August 5, 1994
Linda Stutte

E781 RICH COUNTER ELECTRICAL DESCRIPTION

INTRODUCTION

Experiment 781 will run in the PCenter beam line during the next fixed target run. One of the pieces of equipment to be used will be a RICH (Ring Imaging CHerenkov) counter. This is a large vessel (10 meters in length, 2.4 meters in diameter) containing neon gas at just over one atmosphere pressure. The neon acts as a radiator for charged particles which travel through the vessel. The emitted photons are reflected by a large spherical mirror array at the downstream end of the vessel back toward a detector which consists of a 32 x 89 matrix of photomultiplier tubes. (See Figure 1.) The phototubes are mounted inside an attached box (the phototube box) and supported by a holder plate which also provides a gas barrier between the tubes and the neon radiator via quartz windows that are glued into each holder (Figure 2). Two types of phototubes are used in the detector. One is the Hamamatsu R760, a 1/2 inch diameter tube. The other is the FEU60, a Russian phototube of the same physical size. This memo describes the low and high voltage systems needed for the phototubes.

Neon
45.23 m^3 +
1600
2848 PMTs

LOW VOLTAGE

The phototubes are grouped in sets of 16, two sets comprising a column of 32 phototubes in the 32 x 89 matrix. The output signals from a group of 16 phototubes are soldered onto paddle cards (Figure 3). These cards contain a 1 kohm resistor for each channel which protects the corresponding readout chip from charge build-up whenever the paddle cards are initially connected. The paddle cards plug into the backplane of one of three crates, located outside of the light-tight phototube box (Figure 4). Standard Eurocard connectors are used to make the backplane feed-through (Figure 5).

178 paddle cards

The readout electronics, mounted on cards in the crates, consists of hybrid chips (Figure 6), provided by Moscow State University. Each chip contains a pre-amplifier, a discriminator and a line driver. The R760 phototubes use a 5 microamp threshold chip and the FEU60 phototubes use a 2.5 microamp threshold chip. The output is a differential ECL signal which is fed to a latch readout system via twisted flat cable. Thirty-two chips are mounted on each card (Figure 7), which processes a single column of 32 phototubes. The chips use both +6 volts and - 6 volts, drawing 20 ma and 50 ma per chip, respectively. These voltages are fed to the cards via the crate backplanes from 6 Lambda LXS-7-6-0V power supplies. Each card is individually fused. The voltage buses inside the phototube box are shielded from hand contact.

HIGH VOLTAGE

The high voltage distribution system for the RICH (Figure 8) consists of:

50-60 Hz

1. Seven high voltage power supplies manufactured in Russia and modified at Moscow State University. These supplies need 220 volt AC and draw a maximum power of 500 watts each. The supplies deliver a maximum output voltage of 2500 volts, with 200 milliamp maximum current and 200 watts [illegible]. They have built-in protection from over-current

208V?
2.5 amps

and alarm outputs are also available.

2. A high voltage distribution system which delivers power from the six power supplies to (up to) 96 phototube groups (89 columns plus spares). The voltage for each group is adjusted from the supply voltage using Zener diodes (Figure 9a,b). The R760 phototubes operate at 1000 to 1250 volts, with a current draw of approximately 300 microamps per tube. The FEU60 phototubes operate at 1300 to 1700 volts, with a current draw of approximately 150 microamps per tube. The phototubes have been sorted so that a given vertical column of 32 tubes runs at the same high voltage. This distribution system will be housed in a grounded metal box near the high voltage rack.

3. Ninety-six high voltage cables (RG58) enter the phototube box through an SHV feed-through panel. Each cable supplies a column of phototubes. Each group of 16 phototubes is soldered to a single high-voltage fanout board and to a single ground fanout board. Two boards from each column share a common high voltage input. The distribution boards are mounted to a specially insulated support on the bottom of the phototube box. All boards are separated by insulating sheets (Figure 10).

4. An interlock system will be used so that the high voltage is shut off before the cover can be removed from the phototube box.

High voltage distribution system for RICH consist of

1. 7 high voltage power suplies manufactured in Russia and modified in Moscow State University. It needs AC 220 V and has maximum power 500 Watt. Power supplies have 2.5 KV maximum output voltage, 200 mA maximum current and maximum output power 200 W, and it have built in protection from overcurrent, overvoltage and overpower. It has also remote on/off swith, status and alarm TTL level output through Lemo connectors.

2. High voltage distribution system which deliver power from 6 power supplies 96 photomultiplier groups. It is possible to adjust voltage on each group by substrating up to 300 V from output voltage by 3 Zener diods. There are two type of photomultipliers:
Hamamatst R-760 -which needs voltage of 1.0-1.25 KV and group current of 8-10 mA, and Russian FEU-60 which needs voltage of 1.0-1.7 KV and each group current of 2-5 mA.
This system will be placed into grounded metal box at high voltage rack.

3. 96 high voltage cables RG58 through SHV connectors enter into photomultiplier box welded to radiator vessel and are connected to a row of photomultipliers, working at the same voltage. HV wires from PMs are soldered to a distribution cards, with 32 wires entering each card. Distribution cards are mounted to the special insulated support on the bottom of the PM box. All cards are separated by insulating sheets.

50-60 Hz

- main circuit breaker

Inlet Cap.?

Shunt trip?

Zeners - rated

sharing network?

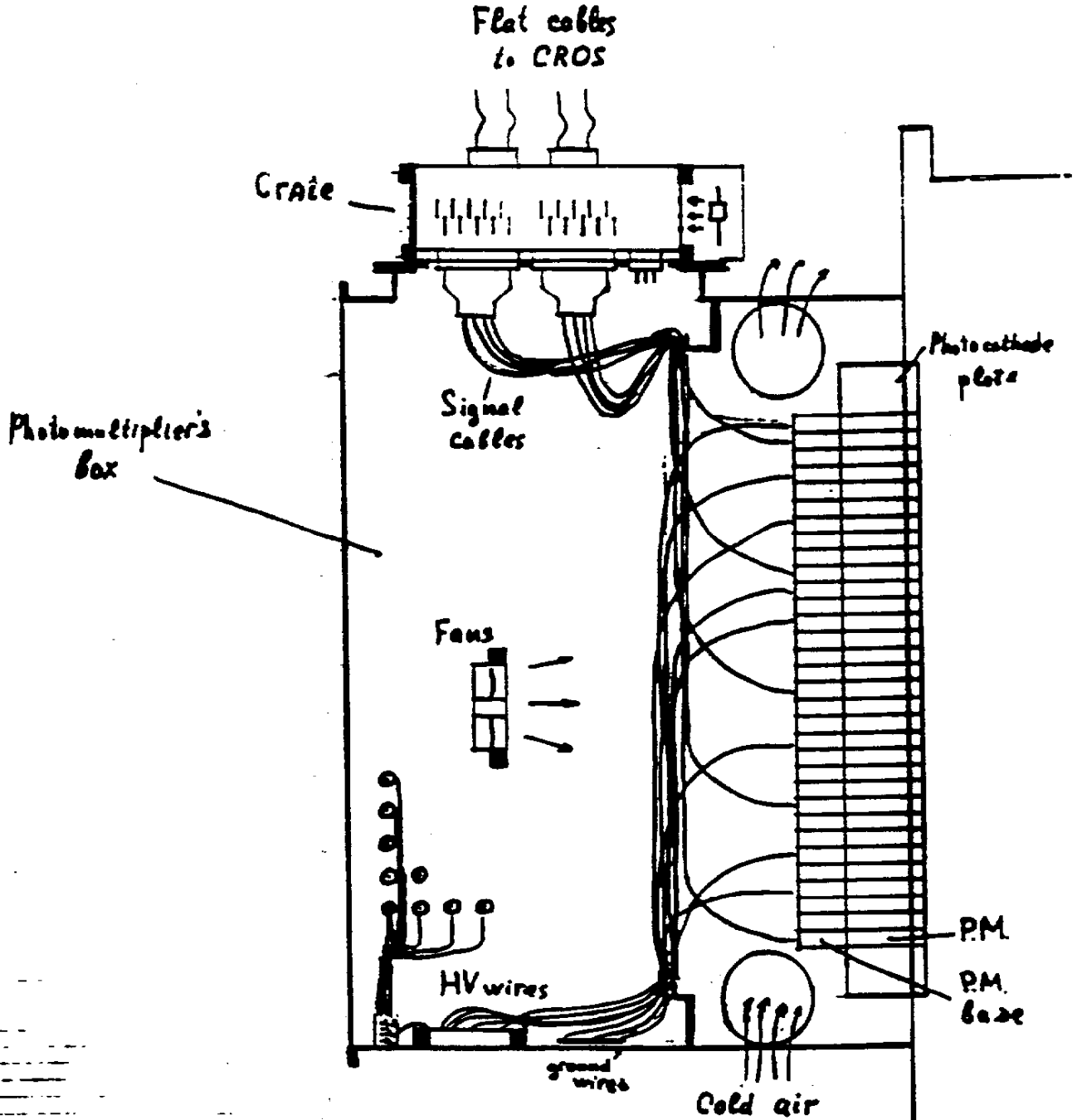

Flat cables
to CROS
Crate
Photomultiplier's
box
Signal
cables
Photocathode
plate
Fans
HV wires
ground
wires
P.M.
P.M.
base
Cold air
beam

FIGURE 2

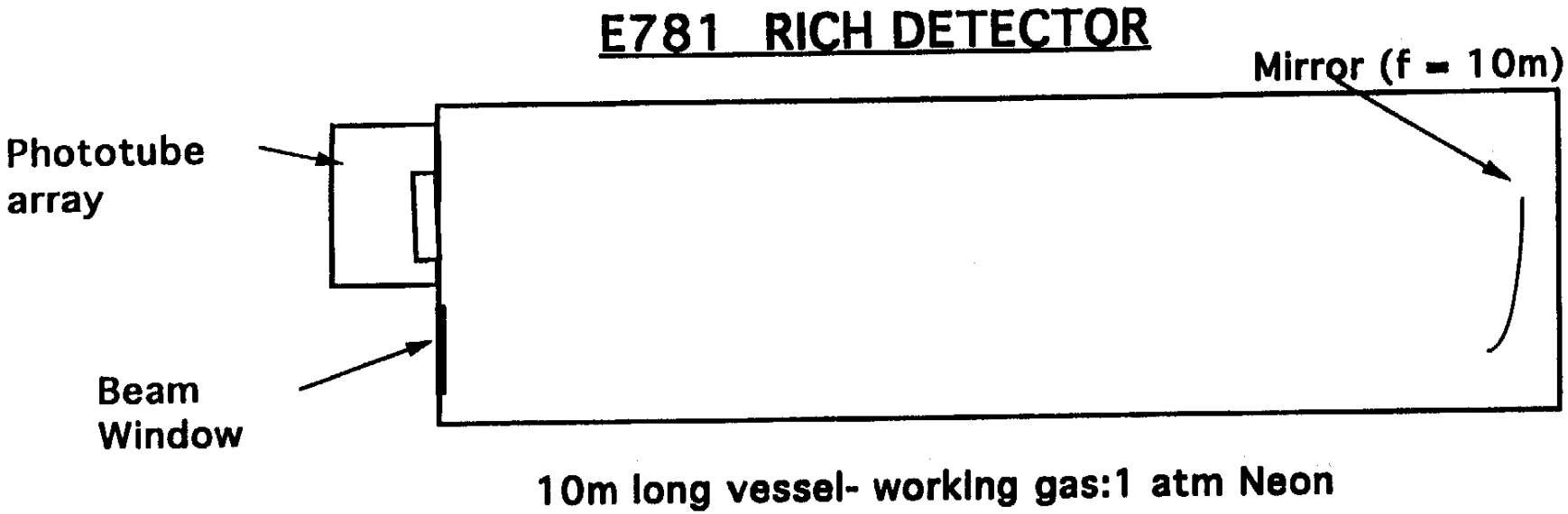
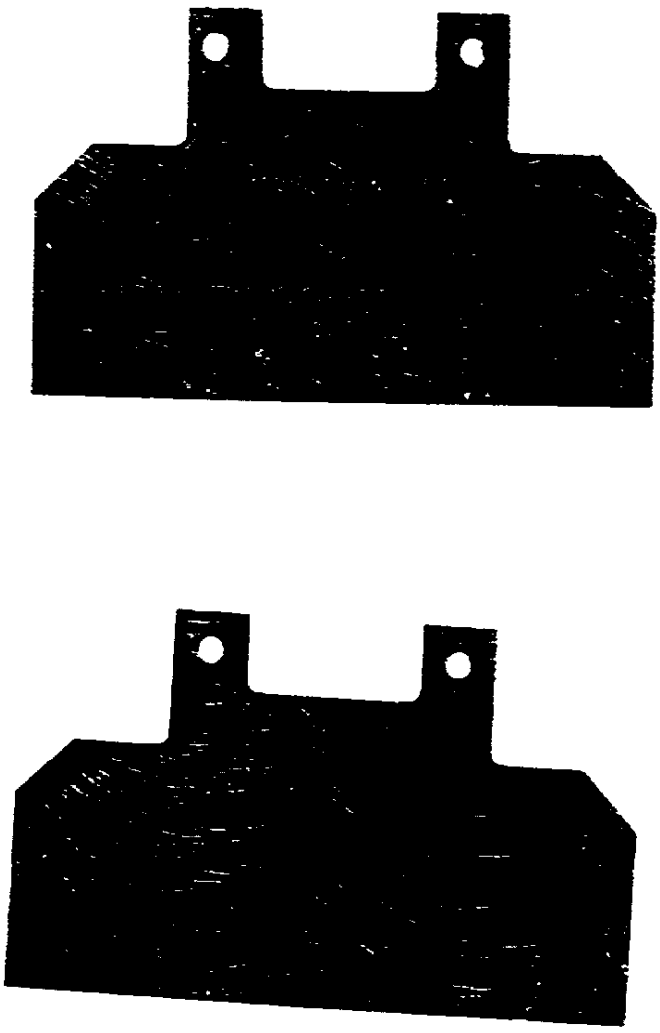

E781 RICH DETECTOR
Mirror (f = 10m)
Phototube array
Beam Window
10m long vessel- working gas:1 atm Neon

FIGURE 1



PADDLE CARDS

FIGURE 3

CRAIES

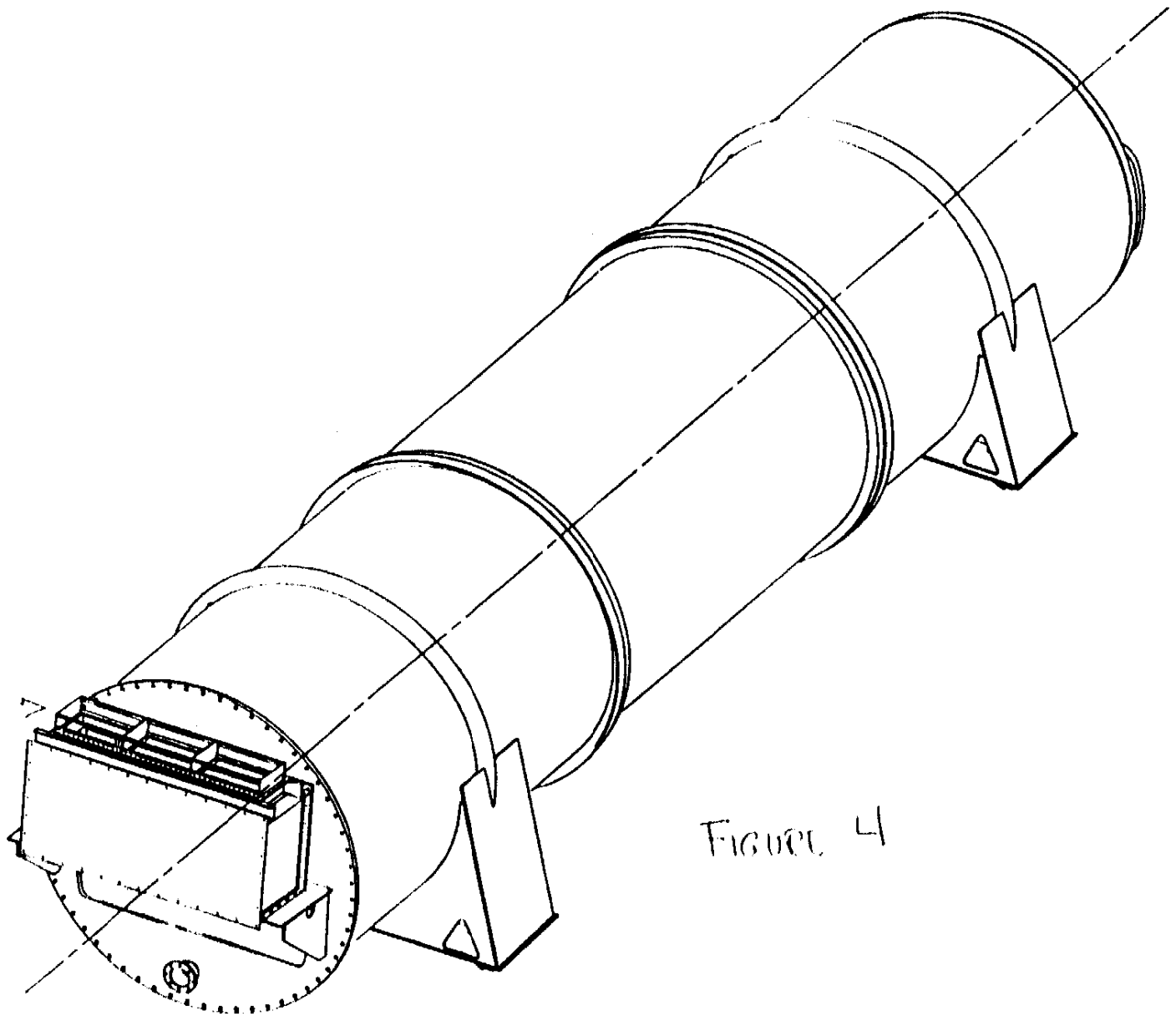


FIGURE 4

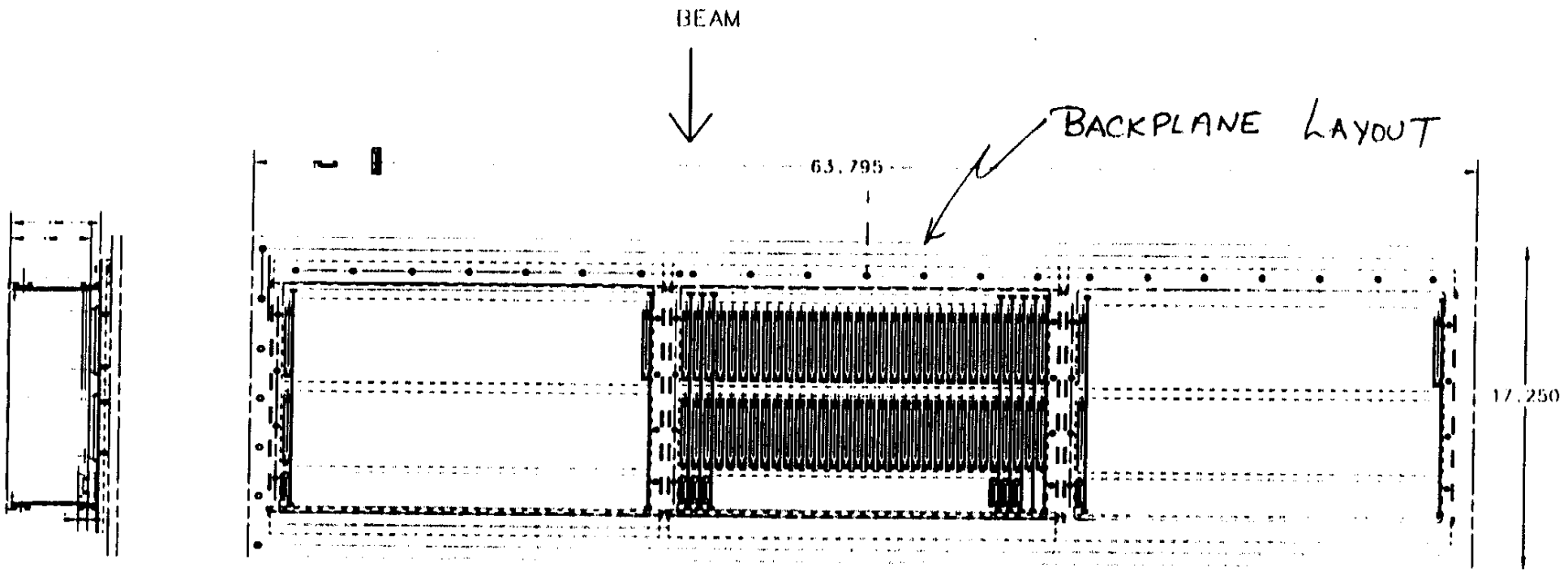


FIGURE 5

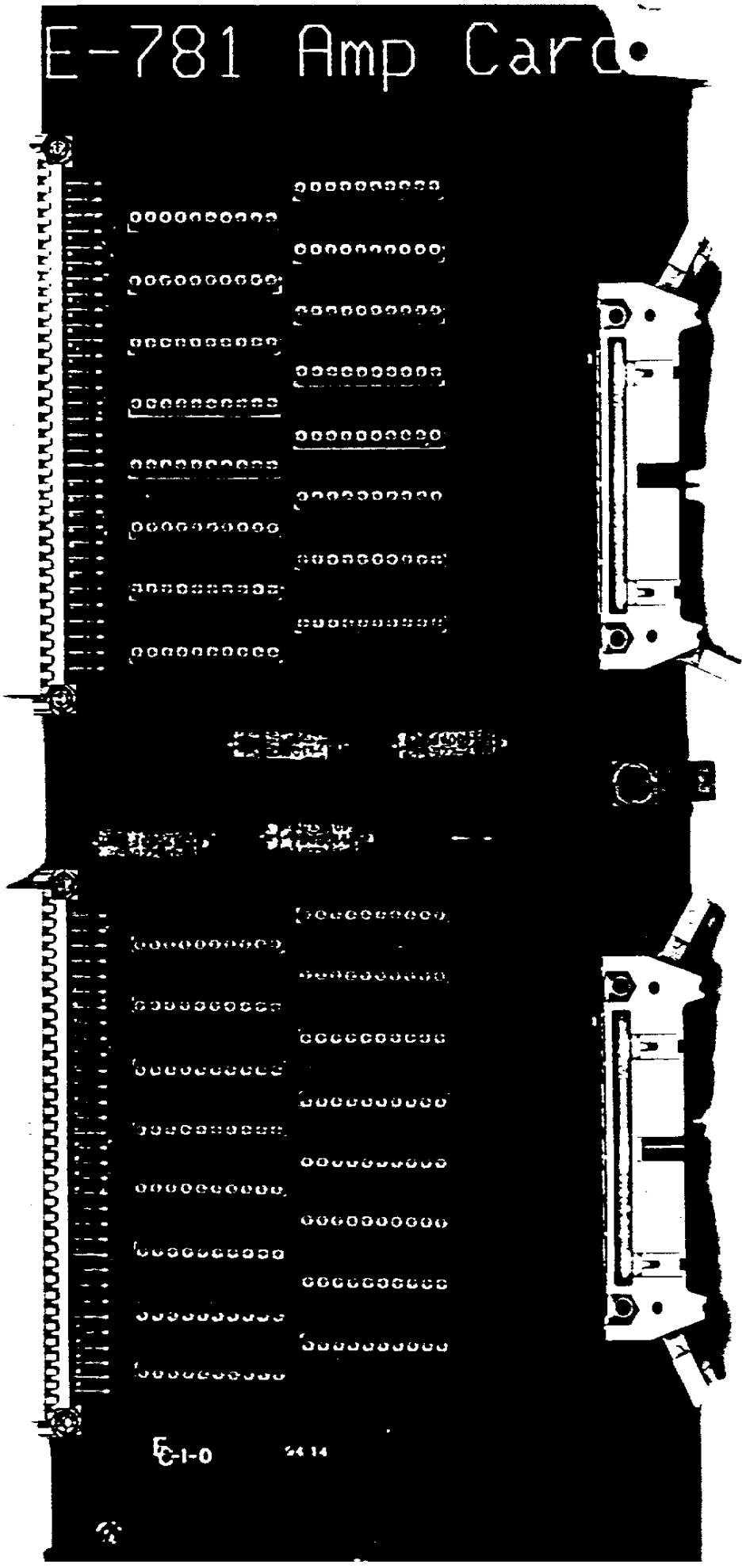


FIGURE 7

High voltage distribution system for RICH

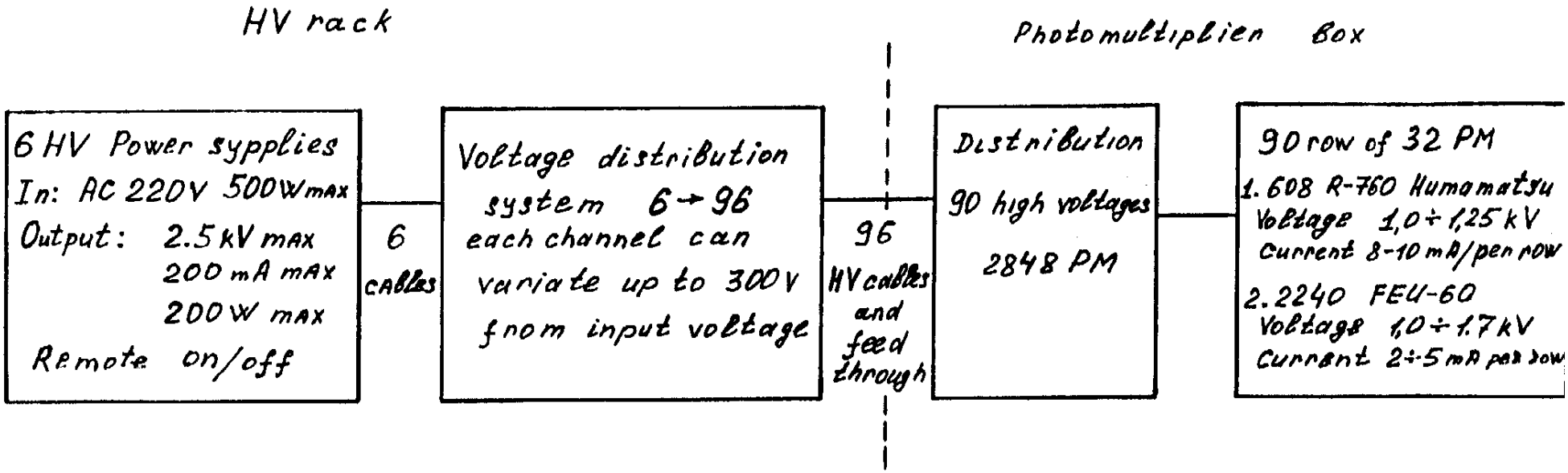


FIGURE 8

4 Nov 93 I. Filimonov
A. Nemitkin

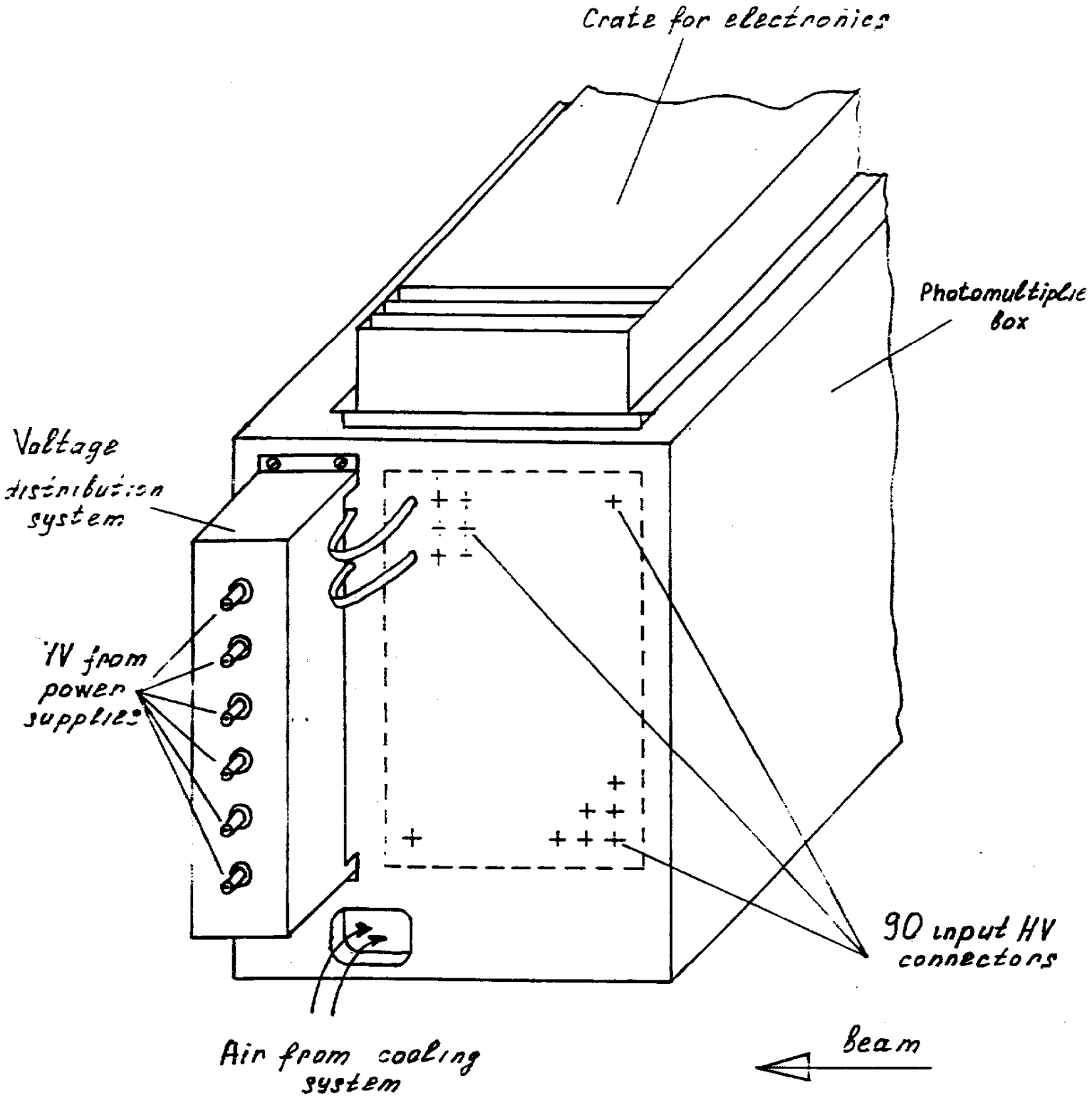
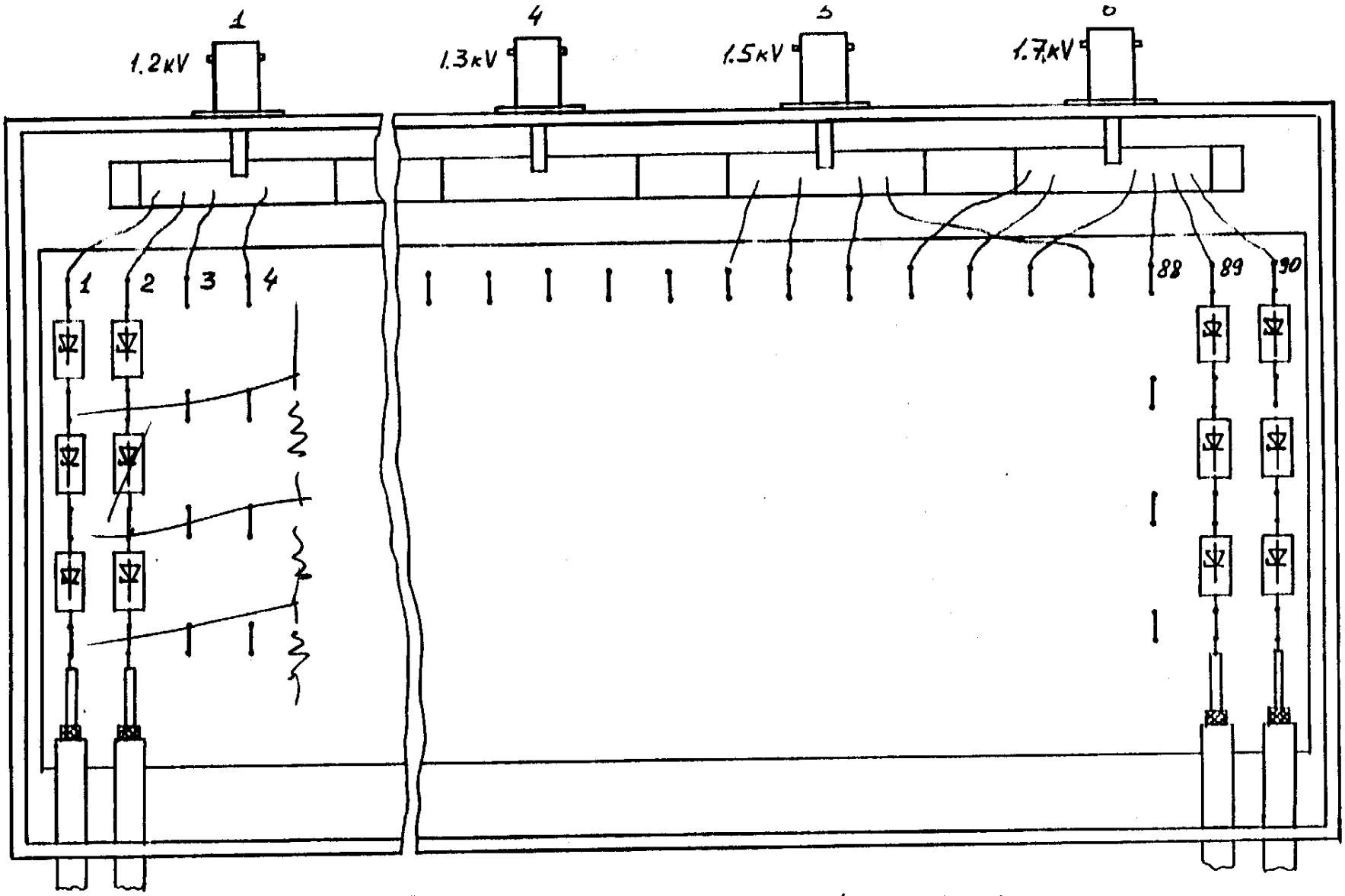

Crate for electronics
Photomultiplie box
Voltage distribution system
HV from power supplies
90 input HV connectors
Air from cooling system
Beam

FIGURE 9a



Zener diods: 100 V 1 W 10 mA
50 V 1 W
25 V 1 W

Voltage distribution system from power supplies to row of PM

FIGURE 9b

Voltage distribution to each photomultiplies inside PM box

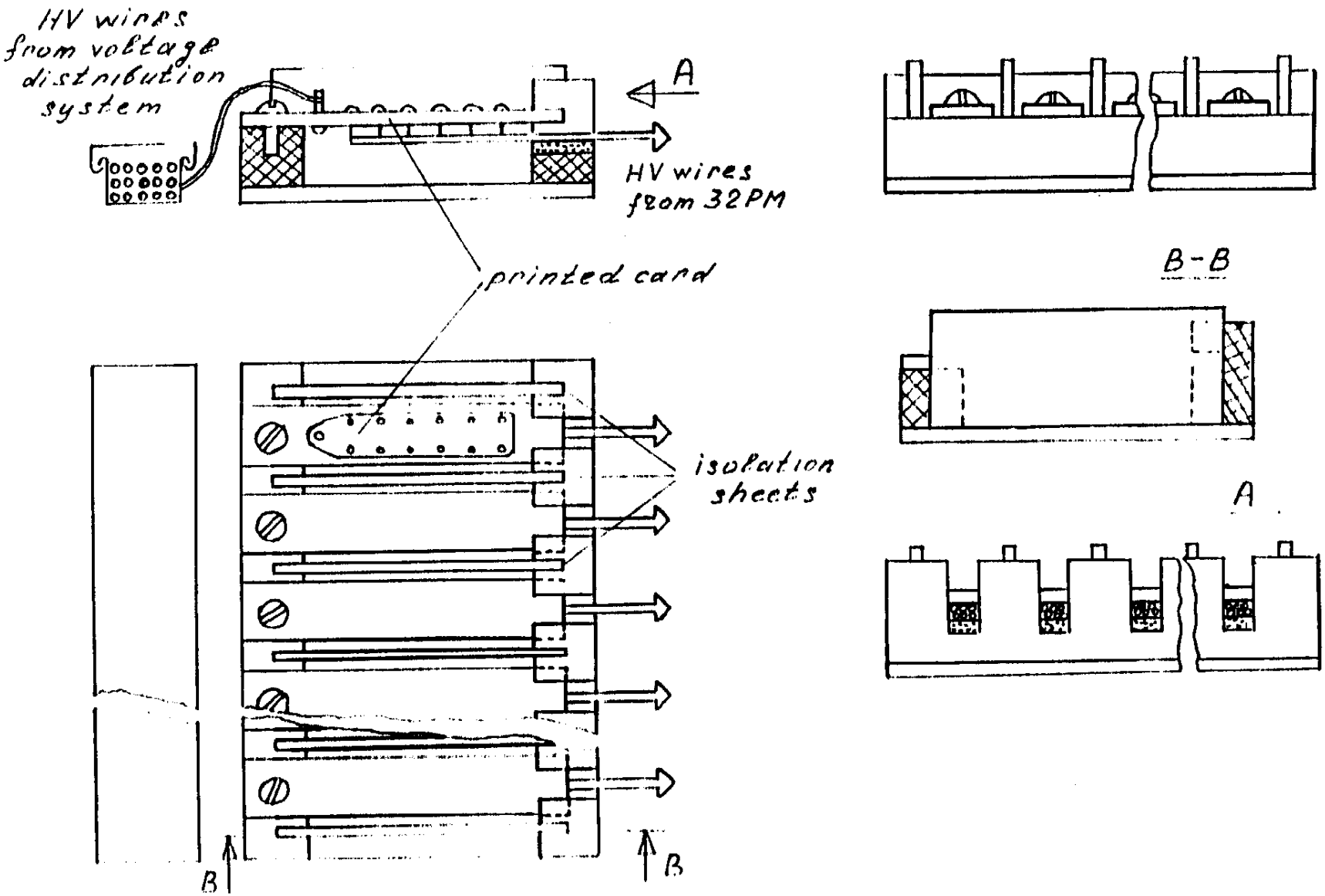
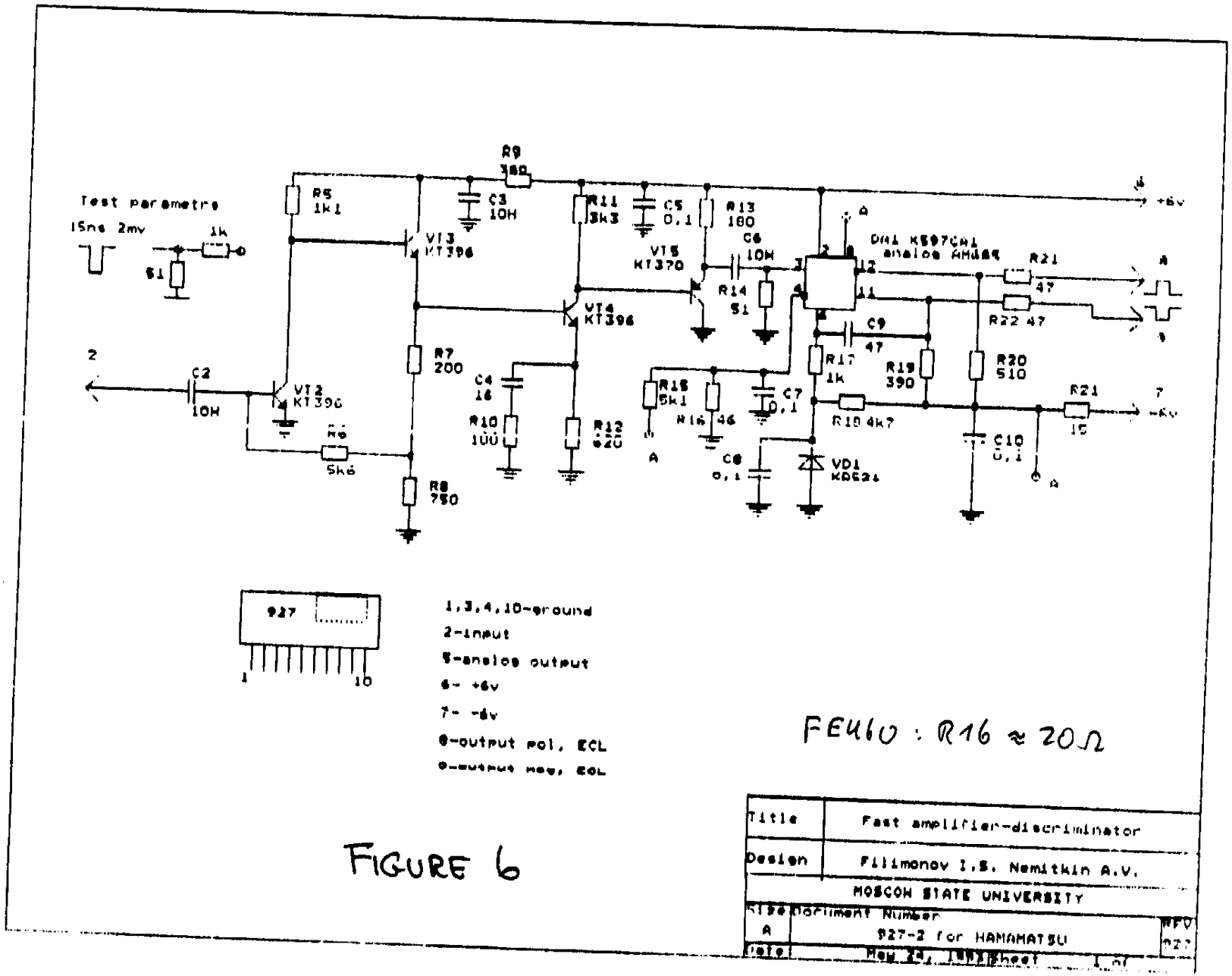


FIGURE 10


Test parametre
15ns 2mv
1k
S1
R5 1k1
R9 360
C3 10H
R11 3k3
C5 0,1
R13 180
VT3 KT396
VT4 KT396
VT5 KT370
C6 10H
R14 51
DA1 K597CA1 analog AMU86
R21 47
R22 47
C9 47
R17 1k
R19 390
R20 510
R21 15
R18 4k7
C10 0,1
R15 5k1
R16 46
C7 0,1
C8 0,1
VD1 KD521
2
C2 10H
VT2 KT396
R6 5k6
R7 200
C4 16
R10 100
R12 820
R8 750
A
927
1
10
1,3,4,10-ground
2-input
5-analog output
6- +6v
7- -6v
8-output pol. ECL
9-output neg. ECL
FEU60 : R16 ≈ 20Ω
FIGURE 6
Title
Fast amplifier-discriminator
Design
Filimonov I.S. Nemitkin A.V.
MOSCOW STATE UNIVERSITY
Size
A
Document Number
927-2 for HAMAMATSU
REV
927
Date
May 24, 1993
Sheet
1 of

FERMILAB

ENGINEERING NOTE

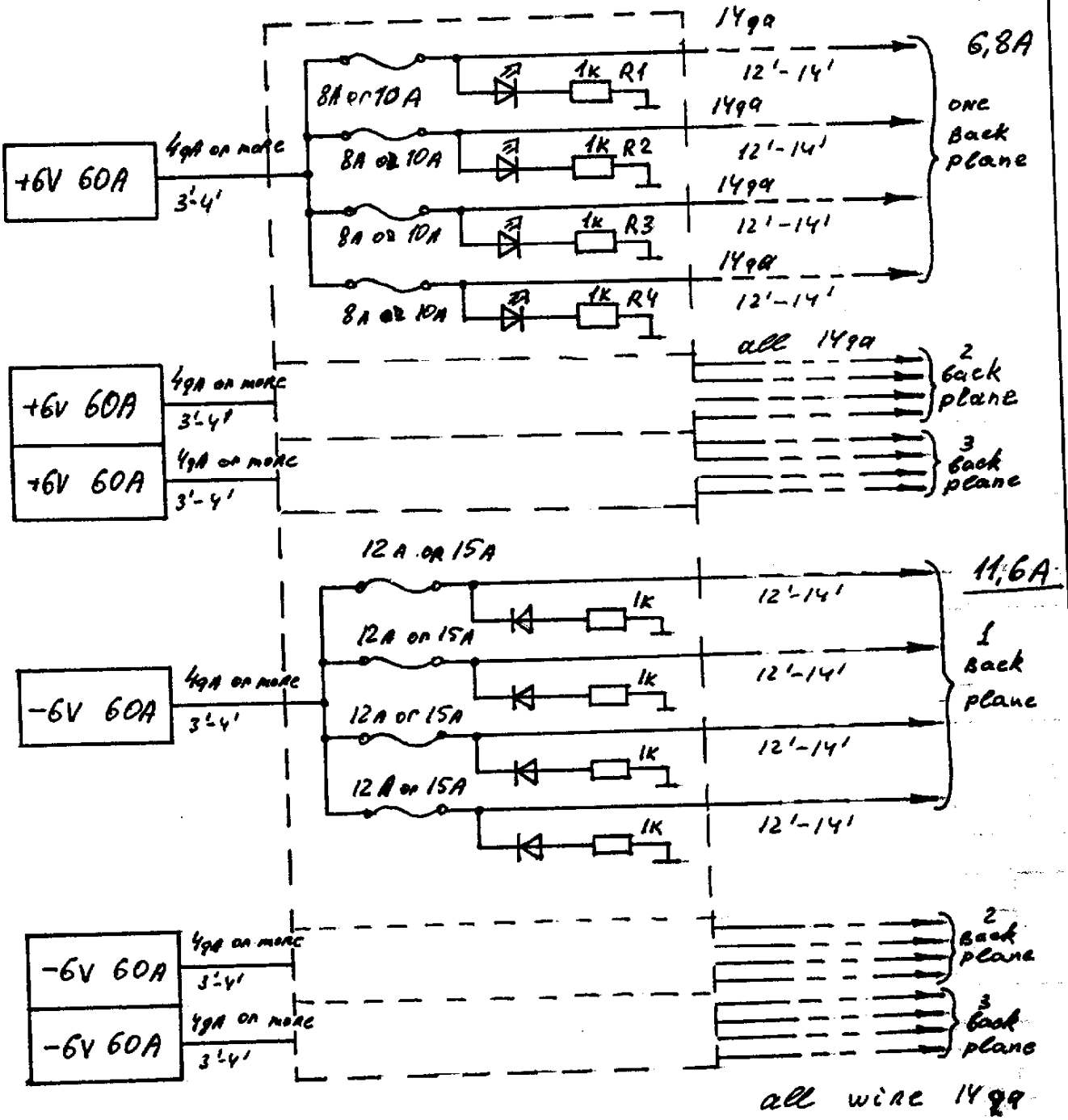
SECTION	PROJECT	SERIAL-CATEGORY	PAGE

SUBJECT: E-781

NAME: A. NEMITKIN

DATE: 07.07.95

REVISION DATE:



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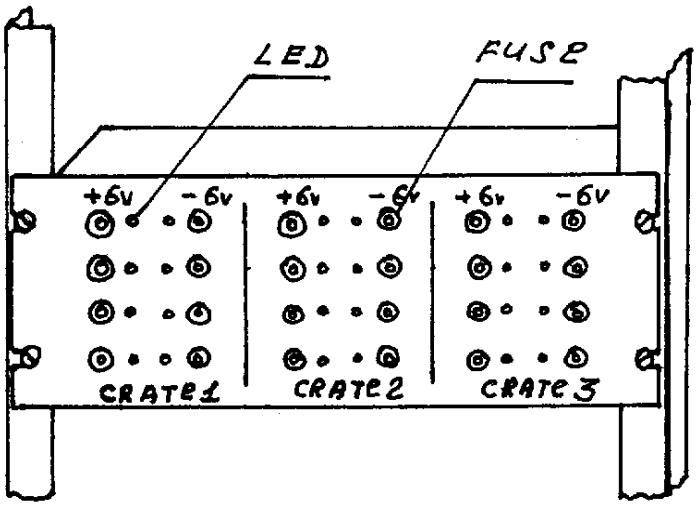
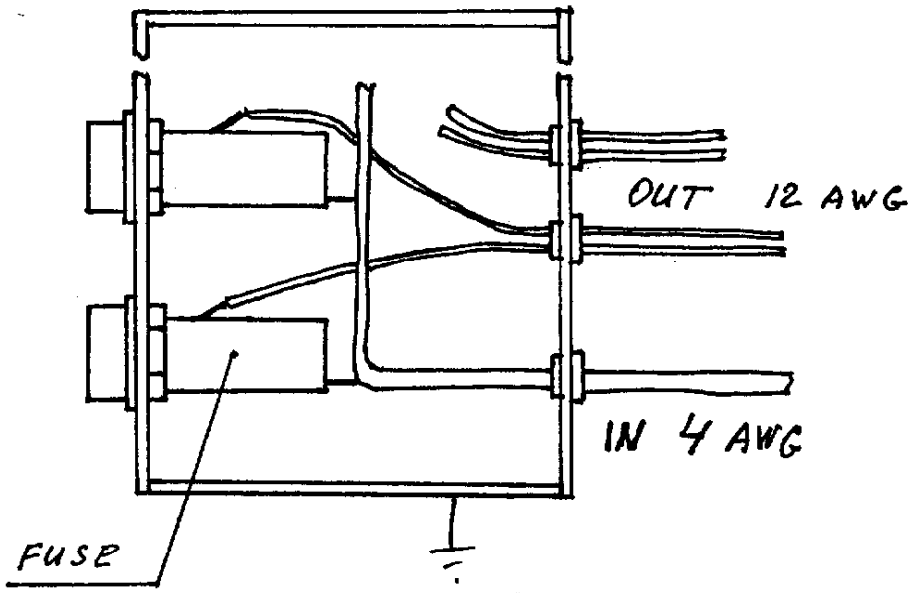
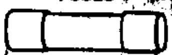




COOPER
Bussmann

BUSS® 5X20MM & SUBMINIATURE FU[illegible]

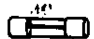
GDA 5 x 20mm FAST-ACTING FUSES



Ceramic, high-interrupting, rated 250V. Meet IEC 127, Sheet 1.

Stock No.	Type	Amps	1-49	50-99
46F053	GDA-50MA	50mA	2.30	2.06
46F054	GDA-63MA	63mA	2.30	2.06
46F055	GDA-80MA	80mA	2.30	2.06
46F056	GDA-100MA	100mA	2.30	2.06
46F057	GDA-125MA	125mA	2.30	2.06
46F058	GDA-160MA	160mA	2.30	2.06
46F059	GDA-200MA	200mA	2.30	2.06
46F060	GDA-250MA	250mA	2.30	2.06
46F061	GDA-315MA	315mA	2.30	2.06
46F062	GDA-400MA	400mA	2.30	2.06
46F063	GDA-500MA	500mA	2.00	1.80
46F064	GDA-630MA	630mA	2.00	1.80
46F065	GDA-800MA	800mA	2.00	1.80
46F066	GDA-1A	1.0	2.00	1.80
46F067	GDA-1.25A	1.25	2.00	1.80
46F068	GDA-1.6A	1.6	2.00	1.80
46F069	GDA-2A	2.0	2.00	1.80
46F070	GDA-2.5A	2.5	2.00	1.80
46F071	GDA-3.15A	3.15	2.00	1.80
46F072	GDA-4A	4.0	2.00	1.80
46F073	GDA-5A	5.0	2.00	1.80
46F074	GDA-6.3A	6.3	2.00	1.80

GMA 5x20mm FAST-ACTING FUSES



Glass, rated 250V, except * 125V. UL listed, CSA certified.

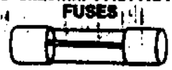
Stock No.	Type	Amps	1-99	100-999
46F027	GMA-63MA	63mA	1.22	1.14
46F028	GMA-100MA	100mA	1.22	1.14
46F029	GMA-125MA	125mA	1.22	1.14
46F030	GMA-200MA	200mA	.77	.69
46F031	GMA-250MA	250mA	.77	.69
46F034	GMA-500MA	500mA	.77	.69
46F035	GMA-600MA	600mA	.77	.69
46F037	GMA-750MA	750mA	.77	.69
46F038	GMA-800MA	800mA	.77	.69
46F039	GMA-1A	1.0	.77	.69
46F042	GMA-1.5A	1.5	.77	.69
46F043	GMA-2A	2.0	.77	.69
46F044	GMA-2.5A	2.5	.77	.69
46F045	GMA-3A	3.0	.77	.69
46F046	GMA-4A*	4.0	.77	.69
46F047	GMA-5A*	5.0	.77	.69
46F048	GMA-6A*	6.0	.77	.69
46F049	GMA-7A*	7.0	.77	.69
46F050	GMA-8A*	8.0	.77	.69
46F051	GMA-10A*	10.0	.77	.69
46F052	GMA-15A*	15.0	.77	.69

MICROTRON® PCB FU[illegible]

Subminiature, rated 125V [illegible] Body sealed for wave soldering. [illegible] 0.120" diameter. Fit [illegible] centering holes. [illegible]

Stock No.	Type	Amps	1-[illegible]
87F1529	MCR-1/16	1/16	[illegible]
87F1530	MCR-1/8	1/8	[illegible]
87F1531	MCR-1/4	1/4	[illegible]
87F1532	MCR-3/8	3/8	[illegible]
87F1533	MCR-1/2	1/2	[illegible]
87F1534	MCR-3/4	3/4	[illegible]
87F1535	MCR-1	1	[illegible]
87F1536	MCR-1½	1½	[illegible]
87F1537	MCR-2	2	[illegible]
87F1538	MCR-2½	2½	[illegible]
87F1539	MCR-3	3	[illegible]
87F1540	MCR-3½	3½	[illegible]
87F1541	MCR-4	4	[illegible]
87F1542	MCR-5	5	[illegible]
87F1543	MCR-7*	7	[illegible]
87F1544	MCR-10*	10	[illegible]

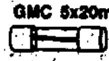
GDB 5x20mm FAST-ACTING FUSES



Glass, 250V, low-interrupting. Meet IEC 127, Sheet 2.

Stock No.	Type	Amps	1-49	50-99
46F077	GDB-50MA	50mA	2.62	2.46
46F078	GDB-63MA	63mA	2.62	2.46
46F079	GDB-80MA	80mA	2.62	2.46
46F080	GDB-100MA	100mA	2.62	2.46
46F081	GDB-125MA	125mA	1.94	1.82
46F082	GDB-160MA	160mA	1.94	1.82
46F083	GDB-200MA	200mA	1.94	1.82
46F084	GDB-250MA	250mA	1.94	1.82
46F085	GDB-315MA	315mA	1.94	1.82
46F086	GDB-400MA	400mA	1.94	1.82
46F087	GDB-500MA	500mA	1.60	1.51
46F088	GDB-630MA	630mA	1.60	1.51
46F089	GDB-800MA	800mA	1.60	1.51
46F090	GDB-1A	1.0	1.60	1.51
46F091	GDB-1.25A	1.25	1.60	1.51
46F092	GDB-1.6A	1.6	1.60	1.51
46F093	GDB-2A	2.0	1.60	1.51
46F094	GDB-2.5A	2.5	1.60	1.51
46F095	GDB-3.15A	3.15	1.60	1.51
46F096	GDB-4A	4.0	1.60	1.51
46F097	GDB-5A	5.0	1.60	1.51
46F098	GDB-6.3A	6.3	1.60	1.51

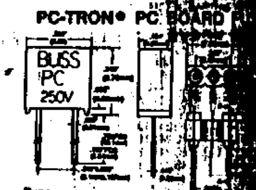
GMC 5x20mm TIME-LAG FUSES



High-interrupting, glass. Rated 250V, except * denotes 125V. UL listed, CSA certified.

Stock No.	Type	Amps	1-49	50-99
86F9941	GMC-600MA	600mA	1.18	1.11
87F1982	GMC-250MA	250mA	1.22	1.14
87F1983	GMC-500MA	500mA	1.18	1.11
87F1984	GMC-750MA	750mA	1.18	1.11
87F1985	GMC-800MA	800mA	1.18	1.11
87F1986	GMC-1A	1.0	1.22	1.14
87F1987	GMC-1.5A	1.5	1.22	1.14
87F1988	GMC-1.6A	1.6	1.22	1.14
87F1989	GMC-2A	2.0	1.22	1.14
87F1990	GMC-2.5A	2.5	1.22	1.14
87F1991	GMC-3A	3.0	1.22	1.14
87F1992	GMC-3.5A*	3.5	1.22	1.14
87F1993	GMC-4A*	4.0	1.22	1.14
87F1994	GMC-5A*	5.0	1.22	1.14
87F1995	GMC-6A*	6.0	1.18	1.11
87F1996	GMC-7A*	7.0	1.18	1.11
87F1997	GMC-8A*	8.0	1.18	1.11
87F1998	GMC-10A*	10.0	1.22	1.14

PC-TRON® PC BOARD [illegible]



Subminiature fuses limit energy [illegible] 250V, except * 125V. Order fuse [illegible]

Stock No.	Type	Amps	[illegible]
PCB SERIES, 0.10" (2.54) [illegible]			
46F8578	PCB-½	½	[illegible]
46F8579	PCB-¾	¾	[illegible]
46F8580	PCB-1	1	[illegible]
46F8581	PCB-1½	1½	[illegible]
46F8582	PCB-2	2	[illegible]
46F8583	PCB-2½	2½	[illegible]
46F8584	PCB-3	3	[illegible]
46F8592	PCB-5*	[illegible]	[illegible]
PCC SERIES, 0.10" (2.54) [illegible]			
46F8585	PCC-½	[illegible]	[illegible]
46F8586	PCC-¾	[illegible]	[illegible]
46F8587	PCC-1	[illegible]	[illegible]
46F8588	PCC-1½	1½	[illegible]
46F8589	PCC-2	[illegible]	[illegible]
46F8591	PCC-3	[illegible]	[illegible]
46F8593	PCC-5*	[illegible]	[illegible]

SOCKET FOR PC-TRON® [illegible]
46F8594 Type PCS. Each [illegible]

5x15mm TIME-DELAY PC [illegible] FUSES

[illegible]

GDC 5x20mm TIME-LAG FUSES

Glass, rated 250V. Meet IEC 127, Sheet 3.

Stock No.	Type	Amps	1-49	50-99
46F099	GDC-32MA	32mA	3.30	3.09
46F100	GDC-40MA	40mA	3.30	3.09
46F101	GDC-50MA	50mA	3.30	3.09
46F102	GDC-63MA	63mA	3.30	3.09
46F103	GDC-80MA	80mA	3.30	3.09
46F104	GDC-100MA	100mA	3.12	2.93
46F105	GDC-125MA	125mA	[illegible]	[illegible]
46F106	GDC-160MA	160mA	3.12	[illegible]
46F107	GDC-200MA	200mA	3.12	[illegible]
46F108	GDC-250MA	250mA	[illegible]	[illegible]
46F109	GDC-315MA	315mA	[illegible]	[illegible]
46F110	GDC-400MA	400mA	[illegible]	[illegible]
46F111	GDC-500MA	500mA	2.00	1.88
46F112	GDC-630MA	630mA	2.00	1.88
46F113	GDC-800MA	800mA	2.00	1.88
46F114	GDC-1A	1.0	2.00	1.88
46F115	GDC-1.25A	1.25	2.00	1.88
46F116	GDC-1.6A	1.6	2.00	1.88
46F117	GDC-2A	2.0	2.00	1.88
46F118	GDC-2.5A	2.5	2.00	1.88
46F119	GDC-3.15A	3.15	2.00	1.88
46F120	GDC-4A	4.0	2.00	1.88
46F121	GDC-5A	5.0	2.00	1.88
46F122	GDC-6.3A	6.3	2.00	1.88

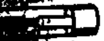
GLD ¼x1¼" PIN-INDICATING FERRULE FUSES

Silver-plated pin extends to indicate [illegible] Rated 125V. CSA certified. Order HKA [illegible] Associated [illegible] GLD [illegible] is [illegible]

Stock No.	Type	Amps	1-49	50-99
27F964	GLD-¾	¾	4.46	4.16
27F965	GLD-1	[illegible]	[illegible]	[illegible]
93F9215	GLD-1½	1½	[illegible]	[illegible]
27F966	GLD-2	[illegible]	[illegible]	[illegible]
27F967	GLD-[illegible]	[illegible]	[illegible]	[illegible]
27F968	GLD-[illegible]	[illegible]	[illegible]	[illegible]
GLD SERIES FUSEHOLDERS				
28F283	HLD	[illegible]	[illegible]	[illegible]
94F2076	HKA	[illegible]	[illegible]	28.72

BUSS® ¼ x 1¼" FUSES

[illegible] ¼x1¼" FAST-ACTING [illegible] FUSES



[illegible] except * 32V. UL listed, CSA [illegible] recognized 12-30A.

Stock No.	Type	Amps	5-45	50-245
[illegible]	AGC-[illegible]	[illegible]	3.84	3.61
[illegible]	AGC-[illegible]	[illegible]	3.00	3.85
[illegible]	AGC-[illegible]	[illegible]	1.19	.94
[illegible]	AGC-[illegible]	[illegible]	1.19	.94
[illegible]	AGC-[illegible]	[illegible]	1.19	.94
[illegible]	AGC-[illegible]	[illegible]	7.30	7.06
[illegible]	AGC-[illegible]	[illegible]	1.19	.94
[illegible]	AGC-[illegible]	[illegible]	1.19	.94
[illegible]	AGC-[illegible]	[illegible]	1.19	.94
[illegible]	AGC-[illegible]	[illegible]	.70	.64
[illegible]	AGC-[illegible]	[illegible]	.70	.64
[illegible]	AGC-[illegible]	[illegible]	.70	.64
[illegible]	AGC-[illegible]	[illegible]	.70	.64
[illegible]	AGC-[illegible]	[illegible]	.38	.30
[illegible]	AGC-[illegible]	[illegible]	.40	.30
[illegible]	AGC-[illegible]	[illegible]	.38	.30
[illegible]	AGC-1	1	.38	.30
[illegible]	AGC-1[illegible]	1[illegible]	.38	.30
[illegible]	AGC-1[illegible]	1[illegible]	.38	.30
[illegible]	AGC-1[illegible]	1[illegible]	.38	.30
[illegible]	AGC-2	2	.38	.30
[illegible]	AGC-2[illegible]	2[illegible]	.38	.30
[illegible]	AGC-2[illegible]	2[illegible]	.38	.30
[illegible]	AGC-3	3	.38	.30
[illegible]	AGC-4	4	.40	.30
[illegible]	AGC-5	5	.40	.30
[illegible]	AGC-6	6	.40	.30
[illegible]	AGC-7½	7½	.38	.30
[illegible]	AGC-8	8	.38	.30
[illegible]	AGC-10*	10	.38	.30
[illegible]	AGC-12*	12	...	...
[illegible]	AGC-15*	15	.38	.30
[illegible]	AGC-20*	20	.38	.30
[illegible]	AGC-25*	25	.38	.30
[illegible]	AGC-30*	30	.38	.30
[illegible]	AGC-35*	35	.38	.30

[illegible] ¼x1¼" FAST-ACTING [illegible] 250V FUSES

[illegible] except axial leads. Glass. Leads: [illegible] (38.10 x 0.813) diameter.

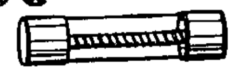
Stock No.	Type	Amps	5-45	50-245
[illegible]	GJV-¼	¼	1.72	1.61
[illegible]	GJV-½	½	1.72	1.61
[illegible]	GJV-¾	¾	1.72	1.24
[illegible]	GJV-1	1	1.39	1.31
[illegible]	GJV-1½	1½	1.39	1.09
[illegible]	GJV-2	2	1.39	1.31
[illegible]	GJV-2½	2½	1.39	1.09
[illegible]	GJV-3	3	1.39	1.31
[illegible]	GJV-4	4	1.47	1.38
[illegible]	GJV-5	5	1.47	1.38
[illegible]	GJV-6	6	1.47	1.38
[illegible]	GJV-7	7	1.47	1.38
[illegible]	GJV-8	8	1.47	1.38

[illegible] ¼x1¼" RECTIFIER FUSES

[illegible] Rated 60V, except * 250V.

Stock No.	Type	Amps	1-49	50-99
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

MDL ¼x1¼" TIME DELAY FUSES



Glass, dual-element. UL listed, CSA certified, rated 250V; except * UL recognized, 32V. Sold in multiples of 5.

Stock No.	Type	Amps	5-45	50-245
27F822	MDL-1/100	1/100	2.22	2.09
27F823	MDL-1/32	1/32	2.22	2.09
27F824	MDL-1/16	1/16	1.75	1.65
27F825	MDL-1/10	1/10	1.75	1.65
28F045	MDL-1/8	1/8	1.75	1.65
27F826	MDL-15/100	15/100	1.75	1.65
27F569	MDL-3/16	3/16	1.75	1.65
27F827	MDL-2/10	2/10	1.75	1.65
28F046	MDL-1/4	1/4	1.19	.92
27F828	MDL-3/10	3/10	1.19	.92
27F570	MDL-3/8	3/8	1.19	.92
27F829	MDL-4/10	4/10	1.19	.92
27F830	MDL-1/2	1/2	1.09	.83
27F831	MDL-6/10	6/10	1.09	.83
27F571	MDL-3/4	3/4	1.09	.83
27F832	MDL-8/10	8/10	1.09	.83
27F833	MDL-1	1	1.09	.83
27F572	MDL-1 1/10	1 1/10	.97	.74
27F834	MDL-1¼	1¼	.97	.74
27F573	MDL-1½	1½	.97	.74
27F835	MDL-1 6/10	1 6/10	.97	.74
27F574	MDL-1 8/10	1 8/10	.97	.74
27F836	MDL-2	2	.97	.74
27F575	MDL-2¼	2¼	.97	.74
27F837	MDL-2½	2½	.97	.74
27F838	MDL-2 8/10	2 8/10	.97	.74
27F576	MDL-3	3	.97	.74
27F839	MDL-3 2/10	3 2/10	.97	.74
27F577	MDL-3½	3½	.97	.74
27F840	MDL-4	4	.97	.74
27F841	MDL-5	5	.97	.74
94F2247	MDL-6	6	4.61	4.33
27F842	MDL-6¼	6¼	.97	.74
27F578	MDL-7	7	.97	.74
27F843	MDL-8	8	.97	.74
27F844	MDL-10*	10	1.22	1.14
27F579	MDL-12*	12	1.22	1.14
28F047	MDL-15*	15	1.22	1.14
27F845	MDL-20*	20	1.22	1.14
27F846	MDL-25*	25	1.22	1.14
27F847	MDL-30*	30	1.22	1.14

AGX ¼x1¼" FAST-ACTING FUSES

Glass. Rated 250V, UL listed, CSA certified; except * 125V UL listed; † 32V, UL recognized. Sold in multiples of 5.

Stock No.	Type	Amps	5-45	50-245
27F974	AGX-1/500	1/500	7.00	6.61
27F975	AGX-1/200	1/200	6.75	6.56
27F976	AGX-1/100	1/100	6.75	6.56
27F977	AGX-1/32	1/32	1.88	1.77
27F978	AGX-1/16	1/16	1.92	1.80
27F979	AGX-1/8	1/8	1.44	1.36
27F980	AGX-3/16	3/16	1.96	1.83
27F982	AGX-2/10	2/10	1.96	1.83
27F981	AGX-¼	¼	1.15	.89
27F983	AGX-3/8	3/8	1.15	.89
27F984	AGX-4/10	4/10	1.15	.89
27F985	AGX-½	½	1.15	.89
27F987	AGX-1	1	.77	.61
27F988	AGX-1½	1½	.77	.61
27F986	AGX-2	2	.50	.46
94F2187	AGX-3*	3	3.88	3.46
28F049	AGX-5*	5	.53	.48
94F2485	AGX-6†	6	2.00	2.00
94F2486	AGX-8†	8	2.00	2.00
94F2186	AGX-10†	10	2.96	2.80
94F2481	AGX-15†	15	2.96	2.86
94F2482	AGX-20†	20	2.22	2.09

COOPER
Bussmann

MDV ¼x1¼" TIME DELAY FUSES

Same as MDL series except with axial leads. Glass, rated 250V. Leads: 1.5" x 0.032" (38.10 x 0.813) diameter. UL listed, CSA certified.

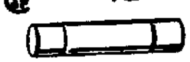
Stock No.	Type	Amps	1-49	50-99
28F001	MDV-1/16	1/16	3.34	3.14
28F002	MDV-1/8	1/8	3.52	3.30
28F003	MDV-¼	¼	2.13	2.00
28F005	MDV-½	½	1.72	1.61
28F006	MDV-¾	¾	1.72	1.61
28F007	MDV-1	1	1.72	1.61
28F008	MDV-1½	1½	1.72	1.61
28F009	MDV-2	2	1.74	1.64
28F011	MDV-3	3	1.74	1.64
93F9216	MDV-4	4	1.72	1.61
28F012	MDV-5	5	1.72	1.61
87F1546	MDV-7	7	1.57	1.47
93F9182	MDV-8	8	1.57	1.23

MDA ¼x1¼" TIME-DELAY CERAMIC FUSES

Rated 250V, except * 125V. UL listed, CSA certified; † UL recognized.

Stock No.	Type	Amps	1-49	50-99
94F5768	MDA-½	½	2.96	2.78
27F589	MDA-1	1	2.18	2.04
96F6102	MDA-1¼	1¼	.....	.....
94F2102	MDA-1½	1½	13.22	12.97
94F5769	MDA-1 6/10	1 6/10	2.63	2.47
27F590	MDA-2	2	2.18	2.04
28F013	MDA-2½	2½	1.92	1.80
28F015	MDA-3	3	1.64	1.54
28F017	MDA-4	4	1.64	1.54
28F018	MDA-5	5	1.64	1.54
94F5771	MDA-6	6	2.18	2.04
28F019	MDA-6¼	6¼	2.18	2.04
28F020	MDA-7	7	2.18	2.04
28F021	MDA-10	10	1.64	1.54
27F591	MDA-12†	12	1.64	1.54
28F022	MDA-15†	15	1.64	1.54
28F023	MDA-20†	20	1.64	1.54
28F024	MDA-25*†	25	2.19	2.06
28F026	MDA-30*†	30	1.64	1.54

ABC ¼x1¼" FAST-ACTING FUSES



Ceramic. Rated 250V, UL listed, CSA certified; except * 125V, UL recognized.

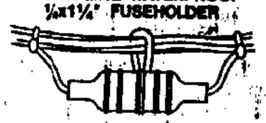
Stock No.	Type	Amps	5-45	50-245
94F2176	ABC-¼	¼	4.50	4.22
94F2178	ABC-½	½	4.60	4.32
93F9189	ABC-¾	¾	.84	.79
96F2211	ABC-1	1	.84	.79
27F952	ABC-2	2	.84	.79
27F953	ABC-3	3	.84	.79
94F2177	ABC-4	4	4.50	4.22
27F954	ABC-5	5	.84	.80
27F955	ABC-6	6	.84	.80
94F2483	ABC-7	7	4.08	3.79
27F956	ABC-8	8	.84	.80
27F957	ABC-10	10	.84	.80
27F958	ABC-12	12	.84	.80
27F959	ABC-15	15	.84	.80
27F960	ABC-20	20	1.30	1.22
27F961	ABC-25*	25	1.30	1.22
27F962	ABC-30*	30	1.30	1.22

8

BUSS® FUSEHOLDERS & FUSEBL[illegible] / [illegible]USS® FUSEHOLDERS & BLOCKS

COOPER Bussmann

HFB IN-LINE WATERPROOF ¼x1¼" FUSEHOLDER



Withstands water, salt spray, ultraviolet light and ozone. Accepts #12 to #18-gauge wire. Yellow for high visibility. 30 amps @ 32V.

Stock No.	Type	1-24	25-49
46F3250	HFB	6.44	6.25

HEB IN-LINE WATERPROOF 13/32x1½" FUSEHOLDERS

NEW

Waterproof holders designed for exposed locations. Accept various wire sizes. Copper crimp. Rated 30A @ 600V.

Stock No.	Type	Wire Range	1-99	100-499
86F808	HEB-AA	#12 to #8	10.86	10.36
86F1461	HEB-BB	#10 to #4	10.58	9.83

2000 SERIES [illegible] FUSEBLOCK[illegible]

5 x 20mm fuseblocks same as [illegible] except with quick-connect/[illegible] rated 15A, 250V. [illegible]

Stock No.	Type	Poles	1-[illegible]
87F1567	2000-1	1	[illegible]
46F908	2000-5	[illegible]	[illegible]
46F917	2000-10	10	[illegible]

HHB SERIES IN-LINE UNIVERSAL FUSEHOLDERS

Versatile nylon fuseholders for dry environments. Designed for ¼" diameter x ⅝ to 1¼" fuses. Accept #12 to #18-gauge wire. Rated 30 amps @ 32V. Type HHB has in-line crimp terminal; HHB-R408 comes with red, 8" (203.20) #14-gauge leads.

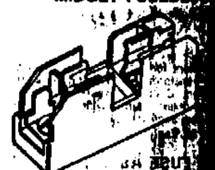
Stock No.	Type	1-49	50-99
46F3260	HHB	1.37	1.28
86F1460	HHB-R408	1.57	1.08

HK SERIES LAMP INDICATING ¼x1¼" FUSEHOLDERS

Vibration-resistant holders fit panels to 3/16" (4.76) thick. All have bayonet knobs, except types HKL-X, HKX have flat-sided knobs. Incandescent lamp, except HKL, HKL-X are neon. Rated 20A, except HKL, HKL-X are 15A. Type HKL is UL recognized, CSA certified.

Stock No.	Type	Volts	Lens Color	1-24	25-49
27F813	HKL	90-250	Clear	8.93	8.78
27F814	HKL-X	90-250	Clear	11.84	11.41
27F812	HKR	22-30	Amber	18.40	18.05
29F461	HKT	13-22	Amber	18.40	18.05
29F462	HKU	4-8	Red	21.08	20.66
29F463	HKX	22-35	Amber	21.09	20.69

MIDGET FUSEBLOC[illegible]



For KTK-R, FNM, FNQ-R [illegible] plastic, 600V, 30A terminal [illegible] nect. UL listed, CSA certified [illegible]

BLOCKS FOR KTK-R & FNQ-R [illegible]

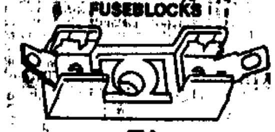
Stock No.	Type	Poles	1-[illegible]
90F8642	BC6031SQ	1	[illegible]
86F522	BC6032SQ	2	[illegible]
86F1636	BC6033SQ	3	[illegible]
BLOCKS FOR FNM SERIES F[illegible]			
29F357	BM6031SQ	1	[illegible]
29F358	BM6033SQ	3	[illegible]

HD/HM/HR SERIES IN-LINE FUSEHOLDERS

Holders mount in panels up to 0.313" thick. Bayonet-type knob. Rated 30 amps, 32V. Type HDJ-A has contacts for #16-20 wire; HDJ-B accepts #14-18 wire; HMI, HMJ, HRK have 8" (203.20) of #14 wire pre-attached. HRK universal model holds ¼" x ⅝ to 1¼" fuses.

Stock No.	Type	Fuse Size	1-99	100-499
IN-LINE FUSEHOLDERS				
30F173	HDJ-A	¼ x 1¼"	1.42	1.30
30F174	HDJ-B	¼ x 1¼"	1.42	1.30
FUSEHOLDERS WITH #14 LEADS				
30F175	HMJ	¼ x 1¼"	3.10	3.00
86F750	HRK	¼ x ⅝-1¼"	2.27	2.12
30F176	HMI	¼ x 1"	3.10	3.00

S-8000 SERIES ¼x1¼" FUSEBLOCKS



Individual thermoplastic barrier blocks with sealed base, 1-piece mounting clips. Multiple units can be assembled to desired number of poles. UL recognized, CSA certified.

Stock No.	Type	Poles	Clip	1-49	50-99
30-AMP SOLDER TERMINALS					
46F901	S-8001-1	1	0°	1.35	1.35
46F902	S-8002-1	1	40°	1.35	1.35
87F1573	S-8002-12	12	40°	15.37	15.11
30-AMP ¼" QUICK-CONNECT TERMINALS					
46F905	S-8201-1	1	0°	1.30	1.25
46F906	S-8202-1	1	40°	1.30	1.25
87F1574	S-8202-12	12	40°	12.10	11.90
46F907	S-8203-1	1	Side	1.80	1.75
30-AMP SCREW TERMINALS					
46F909	S-8301-1	1	0°	2.34	2.30
86F8186	S-8301-2	2	0°	4.66	4.30
87F1575	S-8301-12	12	0°	21.84	21.42

GMT SERIES FAST-ACT[illegible] INDICATING FUSE[illegible]

GMT HLT

Indicating fuses are designed for [illegible] tions, computer and control [illegible] Feature visual swing indication [illegible] activation. UL recognized [illegible] Mount in HLT, HLS fuseholders [illegible]

Stock No.	Type	Color	[illegible]
30F3[illegible]	GMT-[illegible]	[illegible]	[illegible]
30F3[illegible]	GMT-[illegible]	[illegible]	[illegible]
30F3[illegible]	GMT-[illegible]	Red	[illegible]
30F3[illegible]	GMT-[illegible]	[illegible]	[illegible]
30F3[illegible]	GMT-[illegible]	[illegible]	[illegible]
30F3[illegible]	GMT-1¼	White/[illegible]	[illegible]
30F3[illegible]	GMT-2	Orange	[illegible]
30F3[illegible]	GMT-3	Blue	[illegible]
30F3[illegible]	GMT-5	Green	[illegible]
30F3[illegible]	GMT-7½	Blk/White	[illegible]
30F3[illegible]	GMT-10	Red/White	[illegible]
86F8194	GMT-15A	Yellow/[illegible]	[illegible]
FUSEHOLDERS FOR GMT FUSES			
30F300	HLT	Panel-Mount	[illegible]
30F3006	HLS	PC-Board	[illegible]

FOR A COMPLETE SELECTION OF BUSS® TELPOWER® TELECOMMUNICATIONS FUSES

SEE PAGE 1145

[illegible]CK FUSEHOLDERS

Fig. 2

Fig. 4

[illegible] CSA, SEMKO standards. HB [illegible] 20mm (suffix M) or ¼ x 1¼" [illegible] HTC type [illegible] Rated 250V. 1V/M = Vertical [illegible] Horizontal mount.

Type	Fig.	Description†	1-99
[illegible]	1	V/M w/pins	4.11
[illegible]	1	V/M w/pins	4.76
[illegible]	1	V/M	4.76
HTC-35M	2	V/M	2.92
[illegible]	3	H/M	2.47
[illegible]	3	H/M	3.86
[illegible]	4	H/M	3.51
HTC-15M	5	Fuseblock	.96

[illegible]USE CLIPS

Fig. 7

Fig. 9

Fig. 11

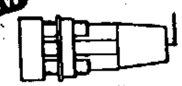
Fig. 12

[illegible] brass except (*) silver-plate

[illegible]	Fig.	Description	1-99
[illegible]	[illegible]	PCB, 3AG	.41
[illegible]	[illegible]	PCB, 3AG	.38
[illegible]	[illegible]	PCB, 3AG, Raised Term.	.47
[illegible]	[illegible]	Rivet/Eyelet, 3AG	33.00
[illegible]	[illegible]	Rivet/Eyelet, 3AG	60.00
[illegible]	10	PCB, 5x20mm	.16
[illegible]	10	PCB, 5x20mm	.32
[illegible]	11	Rivet/Eyelet, 13/32"	.41
[illegible]	11	Rivet/Eyelet, 13/32"	1.43
[illegible]A3400-30	12	PCB, 13/32"	.70

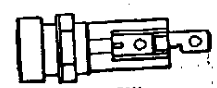
HTC SERIES 5 x 20MM FUSEHOLDERS

NEW



HTC-35M

HTC-65M

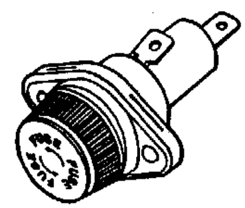


HTC-70M

Panel-mount fuseholders save space. 35M and 65M rated 6.3A, 250V; 70M rated 10A, 250V. UL recognized, CSA certified, SEMKO approved. Meet IEC 257, PC2 standards.

Stock No.	Type	Description	1-99	100-499
93F8379	HTC-35M	Threaded Cap	2.67	2.50
93F8380	HTC-65M	Bayonet Cap	3.03	2.84
93F8381	HTC-70M	Bayonet Cap	3.03	2.84

HP SERIES FUSEHOLDERS



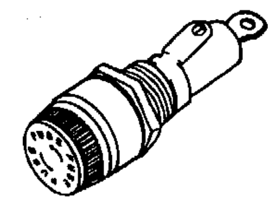
For 13/32" diameter fuses in various lengths. 1-piece side terminal and threaded insert eliminates 2-piece solder fabrication. Combination ¼" quick-connect/solder terminals. Type HPF have screw-type knob; HPS have bayonet knob.

Stock No.	Type	Rating	Fuse	1-99
94F2236	HPS	30A, 600V	13/32", 1½"	6.71
95F1462	HPF-RR	30A, 600V	KTK-R	8.25
94F8452	HPM	30A, 600V	13/32", Flange	13.12
95F1463	HPS-FF	30A, 300V	SC25,30	9.82
46F3295	HPF-EE	15A, 300V	SC0 to 15	6.75
46F3296	HPF-JJ	20A, 300V	SC20, 1 13/32"	6.79
46F3297	HPF-FF	30A, 300V	SC25,30, 1⅝"	7.71
46F3305	HPF	30A, 600V	1½" Long	4.84

CONTACT NEWARK FOR LARGER QUANTITY PRICING.

COOPER Bussmann

HKP SERIES FUSEHOLDERS



Accept ¼" x 1¼" fuses with bayonet type knobs in panels to 0.313" (7.95) thick. Rated 30A/250V except (*) 15A/250V. HKP-OO snap-lock fits panels 0.025-0.085" (0.635-2.16) thick. UL recognized, CSA certified.

Stock No.	Type	Description	1-99	100-499
27F820	HKP	Solder Terminal	2.16	2.03
26F031	HKP-HH*	¼" Q.C.	2.65	2.49
27F862	HKP-OO	Snap Lock	5.52	5.19
27F862	HKP-CC	Short Behind Panel	3.58	3.36
27F819	HJM	For ¼" x 1" fuse	2.96	2.78

HTB SERIES FUSEHOLDERS

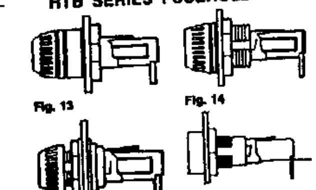


Fig. 13 Fig. 14 Fig. 15 Fig. 16

Designed to international specifications per IEC #257 and accept either 5 x 20mm (suffix M) or ¼ x 1¼" (suffix I) fuses. All models are panel-mountable. UL recognized, CSA certified, SEMKO and VDE approved. Rear panel-mount version allows pre-wiring before insertion in panel. *Additional models available; contact your local Newark branch.*

Stock No.	Type	Fig.	Desc.	1-99
46F3253	HTB-22I	13	L/P,S/C	3.25
46F3254	HTB-22M	13	L/P,S/C	3.25
46F3257	HTB-26I	13	L/P,Q/C	3.60
46F3255	HTB-24I*	13	L/P,S/C	3.25
46F3259	HTB-28I*	13	L/P,Q/C	3.60
46F3261	HTB-42I	14	H/P,S/C	3.25
46F3263	HTB-44I*	14	H/P,S/C	3.25
46F3265	HTB-46I	14	H/P,Q/C	3.60
46F3267	HTB-48I*	14	H/P,Q/C	3.60
46F3269	HTB-62I	15	F/P,S/C	3.25
46F3271	HTB-64I*	15	F/P,S/C	3.25
46F3273	HTB-66I	15	F/P,Q/C	3.60
87F1561	HTB-34I*	16	L/P,S/C	3.25
87F1563	HTB-36I	16	L/P,Q/C	3.60
87F1565	HTB-38I*	16	L/P,Q/C	3.60
87F1566	HTB-32M	16	L/P,S/C	3.25

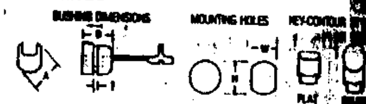
* Right angle rear terminal.
L/P = Low-Profile; S/C = Solder Connect; Q/C = Quick Connect; H/P = High-Profile; F/P = Front Panel; S = Solder.

SPC TECHNOLOGY

WIRE & CABLE ACCESSORIES

CORD STRAIN RELIEF BUSHINGS

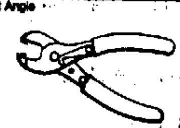
1. Place bushing on cord 2. Press together with pincers or pliers 3. Snap into hole



One-piece nylon-construction bushings withstand temperatures to 300°F. Easily installed with specially designed pincers or ordinary pliers. Eliminates [illegible] that tears cords loose from contacts or connections. Sold in packages of 100.

Stock No.	Type	Cords Accommodated: Wires	Cords Accommodated: Cord Type	Approx. Wire Size	Max. Thick. "T"	Max. Panel Dia. "H"	"W"	Key Contour	Dimensions "A"	Dimensions "B"	Per Package 1-4	Per Package 5-9	Per Package 10-[illegible]
46N7903	SRR-06	2-#18	SP-1, SPT-1	.12x.22"	.062"	.375"	.330"	Round	.391"	.410"	3.49	3.27	[illegible]
46N7904	SRF-10	2-#18 2-#18	SP-1, SPT-1 XT	.12x.22" .08x.18"	.062"	.437"	.390"	Flat	.464"	.410"	4.44	4.22	[illegible]
46N7901	SRF-15	2-#18 3-#18	SPT-2, HPN SPT-1	.12x.30"	.062"	.500"	.465"	Flat	.579"	.406"	4.96	4.74	[illegible]
46N7905	SRF-30	2-#18 3-#18 3-#16	SP-2, SPT-2, HPN SPT-1 SP-2, SPT-2, HPN	.12x.30" .15x.28" .15x.30"	.100"	.500"	.465"	Flat	.579"	.406"	4.96	4.74	[illegible]
46N7906	SRF-40	2-#18 2-#16 3-#18	SPT-2 SPT-2 HPN	.12x.30" .16x.30" .16x.37"	.125"	.562"	.530"	Flat	.625"	.609"	6.60	6.37	[illegible]
46N7907	SRF-50	2-#18 3-#18 2-#18 3-#18 3-#18	SPT-3 SPT-3 SPT-3 SPT-1 SPT-3	.16x.36" .16x.39" .20x.37" .12x.30" .16x.41"	.125"	.730"	.690"	Flat	.750"	.670"	7.91	7.62	[illegible]
46N7908	SRR-10	2-#18 2-#18 3-#18 3-#18	HPD SV, SVT SV, SVT HPD	.270" .250" .255" .290"	.100" .100" .100" .100"	.500" .500" .515" .515"	.460"	Round	.579"	.436"	4.96	4.74	[illegible]
46N7909	SRR-20	2-#18 2-#16 2-#18 3-#18	SJ, SJT, SJO SJ, SJT, SJO SJT SJT	.300" .330" .325" .325"	.125"	.625"	.580"	Round	.703"	.580"	7.82	7.44	[illegible]
46N7902	SRRRA-60*	2-#18 3-#18	SV, SVT SV, SVT	.250" .265"	.100"	.500"	.450"	Round	.540"	.667"	7.24	6.99	[illegible]

*Right Angle



PINCERS INSERTION TOOL FOR VOLTREX RELIEF BUSHINGS

Tool makes assembly for cord strain relief bushings a snap. Specially designed for use with the Voltrex line, this one tool will install all sizes of Voltrex strain reliefs.

23N3647 8508-050. Each .... [illegible]

CORD STRAIN RELIEF BUSHING ASSORTMENT

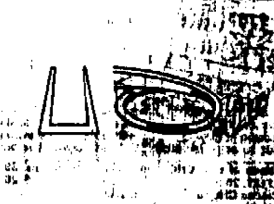
Relief bushing assortment prevents insulation/conductor injury and lengthens cord life. [illegible] piece nylon construction. Withstands temperatures to 300°F. Eliminates need to tie or knot cord [illegible] slip grip on cord. Type 8408-SRF is an assortment of 120 sizes and cord contours of cord strain [illegible] bushings which eliminate strain that tears cord loose from contacts or connections without [illegible] insulation. Includes 10 pieces each of types SRR-06, SRF-10, SRF-15, and SRF-30, 20 pieces each [illegible] SRF-40, SRF-50, SRR-10 and SRR-20. Withstands temperatures to 300°F. Kit includes installation [illegible] cord. Non-slip grip on cord. Packaged in sturdy polystyrene sectioned box with handy identification chart in lid. Order replacement parts separately.

23N3612 Type 8408-SRF. Each .... [illegible]

TEFLON GROMMET STRIPS

Meet MIL Standard 21266. Length per piece, maximum 12.75" minimum 12.62".

Stock No.	Type	Panel Thickness Range	Pieces Per Package	Per Package
[illegible]	CGTT-[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	CGTT-[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	CGTT-[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	CGTT-[illegible]	[illegible]	[illegible]	[illegible]



POLYETHYLENE GROMMET ROLLS

• Fit any Size or Shape Opening in Panels to [illegible] [illegible]

Stock No.	Type	Panel Thickness Range	[illegible]	Per [illegible]
[illegible]	CGP-[illegible]	To .093", 20 Gauge [illegible]	[illegible]	[illegible]
[illegible]	CGP-2	.067"-.071" 16-12 Gauge	[illegible]	[illegible]
[illegible]	CGP-3	.105-.104" 11-8 Gauge	[illegible]	[illegible]
[illegible]	CGP-4	.165-.187" 8-6 Gauge	[illegible]	[illegible]
[illegible]	CGP-5	.188-.250" 6-4 Gauge	[illegible]	[illegible]

FITTINGS & CONNECTORS

Thomas&Betts

TWO-SCREW CONNECTORS

[illegible] 3301 steel connector for armored cable and flexible metal conduit. [illegible] Types 3302-3306 metal connectors with threaded saddle for [illegible] sheath cable and flexible cord. UL listed, CSA certified.

Stock No.	Type	Cable Opening Max.	Cable Opening Min.	K.O. Size	Std. Pkg.	Per Pkg.
[illegible]F1114	3301	0.656"	0.280"	0.500"	100	113.90
[illegible]F2916	3302	0.656"	0.250"	0.500"	Each	1.30
[illegible]F2918	3303	0.820"	0.530"	0.750"	50	106.31
[illegible]F1116	3304	0.070"	0.690"	1.000"	25	69.07
[illegible]	3305	1.365"	0.850"	1.250"	Each	5.61
[illegible]	3306	1.530"	0.930"	1.500"	Each	12.69

XTRAFLEX™ CONDUIT AND TUBING

EFC

[illegible] nonmetallic fittings. Other colors available; contact your local Newark [illegible], UL listed, CSA certified. Sold in 100' spools except types with *

Stock No.	Type	Size	Per Spool
LTC SERIES TYPE B NONMETALLIC LIQUIDTIGHT CONDUIT			
[illegible]F2961	LTC038	0.375" (9.53)	86.13
[illegible]F2962	LTC050	0.500" (12.70)	86.75
[illegible]F2963	LTC075	0.750" (19.05)	102.47
[illegible]F2964	LTC100	1.000" (25.40)	157.05
[illegible]F2965	LTC125	1.250" (31.75)	261.37
[illegible]F7747	LTC150*	1.500" (38.10)	148.93
[illegible]F7748	LTC200*	2.000" (50.80)	206.35
EFC SERIES CORRUGATED, FLEXIBLE NONMETALLIC TUBING			
[illegible]F2967	EFC038	0.375" (9.53)	86.07
[illegible]F2940	EFC050	0.500" (12.70)	86.75
[illegible]F2941	EFC075	0.750" (19.05)	110.84
[illegible]F2942	EFC100	1.000" (25.40)	157.10
[illegible]F2943	EFC125	1.250" (31.75)	207.11
[illegible]F7749	EFC150*	1.500" (38.10)	148.93
[illegible]F7735	EFC200*	2.000" (50.80)	206.35

TELEPHONE WIRE ANALYZER

[illegible] for short circuits, open lines, reversed polarity. Self-contained tone [illegible] can be switched onto a line and, using our phones or sniffers, [illegible] circuit for faults or terminations.

[illegible]F1149 Type TCWA1. Each 376.73

STATION WIRE SYSTEM MODULAR CONNECTORS

[illegible] series standard plugs have larger wire dressing area for easy installation. TCNP narrow plugs are for high density jack fields. TCAJ jacks include double side tape and screws for direct mounting or installation in [illegible]. Fit VERSA-T RAK® system pedestal.

Stock No.	Type	Description	Contacts	Body Width	Each
[illegible]F1140	TCAP4	Tan Std. Plug, 2 Pair	4	0.9" (22.86)	4.86
[illegible]F1150	TCAP6	Ivory Std. Plug, 4 Pair	[illegible]	0.9" (22.86)	5.40
[illegible]F1151	TCAP8	Lt. Gray Std. Plug, 6 Pair	[illegible]	0.9" (22.86)	5.77
[illegible]F1145	TCNP4	Tan Narrow Plug	[illegible]	0.5" (12.70)	5.05
[illegible]F1147	TCNP6	Ivory Narrow Plug	[illegible]	0.5" (12.70)	5.35
[illegible]F1148	TCNP8	Lt. Gray Narrow Plug	[illegible]	0.6" (15.24)	5.51
[illegible]F1132	TCAJ4	Tan Jack, 2 Pair	[illegible]	0.9" (22.86)	4.96
[illegible]F1137	TCAJ6	Ivory Jack, 3 Pair	[illegible]	0.9" (22.86)	5.20
[illegible]F1136	TCAJ8	Lt. Gray Jack, 4 Pair	[illegible]	0.9" (22.86)	5.77

THE BULLET™ LIQUIDTIGHT NONMETALLIC CONNECTORS

Straight

90° Angle

Corrosion-resistant industrial fittings for conduit install fast, easy with high pullout resistance. Straight or 90° angle versions. Include locknut, captivated sealing O-ring. Tapered ferrule fits variety of conduit diameters and field cuts. Ideal for type B nonmetallic liquidtight conduit and flexible nonmetallic tubing. Meet NEMA 4, NEMA 6 standards. UL listed, CSA certified.

Stock No.	Type	Conduit Size	Knockout Size	Each
STRAIGHT LIQUIDTIGHT CONNECTORS				
93F7730	LT38P	0.375" (9.53)	0.500" (12.70)	3.04
93F7731	LT50P	0.500" (12.70)	0.500" (12.70)	3.13
93F7732	LT75P	0.750" (19.05)	0.750" (19.05)	4.35
93F7733	LT100P	1.000" (25.40)	1.000" (25.40)	6.39
93F7734	LT125P	1.250" (31.75)	1.250" (31.75)	10.98
93F7741	LT150P	1.500" (38.10)	1.500" (38.10)	15.63
93F7742	LT200P	2.000" (50.80)	2.000" (50.80)	27.94
90° ANGLE LIQUIDTIGHT CONNECTORS				
93F7743	LT938P	0.375" (9.53)	0.500" (12.70)	4.73
93F7744	LT950P	0.500" (12.70)	0.500" (12.70)	4.73
93F7745	LT975P	0.750" (19.50)	0.750" (19.50)	7.19
93F7746	LT9100P	1.000" (25.40)	1.000" (25.40)	14.57

LIQUIDTIGHT, FLEXIBLE CONDUIT FITTINGS

Straight 45° Angle 90° Angle

1-piece metal units snap in. Neoprene seal ring eliminates locknut. Straight, 45° or 90° angle versions. Nylon insulated throat. Tapered hub threads. Temperature range: −34° to +105°C. UL listed, CSA certified.

Stock No.	Type	Description	Hub & Conduit Size	Each
94F3076	5332	Straight	0.50" (12.70)	4.21
94F3077	5333	Straight	0.75" (19.05)	6.17
90F2629	5334	Straight	1.00" (25.40)	9.53
90F2637	5335	Straight	1.25" (31.75)	15.40
90F6111	5341	45° Angle	0.50" (12.70)*	6.98
94F3047	5342	45° Angle	0.50" (12.70)*	143.63
90F6121	5343	45° Angle	0.75" (19.05)	10.56
93F7736	5344	45° Angle	1.00" (25.40)	18.95
93F7737	5345	45° Angle	1.25" (31.75)	30.77
94F3078	5352	90° Angle	0.50" (12.70)	6.98
90F2858	5353	90° Angle	0.75" (19.05)	10.56
90F2859	5354	90° Angle	1.00" (25.40)	18.96
90F2861	5355	90° Angle	1.25" (31.75)	29.75

* Conduit Size: 0.375" (9.53)

LIQUIDTIGHT STRAIN RELIEF CONNECTORS

Flexible cord and power cable connectors are suitable for hazardous location use in Class I, Div. 2; Class II, Div. 1 and 2; and Class III, Div. 1 and 2, where general purpose equipment is specifically permitted per NEC section 500-2 (a). Hub size: 0.50" (12.70). UL listed, CSA certified.

Stock No.	Type	Cable Size Min.-Max.	Throat Diameter	Std. Pkg.	Per Pkg.
90F2621	2520	0.125-0.250"	0.563"	25	117.82
90F2622	2521	0.250-0.375"	0.563"	25	100.33
90F2623	2522	0.375-0.500"	0.563"	Each	5.09
90F2664	2523	0.450-0.560"	0.563"	Each	5.69
94F3008	2524*	0.500-0.625"	0.625"	10	62.64
90F2666	2525*	0.625-0.750"	0.625"	Each	5.61

*Remove sufficient outer covering of cable to permit conductors to pass thru connector body.

FERMILAB

ENGINEERING NOTE

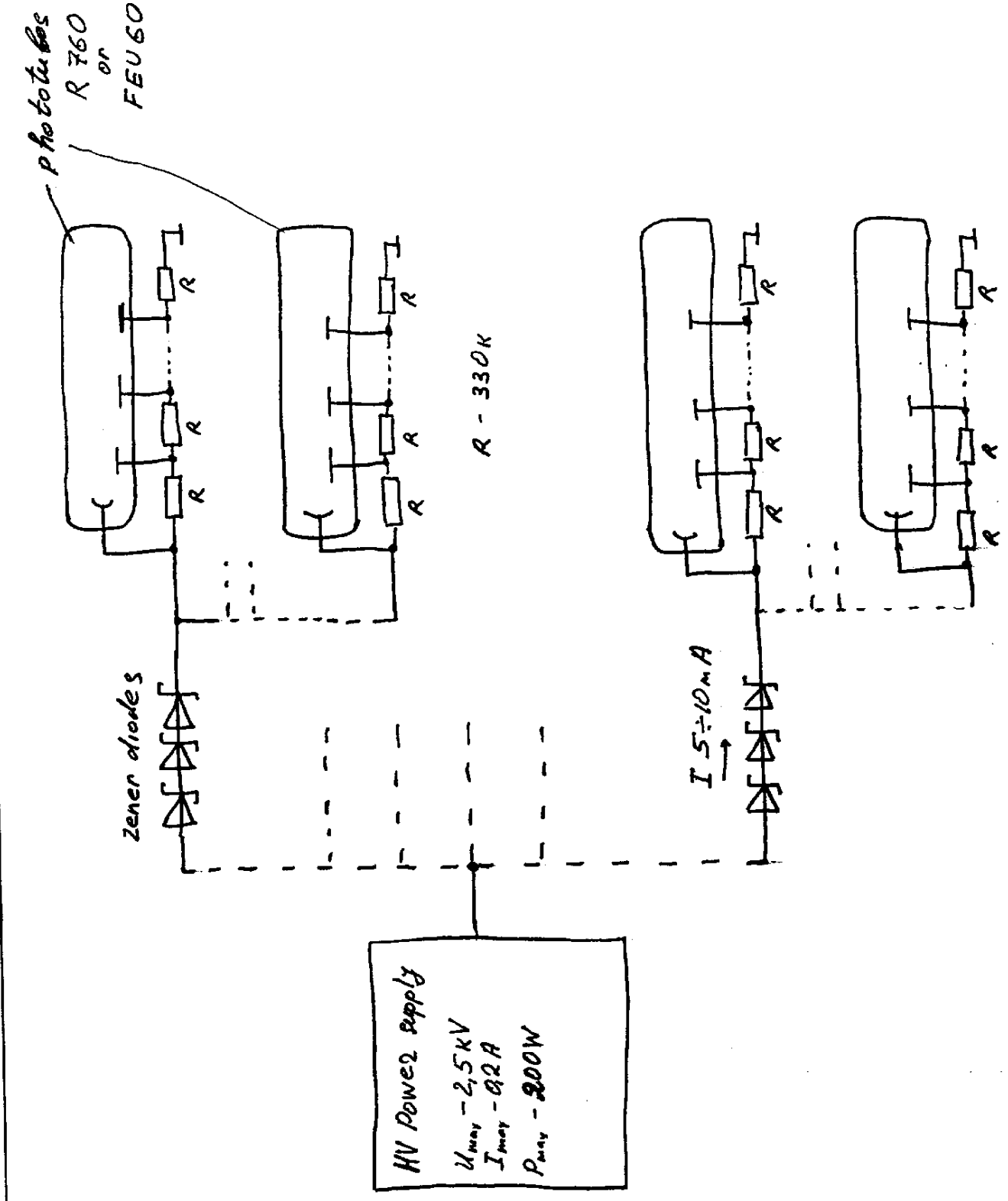
SECTION	PROJECT	SERIAL-CATEGORY	PAGE

SUBJECT

NAME

DATE 07.25.95

REVISION DATE



FERMILAB
ENGINEERING NOTE

SECTION	PROJECT	SERIAL-CATEGORY	PAGE

SUBJECT

NAME

DATE 07.17.95 REVISION DATE

	Hamamatsu		60			
	1	2	3	4	5	6
columns	10	9	23	21	16	10
U_{min}	960 V	1160 V	1020 V	1380 V	1520 V	1660 V
U_{max}	1140 V	1250 V	1360 V	1500 V	1640 V	1880 V
ΔU	180 V	90 V	340 V	120 V	120 V	220 V
I_C	10 mA	11 mA	3,72 mA	4,1 mA	4,5 mA	5,14 mA
I_E	100 mA	99 mA	86 mA	86,2 mA	71,8 mA	51,4 mA
P	114 W	124 W	116,3 W	129,2 W	117,7 W	96,6 W
L	57 %	62 %	58,1 %	64,6 %	58,9 %	48 %
P_{zen}	9 W	2,75 W	10,3 W	4,8 W	4,32 W	7 W

Order list for zener diodes from MOTOROLA

Type	#	Specification
1N5993C	30	5,1Vx0,5W
1N6000C	50	10Vx0,5W
1N6007C	120	20Vx0,5W
1N6011C	30	30Vx0,5W
1N4751C	10	30Vx1W
1N4754C	40	39Vx1W
1N4755C	15	43Vx1W
1N4759C	20	62Vx1W
1N5939C	10	39Vx1,5W
1N5940C	5	43Vx1,5W
1N5942C	5	51Vx1,5W
1N5944C	5	62Vx1,5W
1N5947C	15	82Vx1,5W
1N5948C	15	91Vx1,5W
1N5949C	20	100Vx1,5W
3EZ82D2	5	82Vx3W
3EZ91D2	5	91Vx3W
3EZ100D2	10	100Vx3W
3EZ120D2	10	120Vx3W
3EZ140D2	10	140Vx3W
3EZ160D2	10	160Vx3W
3EZ170D2	5	170Vx3W
3EZ180D2	5	180Vx3W

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

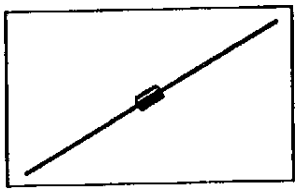
1N5985A thru 1N6025A

500 MILLIWATT HERMETICALLY SEALED GLASS SILICON ZENER DIODES

. . . A complete line of 500 mW Zener Diodes offering the following advantages:

- Complete Voltage Range – 2.4 to 110 Volts
- DO-35 Package – Smaller than Conventional DO-7 Package
- Double Slug Type Construction
- Metallurgically Bonded Construction
- JEDEC Registered
- Oxide Passivated Die

500 MILLIWATT GLASS ZENER DIODES
2.4-110 VOLTS



*MAXIMUM RATINGS

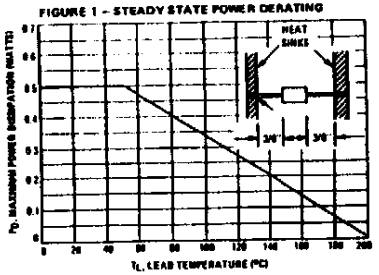
Rating	Symbol	Value	Unit
DC Power Dissipation @ $T_L \leq 50^{\circ}C$, Lead Length = 3/8" Derate above 50°C	P_D	500 3.33	mW mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-55 to +200	°C

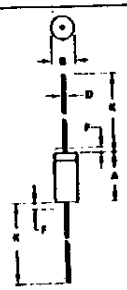
*Indicates JEDEC Registered Data.

MECHANICAL CHARACTERISTICS

CASE: Double slug type, hermetically sealed glass
MAXIMUM LEAD TEMPERATURE FOR SOLDERING PURPOSES: 230°C, 1/16" from case for 10 seconds
FINISH: All external surfaces are corrosion resistant with readily solderable leads.
POLARITY: Cathode indicated by color band. When operated in zener mode, cathode will be positive with respect to anode.
MOUNTING POSITION: Any

FIGURE 1 – STEADY STATE POWER DERATING





NOTES:
1. PACKAGE CONTOUR OPTIONAL WITHIN A AND B. HEAT SLUGS, IF ANY, SHALL BE INCLUDED WITHIN THIS CYLINDER, BUT NOT SUBJECT TO THE MINIMUM LIMIT OF B.
2. LEAD DIAMETER NOT CONTROLLED IN ZONE F TO ALLOW FOR FLASH, LEAD FINISH BUILDUP AND MINOR IRREGULARITIES OTHER THAN HEAT SLUGS.
3. POLARITY DENOTED BY CATHODE BAND.
4. DIMENSIONING AND TOLERANCING PER ANSI Y14.5, 1973.

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	3.96	5.08	0.156	0.200
B	1.52	2.28	0.060	0.090
D	0.46	0.56	0.018	0.022
F	–	1.27	–	0.050
K	25.40	38.10	1.000	1.500

All JEDEC dimensions and notes apply.

CASE 299-02
DO-204AH
GLASS

*ELECTRICAL CHARACTERISTICS (T_L = 30°C unless otherwise noted.) (V_F = 1.5 Volts Max @ I_F = 100 mAdc for all types.)

Motorola Type Number (Note 1)	Nominal Zener Voltage V_Z @ I_{ZT} Volts (Note 2)	Test Current I_{ZT} mA	Max. Zener Impedance (Note 4) Z_{ZT} @ I_{ZT} Ohms B Suffix	Z_{ZT} @ I_{ZT} Ohms A, Non-Suffix	Z_{ZK} @ I_{ZK} = 0.25 mA Ohms B Suffix	Z_{ZK} @ I_{ZK} = 0.25 mA Ohms A, Non-Suffix	Max. Reverse Leakage Current I_R μA @ V_R volts B Suffix	I_R μA @ V_R volts A, Non-Suffix	@ V_R volts B Suffix	@ V_R volts A, Non-Suffix	Max. DC Zener Current I_{ZM} (Note 3)
1N5985A	2.4	5.0	100	110	1900	2000	100	100	1.0	0.5	208
1N5986A	2.7	5.0	100	110	1900	2200	75	100	1.0	0.5	185
1N5987A	3.0	5.0	95	100	2000	2300	50	100	1.0	0.5	167
1N5988A	3.3	5.0	95	100	2200	2400	25	75	1.0	0.5	152
1N5989A	3.6	5.0	90	95	2300	2500	15	50	1.0	0.5	139
1N5990A	3.9	5.0	90	95	2400	2500	10	25	1.0	1.0	128
1N5991A	4.3	5.0	80	90	2500	2500	5.0	15	1.0	1.0	116
1N5992A	4.7	5.0	70	90	2200	2500	3.0	10	1.5	1.0	106
1N5993A	5.1	5.0	50	60	2050	2500	2.0	5.0	2.0	1.0	96
1N5994A	5.6	5.0	25	70	1800	2200	2.0	3.0	3.0	1.5	89
1N5995A	6.2	5.0	10	50	1300	2050	1.0	2.0	4.0	2.0	81
1N5996A	6.8	5.0	8.0	25	750	1800	1.0	2.0	5.2	3.0	74
1N5997A	7.5	5.0	7.0	10	500	1300	0.5	1.0	6.0	4.0	67
1N5998A	8.2	5.0	7.0	15	500	750	0.5	1.0	6.5	5.2	61
1N5999A	9.1	5.0	10	10	600	600	0.1	0.5	7.0	6.0	55
1N6000A	10	5.0	15	22	600	600	0.1	0.5	7.6	6.5	50
1N6001A	11	5.0	18	25	600	600	0.1	0.1	8.4	7.0	45
1N6002A	12	5.0	22	32	600	600	0.1	0.1	9.1	8.0	42
1N6003A	13	5.0	25	36	600	600	0.1	0.1	9.9	8.4	38
1N6004A	15	5.0	30	48	600	600	0.1	0.1	12	9.9	31
1N6005A	16	5.0	36	48	600	600	0.1	0.1	12	9.9	31
1N6006A	18	5.0	42	58	600	600	0.1	0.1	14	11	28
1N6007A	20	5.0	48	62	600	600	0.1	0.1	15	12	26
1N6008A	22	5.0	55	70	600	600	0.1	0.1	17	14	23
1N6009A	24	5.0	62	78	600	600	0.1	0.1	18	15	21
1N6010A	27	5.0	70	88	600	700	0.1	0.1	21	17	19
1N6011A	30	5.0	78	95	600	700	0.1	0.1	23	18	17
1N6012A	33	5.0	88	110	700	800	0.1	0.1	25	21	15
1N6013A	36	5.0	95	130	700	900	0.1	0.1	27	23	14
1N6014A	39	2.0	130	170	800	1000	0.1	0.1	30	25	13
1N6015A	43	2.0	150	180	900	1100	0.1	0.1	33	27	12
1N6016A	47	2.0	170	200	1000	1300	0.1	0.1	36	30	11
1N6017A	51	2.0	180	225	1300	1400	0.1	0.1	39	33	9.8
1N6018A	56	2.0	200	240	1400	1600	0.1	0.1	43	36	8.9
1N6019A	62	2.0	225	285	1400	1700	0.1	0.1	47	39	8.0
1N6020A	68	2.0	240	280	1600	2000	0.1	0.1	52	43	7.4
1N6021A	75	2.0	265	300	1700	2300	0.1	0.1	56	47	6.7
1N6022A	82	2.0	280	350	2000	2800	0.1	0.1	62	52	6.1
1N6023A	91	2.0	300	400	2300	3000	0.1	0.1	69	56	5.5
1N6024A	100	1.0	500	600	3000	4000	0.1	0.1	76	62	5.0
1N6025A	110	1.0	650	980	3000	4500	0.1	0.1	84	68	4.5

*Indicates JEDEC Registered Data

NOTE 1 – TOLERANCE AND VOLTAGE DESIGNATION
Tolerance designation – Device tolerances of ±10% are indicated by an "A" suffix, ±5.0% by a "B" suffix, ±2.0% by a "C" suffix, ±1.0% by a "D" suffix.

NOTE 2 – SPECIAL SELECTIONS AVAILABLE INCLUDE:
(a) Nominal Zener voltages between those shown.
(b) Matched sets: (Standard Tolerances are ±5.0%, ±2.0%, ±1.0%)
a. Two or more units for series connection with specified tolerance on total voltage. Series matched sets make zener voltages in excess of 200 volts possible as well as providing lower temperature coefficients, lower dynamic impedance and greater power handling ability
b. Two or more units matched to one another with any specified tolerance.

NOTE 3:
This data was calculated using nominal voltages. In order to determine the maximum current handling capability on a worst case basis the following formula must be used:

$$I_{zm}(\text{worst case}) = \frac{500\ mW}{V_z(\text{nom}) + \text{tolerance}}$$

NOTE 4:
Z_{ZT} and Z_{ZK} are measured by dividing the ac voltage drop across the device by the ac current applied. The specified limits are for $I_{z(ac)} = 0.1\ I_{z(dc)}$ with the ac frequency = 1.0 kHz.

4

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

1N4728, A thru 1N4764, A

Designers Data Sheet

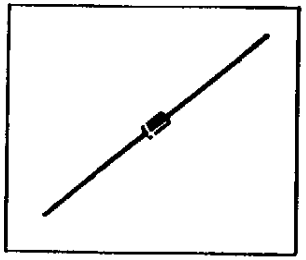
ONE WATT HERMETICALLY SEALED GLASS SILICON ZENER DIODES

- Complete Voltage Range — 3.3 to 100 Volts
- DO-41 Package
- Double Slug Type Construction
- Metallurgically Bonded Construction
- Oxide Passivated Die

Designer's Data for "Worst Case" Conditions

The Designers Data sheets permit the design of most circuits entirely from the information presented. Limit curves — representing boundaries on device characteristics — are given to facilitate "worst case" design.

1.0 WATT
ZENER REGULATOR DIODES
3.3 - 100 VOLTS



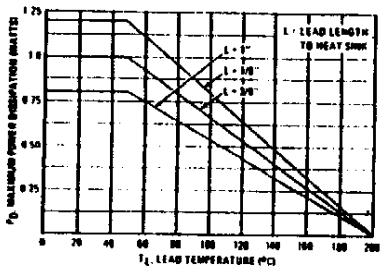
*MAXIMUM RATINGS

Rating	Symbol	Value	Unit
DC Power Dissipation @ T_A = 50°C Derate above 50°C	P_D	1.0 6.67	Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-65 to +200	°C

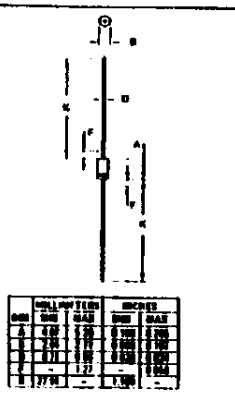
MECHANICAL CHARACTERISTICS

CASE: Double plug type, hermetically sealed glass
MAXIMUM LEAD TEMPERATURE FOR SOLDERING PURPOSES: 230°C, 1/16" from case for 10 seconds
FINISH: All external surfaces are corrosion resistant with readily solderable leads
POLARITY: Cathode indicated by color band. When operated in zener mode, cathode will be positive with respect to anode
MOUNTING POSITION: Any

FIGURE 1 – POWER TEMPERATURE DERATING CURVE



*Indicates JEDEC Registered Data



CASE	MILLIMETERS DIM	MILLIMETERS MAX	INCHES DIM	INCHES MAX
A	2.54	3.30	0.100	0.130
B	0.71	0.86	0.028	0.034
D	0.71	0.86	0.028	0.034
K	27.94	—	1.100	—

CASE 59-03
DO-41
GLASS

NOTES:
1. ALL RULES AND NOTES ASSOCIATED WITH JEDEC DO-41 OUTLINE SHALL APPLY.
2. POLARITY DENOTED BY CATHODE BAND.
3. LEAD DIAMETER NOT CONTROLLED WITHIN "D" DIMENSION.

*Indicates JEDEC Registered Data

*ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) V_F = 1.2 V max, I_F = 200 mA for all types.

JEDEC Type No. (Note 1)	Nominal Zener Voltage V_Z @ I_{ZT} Volts (Notes 2 and 3)	Test Current I_{ZT} mA	Maximum Zener Impedance (Note 4) Z_{ZT} @ I_{ZT} Ohms	Z_{ZK} @ I_{ZK} Ohms	I_{ZK} mA	Leakage Current I_R µA Max	V_R Volts	Surge Current @ T_A = 25°C I_r – mA (Note 5)
1N4728	3.3	76	10	400	1.0	100	1.0	1380
1N4729	3.6	69	10	400	1.0	100	1.0	1260
1N4730	3.9	64	9.0	400	1.0	50	1.0	1150
1N4731	4.3	58	9.0	500	1.0	10	1.0	1070
1N4732	4.7	53	8.0	500	1.0	10	1.0	970
1N4733	5.1	49	7.0	550	1.0	10	1.0	890
1N4734	5.6	45	5.0	600	1.0	10	2.0	810
1N4735	6.2	41	2.0	700	1.0	10	3.0	730
1N4736	6.8	37	3.5	700	1.0	10	4.0	660
1N4737	7.5	34	4.0	700	0.5	10	5.0	605
1N4738	8.2	31	4.5	700	0.5	10	6.0	550
1N4739	9.1	28	5.0	700	0.5	10	7.0	500
1N4740	10	25	7.0	700	0.25	10	7.6	454
1N4741	11	23	8.0	700	0.25	5.0	8.4	414
1N4742	12	21	9.0	700	0.25	5.0	9.1	380
1N4743	13	19	10	700	0.25	5.0	9.9	344
1N4744	15	17	14	700	0.25	5.0	11.4	304
1N4745	16	15.5	16	700	0.25	5.0	12.2	285
1N4746	18	14	20	750	0.25	5.0	13.7	250
1N4747	20	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1N4748	22	11.5	23	750	0.25	5.0	16.7	205
1N4749	24	10.5	25	750	0.25	5.0	18.2	190
1N4750	27	9.5	35	750	0.25	5.0	20.6	170
1N4751	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1N4752	33	7.5	45	1000	0.25	5.0	25.1	135
1N4753	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1N4754	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1N4755	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1N4756	47	5.5	80	1500	0.25	5.0	35.8	95
1N4757	51	5.0	95	1500	0.25	5.0	38.8	88
1N4758	56	4.5	110	2000	0.25	5.0	42.6	80
1N4759	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1N4760	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1N4761	75	3.3	175	3000	0.25	5.0	57.0	65
1N4762	82	3.0	200	3000	0.25	5.0	62.0	60
1N4763	91	2.8	250	3000	0.25	5.0	69.2	55
1N4764	100	2.5	350	3000	0.25	5.0	76.0	45

*Indicates JEDEC Registered Data.

NOTE 1 — Tolerance and Type Number Designation. The JEDEC type numbers listed have a standard tolerance on the nominal zener voltage of [illegible]. A standard tolerance of [illegible] on individual units is also available and is indicated by replacing "A" in the standard type number. C has [illegible] for ±1%.

NOTE 2 — Specials Available Include:

A. Nominal zener voltages between the voltages shown and higher voltage tolerances.
B. Matched sets.

For detailed information on price, availability, and delivery, contact your nearest Motorola representative.

NOTE 3 — Zener Voltage (V_Z) Measurement. Motorola guarantees the zener voltage when measured at 90 seconds while maintaining the lead temperature (T_L) at 30°C ± 1°C, 3/8" from the diode body.

NOTE 4 — Zener Impedance (Z_Z) Definition. The zener impedance is derived from the 60 cycle ac voltage, which results when an ac current having an rms value equal to 10% of the dc zener current (I_{ZT} or I_{ZK}) is superimposed on I_{ZT} or I_{ZK}.

NOTE 5 — Surge Current (I_r) Non-Repetitive. The rating listed in the electrical characteristics table is maximum peak, non-repetitive, reverse surge current of 1/2 square wave or equivalent sine wave pulse of 1/120 second duration superimposed on the test current, I_{ZT}, per JEDEC registration; however, actual device capability is as described in Figure 5.

APPLICATION NOTE

Since the actual voltage available from a given zener diode is temperature dependent, it is necessary to determine junction temperature under any set of operating conditions in order to calculate its value. The following procedure is recommended:

Lead Temperature, T_L, should be determined from

$$T_L = \theta_{LA} P_D + T_A$$

θ_{LA} is the lead-to-ambient thermal resistance (°C/W) and P_D is the power dissipation. The value for θ_{LA} will vary and depends on the device mounting method. θ_{LA} is generally 30 to 40°C/W for the various clips and tie points in common use and for printed circuit board wiring.

The temperature of the lead can also be measured using a thermocouple placed on the lead as close as possible to the tie point. The thermal mass connected to the tie point is normally large enough so that it will not significantly respond to heat surges generated in the diode as a result of pulsed operation once steady-state conditions are achieved. Using the measured value of T_L, the junction temperature may be determined by:

$$T_J = T_L + \Delta T_{JL}$$

ΔT_{JL} is the increase in junction temperature above the lead temperature and may be found as follows:

$$\Delta T_{JL} = \theta_{JL} P_D$$

θ_{JL} may be determined from Figure 3 for dc power conditions. For worst-case design, using expected limits of I_Z, limits of P_D and the extremes of $T_J(\Delta T_J)$ may be estimated. Changes in voltage, V_Z, can then be found from:

$$\Delta V = \theta_{VZ} \Delta T_J$$

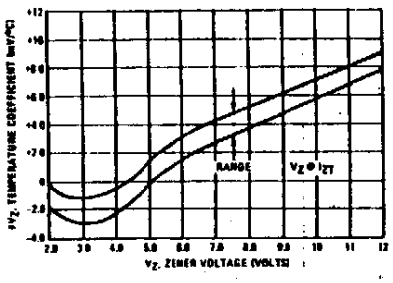
θ_{VZ}, the zener voltage temperature coefficient, is found from Figure 2.

Under high power pulse operation, the zener voltage will vary with time and may also be affected significantly by the zener resistance. For best regulation, keep current excursions as low as possible.

Surge limitations are given in Figure 5. They are lower than would be expected by considering only junction temperature, as current crowding effects cause temperatures to be extremely high in small spots resulting in device degradation should the limits of Figure 5 be exceeded.

FIGURE 2 – TEMPERATURE COEFFICIENTS
(−55°C to +150°C temperature range; 90% of the units are in the ranges indicated.)

a – RANGE FOR UNITS TO 12 VOLTS



b – RANGE FOR UNITS 12 TO 100 VOLTS

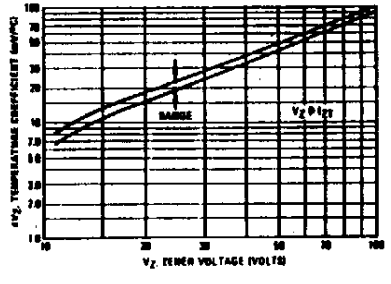


FIGURE 3 – TYPICAL THERMAL RESISTANCE
versus LEAD LENGTH

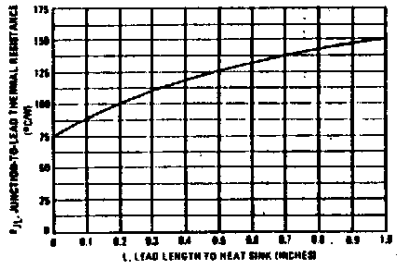


FIGURE 4 – EFFECT OF ZENER CURRENT

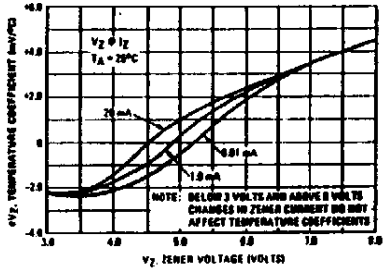
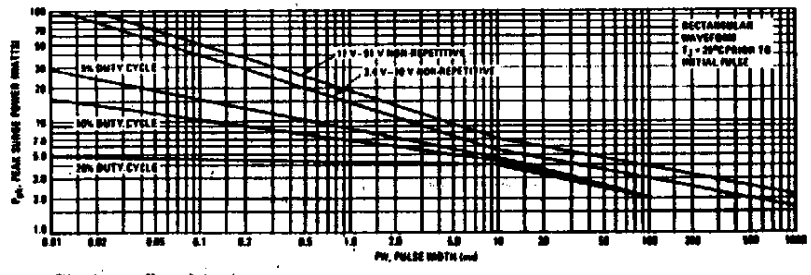


FIGURE 5 – MAXIMUM SURGE POWER



This graph represents 98 percentile data points.
For worst-case design characteristics, multiply surge power by 2/3.

62V × 0.2A = 12.4W

FIGURE 6 – EFFECT OF ZENER CURRENT ON ZENER IMPEDANCE

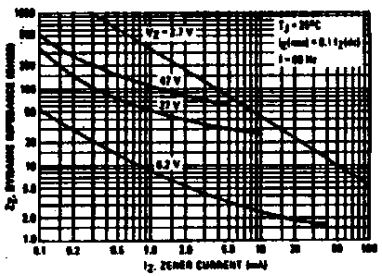


FIGURE 7 – EFFECT OF ZENER VOLTAGE ON ZENER IMPEDANCE

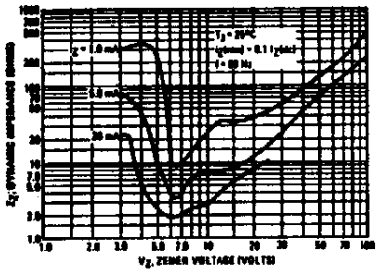


FIGURE 8 – TYPICAL LEAKAGE CURRENT

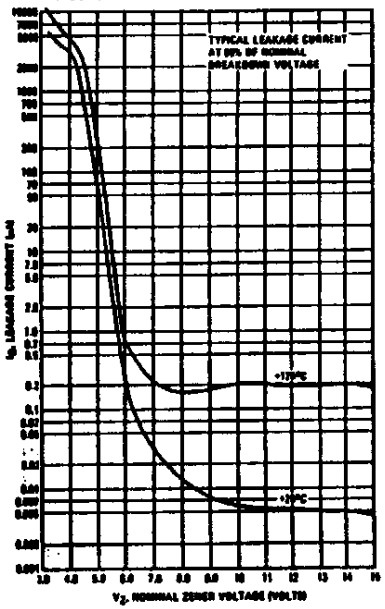


FIGURE 9 – TYPICAL CAPACITANCE versus V_Z

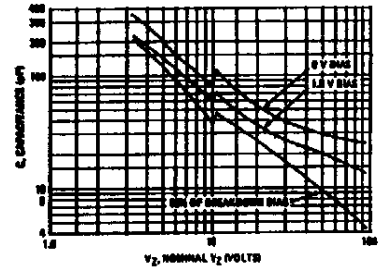
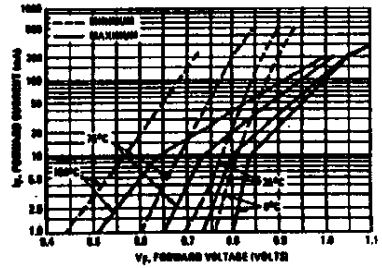


FIGURE 10 – TYPICAL FORWARD CHARACTERISTICS



MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

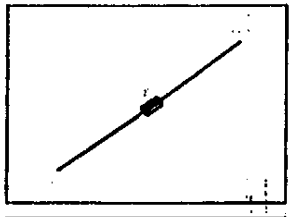
1N5913A thru 1N5956A

1.5 WATT SURMETIC 30 SILICON ZENER DIODES

. . . A complete line of 1.5 Watt Zener Diodes offering the following advantages:

- Complete Voltage Range — 3.3 to 200 Volts
- DO-41 Package — Smaller than Conventional Metal Devices
- Metallurgically Bonded Construction
- JEDEC Registered Parameters
- Oxide Passivated Diode
- Molded Package

1.5 WATTS
ZENER DIODES
3.3 – 200 VOLTS



*MAXIMUM RATINGS

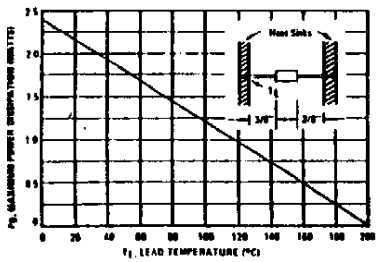
Rating	Symbol	Value	Unit
DC Power Dissipation @ T_L = 75°C, Lead Length = 3/8" Derate above 75°C	P_D	1.5 / 12	Watts / mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200	°C

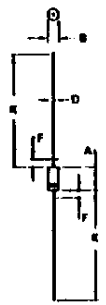
*Indicates JEDEC Registered Data.

MECHANICAL CHARACTERISTICS

CASE: Surmetic 30 void-free, transfer-molded, thermosetting plastic
MAXIMUM LEAD TEMPERATURE FOR SOLDERING PURPOSES: 230°C, 1/16" from case for 10 seconds
FINISH: All external surfaces are corrosion resistant with readily solderable leads
POLARITY: Cathode indicated by color band. When operated in zener mode, cathode will be positive with respect to anode.
MOUNTING POSITION: Any

FIGURE 1 – STEADY STATE POWER DERATING





DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	4.07	5.20	0.160	0.205
B	2.04	2.71	0.080	0.107
D	0.71	0.86	0.028	0.034
F	–	1.27	–	0.050
K	27.94	–	1.100	–

All JEDEC dimensions and notes apply

CASE 59-03
DO-41
PLASTIC

NOTES:
1. ALL RULES AND NOTES ASSOCIATED WITH JEDEC DO-41 OUTLINE SHALL APPLY.
2. POLARITY DENOTED BY CATHODE BAND.
3. LEAD DIAMETER NOT CONTROLLED

*ELECTRICAL CHARACTERISTICS (T_L = 30°C unless otherwise noted, V_F = 1.5 Volts Max @ I_F = 200 mAdc for all types.)

Motorola Type Number (Note 1)	Nominal Zener Voltage V_Z @ I_{ZT} Volts (Note 3)	Test Current I_{ZT} mA	Max. Zener Impedance Z_{ZT} @ I_{ZT} Ohms	Max. Zener Impedance Z_{ZK} Ohms	Max. Zener Impedance @ I_{ZK} mA	Max. Reverse Leakage Current I_R μA	Max. Reverse Leakage Current @ V_R Volts	Maximum DC Zener Current I_{ZM} mAdc
1N5913A	3.3	113.6	10	500	1.0	100	1.0	454
1N5914A	3.6	104.2	9.0	500	1.0	75	1.0	416
1N5915A	3.9	96.1	7.5	500	1.0	25	1.0	384
1N5916A	4.3	87.2	6.0	500	1.0	50	1.0	348
1N5917A	4.7	79.8	5.0	500	1.0	50	1.5	319
1N5918A	5.1	73.5	4.0	350	1.0	50	2.0	294
1N5919A	5.6	66.9	2.0	250	1.0	50	3.0	267
1N5920A	6.2	60.5	2.0	200	1.0	50	4.0	241
1N5921A	6.8	55.1	2.5	200	1.0	50	5.2	220
1N5922A	7.5	50.0	3.0	400	0.5	50	5.5	200
1N5923A	8.2	45.7	3.5	400	0.5	50	7.0	184
1N5924A	9.1	41.2	4.0	500	0.5	50	8.0	150
1N5925A	10	37.5	4.5	500	0.25	10	8.0	138
1N5926A	11	34.1	5.5	550	0.25	10	8.4	125
1N5927A	12	31.2	6.5	550	0.25	10	9.1	115
1N5928A	13	28.8	7.0	550	0.25	10	9.9	110
1N5929A	15	25.0	8.0	600	0.25	10	11.4	100
1N5930A	16	23.4	10	600	0.25	10	12.2	93
1N5931A	18	20.8	12	650	0.25	10	13.7	83
1N5932A	20	18.7	14	650	0.25	10	15.2	75
1N5933A	22	17.0	17.5	650	0.25	10	16.7	68
1N5934A	24	15.6	19	700	0.25	10	18.2	62
1N5935A	27	13.8	23	700	0.25	10	20.6	55
1N5936A	30	12.5	28	750	0.25	10	22.8	50
1N5937A	33	11.4	33	800	0.25	10	25.1	45
1N5938A	36	10.4	38	850	0.25	10	27.4	41
1N5939A	39	9.6	45	900	0.25	10	29.7	38
1N5940A	43	8.7	53	950	0.25	10	32.7	34
1N5941A	47	8.0	67	1000	0.25	10	35.8	31
1N5942A	51	7.4	70	1100	0.25	10	38.8	28
1N5943A	56	6.7	86	1300	0.25	10	42.6	26
1N5944A	60	6.3	90	1300	0.25	10	47.1	24
1N5945A	62	6.0	125	1700	0.25	10	51.7	22
1N5946A	75	5.0	140	2000	0.25	10	56.0	20
1N5947A	82	4.6	160	2000	0.25	1.0	62.2	18
1N5948A	91	4.1	200	3000	0.25	1.0	69.2	16
1N5949A	100	3.7	250	3100	0.25	1.0	76.0	15
1N5950A	110	3.4	300	4000	0.25	1.0	83.6	13
1N5951A	120	3.1	380	4500	0.25	1.0	91.2	12
1N5952A	130	2.8	450	5000	0.25	1.0	98.8	11
1N5953A	150	2.5	600	6000	0.25	1.0	114	10
1N5954A	160	2.3	700	6500	0.25	1.0	121.6	9.0
1N5955A	180	2.1	900	7000	0.25	1.0	136.8	8.0
1N5956A	200	1.9	1200	8000	0.25	1.0	152	7.0

*Indicates JEDEC Registered Data.

NOTE 1 – TOLERANCE AND VOLTAGE DESIGNATION

Tolerance designation — Device tolerances of ±5% are indicated by an "A" suffix, ±2% by a "B" suffix, ±1% by a "C" suffix, ±0.5% by a "D" suffix.

NOTE 2 – SPECIAL SELECTIONS AVAILABLE INCLUDE:

Nominal zener voltages between those shown.

100V × 0.2A = 20W

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

Designer's Data Sheet

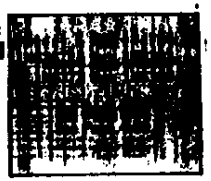
3-Watt Surmetic 30 Silicon Zener Diodes

. . . a complete series of 3 Watt Zener Diodes with limits and operating characteristics that reflect the superior capabilities of silicon-oxide-passivated junctions. All this in an axial-lead, transfer-molded plastic package offering protection in all common environmental conditions.

- Surge Rating of 98 Watts @ 1 ms
- Maximum Limits Guaranteed on Six Electrical Parameters
- Package No Larger Than the Conventional 1 W Package

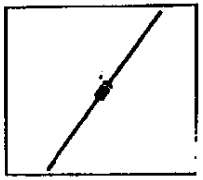
Mechanical Characteristics:

CASE: Void-free, transfer-molded, thermosetting plastic
FINISH: All external surfaces are corrosion resistant and leads are readily solderable and weldable
POLARITY: Cathode indicated by polarity band. When operated in zener mode, cathode will be positive with respect to anode
MOUNTING POSITION: Any
WEIGHT: 0.4 gram (approx)



3EZ3.9D5 thru 3EZ200D5

3-WATT ZENER REGULATOR DIODES 3.9–200 VOLTS



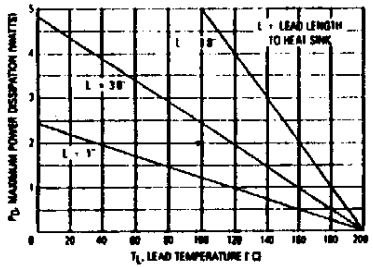
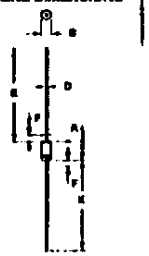


Figure 1. Power-Temperature Derating Curve

OUTLINE DIMENSIONS



NOTES:
1. ALL RULES AND NOTES ASSOCIATED WITH JEDEC DO-41 OUTLINE SHALL APPLY.
2. POLARITY DENOTED BY CATHODE BAND.
3. LEAD DIAMETER NOT CONTROLLED WITHIN "F" DIMENSION.

CASE 59-03
(DO-41)

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
DC Power Dissipation @ T_L = 75°C, Lead Length = 3/8", Derate above 75°C	P_D	3 24	Watts mW/°C
DC Power Dissipation @ T_A = 50°C, Derate above 50°C	P_D	1 6.67	Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200	°C

Designer's Data for "Worst Case" Conditions — The Designer's Data Sheet permits the design of most circuits entirely from the information presented. Limit curves — representing boundaries on device characteristics — are given to facilitate "worst case" design.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) V_F = 1.5 V max, I_F = 200 mA for all types)

Motorola Type No. (Note 1)	Nominal Zener Voltage V_Z @ I_{ZT} Volts (Note 2)	Test Current I_{ZT} mA	Max Zener Impedance (Note 3) Z_{ZT} @ I_{ZT} Ohms	Z_{ZK} @ I_{ZK} Ohms	I_{ZK} mA	Leakage Current I_R µA Max @	V_R Volts	Maximum Zener Current I_{ZM} mA	Surge Current @ T_A = 25°C I_R = mA (Note 4)
3EZ3.9D5	3.8	193	4.5	400	1	50	1	630	4.4
3EZ4.3D5	4.3	174	4.5	400	1	30	1	560	4.1
3EZ4.7D5	4.7	160	4	500	1	20	1	560	3.8
3EZ5.1D5	5.1	147	3.5	550	1	5	1	520	3.5
3EZ5.6D5	5.6	134	2.5	600	1	5	2	480	3.3
3EZ6.2D5	6.2	121	1.5	700	1	5	3	435	2.1
3EZ6.8D5	6.8	110	2	700	1	5	4	393	2.9
3EZ7.5D5	7.5	100	2	700	0.5	5	5	360	2.66
3EZ8.2D5	8.2	91	2.3	700	0.5	5	6	330	2.44
3EZ9.1D5	9.1	82	2.5	700	0.5	3	7	297	2.2
3EZ10D5	10	76	3.5	700	0.25	3	7.6	270	2
3EZ11D5	11	68	4	700	0.25	1	8.4	225	1.82
3EZ12D5	12	63	4.5	700	0.25	1	9.1	246	1.66
3EZ13D5	13	58	4.5	700	0.25	0.5	9.9	208	1.54
3EZ14D5	14	53	5	700	0.25	0.5	10.6	193	1.43
3EZ15D5	15	50	5.5	700	0.25	0.5	11.4	180	1.33
3EZ16D5	16	47	5.5	700	0.25	0.5	12.2	169	1.25
3EZ17D5	17	44	6	750	0.25	0.5	13	150	1.18
3EZ18D5	18	42	6	750	0.25	0.5	13.7	150	1.11
3EZ19D5	19	40	7	750	0.25	0.5	14.4	142	1.05
3EZ20D5	20	37	7	750	0.25	0.5	15.2	135	1
3EZ22D5	22	34	8	750	0.25	0.5	16.7	123	0.91
3EZ24D5	24	31	9	750	0.25	0.5	18.2	112	0.83
3EZ27D5	27	28	10	750	0.25	0.5	20.6	100	0.74
3EZ28D5	28	27	12	750	0.25	0.5	21	96	0.71
3EZ30D5	30	25	16	1000	0.25	0.5	22.5	90	0.67
3EZ33D5	33	23	20	1000	0.25	0.5	25.1	82	0.61
3EZ36D5	36	21	22	1000	0.25	0.5	27.4	75	0.56
3EZ39D5	39	19	28	1000	0.25	0.5	29.7	68	0.51
3EZ43D5	43	17	33	1500	0.25	0.5	32.7	63	0.46
3EZ47D5	47	16	38	1500	0.25	0.5	35.8	57	0.42
3EZ51D5	51	15	45	1500	0.25	0.5	38.8	53	0.39
3EZ56D5	56	13	60	2000	0.25	0.5	42.6	48	0.36
3EZ62D5	62	12	80	2000	0.25	0.5	47.1	45	0.32
3EZ68D5	68	11	70	2000	0.25	0.5	51.7	40	0.29
3EZ75D5	75	10	85	2000	0.25	0.5	56	36	0.27
3EZ82D5	82	9.1	95	2000	0.25	0.5	62.2	33	0.24
3EZ91D5	91	8.2	115	3000	0.25	0.5	69.2	30	0.22
3EZ100D5	100	7.5	150	3000	0.25	0.5	76	28	0.2
3EZ110D5	110	6.8	225	4000	0.25	0.5	83.6	25	0.18
3EZ120D5	120	6.3	300	4500	0.25	0.5	91.2	23	0.16
3EZ130D5	130	5.8	375	5000	0.25	0.5	98.8	21	0.15
3EZ140D5	140	5.3	475	5000	0.25	0.5	106.4	19	0.14
3EZ150D5	150	5	550	6000	0.25	0.5	114	18	0.13
3EZ160D5	160	4.7	625	6500	0.25	0.5	121.6	17	0.12
3EZ170D5	170	4.5	650	7000	0.25	0.5	129.2	16	0.12
3EZ180D5	180	4.2	700	7000	0.25	0.5	136.8	15	0.11
3EZ190D5	190	4	800	8000	0.25	0.5	144.5	14	0.1
3EZ200D5	200	3.7	875	8000	0.25	0.5	152	13	0.1

NOTES:
(1) TOLERANCES — Suffix 1 indicates 1% tolerance, suffix 2 indicates 2% tolerance, suffix 5 indicates 5% tolerance and suffix 10 indicates 10% tolerance, any other tolerance will be considered as a special device.
(2) ZENER VOLTAGE (V_Z) MEASUREMENT — Motorola guarantees the zener voltage when measured at 40 ms ± 10 ms 3/8" from the diode body, and an ambient temperature of 25°C (+8°C, −2°C).
(3) ZENER IMPEDANCE (Z_Z) DERIVATION — The zener impedance is derived from the 60 cycle ac voltage, which results when an ac current having an rms value equal to 10% of the dc zener current (I_{ZT} or I_{ZK}) is superimposed on I_{ZT} or I_{ZK}.
(4) SURGE CURRENT (I_R) NON-REPETITIVE — The rating listed in the electrical characteristics table is maximum peak, non-repetitive, reverse surge current of 1/2 square wave or equivalent sine wave pulse of 1/120 second duration superimposed on the test current, I_{ZT}, per JEDEC standards, however, actual device capability is as described in Figure 3.

180V × 0.2A = 36W

FERMILAB

ENGINEERING NOTE

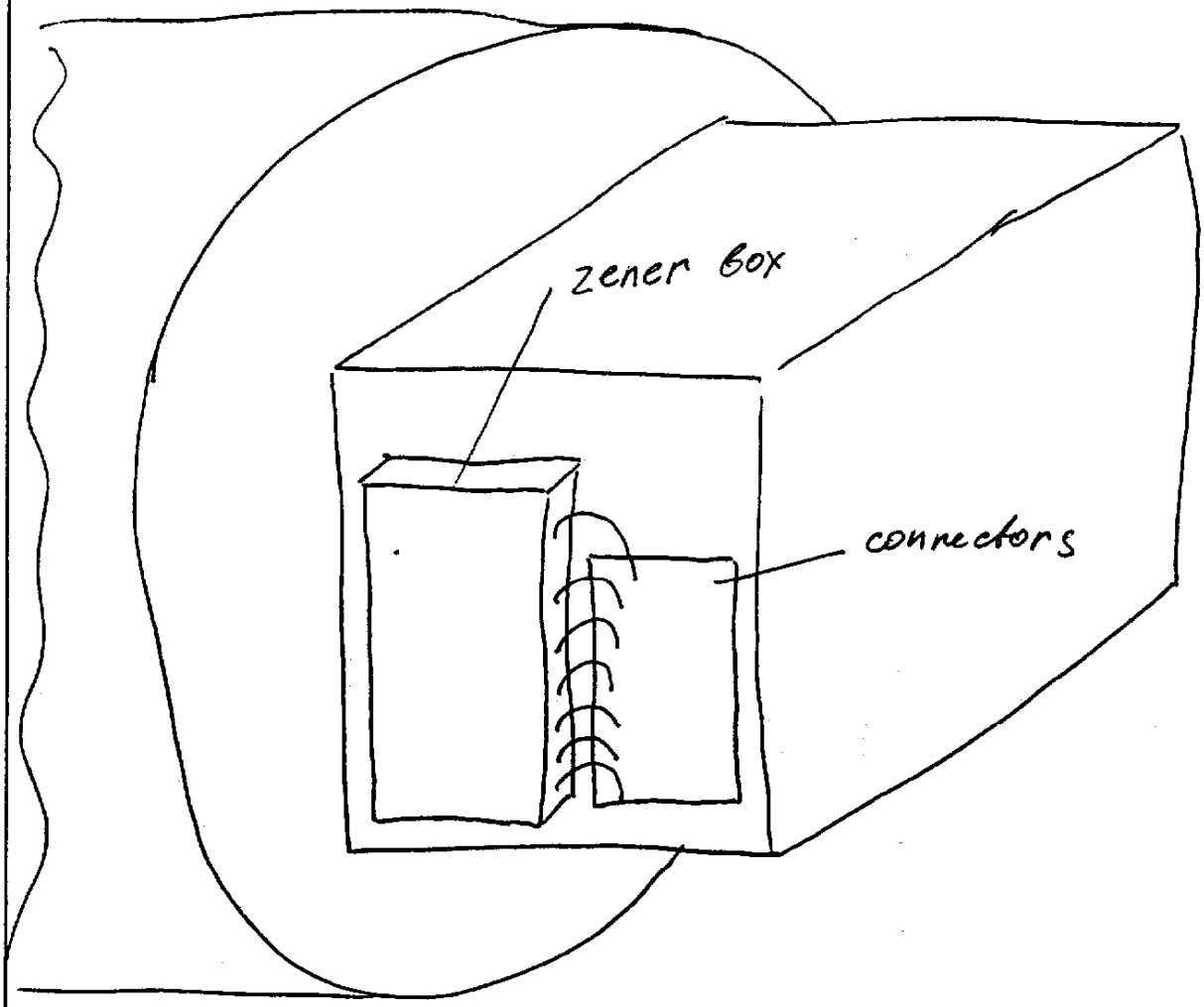
SECTION	PROJECT	SERIAL-CATEGORY	PAGE

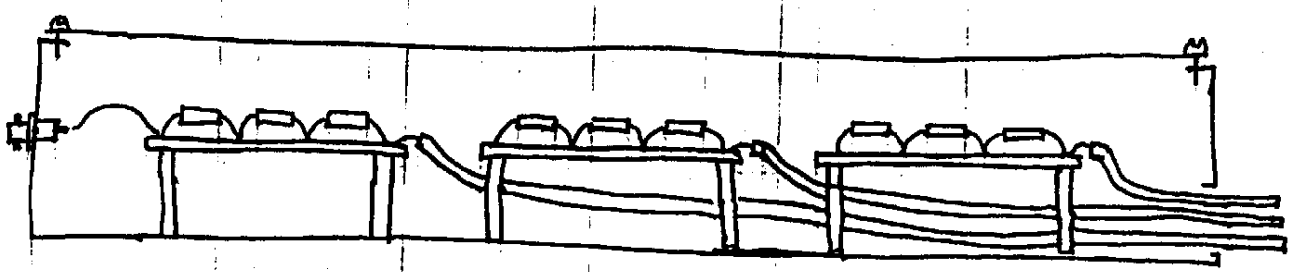
SUBJECT

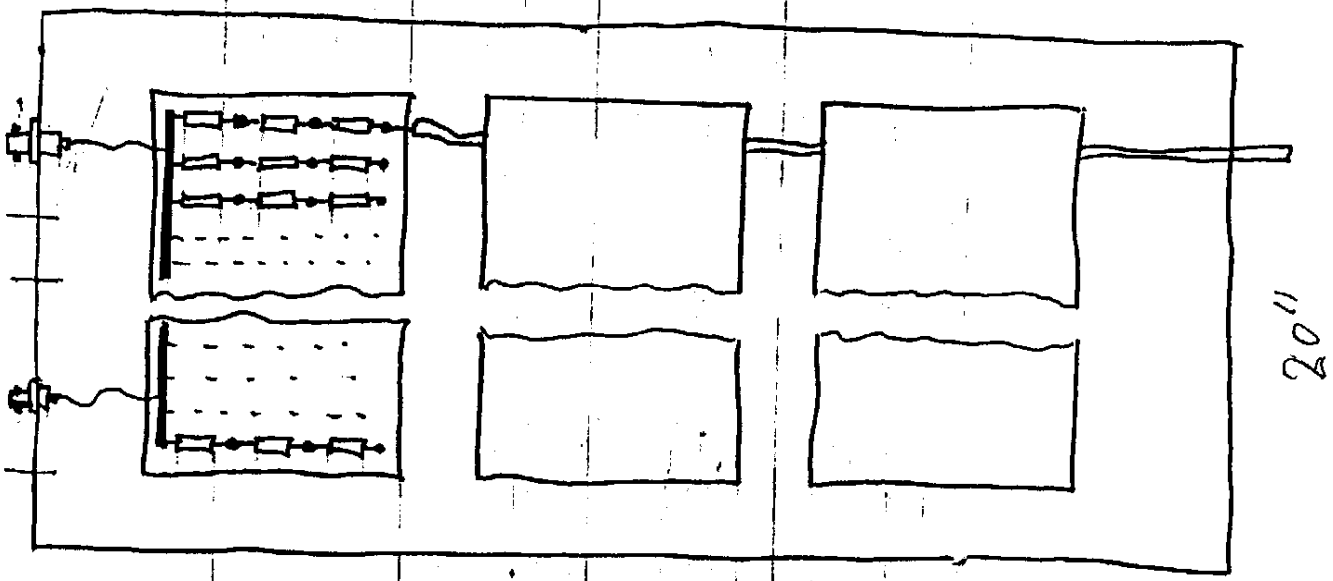
NAME

DATE 07.25

REVISION DATE







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