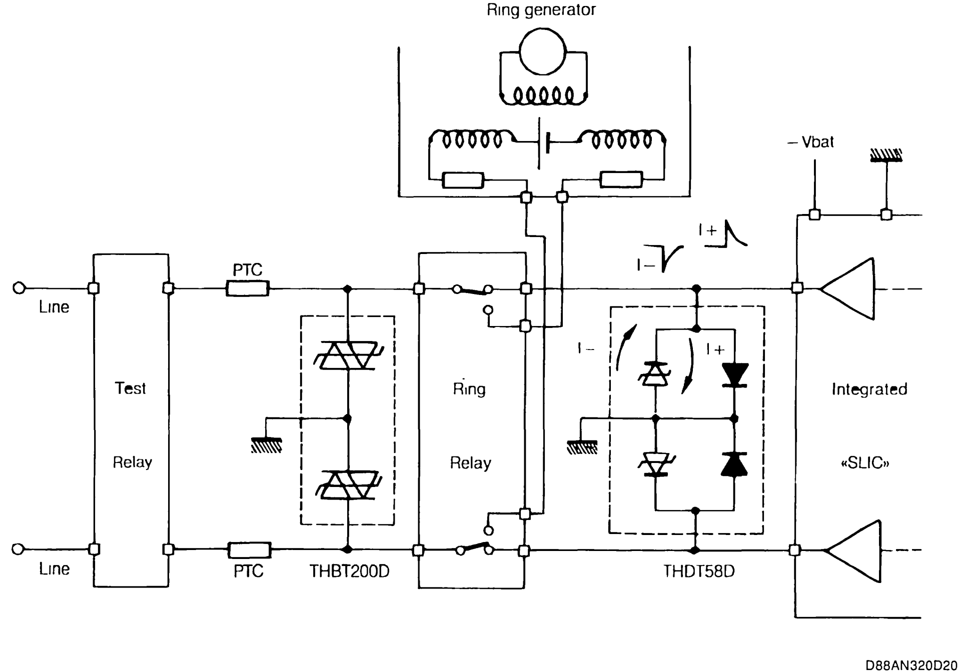
SGS-THOMSON Microelectronics has developped two new components especially dedicated to this application (figure 18).

The double Trisil THBT200D is designed to protect the ring generator and the contacts of relay against overvoltages. It allows to protect the two lines by flowing the surge currents to the ground.

The double Trisil THDT58D is designed to protect the integrated «SLIC» circuits. The diode clamps positive overvoltages and the Trisil negative overvoltages (– 60 V).

Thus, only two TO 220 cases allow to protect a line on subscriber's card.

Figure 18 : Integrated «SLIC» Circuit Protection.



The THBT200D protects the ring generation and the relay.
The THDT58D protects the integrated «SLIC» circuit.

IV.2 - DC APPLICATIONS

The TRISIL can also be used outside the field of telephony. If a circuit is powered by a DC supply, it is absolutely necessary to ensure that the **hold current is higher than the maximum current available** (the case of a short-circuit).

Although the TRISIL is normally triggered in both cases, return to normal after the disturbance is not the same.

In the case of figure 19, the current does not drop below the hold current. The TRISIL cannot return to the blocked state and thus remains as a quasi short-circuit preventing operation of the equipment to be protected.

In the case of figure 20, the current drops below the value of the hold current and the internal mechanism of the TRISIL enables it to return to the blocked state after the current surge.

Since the TRISIL voltage at the conducting state is low, the condition can be expressed by inequality (4) : $I_H > (V_C/R)$

$$\boxed{I_H > \frac{V_C}{R}} \quad (4)$$

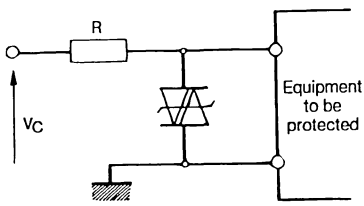


Figure 19 : Wrong Choice of the Trisil for DC Operation.

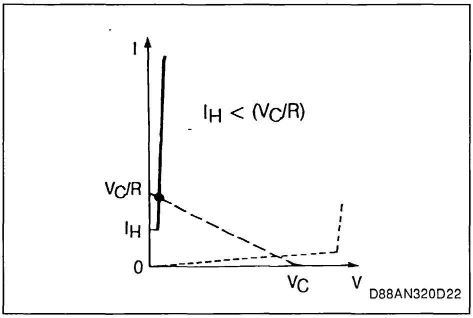
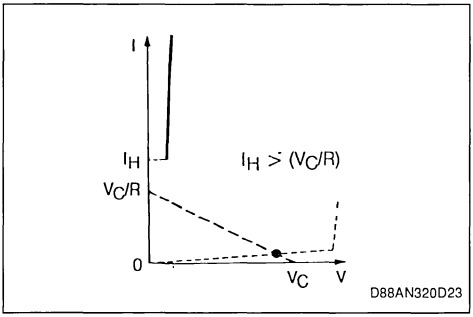


Figure 20 : Right Choice of the Trisil DC Operation.



IV.3 - AC APPLICATIONS

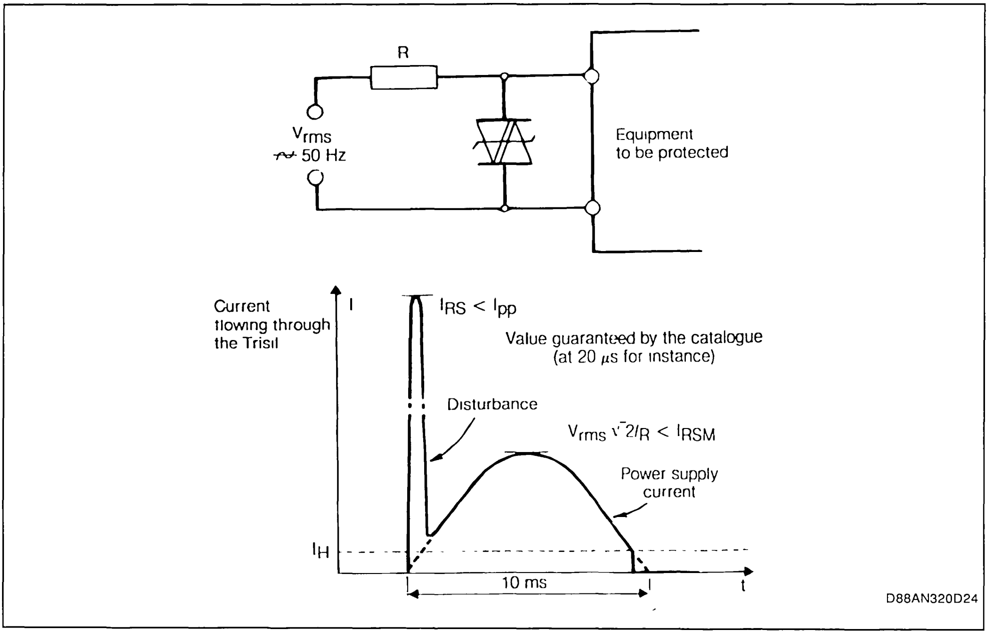
If a circuit is powered by an AC supply, the problem met previously does not arise since the current returns to zero at the end of each half-wave. However, the TRISIL should be rated to withstand the mains current for a half-wave (10 ms), a long period compared with that of the disturbance (figure 21).

At the occurence of the surge, the TRISIL is normally triggered and begins to conduct, but because of the alternating current, the current flowing through the component does not fall below the hold level (I_H) before the end of the half-wave.

The TRISIL thus has to withstand two currents : the first, of about a hundred amperes for a short period (condition for non destruction : $I_{RS} < I_{PP}$), the second a more moderate current of perhaps ten amperes but for a longer period (condition for non destruction : $V_{rms}\sqrt{2}/R < I_{TSM}$).

The component used should thus be selected as a function of the more stringent condition.

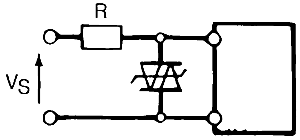
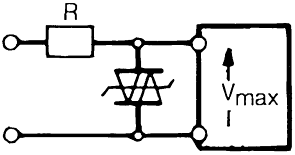
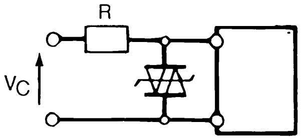
Figure 21 : Operation of a Trisil in an AC Circuit.



V - CONCLUSIONS

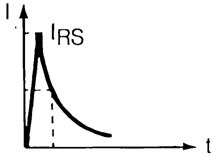
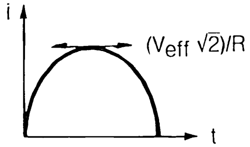
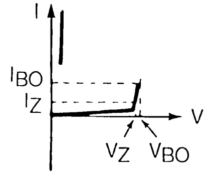
Because of the switching from a blocked state (at rest) to a conducting state with a low voltage drop (transient operation when handling overloads) the TRISIL, a SEMICONDUCTOR component, can be used to protect circuits from high surge currents while avoiding all risks of overvoltage across the circuit being protected.

TRISIL CATALOGUE

Operating Conditions	Selection of the TRISIL Parameter	Corresponding TRISIL Reference
 D88AN320D25 Maximum Operating Voltage	$V_{RM} > V_S$ Where, by Definition, $V_{RM} = 0.9V_{BR}$ V_{BR} is provide in the TRANSIL reference	TPX V_{BR} X XX
Maximum permitted voltage V_{max} to ensure protection of the equipment  D88AN320D26	$V_{BO} < V_{MAX}$ Make sure to consider the influence of the temperature $[V_{BO}]_T = [V_{BO}]$ 25°C $[1 + \alpha_T\ (T-25)]$ V_{BO} is Indicated by a suffix : A or B $V_{BO} = V_{BR}/0.75$ for Index A $V_{BO} = V_{BR}/0.82$ for Index B	TPX V_{BR} A XX or TPX V_{BR} B XX
For DC Operation  D88AN320D27	$I_H > V_C/R$ Caution : the hold current decreases with the temperature The I_H is indicated by the last suffix 12 I_H = 120mA at 25°C 18 I_H = 180mA at 25°C	TPX V_{BR} A 12 TPX V_{BR} A 18 TPX V_{BR} B 12 TPX V_{BR} B 18

See the rest of the table for the sturdiness of the component.

Table 3 : Selection of the Correct Trisil for a Given Application.

Operating Conditions	**Selection of the TRISIL Parameter**		**Reference Suffix TRISIL TPX V_{BR} A or B - 12 or 18**	
			A	**B**
Capacity to Withstand Short Overloads  D88AN320D28	$I_{RS} < I_{PP}$ Standard waves 8/20µs 10/1000µs	I_{PP} 8/20 I_{PP} 10/1000	100A 50A	150A 100A
Capacity to Withstand Longer Overloads  D88AN320D29	$\frac{V_{eff}\sqrt{2}}{R} < I_{TSM}$ In the Case of AC at 50Hz	I_{TSM}	30A	50A
Maximum Dissipation in Avalanche Operation  D88AN320D30	$V_Z I_Z \le P$	P	1.7W	5W

SURFACE MOUNT DEVICES

SGS-THOMSON Microelectronics has developped the medium power cases SOD 6 and SOD 15 for surface mount in order to enlarge its melf and minimelf product range.

These products are specially adapted for high current applications.

Effectively in the case of dissipations higher than 1.5 W, the diameter of the dice to be sealed would require the use of large melf packages. This would lead to a difficult or quasi impossible mounting on card.

The advantages offered by the surface mount plastic cases, SOD 6 and SOD 15 are the following :

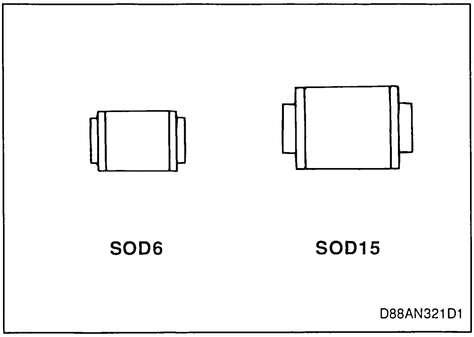
- They perform better in VRT test (quick variation of temperature),
- They case "pick and place",
- They avoid the problems due to wave soldering : shadow areas.

I - GENERAL GEOMETRY CHARACTERISTICS

In this power range, two sizes have been developped (cf. figure 1).

The bending of the leads "J BEND" allows to reduce at the minimum the case length making easier the handling. The case height which guarantees the required electrical and thermal performances stays in the average values of the SMD components (integrated or passive components). Effectively, this standard conditions the card space in the boxes.

Figure 1.



II - THERMAL AND ELECTRICAL PERFORMANCES

The internal concept allows to optimize the thermal and electrical performances thanks for instance, to the modification of the traditional wire cabling methods (gold or aluminium) which consider only a very little proportion of the die upper surface.

This new kind of assembly allows to increase the surge capabilities of the component.

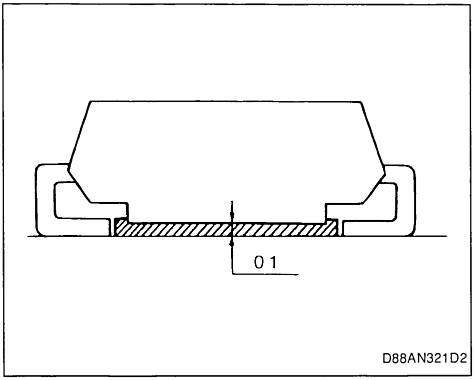
III - COMPATIBILITY OF THE CASE WITH THE DIFFERENT ASSEMBLY TECHNICS ON CIRCUIT

III.1 - WAVE SOLDERING

The lower part of the package allows to satisfy the sticking requirements (controlled thickness, absorption of the eventual overflowings) see figure 2.

On another hand the total height of 2,8 mm assures a good performance in the wave minimizing the screen effect.

Figure 2.



III.2 - PASTE SOLDERING

According to this method the components are not pre-sticked but only maintained with not yet remelted solder paste.

The excellent stability of these cases and the quite large surfaces for contact with the circuit make them perfectly compatible with this assembly technology.

Moreover the use of an expoxy resin specially developped for the SMD components allows to do the refusion equaly according to the know processes in this field :

- steam phase,
- furnace,
- hot plate
- etc...

III.3 - COMPATIBILITY OF THE CASE WITH THE PLACING TECHNICS

Those packages are delivered pre-positioned on 16 and 12 normalized embossed carrier directly usable on automatic equipments (figure 3). The placing may be done by mechanical prehension or by depression pipette.

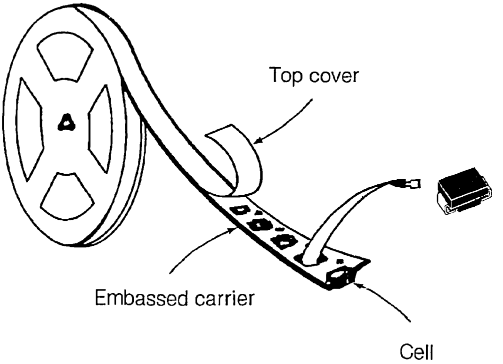
Prehension by technical plier is eased by the rectangular general shape.

Moreover two main aspects ease the handling made by sucking pipette.

The flatness of the upper side avoid the air leaks and thus the losses of efficiency during the holding by depression.

The symetrical general shape gives a good equilibrium during the picking and the placing on circuit.

Figure 3.



D88AN321D3

SGS-THOMSON
MICROELECTRONICS

APPLICATION NOTE

PROTECT YOUR TRIACS

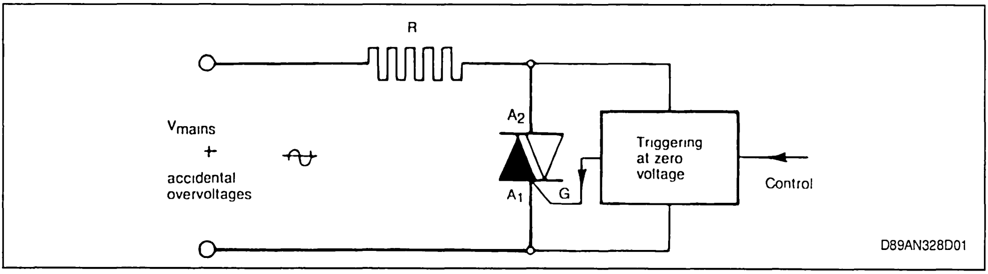
By P. RAULT

In most of their applications, triacs are directly exposed to overvoltages transmitted by the mains. When used to drive resistive loads (temperature regulation), it is indispensable to provide them with eficient protection.

WHY PROTECTION ?

In a typical utilization circuit (figure 1), an overvoltage superimposed on the network voltage can turn on the triac by exceeding its avalanche voltage. Under these conditions, because of its internal structure, only part of triac is effectively turned on and can thus withstand only very low di/dt. This explains the considerable danger of damage to the component when used to drive purely resistive loads. In reality, the di/dt when turning on can, in this case, reach very high values (> 100 A/µs) since only the inductance of the connections limits the rate at which the current can increase.

Figure 1 : Typical Circuit.
The Triac is directly connected to the distribution network : risk of damage.



WHAT WE PROPOSE

The principle of the protection which we have studied consists in turning on the triac by the gate, as soon as the voltage across it exceeds a certain value (figure 2), thus under conditions which ensure a high level of safety. To do this we use a bidirectional TRANSIL diode whose current/voltage characteristic is recalled in figure 3.

When the voltage applied to the triac reaches the VBR voltage of the TRANSIL, the latter conducts, producing a current in the triac gate and turning it on (figure 4). The triac continues to conduct till the half cycle current passes through zero (figure 5).

Figure 2 : Protection of the Triac by a Bidirectional TRANSIL Diode.
The Triac is turned on by gate (current i) as soon as voltage A2 exceeds the voltage V_{BR} of the TRANSIL.

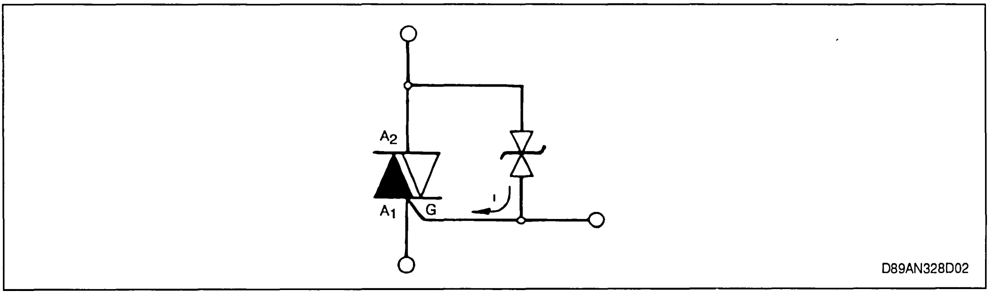


Figure 3 : Voltage-current Characteristic of a TRANSIL Diode.
V_{BR} Specified at 1mA (tolerance 5 or 10%)
V_{CL} limitation voltage, given for a high I_{PP} current level (from several amperes to several tens of amperes, depending of the type.

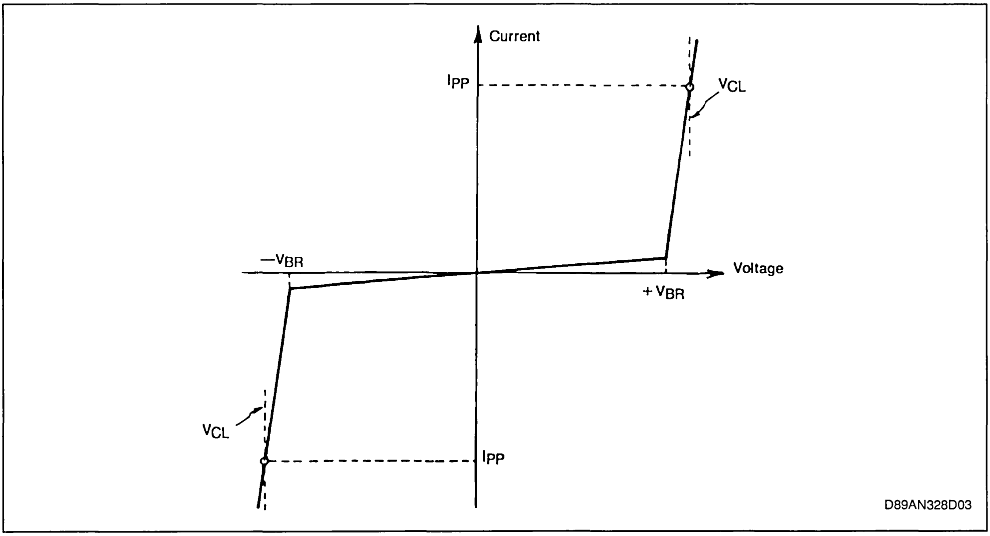


Figure 4 : Characteristic of the TRIAC + TRANSIL Assembly.
Case of a 600V/12A triac protected by a 440V TRANSIL diode (the dotted line gives the characteristic of the triac alone).

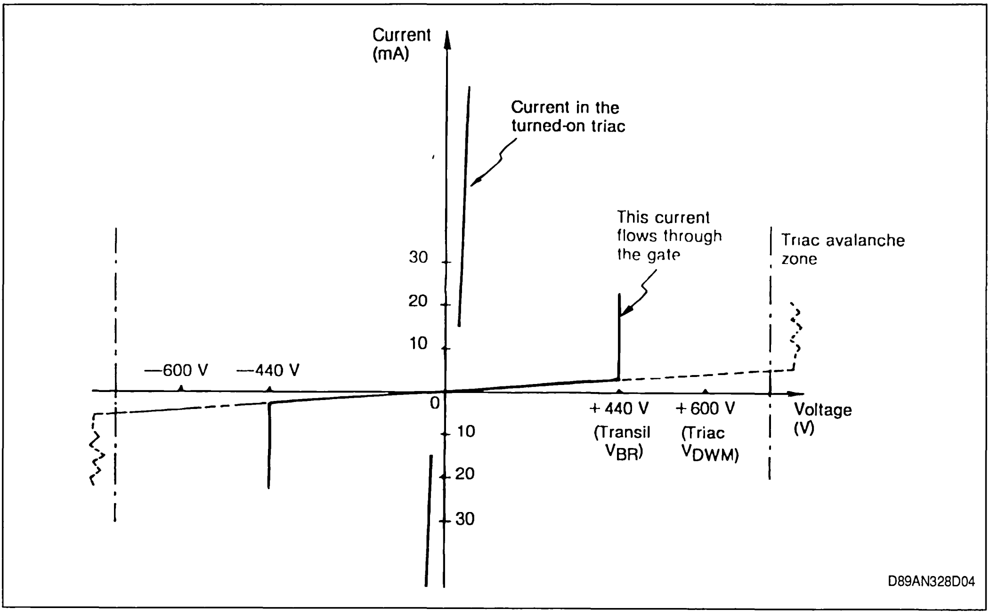
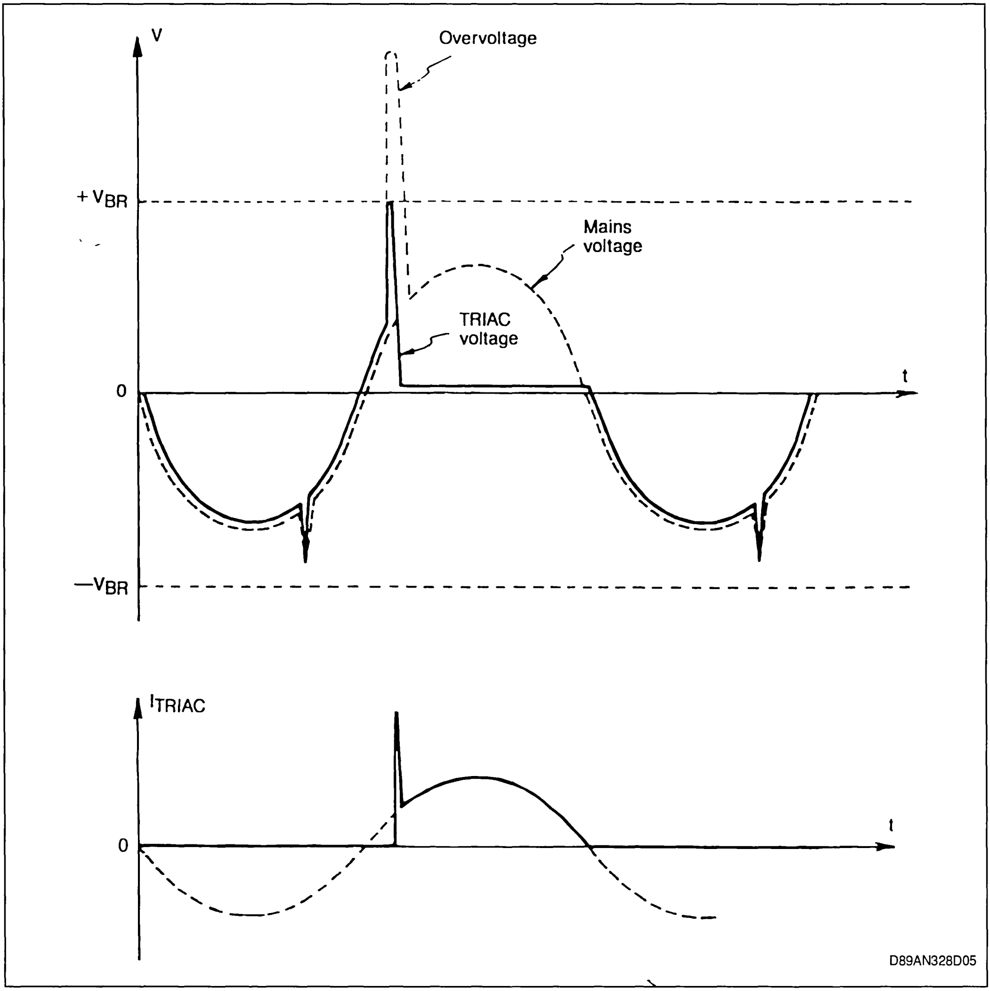


Figure 5 : Behaviour of a Triac Protected by a TRANSIL Diode.
(the triac is turned on by the gate at the beginning of the overvoltage and continues conduction-through the rest of the half-wave).



THE ADVANTAGES OF THIS SOLUTION

- The triac will always operate within the voltage limits given by the manufacturer (± VDWM) and thus far from the avalanche zone.
- Not much power is dissipated in the triac during the disturbance : when it is turned on, the dissipated power is localized in the protection component (the TRANSIL is made for that !).
- The triac is turned on by a gate current which will ensure optimal di/dt conditions.

THE RESULT OBTAINED

We have carried out tests with repetitive overloads (1Hz) under various conditions :

Exponential shock waves of about 1ms, calibrated in voltage (up to 2000V) and controlled in di/dt (500A/µS maxi).

The tests were carried out with steep-edged voltage pulses (dV/dt > 1000V/µs) and also with gradual slopes (< 50V/ms).

All these tests were successful : zero failure.

SELECTION OF THE TRANSIL DIODE REQUIRED FOR PROTECTING A TRIAC

VOLTAGE : VR

Obviously the triac associated with the TRANSIL diode should not be turned on by the maximum mains voltage. An additional safety margin should be given to prevent untimely turning on by the small voltage spikes, often repetitive, which are always present on a «normally» disturbed mains line.

$VR > Vmains\ x\sqrt{2} + \text{safety margin}$

In the absence of accurate specifications, add 20% for the safety margin.

Example : 220V network :

$VR > 220\sqrt{2} + 20\% = 375V$

POWER

The TRANSIL only conducts when turning on the triac ($t \equiv 1\mu s$).

The current, during this time, can reach very high levels (several tens of amperes) in the case of disturbances with steep edges (> >1000V/µS), however the dissipated power remains well within the possibilities of TRANSILS.

The BZW 04 (400W/1ms) suffices in all cases.

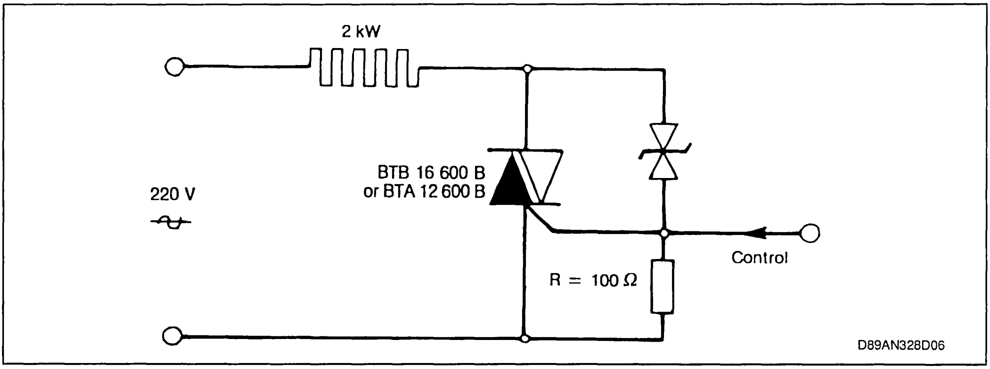
PRACTICAL EXAMPLE

Drive circuit for a 2kW heating element on 220V mains (figure 6).

The BZW 04.376 type TRANSIL perfectly protects the BTB 16.600 B triac (VDWM = ± 600V).

The 100 – Ω resistor, R, between the gate and A1 is not absolutely indispensable but it enables preserving the dV/dt characteristic of the triac which is reduced (by about 20%) by the junction capacitance of the TRANSIL between anode and gate.

Figure 6 : Practical Example of the Protection of a 12 or 16A Triac against Overvoltages.



CONCLUSION

With the protection circuit proposed by us, the triac always operates under perfectly defined conditions in case of overvoltages :

- The voltage remains limited to the maximum specified for the triac
- Turn-on is ensured by a gate current.

This circuit, which we have tested in a number of different setups (different loads, high amplitude overvoltages, disturbances of long duration, etc...), enables a considerable increase in the reliability of circuits using triacs and is indispensable for driving resistive loads on highly disturbed networks.

APPLICATION NOTE

8 WAY TRANSIL ARRAY
TH6P04T6V5CL / TH6P04T25CL

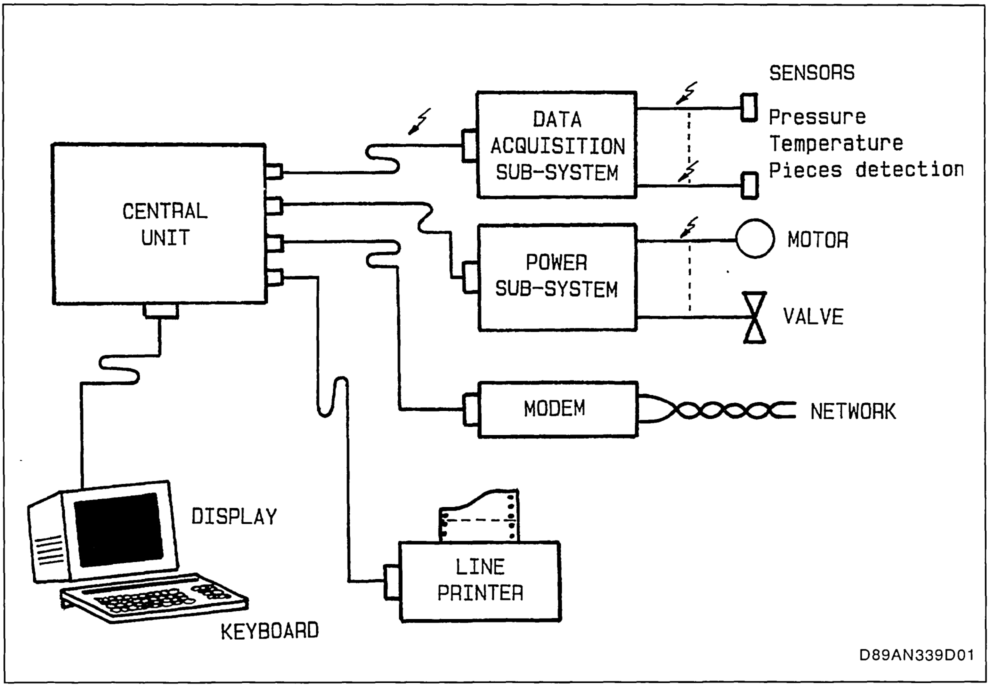
A. BREMOND

NECESSITY OF OVERVOLTAGE SUPPRESSORS

Electronic systems that work in isolation are rare. In most cases, information technology, data processing and automated manufacturing a central unit is connected to a sub-system performing different tasks :

- Man-machine interface.
- Printers.
- Exchange of data with other systems.
- Purchase of digital or linear data acquisition.
- Commands for devices like motors, etc.

Figure 1 : General System Design.



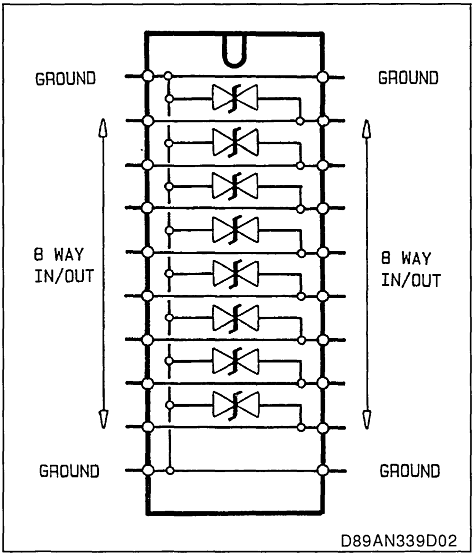
Complex systems of this type are vulnerable to the perturbation to be found in the "real world". There exist three kinds of perturbation :

- Electrostatic discharge produced by the connection of two systems at different voltages.
- Industrial overvoltages caused principally by high current switching. This current is caught by capacitive coupling on the input/output wires of the equipment.
- Atmospheric overvoltages due to lightning phenomena. This affects overhead lines. Equally, underground cables can suffer induced overvoltages. For this type of disturbance the use of gas lightning arresters must be combined with semi-conductor overvoltage suppressors.

TRANSIL ARRAY TH6P04xx SERIES : A RATIONAL SOLUTION

The TH6P04XX series (fig. 2) is an 8 way overvoltage suppressor located in a 20 pin DIL package. There are two voltages available. There are the voltage most commonly found in the computer and industrial world.

Figure 2 : Functionnal Diagram of TH6P04XX.



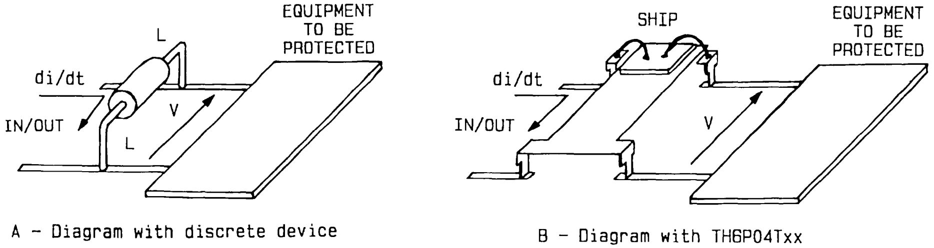
The voltages are 5 volts for the TH6P04T6V5CL and 24 volts for the TH6P04T25CL.In comparison with discrete devices, this package offers the following advantages :

- Compactness of the lay-out.
- Facility of implantation on integrated circuits with CAD for example.
- Possibility to plug in the overvoltage function by a socket.
- Low leakage current (at 70 °C) < 50 µA for the TH6P04T6V5CL, < 10µA for theTH6P04T25CL.
- Low input capacitance (700 pF for TH6P04T6V5CL, 500pF for TH6P04T25CL each pin to ground at 0 volt bias).
- Integrated fuse function (I^2t = 0.6 A2s).
- Optimised clamping voltage due to the "4 points" design.

In the use of discrete components, the voltage seen by the equipment to be protected is equal to the clamping voltage plus the value due to the di/dt.

In the case of the TH6P04xx the equipment sees only the clamping voltage.

Figure 3 : Comparison between Discrete Device and TH6P04xx.



A - Diagram with discrete device

B - Diagram with TH6P04Txx

The voltage on the equipment during a surge is V_{CL}+ 2L(di/dt) for diagram A and V_{CL} for diagram B.

L = Parasitic inductance

D89AN339D03

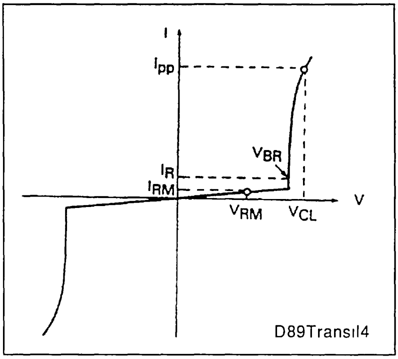
SOME NUMBERS

Figure 4 : Device Description.

ELECTRICAL CHARACTERISTICS

0 °C ≤ $T_{amb} = T_j$ ≤ 70 °C

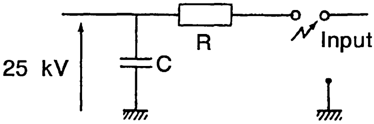
Symbol	Parameter
V_{RM}	Stand-off Voltage
V_{BR}	Breakdown Voltage
V_{CL}	Clamping Voltage
I_{RM}	Leakage Current @ V_{RM}
I_{pp}	Surge Current
C	Input Capacitance



Symbol	Test Conditions	Types	Min.	Typ.	Max.	Unit
V_{BR}	I_R = ± 1 mA	TH6P04T6V5CL	± 6.5			V
		TH6P04T25CL	± 25			
I_{RM}	V_{RM} = ± 6 V	TH6P04T6V5CL			± 50	µA
	V_{RM} = ± 24 V	TH6P04T25CL			± 10	
C1	Each Input Pin to Ground at 0 V Bias	TH6P04T6V5CL			700	pF
		TH6P04T25CL			500	
C2	Each Input Pin to Ground at 5 V Bias	TH6P04T6V5CL			500	pF
		TH6P04T25CL			300	
$V_{CL}1$	I_{pp} = 40 A (see note 1) 8-20 µs to all Inputs Sequentially	TH6P04T6V5CL			± 12	V
		TH6P04T25CL			± 38	
$V_{CL}2$	8-20 µs Simultaneously 80 A (see note 1) peak pulse current to all inputs with a 10 Ω resistor in serie.	TH6P04T6V5CL			± 12	V
		TH6P04T25CL			± 35	
$V_{CL}3$	25 kV ESD Overstress (see notes 1 and 2)	TH6P04T6V5CL			± 12	V
		TH6P04T25CL			± 35	

Notes :

1. V_{CL} mesured on outputs.
2. According to MIL STD 883C method 3015-2
   C = 150 pF R = 150 Ω F = 10 Hz Exposure = 5 secs



PACKAGE MECHANICAL DATA :
DIP-20 Plastic

D89AN339D04

APPLICATIONS

As for the discrete clamping overvoltage suppressor the TH6P04xx can be used :

Alone

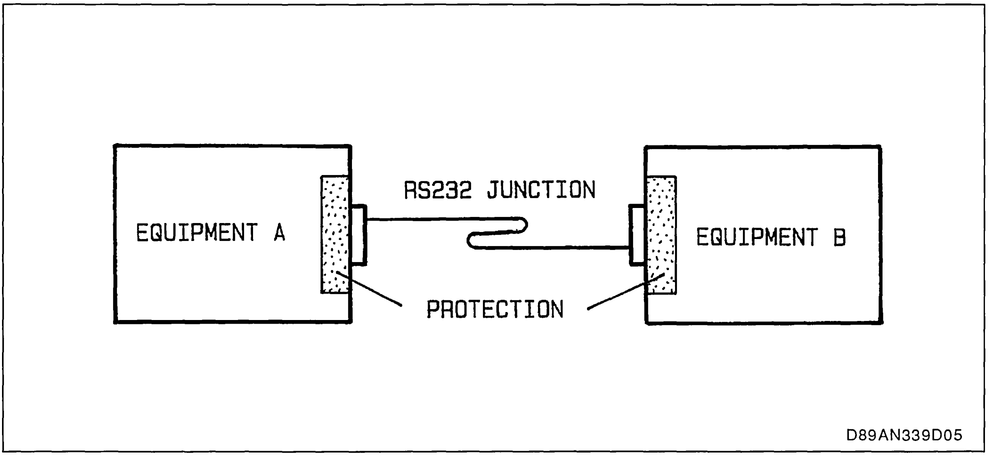
- For the suppression of the electrostatic discharge.
- For the clamping of overvoltages remaining in its operating range.

In complement

- To have the best clamping voltage in the case of systems using gas lightning arresters.

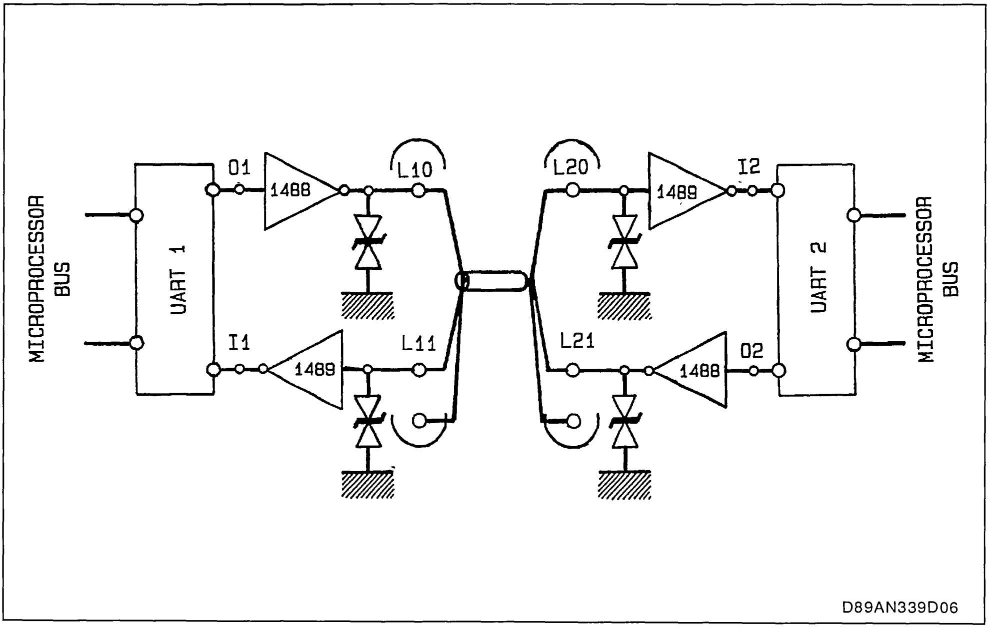
RS232C JUNCTION PROTECTION

Figure 5 : Junction Protection.



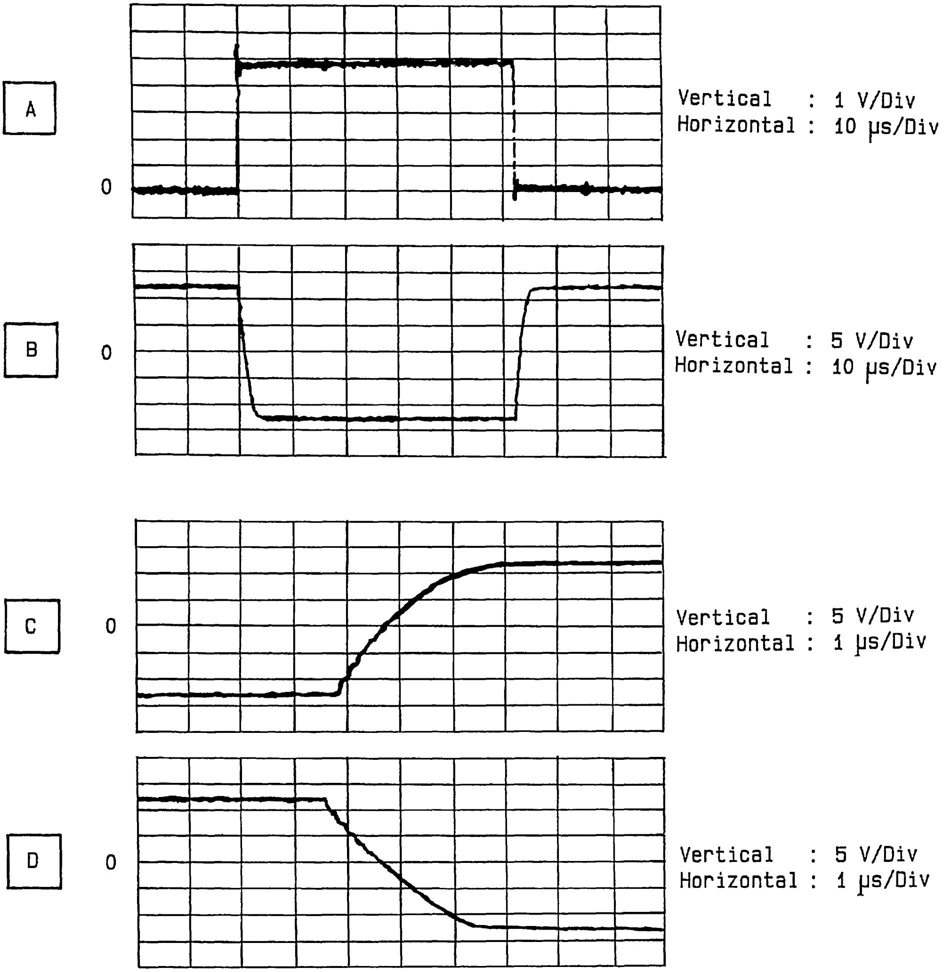
This type of connection (fig. 5 and 6) is the most used in the computer and industrial world. The necessity to switch on and off (switching performed frequently with voltage across the lines) makes apparatus very sensitive to electrostatic discharge (ESD).

Figure 6 : Principle of Protection.



The protection comprises a bidirectional clamping device (TRANSIL) between each junction line and the ground (fig. 8).

Figure 7 : Effect of the Line and the Suppressor on the Signal Edges.



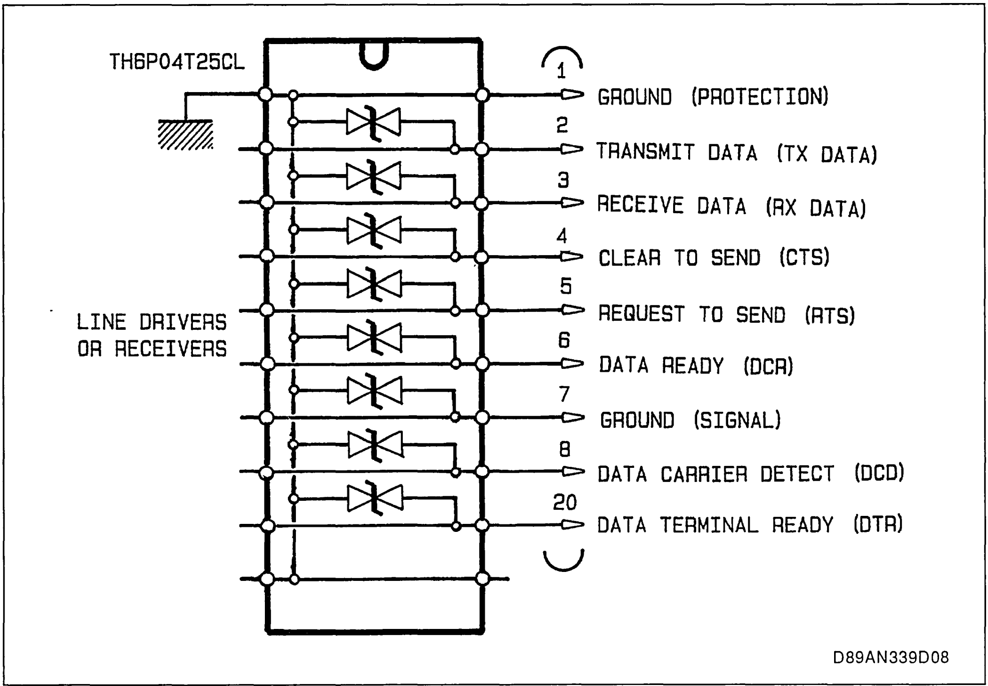
A. Signal on UART1 output (01)
B. Signal on junction RS232C input (L20)
C. Rising edge on junction RS232C input (L20)
C. Falling edge on junction RS232C input (L20)

TEST PARAMETERS : * Speed = 19200 bauds
* Line lenght = 12 m

D89AN339D07

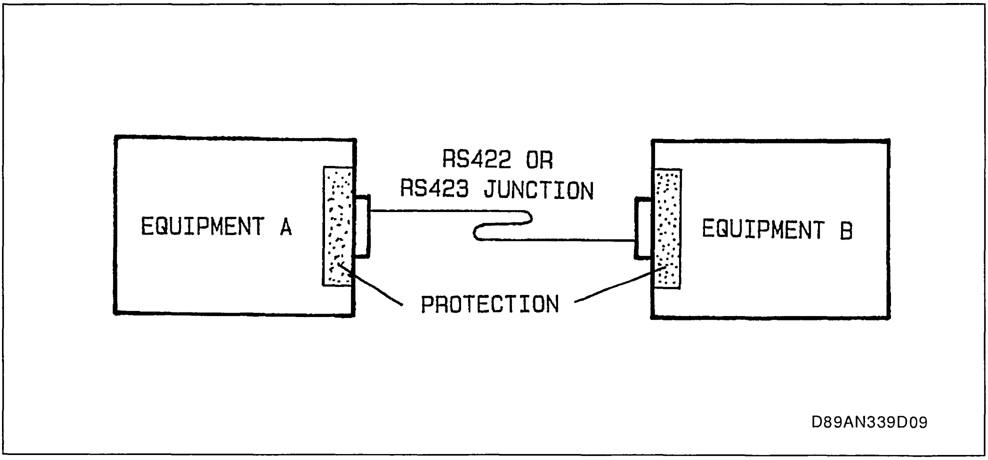
The low capacitance of each device allows transmission of the data with a low perturbation of the edges.

Figure 8 : RS232C Junction Protection.



RS422 AND RS423 JUNCTIONS PROTECTION.

Figure 9 : Localisation of the Protection.



The RS422 and RS423 standards allows the transmission on long lines (few 10 meters). These lengths require the use of protection devices. (Fig. 10 and 11).

Figure 10 : RS422 Principle of Protection.

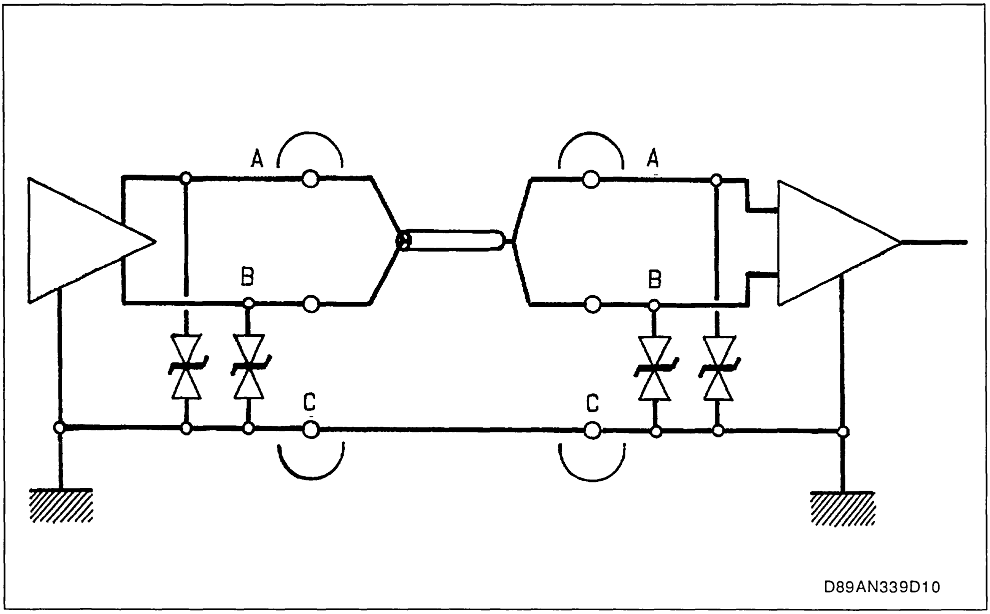
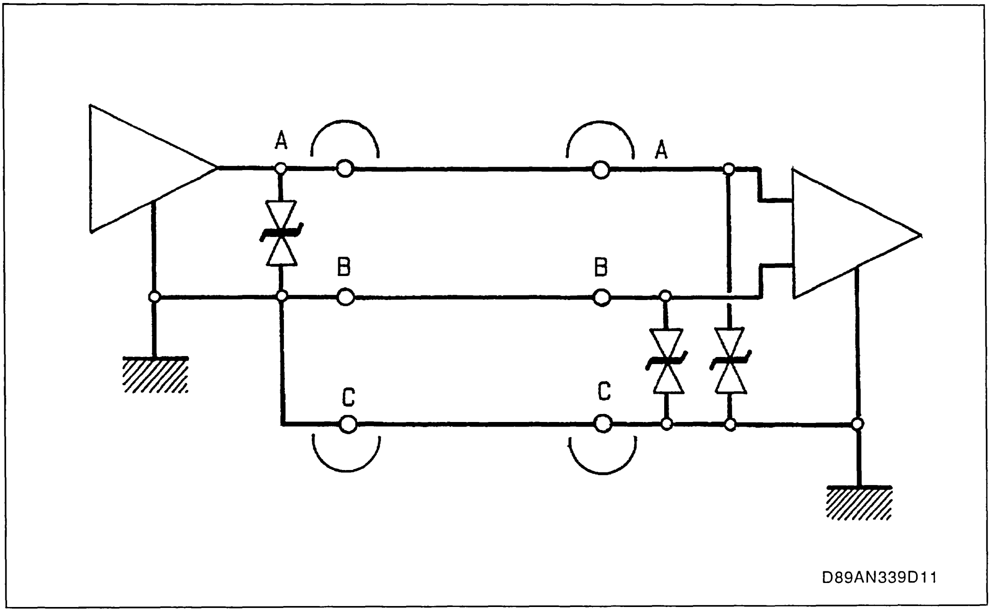
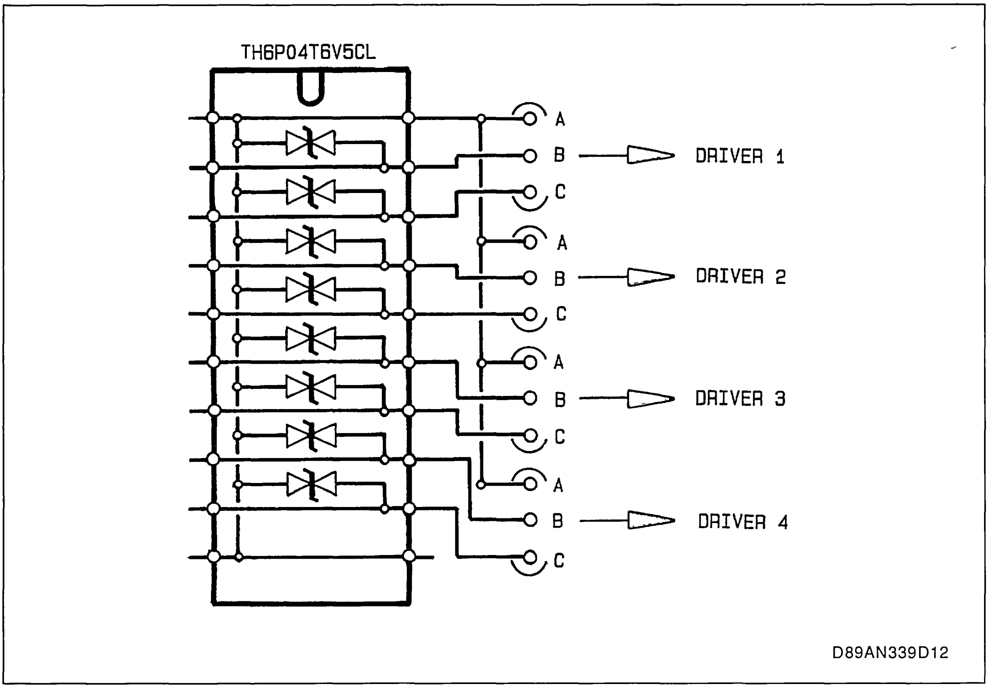


Figure 11 : RS423 Principle of Protection.



With the "TRANSIL ARRAY" integrated circuit the protection function may be located as in the following example (fig. 12).

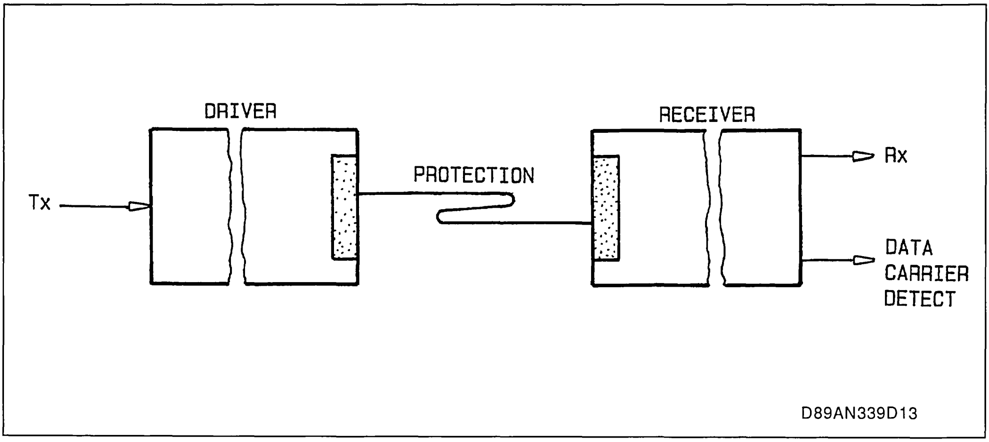
Figure 12 : Two RS422 Protection.



20 mA LOOP PROTECTION

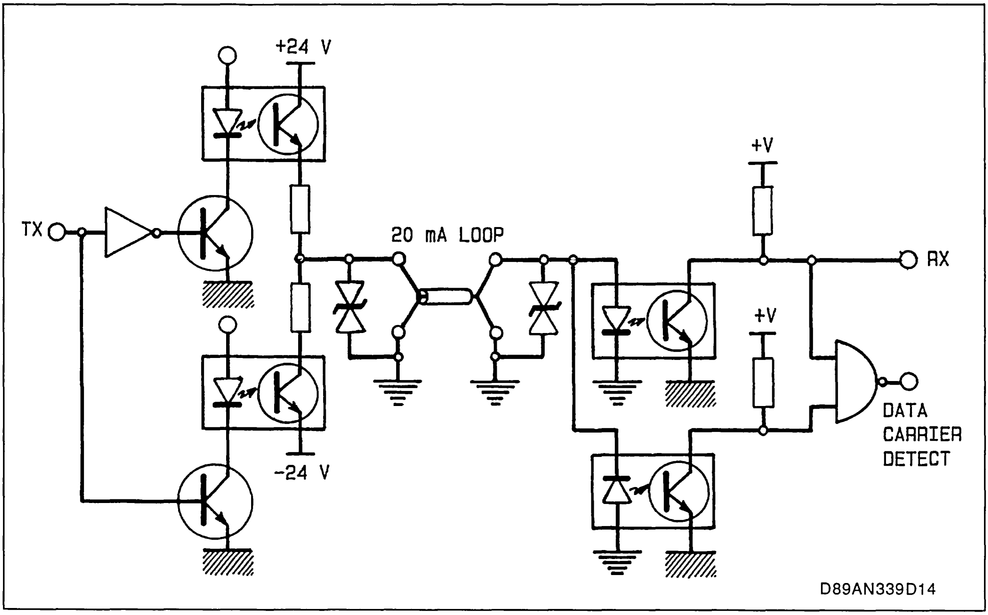
In applications with high perturbation, it is necessary to use low impedance opto-isolated lines (fig. 13).

Figure 13 : Location of the Protection.



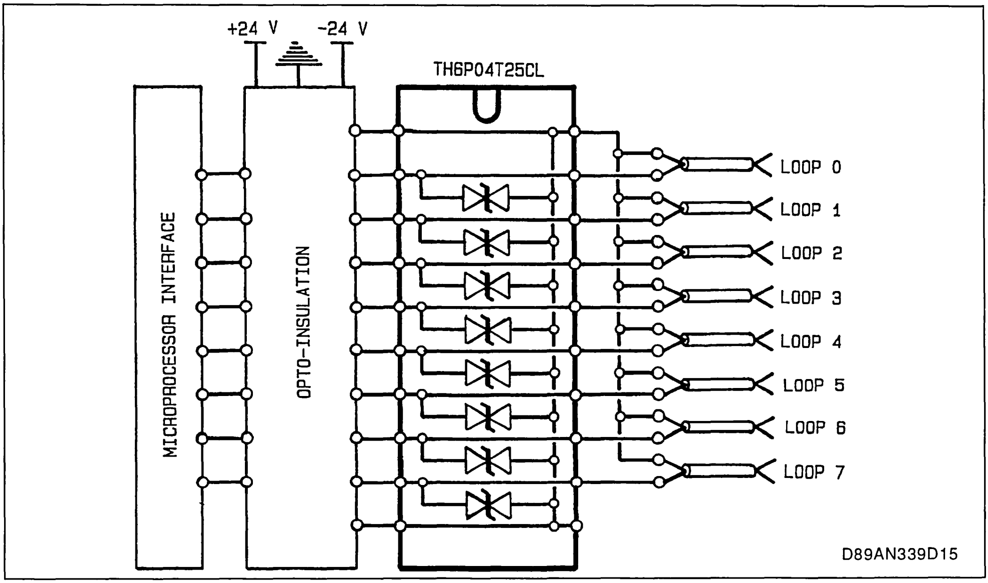
This type of junction works generally with reverse of the current polarity, this permits detection of line cutting (fig. 14).

Figure 14 : Principle of the Protection.



In this case the use of "TRANSIL ARRAY" devices permits also a big surface gain.

Figure 15 : 8 Ways Driver or Receiver Loops.



LINEAR INPUT PROTECTION

In more and more cases process control many times needs the sampling of linear values such as :

- Temperature
- Pressure
- Voltage
- Current
- etc...

In these very special cases the TH6P04xx is an excellent complement of the interface modul (fig. 16 and 17).

Figure 16 : Location of the Protection.

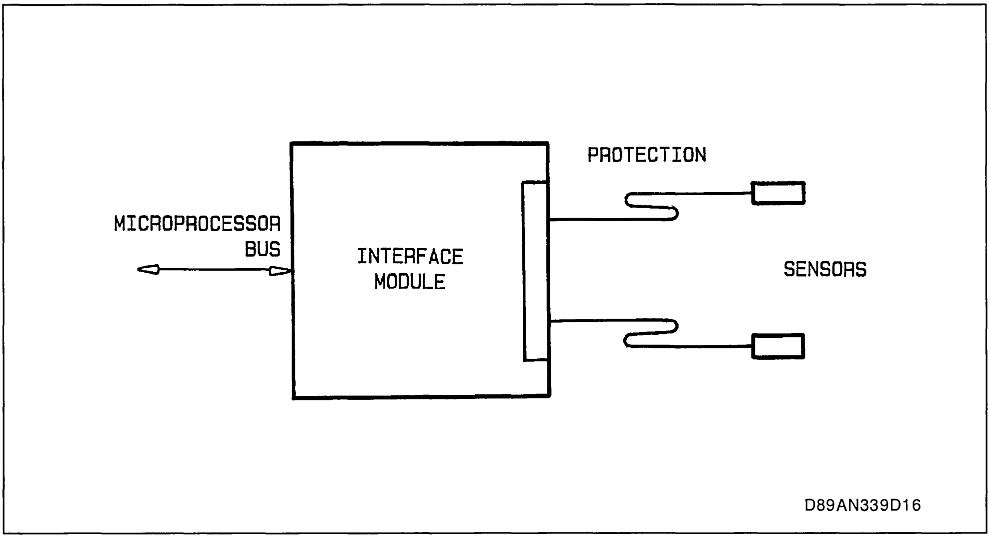
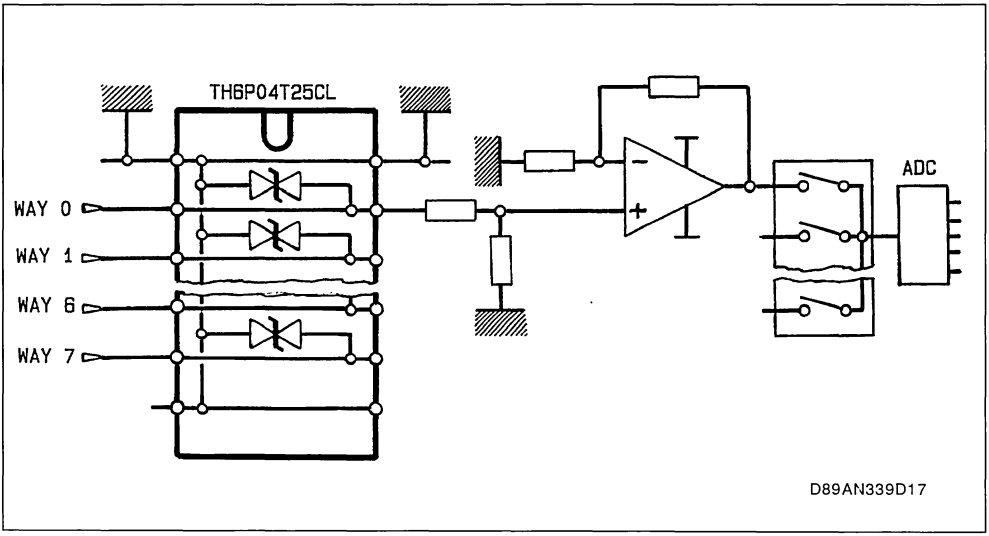


Figure 17 : 8 Linear Way Input Module.



NOTES

SALES OFFICES

AUSTRALIA

NSW 2027 EDGECLIFF
Suite 211, Edgecliff centre
203-233, New South Head Road
Tel (61-2) 327 39 22
Telex 071 126911 TCAUS
Telefax (61-2) 327 61 76

BRAZIL

05413 SÃO PAULO
R Henrique Schaumann 286-CJ33
Tel (55-11) 883-5455
Telex (39-11) 37988 "UMBR BR"

CANADA

BRAMPTON, ONTARIO
341 Main St North
Tel (416) 455-0505
Telefax 416-455-2606

CHINA

BEIJING
Beijing No 5 Semiconductor
Device Factory
14 Wu Lu Tong Road
Da Shang Mau Wai
Tel (861) 2024378
Telex 222722 STM CH

DENMARK

2730 HERLEV
Herlev Torv, 4
Tel (45-2) 94 85 33
Telex 35411
Telefax (45-2) 948694

FRANCE

94253 GENTILLY Cedex
7 - avenue Gallieni - BP 93
Tel (33-1) 47 40 75 75
Telex 632570 STMHQ
Telefax (33-1) 47 40 79 10

67000 STRASBURG
20, Place des Halles
Tel (33) 88 25 49 90
Telex 870001F
Telefax (33) 88 22 29 32

HONG KONG

WANCHAI
22nd Floor - Hopewell centre
183 Queen's Road East
Tel (852-5) 8615788
Telex 60955 ESGIES HX
Telefax (852-5) 8656589

INDIA

NEW DELHI 110 001
Liason Office
c/o Diners Business Services Pvt Ltd
World Trade Tower - First Floor
Barakhamba Lane
Tel 331 4668 - 331 2840
Telex 031 63421 DBSD IN
Telefax 331 2830

ITALY

20090 ASSAGO (MI)
V le Milanofiori - Strada 4 - Palazzo A/4/A
Tel (39-2) 89213 1 (10 linee)
Telex 330131 - 330141 SGSAGR
Telefax (39-2) 8250449

40033 CASALECCHIO DI RENO (BO)
Via R Fucini, 12
Tel (39-51) 591914
Telex 512442
Telefax (39-51) 591305

00161 ROMA
Via A Torlonia, 15
Tel (39-6) 8443341/2/3/4/5
Telex 620653 SGSATE I
Telefax (39-6) 8444474

JAPAN

TOKYO 108
Nisseki - Takanawa Bld 4F
2-18-10 Takanawa
Minato-Ku
Tel (81-3) 280-4121
Telefax (81-3) 280-4131

KOREA

SEOUL 121
8th floor Shinwon Building
823-14, Yuksam-Dong
Kang-Nam-Gu
Tel (82-2) 552-0399
Telex SGSKOR K29998
Telefax (82-2) 552-1051

NETHERLANDS

5612 AM EINDHOVEN
Dillenburgstraat 25
Tel (31-40) 550015
Telex 51186
Telefax (31-40) 528835

SINGAPORE

SINGAPORE 2056
28 Ang Mo Kio - Industrial Park 2
Tel (65) 4821411
Telex RS 55201 ESGIES
Telefax (65) 4820240

SPAIN

08021 BARCELONA
Calle Platon, 6 4th Floor, 5th Door
Tel (34-3) 2022017-2020316
Telefax (34-3) 2021461

28027 MADRID
Calle Albacete, 5
Tel (34-1) 4051615
Telex 27060 TCCEE
Telefax (34-1) 4031134

SWEDEN

S-16421 KISTA
Borgarfjordsgatan, 13 - Box 1094
Tel (46-8) 7939220
Telex· 12078 THSWS
Telefax (46-8) 7504950

SWITZERLAND

1218 GRAND-SACONNEX (GENÈVA)
Chemin Franois-Lehmann, 18/A
Tel. (41-22) 7986462
Telex 415493 STM CH
Telefax (41-22) 7984869

TAIWAN

TAIPEI
12th Floor
571, Tun Hua South Road
Tel (886-2) 755-4111
Telex 10310 ESGIE TW
Telefax. (886-2) 755-4008

UNITED KINGDOM and EIRE

MARLOW, BUCKS
Planar House, Parkway
Globe Park
Tel (44-628) 890800
Telex 847458
Telefax (44-628) 890391

SALES OFFICES

U.S.A.

NORTH & SOUTH AMERICAN
MARKETING HEADQUARTERS
1000 East Bell Road
Phoenix, AZ 85022-2699
(1)-(602) 867-6340

SALES COVERAGE BY STATE

ALABAMA
Huntsville - (205) 533-5995

ARIZONA
Phoenix - (602) 867-6340

CALIFORNIA
Irvine - (714) 250-0455
San Jos - (408) 452-8585

COLORADO
Boulder (303) 449-9000

GEORGIA
Norcross - (404) 242-7444

ILLINOIS
Schaumburg - (708) 517-1890

MARYLAND
Columbia - (301) 995-6952

MASSACHUSSETTS
Waltham - (617) 890-6688

NEW JERSEY
Voorhees - (609) 772-6222

OREGON
Tigard - (503) 620-5517

TEXAS
Austin - (512) 339-4191
Carrollton - (214) 466-8844

WASHINGTON
Seattle - (206) 524-6421

FOR RF AND MICROWAVE POWER TRANSISTORS CONTACT THE FOLLOWING REGIONAL OFFICES IN THE U S A

CALIFORNIA
Hawthorne - (213) 675-0742

NEW JERSEY
Totowa - (201) 890-0884

PENNSYLVANIA
Montgomeryville - (215) 362-8500

TEXAS
Carrollton - (214) 466-8844

WEST GERMANY

6000 FRANKFURT
Gutleutstrabe 322
Tel. (49-69) 237492
Telex 176997 689
Telefax (49-69) 231957
Teletex 6997689=STVBP

8011 GRASBRUNN
Bretonischer Ring 4
Neukeferloh Technopark
Tel · (49-89) 460060
Telex 528211
Telefax (49-89) 4605454
Teletex 897107=STDISTR

3000 HANNOVER 1
Eckenerstrasse 5
Tel (49-511) 634191
Telex 175118418
Teletex 5118418 csfbeh
Telefax (49-511) 633552

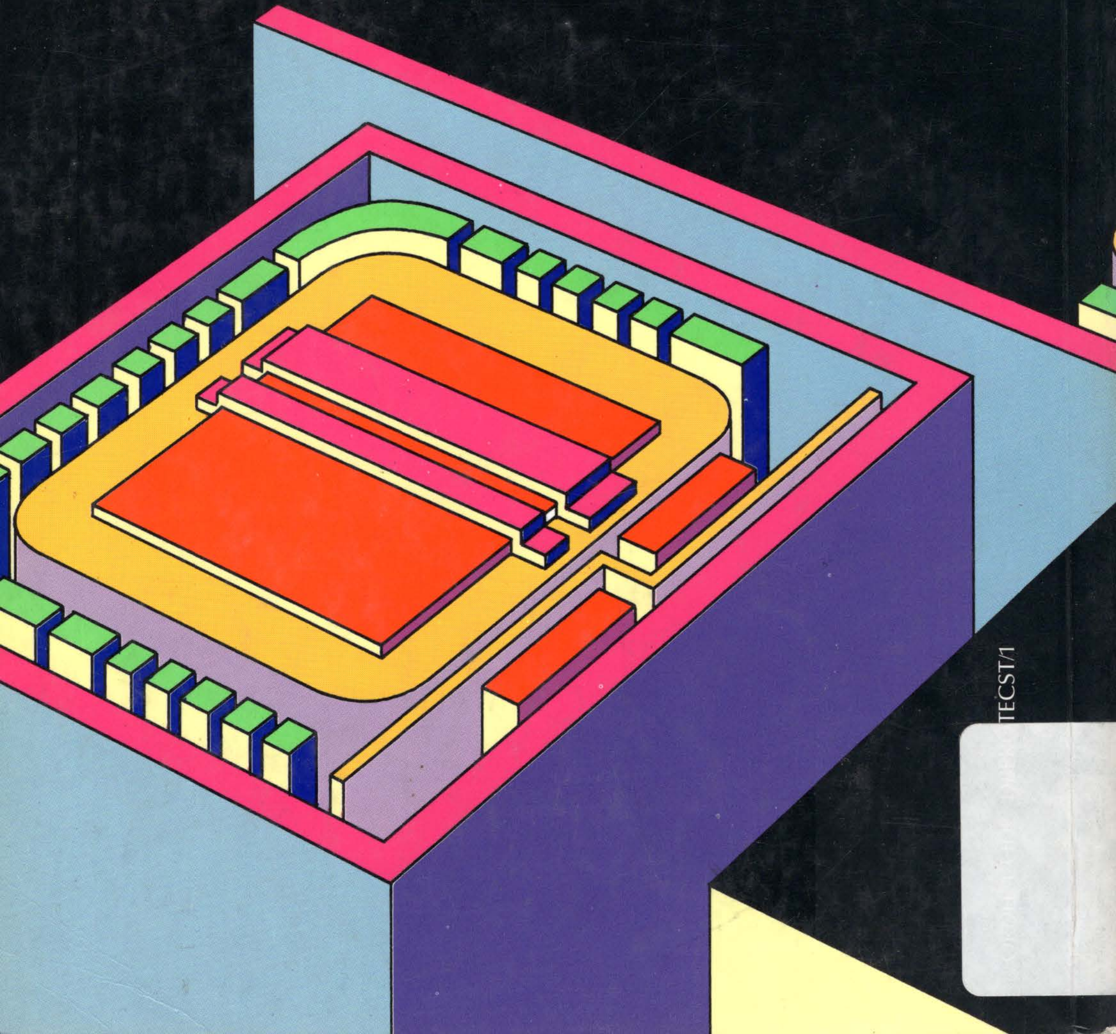
8500 NÜRNBERG 20
Erlenstegenstrasse, 72
Tel (49-911) 597032
Telex 626243
Telefax. (49-911) 5980701

5200 SIEGBURG
Frankfurter Str 22a
Tel. (49-2241) 660 84-86
Telex. 889510
Telefax (49-2241) 67584

7000 STUTTGART
Oberer Kirchhaldenweg 135
Tel (49-711) 692041
Telex 721718
Telefax (49-711) 691408

Cover design by Keith & Koppel, Segrate, Italy
Type setting and layout on Desk Top Publishing
by AZIMUT, Hénin Bt., France
Printed by Garzanti, Cernusco S./N., Italy

SGS-THOMSON Microelectronics GROUP OF COMPANIES
Australia - Brazil - China - France - Hong Kong - Italy - Japan - Korea - Malaysia - Malta - Morocco - The Netherlands - Singapore - Spain - Sweden - Switzerland - Taiwan - United Kingdom - U S A - West Germany



TECST/1