TRA3225

Medium-Current Silicon Rectifier

250 Volts, 32 Amperes

Compact, highly efficient silicon rectifiers for medium–current applications requiring:

- High Current Surge – 500 Amperes @ T_J = 175°C
- Peak Performance @ Elevated Temperature – 32 Amperes
- Low Cost
- Compact, Molded Package for Optimum Efficiency in a Small Case Configuration

Mechanical Characteristics

- Finish: All External Surfaces are Corrosion Resistant, and Contact Areas are Readily Solderable
- Polarity: Indicated by Cathode Band
- Weight: 1.8 Grams (Approximately)
- Maximum Temperature for Soldering Purposes: 260°C
- Marking: 3225

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
DC Blocking Voltage	V_R	250	Volts
Non–Repetitive Peak Reverse Voltage (Halfwave, Single Phase, 60 Hz)	V_{RSM}	310	Volts
Average Forward Current (Single Phase, Resistive Load, T_C = 150°C)	I_O	32	Amps
Non–Repetitive Peak Surge Current (Halfwave, Single Phase, 60 Hz)	I_{FSM}	500	Amps
Operating Junction Temperature Range	T_J	–65 to +175	°C
Storage Temperature Range	T_{stg}	–65 to +175	°C

ON Semiconductor™

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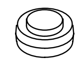


MICRODE BUTTON
CASE 193

MARKING DIAGRAM

3225 = Device Code
L = Location Code
YY = Year
WW = Work Week

ORDERING INFORMATION

Device	Package	Shipping
TRA3225	Microde Button	5000 Units/Box

THERMAL CHARACTERISTICS

Characteristic	Symbol	Value	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.8	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Max	Unit
Instantaneous Forward Voltage (Note 1.) (I_F = 100 Amps, T_C = 25°C)	V_F	–	1.15	Volts
Reverse Current (Note 1.) (V_R = 250 V, T_C = 25°C) (V_R = 250 V, T_C = 100°C)	I_R	 – –	 20 250	μA
Forward Voltage Temperature Coefficient (I_F = 10 mA)	V_{FTC}	– 2*	– 2*	mV/°C

1. Pulse Test: Pulse Width < 300 μs, Duty Cycle < 2%.

*Typical

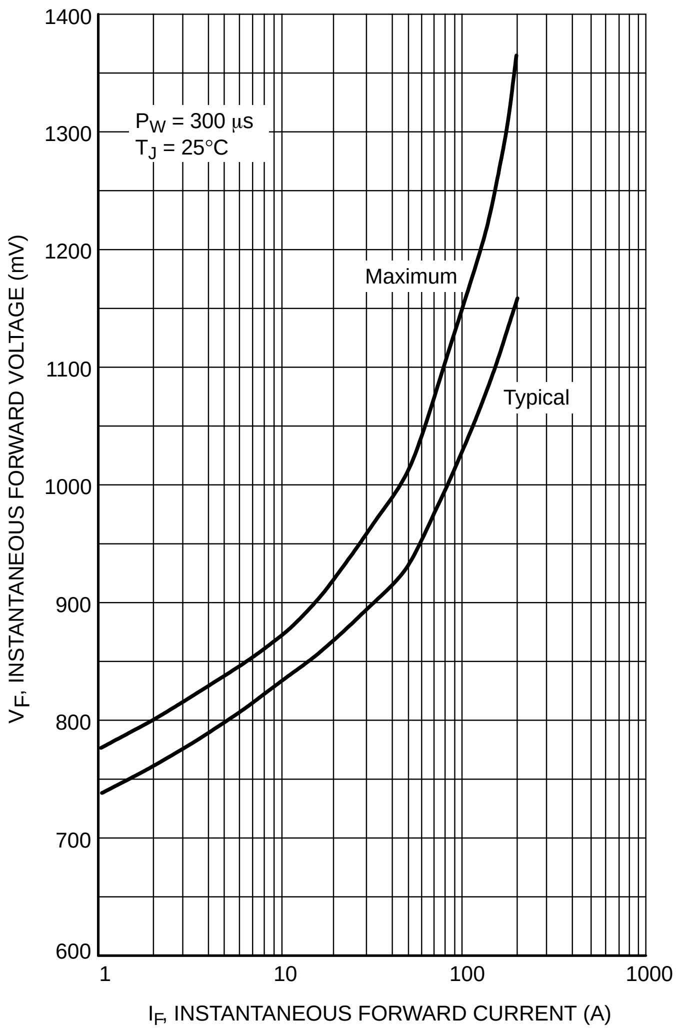


Figure 1. Forward Voltage

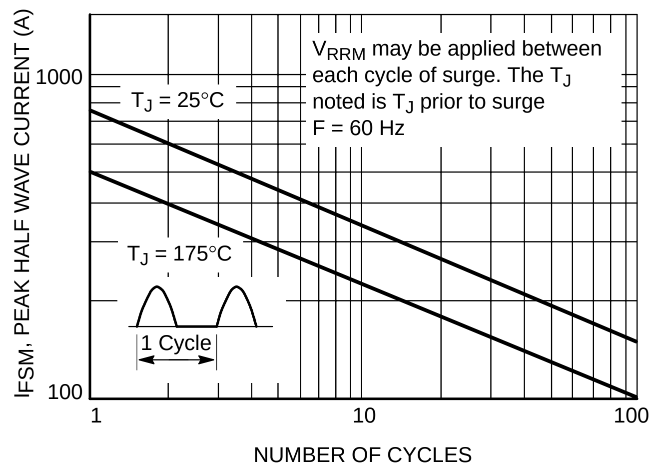


Figure 2. Non–Repetitive Surge Current

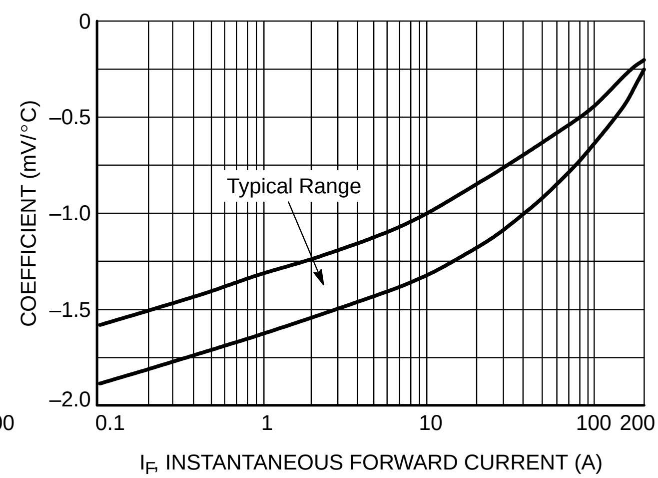


Figure 3. V_F Temperature Coefficient

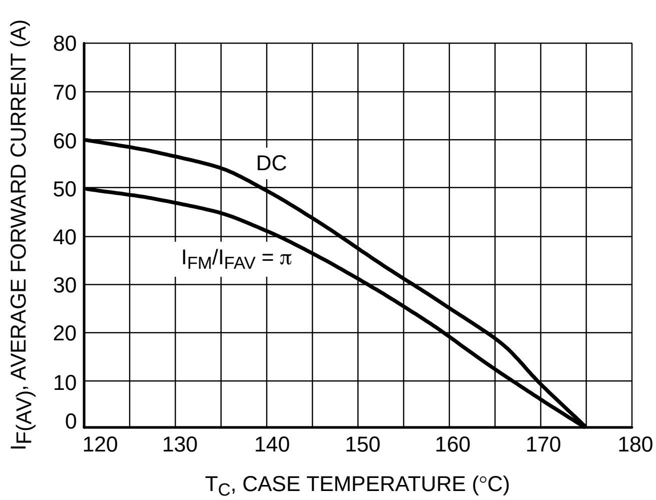


Figure 4. Current Derating

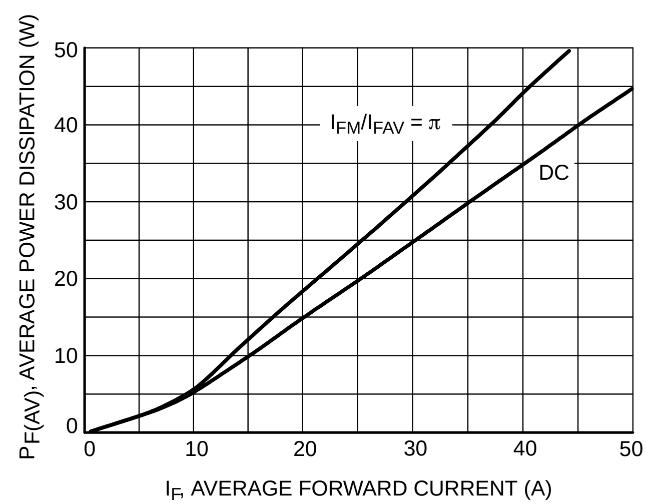


Figure 5. Forward Power Dissipation

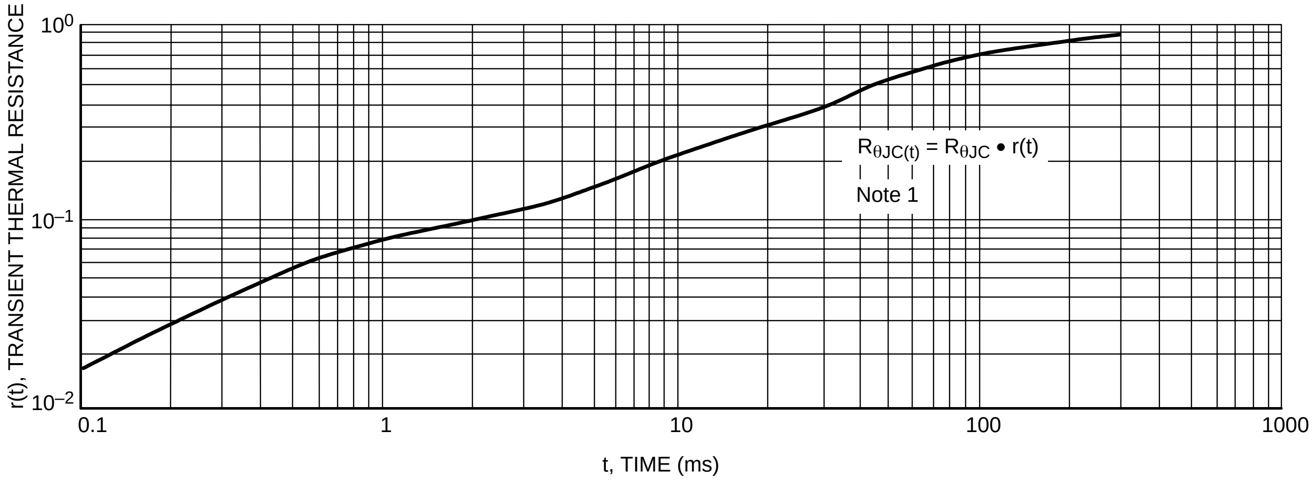
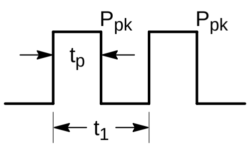


Figure 6. Thermal Response

NOTE 1



DUTY CYCLE, $D = t_p/t_1$
PEAK POWER, P_{pk} is peak of an equivalent square power pulse

To determine maximum junction temperature of the diode in a given situation, the following procedure is recommended.

The temperature of the case should be measured using a thermocouple placed on the case at the temperature reference point (see the outline drawing on page 1). The thermal mass connected to the case is normally large enough so that it will not significantly respond to heat surges generated in the diode as a result of pulse operation once steady state conditions are achieved.

Using the measured value of T_C, the junction temperature may be determined by:

$$T_J = T_C + \Delta T_{JC}$$

Where ΔT_{JC} is the increase in junction temperature above the case temperature, it may be determined by:

$$\Delta T_{JC} = P_{pk} \cdot R_{\theta JC} [D + (1 - D) \cdot r(t_1 + t_p) + r(t_p) - r(t_1)]$$

where:

$r(t)$ = normalized value of transient thermal resistance at time, t, from Figure 6, i.e.:

$r(t_1 + t_p)$ = normalized value of transient thermal resistance at time $t_1 + t_p$.

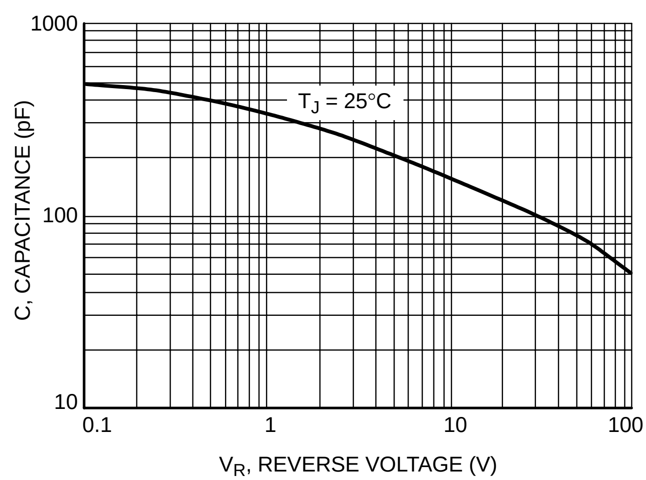


Figure 7. Typical Capacitance

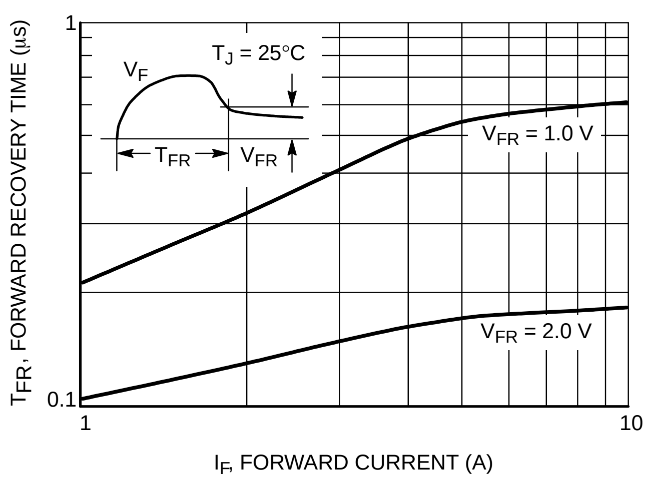


Figure 8. Forward Recovery Time

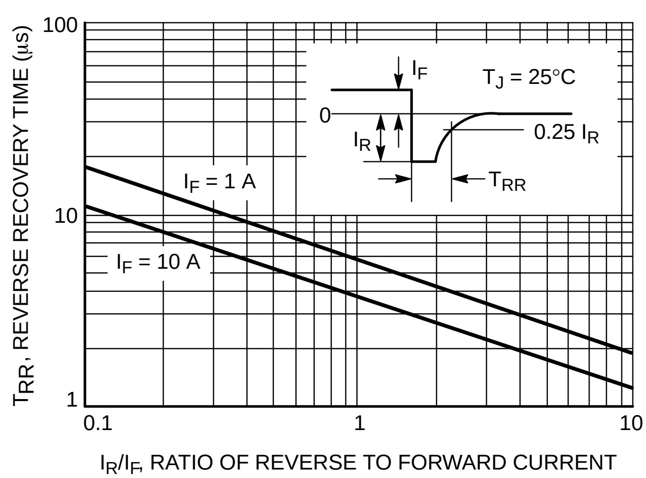


Figure 9. Reverse Recovery Time

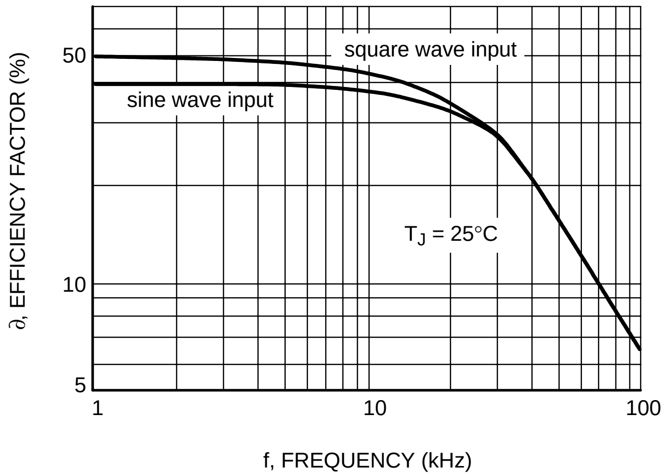


Figure 10. Rectification Waveform Efficiency

RECTIFICATION EFFICIENCY NOTE

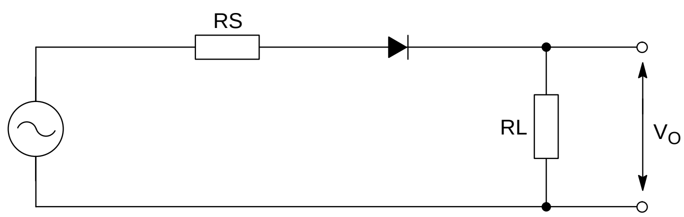


Figure 11. Single Phase Half–Wave Rectifier Circuit

The rectification efficiency factor ∂ shown in Figure 10 was calculated using the formula:

$$\partial = \frac{P_{(dc)}}{P_{(rms)}} = \frac{\frac{V^2{}_{o(dc)}}{R_L}}{\frac{V^2{}_{o(rms)}}{R_L}} \cdot 100\% = \frac{V^2{}_{o(dc)}}{V^2{}_{o(ac)} + V^2{}_{o(dc)}} \cdot 100\% \qquad (1)$$

For a sine wave input Vm sin(wt) to the diode, assume lossless, the maximum theoretical efficiency factor becomes:

$$\partial_{(sine)} = \frac{\frac{V^2{}_m}{\pi^2 R_L}}{\frac{V^2{}_m}{4R_L}} \cdot 100\% = \frac{4}{\pi^2} \cdot 100\% = 40.6\% \qquad (2)$$

For a square wave input of amplitude Vm, the efficiency factor becomes:

$$\partial_{(square)} = \frac{\frac{V^2{}_m}{2R_L}}{\frac{V^2{}_m}{R_L}} \cdot 100\% = 50\% \qquad (3)$$

(a full wave circuit has twice these efficiencies)

As the frequency of the input signal is increased, the reverse recovery time of the diode (Figure 9) becomes significant, resulting in an increase ac voltage component across RL which is opposite in polarity to the forward current, thereby reducing the value of the efficiency factor ∂, as shown on Figure 10.

It should be emphasized that Figure 10 shows waveform efficiency only; it does not provide a measure of diode losses. Data was obtained by measuring the ac component of V_O with a true rms ac voltmeter and the dc component with a dc voltmeter. The data was used in Equation 1 to obtain points for Figure 10.

Assembly and Soldering Information

There are t*wo basic areas* of consideration for successful implementation of button rectifiers:

1. Mounting and Handling
2. Soldering

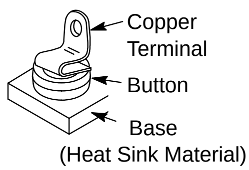
Each should be carefully examined before attempting a finished assembly or mounting operation.

Mounting and Handling

The button rectifier lends itself to a multitude of assembly arrangements, but one key consideration must *always* be included: One Side of the Connections to the Button Must be Flexible!

This stress relief to the button should also be chosen for maximum contact area to afford the best heat transfer – but not at the expense of flexibility. For an annealed copper terminal a thickness of 0.015″ is suggested.

Strain Relief Terminal
for Button Rectifier



The base heat sink may be of various materials whose shape and size are a function of the individual application and the heat transfer requirements.

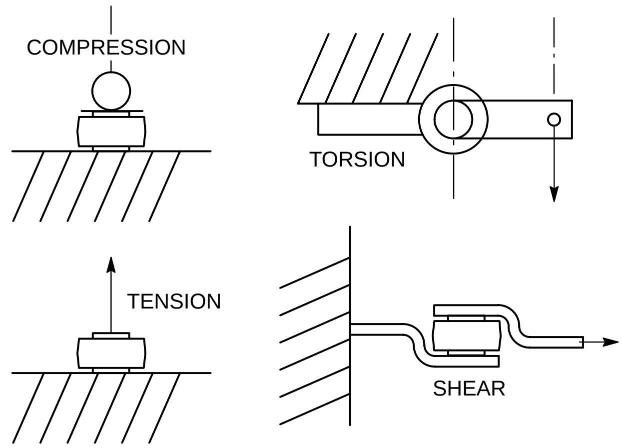
Common Materials	Advantages and Disadvantages
Steel	Low Cost: relatively low heat conductivity
Copper	High Cost: high heat conductivity
Aluminum	Medium Cost: medium heat conductivity. Relatively expensive to plate and not all platers can process aluminum.

Handling of the button during assembly must be relatively gentle to minimize sharp impact shocks and avoid nicking of the plastic. Improperly designed automatic handling equipment is the worst source of unnecessary shocks. Techniques for vacuum handling and spring loading should be investigated.

The mechanical stress limits for the button diode are as follows:

Compression	32 lbs.	142.3 Newton
Tension	32 lbs.	142.3 Newton
Torsion	6–inch lbs.	0.68 Newtons–meters
Shear	55 lbs.	244.7 Newton

MECHANICAL STRESS



Exceeding these recommended maximums can result in electrical degradation of the device.

Soldering

The button rectifier is basically a semiconductor chip bonded between two nickel–plated copper heat sinks with an encapsulating material of epoxy compound. The exposed metal areas are also tin plated to enhance solderability.

In the soldering process it is important that the temperature not exceed 260°C if device damage is to be avoided. Various solder alloys can be used for this operation but two types are recommended for best results:

1. 95% Sn, 5% Sb; melting point 237°C
2. 96.5% tin, 3.5% silver; melting point 221°C
3. 63% tin, 37% lead; melting point 183°C

Solder is available as preforms or paste. The paste contains both the metal and flux and can be dispensed rapidly. The solder preform requires the application of a flux to assure good wetting of the solder. The type of flux used depends upon the degree of cleaning to be accomplished and is a function of the metal involved. These fluxes range from a mild rosin to a strong acid; e.g., Nickel plating oxides are best removed by an acid base flux while an activated rosin flux may be sufficient for tin plated parts.

Since the button is relatively lightweight, there is a tendency for it to float when the solder becomes liquid. To prevent bad joints and misalignment, it is suggested that a weighting or spring loaded fixture be employed. It is also important that severe thermal shock (either heating or cooling) be avoided as it may lead to damage of the die or encapsulant of the part.

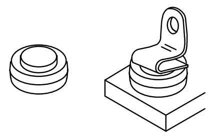
Button holding fixtures for use during soldering may be of various materials. Stainless steel has a longer use life while black anodized aluminum is less expensive and will limit heat reflection and enhance absorption. The assembly volume will influence the choice of materials. Fixture dimension tolerances for locating the button must allow for expansion during soldering as well as allowing for button clearance.

Heating Techniques

The following four heating methods have their advantages and disadvantages depending on volume of buttons to be soldered.

1. **Belt furnaces** readily handle large or small volumes and are adaptable to establishment of “on–line’’ assembly since a variable belt speed sets the run rate. Individual furnace zone controls make excellent temperature control possible.
2. **Flame Soldering** involves the directing of natural gas flame jets at the base of a heatsink as the heatsink is indexed to various loading–heating–cooling–unloading positions. This is the most economical labor method of soldering large volumes. Flame soldering offers good temperature control but requires sophisticated temperature monitoring systems such as infrared.
3. **Ovens** are good for batch soldering and are production limited. There are handling problems because of slow cooling. Response time is load dependent, being a function of the watt rating of the oven and the mass of parts. Large ovens may not give an acceptable temperature gradient. Capital cost is low compared to belt furnaces and flame soldering.
4. **Hot Plates** are good for soldering small quantities of prototype devices. Temperature control is fair with overshoot common because of the exposed heating surface. Solder flow and positioning can be corrected during soldering since the assembly is exposed. Investment cost is very low.

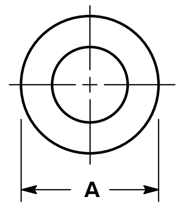
Regardless of the heating method used, a soldering profile giving the time–temperature relationship of the particular method must be determined to assure proper soldering. Profiling must be performed on a scheduled basis to minimize poor soldering. The time–temperature relationship will change depending on the heating method used.

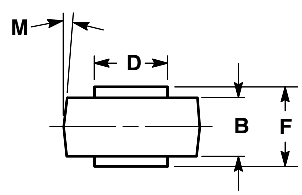


SCALE 1:1

MICRODE
CASE 193−04
ISSUE L

DATE 22 SEP 2003





NOTES:
1. CASE 193−03 OBSOLETE, NEW STANDARD 193−04.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	8.43	8.69	0.332	0.342
B	4.19	4.45	0.165	0.175
D	5.54	5.64	0.218	0.222
F	5.94	6.25	0.234	0.246
M	5 °NOM		5 °NOM	

GENERIC MARKING DIAGRAM*

DEV	= Specific Device Code
A	= Assembly Location
YY	= Year
WW	= Work Week

*This information is generic. Please refer to device data sheet for actual part marking.

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DESCRIPTION:	**CASE 193−04, MICRODE**		**PAGE 1 OF 1**

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