

## TRANSIENT SUPPRESSION CONNECTOR DESIGN GUIDE



Since 1987, EMP Connectors has provided advanced transient suppression and EMI filter connectors for both military and commercial applications. We specialize in custom-built, high-powered designs and EMP is the industry leader in packaging this technology within the smallest overall connector envelope.

This guide contains a small portion of our transient suppression capabilities and product offerings. Please call or e-mail one of our in-house application specialists who will assist in defining your requirements which will allow EMP to create a customized proposal drawing to meet those requirements.



EMP Connectors, Inc.  
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## Advantages of connectors with Transient and EMI Suppression:

1. Transient protection can be combined with EMI filtering if required (See Filter Connector Design Guide).
2. Mixture of electrical parameters such as power, voltage, polarity, and capacitance are available within the same connector.
3. Protection is located at the interface of the system.
4. System retrofit to EMP/EMI is compatible with unprotected connectors.
5. Electrical components protected by the shell housing, reducing environmental and mechanical damage.

## Electrical Characteristics:

1. At EMP we have the technology to package zener diodes within the connector housing to shunt the pulse energy to ground. Our standard product offering is a 600W device (8 X 20 waveform), however a higher power rating may be requested for specific applications.
2. In addition to specific diode values shown on page 3, general characteristics are as follows:

Operating Temp Range		-55° C to 125° C
Current Rating	Size 16	15 amps
	Size 20	7.5 amps
	Size 22	5 amps
Maximum RF Current		3 amps

## Bipolar vs. Unipolar:

1. Alternating Current (AC) applications require the use of Bipolar devices.
2. Applications which have both positive and negative DC voltages require Bipolar devices.
3. Direct Current (DC) applications may use either Bipolar or Unipolar devices.  
Some factors to consider in choosing the type of device are:

Condition	Bipolar Recommended	Unipolar Recommended
Upset Prevention	No	Yes
Long Opposite Going Voltage	Yes	No
Capacitance to be Minimized	Better	OK

## Cost Considerations:

1. If filtering is required in conjunction with transient suppression, capacitive "C" filtering of 47nF or less is considerably less expensive than other configurations.
2. The greater the number of cavities in the connector, the lower the cost per line.
3. The lower the power rating of the diodes specified, the lower the cost per line.
4. Receptacles are less expensive than plugs (fewer shell components).
5. Square Flange receptacles provide more stable shell to ground conductivities than jam nut receptacles, and are less expensive.
6. Pin contacts for the connector interface are less expensive than socket contacts.
7. The greater the quantity of connectors the program will use, the lower the cost. Develop a standard connector for use throughout a program if feasible.



# CHECKLIST - DIODE SUPPRESSION

PLEASE FAX CHECKLIST ATTN: EMP SALES (714) 665-2099

Reference EMP P/N: \_\_\_\_\_ I.A.W. Mil-Spec: \_\_\_\_\_  
(See Last Page)

Shell Modifications: (Flange location, clinch nuts, helicoils, other)  
 \_\_\_\_\_  
 \_\_\_\_\_

Special Requirements & Considerations:  
 \_\_\_\_\_  
 \_\_\_\_\_

Contact Termination:  PC Tail     Solder Cup     Crimp     Other: \_\_\_\_\_

## Diode Suppression

Pin Positions	Diode Value (See Next Page)	Low Cap	Power Rating
1		<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> 600W <input type="checkbox"/> 1,000W <input type="checkbox"/> 2,000W
2		<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> 600W <input type="checkbox"/> 1,000W <input type="checkbox"/> 2,000W
3		<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> 600W <input type="checkbox"/> 1,000W <input type="checkbox"/> 2,000W
4		<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> 600W <input type="checkbox"/> 1,000W <input type="checkbox"/> 2,000W

Pin Positions	Diode Value (See Next Page)	Low Cap	Power Rating
5		<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> 600W <input type="checkbox"/> 1,000W <input type="checkbox"/> 2,000W
6		<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> 600W <input type="checkbox"/> 1,000W <input type="checkbox"/> 2,000W
7		<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> 600W <input type="checkbox"/> 1,000W <input type="checkbox"/> 2,000W
8		<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> 600W <input type="checkbox"/> 1,000W <input type="checkbox"/> 2,000W

Company: \_\_\_\_\_  
 Requested By: \_\_\_\_\_

Phone: \_\_\_\_\_  
 E-Mail: \_\_\_\_\_

- NOTES: 1. For non-protected lines specify as Insulated Feedthru or Ground.  
 2. If filters are needed in conjunction with diode suppression see Filter Connector Checklist in addition to Diode Suppression Checklist.  
 3. Diode Power Rating: EMP Connectors has an internal standard of 600W, higher power ratings available upon request.



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# DIODE SELECTION CHART

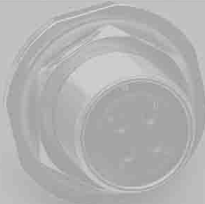
## BIPOLAR

DIODE VALUE	NOMINAL V <sub>br</sub>	MINIMUM V <sub>br</sub>	MAXIMUM V <sub>br</sub>	TEST CURRENT	MAX REVERSE LEAKAGE I <sub>r</sub> ( $\mu$ A) @ V <sub>r</sub>					REVERSE STANDOFF V <sub>r</sub>	CAPACITANCE - pF TYPICAL @ V <sub>r</sub> $\pm$ 50% ACCEPTABLE					MAXIMUM CLAMPING VOLTAGE V <sub>c</sub> (VOLTS)
					200	300	400	600	1000		200	300	400	600	1000	
006	6.8	6.46	7.14	10mA	100	150	300	300	500	5.2	789	1153	1537	2305	3839	10.5
007	7.5	7.13	7.88	10mA	200	300	600	600	1,000	6.0	629	943	1254	1881	3140	11.3
008	8.2	7.79	8.40	10mA	100	150	300	300	500	7.0	506	759	1009	1513	2527	12.1
009	9.1	8.7	9.6	1mA	40	60	120	120	200	7.5	460	689	916	1374	2294	13.4
010	10.0	9.5	10.5	1mA	10	15	30	30	50	8.5	385	578	769	1153	1925	14.5
011	11.1	10.5	11.6	1mA	3	3	6	6	10	9.0	356	534	710	1065	1775	15.6
012	12.0	11.4	12.6	1mA	2	2	5	5	8	10.0	307	460	612	918	1530	16.7
013	13.1	12.4	13.7	1mA	2	2	5	5	8	11.0	269	403	536	804	1340	18.2
015	15.1	14.3	15.8	1mA	2	2	3	3	5	12.0	238	356	475	713	1188	21.2
016	16.0	15.2	16.8	1mA	2	2	3	3	5	13.0	212	319	425	637	1062	22.5
018	18.0	17.1	18.9	1mA	2	2	3	3	5	15.0	174	260	347	521	868	25.2
020	20.0	19.0	21.0	1mA	2	2	3	3	5	17.0	146	218	291	437	728	27.7
022	22.0	20.9	23.1	1mA	2	2	3	3	5	18.0	134	202	269	403	672	30.6
024	24.0	22.8	25.2	1mA	2	2	3	3	5	20.0	116	174	232	348	580	33.2
027	27.1	25.7	28.4	1mA	2	2	3	3	5	22.0	101	152	203	304	507	37.5
030	30.0	28.5	31.5	1mA	2	2	3	3	5	25.0	85	127	170	254	424	41.4
033	33.1	31.4	34.7	1mA	2	2	3	3	5	28.0	72	108	144	217	361	45.7
036	36.0	34.2	37.8	1mA	2	2	3	3	5	30.0	66	98	131	197	328	49.9
039	39.1	37.1	41.0	1mA	2	2	3	3	5	33.0	57	86	115	172	287	53.9
043	43.1	40.9	45.2	1mA	2	2	3	3	5	36.0	51	76	102	152	254	59.3
047	47.1	44.7	49.4	1mA	2	2	3	3	5	40.0	44	66	88	131	219	64.8
051	51.1	48.5	53.6	1mA	2	2	3	3	5	43.0	40	59	79	119	198	70.1
056	56.0	53.2	58.8	1mA	2	2	3	3	5	47.0	35	52	70	105	175	77.0
062	62.0	58.9	65.1	1mA	2	2	3	3	5	53.0	30	44	59	89	148	85.0
063	63.0	60.0	66.0	1mA	2	2	3	3	5	53.5	28	42	56	84	140	87.0
068	68.0	64.6	71.4	1mA	2	2	3	3	5	58.0	26	39	52	78	130	92.0
075	75.1	71.3	78.8	1mA	2	2	3	3	5	64.0	23	34	45	68	113	103.0
082	82.0	77.9	86.1	1mA	2	2	3	3	5	70.0	20	30	40	60	100	113.0
091	91.0	86.5	95.5	1mA	2	2	3	3	5	75.0	18	27	36	55	91	125.0
100	100.0	95.0	105.0	1mA	2	2	3	3	5	82.0	16	24	32	48	80	137.0
110	110.5	105.0	116.0	1mA	2	2	3	3	5	94.0	13	20	26	40	66	152.0
120	120.0	114.0	126.0	1mA	2	2	3	3	5	100.0	12	18	24	37	61	168.0
131	130.5	124.0	137.0	1mA	2	2	3	3	5	110.0	11	16	21	32	53	182.0
137	137.0	130.0	144.0	1mA	2	2	3	3	5	116.5	10	14	19	29	48	190.0
151	150.5	143.0	158.0	1mA	2	2	3	3	5	128.0	9	13	17	26	43	213.0
171	170.5	162.0	179.0	1mA	2	2	3	3	5	150.0	7	11	14	22	36	245.0
180	180.0	171.0	189.0	1mA	2	2	3	3	5	154.0	7	10	14	20	34	261.0
191	190.5	181.0	200.0	1mA	2	2	3	3	5	160.0	6	9	12	19	31	278.0
200	200.0	190.0	210.0	1mA	2	2	3	3	5	170.0	6	9	12	17	29	294.0
220	220.0	209.0	231.0	1mA	2	2	3	3	5	185.0	5	8	10	16	26	328.0
232	232.0	220.0	243.0	1mA	2	2	3	3	5	197.2	5	7	9	14	23	340.0

## UNIPOLAR

DIODE VALUE	NOMINAL V <sub>br</sub>	MINIMUM V <sub>br</sub>	MAXIMUM V <sub>br</sub>	TEST CURRENT	MAX REVERSE LEAKAGE I <sub>r</sub> ( $\mu$ A) @ V <sub>r</sub>					REVERSE STANDOFF V <sub>r</sub>	CAPACITANCE - pF TYPICAL @ V <sub>r</sub> $\pm$ 50% ACCEPTABLE					MAXIMUM CLAMPING VOLTAGE V <sub>c</sub> (VOLTS)
					200	300	400	600	1000		200	300	400	600	1000	
006	6.8	6.45	7.14	10mA	200	300	600	600	1,000	5.8	844	1267	1685	2534	4223	10.5
007	7.5	7.13	7.88	10mA	100	150	300	300	5000	6.4	738	1106	1471	2212	3683	11.3
008	8.2	7.79	8.61	10mA	40	60	120	120	200	7.0	650	975	1297	1950	3247	12.1
009	9.1	8.7	10.2	1mA	10	15	30	30	50	7.8	564	846	1125	1692	2817	13.4
010	10.0	9.5	10.5	1mA	3	3	6	6	10	8.6	496	744	990	1488	2478	14.5
011	11.1	10.5	11.6	1mA	3	3	6	6	10	9.4	436	653	868	1306	2174	15.6
012	12.0	11.4	12.6	1mA	2	2	5	5	8	10.2	389	584	777	1168	1945	16.7
013	13.1	12.4	13.7	1mA	2	2	5	5	8	11.1	347	520	693	1040	1733	18.2
015	15.1	14.3	15.8	1mA	2	2	3	3	5	12.8	285	427	570	855	1425	21.2
016	16.0	15.2	16.8	1mA	2	2	3	3	5	13.6	262	393	524	787	1311	22.5
018	18.0	17.1	18.9	1mA	2	2	3	3	5	15.3	223	335	446	669	1116	25.2
020	20.0	19.0	21.0	1mA	2	2	3	3	5	17.1	192	287	383	575	958	27.7
022	22.0	20.9	23.1	1mA	2	2	3	3	5	18.8	168	252	336	505	841	30.6
024	24.0	22.8	25.2	1mA	2	2	3	3	5	20.5	149	224	299	448	747	33.2
025	25.0	24.75	26.25	1mA	2	2	3	3	5	21.2	138	207	276	414	690	33.9
027	27.1	25.7	28.4	1mA	2	2	3	3	5	23.1	127	190	254	380	634	37.5
030	30.0	28.5	31.5	1mA	2	2	3	3	5	25.6	110	165	220	331	551	41.4
033	33.1	31.4	34.7	1mA	2	2	3	3	5	28.2	96	145	193	289	482	45.7
036	36.0	34.2	37.8	1mA	2	2	3	3	5	30.8	85	128	171	256	427	49.9
039	39.1	37.1	41.0	1mA	2	2	3	3	5	33.3	77	115	154	230	384	53.9
043	43.1	40.9	45.2	1mA	2	2	3	3	5	36.8	67	100	134	201	335	59.3
047	47.1	44.7	49.4	1mA	2	2	3	3	5	40.2	59	89	118	178	296	64.8
051	51.1	48.5	53.6	1mA	2	2	3	3	5	43.6	53	80	106	159	265	70.1
056	56.0	53.2	58.8	1mA	2	2	3	3	5	47.8	47	70	94	140	234	77.0
062	62.0	58.9	65.1	1mA	2	2	3	3	5	53.0	41	61	81	122	203	85.0
068	68.0	64.6	71.4	1mA	2	2	3	3	5	58.1	36	54	72	107	179	92.0
075	75.1	71.3	78.8	1mA	2	2	3	3	5	64.1	31	47	62	94	156	103.0
082	82.0	77.9	86.1	1mA	2	2	3	3	5	70.1	28	41	55	83	138	113.0
091	91.0	86.5	95.5	1mA	2	2	3	3	5	77.8	24	36	48	72	120	125.0
100	100.0	95.0	105.0	1mA	2	2	3	3	5	85.5	21	31	42	63	105	137.0
110	110.5	105.0	116.0	1mA	2	2	3	3	5	94.0	18	28	37	55	92	152.0
120	120.0	114.0	126.0	1mA	2	2	3	3	5	102.0	17	25	33	50	83	165.0
131	130.5	124.0	137.0	1mA	2	2	3	3	5	111.0	15	22	30	44	74	179.0
151	150.5	143.0	158.0	1mA	2	2	3	3	5	128.0	12	18	24	37	61	207.0
160	160.5	152.0	168.0	1mA	2	2	3	3	5	136.0	11	17	22	34	56	219.0
171	170.5	162.0	179.0	1mA	2	2	3	3	5	145.0	10	15	20	31	51	234.0
180	180.0	171.0	189.0	1mA	2	2	3	3	5	154.0	9	14	19	28	47	246.0
200	200.0	190.0	210.0	1mA	2	2	3	3	5	171.0	8	12	16	25	41	274.0
220	220.0	176.0	264.0	1mA	2	2	3	3	5	187.0	7	10	14	21	35	299.0

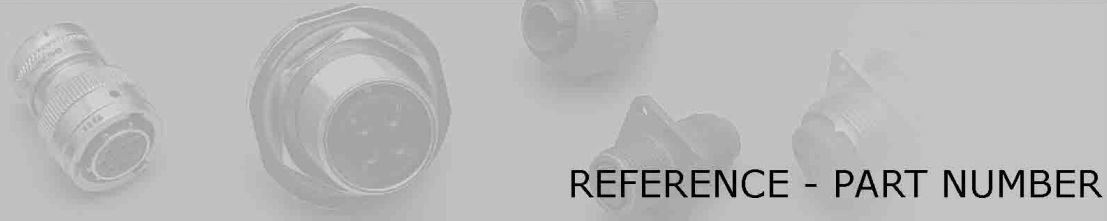
NOTE: Low capacitance lines may be requested when selecting a diode. A typical low capacitance line would be specified as [100pF Maximum].



## Reference Connector Specifications

EMP Connectors comply with the performance requirements set forth by the specifications below.

Test	MIL-DTL-38999 Paragraph Ref.	Description	Requirement
Temperature Cycling	4.5.4	Per Method 1003 of MIL-STD-1344, Condition A, temp range -55°C to 125°C.	No evidence of breaking or electrical deterioration.
Durability	4.5.7	Mated and unmated 500 times to mating connector at a rate of 200 ±100 cycles/hr.	No electrical or mechanical defects affecting performance.
Insulation Resistance (IR)	4.5.9.1	Per Method 3003 of MIL-STD-1344. Measurements shall be between any pair of contacts and between any contact and the connector shell shall be 5,000 MΩ minimum. IR after altitude immersion shall be 1000 MΩ minimum. IR after humidity shall be 100 MΩ Min.	Equal to or greater than the minimum value in the table when tested at the specified voltage per the performance data table.
Dielectric Withstanding Voltage (DWV) (Sea Level)	4.5.10.1	Per Method 3001 of MIL-STD-1344. Measurements shall be between each contact, each adjacent contact, and the shell. Test Voltage shall be maintained at the specified value for for 2 seconds minimum.	There shall be no dielectric breakdown or flashover when tested at specified voltage in per the performance data table.
Dielectric Withstanding Voltage (DWV) (Altitude)	4.5.10.2	Per Method 3001 of MIL-STD-1344. Measurements shall be between each contact, each adjacent contact, and the shell. Test Voltage shall be maintained at the specified value for for 2 seconds minimum. Connector shall be unmated, and only the engaging face shall be subjected to altitude.	Tested to applicable drawing / requirements.
Insert Retention	4.5.11	Per Method 2010 of MIL-STD-1344. A Pressure of 100 psi with a 25 lb. minimum force shall be applied to inserts.	Inserts shall not be displaced or show evidence of damage.
Salt Spray (Corrosion)	4.5.12	Per Method 1001 of MIL-STD-1344, Condition B.	Shall show no exposure of base metal.
Contact Retention	4.5.19	An axial load is applied to the mating end of each contact for 5 seconds minimum. 10 lbs. - size 22, 15 lbs. - size 20, & 25 lbs. - size 16.	Axial displacement of contacts shall not exceed .012 inches.
Vibration	4.5.22.1	Per Method 2005 of MIL-STD-1344, Condition VI Letter J, 8 hrs. longitudinal and perpendicular axis 25°C and 4 hrs. @ -55°C and 125°C.	No evidence of deterioration of Attenuation or IR.
Physical Shock	4.5.23.1	Per Method 2004 of MIL-STD-1344.	No evidence of deterioration of Attenuation or IR.
Humidity	4.5.25	Per Method 1002 of MIL-STD-1344.	Insulation Resistance greater than 100 MΩ when tested at high humidity.
Fluid Immersion	4.5.29	Per Method 1016 of MIL-STD-1344.	Shall meet attenuation after drying.
Electrical Performance	***	All EMP Connectors are 100% electrically tested which includes DWV, Insulation Resistance, and Capacitance Range.	All additional testing can be completed upon customer request.



**CIRCULAR**

**A 3 1 F J 3 5 P N - S \* \***

CONNECTOR TYPE

- A = MIL-DTL-38999
- B = MIL-C-26482
- C = MIL-DTL-83723
- D = MIL-C-81511
- G = MIL-C-28840
- K = MIL-C-5015

SERIES

- 0 = SPECIAL
- 1 = SERIES I
- 2 = SERIES II
- 3 = SERIES III
- 4 = SERIES IV

STYLE

- 1 = SQ. FLANGE / WALL MT.
- 2 = BOX MOUNT
- 3 = JAM-NUT
- 4 = FEED THRU
- 5 = ADAPTER
- 6 = PLUG
- 7 = BACK PANEL MOUNT
- 8 = SOLDER MOUNT
- 9 = RECEPTACLE

PLATING

- A = TIN
- C = CLEAR CAD
- D = FUSED TIN
- E = NICKEL
- F = ELECTROLESS NICKEL
- G = GOLD
- H = PASSIVATION
- M = COMPOSITE
- S = SILVER
- W = O.D. CADMIUM
- Y = YELLOW CADMIUM

MODIFICATION CODE

(DETERMINED AT FACTORY)

TERMINATION STYLE

- A = PC TAIL
- B = SOLDER CUP
- C = CRIMP
- D = N/A (ADAPTER OR OTHER)

KEYING / CLOCKING

SEE MIL-STDS

CONTACT STYLE

- P = PIN
- S = SOCKET

ADAPTER

- A = P/S PIN ON PLUG SIDE
- B = S/P SOCKET ON PLUG SIDE
- C = P/P
- D = S/S

INSERT ARRANGEMENT

SEE MIL-STDS

SHELL SIZE

- A = 8-9
- B = 10-11
- C = 12-13
- D = 14-15
- E = 16-17
- F = 18-19
- G = 20-21
- H = 22-23
- J = 24-25
- K = 1
- L = 2
- M = 3

SHELL SIZE (28840 ONLY)

- A = 11
- B = 13
- C = 15
- D = 17
- E = 19
- F = 23
- G = 25
- H = 29
- J = 33

**D-SUB / MICROMINIATURE**

**H D S C 6 2 P \* \***

HIGH DENSITY

USE AS REQUIRED

D-SUB SERIES

STYLE

- A = ADAPTER
- C = CRIMP
- F = FEED THRU
- I = IDC TERMINATION
- L = RIGHT ANGLE BOARD MT.
- S = SOLDER CUP
- T = PC TAIL

SHELL SIZE

- E = 1
- A = 2
- B = 3
- C = 4
- D = 5
- M = MICROMINIATURE

MODIFICATION CODE

(DETERMINED AT FACTORY)

CONTACT STYLE

- P = PIN
- S = SOCKET

ADAPTER

- A = PIN/SOCKET
- B = PIN/PIN
- C = SOCKET/SOCKET

NUMBER OF CONTACTS

NOTES: 1. Consult factory for ARINC or any other connector housing with a TVS or Filter requirement.