National Semiconductor

LM35/LM35A/LM35C/LM35CA/LM35D Precision Centigrade Temperature Sensors

General Description

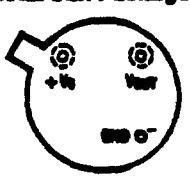
The LM35 series are precision integrated-circuit temperature sensors, whose output voltage is linearly proportional to the Celsius (Centigrade) temperature. The LM35 thus has an advantage over linear temperature sensors calibrated in ° Kelvin, as the user is not required to subtract a large constant voltage from its output to obtain convenient Centigrade scaling. The LM35 does not require any external calibration or trimming to provide typical accuracies of ±¼°C at room temperature and ±¾°C over a full −55 to +150°C temperature range. Low cost is assured by trimming and calibration at the wafer level. The LM35's low output impedance, linear output, and precise inherent calibration make interfacing to readout or control circuitry especially easy. It can be used with single power supplies, or with plus and minus supplies. As it draws only 60 μA from its supply, it has very low self-heating, less than 0.1°C in still air. The LM35 is rated to operate over a −55° to +150°C temperature range, while the LM35C is rated for a −40° to +110°C range (−10° with improved accuracy). The LM35 series is available packaged in hermetic TO-46 transistor packages, while the LM35C is also available in the plastic TO-92 transistor package.

Features

- Calibrated directly in ° Celsius (Centigrade)
- Linear + 10.0 mV/°C scale factor
- 0.5°C accuracy guaranteeable (at +25°C)
- Rated for full −55° to +150°C range
- Suitable for remote applications
- Low cost due to wafer-level trimming
- Operates from 4 to 30 volts
- Less than 60 μA current drain
- Low self-heating, 0.08°C in still air
- Nonlinearity only ±¼°C typical
- Low impedance output, 0.1 Ω for 1 mA load

Connection Diagrams

TO-46
Metal Can Package*



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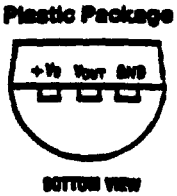
*Case is connected to negative pin

Order Number LM35H, LM35AH, LM35CH, LM35CAH or LM35DH
See NS Package Number H03H

TO-92
Plastic Package



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Order Number LM35CZ or LM35DZ
See NS Package Number Z03A

Typical Applications

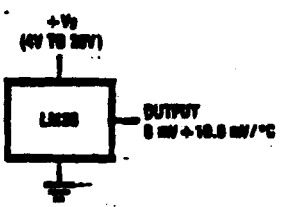

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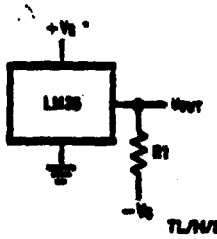
FIGURE 1. Basic Centigrade Temperature Sensor (+2°C to +150°C)



Choose $R_1 = -V_S/50\ \mu A$

$V_{OUT} = +1{,}500$ mV at +150°C
$= +250$ mV at +25°C
$= -550$ mV at −55°C

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FIGURE 2. Full-Range Centigrade Temperature Sensor

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Absolute Maximum Ratings (Note 10)

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/Distributors for availability and specifications.

Supply Voltage	+35V to −0.2V
Output Voltage	+6V to −1.0V
Output Current	10 mA
Storage Temp., TO-46 Package,	−60°C to +180°C
TO-92 Package,	−60°C to +150°C
Lead Temp. (Soldering, 10 seconds):	
TO-46 Package,	300°C
TO-92 Package,	260°C

Specified Operating Temperature Range: T_{MIN} to T_{MAX} (Note 2)

LM35, LM35A	−55°C to +150°C
LM35C, LM35CA	−40°C to +110°C
LM35D	0°C to +100°C

Electrical Characteristics (Note 1) (Note 6)

Parameter	Conditions	LM35A			LM35CA			Units (Max.)
		Typical	Tested Limit (Note 4)	Design Limit (Note 5)	Typical	Tested Limit (Note 4)	Design Limit (Note 5)	
Accuracy (Note 7)	$T_A = +25°C$	±0.2	±0.5		±0.2	±0.5		°C
	$T_A = -10°C$	±0.3			±0.3		±1.0	°C
	$T_A = T_{MAX}$	±0.4	±1.0		±0.4	±1.0		°C
	$T_A = T_{MIN}$	±0.4	±1.0		±0.4		±1.5	°C
Nonlinearity (Note 8)	$T_{MIN} \le T_A \le T_{MAX}$	**±0.18**		**±0.35**	**±0.15**		**±0.3**	°C
Sensor Gain (Average Slope)	$T_{MIN} \le T_A \le T_{MAX}$	**+10.0**	**+9.9, +10.1**		**+10.0**		**+9.9, +10.1**	mV/°C
Load Regulation (Note 3) $0 \le I_L \le 1$ mA	$T_A = +25°C$	±0.4	±1.0		±0.4	±1.0		mV/mA
	$T_{MIN} \le T_A \le T_{MAX}$	**±0.5**		**±3.0**	**±0.5**		**±3.0**	mV/mA
Line Regulation (Note 3)	$T_A = +25°C$	±0.01	±0.05		±0.01	±0.05		mV/V
	$4V \le V_S \le 30V$	**±0.02**		**±0.1**	**±0.02**		**±0.1**	mV/V
Quiescent Current (Note 9)	$V_S = +5V, +25°C$	56	67		56	67		µA
	$V_S = +5V$	**105**		**131**	**91**		**114**	µA
	$V_S = +30V, +25°C$	56.2	68		56.2	68		µA
	$V_S = +30V$	**105.5**		**133**	**91.5**		**116**	µA
Change of Quiescent Current (Note 3)	$4V \le V_S \le 30V, +25°C$	0.2	1.0		0.2	1.0		µA
	$4V \le V_S \le 30V$	**0.5**		**2.0**	**0.5**		**2.0**	µA
Temperature Coefficient of Quiescent Current		**+0.39**		**+0.5**	**+0.39**		**+0.5**	µA/°C
Minimum Temperature for Rated Accuracy	In circuit of *Figure 1*, $I_L = 0$	+1.5		+2.0	+1.5		+2.0	°C
Long Term Stability	$T_J = T_{MAX}$, for 1000 hours	±0.08			±0.08			°C

Note 1: Unless otherwise noted, these specifications apply: $-55°C \le T_J \le +150°C$ for the LM35 and LM35A; $-40° \le T_J \le +110°C$ for the LM35C [illegible] $0° \le T_J \le +100°C$ for the LM35D. $V_S = +5Vdc$ and $I_{LOAD} = 50$ µA, in the circuit of *Figure 2*. These specifications also apply from +2°C to T_{MAX} [illegible] *Figure 1*. Specifications in **boldface** apply over the full rated temperature range.

Note 2: Thermal resistance of the TO-46 package is 440°C/W, junction to ambient, and 24°C/W junction to case. Thermal resistance of the TO-92 [illegible] 180°C/W junction to ambient.

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Electrical Characteristics (Note 1) (Note 6) (Continued)

Parameter	Conditions	LM35			LM35C, LM35D			Units (Max.)
		Typical	Tested Limit (Note 4)	Design Limit (Note 5)	Typical	Tested Limit (Note 4)	Design Limit (Note 5)	
Accuracy, LM35, LM35C (Note 7)	$T_A = +25°C$	±0.4	±1.0		±0.4	±1.0		°C
	$T_A = -10°C$	±0.5			±0.5		±1.5	°C
	$T_A = T_{MAX}$	±0.8	±1.5		±0.8		±1.5	°C
	$T_A = T_{MIN}$	±0.8		±1.5	±0.8		±2.0	°C
Accuracy, LM35D (Note 7)	$T_A = +25°C$				±0.6	±1.5		°C
	$T_A = T_{MAX}$				±0.9		±2.0	°C
	$T_A = T_{MIN}$				±0.9		±2.0	°C
Nonlinearity (Note 8)	$T_{MIN} \le T_A \le T_{MAX}$	±0.3		±0.5	±0.2		±0.5	°C
Sensor Gain (Average Slope)	$T_{MIN} \le T_A \le T_{MAX}$	+10.0	+9.8, +10.2		+10.0		+9.8, +10.2	mV/°C
Load Regulation (Note 3) $0 \le I_L \le 1$ mA	$T_A = +25°C$	±0.4	±2.0		±0.4	±2.0		mV/mA
	$T_{MIN} \le T_A \le T_{MAX}$	±0.5		±5.0	±0.5		±5.0	mV/mA
Line Regulation (Note 3)	$T_A = +25°C$	±0.01	±0.1		±0.01	±0.1		mV/V
	$4V \le V_S \le 30V$	±0.02		±0.2	±0.02		±0.2	mV/V
Quiescent Current (Note 9)	$V_S = +5V$, +25°C	56	80		56	80		µA
	$V_S = +5V$	105		158	91		138	µA
	$V_S = +30V$, +25°C	56.2	82		56.2	82		µA
	$V_S = +30V$	105.5		161	91.5		141	µA
Change of Quiescent Current (Note 3)	$4V \le V_S \le 30V$, +25°C	0.2	2.0		0.2	2.0		µA
	$4V \le V_S \le 30V$	0.5		3.0	0.5		3.0	µA
Temperature Coefficient of Quiescent Current		+0.39		+0.7	+0.39		+0.7	µA/°C
Minimum Temperature for Rated Accuracy	In circuit of *Figure 1*, $I_L = 0$	+1.5		+2.0	+1.5		+2.0	°C
Long Term Stability	$T_J = T_{MAX}$, for 1000 hours	±0.08			±0.08			°C

Note 3: Regulation is measured at constant junction temperature, using pulse testing with a low duty cycle. Changes in output due to heating effects can be computed by multiplying the internal dissipation by the thermal resistance.

Note 4: Tested Limits are guaranteed and 100% tested in production.

Note 5: Design Limits are guaranteed (but not 100% production tested) over the indicated temperature and supply voltage ranges. These limits are not used to calculate outgoing quality levels.

Note 6: Specifications in boldface apply over the full rated temperature range.

Note 7: Accuracy is defined as the error between the output voltage and 10mv/°C times the device's case temperature, at specified conditions of voltage, current, and temperature (expressed in °C).

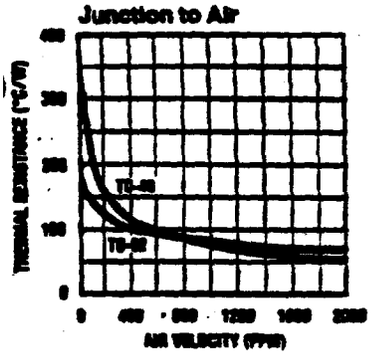
Note 8: Nonlinearity is defined as the deviation of the output-voltage-versus-temperature curve from the best-fit straight line, over the device's rated temperature range.

Note 9: Quiescent current is defined in the circuit of *Figure 1*.

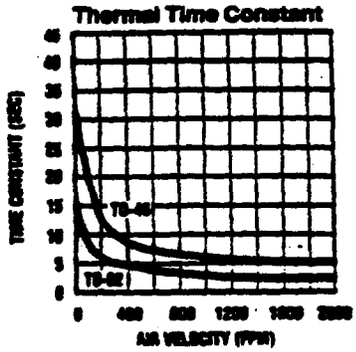
Note 10: Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. DC and AC electrical specifications do not apply when operating the device beyond its rated operating conditions. See Note 1.

Typical Performance Characteristics

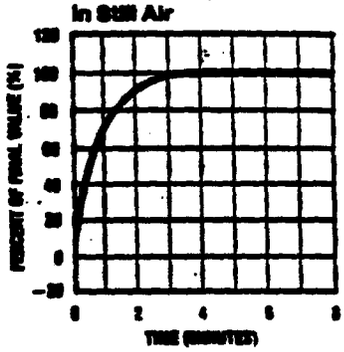
Thermal Resistance Junction to Air



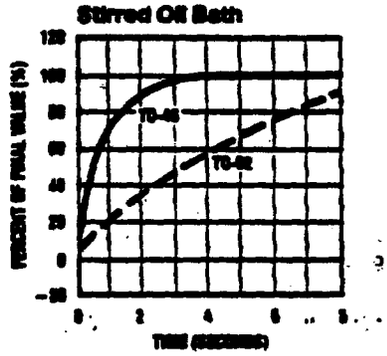
Thermal Time Constant



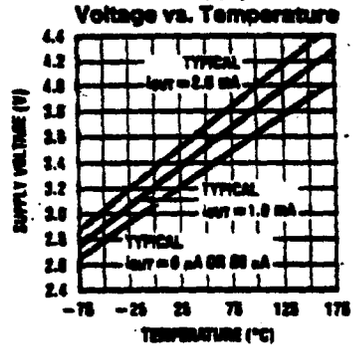
Thermal Response in Still Air



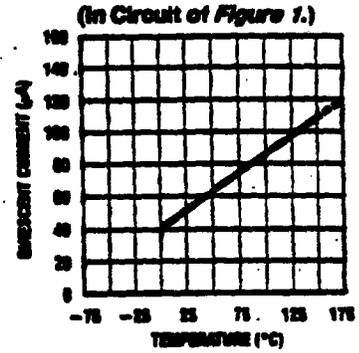
Thermal Response in Stirred Oil Bath



Minimum Supply Voltage vs. Temperature



Quiescent Current vs. Temperature (In Circuit of *Figure 1.*)



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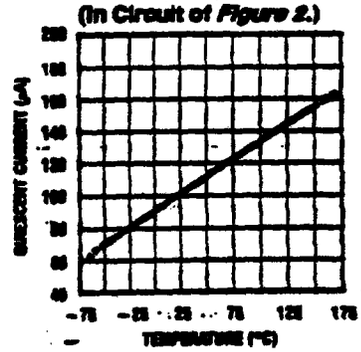
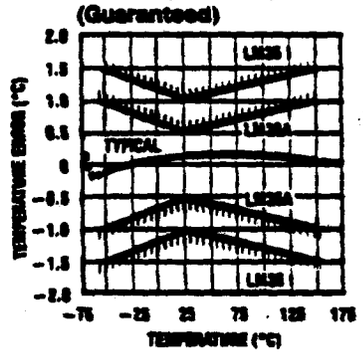
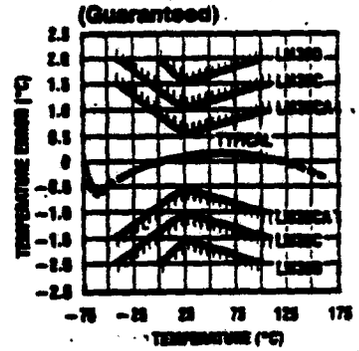
Quiescent Current vs. Temperature (In Circuit of *Figure 2.*)



Accuracy vs. Temperature (Guaranteed)



Accuracy vs. Temperature (Guaranteed)



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Applications

The LM35 can be applied easily in the same way as other integrated-circuit temperature sensors. It can be glued or cemented to a surface and its temperature will be within about 0.01°C of the surface temperature.

This presumes that the ambient air temperature is almost the same as the surface temperature; if the air temperature were much higher or lower than the surface temperature, the actual temperature of the LM35 die would be at an intermediate temperature between the surface temperature and the air temperature. This is especially true for the TO-92 plastic package, where the copper leads are the principal thermal path to carry heat into the device, so its temperature might be closer to the air temperature than to the surface temperature.

To minimize this problem, be sure that the wiring to the LM35, as it leaves the device, is held at the same temperature as the surface of interest. The easiest way to do this is to cover up these wires with a bead of epoxy which will insure that the leads and wires are all at the same temperature as the surface, and that the LM35 die's temperature will not be affected by the air temperature.

The TO-46 metal package can also be soldered to a metal surface or pipe without damage. Of course, in that case the V− terminal of the circuit will be grounded to that metal. Alternatively, the LM35 can be mounted inside a sealed-end metal tube, and can then be dipped into a bath or screwed into a threaded hole in a tank. As with any IC, the LM35 and accompanying wiring and circuits must be kept insulated and dry, to avoid leakage and corrosion. This is especially true if the circuit may operate at cold temperatures where condensation can occur. Printed-circuit coatings and varnishes such as Humiseal and epoxy paints or dips are often used to insure that moisture cannot corrode the LM35 or its connections.

These devices are sometimes soldered to a small light-weight heat fin, to decrease the thermal time constant and speed up the response in slowly-moving air. On the other hand, a small thermal mass may be added to the sensor, to give the steadiest reading despite small deviations in the air temperature.

Temperature Rise of LM35 Due To Self-heating (Thermal Resistance)

	TO-46, no heat sink	TO-46, small heat fin*	TO-92, no heat sink	TO-92, small heat fin**
Still air	400°C/W	100°C/W	180°C/W	140°C/W
Moving air	100°C/W	40°C/W	90°C/W	70°C/W
Still oil	100°C/W	40°C/W	90°C/W	70°C/W
Stirred oil	50°C/W	30°C/W	45°C/W	40°C/W
(Clamped to metal, Infinite heat sink)	(24°C/W)			

* Wakefield type 201, or 1" disc of 0.020" sheet brass, soldered to case, or similar.

** TO-92 package glued and leads soldered to 1" square of 1/16" printed circuit board with 2 oz. foil or similar.

Typical Applications (Continued)

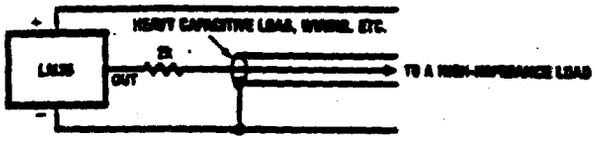

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FIGURE 3. LM35 with Decoupling from Capacitive Load

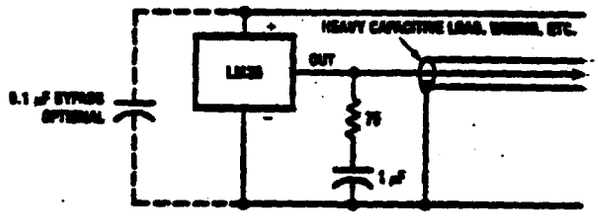

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FIGURE 4. LM35 with R-C Damper

CAPACITIVE LOADS

Like most micropower circuits, the LM35 has a limited ability to drive heavy capacitive loads. The LM35 by itself is able to drive 50 pf without special precautions. If heavier loads are anticipated, it is easy to isolate or decouple the load with a resistor; see *Figure 3*. Or you can improve the tolerance of capacitance with a series R-C damper from output to ground; see *Figure 4*.

When the LM35 is applied with a 200Ω load resistor as shown in *Figure 5, 6,* or *8*, it is relatively immune to wiring capacitance because the capacitance forms a bypass from ground to input, not on the output. However, as with any linear circuit connected to wires in a hostile environment, its performance can be affected adversely by intense electromagnetic sources such as relays, radio transmitters, motors with arcing brushes, SCR transients, etc, as its wiring can act as a receiving antenna and its internal junctions can act as rectifiers. For best results in such cases, a bypass capacitor from V_{IN} to ground and a series R-C damper such as 75Ω in series with 0.2 or 1 μF from output to ground are often useful. These are shown in *Figures 13, 14,* and *16*.

Typical Applications (Continued)

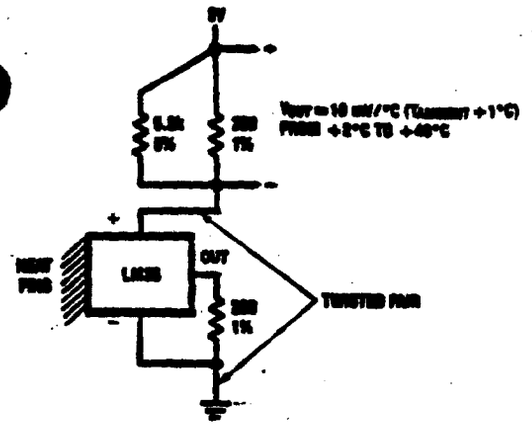

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FIGURE 5. Two-Wire Remote Temperature Sensor (Grounded Sensor)

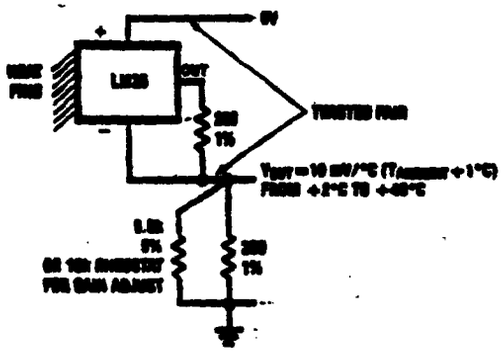

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FIGURE 6. Two-Wire Remote Temperature Sensor (Output Referred to Ground)

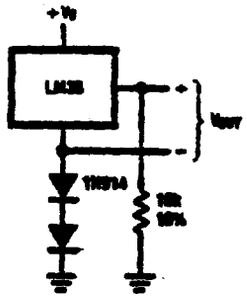

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FIGURE 7. Temperature Sensor, Single Supply, −55° to +150°C

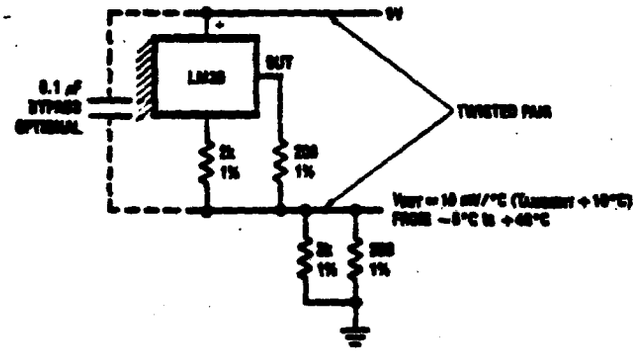

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FIGURE 8. Two-Wire Remote Temperature Sensor (Output Referred to Ground)

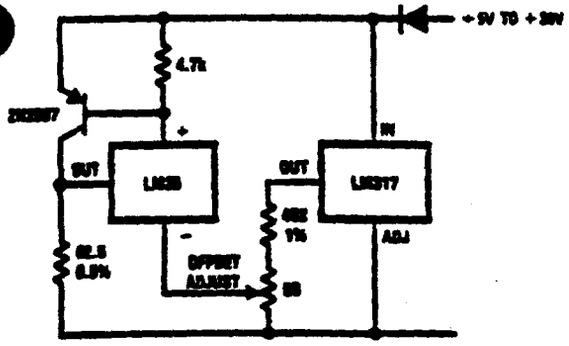

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FIGURE 9. 4-To-20 mA Current Source (0°C to +100°C)

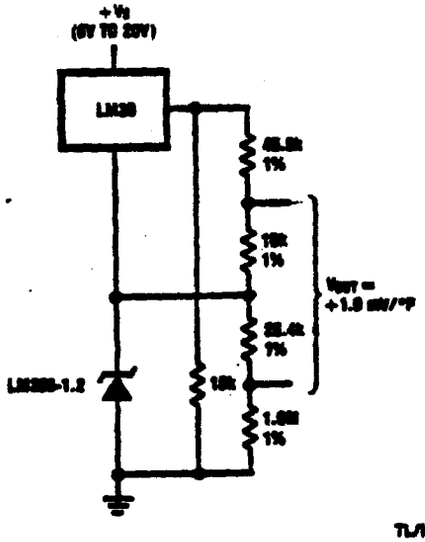

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FIGURE 10. Fahrenheit Thermometer

Typical Applications (Continued)

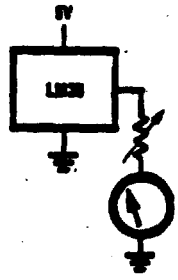

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FIGURE 11. Centigrade Thermometer (Analog Meter)

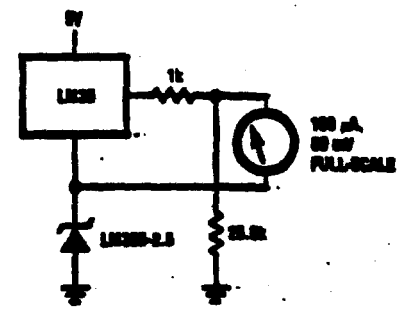

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FIGURE 12. Expanded Scale Thermometer (50° to 80° Fahrenheit, for Example Shown)

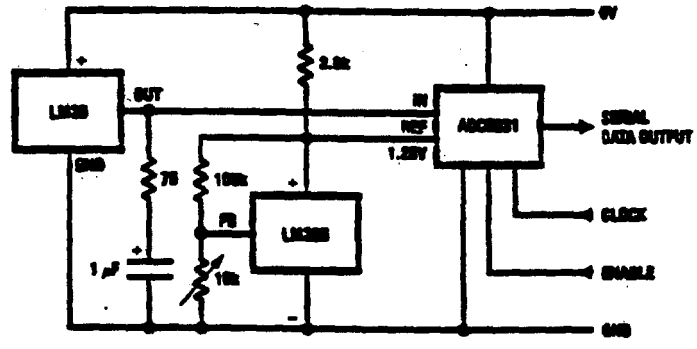

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FIGURE 13. Temperature To Digital Converter (Serial Output) (+ 128°C Full Scale)

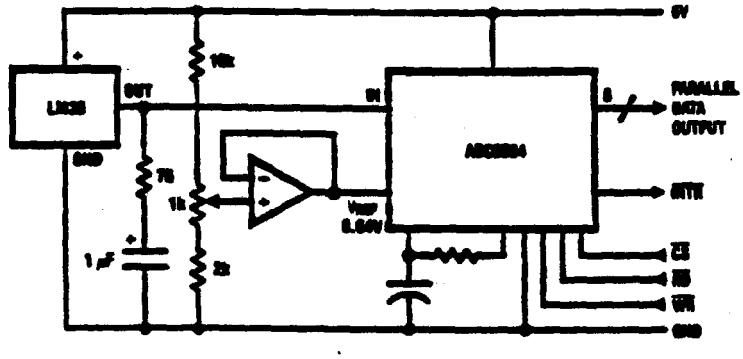

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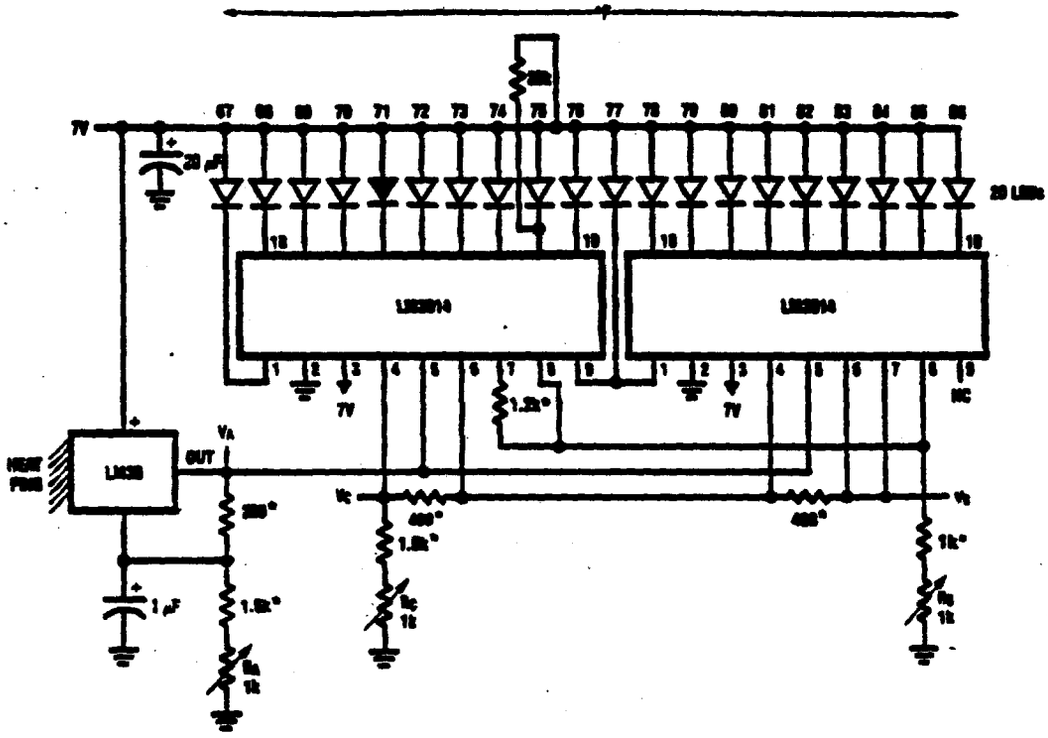
FIGURE 14. Temperature To Digital Converter (Parallel TRI-STATE® Outputs for Standard Data Bus to μP Interface) (128°C Full Scale)

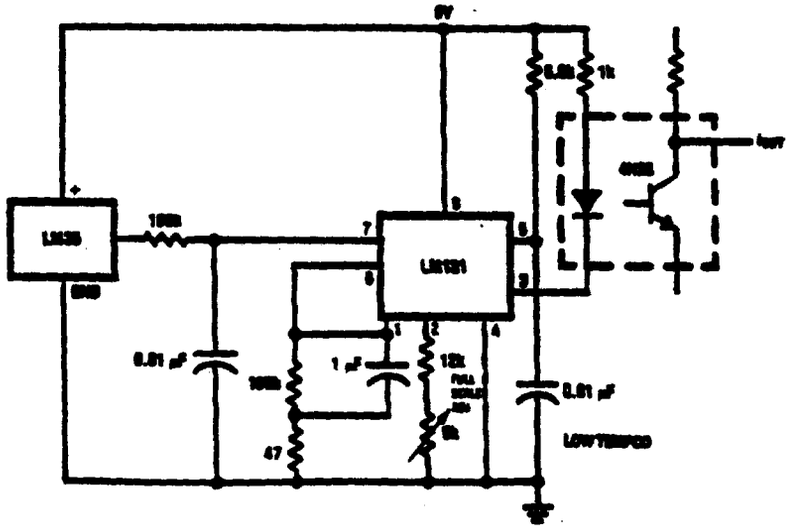
Typical Applications (Continued)



TL/H/5515–14

*=1% or 2% film resistor
-Trim R_B for V_B=3.075V
-Trim R_C for V_C=1.955V
-Trim R_A for V_A=0.075V + 100mV/°C × $T_{ambient}$
-Example, V_A=2.275V at 22°C

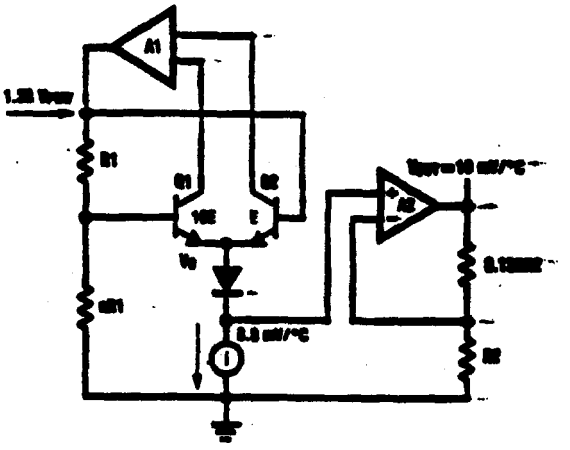
FIGURE 15. Bar-Graph Temperature Display (Dot Mode)



TL/H/5515–15

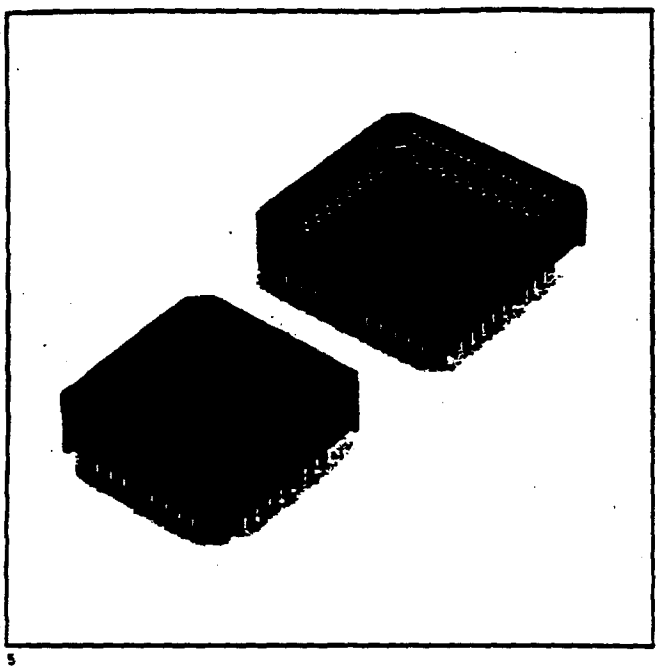
FIGURE 16. LM35 With Voltage-To-Frequency Converter And Isolated Output (2°C to +150°C; 20 Hz to 1500 Hz)

Block Diagram



TL/H/5510–21

Open Shroud PLCC



- Accepts JEDEC PLCCs in Registration MO-047 AA-AH
- Visual polarizing, PLCC corner, pin "1" I.D.
- Underside orientation to P.C. board plastic post feature option
- Contacts have discrete egress from socket bottom, prevents solder bridging and up-contact wicking
- Floor of socket has drainage holes for post solder cleaning
- Industry top extraction feature for package removal, some sizes
- Side package extraction feature, some sizes
- Stainless steel clip available for locking in PLCC package for high vibration — mechanical shock application

Physical

Insulation Material: Glass Fortified Polyethylene Teraphthalate
Flammability Rating: UL 94 V-0
Color: Black
Contact Material: Ni Ag Alloy 770
Contact Plating: 90/10 Bright SnPb Nickel Underplate

Electrical

Current Rating: 1 A
Insulation Resistance: $> 1 \times 10^{12}\ \Omega$
Withstanding Voltage: 1000 Vrms at Sea Level

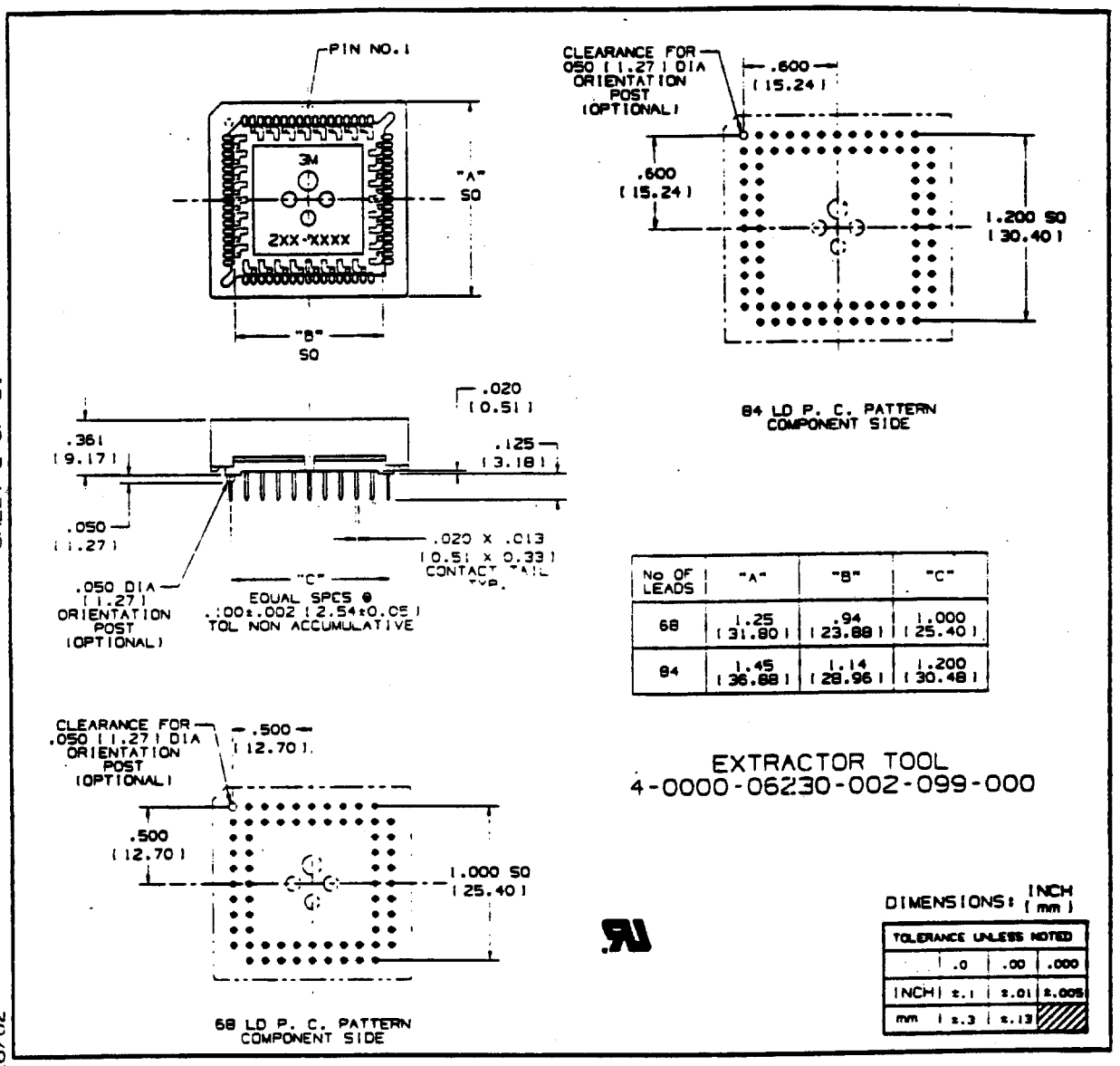
Environmental

Temperature Rating: −67°F to +221°F (−55°C to +105°C)

UL File No.: E68080

3M Electronic Products Division
PO Box 2963
Austin, TX 78769-2963

Open Shroud PLCC



No OF LEADS	"A"	"B"	"C"
68	1.25 [31.80]	.94 [23.88]	1.000 [25.40]
84	1.45 [36.88]	1.14 [28.96]	1.200 [30.48]

EXTRACTOR TOOL
4-0000-06230-002-099-000

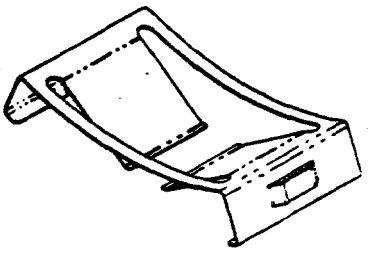
ORDER INFORMATION

No OF LEADS	SOCKET PART NUMBER	OPTIONAL RETAINER CLIP
68	2-0068-06234-05X-038-077	2-0068-06234-007-080-000
84	2-0084-06235-05X-038-077	2-0084-06235-007-080-000

X : 5 (WITH ORIENTATION POST)
: 6 (WITHOUT ORIENTATION POST)

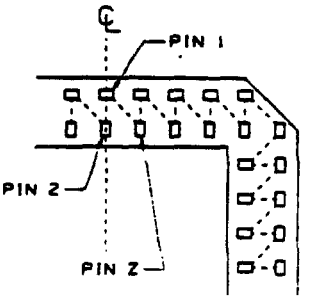
Open Shroud PLCC

SHEET 3 OF 3.



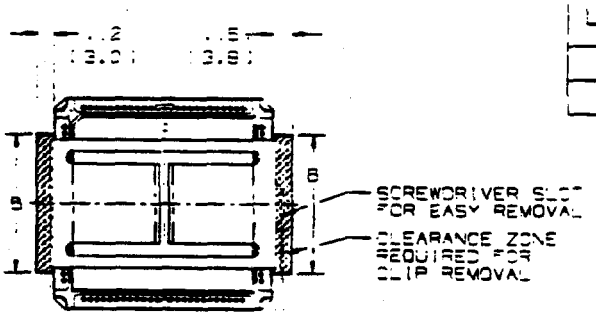
RETAINER CLIP

PIN OUT LOGIC
(VIEW FROM COMPONENT SIDE)

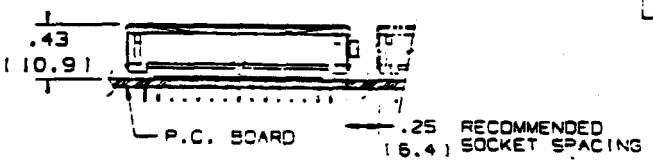


68 & 84
LEAD PLCC
(VIEW FROM COMPONENT SIDE)

LEAD COUNT	PIN NUMBERS Z
68	68
84	84



RETAINER CLIP		
LEAD COUNT	"A"	"B"
68	1.35 (34.26)	1.02 (25.89)
84	1.56 (39.59)	1.08 (27.41)



TS/0326/02

DIMENSIONS: INCH (mm)

TOLERANCE UNLESS NOTED			
	.0	.00	.000
INCH	±.1	±.01	±.005
mm	±.3	±.13	

LT117A/LT317A
LM117/LM317

Positive Adjustable Regulator

FEATURES

- *Guaranteed* 1% Output Voltage Tolerance
- *Guaranteed* max. 0.01%/V Line Regulation
- *Guaranteed* max. 0.3% Load Regulation
- Min. 1.5A Output Current
- 100% Burn-in in Thermal Overload

APPLICATIONS

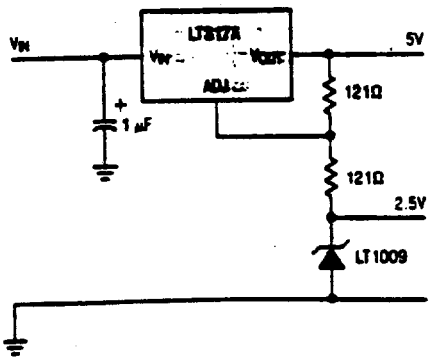
- Wide Range Power Supplies
- Constant Current Supplies
- Voltage Programmable Supplies

DESCRIPTION

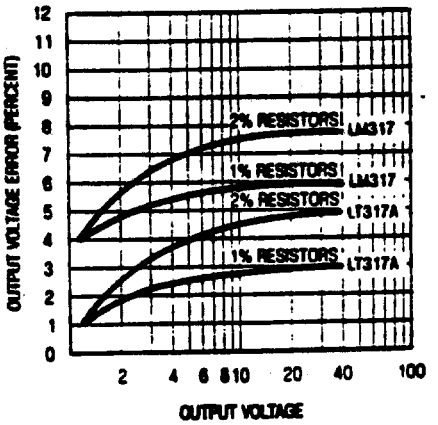
The LT117A Series are 3-terminal positive adjustable voltage regulators which offer improved performance over earlier devices. A major feature of the LT117A is the output voltage tolerance is guaranteed at a maximum of ± 1%, allowing an overall power supply tolerance to be better than 3% using inexpensive 1% resistors. Line and load regulation performance has been improved as well. Additionally, the LT117A reference voltage is guaranteed not to exceed 2% when operating over the full load, line and power dissipation conditions. The LT117A adjustable regulators offer an improved solution for all positive voltage regulator requirements with load currents up to 1.5 amps.

4

Regulator with Reference



Output Voltage Error



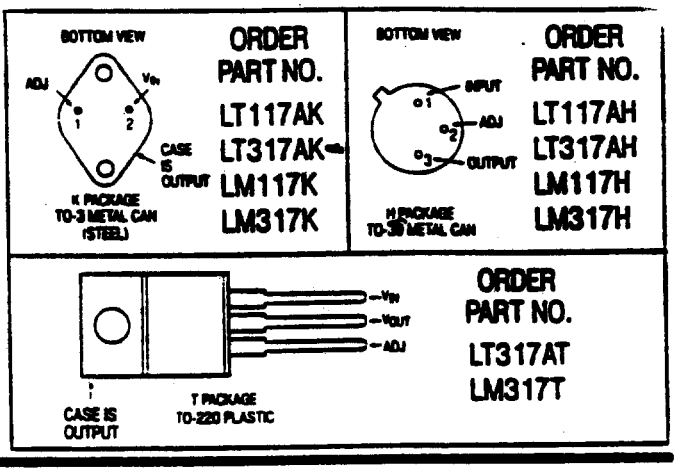
ABSOLUTE MAXIMUM RATINGS

Power Dissipation ..... Internally Limited
Input to Output Voltage Differential 40V
Operating Junction Temperature Range
LT117A/LM117 ..... −55°C to 150°C
LT317A/LM317 ..... 0°C to 125°C
Storage Temperature Range
LT117A/LM117 ..... −65°C to 150°C
LT317A/LM317 ..... −65°C to 150°C
Lead Temperature (Soldering, 10 sec.)..... 300°C

PRECONDITIONING:

100% THERMAL LIMIT BURN-IN

PACKAGE/ORDER INFORMATION



ELECTRICAL CHARACTERISTICS (See Note 1) LT117A/LM117

SYMBOL	PARAMETER	CONDITIONS		LT117A MIN	LT117A TYP	LT117A MAX	LM117 MIN	LM117 TYP	LM117 MAX	UNITS
V_{REF}	Reference Voltage	I_{OUT} = 10mA T_J = 25°C		1.238	1.250	1.262				V
		3V ≤ (V_{IN} − V_{OUT}) ≤ 40V 10mA ≤ I_{OUT} ≤ I_{max}, P ≤ P_{max}	●	1.225	1.250	1.270	1.20	1.25	1.30	V
$\frac{\Delta V_{OUT}}{\Delta V_{IN}}$	Line Regulation	3V ≤ (V_{IN} − V_{OUT}) ≤ 40V. (See Note 2)			0.005	0.01		0.01	0.02	%/V
			●		0.01	0.02		0.02	0.05	%
$\frac{\Delta V_{OUT}}{\Delta I_{OUT}}$	Load Regulation	10mA ≤ I_{OUT} ≤ I_{max} (See Note 2) V_{OUT} ≤ 5V V_{OUT} ≥ 5V			5 0.1	15 0.3		5 0.1	15 0.3	mV %
		V_{OUT} ≤ 5V V_{OUT} ≥ 5V	● ●		20 0.3	50 1		20 0.3	50 1	mV %
	Thermal Regulation	T_A = 25°C, 20msec Pulse			0.002	0.02		0.03	0.07	%/W
	Ripple Rejection	V_{OUT} = 10V, f = 120Hz C_{ADJ} = 0	●		65			65		dB
		C_{ADJ} = 10μF	●	66	80		66	80		dB
I_{ADJ}	Adjust Pin Current		●		50	100		50	100	μA
ΔI_{ADJ}	Adjust Pin Current Change	10mA ≤ I_{OUT} ≤ I_{max} 2.5V ≤ (V_{IN} − V_{OUT}) ≤ 40V	●		0.2	5		0.2	5	μA
I_{min}	Minimum Load Current	(V_{IN} − V_{OUT}) = 40V	●		3.5	5		3.5	5	mA
	Current Limit	(V_{IN} − V_{OUT}) ≤ 15V K Package H Package	● ●	1.5 0.5	2.2 0.8		1.5 0.5	2.2 0.8		A A
		(V_{IN} − V_{OUT}) = 40V, T_J = 25°C K Package H Package		0.3 0.15	0.5 0.2		0.3 0.15	0.4 0.2		A A
$\frac{\Delta V_{OUT}}{\Delta Temp}$	Temperature Stability	−55°C ≤ T_J ≤ +150°C			1	2		1		%
$\frac{\Delta V_{OUT}}{\Delta Time}$	Long Term Stability	T_A = 125°C			0.3	1		0.3	1	%
e_n	RMS Output Noise (% of V_{OUT})	T_A = 25°C, 10Hz ≤ f ≤ 10kHz			0.001			0.001		%
Θ_{jc}	Thermal Resistance Junction to Case	H Package K Package			12 2.3	15 3		12 2.3	15 3	

ECTRICAL CHARACTERISTICS (See Note 1) LT317A/LM317

SYMBOL	PARAMETER	CONDITIONS		LT317A MIN	LT317A TYP	LT317A MAX	LM317 MIN	LM317 TYP	LM317 MAX	UNITS
V_{REF}	Reference Voltage	I_{OUT} = 10mA T_J = 25°C		1.238	1.250	1.262				V
		3V ≤ (V_{IN} − V_O) ≤ 40V 10mA ≤ I_{OUT} ≤ I_{max}, P ≤ P_{max}	●	1.225	1.250	1.275	1.20	1.25	1.30	V
$\frac{\Delta V_{OUT}}{\Delta V_{IN}}$	Line Regulation	3V ≤ (V_{IN} − V_{OUT}) ≤ 40V, (See Note 2)			0.005	0.01		0.01	0.04	%/V
			●		0.01	0.02		0.02	0.07	%/V
$\frac{\Delta V_{OUT}}{\Delta I_{OUT}}$	Load Regulation	10mA ≤ I_{OUT} ≤ I_{max}, (See Note 2) V_O ≤ 5V V_O ≥ 5V			5 0.1	25 0.5		5 0.1	25 0.5	mV %
		V_O ≤ 5V V_O ≥ 5V	● ●		20 0.3	50 1		20 0.3	70 1.5	mV %
	Thermal Regulation	T_A = 25°C, 20msec Pulse	●		0.002	0.02		0.04	0.07	%/W
	Ripple Rejection	V_O = 10V, f = 120Hz C_{ADJ} = 0			65			65		dB
		C_{ADJ} = 10μF		66	80		66	80		dB
I_{ADJ}	Adjust Pin Current				50	100		50	100	μA
ΔI_{ADJ}	Adjust Pin Current Change	10mA ≤ I_{OUT} ≤ I_{max} 2.5V ≤ (V_{IN} − V_{OUT}) ≤ 40V	●		0.2	5		0.2	5	μA
I_{min}	Minimum Load Current	(V_{IN} − V_{OUT}) = 40V	●		3.5	10		3.5	10	mA
	Current Limit	(V_{IN} − V_{OUT}) ≤ 15V K and T Package H Package	● ●	1.5 0.5	2.2 0.8		1.5 0.5	2.2 0.8		A A
		(V_{IN} − V_{OUT}) = 40V, T_J = 25°C K and T Package H Package		0.15 0.075	0.4 0.2		0.15 0.075	0.4 0.2		A A
$\frac{\Delta V_{OUT}}{\Delta Temp}$	Temperature Stability	0°C ≤ T_J ≤ 125°C			1	2		1		%
$\frac{\Delta V_{OUT}}{\Delta time}$	Long Term Stability	T_A = 125°C			0.3	1		0.3	1	%
e_n	RMS Output Noise (% of V_{OUT})	T_A = 25°C, 10Hz ≤ f ≤ 10kHz			0.001			0.001		%
θ_{JC}	Thermal Resistance Junction to Case	H Package K Package T Package			12 2.3 4	15 3 5		12 2.3 4	15 3	°C/W °C/W °C/W

The ● denotes the specifications which apply over the full operating temperature range.

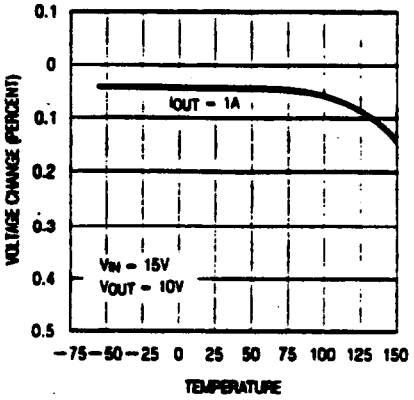
Note 1: Unless otherwise specified, these specifications apply for V_{IN} − V_{OUT} = 5V; and I_{OUT} = 0.1A for the TO-39 and I_{OUT} = 0.5A for the TO-3 and TO-220 packages. Although power dissipation is internally limited, these specifications are applicable for power dissipations of 2W for the TO-39, and 20W for the TO-3 and TO-220. I_{MAX} is 1.5A for the TO-3 and TO-220 packages and 0.5A for the TO-39.

Note 2: Regulation is measured at constant junction temperature, using pulse testing with a low duty cycle. Changes in output voltage due to heating effects are covered under the specification for thermal regulation. Load regulation is measured on the output pin at a point ⅛" below the base of the K and H package and at the junction of the wide and narrow portion of the lead on the T package.

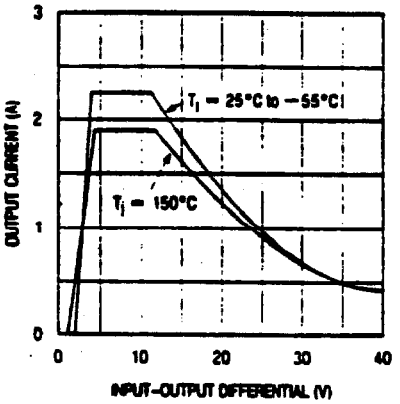
4

TYPICAL PERFORMANCE CHARACTERISTICS

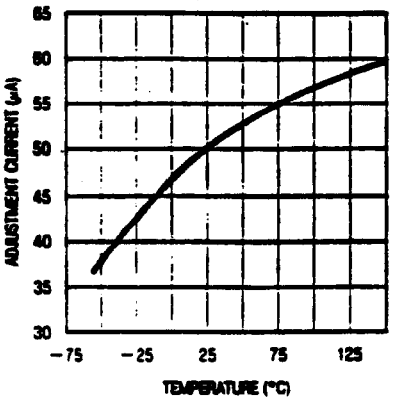
Load Regulation



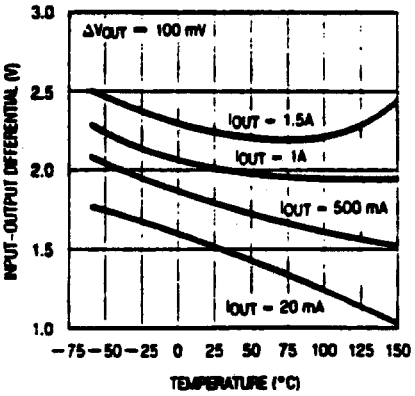
Current Limit (TO-3 and TO-220 Package)



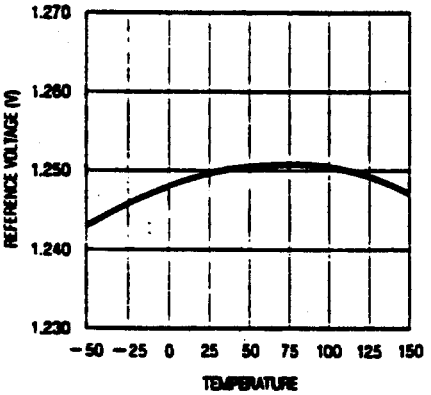
Adjustment Current



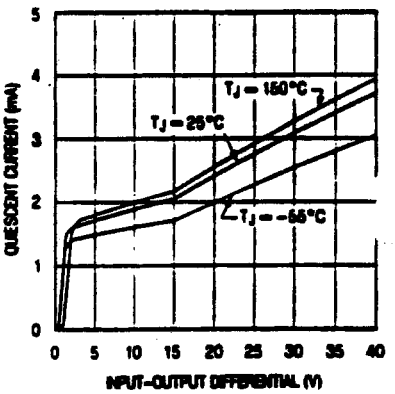
Dropout Voltage



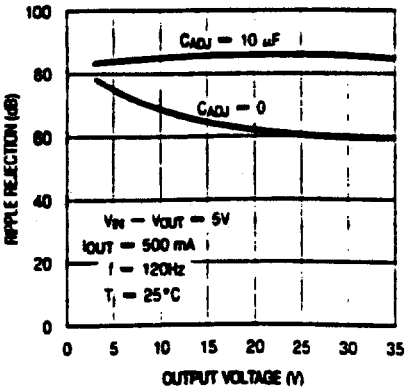
Temperature Stability



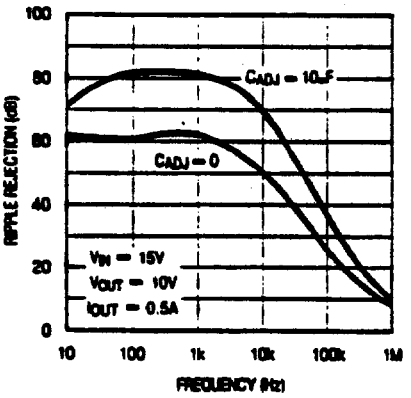
Minimum Operating Current



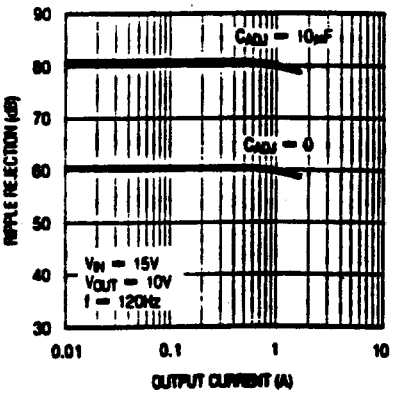
Ripple Rejection



Ripple Rejection (dB)



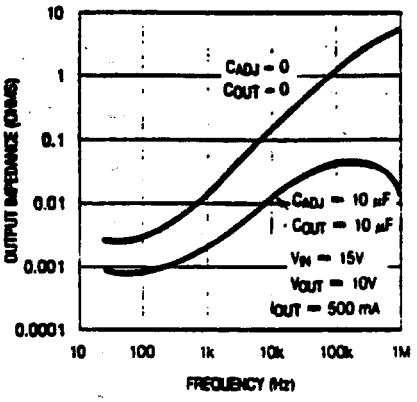
Ripple Rejection



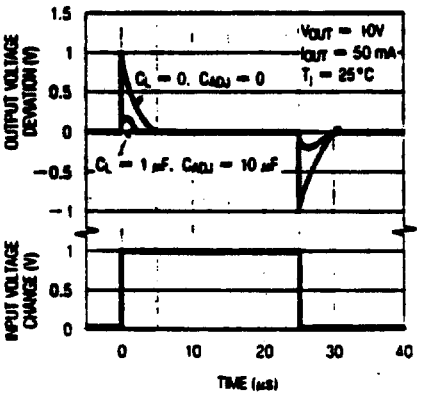
LINEAR TECHNOLOGY

TYPICAL PERFORMANCE CHARACTERISTICS

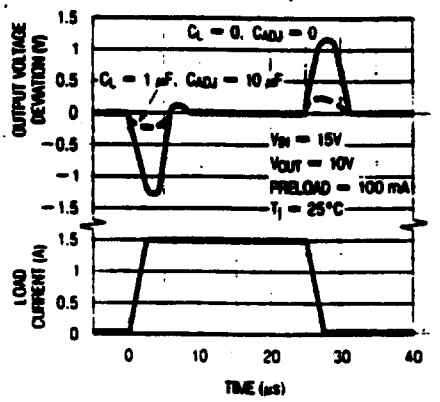
Output Impedance



Line Transient Response



Load Transient Response



APPLICATIONS INFORMATION

General: The LT117A develops a 1.25V reference voltage between the output and the adjustable terminal (see Figure 1). By placing a resistor, R1, between these two terminals, a constant current is caused to flow through R1 and down through R2 to set the overall output voltage. Normally this current is the specified minimum load current of 5mA or 10mA.

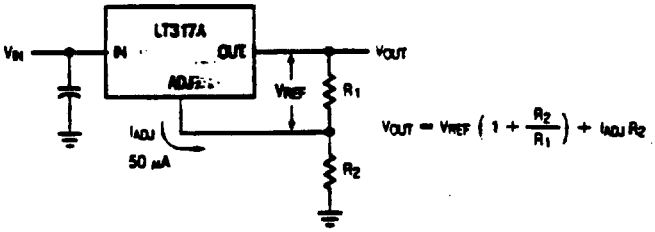


Figure 1

Because I_{ADJ} is very small and constant when compared with the current through R1, it represents a small error and can usually be ignored.

It is easily seen from the above equation, that even if the resistors were of exact value, the accuracy of the output is limited by the accuracy of V_{REF}. Earlier adjustable regulators had a reference tolerance of ±4%. This tolerance is dangerously close to the ±5% supply tolerance required in many logic and analog systems. Further, many 1% resistors can drift 0.01%/°C adding another 1% to the output voltage tolerance.

For example, using 2% resistors and ±4% tolerance for V_{REF}, calculations will show that the expected range of a 5V regulator design would be 4.66V < V_{OUT} < 5.36V or approximately ±7%. If the same example were used for a 15V regulator, the expected tolerance would be ±8%. With these results most applications require some method of trimming, usually a trim pot. This solution is both expensive and not conducive to volume production.

> One of the enhancements of Linear Technology's adjustable regulators over existing devices is tightened initial tolerance. This allows relatively inexpensive 1% or 2% film resistors to be used for R1 and R2 while setting output voltage within an acceptable tolerance range.

With a guaranteed 1% reference, a 5V power supply design, using ±2% resistors, would have a worst case manufacturing tolerance of ±4%. If 1% resistors were used, the tolerance would drop to ±2.5%. A plot of the worst case output voltage tolerance as a function of resistor tolerance is shown on the front page.

For convenience, a table of standard 1% resistor values is shown below.

Table of ½% and 1% Standard Resistance Values

1.00	1.47	2.15	3.16	4.64	6.81
1.02	1.50	2.21	3.24	4.75	6.98
1.05	1.54	2.26	3.32	4.87	7.15
1.07	1.58	2.32	3.40	4.99	7.32
1.10	1.62	2.37	3.48	5.11	7.50
1.13	1.65	2.43	3.57	5.23	7.68
1.15	1.69	2.49	3.65	5.36	7.87
1.18	1.74	2.55	3.74	5.49	8.06
1.21	1.78	2.61	3.83	5.62	8.25
1.24	1.82	2.67	3.92	5.76	8.45
1.27	1.87	2.74	4.02	5.90	8.66
1.30	1.91	2.80	4.12	6.04	8.87
1.33	1.96	2.87	4.22	6.19	9.09
1.37	2.00	2.94	4.32	6.34	9.31
1.40	2.05	3.01	4.42	6.49	9.53
1.43	2.10	3.09	4.53	6.65	9.76

Standard Resistance Values are obtained from the Decade Table by multiplying by multiples of 10. As an example, 1.21 can represent 1.21Ω, 12.1Ω, 121Ω, 1.21KΩ etc.

Bypass Capacitors: Input bypassing using a 1μF tantalum or 25μF electrolytic is recommended when the input filter capacitors are more than 5 inches from the device. Improved ripple rejection (80 dB) can be accomplished by adding a 10μF capacitor from the adjust pin to ground. Increasing the size of the capacitor to 20μF will help ripple rejection at low output voltage since the reactance of this capacitor should be small compared to the voltage setting resistor, R2. For improved AC transient response and to prevent the possibility of oscillation due to unknown reactive load, a 1μF capacitor is also recommended at the output. Because of their low impedance at high frequencies, the best type of capacitor to use is solid tantalum.

Protection Diodes: The LT117A/317A do not require a protection diode from the adjustment terminal to the output (see Figure 2). Improved internal circuitry eliminates the need for this diode when the adjustment pin is bypassed with a capacitor to improve ripple rejection.

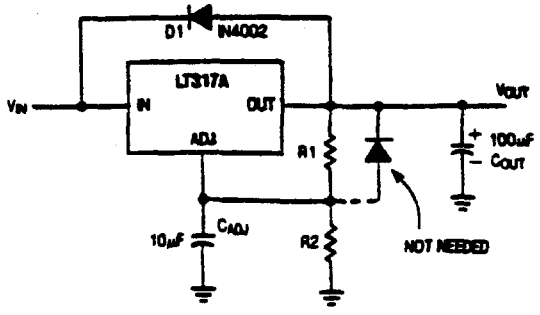


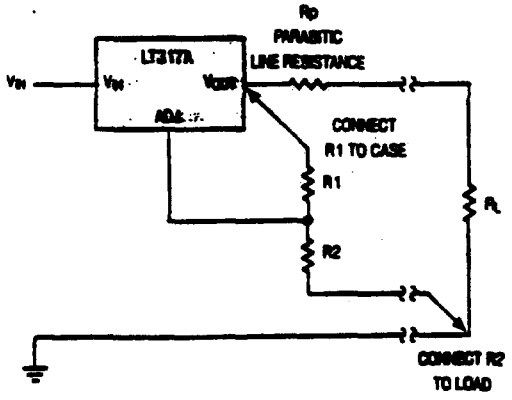
Figure 2

If a very large output capacitor is used, such as a 100μF shown in Figure 2, the regulator could be damaged or destroyed if the input is accidentally shorted to ground or crowbarred. This is due to the output capacitor discharging into the output terminal of the regulator. To prevent damage a diode D1 is recommended to safely discharge the capacitor.

Load Regulation: Because the LT117A is a three-terminal device, it is not possible to provide true remote load sensing. Load regulation will be limited by the resistance of the wire connecting the regulator to the load. For the data sheet specification, regulation is measured at the bottom of the package. Negative side sensing is a true Kelvin connection, with the bottom of the output divider returned to the negative side of the load. Although it may not be immediately obvious, best load regulation is obtained when the top of the divider is connected *directly* to the case *not to the load*. This is illustrated in *Figure 3*. If R1 were connected to the load, the effective resistance between the regulator and the load would be

$$R_p \times \left(\frac{R2 + R1}{R1}\right), R_p = \text{Parasitic Line Resistance.}$$

Connected as shown, R_p is not multiplied by the divider ratio. R_p is about 0.004Ω per foot using 16 guage wire. This translates to 4mV/ft at 1A load current, so it important to keep the positive lead between regulator and load as short as possible.

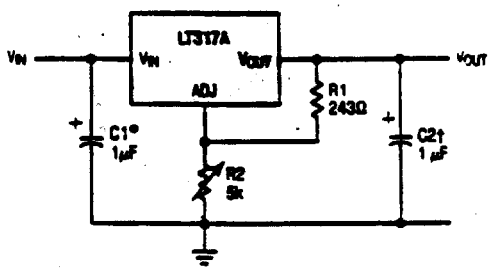


Connections for Best Load Regulation

Figure 3

TYPICAL APPLICATIONS

1.2V–25V Adjustable Regulator

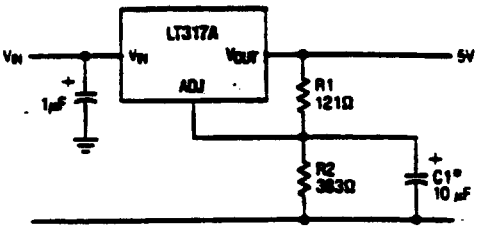


Optional — improves transient response

Needed if device is far from filter capacitors

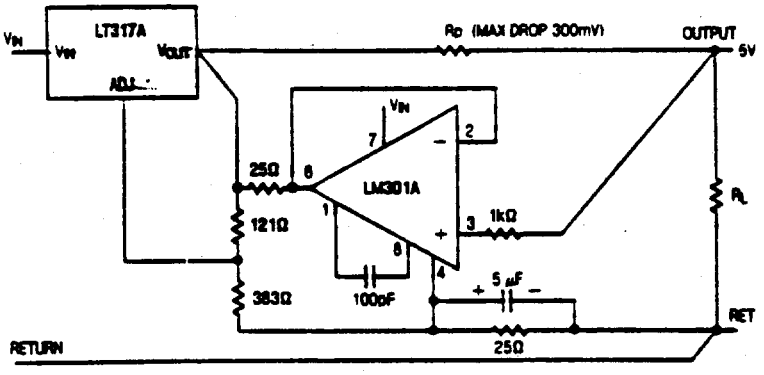
$$V_{OUT} = 1.25V\left(1 + \frac{R2}{R1}\right)$$

Improving Ripple Rejection

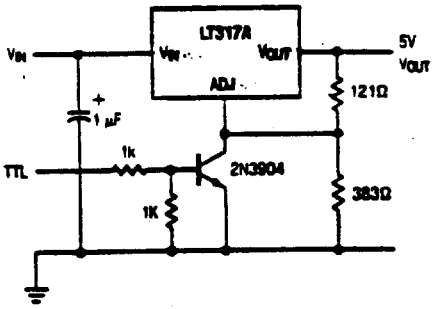


*C1 IMPROVES RIPPLE REJECTION
X_C SHOULD BE SMALL COMPARED TO R2

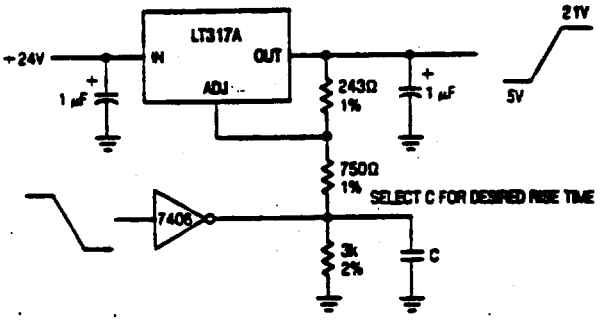
Remote Sensing



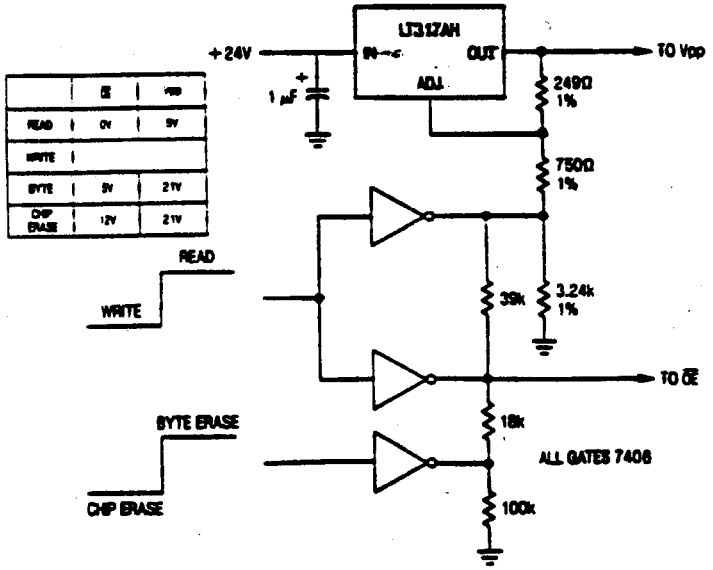
5V Regulator with Shut Down



21V Programming Supply for UV PROM/EEROM

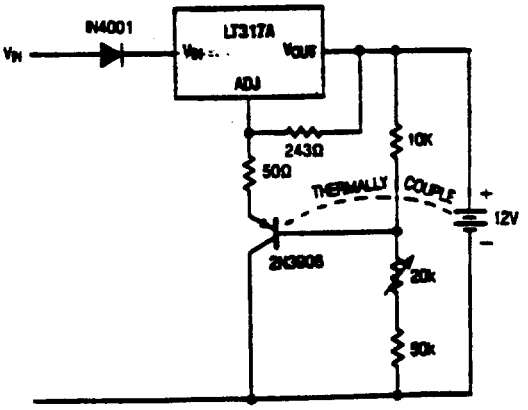


2816 EEPROM Supply Programmer for Read/Write Control



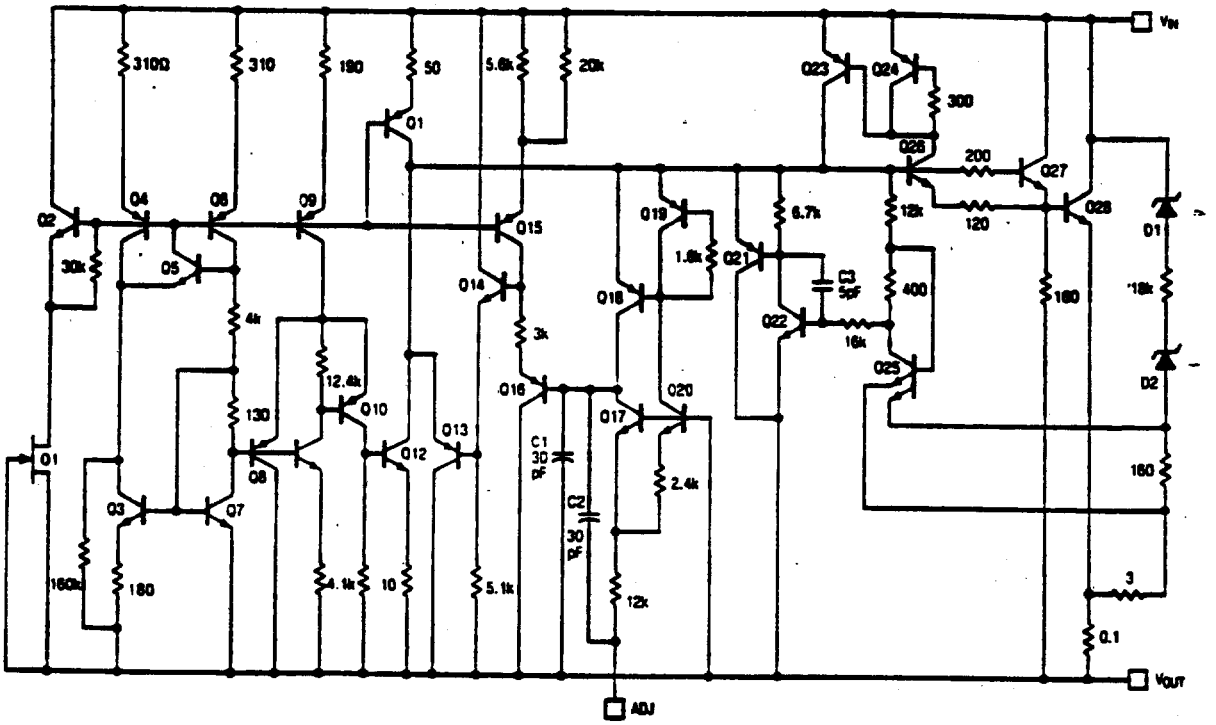
	OE	VPP
READ	0V	5V
WRITE		
BYTE	5V	21V
CHIP ERASE	12V	21V

Temperature Compensated Lead Acid Battery Charger



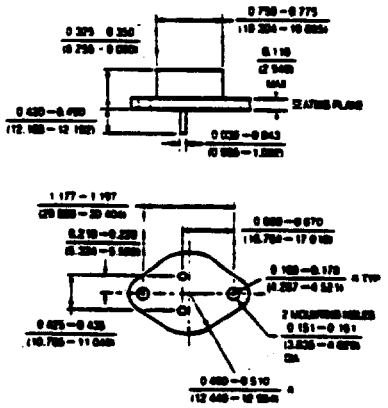
SCHEMATIC DIAGRAM

LT117A/LT317A



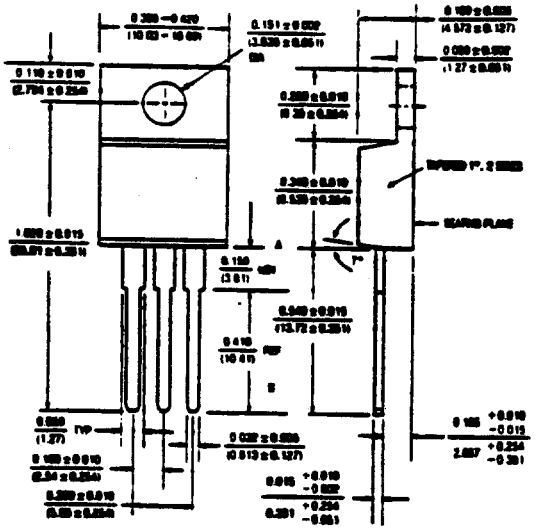
PACKAGE DESCRIPTION

K Package TO-3 STEEL Metal Can



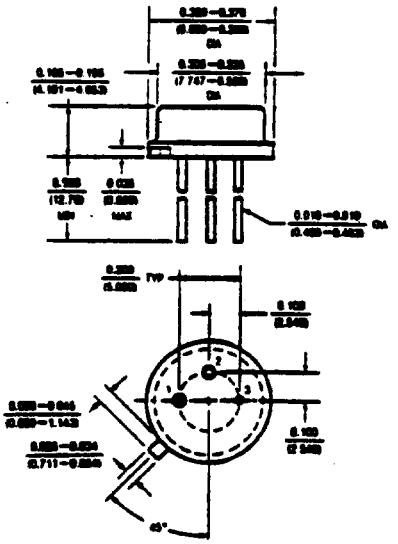
	T_j max.	θ_{ja}	θ_{jc}
117A 117	150°C	35°C/W	3°C/W
317A 317	125°C	35°C/W	3°C/W

T Package TO-220 Plastic



	T_j max.	θ_{ja}	θ_{jc}
317A 317	125°C	50°C/W	5°C/W

H Package 3-Lead Metal Can



	T_j max.	θ_{ja}	θ_{jc}
117A 117	150°C	150°C/W	15°C/W
317A 317	125°C	150°C/W	15°C

LINEAR TECHNOLOGY

24

FDC TYPE

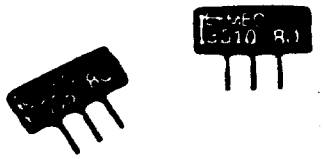
■ SPECIFICATIONS

Part Number	Impedance	Delay Time	Rise Time	Bandwidth
[redacted]	50Ω ± 10%	0.1 ns ± 50 ps	150 ps or less	2.5 GHz or more
[redacted]		0.2 ns ± 50 ps	150 ps or less	2.0 GHz or more
[redacted]		0.3 ns ± 50 ps	150 ps or less	2.0 GHz or more
[redacted]		0.4 ns ± 50 ps	150 ps or less	2.0 GHz or more
[redacted]		0.5 ns ± 50 ps	200 ps or less	1.5 GHz or more
[redacted]		0.6 ns ± 50 ps	200 ps or less	1.5 GHz or more
[redacted]		0.7 ns ± 50 ps	200 ps or less	1.5 GHz or more
[redacted]		0.8 ns ± 50 ps	200 ps or less	1.0 GHz or more
[redacted]		0.9 ns ± 50 ps	200 ps or less	1.0 GHz or more
[redacted]		1.0 ns ± 50 ps	200 ps or less	1.0 GHz or more
[redacted]		1.1 ns ± 50 ps	250 ps or less	900 MHz or more
[redacted]		1.2 ns ± 50 ps	250 ps or less	900 MHz or more
[redacted]		1.3 ns ± 50 ps	250 ps or less	900 MHz or more
[redacted]		1.4 ns ± 50 ps	250 ps or less	900 MHz or more
[redacted]		1.5 ns ± 50 ps	250 ps or less	900 MHz or more
[redacted]		1.6 ns ± 50 ps	300 ps or less	800 MHz or more
[redacted]		1.7 ns ± 50 ps	300 ps or less	800 MHz or more
[redacted]		1.8 ns ± 50 ps	300 ps or less	800 MHz or more
[redacted]		1.9 ns ± 50 ps	300 ps or less	800 MHz or more
[redacted]		2.0 ns ± 50 ps	300 ps or less	800 MHz or more
FDC-2505		2.5 ns ± 0.20 ns	500 ps or less	450 MHz or more
[redacted]		3.0 ns ± 0.20 ns	500 ps or less	450 MHz or more
[redacted]		3.5 ns ± 0.25 ns	600 ps or less	400 MHz or more
[redacted]		4.0 ns ± 0.30 ns	700 ps or less	350 MHz or more
[redacted]		4.5 ns ± 0.30 ns	700 ps or less	350 MHz or more
[redacted]		5.0 ns ± 0.30 ns	700 ps or less	350 MHz or more
[redacted]	100Ω ± 10%	0.5 ns ± 0.10 ns	300 ps or less	800 MHz or more
[redacted]		1.0 ns ± 0.10 ns	300 ps or less	800 MHz or more
[redacted]		1.5 ns ± 0.15 ns	400 ps or less	550 MHz or more
[redacted]		2.0 ns ± 0.20 ns	400 ps or less	550 MHz or more
FDC-2510		2.5 ns ± 0.20 ns	500 ps or less	450 MHz or more
FDC-3010		3.0 ns ± 0.20 ns	500 ps or less	450 MHz or more
FDC-3510		3.5 ns ± 0.25 ns	600 ps or less	400 MHz or more
FDC-4010		4.0 ns ± 0.30 ns	700 ps or less	350 MHz or more
FDC-4510		4.5 ns ± 0.30 ns	700 ps or less	350 MHz or more
FDC-5010		5.0 ns ± 0.30 ns	700 ps or less	350 MHz or more

FDC TYPE

Single-In Line Ultra High-Speed Fixed Delay Line

FDC type is an ultra high-speed compact designed fixed delay line with our high performance and hig density delay line elements housed in a single-in line package.
Units are 0.236-inch high, 0.488-inch long and 0.098-inch wide and suitable for high-density installation. It can be fully matched to high-speed logical elements such as ECL 100K, 10KH and 10K series and has extensive range of the applications including analog signal circuit.
The pin arrangement of the FDC type is the same (except height) as that of our fixed delay line FDD type so that the delay time can be adjusted at intervals of 500ps over the range of 0.5ns to 10ns.
(However, adjustment is possible at interval of 100ps over the range of 100ps to 2ns for the 50 ohms impedance systems.)

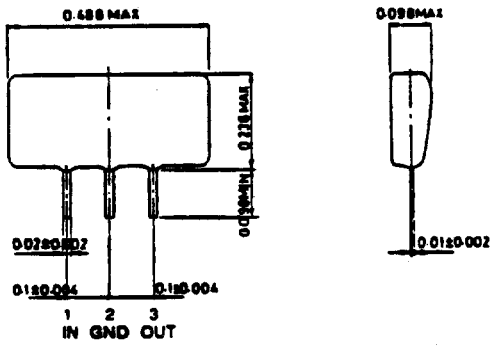


■ COMMON SPECIFICATIONS

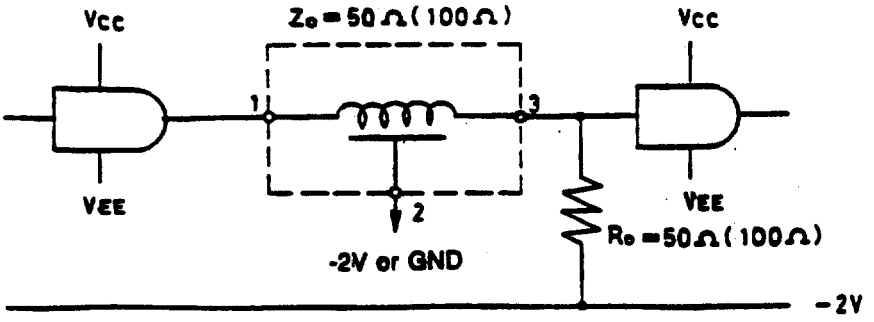
- Distortion of waveform: Over shoot / Pre shoot under ± 20%
- Delay time temp. coefficient: ±100ppm/°C
- Insulation resistance: DC 50V, 100MΩ
- Durable voltage: DC 50V, 1 minute
- Operating temperature range: −10°C ~ +80°C
- Storage temperature range: −40°C ~ +120°C

■ OUTER DIMENSIONS AND PIN ARRANGEMENT

Unit: inch



■ APPLICATION TO ECL



FUSES
SUBMINIATURE

PICO II™ Fast-Acting Type

ELECTRICAL CHARACTERISTICS:

RATING	AMPERAGE	BLOW TIME
100%	1/16—15	4 hours, minimum
200%	1/16—10	5 seconds, maximum
200%	12—15	10 seconds, maximum

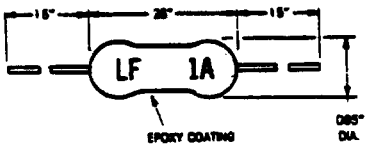
APPROVALS: Recognized under the Components Program of Underwriters Laboratories through 10 amperes. Certified by CSA through 7 amperes.

PATENTS: U.S. Patent #4,385,281.

FUSES TO MIL SPEC: See Military Section.

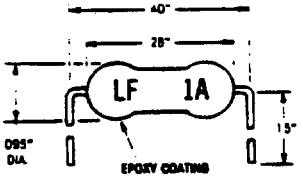
OPTIONAL COLOR CODING: PICO II™ Fuses can be color-coded per IEC (International Electrotechnical Commission) Standards Publication 127. The first three bands indicate current rating in milliamperes. The fourth and wider band designates the time-current characteristics of the fuse (red is fast-acting).

251 000 Series (Non color-coded)



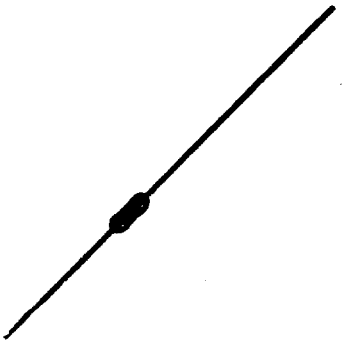
NOTE: Leads are solder-coated copper, .025" diameter for 1/16 — 10A, .032" diameter for 12 — 15A.

252 000 Series (Non color-coded)



NOTE: LF and amperage rating are LASER-MARKED on both sides of all non color-coded PICO II™ fuses.

251 000 Series — Axial Leads



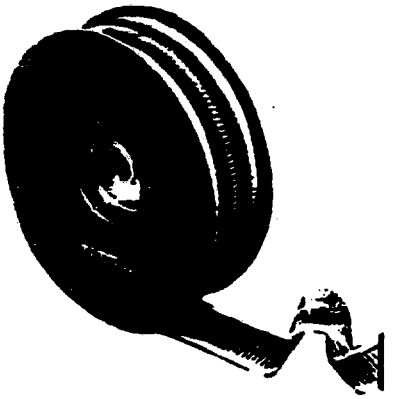
252 000 Series — Radial Leads

AMPERE RATING	FIRST SIGNIFICANT FIGURE	SECOND SIGNIFICANT FIGURE	MULTIPLIER
1/16	Blue	Red	Black
1/8	Brown	Red	Brown
1/4	Red	Green	Brown
3/8	Orange	Violet	Brown
1/2	Green	Black	Brown
3/4	Violet	Green	Brown
1	Brown	Black	Red
1-1/2	Brown	Green	Red
2	Red	Black	Red
2-1/2	Red	Green	Red
3	Orange	Black	Red
3-1/2	Orange	Green	Red
4	Yellow	Black	Red
5	Green	Black	Red
7	Violet	Black	Red
10	Brown	Black	Orange
12	Brown	Red	Orange
15	Brown	Green	Orange

PART NUMBER			
AXIAL LEADS	RADIAL LEADS	AMPERE RATING	VOLTAGE RATING
251.062	252.062	1/16	125
251.125	252.125	1/8	125
251.250	252.250	1/4	125
251.375	252.375	3/8	125
251.500	252.500	1/2	125
251.750	252.750	3/4	125
251 001	252 001	1	125
251 01.5	252 01.5	1-1/2	125
251 002	252 002	2	125
251 02.5	252 02.5	2-1/2	125
251 003	252 003	3	125
251 03.5	252 03.5	3-1/2	125
251 004	252 004	4	125
251 005	252 005	5	125
251 007	252 007	7	125
251 010	252 010	10	125
251 012	252 012	12	32
251 015	252 015	15	32

NOTE: To order color-coded PICO II™ fuses, use **255 Series** (for Axial leads) or **256 Series** (for Radial leads) in part number table above.

TAPED FUSES: PICO II™ Fuses are available on tape for use with automatic insertion equipment . . . Contact factory.



26

GENERAL SEMICONDUC. JR

TransZorb® UNIDIRECTIONAL 5KP5.0 THRU 5KP110A

ELECTRICAL CHARACTERISTICS @ 25°C

General Semiconductor Part Number	Breakdown Voltage BV Volts Min.	@ IT mA	Maximum Reverse Leakage @ V_R I_R µA	Maximum Voltage Temperature Variation of BV mV/°C
5KP5.0	6.40	50	2000	4.0
5KP5.0A	6.40	50	2000	4.0
5KP6.0	6.67	50	5000	4.0
5KP6.0A	6.67	50	5000	4.0
5KP6.5	7.22	50	2000	4.0
5KP6.5A	7.22	50	2000	4.0
5KP7.0	7.78	50	1000	5.0
5KP7.0A	7.78	50	1000	5.0
5KP7.5	8.33	5	250	6.0
5KP7.5A	8.33	5	250	6.0
5KP8.0	8.89	5	150	6.0
5KP8.0A	8.89	5	150	6.0
5KP8.5	9.44	5	50	7.0
5KP8.5A	9.44	5	50	7.0
5KP9.0	10.0	5	20	8.0
5KP9.0A	10.0	5	20	8.0
5KP10	11.1	5	15	9.0
5KP10A	11.1	5	15	9.0
5KP11	12.2	5	10	10
5KP11A	12.2	5	10	10
5KP12	13.3	5	10	11
5KP12A	13.3	5	10	11
5KP13	14.4	5	10	12
5KP13A	14.4	5	10	12
5KP14	15.6	5	10	13
5KP14A	15.6	5	10	13
5KP15	16.7	5	10	15
5KP15A	16.7	5	10	15
5KP16	17.8	5	10	18
5KP16A	17.8	5	10	16
5KP17	18.9	5	10	19
5KP17A	18.9	5	10	18
5KP18	20.0	5	10	20
5KP18A	20.0	5	10	19
5KP20	22.2	5	10	24
5KP20A	22.2	5	10	22
5KP22	24.4	5	10	27
5KP22A	24.4	5	10	24
5KP24	26.7	5	10	30
5KP24A	26.7	5	10	27
5KP26	28.9	5	10	33
5KP26A	28.9	5	10	29
5KP28	31.1	5	10	34
5KP28A	31.1	5	10	30
5KP30	33.3	5	10	38
5KP30A	33.3	5	10	35
5KP33	36.7	5	10	41
5KP33A	36.7	5	10	38
5KP36	40.0	5	10	45
5KP36A	40.0	5	10	40
5KP40	44.4	5	10	50
5KP40A	44.4	5	10	45
5KP43	47.8	5	10	54
5KP43A	47.8	5	10	49
5KP45	50.0	5	10	57
5KP45A	50.0	5	10	51
5KP48	53.3	5	10	62
5KP48A	53.3	5	10	55
5KP51	56.7	5	10	65
5KP51A	56.7	5	10	60
5KP54	60.0	5	10	70
5KP54A	60.0	5	10	64
5KP58	64.4	5	10	77
5KP58A	64.4	5	10	69
5KP60	66.7	5	10	79
5KP60A	66.7	5	10	70
5KP64	71.1	5	10	85
5KP64A	71.1	5	10	75
5KP70	77.8	5	10	93
5KP70A	77.8	5	10	84
5KP75	83.3	5	10	100
5KP75A	83.3	5	10	90
5KP78	86.7	5	10	104
5KP78A	86.7	5	10	94
5KP85	94.4	5	10	113
5KP85A	94.4	5	10	102
5KP90	100	5	10	120
5KP90A	100	5	10	109
5KP100	111	5	10	134
5KP100A	111	5	10	122
5KP110	122	5	10	147
5KP110A	122	5	10	132

V_F at 100 amps peak, 8.3 msec sine wave = 3.5 volts maximum.

FIGURE 3—Pulse Waveform

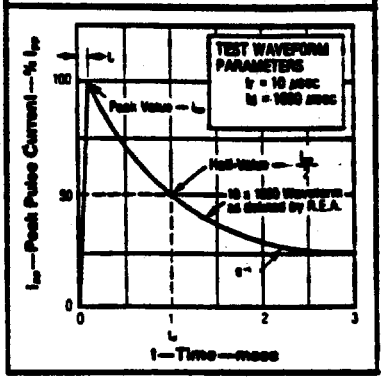
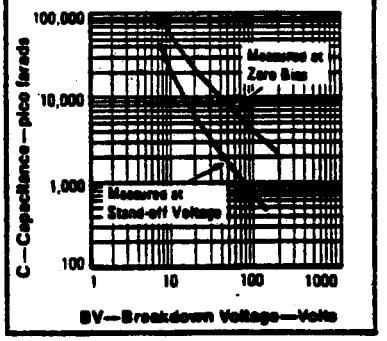


FIGURE 4—Typical Capacitance vs Breakdown Voltage



NOTES

Note 1: A TransZorb is normally selected according to the reverse "Stand Off Voltage" (V_R) which should be equal to or greater than the DC or continuous peak operating voltage level.

ABBREVIATIONS & SYMBOLS

V_R Stand-Off Voltage: Applied Reverse Voltage to assure a nonconductive condition. (See Note 1)

BV(min) This is the minimum Breakdown Voltage the device will exhibit and is used to assure that conduction does not occur prior to this voltage level at 25°C.

V_C(max) Maximum Clamping Voltage. The maximum peak voltage appearing across the TransZorb when subjected to the peak pulse current in a one millisecond time interval. The peak pulse voltages are the combination of voltage rise due to both the series resistance and thermal rise.

I_{PP} Peak Pulse Current — See Figure

I_P Peak Pulse Power

I_R Reverse Leakage

INTERNATIONAL RECTIFIER IOR

1N5401 SERIES

3 Amp Medium Power Silicon Rectifier Diodes

Major Ratings and Characteristics

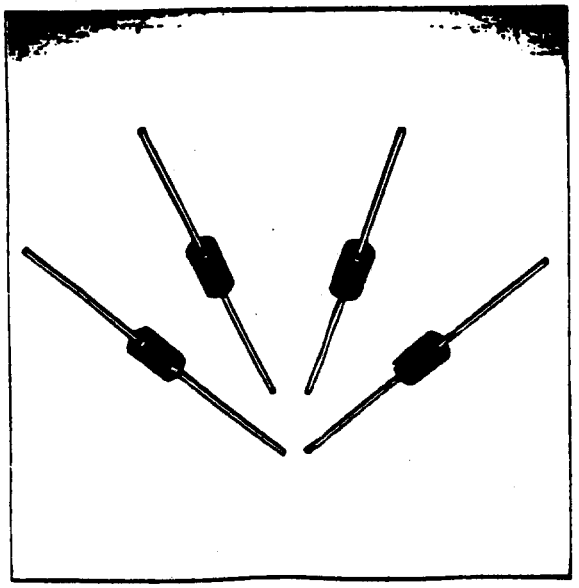
		1N5401	Units
$I_{F(AV)}$		3.0*	A
@ max T_L		105*	°C
I_{FSM}	50Hz	191	A
	60Hz	200*	A
$I^2\sqrt{t}$		2580*	$A^2\sqrt{s}$
T_L Range		−65 to 170*	°C
V_{RRM} Range		100 to 1000*	V

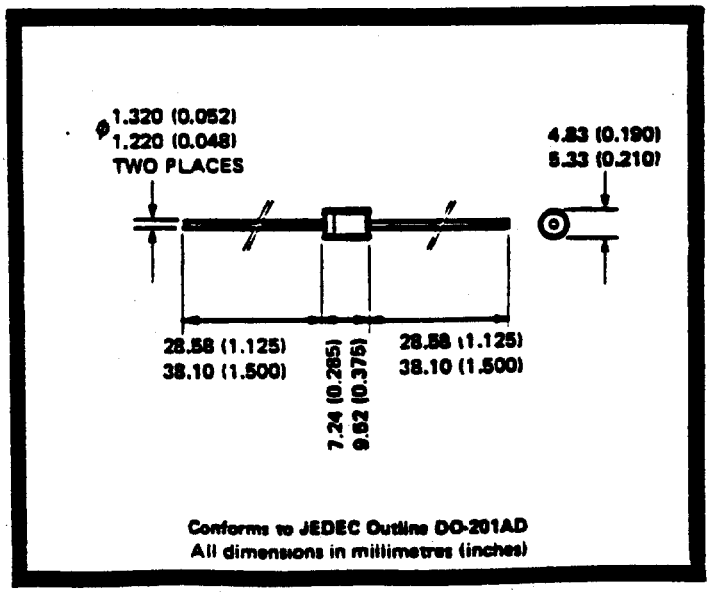
*JEDEC registered values

Description/Features

- 3A lead mounted rectifier.
- Subminiature molded package.
- Corrosion resistant surfaces.
- Peak reverse voltage from 100 to 1000V.
- Improved environmental operating capability.
- High surge current capability.

B





Voltage Ratings

	V_{RRM} – Maximum Repetitive Peak Reverse Voltage (V)	V_R – Maximum Direct Reverse Voltage (V)
Part numbers	T_L = –65 to 175°C	T_L = –65 to 150°C
1N5401	100*	100*
1N5402	200*	200*
1N5404	400*	400*
1N5406	600*	600*
1N5407	800*	800*
1N5408	1000*	1000*

Electrical Specifications

		1N5401	Units	Conditions
$I_{F(AV)}$	Maximum average forward current @ Max T_L	3.0*	A	180° sine wave conduction
		105*	°C	
I_{FSM}	Maximum peak one cycle non-repetitive surge current	191	A	t = 10ms; Following any rated load condition and with rated V_{RRM} reapplied
		200*	A	t = 8.3ms
$I^2\sqrt{t}$	Maximum $I^2\sqrt{t}$ for fusing ①	2580	$A^2\sqrt{s}$	t = 0.1 to 10ms, V_{RRM} = 0 following surge
V_{FM}	Maximum peak forward voltage	1.2*	A	$I_{F(AV)}$ = 3A (9.4 A_{pk}), T_J = 25°C
I_{RM}	Maximum average reverse current	100	μA	T_L = 105°C, V_{RRM} = rated V_{RRM}, $I_{F(AV)}$ = 3A
I_R	Maximum direct reverse current	500*	μA	T_L = 150°C, V_R = rated V_R

① I^2t for time $t_x = I^2\sqrt{t} \cdot \sqrt{t_x}$

*JEDEC registered value.

Thermal and Mechanical Specifications

T_L	Lead operating temperature range	–65 to 170*	°C	
T_{stg}	Storage temperature range	–65 to 175*	°C	
wt	Approximate weight	0.65 (0.023)	g (oz)	
T_{sld}	Max. lead temperature during soldering	240*	°C	Duration, 10s max. measured 3.2mm (0.125in) from device case

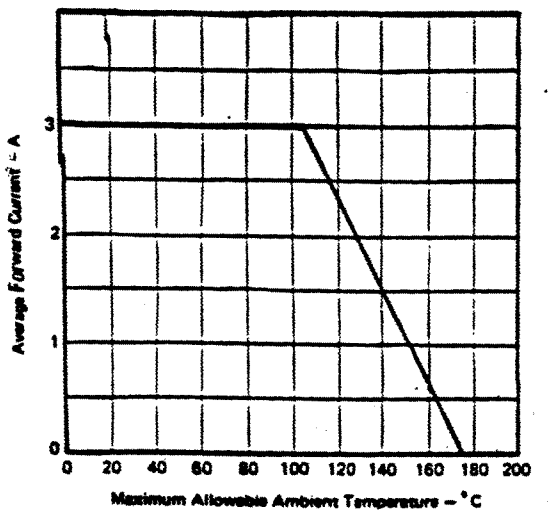


Fig. 1 – Average Forward Current Vs. Maximum Allowable Ambient Temperature

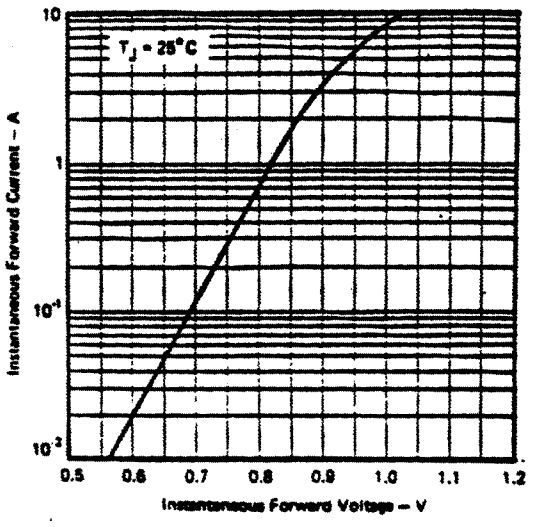


Fig. 2 – Maximum Forward Voltage Vs. Forward Current

B

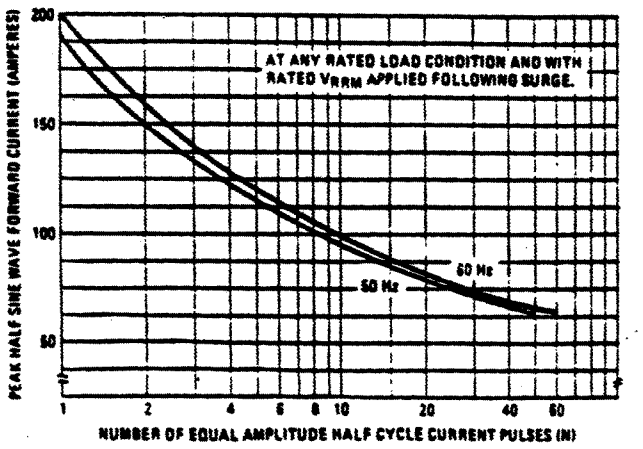


Fig. 3 – Maximum Non-Repetitive Surge Current Vs. Number of Current Pulses

INTERNATIONAL RECTIFIER IOR

1N4001 SERIES

1.0 Amp Silicon Rectifier Diodes

Major Ratings and Characteristics

	1N4001	Units
$I_{F(AV)}$	1.0 *	A
@ Max. T_A	75 *	°C
I_{FSM}		
@ 50 Hz	28.7	A
@ 60 Hz	30 *	A
$I^2\sqrt{t}$	58.1	$A^2\sqrt{s}$
T_J Range	-65 to 175 *	°C
V_{RRM} Range	50 to 1000 *	V

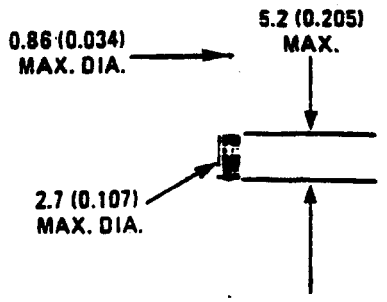
Description/Features

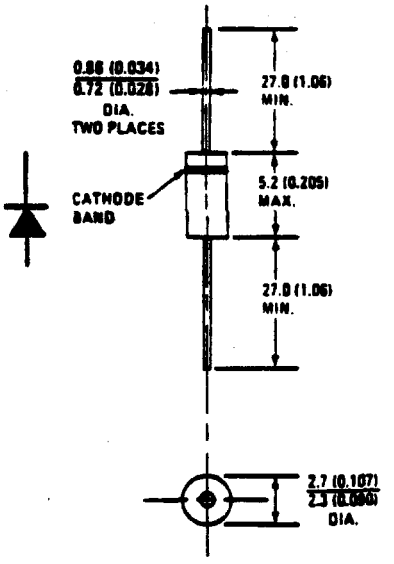
- Economical 1 ampere general purpose diode for industrial application
- Molded epoxy DO-204AL case style
- Low forward voltage drop and high surge rating
- Excellent reliability

*JEDEC registered value.

B

CASE STYLE AND DIMENSIONS





Case Style DO-204AL (DO-41)
Dimensions in Millimeters and (Inches)

(29)

VOLTAGE RATINGS

Part Number	V_{RRM} – Max. Repetitive Peak Reverse Voltage (V)	$V_{R(RMS)}$ – Max. RMS Reverse Voltage (V)	V_R – Max. DC Blocking Voltage (V)
	T = –65 to 175°C	T = –65 to 175°C	T = –65 to 165°C
1N4001	50*	35	50*
1N4002	100*	70	100*
1N4003	200*	140	200*
1N4004	400*	280	400*
1N4005	600*	420	600*
1N4006	800*	560	800*
1N4007	1000*	700	1000*

ELECTRICAL SPECIFICATIONS

		1N4001	Units	Conditions
$I_{F(AV)}$	Max. average forward current	1.0*	A	Half sine wave conduction
	@ Max. T_A	75*	°C	① , double side cooled.
I_{FSM}	Max. peak one cycle, non-repetitive surge current	28.7	A	Half cycle 50 Hz sine wave or 6 ms rectangular pulse. Following any rated load condition, and with rated V_{RRM} reapplied.
		30*		Half cycle 60 Hz sine wave or 5 ms rectangular pulse.
$I^2\sqrt{t}$	Max. $I^2\sqrt{t}$ for fusing ①	58.1	$A^2\sqrt{s}$	t = 0.1 to 10 ms with V_{RRM} following surge = rated V_{RRM}.
V_{FM}	Max. peak forward voltage	1.1*	V	T_A = –65°C to 75°C, I_F = 1 Adc
		1.6*	V	T_A = –65°C to 75°C, $I_{F(AV)}$ = 1A (3.14A peak)
I_R	Max. dc reverse current	10*	µA	T_A = 25°C — V_R = Rated V_R.
		50*	µA	T_A = 100°C
$I_{R(AV)}$	Max. average reverse current	30*	µA	T_A = 75°C, $I_{F(AV)}$ = 1A, V_{RRM} = rated V_{RRM}

THERMAL-MECHANICAL SPECIFICATIONS

T_J	Max. operating junction temperature range	–65* to 175*	°C	
T_{stg}	Max. storage temperature range	–65* to 200*	°C	
wt	Approximate weight	0.33 (0.012)	g (oz)	
	Case Style	DO-204AL (DO-41)		

① T_L is measured 8.7 mm (0.344 in.) to 9.5 mm (0.375 in.) from device case.

① I^2t for time $t_x = I^2\sqrt{t} \cdot \sqrt{t_x}$.

*JEDEC registered values.

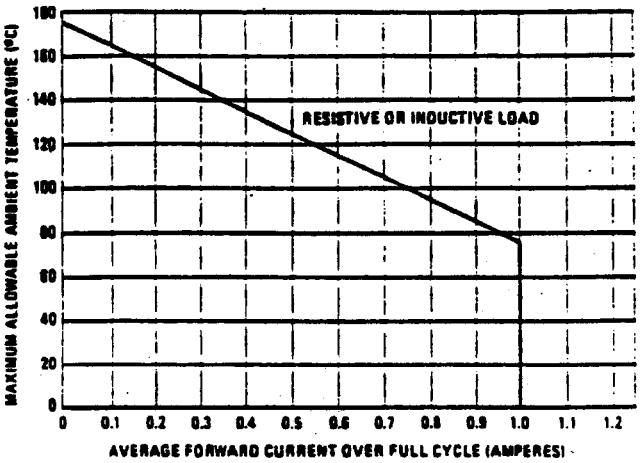


Fig. 1 – Average Forward Current Vs. Maximum Allowable Ambient Temperature

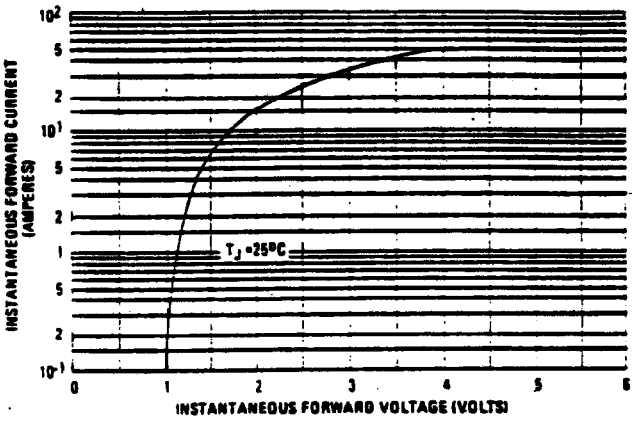


Fig. 2 – Maximum Forward Voltage vs. Forward Current

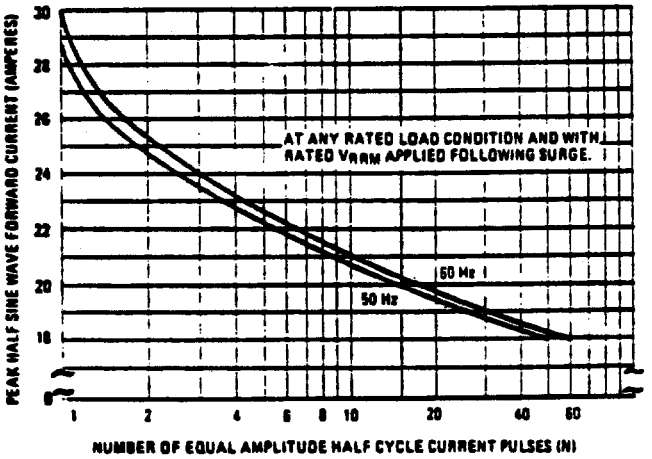


Fig. 3 – Maximum Non-Repetitive Surge Current Vs. Number of Current Pulses

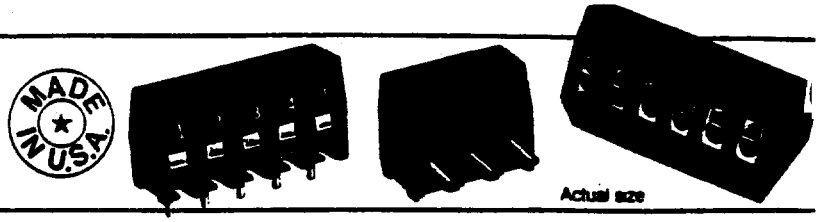
B

Beau® Eurostyle® PC Terminal Strips

Single Row, Closed Side

15 amps
.197" centers (5,0)
thermoplastic

85



Specifications

Series No.	85
Construction	Closed side: feed thru
Terminal centers	.197" (5,0)
Current rating, amps (UL/CSA)	15 / 15
Voltage rating, rms 1. UL Recognized. . . Class B: Comm'l equip Class C: Gen'l ind'l Class C: Limited rating 2. CSA Certified Type B: Comm'l equip Type D: Special components 3. Withstand volts, rms	 250 50 300 300 300 6500
Insulator material	Thermoplastic. UL temp index 130°C. UL flame retardant rating 94V-0. Color, black.
Wire size recommended, AWG	14 (max); 30 (min)
Terminal screws (standard; also see options below)	No. M2.5 × 0.45 captive head screws. Steel, zinc plated.
Bottom terminal (3rd digit of part no.) ▲	4 45° PC terminal 5 Straight-thru PC terminal 8 Right-angle PC terminal
No. of circuits (4th & 5th digits of part no.)▲	2 to 24
Options (add dash numbers to part no.) ▲	−10A thru −11D Imprinting (on the open side) −49 Nickel-plated brass captive screws −72 Without wire guard −P With standoff pads, .080" dia × .025" (2.03 × 0.64). Not available on 45° style. −10mm 10mm spacing (12 circuit max)

Dimensions in parentheses are millimeters.

High circuit density. .197" (5 mm) contact spacing provides 5 terminations in less than an inch.

Very small footprint. Takes very little PCB space.

Made in USA. Beau Eurostyle PC terminal strips are a direct equivalent to popular 5 mm European style terminal strips.

Touchproof. Recessed screws prevent accidental shorting.

Captive screws won't fall out. Prevents accidents from screws falling into assembly. Furnished backed out, ready to wire.

Captive wire protectors hold wires securely in place. Assures a good connection and increases pullout strength.

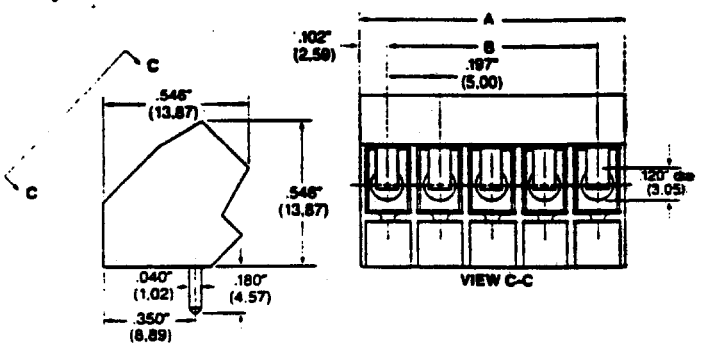
Large wire entry. Easy entry for stranded or multiple wires.

Easy identification. Imprinting, .070" high, can be provided on the front side of the strip.

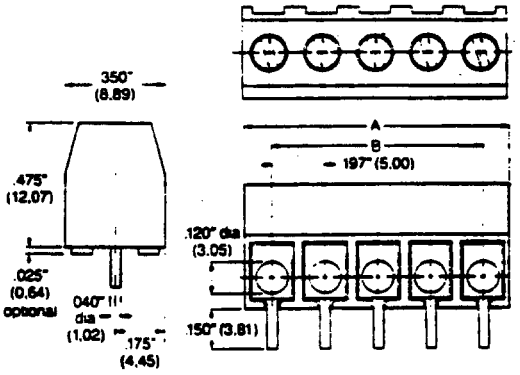
Closed side acts as wire stop. Wires can't pass through to short out components. Saves space by closer component mounting.

▲ HOW TO ORDER. First two digits of part number are series number. 3rd digit is bottom terminal. 4th and 5th digits are no. of circuits. For options, add dash numbers. Example: 85509-49-P.

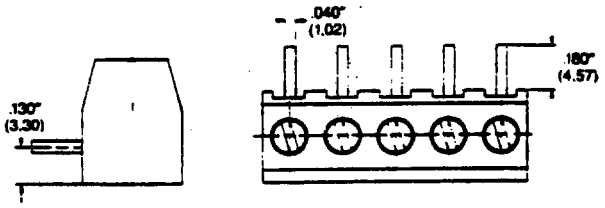
Style 4: 45° PC terminals



Style 5: Straight-thru PC terminals



Style 8: Right-angle PC terminals



No. of circuits	A in.	A mm	B in.	B mm
2	.400	10.15	.197	5.00
3	.597	15.15	.394	10.00
4	.793	20.15	.591	15.00
5	.990	25.15	.787	20.00
6	1.187	30.15	.984	25.00
7	1.384	35.15	1.181	30.00
8	1.581	40.15	1.378	35.00
9	1.778	45.15	1.575	40.00
10	1.975	50.15	1.772	45.00
11	2.171	55.15	1.969	50.00
12	2.368	60.15	2.165	55.00
13	2.566	65.15	2.362	60.00
14	2.762	70.15	2.560	65.00
15	2.959	75.15	2.756	70.00
16	3.156	80.15	2.953	75.00
17	3.352	85.15	3.150	80.00
18	3.549	90.15	3.346	85.00
19	3.746	95.15	3.543	90.00
20	3.943	100.15	3.740	95.00
21	4.140	105.15	3.937	100.00
22	4.337	110.15	4.134	105.00
23	4.534	115.15	4.331	110.00
24	4.730	120.15	4.528	115.00

Tolerance on length ± (.005" + .002" per inch) . . . ± (0.13 + 0.002 per mm)

JOHNSON®

SHIELDED TEST JACKS
R F CIRCUIT TEST POINTS

inches (millimeters)

ELECTRICAL RATINGS

Impedance: 29 ohms
Frequency Range: 0 - 2 GHz
Working Voltage: 300 Vrms
Dielectric Withstanding Voltage: 2000 VDC
Contact Resistance: Center contact: 6 milliohms
Outer conductor: 2.5 milliohms

MECHANICAL RATINGS

Insertion Force: Inner conductor: 32 oz. max. 2 oz. min.
Outer conductor: 48 oz. max. 6 oz. min.

Durability: 250 cycles

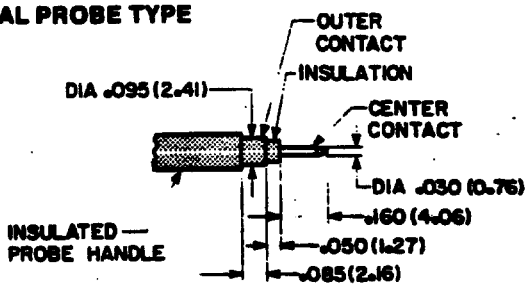
ENVIRONMENTAL RATINGS

Temperature Range: -65° C to +85° C
Corrosion: Salt spray, 24 hours
Shock: Method 213, Test Condition B, MIL-STD-202
Vibration: Method 204, Test Condition B, MIL-STD-202

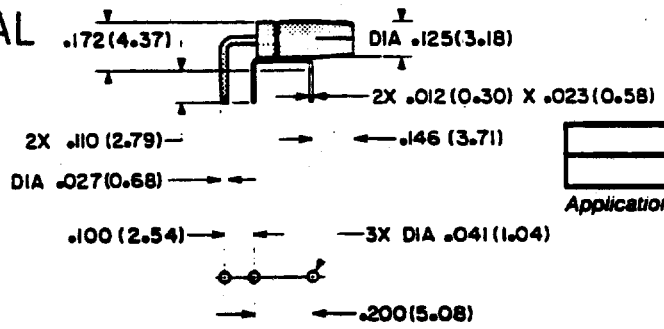
MATERIAL SPECIFICATIONS

Contact: Beryllium copper per QQ-C-533/530
Insulator Material: TFE Fluorocarbon per L-P-403
Finish: Center Contact and Body: Bright Tin

SHIELDED TEST JACK INTERFACE — TYPICAL PROBE TYPE



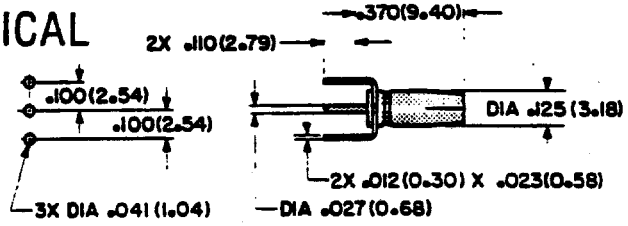
HORIZONTAL



BRIGHT TIN PLATED
129-0701-301

Application detail Page 68

VERTICAL



BRIGHT TIN PLATED
129-0701-201

Application detail Page 68

TIP JACKS

APPLICATION • Connection to test equipment • Power supplies • Electrical instruments

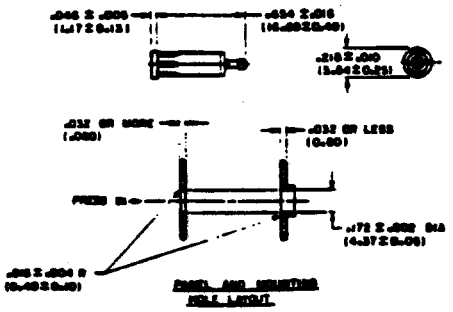
Insulated Standard: Rib-Loc® Type

SPECIFICATIONS

Contact: Brass body per QQ-B-626D with wrap around beryllium copper spring per QQ-C-533
Finish: Silver
Body: Nylon 66 per ASTM D4066
Std. Colors: Ten per FED-STD-595
Panel Thickness: Up to .375" (9.05mm)

RATINGS

Current: 5 amps
Breakdown Voltage: 3500 Vrms minimum†
Contact Resistance: 0.005 ohms maximum
Contact-To-Panel C: 1 pF nominal



For Standard Tip Plug: .080" (2mm) Diameter
FEATURES:
- Machined contact with turret terminal
- Installs by pressing into mounting hole, no mounting hardware required
- Closed entry blocks access of probes greater than .085" (2.16mm)
- Nylon UL approved for self extinguishing

SILVER PLATINUM			
PART NO.	COLOR	PART NO.	COLOR
105-1041-001	White	105-1047-001	Yellow
105-1042-001	Red	105-1048-001	Brown
105-1043-001	Black	105-1050-001	Blue
105-1044-001	Green	105-1052-001	Violet
105-1046-001	Orange	105-1053-001	Gray

E.F. JOHNSON COMPANY, Component Products, P.O. Box 59089, Minneapolis, Minnesota 55459-
OUTSTATE CALL TOLL FREE: 1-800-247-8256 IN MINN. CALL: 1-507-835-6222 TLX: 290470 FAX: 1-507-835-[illegible]

† Avoid user injury due to misapplication.
See safety advisory and definitions page 1

32, 33, 34

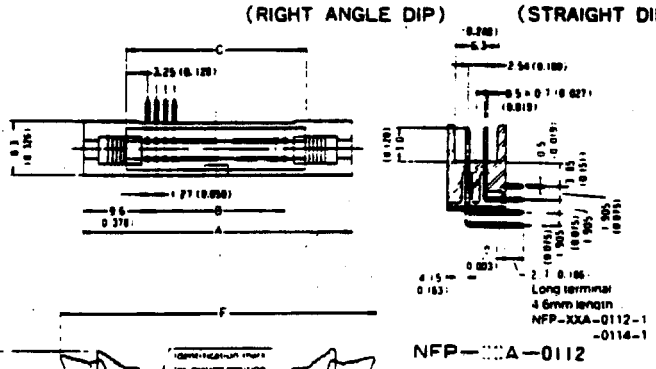
HEADER A TYPE

0.635mm PITCH (25MIL PITCH)

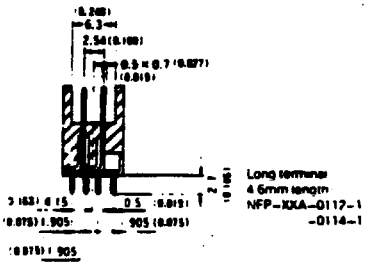
NFP—00A—0112、0114

NFP—00A—0112、NFP—00A—0114

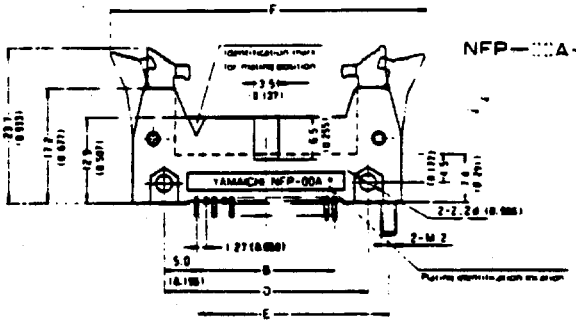
(RIGHT ANGLE DIP) (STRAIGHT DIP)



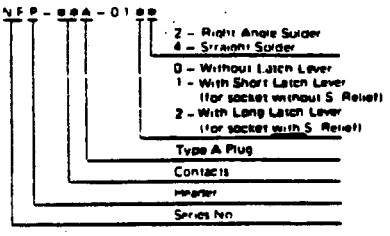
NFP—□□A—0112



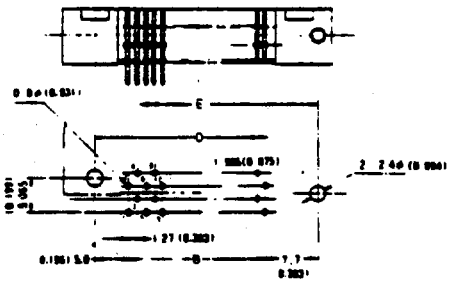
NFP—□□A—0114



PART No. IDENTIFICATION



Note:
1. Add "A" at the end of Part No. for optional grade A gold plating.
2. Optional right angle or straight longer solder tail for multi layer P.C. Board is available. Contact factory for details.



P.C. BOARD HOLE SIZE

	TYPE NO	A	B	C	D	E	F
☆	NFP-10A-0112·0114	24.28 (0.955)	5.08 (0.200)	11.58 (0.455)	15.08 (0.593)	0.48 (0.806)	38.2 (1.503)
☆	NFP-16A-0112·0114	28.09 (1.105)	8.89 (0.350)	15.39 (0.605)	18.89 (0.743)	21.29 (0.8[illegible])	42.0 (1.653)
☆	NFP-20A-0112·0114	30.63 (1.205)	11.43 (0.450)	17.93 (0.705)	[illegible].43 (0.843)	26.83 (1.056)	44.6 (1.755)
☆	NFP-26A-0112·0114	34.44 (1.355)	15.24 (0.600)	21.74 (0.855)	25.24 (0.993)	30.34 (1.2[illegible]6)	48.4 (1.905)
☆	NFP-34A-0112·0114	39.52 (1.555)	20.32 (0.800)	26.82 (1.055)	30.32 (1.193)	35.72 (1.406)	53.5 (2.106)
☆	NFP-40A-0112·0114	43.33 (1.705)	24.13 (0.950)	30.63 (1.205)	34.13 (1.343)	39.53 (1.556)	57.3 (2.255)
☆	NFP-50A-0112·0114	49.68 (1.955)	30.48 (1.200)	36.98 (1.455)	[illegible] (1.593)	45.[illegible] (1.806)	63.6 (2.503)
☆	NFP-60A-0112·0114	56.03 (2.205)	36.83 (1.450)	[illegible].33 (1.70[illegible])	46.83 (1.843)	52.23 (2.056)	70.0 (2.755)
☆	NFP-64A-0112·0114	58.57 (2.305)	39.37 (1.550)	45.87 (1.805)	49.37 (1.943)	54.77 (2.156)	72.5 (2.854)
☆	NFP-80A-0112·0114	68.73 (2.705)	49.53 (1.950)	56.03 (2.205)	59.53 (2.343)	64.93 (2.556)	82.7 (3.255)
☆	NFP-100A-0112·0114	81.43 (3.206)	62.23 (2.450)	68.73 (2.706)	72.23 (2.844)	77.63 (3.056)	95.40 (3.756)

☆ Tooled

Dimension: mm (inch)

SPECIFICATION

1. Insulation Resistance : 1,000 MΩ Minimum at 500V D.C.
2. Break Down Voltage : 500V A.C. for One Minute
3. Voltage Rating : 150V
4. Current Rating : 0.5A
5. Operating Temperature : −20°C to 105°C
6. Mating Cable : Solid Conductor Flat Cable AWG 30 (with PVC and FEP Insulator)
   : Stranded Conductor Flat Cable AWG 30 and AWG 32 (with PVC and FEP Insulator)
   * FEP (Teflon)

MATERIAL

1. Body, Strain Relief, Latch : Polybutylene terephthalate (UL 94-VO)

2. Contact

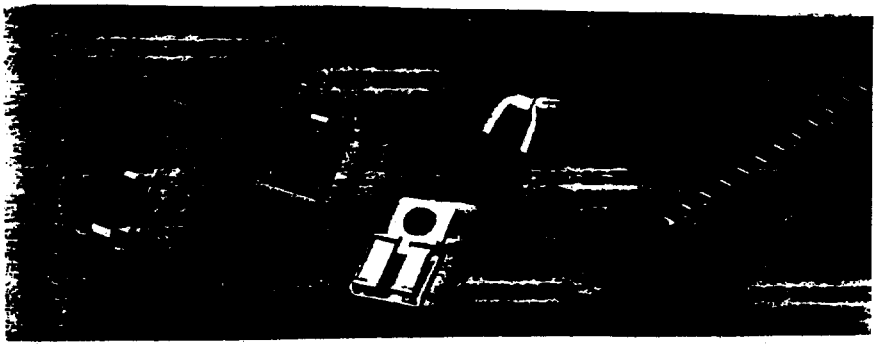
NFP-	A	: Phosphor Bronze
NFS-	A	: Beryllium Copper
NFP-	G	: Beryllium Copper
NBP	-1001	: Phosphor Bronze
NBS	-1001	: Phosphor Bronze
NBP	-1200	: Copper Nickel Lead
NBS	-1200	: Phosphor Bronze
NFP-	A-013	: Phosphor Bronze
NFS-	A-1314	: Phosphor Bronze

3. Metal Shell : Steel (Nickel Finish)

PLATING SPECIFICATION

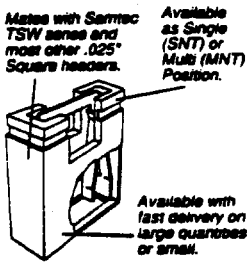
TYPE No.	THICKNESS	CONTACT AREA	IDENTIFICATION
NFP- A-01 2 NFS- A NFP- A-0132	Grade A	Ni 2.5 – 4.5 micron (98 – 177 μinch) Au 0.76 micron (30 μinch)	A
	Grade B	Ni 2.5 – 4.5 micron (98 – 177 μinch) Au 0.3 – 0.5 micron (12 μinch)	STANDARD NO MARK
NFP- -A-01 4 NFP- G NBP -1001 NBS -1001	Grade AF	Ni 2.5 – 4.5 micron (98 – 177 μinch) Au 0.76 micron (30 μinch)	A
	Grade BF	Ni 2.5 – 4.5 micron (98 – 177 μinch) Au 0.3 – 0.5 micron (12 μinch)	STANDARD NO MARK
NBP- -1200 NBS- -1200 NFP- -A-0134 NFS- -A-1314	Grade AS	Ni 2.5 – 4.5 micron (98 – 177 μinch) Au 0.76 micron (30 μinch)	A
	Grade BS	Ni 2.5 – 4.5 micron (98 – 177 μinch) Au 0.3 – 0.5 micron (12 μinch)	STANDARD NO MARK

samtec



SHUNTS & JUMPERS SNT, MNT, SNL & JL SERIES

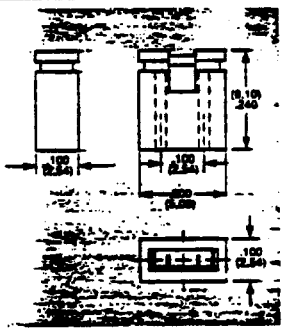
.100 Centerline Shunts with G.F. Polyester Insulator



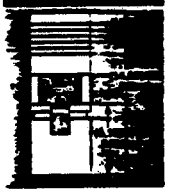
Specifications: SNT & MNT

Insulator Material: Glass Filled Polyester
Flammability Rating: UL 94V-O
Insulation Resistance: 5000 megohm @ 1000 VDC
Temperature Range: –40°C to +90°C
Withstanding Voltage: 1 KV eff. 60 sec
Contact Material: Phosphor Bronze
Contact Plating: Au over Ni or Sn over Ni
Current Rating: 2.5 amp
Contact Resistance: 5 milliohms @ 200 milliamp
Retention in Body: 1 lb
Lead size Range: .022" SQ to .028" SQ
Insertion Depth: .170" minimum
Insertion Force: 15 oz avg (.025" SQ pin)
Withdrawal Force: 12.8 oz avg (.025" SQ pin)

SNT – 100 – BODY COLOR – PLATING OPTION – HANDLE OPTION



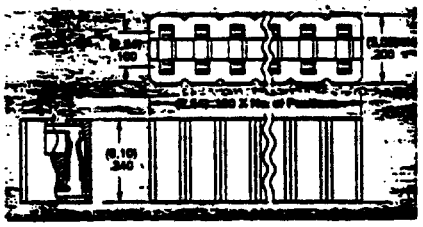
BODY COLOR	PLATING OPTION	HANDLE OPTION
–BK Black	–T = 200µ" Tin	–H Handle (Black only)
–OR Orange	–G = 10µ" Gold	
–RD Red	–H = 30µ" Gold on Contact, Gold Flash on Balance	
–BL Blue		
–YW Yellow		



Mates with: TSW, MTSW, STW, BST, LCW, TST

MNT – 1 – NO. OF POSITIONS – BODY COLOR – PLATING OPTION

02 thru 20 (20 positions standard)



BODY COLOR	PLATING OPTION
–BK = Black	–T = 200µ" Tin
	–G = 10µ" Gold
	–H = 30µ" Gold on Contact, Gold Flash on Balance

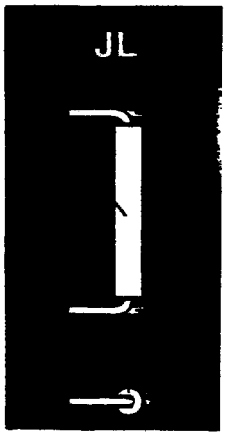
Mates with: TSW, MTSW, STW, BST, LCW, TST

Note: Non-standard strip lengths are non-returnable.

JL Series Jumper Links Meet Mil Specs

Specifications: JL

Insulator Material: White Teflon per MIL–T–16878 Type E
Flammability Rating: VWI
Insulation Resistance: >10^{10} ohm-cm
Temperature Range: –105°C to +200°C
Withstanding Voltage: 600 V continuous
Terminal Material: Tinned 22 gauge Copper Wire
Plating: Ag per MIL–QQW–343
Current Rating: 1.5 amp @ 50°C
Packaging: 1000 per bag



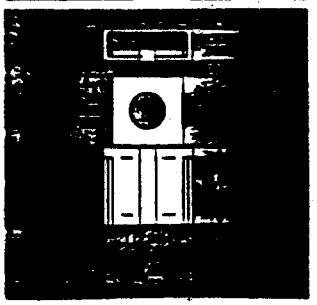
Part No.	A
JL-100-25-T	(2,54) .100
JL-250-25-T	(6,35) .250
JL-300-25-T	(7,62) .300
JL-400-25-T	(10,16) .400
JL-500-25-T	(12,70) .500
JL-600-25-T	(15,24) .600
JL-1000-25-T	(25,40) 1.000

Economical SNL Series Shunt with No Insulator for Lowest Profile

Specifications: SNL

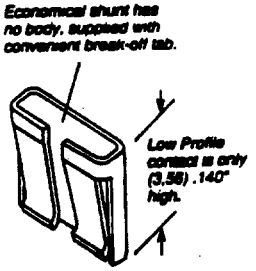
Same as SNT except:
Insertion Force: 16 oz avg (.025" SQ pin)
Withdrawal Force: 8 oz avg (.025" SQ pin)
Insulation Material: None

SNL – 100 – PLATING OPTION



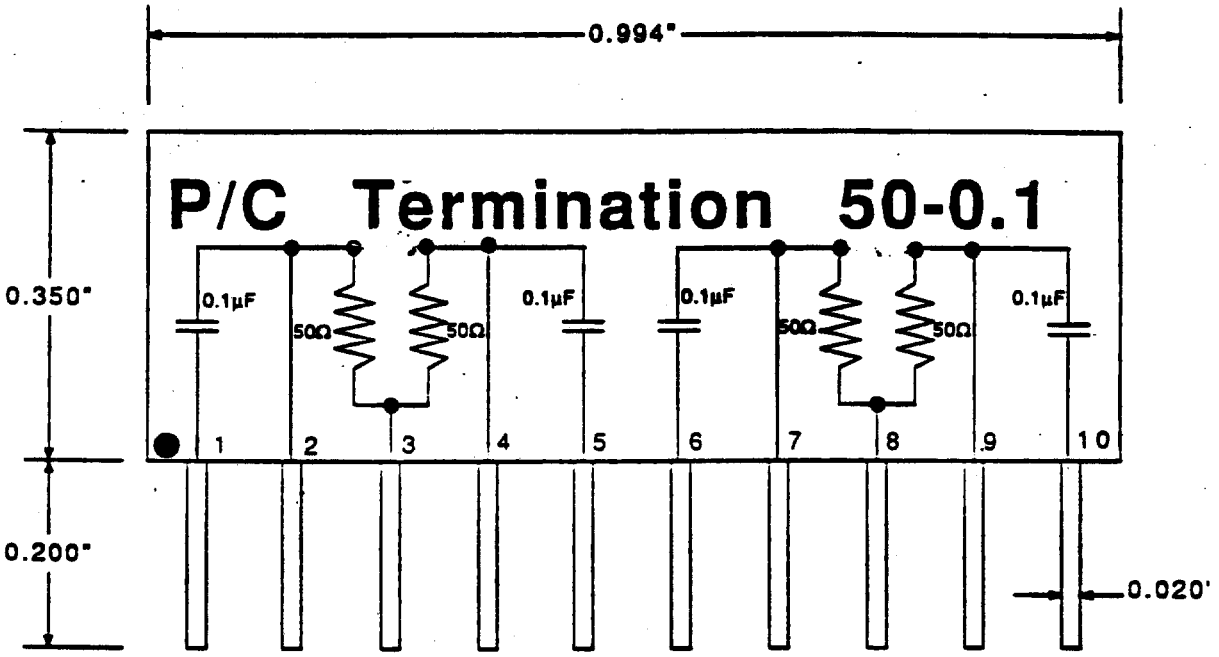
PLATING OPTION
–T 200µ" Tin
–G 10µ" Gold

Mates with: TSW, MTSW, STW, BST, LCW, TST



Postamp/Comparator Module Termination Networ

Package Marking



Specifications:

Physical Requirements

Maximum Package Height: 0.350"
Maximum Package Length: 1.000"
Maximum Package Thickness: 0.100"
Package Marking: "P/C TERMINATION 50-0.1"

Electrical Requirements

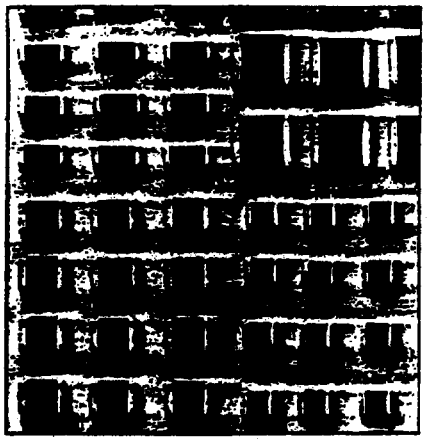
Resistors
Value: 50Ω, +/- 2%
Power: 100 mW @ 70 C
TCR: +/-100PPM
Ratio Match between all four resistors +/-1%

Capacitors
Dielectric Type: Z5U
Value: 0.1µF, +80,-20%
Working Voltage: 25 Volts

Merle Haldeman
10-3-89

SURFACE MOUNTED MONOLITHIC CERAMIC CHIP CAPACITORS

Series GRM



FEATURES

- **Miniature size**
- **Wide capacitance, TC, voltage and tolerance range**
- **Industry standard sizes**
- **8 mm and 12 mm tape & reel for auto-placement**
- **Nickel barrier layer termination is standard**
- **Largest production volume and capacity in the industry**

PART NUMBERING SYSTEM

GRM 40 --- X7R 103 K 050 A D

CAPACITOR TYPE AND SIZE
See below and following pages.

3-digit code appears as necessary to indicate special thickness requirements. Please consult your local sales office for details.

TEMPERATURE CHARACTERISTICS
Standard TC's (described herein)
COG = 0, ± 30ppm (Notes 1 & 2)
X7R = ± 15%
Z5U = + 22, − 56%
Y5V = + 22, − 82%
(See Note 2 below)
P2H = N150 ± 60ppm
R2H = N220 ± 60ppm
S2H = N330 = ± 60ppm
T2H = N470 ± 60ppm
U2J = N750 ± 120ppm

CAPACITANCE VALUE
Expressed in picofarads and identified by a three-digit number. First two digits represent significant figures. Last digit specifies the number of zeros to follow. For fractional values below 10pF, the letter "R" is used as the decimal point and the last digit becomes significant. (5.7pF = 5R7)

CAPACITANCE TOLERANCE
(Note 2)
COG: (10pF or less)
B = ± .1pF
C = ± .25pF
D = ± .5pF
F = ± 1pF on special request
(over 10pF)
F = ± 1%
G = ± 2%
J = ± 5%
K = ± 10%
X7R: K = ± 10%
M = ± 20%
J = ± 5% on special request
Z5U: M = ± 20%
Z = + 80, − 20%
Y5V: Z = + 80, − 20%

VOLTAGE
Identified by a three-digit number.

MARKING
A = Unmarked
B = EIA Marking (standard)
C = Non-standard

PACKAGING

Reel Diameter Tape Material	EIA-481-A Standard
7" Paper Tape	D
7" Plastic Tape	L
13" Paper Tape	J
13" Plastic Tape	K
Bulk	B

See page 35 for additional marking and packaging information.

NOTE 1: TC Tolerance (COG)

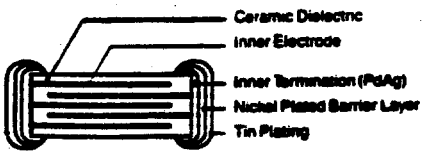
Capacitance (pF)	TC Tolerance (ppm)
10 or over	± 30 (G)
4.0-9.9	± 60 (H)
2.1-3.9	± 120 (J)
.4-2.0	± 250 (K)

NOTE 2: Refer to EIA-RS 198 for limitations

CHIP TERMINATION DIAGRAMS

Nickel Barrier Layer (Standard)

GRM Series



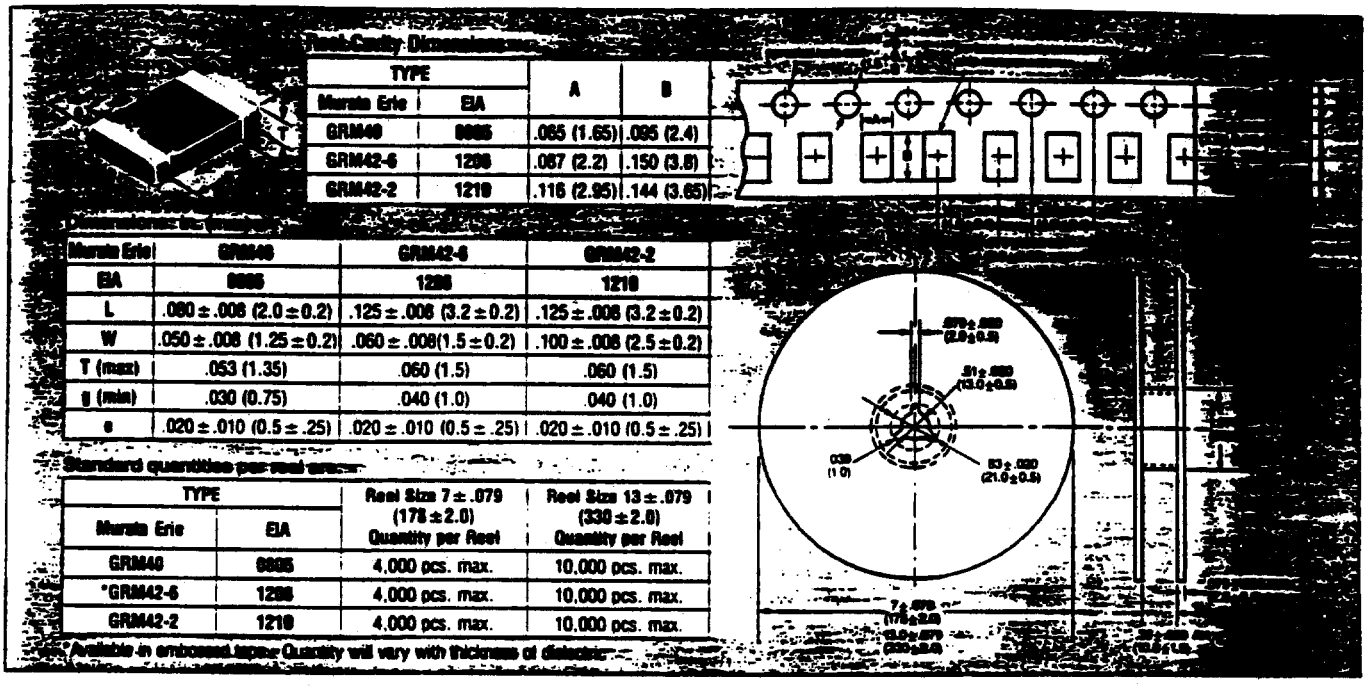
NOTE: Other Terminations Available Upon Request. Please Contact Local Sales Office.

39,40,43,44

SURFACE MOUNTED CHIP CAPACITORS
TAPE & REEL
8mm to EIA RS481 Paper Tape

Series GRM

DIMENSIONS: in. (mm)



TYPE Murata Erie	TYPE EIA	A	B
GRM40	0805	.065 (1.65)	.095 (2.4)
GRM42-6	1206	.087 (2.2)	.150 (3.8)
GRM42-2	1210	.116 (2.95)	.144 (3.65)

Murata Erie	GRM40	GRM42-6	GRM42-2
EIA	0805	1206	1210
L	.080 ± .008 (2.0 ± 0.2)	.125 ± .008 (3.2 ± 0.2)	.125 ± .008 (3.2 ± 0.2)
W	.050 ± .008 (1.25 ± 0.2)	.060 ± .008(1.5 ± 0.2)	.100 ± .008 (2.5 ± 0.2)
T (max)	.053 (1.35)	.060 (1.5)	.060 (1.5)
g (min)	.030 (0.75)	.040 (1.0)	.040 (1.0)
e	.020 ± .010 (0.5 ± .25)	.020 ± .010 (0.5 ± .25)	.020 ± .010 (0.5 ± .25)

Standard quantities per reel are:

TYPE Murata Erie	TYPE EIA	Reel Size 7 ± .079 (178 ± 2.0) Quantity per Reel	Reel Size 13 ± .079 (330 ± 2.0) Quantity per Reel
GRM40	0805	4,000 pcs. max.	10,000 pcs. max.
*GRM42-6	1206	4,000 pcs. max.	10,000 pcs. max.
GRM42-2	1210	4,000 pcs. max.	10,000 pcs. max.

*Available in embossed tape. Quantity will vary with thickness of dielectric.

CAPACITANCE RANGE—8mm TAPE & REEL

TEMP. CHAR.	C0G					
TYPE AND SIZE	GRM40		GRM42-6		GRM42-2	
VOLTAGE	50	100	50	100	50	100
CAPACITANCE (pF) 1	1	1	1	1	1	1
10						
100		680				
1,000	1,000		2,700	6,800	4,700	8,900
(µF) .01						
.1						
1.0						

TEMP. CHAR.	X7R								
TYPE AND SIZE	GRM40			GRM42-6			GRM42-2		
VOLTAGE	25	50	100	25	50	100	25	50	100
CAPACITANCE (pF) 1									
10									
100		220	220		220	220			
1,000	2,200								
(µF) .01	.068	.047	.012	.018		.033	.082	.082	.027
.1				.15	.12		.18	.15	.1
1.0									

TEMP. CHAR.	Y5V								
TYPE AND SIZE	GRM40			GRM42-6			GRM42-2		
VOLTAGE	25	50	100	25	50	100	25	50	100
CAPACITANCE (pF) 1									
10									
100		1,000	1,000		1,000	1,000			
1,000	2,200								
(µF) .01			.012	.056		.039			.082
.1	.15	.1		.39	.24		.27	.18	
1.0							.68	.39	

TEMP. CHAR.	Z5U					
TYPE AND SIZE	GRM40		GRM42-6		GRM42-2	
VOLTAGE	50	100	50	100	50	100
CAPACITANCE (pF) 1						
10						
100						
1,000	1,000	1,000	1,000	1,000		
(µF) .01	.068	.015		.033		.027 .068
.1			.15		.12	
1.0					.33	

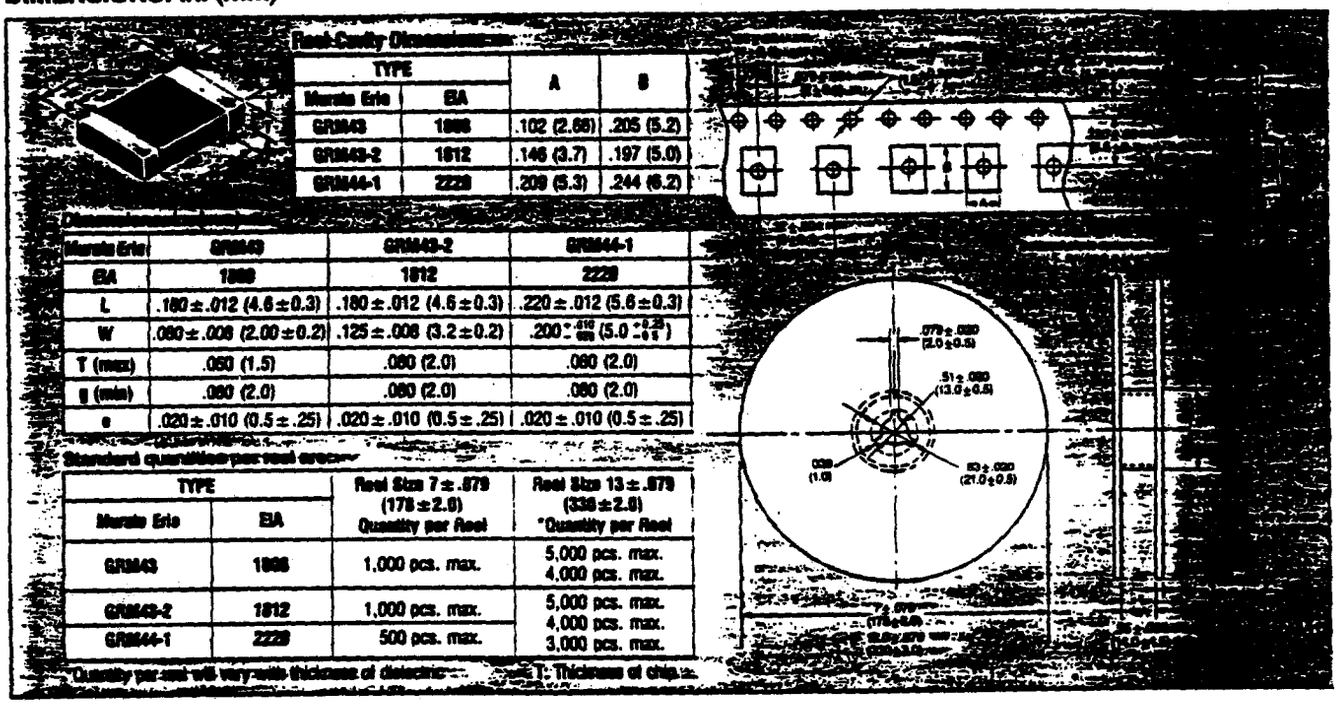
200V and 500V units available on request (contact local Sales Office).

(39,40,43,44

SURFACE MOUNTED CHIP CAPACITORS
TAPE & REEL
12mm To EIA RS481 Embossed Plastic Tape

Series GRM

DIMENSIONS: in. (mm)



Reel-Cavity Dimensions

TYPE		A	B
Murata Erie	EIA		
GRM43	1808	.102 (2.60)	.205 (5.2)
GRM43-2	1812	.146 (3.7)	.197 (5.0)
GRM44-1	2220	.209 (5.3)	.244 (6.2)

Murata Erie	GRM43	GRM43-2	GRM44-1
EIA	1808	1812	2220
L	.180±.012 (4.6±0.3)	.180±.012 (4.6±0.3)	.220±.012 (5.6±0.3)
W	.080±.008 (2.00±0.2)	.125±.008 (3.2±0.2)	.200 (5.0)
T (max)	.060 (1.5)	.080 (2.0)	.080 (2.0)
g (min)	.080 (2.0)	.080 (2.0)	.080 (2.0)
e	.020±.010 (0.5±.25)	.020±.010 (0.5±.25)	.020±.010 (0.5±.25)

Standard quantities per reel are:

TYPE		Reel Size 7±.079 (178±2.0) Quantity per Reel	Reel Size 13±.079 (330±2.0) *Quantity per Reel
Murata Erie	EIA		
GRM43	1808	1,000 pcs. max.	5,000 pcs. max. 4,000 pcs. max.
GRM43-2	1812	1,000 pcs. max.	5,000 pcs. max. 4,000 pcs. max.
GRM44-1	2220	500 pcs. max.	3,000 pcs. max.

*Quantity per reel will vary with thickness of dielectric. T: Thickness of chip.

CAPACITANCE RANGE—12mm TAPE & REEL

TEMP. CHAR.	COG						X7R						Y5V									Z5U					
TYPE AND SIZE	GRM43		GRM43-2		GRM44-1		GRM43		GRM43-2		GRM44-1		GRM43			GRM43-2			GRM44-1			GRM43		GRM43-2		GRM44-1	
VOLTAGE	50	100	50	100	50	100	25/50	100	25/50	100	25/50	100	25	50	100	25	50	100	25	50	100	50	100	50	100	50	100
CAPACITANCE (pF) 1																											
10																											
100	150	150																									
1,000	4,300	3,900	8,800	3,300 6,200	5,600	5,600	3,900	3,900														.01	.01				
(µF) .01					.016	.015									.068			.068						.082			
.1							.22	.12	.39	.18	.27 .62	.27 .39	.22 .68	.13 .47	.12	.22 .82	.39 .68	.22	1.0	1.0	.15 .56	.47	.12	.39 .68	.18	.33 .39	
1.																			2.2	1.5						1.0 .15	
10																											

200V and 500V units available on request (contact local Sales Office).

39, 40, 43, 4

Mepco / Centralab

PART NUMBER DESIGNATION

MEPCO/CENTRALAB Series 49MC Molded Chip Capacitors can be completely specified using the following designation:

49 MC 106 A 016 K 0 A S FT

- **FT** — PACKAGING: FB=Blister Pack 50 unit Trays; FT=Tape & Reel (EIA RS-481A); FS=Requires M/C Internal Spec
- **S** — TERMINATION FINISH: S=Solder Plated (200μ" min. 90/10)
- **A** — GRADE/RELIABILITY LEVEL: A=Industrial Grade; M=CWR11 'M' Level; P=CWR11 'P' Level; X=Requires M/C Internal Spec
- **0** — UNSLEEVED
- **K** — CAPACITANCE TOLERANCE: K==10% Cap Tolerance; M==±20% Cap Tolerance
- **016** — DC VOLTAGE RATING
- **A** — CASE CODE
- **106** — CAPACITANCE in Picofarad Code* First two digits are significant figures. Third digit is number of zeros to follow.
- **MC** — MOLDED CHIP SERIES
- **49** — SMD CHIP TANTALUM CAPACITOR

USE→ 49MC106C016K0ASFT

THE MOLDED CHIP PART NUMBER
—Start P/N with 49MC—
then obtain Capacitance Code,* Case Code and Voltage Rating from the CV table below, add Tolerance, Level, Termination and Packaging from lists above.

PHYSICAL SPECIFICATIONS

DIMENSIONS—Inches

CASE CODE EIA	CASE CODE 49MC	(L) LENGTH	(W) WIDTH	(H) HEIGHT	(B) PAD WIDTH	TAB DIMENSIONS (W2) min-max	TAB DIMENSIONS (H2)
3216	A	.126 ± .008	.063 ± .008	.063 ± .008	.031 ± .012	.043-.051	.028 min
3528	B	.138 ± .008	.110 ± .008	.075 ± .008	.031 ± .012	.083-.091	.028 min
6032	C	.236 ± .012	.126 ± .012	.098 ± .012	.051 ± .012	.083-.091	.039 min
7343	D	.287 ± .012	.169 ± .012	.110 ± .012	.051 ± .012	.091-.098	.039 min

DIMENSIONS—mm

CASE CODE EIA	CASE CODE 49MC	(L) LENGTH	(W) WIDTH	(H) HEIGHT	(B) PAD WIDTH	TAB DIMENSIONS (W2) min-max	TAB DIMENSIONS (H2)
3216	A	3.2 ± 0.2	1.6 ± 0.2	1.6 ± 0.2	0.8 ± 0.3	1.1-1.3	0.7 min
3528	B	3.5 ± 0.2	2.8 ± 0.2	1.9 ± 0.2	0.8 ± 0.3	2.1-2.3	0.7 min
6032	C	6.0 ± 0.3	3.2 ± 0.3	2.5 ± 0.3	1.3 ± 0.3	2.1-2.3	1.0 min
7343	D	7.3 ± 0.3	4.3 ± 0.3	2.8 ± 0.3	1.3 ± 0.3	2.3-2.5	1.0 min

49MC CAPACITANCE—VOLTAGE—CASE CODE TABLE

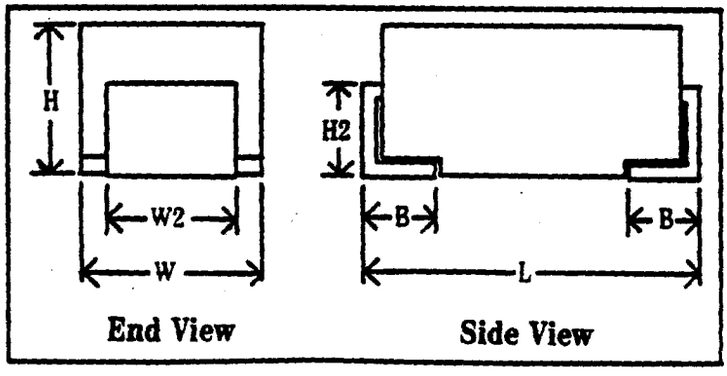
Select standard Capacitance/Voltage ratings and corresponding standard Molded Chip case codes from this table.

CAP µF	PICOFARAD CODE*	004 V	006 V	010 V	016 V	020 V	025 V	035 V	050 V
0.10	104	→	→	→	→	→	→	A	A
0.15	154	→	→	→	→	→	→	A	B
0.22	224	→	→	→	→	→	→	A	B
0.33	334	→	→	→	→	→	→	A	B
0.47	474	→	→	→	→	→	A	B	C
0.68	684	→	→	→	→	A	→	B	C
1.0	105	→	→	→	A	→	→	B	C
1.5	155	→	→	A	→	→	B	C	D
2.2	225	→	A	→	→	B	→	C	D
3.3	335	A	→	→	B	C	C	D	D
4.7	475	→	→	B	C	C	D	D	
6.8	685	→	B	C	C	→	D	D	
10.0	106	B	→	C	C	D	D		
15.0	156	→	C	C	→	D	D		
22.0	226	C	→	→	D	D			
33.0	336	C	→	D	D				
47.0	476	→	D	D					
68.0	686	→	D						

Arrow indicates that next higher voltage is the standard rating available. Units will be marked with the highest voltage available for that case size and capacitance rating.

Devices rated at 6.3 volts will be marked 6 volts.

CASE OUTLINE DRAWING



MARKINGS

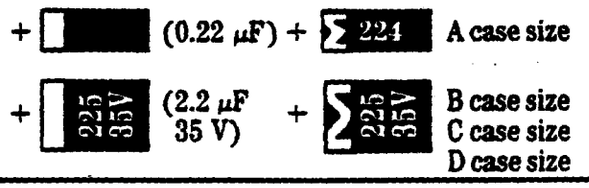
■ The small physical size of the MOLDED CHIP dicates a minimum amount of alpha-numeric marking on the body of the capacitor. The capacitance in picofarad code and the Rated Working Voltage (DC) will be marked on the B, C, and D case size units. The A case size units may have the capacitance only marked in picofarad code (see "How To Specify" on page 48). All case sizes will have positive polarity indicated at the anode termination. Capacitance may be marked in µF at the manufacturer's option.

POLARITY
(Mepco/Centralab Unit Identifier)
(Positive Termination Indicator)

■ Series 49MC capacitors are polar devices. Proper polarity must be observed or damage to the capacitor and/or the circuit will result. Polarity is marked with a white stripe or the letter "M" (in white) on the positive (anode) end. The letter "M" will serve as the Mepco/Centralab identifier as well as indicating positive polarity.

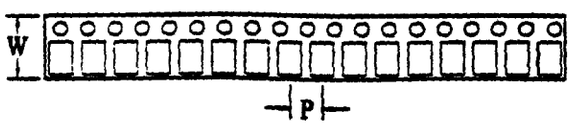
MARKING EXAMPLES BY CASE SIZE

Polarity indicated by either a
White Stripe...or...a White "M"



PACKAGING
TAPE & REEL

■ 49MC Series capacitors are available in Tape & Reel packaging to facilitate the use of automatic placement equipment. Tape & Reel is per EIA (Electronic Industries Association) specification RS-481A. Capacitor orientation within tape pockets is negative terminal toward sprocket holes and mounting side down. 8 and 12 mm tape widths are used according to case size. Quantities less than a full reel will be shipped in Blister Pack trays.



MAXIMUM SOLDERING PROFILE

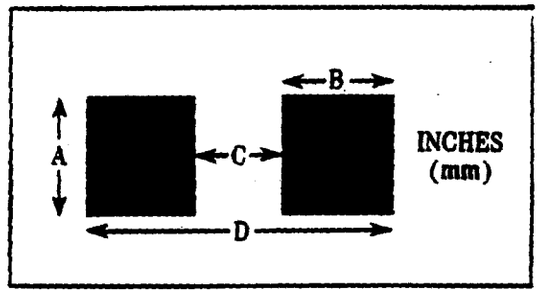
■ All MOLDED CHIP Capacitors may be exposed to (±5°C) for a period of 5 (±0.5) seconds. Soldering te atures in excess of 265°C and a duration of longer t 5.5 seconds are not recommended.

SOLDERABILITY INSPECTION CRITERIA

■ Magnification: 10X
Both termination end faces, excluding the areas of tl terminations egressing from the package, shall be co with a smooth and bright solder coating with no mor than a small amount of scattered imperfections, such pinholes or un-wetted or de-wetted areas. The imperfect shall not be concentrated in one area.

Termination edges are not solderable surfaces.

RECOMMENDED PAD DIMENSIONS FOR REFLOW SOLDERING



Case Size	A Min.	B Nom.	C Nom.	D Nom.
A	.071 (1.80)	.085 (2.15)	.053 (1.35)	.223 (5.65)
B	.110 (2.80)	.085 (2.15)	.065 (1.65)	.235 (5.95)
C	.110 (2.80)	.107 (2.70)	.124 (3.15)	.337 (8.55)
D	.118 (3.00)	.107 (2.70)	.176 (4.45)	.389 (9.85)

TAPE & REEL SPECIFICATIONS

EIA Case Size	49MC Case Code	(W) Tape Width	(P) Unit Pitch Ctr/Ctr	Quantity per full 7" Reel	Quanti per ful 13" Ree
3216	A	8 mm	4 mm	2,000	9,000
3528	B	8 mm	4 mm	2,000	8,000
6032	C	12 mm	8 mm	500	3,000
7343	D	12 mm	8 mm	500	?

CASE C
(CENTERED)

CAP, CASE C-TOP

41

Mike;

How is this? It's size 1210 and gives us plenty of muRata ERIE valu to use if 1.5μF doesn't work

Meri

CHIPS–GRM Series to REPLACE TANTALUMS IN SURFACE MOUNT APPLICATIONS

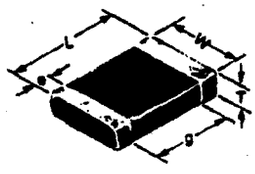
These new chip ceramic capacitors are specifically designed to replace tantalum units in surface mount applications. They offer the long term reliability and stability inherent to ceramic devices and are specifically designed for bypassing applications. Their high frequency D.F. and ESR performance is considerably improved over that possible with tantalum.

FEATURES

- Long term reliability
- Higher breakdown voltage
- No polarity considerations
- Low D.F. and ESR at higher frequencies
- Equivalent performance with lesser values in many applications

***EIA Preferred Size**

MURATA ERIE DESIGNATION		GRM39		GRM40		GRM42-6		GRM42-2		[illegible]	
EIA TYPE DESIGNATION		0603		[illegible]		[illegible]		[illegible]		[illegible]	
DIMENSIONS: in. (mm)	L	.060±.008 (1.5±0.2)		.080±.008 (2.0±0.2)		.125±.008 (3.2±0.2)		.125±.008 (3.2±0.2)		[illegible]	
	W	.030±.008 (0.75±0.2)		.050±.008 (1.25±0.2)		.080±.008 (1.5±0.2)		.100±.008 (2.5±0.2)		[illegible]	
	T max.	.035 (0.9)		.053 (1.35)		.060 (1.5)		.060 (1.5)		[illegible]	
	g min.	.020 (0.5)		.030 (0.75)		.040 (1.0)		.040 (1.0)		[illegible]	
	e	.014±.006 (0.35±0.2)		.020±.010 (0.5±0.25)		.020±.010 (0.5±0.25)		.020±.010 (0.5±0.25)		.020±.010 (0.5±0.25)	
WVDC		16		16		16		16		[illegible]	
Temperature Characteristic:		X7R	Y5V	X7R	Y5V	X7R	Y5V	X7R	Y5V	X7R	Y5V
Capacitance (μF)	.01										
	.012	.012									
	.015			.015							
	.018										
	.022		.027								
	.027	.027									
	.033				[illegible]						
	.039										
	.047										
	.056										
	.068										
	.082			[illegible]							
	.1										
	.12		.1					.12			
	.15						.15				
	.18										
	.22										
	.27				.22	.22					
	.33										
	.39							.33			
	.47										
	.56										
	.68								.68		
	.82									.56	
	1.0										
	1.2						1.0				
	1.5										
	1.8										
	2.2										2.2

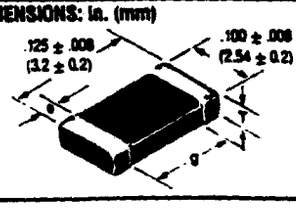


SUBCHIP CAPACITORS for LOW PROFILE & SUB-PLCC APPLICATIONS

FEATURES

- Sub-PLCC mounting of capacitor minimizes circuit inductance and allows higher packaging density.
- Available in standard Palladium/Silver (GR) or Nickel Barrier (GRM) Terminations.
- Available in Bulk or Tape & Reel.
- Reliability data available on request.
- Please contact factory for other values or dimensional requirements.

DIMENSIONS: in. (mm)



MURATA ERIE PART NUMBER	Value (μF)	Temp. Char.	WV	T max in. (mm)
GRM42-225Z5U154Z025	.15	Z5U	25	.024 (0.6)
GRM42-221Z5U224Z025	.22	Z5U	25	.026 (0.66)
GRM42-226Z5U334Z025	.33	Z5U	25	.028 (0.7)
GRM42-224Y5V154Z025	.15	Y5V	25	.020 (0.5)
GRM42-225Y5V224Z025	.22	Y5V	25	.024 (0.6)
GRM42-226Y5V334Z025	.33	Y5V	25	.028 (0.7)

PART NUMBERING SYSTEM

GRM42-221 Z5U 224 Z 025 A _

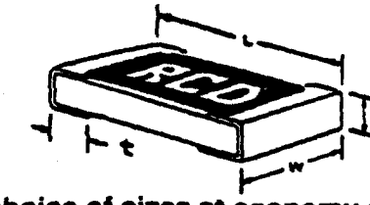
- Capacitor type and size
- Variation code indicating thickness controlled design
- Temperature characteristic
- Nominal capacitance
- Tolerance (+80, −20%)
- 3-digit voltage rating
- Unmarked
- *Packaging code

*B=Bulk
*D=T/R (7" reel, paper tape)

GRM42- · Y5V 155 Z016(B)

1/16 WATT TO 3 WATT

MC SERIES



FEATURES

- Wraparound termination with *No Leach*™ nickel barrier
- Heavy solder plating facilitates the soldering process whether vapor phase, infrared reflow, or wave
- 1% and 5% chips available from stock (refer to pg. 4)
- **Available on exclusive *'SWIFT'* delivery program**
- ZC is zero-ohm jumper, MC is 200 ppm, MCR is 100 ppm
- 4 digit marking available on 1% (except 0603) 3 digit on 2%, 5%, 10% tolerances — 1210 | 122
- Untrimmed chips available
- Bondable chips available

Wide choice of sizes at economy prices!

RCD's chip resistors were designed to meet the stringer ronmental requirements of MIL-R-55342. The MC Series therefore offer significant performance improvements ov try average. Pricing remains extremely competitive due t automated production. Delivery of the international stanc 1206 size is from stock in all 1% and 5% values from 10 RCD now offers a turnkey surface mount assembly se Why not consider us to assemble your next SM projec

ACTUAL SIZE	RCD Type MC-,MCR-,ZC-	MC/MCR Wattage at 70°C	MC/MCR Dual Rating*	MC/MCR Voltage Rating	TYPE ZC Amp Rating	STANDARD Resistance Range	L (Length)	W (Width)	T (Thickness)	t (ter
New!→	0603	.0625	0.1	50V	NA	10Ω to 1MΩ	.061 ± .005 [1.55 ± .12]	.031 ± .004 [.8 ± .1]	.016 ± .006 [.40 ± .15]	.010 [.25
	0805	0.1	0.125	100V	1A	10Ω to 1 MΩ	.079 ± .006 [2.0 ± .15]	.050 ± .006 [1.25 ± .15]	.020 ± .006 [.50 ± .15]	.016 [.4
	1A (Stock Item)	0.125	0.25	200V	2A	2.2Ω to 22 MΩ	.126 ± .008 [3.2 ± .2]	.061 ± .006 [1.55 ± .15]	.024 ± .006 [.61 ± .15]	.020 [.51
	1206	0.25	0.30	200V	2A	3.3Ω to 10 MΩ	.126 + .008 [3.2 ± .2]	.061 ± .006 [1.55 ± .15]	.024 ± .006 [.61 ± .15]	.020 [.51
	1210	0.25	0.50	200V	2A	10Ω to 2.2 MΩ	.126 ± .008 [3.2 ± .2]	.098 ± .008 [2.5 ± .2]	.024 ± .010 [.61 ± .25]	.020 : [.5 ±
	2010	0.50	0.75	200V	NA	10Ω to 2.2 MΩ	.197 ± .008 [5.0 ± .2]	.102 ± .008 [2.6 ± .2]	.025 ± .010 [.63 ± .25]	.020 : [.50 :
	2512	1.0	1.5	200V	3A	10Ω to 2.2 MΩ	.245 ± .015 [6.22 ± .38]	.125 ± .010 [3.2 ± .25]	.025 ± .010 [.63 ± .25]	
	4020**	2.0	3.0	350V	NA	10Ω to 2.2 MΩ	.394 ± .01 [10.0 ± .25]	.197 ± .010 [5.0 ± .25]	.028 ± .012 [.71 ± .3]	.035 : [.89 :

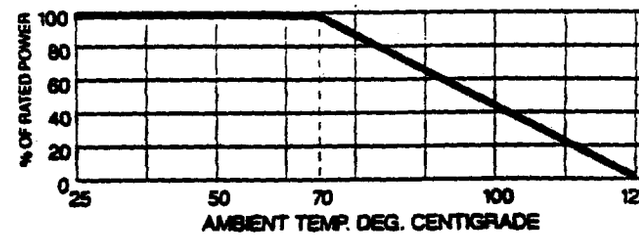
*Chips may be operated up to the dual rated level with consideration of mounting density, P.C. board material and ambient temperature to control self-heating to 125°C max.
**Information on MC 4020 is preliminary. Consult factory for availability.

PERFORMANCE CHARACTERISTICS

Characteristic	Test Method	Max. ΔR + .05Ω (10Ω to 1MΩ range)
Temperature Coefficient (Typ.)	-55 to + 125°C	±100 or ±200[1]ppm
Thermal Shock (-55° to + 150°C)	MIL-Std-202, M 107	0.5%
Short Time Overload (2.5 × 5 sec)[2]	M 55342 p. 4. 7. 5	0.5%
Low Temp. Operation (-55°C)	M 55342 p. 4. 7. 4	0.5%
High Temp. Exposure (125°C, 100 hrs)	M 55342 p. 4. 7. 6	0.5%
Resistance to Bonding Exposure	M 55342 p. 4. 7. 7	0.25%
Moisture Resistance	MIL -Std-202, M 106	0.5%
Load Life (1000 hours)	MIL-Std-202, M 108	1.0%*
Solderability	MIL-Std-202, M 208	95% Min. Coverage

*Load life for dual rating is ± 5% + .05Ω Max.
[1]"MCR" is 100ppm, "MC" is 200ppm 10Ω-1M, 400ppm <10Ω or > 1M
[2]STO test is 2x rated power on MC1206 type. STO test does not apply to dual wattage ratings.

DERATING CURVE



HOW TO ORDER:

MCR 1206 100Ω (ohm) 1% T

RCD Type (MC is 200 ppm, MCR is 100 ppm, ZC is chip jumper)

Resistance Value (.05Ω Max. on ZC type)

Tolerance (±1%, ±2%, ±5%, ±10%)

Packaging - 'B' is bulk, 'T' is Tape & Reel, 'M' is Magazine Cartridge

Also advise at the time of ordering whether marking on the chip is required. (RCD option if not specified by customer)

PACKAGING

Type MC-, MCR-, ZC-	Packaging Options*
0603, 0805	bulk, 8mm tape
1A, 1206	bulk, magazine, 8mm tape
1210	bulk, 8mm tape
2010, 2012, 2512	bulk, 12mm tape
4020	bulk, 16mm tape

*Standard 8mm tape is paper, other sizes are embossed plastic. Plastic tape and reels on 8mm size but must be requested at the time of ordering.

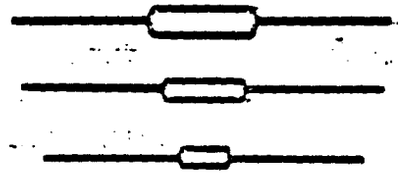
RCD Components, Inc., 520 East Industrial Park Dr., Manchester, NH USA 03103
Tel: (603) 669-0054 Fax: (603) 669-5455 Tlx: 943512

45,47-51, 53-58, 64, 65

OHMITE® AXIAL LEAD WIREWOUND RESISTORS

4

20 SERIES VITREOUS ENAMEL CONFORMAL COATING RESISTORS



Rugged, economical wirewound resistors for industrial applications. ±5% tolerance. 1kV dielectric breakdown voltage (500V for 1 watt size.) Typical temperature coefficient for 10 ohm and above: ±30 ppm/°C.

20 SERIES STANDARD OHMIC VALUES

1.0	12	36	82	250	500	1100	3300	7000	20000
1.5	15	39	100	270	560	1200	3500	7500	22000
2.0	18	40	120	300	600	1500	3900	8000	25000
2.2	20	47	125	330	680	1800	4000	9000	30000
3.0	22	50	150	350	750	2000	4500	10000	40000
4.0	25	56	180	360	800	2200	4700	12000	50000
5.0	27	62	200	400	820	2500	5000	13000	....
7.5	30	68	220	450	900	2700	6000	15000	....
10	33	75	225	470	1000	3000	6800	....	....

21J SERIES 1 WATT
Dimensions: .400"L x .156"D

Stock No.	Ohms	1-24	25-99	100-999
13F5000	1.0 to 7.5	2.67	2.44	2.01
13F5000	10 to 82	2.61	2.14	1.77
13F5000	100 to 900	2.77	2.36	1.84
13F5000	1K to 1.8K	2.84	2.41	1.89
13F5010	2K to 3K	2.84	2.41	1.89

22J SERIES 2 WATT
Dimensions: .442"L x .250"D

Stock No.	Ohms	1-24	25-99	100-999
13F5000	1.0 to 7.5	1.16	1.01	.82
13F5001	10 to 470	1.09	.86	.70
13F5001	500 to 900	1.36	1.07	.89
13F5001	1K	1.44	1.23	1.02
13F5002	1.1K to 2.7K	1.44	1.23	1.02
13F5002	3K to 4.7K	1.77	1.56	1.25
13F5002	5K	2.06	1.79	1.49
13F5003	6K to 10K	2.06	1.79	1.49

23J SERIES 3 WATT
Dimensions: 1.0"L x .250"D

Stock No.	Ohms	1-24	25-99	100-999
13F5004	1.0 to 7.5	1.34	1.09	.87
13F5005	10 to 470	1.19	.94	.77
13F5005	500 to 900	1.34	1.13	.94
13F5005	1K	1.66	1.32	1.09
13F5006	1.1K to 2.5K	1.66	1.32	1.09
13F5006	3K to 4.7K	1.82	1.66	1.37
13F5006	5K	2.29	1.87	1.54
13F5007	6K to 10K	2.29	1.87	1.54
13F5008	12K to 18K	2.29	1.87	1.54
13F5009	20K to 25K	2.29	2.34	1.84

26J SERIES 10 WATT
Dimensions: 1.797"L x .343"D

Stock No.	Ohms	1-24	25-99	100-999
13F5000	1.0 to 7.5	1.76	1.51	1.24
13F5001	10 to 18	1.66	1.32	1.19
13F5001	20 to 470	1.66	1.66	1.11
13F5001	500 to 900	1.82	1.66	1.37
13F5001	1K	2.66	1.73	1.42
13F5002	1.2K to 2.7K	2.66	1.73	1.42
13F5002	3K to 4.7K	2.99	1.86	1.65
13F5002	5K	2.99	2.66	1.66
13F5004	6K to 7.5K	2.99	2.66	1.66
13F5005	12K to 16K	2.99	2.66	1.66
13F5006	20K	3.11	2.84	2.19
13F5008	22K to 50K	3.11	2.84	2.19

40 SERIES SILICONE-CERAMIC CONFORMAL

Silicone-ceramic conformal axial lead resistors with ±5% tolerance, 1000VAC dielectric breakdown voltage. Temperature coefficient: less than 1 ohm - 60 ppm/°C; 1 to 10 ohms - ±40 ppm/°C; 10 ohms and greater - ±30 ppm/°C.

40 SERIES STANDARD OHMIC VALUES

.1	.5	10.0	50.0	1K
.15	.75	12.0	100	2K
.2	1.0	15.0	270	3.9K
.3	5.0	20.0	300	10.0K
....	....	....	350	....

40J SERIES 3 WATT
Dimensions: .442"L x .250"D

Stock No.	Ohms	1-24	25-99	100-999
44F5212	0.1 to 0.2	1.04	1.06	1.30
44F5212	0.3	1.08	1.10	.96
44F5213	0.5 to 0.75	1.08	1.10	.96
44F5213	1.0 to 5.0	.96	.96	.96
44F5214	10 to 300	.92	.76	.77
44F5215	1K	1.08	1.06	.84
44F5216	2K	1.08	1.06	.84
44F5218	3.9K	1.46	1.34	2.02
44F5217	10K	1.66	1.44	1.19

40J SERIES 5 WATT
Dimensions: .687"L x .343"D

Stock No.	Ohms	1-24	25-99	100-999
44F5218	0.1 to 0.2	2.32	1.66	1.03
44F5218	0.3	1.66	1.41	1.16
44F5219	0.5 to 0.75	1.66	1.41	1.16
44F5220	1.0 to 5.0	1.16	.96	.91
44F5221	10 to 300	.96	.92	.86
44F5241	2K	1.62	1.21	1.66
44F5241	3.9K	1.74	1.46	1.22
44F5222	10K	2.01	1.71	1.46

40J SERIES 10 WATT
Dimensions: 1.843"L x .406"D

Stock No.	Ohms	1-24	25-99	100-999
44F5223	0.1 to 0.2	2.76	2.27	1.96
44F5223	0.3	2.66	1.76	1.39
44F5224	0.5 to 0.75	2.66	1.76	1.39
44F5225	1.0 to 5.0	1.39	1.16	.92
44F5240	10 to 300	1.16	1.06	.92
44F5240	1K	1.71	1.46	1.39
44F5242	2K	1.71	1.46	1.39
44F5242	3K to 3.9K	2.66	1.77	1.46
44F5213	10K	2.41	2.66	1.66

60 SERIES SILICONE-CERAMIC-CONFORMAL

All welded-construction designed for high stability, precision power applications. Low temperature coefficient: 20 ppm/°C for 10 ohms and above. Dielectric withstanding voltage: 1000VAC. ±1% tolerance standard. Meet MIL-R-26 requirements.

STANDARD RESISTANCE - OHMS

.1	1.0	15.0	100.0	1K	24.9
.15	1.5	20.0	121.0	3.01K	30.1K
.20	2.0	24.9	200.0	3.32K	40.2K
.302	4.02	50.2	301.0	4.02K	49.9K
.499	4.99	61.9	499	5.11K	
.75	10.0	75.0	909.0	10K	

60F SERIES 3 WATT
Dimensions: .687"L x .219"D

Stock No.	Ohms	1-9	10-49	50-99
44F5227	01. to 0.2	3.44	2.92	2.41
44F5227	.75	2.46	2.08	1.73
44F5227	1.0	1.29	1.09	.96
44F5228	4.99	1.29	1.09	.96
44F5228	15 to 499	1.09	.92	.76
44F5228	909	1.37	1.16	.96
44F5228	1K	1.66	1.34	1.16
44F5228	3.01K to 4.02K	1.76	1.49	1.32
44F5228	5.11K to 10K	2.06	1.76	1.42

60F SERIES 5 WATT
Dimensions: .937"L x .343"D

Stock No.	Ohms	1-9	10-49	50-99
44F5229	0.1 to 0.2	4.19	3.46	2.67
44F5229	.75	2.64	2.01	2.06
44F5229	1.0	1.84	1.31	1.06
44F5229	2.0 to 4.99	1.84	1.31	1.09
44F5229	10.0 to 499	1.29	1.09	.96
44F5229	1K	1.66	1.09	1.32
44F5229	3.01K to 4.02K	1.66	1.09	1.32
44F5229	10K	2.16	1.76	1.57
44F5230	24.9K to 30.1K	2.46	2.07	1.71
44F5230	40.2K to 49.9K	2.46	2.07	1.71

60F SERIES 10 WATT
Dimensions: 1.843"L x .406"D

Stock No.	Ohms	1-9	10-49	50-99
44F5231	0.1 to 0.2	4.86	4.10	3.46
44F5231	.75	2.84	2.01	2.46
44F5232	1.0 to 4.99	1.84	1.66	1.39
44F5232	10.0 to 301	1.66	1.32	1.09
44F5232	1.0K	2.39	1.91	1.66
44F5233	3.01K to 4.02K	2.62	2.14	1.76
44F5233	5.11K to 10K	2.62	2.46	2.06
44F5234	24.9K to 30.1K	2.62	2.46	2.06
44F5234	40.2K to 49.9K	2.62	2.46	2.06

:OSTATS

' RHEOSTATS

E Series Rheostat

nic coating. Operate at maximum rat
t of 40°C. 300° rotation (±6°). .519"
t with ¼-32 bushing and hex nut on
diameter: ½". Order knob type 5151

Amps	1-4	5-9
.55 .39 .27 .12	45.17	36.33

NCLOSED MINIATURE
ATS

aximum hot spot temperature rise of
r operating at high military ambients.
ntances have vitreous enamel coate-
ner 1-ceramic casing, 300° ro-
ion. ±10%. Mount with ¼-32
thread, ...nuts. Shaft diameter: ½".
247 separately below.

Amps	1-9	10-24
3.530 2.800 2.040 1.440 1.250	22.30	16.51
1.120 0.910 0.710 0.600 0.500	22.30 22.30 19.52 19.52 19.52	16.51 16.51 15.48 15.48 15.48
0.410 0.380 0.320 0.270 0.220	19.52	15.48
0.190 0.160 0.130 0.100 0.080 0.070	19.52 19.52 19.52 20.69 20.69 20.69	15.48 15.48 15.48 14.84 14.84 14.84
0.060 0.050 0.041 0.036 0.029	21.39 21.39 22.99 22.99 22.99	15.83 15.83 16.99 16.99 16.99

DIAL PLATES

s are etched on a black background.
ie approximate percentage of rheo-
n of Use type 5001 with knob
5 ge 5000 with knob type
with ...b type 5151.

Type	Each
5001	5.66
5000	1.34
5007	1.34

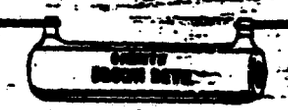
WIREWOUND RESISTORS

OHMITE

200 SERIES "BROWN DEVIL" VITREOUS ENAMEL WIREWOUND POWER RESISTORS

High quality, compact wirewound resistors for voltage-dropping, bias units, lessons, etc. Extra-sturdy vitreous enamel. Protected against shock, vibration, heat and humidity. Have standard ...

tolerance of ±5%. 5-watt units have 1x1½" cores; 12 watts, 1¼"x1¼" cores; 25-watt units, 2x1½" cores. All have 1½" leads.



13F150 B5J SERIES —5 WATT RESISTORS

Type	Ohms	Price Code	Type	Ohms	Price Code	Type	Ohms	Price Code	Type	Ohms	Price Code
B5J1R0	1	A	B5J30R	30	B	B5J500	500	B	B5J4K0	4,000	C
B5J1R5	1.5	A	B5J40R	40	B	B5J600	600	B	B5J5K0	5,000	C
B5J2R0	2	A	B5J50R	50	B	B5J1K0	1,000	B	B5J6K0	6,000	D
B5J3R0	3	A	B5J75R	75	B	B5J1K2	1,200	C	B5J7K0	7,000	D
B5J4R0	4	A	B5J100	100	B	B5J1K25	1,250	C	B5J7K5	7,500	D
B5J5R0	5	A	B5J125	125	B	B5J1K5	1,500	C	B5J8K0	8,000	D
B5J7R5	7.5	A	B5J150	150	B	B5J2K0	2,000	C	B5J10K	10,000	D
B5J10R	10	B	B5J200	200	B	B5J2K25	2,250	C	B5J12K5	12,500	D
B5J12R	12	B	B5J250	250	B	B5J2K5	2,500	C	B5J15K	15,500	D
B5J15R	15	B	B5J300	300	B	B5J3K0	3,000	C	B5J20K	20,000	E
B5J20R	20	B	B5J350	350	B	B5J3K5	3,500	C	B5J25K	25,000	E
B5J25R	25	B	B5J400	400	B						

B5J SERIES PRICE CODE

Price Code	1-24	25-99	100-249
A	1.85	1.69	1.32
B	1.55	1.32	1.06
C	1.63	1.39	1.14
D	1.59	1.53	1.29
E	2.11	1.79	1.48

13F155 B12J SERIES —12 WATT RESISTORS

Type	Ohms	Price Code	Type	Ohms	Price Code	Type	Ohms	Price Code	Type	Ohms	Price Code
B12J1R0	1	F	B12J40R	40	A	B12J700	700	A	B12J4K5	4,500	F
B12J1R5	1.5	F	B12J50R	50	A	B12J750	750	A	B12J5K0	5,000	F
B12J2R0	2	F	B12J75R	75	A	B12J800	800	A	B12J6K0	6,000	G
B12J3R0	3	F	B12J100	100	A	B12J1K0	1,000	A	B12J7K0	7,000	G
B12J4R0	4	F	B12J125	125	A	B12J1K2	1,200	F	B12J7K5	7,500	G
B12J5R0	5	F	B12J150	150	A	B12J1K250	1,250	F	B12J8K0	8,000	G
B12J7R5	7.5	A	B12J200	200	A	B12J1K5	1,500	F	B12J10K	10,000	G
B12J10R	10	A	B12J250	250	A	B12J1K75	1,750	F	B12J15K	15,000	G
B12J12R	12	A	B12J300	300	A	B12J2K0	2,000	F	B12J20K	20,000	H
B12J15R	15	A	B12J400	400	A	B12J2K25	2,250	F	B12J25K	25,000	H
B12J20R	20	A	B12J500	500	A	B12J2K5	2,500	F	B12J30K	30,000	I
B12J25R	25	A	B12J600	600	A	B12J3K0	3,000	F	B12J40K	40,000	I
B12J30R	30	A				B12J3K5	3,500	F	B12J45K	45,000	I
B12J35R	35	A				B12J4K0	4,000	F	B12J50K	50,000	I

B12J SERIES PRICE CODE

Price Code	1-24	25-99	100-249
A	1.85	1.69	1.32
F	3.19	1.89	
G	3.44	2.69	
H	3.61	3.12	
I	3.69	3.69	

13F160 B20J SERIES —20 WATT RESISTORS

Type	Ohms	Price Code	Type	Ohms	Price Code	Type	Ohms	Price Code	Type	Ohms	Price Code
B20J1R0	1	AA	B20J75R	75	BB	B20J500	500	BB	B20J5K0	5,000	CC
B20J2R0	2	AA	B20J100	100	BB	B20J650	650	BB	B20J10K	10,000	DD
B20J3R0	3	AA	B20J150	150	BB	B20J750	750	BB	B20J15K	15,000	FF
B20J4R0	4	AA	B20J200	200	BB	B20J1K0	1,000	BB	B20J20K	20,000	FF
B20J5R0	5	AA	B20J250	250	BB	B20J1K2	1,200	CC	B20J25K	25,000	FF
B20J10R	10	BB	B20J300	300	BB	B20J1K5	1,500	CC	B20J50K	50,000	FF
B20J25R	25	BB	B20J350	350	BB	B20J2K0	2,000	CC	B20J100K	100,000	GG
B20J50R	50	BB	B20J400	400	BB	B20J3K0	3,000	CC			

B20J SERIES PRICE CODE

Price Code	1-24	25-99	100-249
AA	2.64	2.59	2.13
BB	2.32	1.99	1.69
CC	2.54	2.19	1.79
DD	3.57	2.49	2.09
FF	3.15	2.69	2.19
GG	3.86	3.35	2.79

98 SERIES MOLDED VITREOUS ENAMEL WIREWOUND RESISTORS ±5% TOLERANCE

OHMITE

Axial-lead resistors with all-welded, molded construction and flame resistant vitreous enamel coating. Markings resist high temperatures, solvents and abrasions. Standard resistance tolerance: ±5%. Consistent form permits mounting in clips with heat sink: benefits up to 100%. Meets MIL-R-26 requirements for "insulated" resistors. Dielectric withstanding voltage: 1000VAC: 2, 3, 5, 7 & 10 watt rating; 500 VAC: 1 watt rating. Mounting hardware which exceeds power ratings available separately below.

98J SERIES 5% WATT

Stock No.	Ohms	Dimensions	1-24	25-99	100-249
13F145	1.0 to 7.5 10.0 to 1k 1.2k to 6k 6.8k to 10k	.565"Lx.234"D	1.38 1.14 1.68 2.34	1.16 .97 1.41 1.96	.95 .80 1.17 1.64

98J SERIES 8 WATT

Stock No.	Ohms	Dimensions	1-24	25-99	100-249
13F146	1.0 to 7.5 10.0 to 1k 1.2k to 6k 6.8k to 10k 12k to 20k 22k to 25k	.865"Lx.234"D	1.82 1.48 2.82 2.57 2.57 2.42	1.57 1.22 1.72 2.44 2.44 2.21	1.13 1.01 1.41 2.01 2.01 2.40

98J SERIES 11 WATT

Stock No.	Ohms	Dimensions	1-24	25-99	100-249
13F147	1.0 to 7.5 10.0 to 1k 1.2k to 6k 6.8k to 10k 12k to 20k 22k to 40k 47k to 50k	1.796"Lx.343"D	2.49 2.19 2.78 3.69 3.69 4.31 4.31	2.09 1.85 2.33 3.09 3.09 3.57 3.57	1.88 1.53 1.93 2.54 2.54 2.94 2.94

98 SERIES RESISTOR MOUNTING HARDWARE CLIPS — NEW

Stock No.	Type	Watts	Dimensions	Holes	1-9	10-99	100-249
98F7856	5800	1½	.40"Lx.160"W	1	.54	.71	.58
98F7859	5804	3½	.50"Lx.257"W	2	.54	.71	.58
98F7857	5806	5	.50"Lx.257"W	2	.54	.71	.58
98F7796	5808	11	1.75"Lx.333"W	2	.54	.71	.58

OHMIC VALUES FOR 98 SERIES RESISTORS

1.0	10	30	68	200	400	750	2200	4700	12000
1.5	12	33	75	220	470	800	2500	5000	15000
2.0	15	39	82	250	500	1000	2700	5600	18000
3.0	20	40	100	270	560	1200	3000	6000	20000
4.0	22	47	120	300	600	1500	3300	6800	22000
5.0	25	50	150	330	680	1800	3600	7500	25000
7.5	27	56	180	360	700	2000	4000	10000	50000

91J SERIES 1% WATT

Stock No.	Ohms	Dimensions	1-24	25-99	100-249
13F160	1.0 to 7.5 10.0 to 1k 1.2k to 3k	.437"Lx.140"D	2.36 2.04 2.67	2.25 2.20 2.53	2.14 1.86 2.60

GENERAL SPECIFICATIONS

ELECTRICAL	
Resistance range	10Ω~2MΩ
Resistance tolerance	±20%
Power ratings	0.25W (70°C), 0W (125°C)
Max. input voltage	200V
Max. wiper current	100mA
Electrical angle, nominal	210°
End resistance, max.	1% of resistance value or 2Ω, whichever is greater
Contact resistance variation	1% of resistance value or 3Ω, whichever is greater
Operating temperature	−55°C~125°C
Temp. coefficient, max.	10Ω to 50Ω: ±250ppm/°C, 100Ω~2MΩ: ±100ppm/°C
Insulation resistance, min.	1,000MΩ (DC500V)
Dielectric strength	500Vrms (1 minute)
MECHANICAL	
Mechanical angle, nominal	240°
Operating torque, max.	150gcm
Stop strength, min.	350gcm

ENVIRONMENTAL (MIL-R-22097/MIL-STD-202)

Item	Test conditions	ΔR/R	S.S.
Thermal shock	−65°C~125°C, 5 cycles	±2%	±1%
Humidity	80~98%RH, 10 cycles, 240 hrs.	±2%	–
Shock	100G, 6 directions, 3 times	±1%	±1%
Vibration	20G, 10~2,000Hz, 12 hrs.	±1%	±1%
Soldering heat	260°C 10 sec./or 215° 3 min.	±1%	–
Load life	70°C, rated power, 1,000 hrs.	±3%	±1%
Low temp. operation	−55°C, 2 hrs.	±2%	±2%
High temp. exposure	125°C, 250 hrs.	±3%	±2%
Rotational life	100 cycles	±(2Ω +3%)	–

ΔR/R: Change in total resistance, S.S.: setting stability

PACKAGING

ST-4A & B
1. Reeled tape (500 pcs per reel) tape width:12mm part pitch : 8mm
2. Plastic magazine (50 pcs per stick)
3. Vinyl bag (in bulk) (100 pcs per bag)

ST-4C
1. Plastic magazine (50 pcs per stick)
2. Vinyl bag (in bulk) (100 pcs per bag)

STANDARD RESISTANCE VALUES

CODE	OHMS	CODE	OHMS	CODE	OHMS	CODE	OHMS	CODE	OHMS	CODE	OHMS
100	10	101	100	102	1K	103	10K	104	100K	105	1M
200	20	201	200	202	2K	203	20K	204	200K	205	2M
500	50	501	500	502	5K	503	50K	504	500K		

APPLICATION NOTES

Parts will meet original specifications after exposure to:

Reflow Soldering: ..... Peak Temperature=240°C
Solder Melting Point Temp.=180°C
Time @ Melting Point=10 seconds maximum

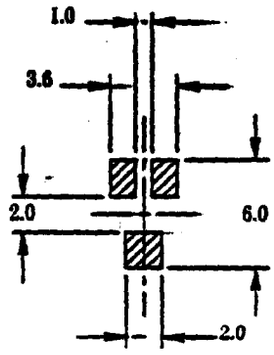
Vapor Phase Soldering: ... 180 seconds maximum @ 215°C or
10 seconds maximum @ 260°C

Wave Soldering: ..... Peak Temperature=260°C
Time in Solder Wave=4 seconds maximum

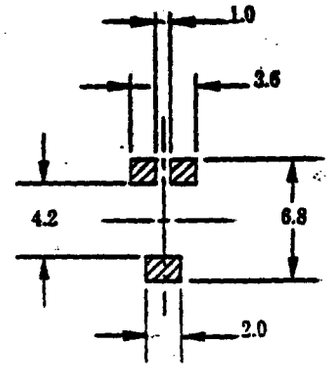
Manual Soldering: ..... Soldering Iron Tip Temp.=350°C maximum
Soldering Time=3 seconds maximum
Soldering Iron Wattage=40 watts maximum

P.C. BOARD PAD OUTLINE

ST-4A



ST-4B



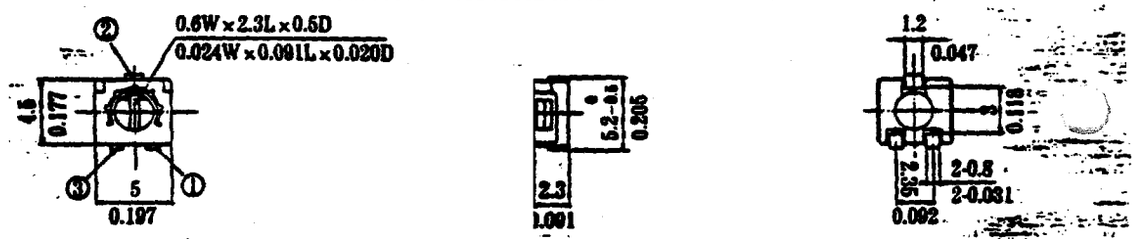
METRIC/ENGLISH CONVERSION TABLE

mm	inches
0.3	.012
1.0	.039
2.0	.079
3.6	.142
4.2	.165
6.0	.236
6.8	.268

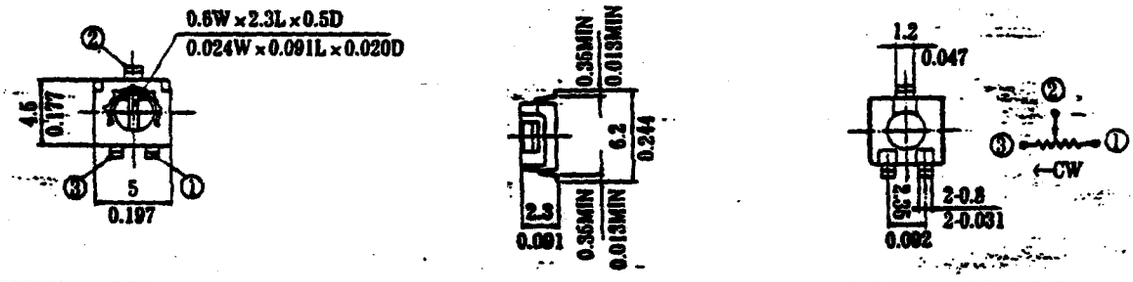
NOTES:
1. ALL DIMENSIONS ARE IN MILLIMETERS.
2. DIMENSIONAL TOLERANCES ARE ±0.3 UNLESS OTHERWI SPECIFIED.

DIMENSIONS (IN MM/INCH)

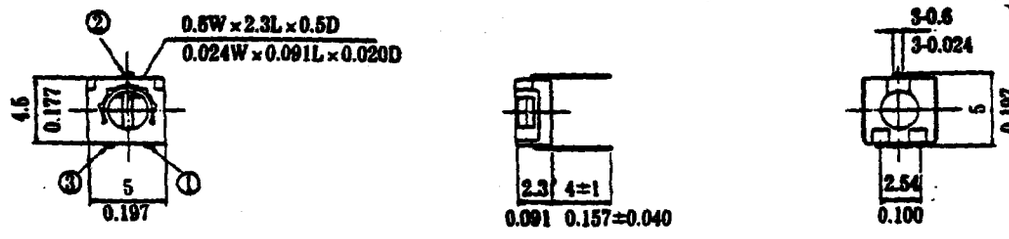
ST-4A
Top adjustment
J-Lead



ST-4B
Top adjustment
Gull Wing



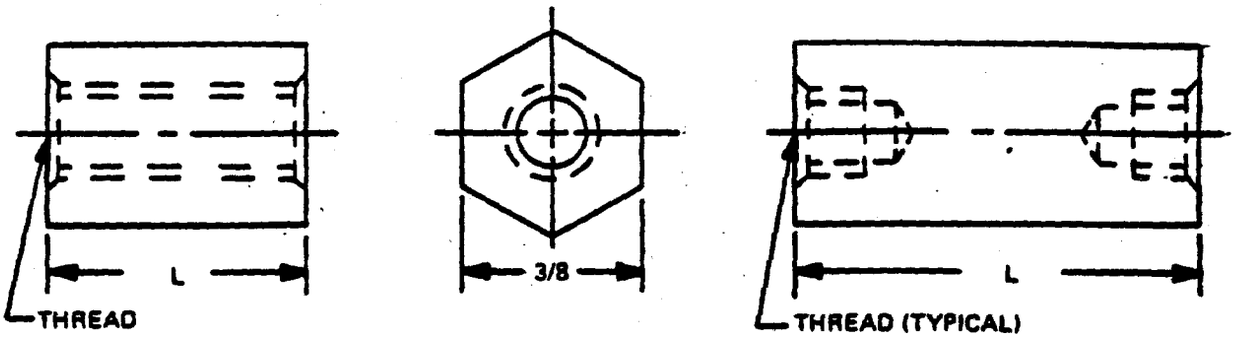
ST-4C
Top adjustment
Through Hole



Tolerances are ±0.3 mm and ±.012 inches

(63)

3/8 HEX FEMALE STANDOFFS



ORDERING CODE

XXXX XXXX X X

LENGTH | THREAD | MATERIAL | FINISH

See page [7] for thread depth
See page [6] for finish code
For parts not listed contact Sales Office

LENGTH	PART NO.
1/8	2232
3/16	2233
1/4	2234
5/16	2235
3/8	2236
7/16	2237
1/2	2238
9/16	2239
5/8	2240
11/16	2241
3/4	2242
13/16	2243
7/8	2244
15/16	2245
1"	2246
1-1/16	2247
1-1/8	2248
1-3/16	2249
1-1/4	2250
1-5/16	2251
1-3/8	2252
1-7/16	2253
1-1/2	2254
1-9/16	2255

LENGTH	PART NO.
1-5/8	2256
1-11/16	2257
1-3/4	2258
1-13/16	2259
1-7/8	2260
1-15/16	2261
2"	2262
2-1/8	2263
2-1/4	2264
2-3/8	2265
2-1/2	2266
2-5/8	2267
2-3/4	2268
2-7/8	2269
3"	2270
3-1/4	2271
3-1/2	2272
3-3/4	2273
4"	2274
4-1/4	2275
4-1/2	2276
4-3/4	2277
5"	2278
5-1/4	2279

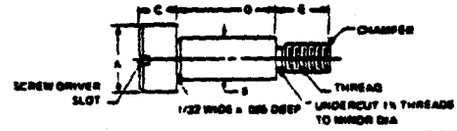
LENGTH	PART NO.
5-1/2	2280
5-3/4	2281
6"	2282
6-1/4	2283
6-1/2	2284
6-3/4	2285
7"	2286
7-1/4	2287
7-1/2	2288
7-3/4	2289
8"	2290
8-1/4	2291
8-1/2	2292
8-3/4	2293
9"	2294
9-1/4	2295
9-1/2	2296
9-3/4	2297
10"	2298

THREAD	CODE
6-32	632
8-32	832
10-32	1032
12-24	1224
1/4-20	2520

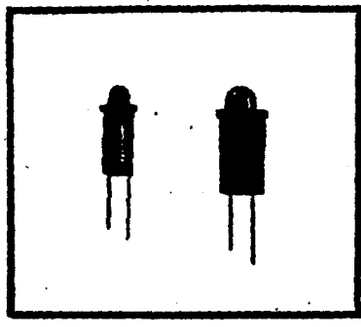
MATERIAL	CODE
Aluminum	A
Brass	B
Stainless Steel	SS
Steel	S
Nylon	N

PRECISION SHOULDER SCREWS—SLOTTED HEAD

See page [6] for finish code
For parts not listed
contact Sales Office



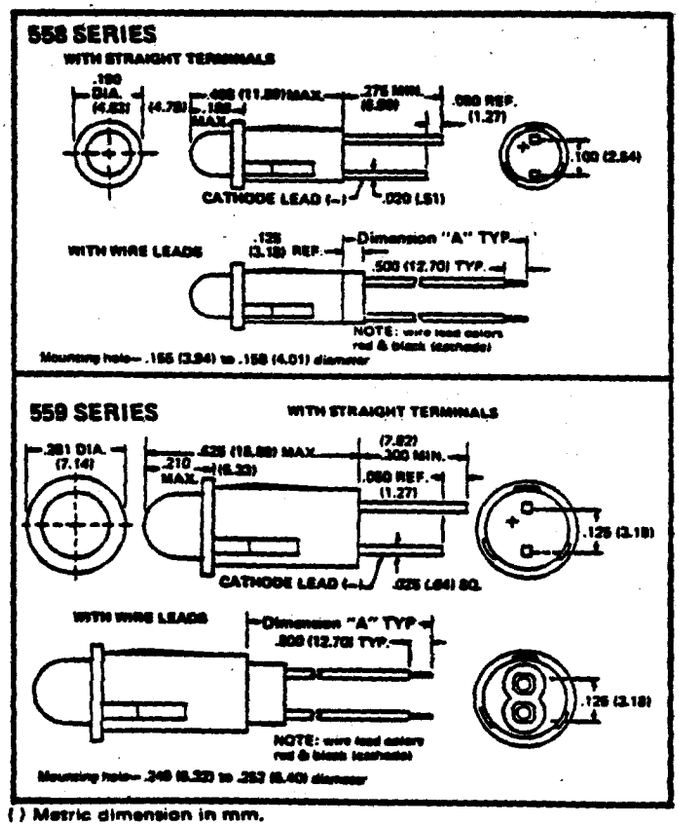
PART NO.	THREAD	A ±.004	B +.000 −.001	C ±.010	D +.002 −.000	E ±.005
7035	10-32	3/8	.2495	3/16	.1250	1/4
7036	10-32	3/8	.2495	3/16	.1875	1/4
7037	10-32	3/8	.2495	3/16	.2500	1/4
7038	10-32	3/8	.2495	3/16	.3125	1/4
7039	10-32	3/8	.2495	3/16	.3750	1/4
7040	10-32	3/8	.2495	3/16	.4375	1/4
7041	10-32	3/8	.2495	3/16	.5000	1/4
7042	10-32	3/8	.2495	3/16	.5625	1/4
7043	10-32	3/8	.2495	3/16	.6250	1/4
7044	10-32	3/8	.2495	3/16	.6875	1/4
7045	10-32	3/8	.2495	3/16	.7500	1/4
7046	10-32	3/8	.2495	3/16	.8750	1/4
7047	10-32	3/8	.2495	3/16	1.000	1/4
7048	10-32	3/8	.2495	3/16	1.250	1/4
7049	10-32	3/8	.2495	3/16	1.375	1/4
7050	10-32	3/8	.2495	3/16	1.500	1/4
7051	1/4-20	7/16	.3120	7/32	.2500	3/8
7052	1/4-20	7/16	.3120	7/32	.3125	3/8
7053	1/4-20	7/16	.3120	7/32	.3750	3/8
7054	1/4-20	7/16	.3120	7/32	.5000	3/8
7055	1/4-20	7/16	.3120	7/32	.6250	3/8
7056	1/4-20	7/16	.3120	7/32	.7500	3/8
7057	1/4-20	7/16	.3120	7/32	.8750	3/8
7058	1/4-20	7/16	.3120	7/32	1.000	3/8
7059	1/4-20	1/2	.3745	7/32	.2500	3/8
7060	1/4-20	1/2	.3745	7/32	.3125	3/8
7061	1/4-20	1/2	.3745	7/32	.3750	3/8
7062	1/4-20	1/2	.3745	7/32	.5000	3/8
7063	1/4-20	1/2	.3745	7/32	.6250	3/8
7064	1/4-20	1/2	.3745	7/32	.7500	3/8
7065	1/4-20	1/2	.3745	7/32	.8750	3/8
7066	1/4-20	1/2	.3745	7/32	1.000	3/8
7067	5/16-18	1/2	.3745	7/32	.2500	7/16
7068	5/16-18	1/2	.3745	7/32	.3125	7/16
7069	5/16-18	1/2	.3745	7/32	.3750	7/16
7070	5/16-18	1/2	.3745	7/32	.5000	7/16
7071	5/16-18	1/2	.3745	7/32	.6250	7/16
7072	5/16-18	1/2	.3745	7/32	.7500	7/16
7073	5/16-18	1/2	.3745	7/32	.8750	7/16
7074	5/16-18	1/2	.3745	7/32	1.000	7/16
7075	3/8-16	5/8	.4995	1/4	.2500	1/2
7076	3/8-16	5/8	.4995	1/4	.3125	1/2
7077	3/8-16	5/8	.4995	1/4	.3750	1/2
7078	3/8-16	5/8	.4995	1/4	.5000	1/2
7079	3/8-16	5/8	.4995	1/4	.6250	1/2
7080	3/8-16	5/8	.4995	1/4	.7500	1/2
7081	3/8-16	5/8	.4995	1/4	.8750	1/2
7082	3/8-16	5/8	.4995	1/4	1.000	1/2



Snap-in LED Indicators

.156" and .250" mounting hole

558 & 559 series



( ) Metric dimension in mm.

558 Series: Mount in .156" hole
559 Series: Mount in .250" hole

Features

- Snap-in mounting requires no additional hardware
- Available with Red, Green or Yellow LEDs, with and without integral current limiting resistors
- Compact design allows high density packaging:
  558 Series mounts on 0.2" centers
  559 Series mounts on 0.3" centers
- Straight terminals suitable for wire-wrapping and/or soldering, or wire leads
- Designed for quick positive insertion in panels from .031" through .062"
- Black housing enhances contrast ratio
- Polarity identified
- High Brightness LEDs
- Wide Angle visibility
- Low power requirements-10-20 mA
- Solid State reliability
- IC compatible
- Vibration and shock resistant

Applications

- Computers
- Process controllers
- Instrumentation
- Point of sale
- Communications equipment
- Medical equipment
- Home entertainment equipment
- Vending machines

Ordering Information

Series: 558 / 559 — Lamp Type, Electrical: 01 01 — Terminal Type: 00X

Lamp type (LED color)

Standard Efficiency	
01	Red diffused
02	Green diffused
03	Yellow diffused

High Efficiency*	
21	Red diffused
22	Green diffused
23	Yellow diffused

* 559 only

Electrical

01	Requires external resistor
02	5V, 15mA (01, 02, 03 lamp only)
03	12V, 15mA (01 lamp only-559 only)

Terminal type

001	Straight Terminals
Dimension "A" wire leads	
003	6.000 (152.40) Typ.
004	8.000 (203.20) Typ.
005	10.000 (254.00) Typ.
006	12.000 (304.80) Typ.
007	14.000 (355.60) Typ.

Dialight reserves the right to make changes at anytime in order to improve design and to supply the best product possible.

Standard Efficiency snap-in LED indicators 558 and 559 Series

Operating Characteristics — 558 and 559 Series without Integral Resistor

Symbol	Characteristics	RED Min.	RED Typ.	RED Max.	GREEN Min.	GREEN Typ.	GREEN Max.	YELLOW Min.	YELLOW Typ.	YELLOW Max.	Units		TEST CONDITIONS RED	TEST CONDITIONS GREEN	TEST CONDITIONS YELLOW
I_V	Luminous Intensity: 558 Series	.3	2.4		.8	2.0		1.0	2.5		mcd	I_F	20mA	20mA	10mA
	559 Series	.8	1.5		1.6	3.2		1.6	3.2				10mA		20mA
λ_{pk}	Wavelength: 558 Series		655			560			590		nm				
	559 Series		700												
V_F	Forward Voltage: 558 Series		1.5	2.0		2.4	3.0		2.2	3.0	V	I_F	20mA	20mA	10mA
	559 Series		1.9	2.4									5mA		20mA
BV_R	Reverse breakdown voltage	3.0			5.0			3.0			V	I_R	100µA* 10µA	10µA	10µA

*558-0101-XXX

Maximum Ratings — 558 and 559 Series without Integral Resistor

Characteristics	RED 558 Series Min.	RED 558 Series Max.	RED 559 Series Min.	RED 559 Series Max.	GREEN Min.	GREEN Max.	YELLOW Min.	YELLOW Max.	Units	TEST CONDITIONS
Power Dissipation		100		70		120		120	mW	derate from 25° C 1.62 mW/° C
Forward DC Current		50		30		30		558 20 559 30	mA	
Peak Forward Current		1				1		1	A	1µs pulse 300pps
Peak Reverse Voltage		5				5		5	V	
Operating temperature	-55	+100	-25	+80	-55	+100	-55	+100	°C	
Storage temperature			-30	+85						
Lead Soldering temperature		260				260		260	°C	

Operating Characteristics — 558 and 559 Series WITH INTEGRAL RESISTOR (5V and 12V*)

Symbol	Characteristics	RED Min.	RED Typ.	RED Max.	GREEN Min.	GREEN Typ.	GREEN Max.	YELLOW Min.	YELLOW Typ.	YELLOW Max.	Units	TEST CONDITIONS	Red	Gr., Yel.
I_V	Luminous Intensity 558 series	.3	.8		.5	2.0		.5	2.0		mcd	V_F	5.0V	5.0V
	558-0X02	.6			.8	2.0		.6	2.0		mcd	V_F	5.0V	5.0V
	559-0103	.6									mcd	V_F	12.0V	
λ_{pk}	Wavelength		655			565			590		nm			
I_F	Forward Current		15	20		15	20		15	20	mA	V_F	5.0V	5.0V
			12	20							mA	V_F	12.0V	
BV_R	Reverse Breakdown Voltage	3			3			3			V	I_R	10µA	10µA

Maximum Ratings — 558 and 559 Series WITH INTEGRAL RESISTOR (5V and 12V*)

Characteristics		RED Min.	RED Max.	YELLOW Min.	YELLOW Max.	GREEN Min.	GREEN Max.	Units	Test Conditions
DC Forward Voltage	558 & 559-0202, -0302		7.5		7.5		7.5	V	Derate to 5V at 100°C
	559-0102, -0103		14						Derate to 12V at 70° C
Reverse Voltage			7.0		7.0		7.0		
Operating & Storage temperature	(5V)	-55	+100					°C	
	(12V)	-55	+70					°C	
Lead Soldering Temp.			230		230		230	°C	Maximum 7 Seconds

*12V available in RED only.

(70, 71)

High Efficiency
Snap-in LED Indicators
559 series

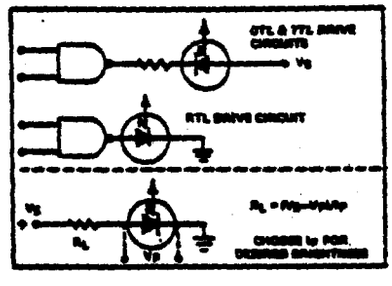
Absolute Maximum Ratings

Parameter	Red	Yellow	Green	Units
Power Dissipation (derate linearly from 25° C at 1.14mW/° C)	105	105	105	mW
Average Forward Current	35	35	35	mA
Peak Operating Forward Current (1μsec pulse width, 3% duty cycle)	1	1	1	A
Operating and Storage Temperature Range	-50° C to +100° C			
Lead Solder Temperature (1/16 inch from case)	230° C for 7 seconds			

Operating Characteristics at T_A = 25° C

Symbol	Parameter	Description	Min.	Typ.	Max.	Units	Test Conditions
V_F	Forward Voltage	Red & Yellow		2.2	3.0	V	I_F = 10mA
		Green		2.2	3.0	V	I_F = 20mA
BV_R	Reverse Voltage	All	5.0			V	I_R = 100μA
λpk	Peak Wavelength	Red		635		nm	Measurement at Peak
		Yellow		585		nm	Measurement at Peak
		Green		565		nm	Measurement at Peak
I_V	Luminous Intensity	Red	3.0	4.0		mcd	I_F = 10mA
		Yellow	2.2	3.0		mcd	I_F = 10mA
		Green	2.2	3.0		mcd	I_F = 20mA
τ_S	Rise and Fall Time	Red & Yellow		90		ns	
		Green		200		ns	
C	Capacitance	All		45		pF	V_F = 0, f=1MHz

Typical Drive Circuits



Typical Resistor Values

DC Voltage	Current @ 10 mA R_L	Current @ 20 mA R_L
3.6	150 Ω	75 Ω
5	330 Ω	150 Ω
6	390 Ω	180 Ω
10	820 Ω	390 Ω
14	1200 Ω	620 Ω
28	2700 Ω	1300 Ω

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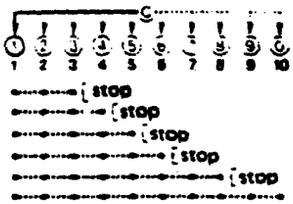
- Rating resistive circuit : 12 V 0,5 A – 24 V 0,3 A
- Minimum contact rating : 1 mA – 10 mV (See page 7)
- Contact resistance (nominal) : < 20 mΩ
- Dielectric strength
  between contacts : 1 kV eff. 50 Hz
  between contacts and body : 1 kV eff. 50 Hz
- Capacitance
  between contacts and shell : 2 pF
  between contacts : 1 pF
- Insulation resistance at ambient under 500 V = : 10 000 MΩ
- Non shorting contacts
- Life : 100 000 contacts

- Switch body : cadmiated bichromated
- Contacts : 2 μ gold on 2 μ nickel (multicon
- Termination spills : 2 μ gold on 2 μ nickel
- Insulator standard version : glass filled poly
  tropical version : P.B.T.P.
- Solder time : 5 seconds at 250°C
- Vibration : normal operation 10 – 500 ; 1,5 mm amplitude
- Operating temperature range : – 40
- Damp heat : 10 days to spec NFC 20
- Saline atmosphere : 96 hours to spec NFC 2

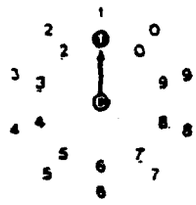
conformity to specifications and list

- ♦ Specification NFC 93413
- ✚ Included in NATO list.

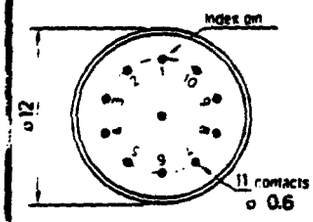
Electrical Schematic
For all models
Non - shorting contacts.



For shorting contacts consult SECME



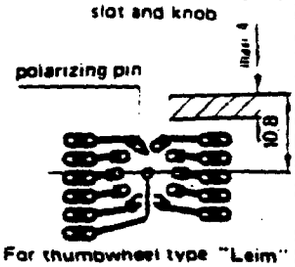
REAR VIEW



REAR VIEW
OF SWITCH BODY

Pad layout
track side of PCB

For "Leim's" with screwdriver slot and knob

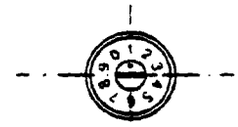


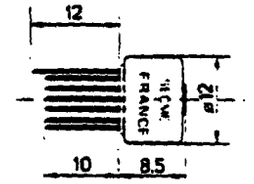
For thumbwheel type "Leim"

single pole positions

positions	PART NUMBER STANDARD	PART NUMBER TROPICAL	SPECIFICATIONS
3	26 11003 23	27 11003 23	♦HK 30 CCQ
4	26 11004 23	27 11004 23	♦HK 30 CCQ
5	26 11005 23	27 11005 23	♦HK 30 CCQ
6	26 11006 23	27 11006 23	✚ ♦HK 30 CCQ
8	26 11008 23	27 11008 23	✚ ♦HK 30 CCQ
10 Without stop	26 11000 23	27 11000 23	✚ ♦HK 30 CCQ

Weight : 3,5 g
Packaged in boxes of 10





TROPICAL VERSION : designed for wave soldering use a self adhesive removable pad.- see page 7

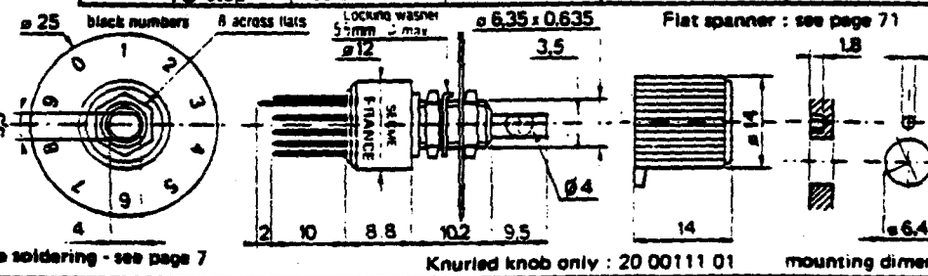
single pole positions

Delivered with knurled knob and aluminium disc.

positions	PART NUMBER STANDARD	PART NUMBER SEALED TO 1 BAR	SPECIFICATIONS
3	26 31003 23	27 31003 23	✚ ♦HK 30 CCQ
4	26 31004 23	27 31004 23	♦HK 30 CCQ
5	26 31005 23	27 31005 23	✚ ♦HK 30 CCQ
6	26 31006 23	27 31006 23	♦HK 30 CCQ
8	26 31008 23	27 31008 23	♦HK 30 CCQ
10 Without stop	26 31000 23	27 31000 23	♦HK 30 CCQ

Weight : 14,5 g
Packaged in boxes of 10

FOR TO : consult SEC.



Flat spanner : see page 71

SEALED : Version specially designed for wave soldering - see page 7

Knurled knob only : 20 00111 01

mounting dimens

single pole positions

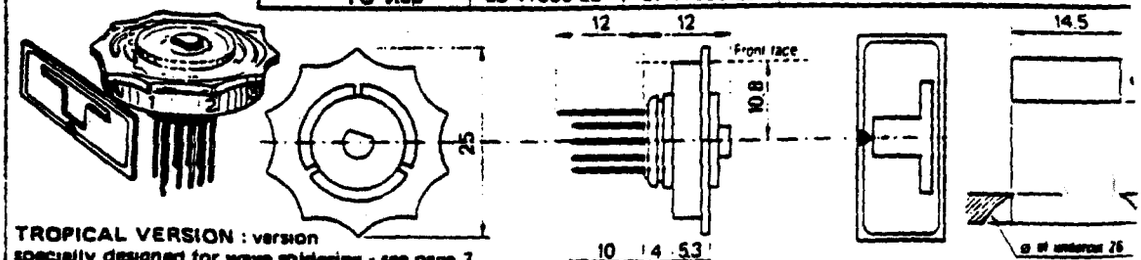
positions	PART NUMBER STANDARD	PART NUMBER TROPICAL
3	26 41003 23	27 41003 23
4	26 41004 23	27 41004 23
5	26 41005 23	27 41005 23
6	26 41006 23	27 41006 23
8	26 41008 23	27 41008 23
10 Without stop	26 41000 23	27 41000 23

Weight : 5 g
Packaged in boxes of 10

Delivered with aluminium strip havi black figures on a self-adhesive aluminium mask.

On request : aluminium disc with black letters 26 40998 81

For vertical impression : consult us



TROPICAL VERSION : version specially designed for wave soldering - see page 7

mounting dimensions

Flat Cable
9R280XX Series

BELDEN

.050 Pitch Rainbow Cable

Computer and Instrumentation
28 Gage
Stranded Conductors (7x36)

Product Description
Tinned copper (.050 conductor spacing). PVC preinsulated-laminated to a clear PVC film. Color code: Brown, Red, Orange, Yellow, Green, Blue, Violet, Gray, White, Black.

For additional gage size and centering options or C.S.A. approval, contact your nearest Belden Distributor or Belden Sales Representative.

Will terminate to any standard IDC connector.

Standard Specifications

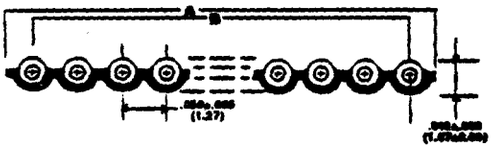
Voltage Rating	300V rms
Dielectric Withstand Voltage	2000V rms
Propagation Delay	GSG 1.4 ns/ft. (4.6 ns/M) nom.
Insulation Resistance	10^3MΩ (10 ft. sample)
Characteristic Impedance	150Ω GS, 105Ω GSG
Nominal Capacitance @ 1 MHz	10 pF/ft. (33 pF/m) GS 15 pF/ft. (49 pF/m) GSG
Inductance @ 1.MHz	0.29 µH/ft. (.95 µH/m) GS 0.20 µH/ft. (.66 µH/m) GSG
Standard Put-Up Length	100 ft. (30.4 m)
Cable Configuration Tested	GS=Ground–Signal GSG=Ground–Signal–Ground
Temperature Rating	–70°C to 150°C

Description U.L. Style	Trade No.	No. of Cond.	Nominal Width A Inch	A mm	B Inch	B mm
	9R28010†	10	.50	12.70	.45	11.4
	[illegible]	[illegible]	.70	17.78	.65	16.5
	9R28016†	16	.80	20.32	.75	19.1
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	9R28024†	24	1.20	30.48	1.15	29.2
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	9R28026†	26	1.30	33.02	1.25	31.8
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	9R28036†	36	1.80	45.70	1.75	44.5
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	9R28040†	40	2.00	50.80	1.95	49.5
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	9R28060†	60	3.00	76.20	2.95	74.9
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

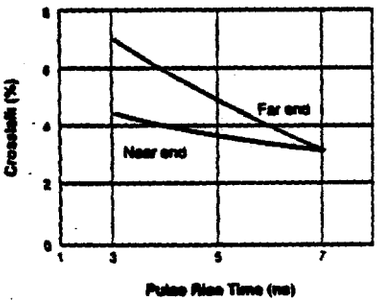
9A 2884
300V 105°C

† Passes VW-1 Vertical Wire Flame Test.

Dimensions inch (mm)

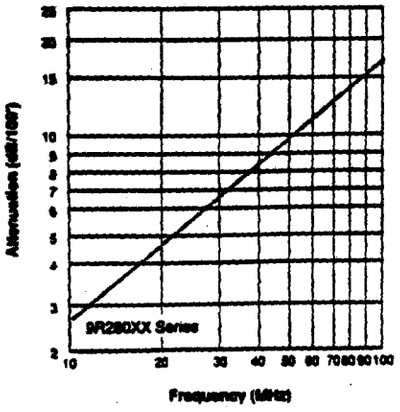


Unbalanced Crosstalk

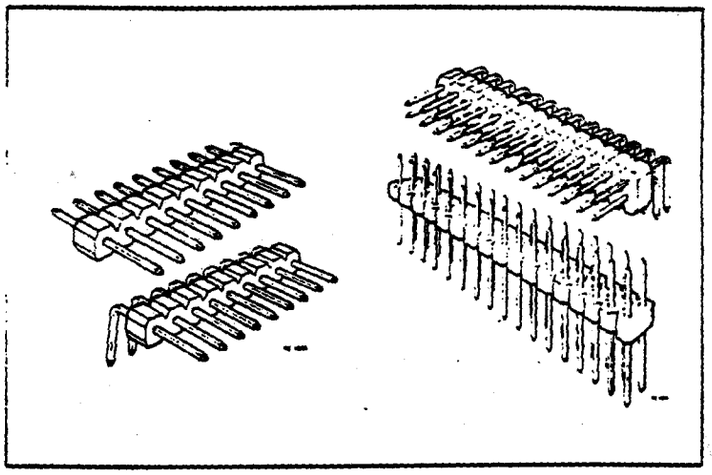


*GSG

Attenuation*



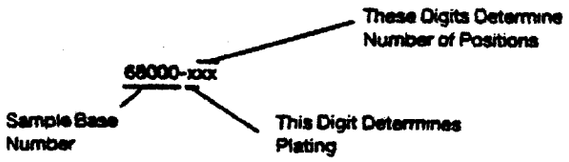
- **Can be manually broken to the desired length.**
- **Drawn 0,64 mm (0.025 in.) square wire presents 4 quality surfaces suitable for wire wrapping.**
- **Standoffs allow cleaning to eliminate soldering contaminates.**
- **Optional retention tail provides 0.5 lb minimum retention prior to soldering on 0.062 in. thick pc boards.**



Spacing		2,54 mm (0.100 in.) and 2,54 × 2,54 mm (0.100 × 0.100 in.)
Polarization		By omitting a pin
Body	**Material**	Glass-filled nylon (UL 94 V-0). Color black
	Insulation Resistance	5000 M Ω min.
	Temperature Range	−65° C to +105° C
	Withstanding Voltage	1500 V rms (sea level)
Pin	**Material**	Phosphor bronze
	Finish	Gold, tin-lead or GXT™ (see "Ordering Data")
	Current Rating	5A max.
	Retention Force to Body	8.9 N (2 lb.) in either direction

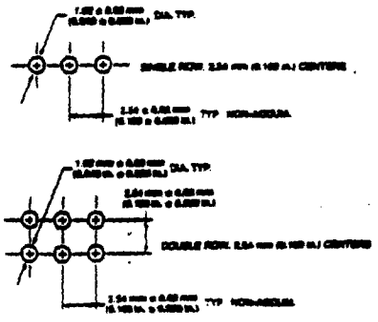
Note on Part Numbers

All parts in this section have an eight-digit part number: the first five digits are the base number; the last three digits constitute the dash number. In some of the following tables; dash numbers will be provided. In others, dash numbers will be indicated by -xxx; in this case, you must provide the dash number based on your particular plating and position requirements.



The number codes for available plating options are provided at the end of each part number list. The number of positions available are listed in their own column.

Recommended P.C.B. Hole Patterns



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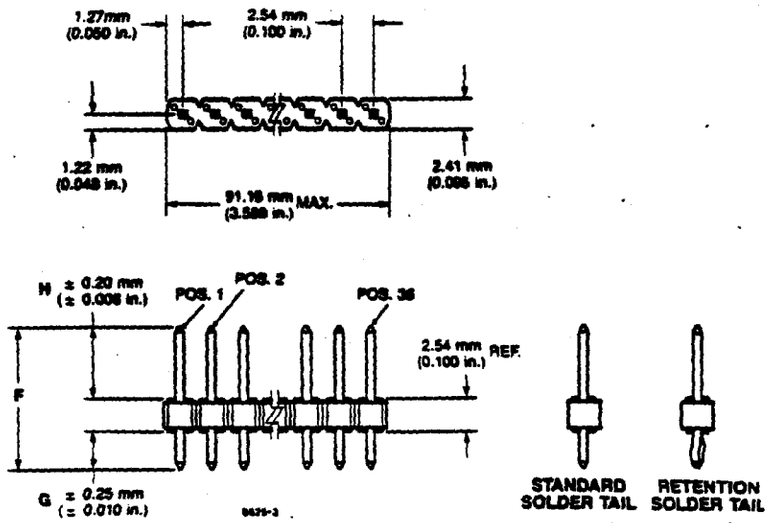
Straight Single Row
BergStik® II Headers



(Part number series preceded by " are not listed).

H Length Above Plastic		G Length Below Plastic		F Overall Length		Part Numbers Bold lettering indicates standard product	Number of	Plating*
mm	in.	mm	in.	mm	in.			
5.08	0.200	2.41	0.095	10.03	0.395	68705-xxx	1-36	1,2,3,4,5 or 6
5.84	0.230	2.41	0.095	10.80	0.425	68000-xxx	1-36	1,2,3,4,5 or 6
5.84	**0.230**	**3.05**	**0.120**	**11.43**	**0.450**	**68001-xxx**	**1-36**	**1,2,3,4,5 or 6**
5.84	**0.230**	**3.05**	**0.120**	**11.43**	**0.450**	**68180-xxx****	**1-36**	**1,2,3,4,5 or 6**
5.84	0.230	3.81	0.150	12.19	0.480	68002-xxx	1-36	1,2,3,4,5 or 6
5.84	0.230	4.65	0.183	13.03	0.513	68031-xxx	1-36	1,2,3,4,5 or 6
5.84	0.230	7.33	0.285	15.62	0.615	68717-xxx	1-36	1,2,3,4,5 or 6
5.84	0.230	9.86	0.388	18.24	0.718	68479-xxx	1-36	1,2,3,4,5 or 6
5.84	0.230	10.16	0.400	18.54	0.730	68418-xxx	1-36	1,2,3,4,5 or 6
5.84	0.230	12.27	0.483	20.65	0.813	68416-xxx	1-36	1,2,3,4,5 or 6
5.84	0.230	15.10	0.595	23.50	0.925	68465-xxx	1-36	1,2,3,4,5 or 6
5.84	0.230	17.65	0.695	26.04	1.025	68490-xxx	1-36	1,2,3,4,5 or 6
6.86	0.270	2.54	0.100	11.94	0.470	68771-xxx	1-36	1,2,3,4,5 or 6
7.11	0.280	17.02	0.670	26.67	1.050	68654-xxx	1-36	1,2,3,4,5 or 6
8.08	**0.318**	**3.05**	**0.120**	**13.67**	**0.538**	**"78511-xxx**	**1-36**	**1,2,3,4,5 or 6**
8.08	**0.318**	**3.05**	**0.120**	**13.67**	**0.538**	**"78229-xxx****	**1-36**	**1,2,3,4,5 or 6**
8.08	0.318	3.81	0.150	14.43	0.568	68024-xxx	1-36	1,2,3,4,5 or 6
8.08	0.318	5.72	0.225	16.33	0.643	68633-xxx	1-36	1,2,3,4,5 or 6
8.08	0.318	7.37	0.290	17.98	0.708	68655-xxx	1-36	1,2,3,4,5 or 6
8.08	0.318	10.59	0.417	21.21	0.835	68483-xxx	1-36	1,2,3,4,5 or 6
8.59	0.338	1.57	0.062	12.70	0.500	68795-xxx	1-36	1,2,3,4,5 or 6
8.64	0.340	11.18	0.440	22.35	0.880	68731-xxx	1-36	1,2,3,4,5 or 6
9.65	0.380	3.05	0.120	15.24	0.600	68604-xxx	1-36	1,2,3,4,5 or 6
10.16	0.400	2.92	0.115	15.62	0.615	68415-xxx	1-36	1,2,3,4,5 or 6
10.16	0.400	5.16	0.203	17.86	0.703	68631-xxx	1-36	1,2,3,4,5 or 6
10.16	0.400	10.49	0.413	23.19	0.913	68472-xxx	1-36	1,2,3,4,5 or 6
10.16	0.400	15.57	0.613	28.27	1.113	68656-xxx	1-36	1,2,3,4,5 or 6
11.63	0.458	11.63	0.458	25.81	1.016	68686-xxx	1-36	1,2,3,4,5 or 6
12.70	0.500	3.05	0.120	18.29	0.720	69152-xxx	1-36	1,2,3,4,5 or 6
13.54	0.533	13.56	0.533	29.62	1.166	68755-xxx	1-36	1,2,3,4,5 or 6
13.72	0.540	2.41	0.095	18.67	0.735	68653-xxx	1-36	1,2,3,4,5 or 6
14.99	0.590	3.30	0.130	20.83	0.820	68658-xxx	1-36	1,2,3,4,5 or 6
15.24	0.600	5.41	0.213	15.24	0.600	68689-xxx	1-36	1,2,3,4,5 or 6
15.49	0.610	2.92	0.115	20.96	0.825	68456-xxx	1-36	1,2,3,4,5 or 6
17.70	0.697	3.25	0.128	23.50	0.925	68466-xxx	1-36	1,2,3,4,5 or 6
17.78	0.700	17.02	0.670	37.34	1.470	68652-xxx	1-36	1,2,3,4,5 or 6

*See plating designations on page 113.
**Retention solder tail part number.