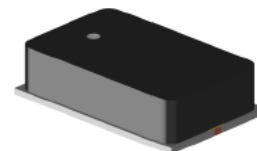


## PIN Diode Limiter 2 - 8 GHz

Rev. V1

### Features

- Surface Mount SP2T Switch in Compact Outline:  
8 L x 5 W x 2.5 H mm Package
- Incorporates PIN Limiter & Schottky Diodes
- DC Blocks & DC Return
- Higher Average Power Handling than Plastic  
Packaged MMIC Switches: 100 W CW
- Low Insertion Loss: 1.1 dB
- Low Flat Leakage Power: 21 dBm
- RoHS\* Compliant



### Description

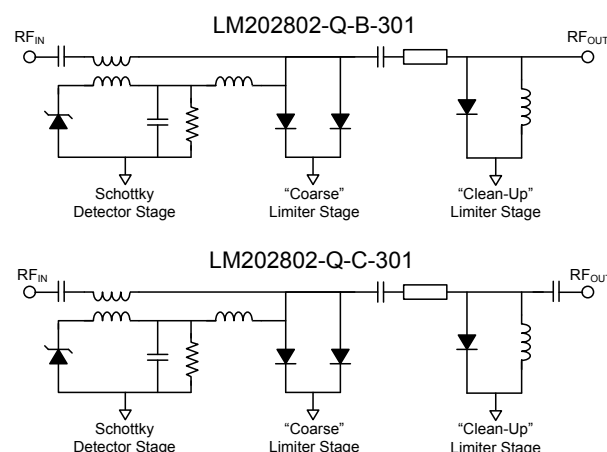
The LM202802-Q-x-301 Surface Mount Silicon PIN Diode Limiters are manufactured using a proven hybrid manufacturing process incorporating PIN diodes and passive devices integrated within a ceramic substrate. This low profile, compact, surface mount component, offers superior low and high signal performance to comparable MMIC devices in QFN packages. The limiter modules are designed to optimize small signal insertion loss, noise figure and high signal flat leakage performance in a compact, surface mount package.

Using PIN diodes with lower thermal resistance ( $<20^{\circ}\text{C/W}$ ), and a de-coupled Schottky detector network as a current source, RF CW incident power levels of 50 dBm and RF peak incident power levels of 60 dBm @ 25  $\mu\text{s}$  RF pulse width, 5% duty cycle are very achievable. In addition, this design concept provides lower flat leakage power ( $<21$  dBm) and lower spike leakage energy ( $<0.5$  Ergs) for superior LNA protection. The LM202802-Q-x-301 limiter can be configured without a DC block on the output to obtain lower flat leakage power ( $<10$  dBm) with an external ZBD schottky diode. This limiter part number is LM202802-Q-B-301. The Schottky diode part number in surface mount, 3 terminal plastic package is MZB601-2012.

These LM202802-Q-x-301 limiters are ideal for octave band radar applications, from 2 - 8 GHz, requiring high volume, surface mount, solder re-flow manufacturing. These products are durable, reliable, and capable of meeting all military, commercial, and industrial environments.

This diode is ideally suited for Active Receiver Protection applications.

### Schematic



### Ordering Information

Part Number <sup>1</sup>	Package
LM202802-Q-x-301-T	tube packaging
LM202802-Q-x-301-R	250 or 500 piece reel
LM202802-Q-x-301-W	waffle packaging
LM202802-Q-x-301-E	RF evaluation board w/ heat sink

1. Replace x with B or C.  
B = DC block capacitor at input end  
C = DC block capacitor at input and output end

\*Restrictions on Hazardous Substances,  
European Union Directive 2011/65/EU.

PIN Diode Limiter  
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Electrical Specifications: Freq. = 2 - 8 GHz,  $P_{IN} = 0$  dBm,  $T_A = +25^\circ\text{C}$ ,  $Z_0 = 50\ \Omega$ 

Parameter	Test Conditions	Units	Min.	Typ.	Max.
Insertion Loss	$2\text{ GHz} \leq F \leq 8\text{ GHz}$	dB	—	1.1	1.4
Return Loss	$2\text{ GHz} \leq F \leq 8\text{ GHz}$	dB	13	15	—
P1dB	$2\text{ GHz} \leq F \leq 8\text{ GHz}$	dBm	8	10	12
2 <sup>ND</sup> Harmonic	5 GHz	dBc	45	50	—
Peak Incident Power	RF Pulse Width = 25 $\mu\text{s}$ , duty cycle = 5%, $t_{RISE} \leq 2\ \mu\text{s}$ , $t_{FALL} \leq 2\ \mu\text{s}$	dBm	—	60	60
CW Incident Power	$2\text{ GHz} \leq F \leq 8\text{ GHz}$	dBm	—	50	51
Flat Leakage Power	$P_{IN} = 60$ dBm, RF Pulse Width = 25 $\mu\text{s}$ , duty cycle = 5%, $t_{RISE} \leq 2\ \mu\text{s}$ , $t_{FALL} \leq 1\ \mu\text{s}$	dBm	—	21	23
Spike Leakage Energy	$P_{IN} = 60$ dBm peak, RF pulse width = 25 $\mu\text{s}$ , duty cycle = 5%	erg	—	0.5	0.6
Recovery Time	50% falling edge of RF pulse to 1 dB IL, $P_{IN} = 50$ dBm peak, RF pulse width = 25 $\mu\text{s}$ , duty cycle = 5%, $t_{RISE} \leq 2\ \mu\text{s}$ , $t_{FALL} \leq 1\ \mu\text{s}$	$\mu\text{s}$	—	5	10

Absolute Maximum Ratings<sup>2,3</sup>

Parameter	Test Conditions	Absolute Maximum
RF CW Incident Power	@ $+85^\circ\text{C}$ , source & load VSWR $<1.2:1$ derate linearly to 0 W @ $T_C = +150^\circ\text{C}^4$	50 dBm
RF Peak Incident Power	@ $+85^\circ\text{C}$ , source & load VSWR $<1.2:1$ RF pulse width = 25 $\mu\text{s}$ , duty cycle = 5%, & RF pulse width = 50 $\mu\text{s}$ , duty cycle = 1%, derate linearly to 0 W @ $T_C = +150^\circ\text{C}^4$	60 dBm
Thermal Resistance	Junction to bottom surface of package	$10^\circ\text{C/W}$
Insertion Loss Rate of Change with Operating Temperature	—	$ -0.005\text{ dB} / ^\circ\text{C} $
Junction Temperature	—	$+175^\circ\text{C}$
Operating Temperature	—	$-65^\circ\text{C}$ to $+125^\circ\text{C}$
Storage Temperature	—	$-65^\circ\text{C}$ to $+150^\circ\text{C}$
Assembly Temperature	—	$260^\circ\text{C}$ for 10 seconds

2. Exceeding any one or combination of these limits may cause permanent damage to this device.

3. MACOM does not recommend sustained operation near these survivability limits.

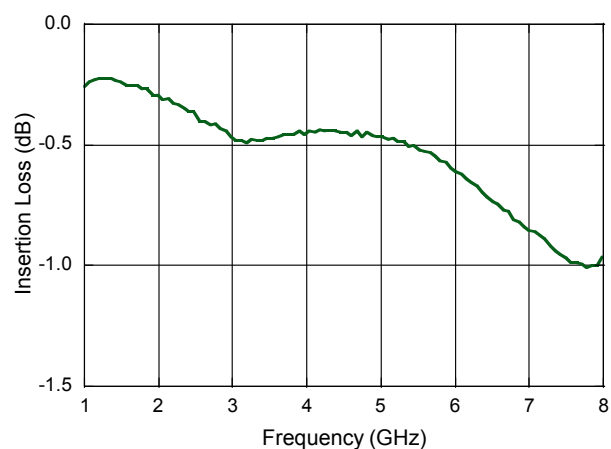
4.  $T_C$  is defined as the temperature of the bottom surface of the package.

2

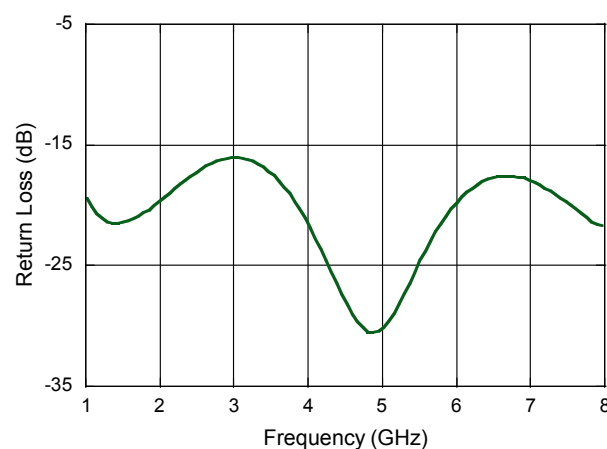
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## Typical Performance Curves

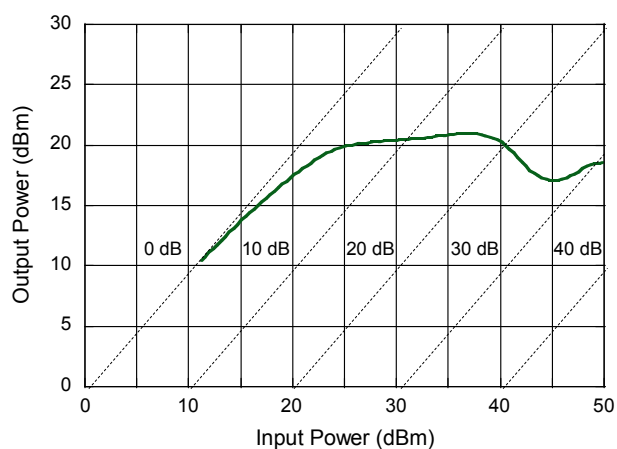
**Insertion Loss vs. Frequency**



**Return Loss vs. Frequency**



**CW Output Power vs. CW Input Power**



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### Handling Procedures

Please observe the following precautions to avoid damage:

### Static and Moisture Sensitivity

These electronic devices are sensitive to electrostatic discharge (ESD) and can be damaged by static electricity. Proper ESD control techniques should be used when handling these Class 0 (HBM) devices.

The moisture sensitivity level rating for this device is MSL 2.

### Environmental Capabilities

This limiter is capable of meeting the environmental requirements of MIL-STD-750 and MIL-STD-202.

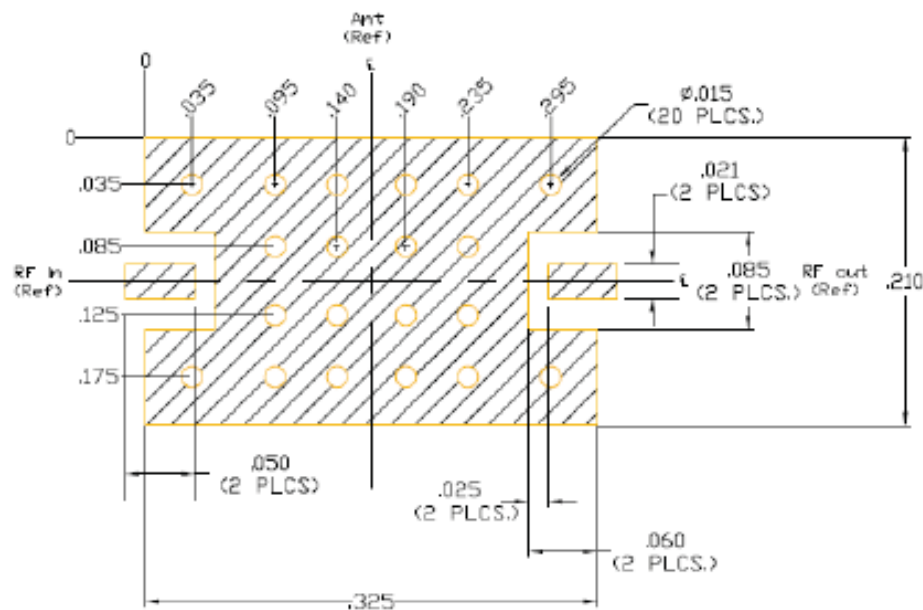
### Thermal Grounding Caution

Product engineering dictates that the LM family of high power limiters require proper heat sinking for high power applications >40 dBm (10 W). MACOM recommends using the part number PNMN13881 heat sink block which was developed for LM family.

### Assembly Instructions

The LM202802-Q-x-301 limiters are capable of being placed onto circuit boards with pick and place manufacturing equipment from tube or tape & reel dispensing. The devices are attached to the circuit board using conventional solder re-flow or wave soldering procedures with RoHS type or Sn 60 / Pb 40 type solders per Table I & Graph I Time-Temperature recommended profile.

### RF Circuit Solder Footprint, case style 301 (CS301)

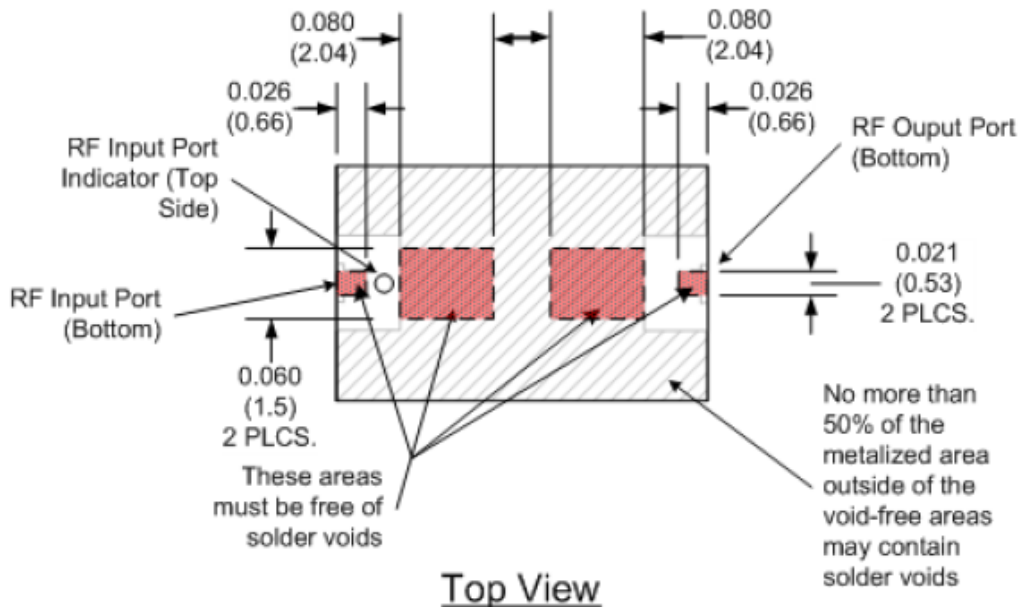


Recommended RF circuit is Rogers R04350B, 10 mils thick.

The hatched metal area on circuit side of device is RF, DC and thermal grounded. Vias should be solid copper fill and gold plated for optimum heat transfer from backside of switch module through circuit vias to metal thermal ground.

## Criteria for Proper Mounting on PCB

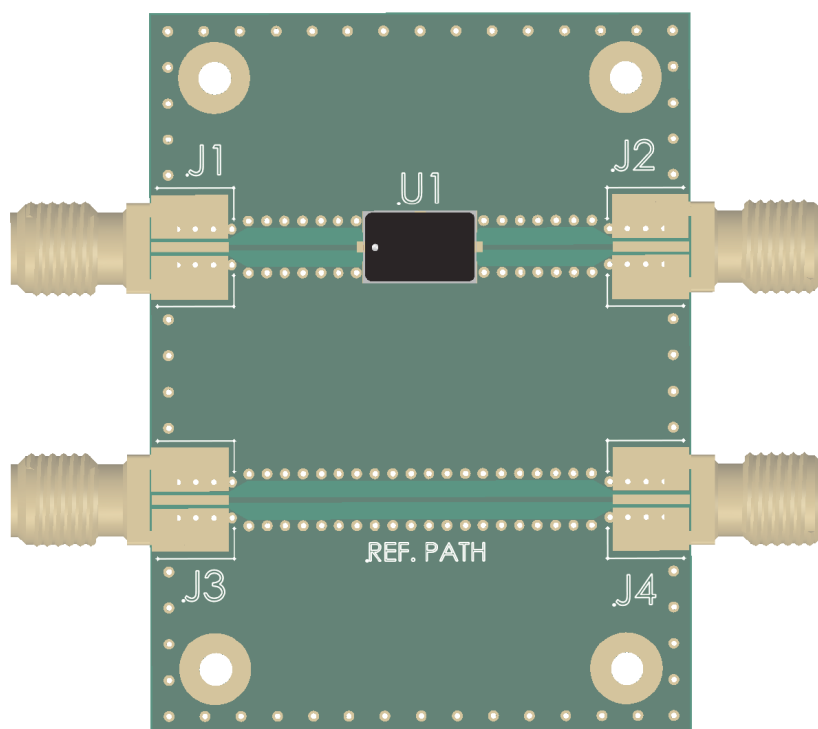
When a large signal is incident upon the input of the LM202802-Q-x-301, the impedance of the coarse limiter diodes is forced to a low value by the charge which is injected into these diodes by the combination of the current from the internal detector stage and the large RF voltage initially present across these diodes. As the impedance of these diodes decreases, an increasingly large impedance mismatch with the impedance of the transmission line to which the limiter is connected is created. Ultimately, the impedance of the coarse limiter diodes is reduced to a few ohms or less. This mismatch creates a standing wave, with a current maximum and voltage minimum located at the position of the coarse limiter diodes. While the large majority of the input signal power is reflected back to its source due to the impedance mismatch, the significant RF current that flows at the current maximum causes Joule heating to occur in the coarse limiter diodes. In order to maintain the junction temperature of these diodes below their maximum rated value, there must be a path with minimal thermal resistance from the coarse diodes to the external system heat sink. Also, there must be a minimal electrical resistance and inductance between the underside of the limiter module package and the system ground in order to achieve maximum RF isolation between the input and the output of the limiter module.



Dimensions in inches (mm).

For these reasons, it is imperative that there are no voids in the electrical and thermal paths directly under the coarse limiter diodes. Care must be taken when mounting the LM202802-Q-x-301 to avoid voids in the solder joint in the area along the lengthwise axis of the package, under and between the filled vias in the AlN substrate of the module which are shown in the diagram (above). It is also important to ensure no solder voids exist between the limiter module RF ports and the PCB to which the limiter module is attached. No greater than 50% of the remaining metalized area on the bottom of the package may contain solder voids.

## SP2T Switch Evaluation Board Layout



The evaluation board for the LM202802-Q-x-301 limiter is shown above. This evaluation board comprises two sections: the evaluation circuit for the limiter module; and, a reference transmission line.

The limiter module is mounted in position U1. Its RF input is connected to J1 and its output port is connected to J2, via two 50- $\Omega$  microstrip transmission lines.

The reference path 50- $\Omega$  microstrip transmission line structure can be utilized to determine the insertion loss of the transmission line structures connected between J1 and the limiter module input, as well as between the limiter module output and J2, so that their respective insertion losses may be subtracted from the total insertion loss measured between J1 and J2. This enables the resolution of the insertion loss of the limiter module only.

The evaluation board is supplied mounted on a heat sink. The maximum RF input power specified in the Absolute Maximum Ratings table must not be exceeded.

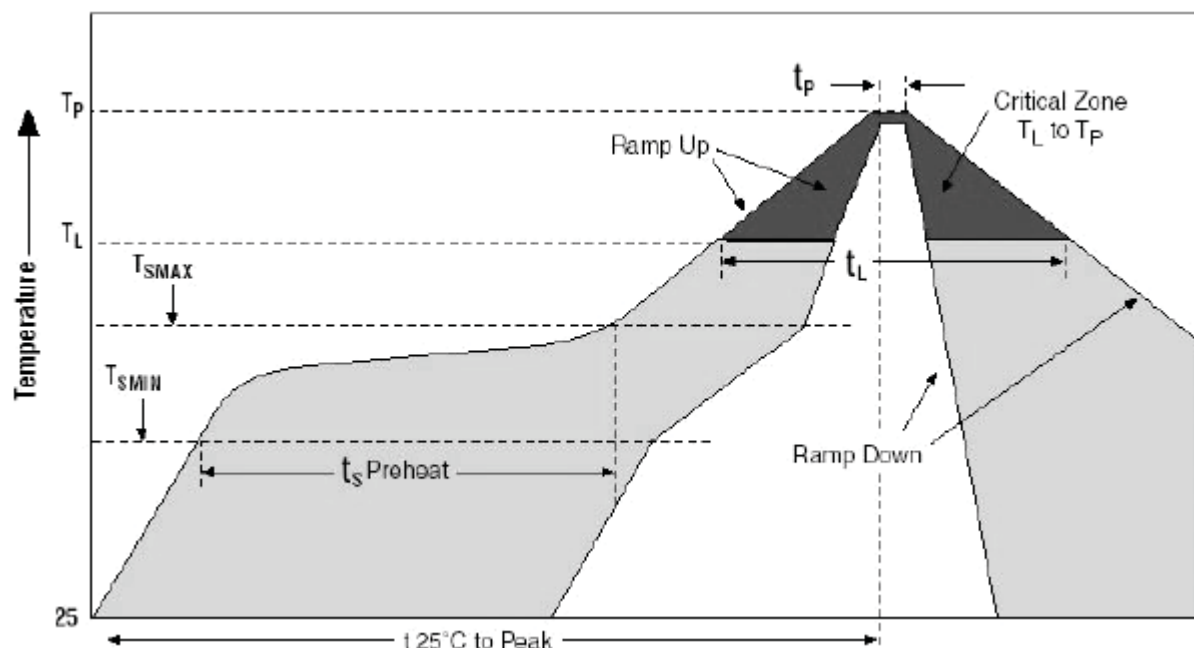
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**Table 1: Time-Temperature Profile for Sn 60 / Pb 40 or RoHS Type Solders**

Profile Feature	Sn-Pb Eutectic Assembly	Pb-Free Assembly
Average ramp-up rate (TL to TP)	3°C/second maximum	3°C/second maximum
Preheat - Temperature Minimum (TSMIN) - Temperature Maximum (TSMAX) - Time (Minimum to maximum) (ts)	100°C 150°C 60 - 120 seconds	150°C 200°C 60 - 180 seconds
TSMAX to TL - Ramp-up Rate	—	3°C/second maximum
Time Maintained above: - Temperature (TL) - Time (tL)	183°C 60 - 150 seconds	217°C 60 - 150 seconds
Peak Temperature (TP)	225 +0 / -5°C	260 +0 / -5°C
Time within 5°C of actual Peak Temperature (TP)	10 - 30 seconds	20 - 40 seconds
Ramp-down Rate	6°C/second maximum	6°C/second maximum
Time 25°C to Peak Temperature	6 minutes maximum	8 minutes maximum

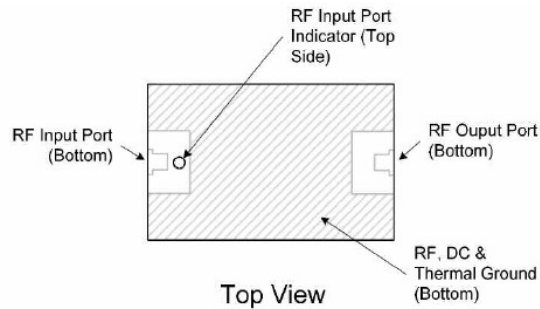
**Graph1: Solder Re-Flow Time-Temperature Function**



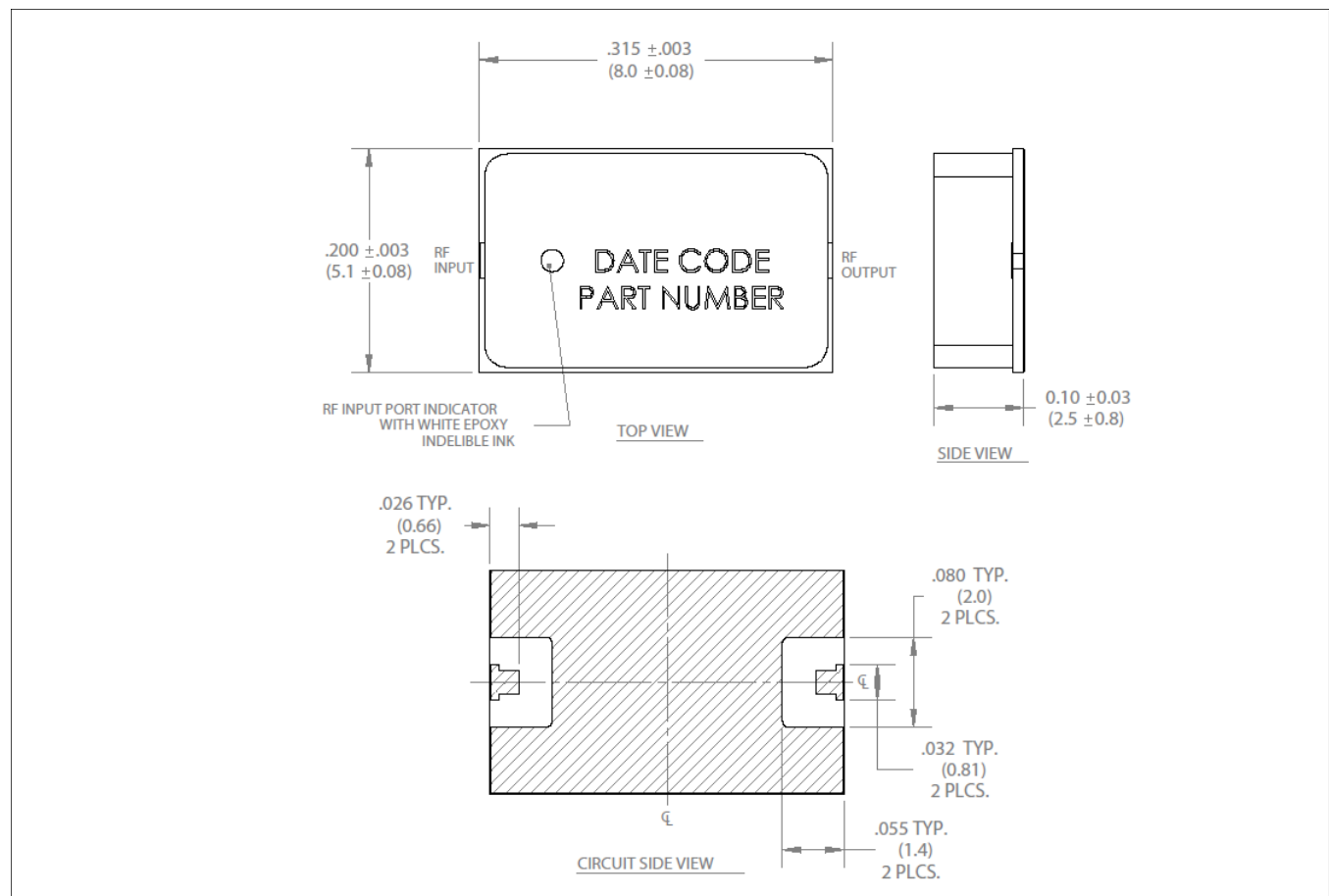
## PIN Diode Limiter 2 - 8 GHz

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### Pin Out



### Outline Drawing, Case Style 301 (CS301)



The hatched metal area on circuit side of device is RF and DC grounded.  
 Dimensions are in inches (mm)  
 Substrate Material: 20 mil thick Alumina Nitride (ALN)  
 RF Cover: Black Ceramic  
 Top Side and Backside Metallization: 100  $\mu$  IN. typical plated over Ti-Pd.

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