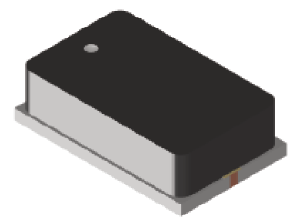
# LM2933-Q-B-301

## PIN Diode Limiter
## 2.9 - 3.3 GHz

Rev. V1

### Features

- Surface Mount Limiter in 8 L x 5 W x 2.5 H mm Package
- Incorporates PIN Limiter Diodes, DC Blocks, Schottky Diode & DC Return
- Higher Peak Power Handling than Plastic-Packaged Limiters (1.6 KW Peak)
- Higher Average Power Handling than Plastic-Packaged Limiters (100 W CW)
- Very Low Insertion Loss (0.6 dB)
- Low Flat Leakage Power (23 dBm)
- RoHS* Compliant

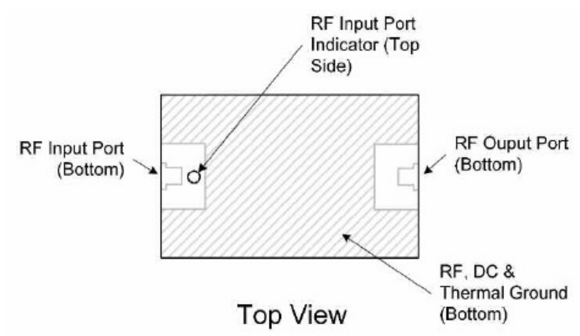


### Description

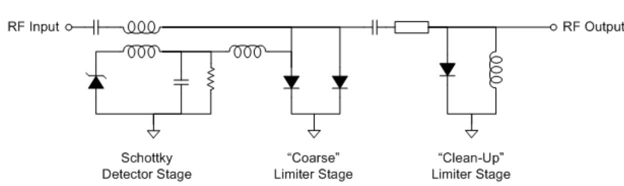
The LM2933-Q-B-301 is a surface mount silicon PIN diode, passive two stage power limiter which can operate over the frequency range of 2.9 to 3.3 GHz. This device is manufactured using a proven hybrid manufacturing process incorporating PIN diodes and passive devices integrated onto a ceramic substrate. This low profile, compact, surface mount component offers outstanding small & large signal performance. This product is designed for optimal small signal insertion loss for very low receiver noise figure and excellent large-input-signal flat leakage power for effective receiver protection from 2.9 to 3.3 GHz.

The very low thermal resistance (20ºC/W, junction to bottom surface of package) of the PIN diodes in this device and the presence of a Schottky detector bias current source enables it to reliably handle RF incident power levels up to 47 dBm CW and RF peak incident power levels up to 62 dBm (70 µs pulse width, 3% duty cycle). The I layer thickness of the output stage and the design of the internal Schottky detector current source combine to produce flat leakage of 23 dBm typical and spike leakage energy of 0.25 ergs, typical. No external control signals are required. This limiter module includes internal DC blocking capacitors in the RF signal path, as well as an internal DC return path. This PIN diode limiter is ideally suited for receiver and LNA protection applications.

### Pin Out




### Limiter Schematic




### Ordering Information

| Part Number | Package |
|---|---|
| LM2933-Q-B-301-T | tube packaging |
| LM2933-Q-B-301-R | 250 or 500 piece reel |
| LM2933-Q-B-301-W | waffle packaging |
| LM2933-Q-B-301-E | RF evaluation board |

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

## Electrical Specifications: Freq. = 2.9 - 3.5 GHz, $P_{IN}$ = 0 dBm, $T_A$ = +25°C, $Z_0$ = 50 Ω

| Parameter | Test Conditions | Units | Min. | Typ. | Max. |
|---|---|---|---|---|---|
| Insertion Loss | 2.9 GHz ≤ F ≤ 3.3 GHz | dB | — | 0.6 | 0.7 |
| Return Loss | 2.9 GHz ≤ F ≤ 3.3 GHz | dB | 14 | 15 | — |
| P1dB | 1 GHz ≤ F ≤ 2 GHz | dBm | 7 | 8 | 10 |
| 2nd Harmonic | Output Frequency = 3 GHz | dBc | — | -50 | -45 |
| Peak Incident Power | RF Pulse Width = 70 µs, 3% Duty<br>RF Pulse Width = 40 µs, 10% Duty | dBm | — | — | 62<br>57 |
| CW Incident Power | 1 GHz ≤ F ≤ 2 GHz | dBm | — | — | 47 |
| Flat Leakage Power | RF Pulse Width = 70 µs, 3% Duty | dBm | — | 23 | 24 |
| Spike Leakage Power | $P_{IN}$ = 50 dBm peak, RF Pulse Width = 1 µs, 1% Duty | Ergs | — | 0.25 | 0.30 |
| Recovery Time | 50% falling edge of RF Pulse to 1 dB IL, $P_{IN}$ = 53 dBm peak, RF Pulse Width = 70 µs, 3% Duty | µs | — | 1.5 | 2.0 |

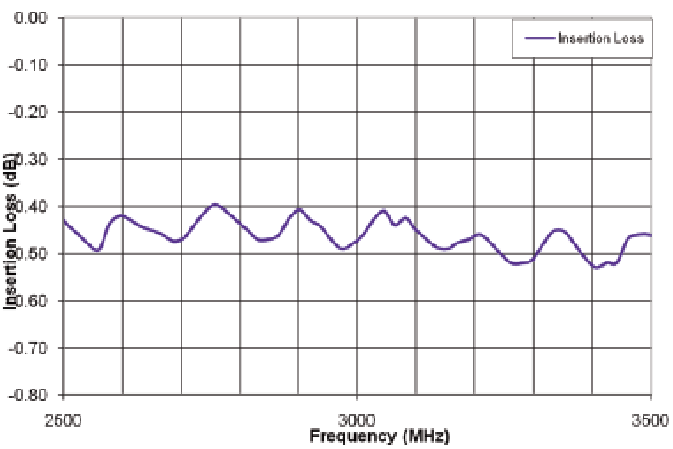
## Absolute Maximum Ratings[1,2]

| Parameter | Absolute Maximum |
|---|---|
| RF CW Incident Power @ +85°C,<br>Source & Load VSWR <1.2:1<br>Derate linearly t 0 W @ $T_C$ = +150°C[3] | 47 dBm |
| RF Peak Incident Power @ +85°C,<br>Source & Load VSWR <1.2:1<br>Derate linearly t 0 W @ $T_C$ = +150°C[3] | 62 dBm |
| Thermal Resistance<br>Junction to bottom surface of package | 25°C/W |
| Junction Temperature | +175°C |
| Operating / Storage Temperature | -65°C to +125°C |
| Assembly Temperature | 260°C for 30 seconds |

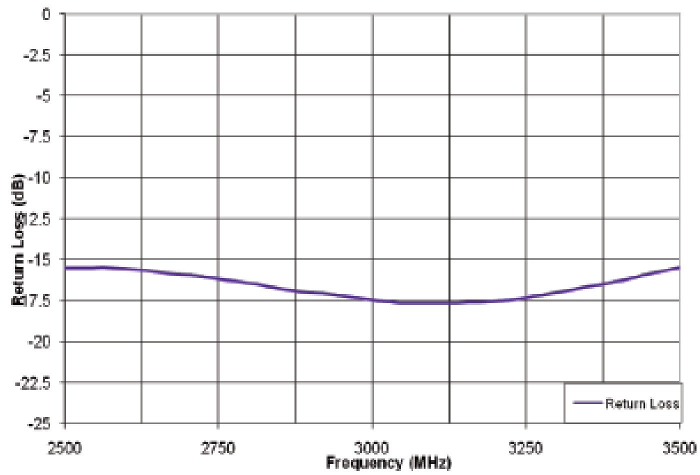
1. Exceeding any one or combination of these limits may cause permanent damage to this device.
2. MACOM does not recommend sustained operation near these survivability limits.
3. $T_C$ is defined as the temperature of the bottom surface of the package.

### Typical Performance Curves

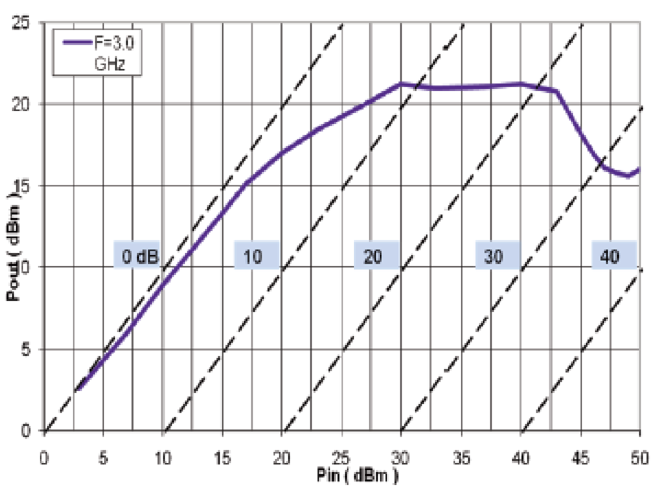
***Insertion Loss vs. Frequency***



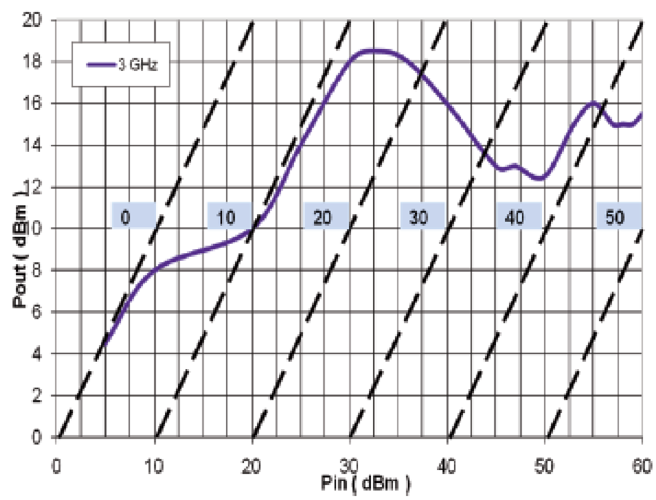

***Return Loss vs. Frequency***




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




***Flat Leakage Output Power vs. CW Input Power***



## Criteria for Proper Mounting on PCB

When a large signal is incident upon the input of the LM2933-Q-B-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.

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 LM2933-Q-B-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 (Fig. 1). 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.

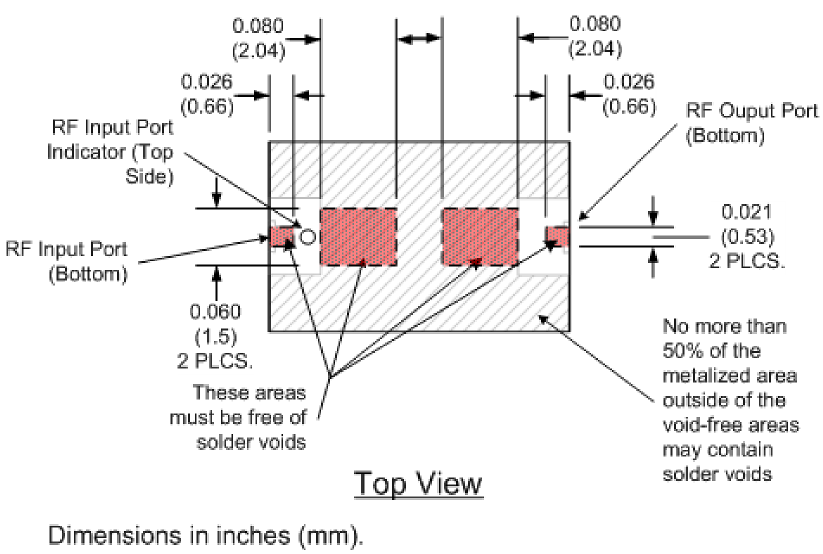



Figure 1

### Limiter Evaluation Board Layout

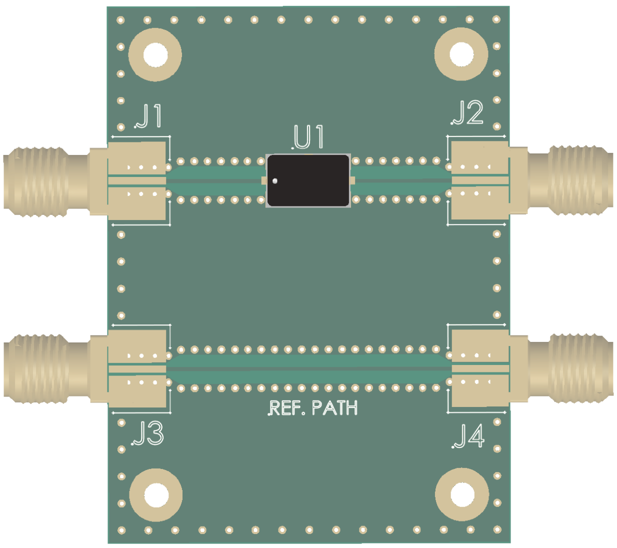



Figure 2

The evaluation board for the LM2933-Q-B-301 limiter is shown in Figure 2. 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 Ω microstrip transmission lines.

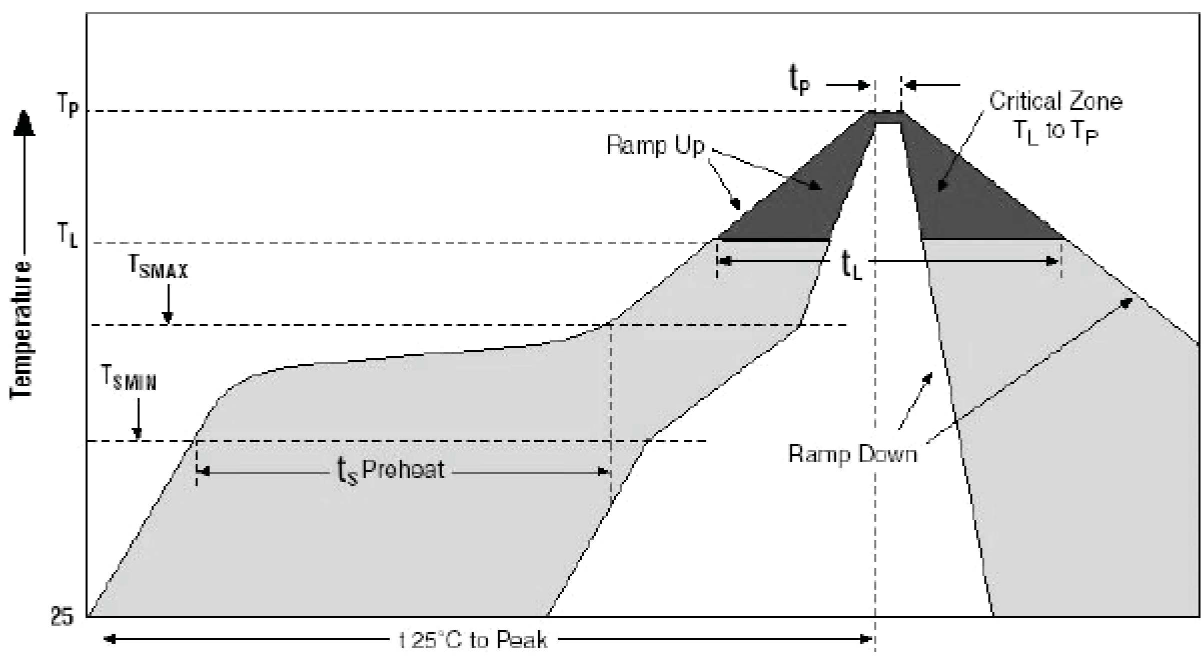
The reference path 50-Ω microstrip transmission line structure can be utilized to determine the insertion loss of the transmission line structures connected between J1 and the limiter module input, as well as between the limiter module output and J2, so that their respective insertion losses may be subtracted 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.

## 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<br>- Temperature Minimum (TSMIN)<br>- Temperature Maximum (TSMAX)<br>- Time (Minimum to maximum) (ts) | 100°C<br>150°C<br>60-120 seconds | 150°C<br>200°C<br>60-180 seconds |
| TSMAX to TL<br>- Ramp-up Rate | — | 3°C/second maximum |
| Time Maintained above:<br>- Temperature (TL)<br>- Time (tL) | 183°C<br>60-150 seconds | 217°C<br>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



## 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 1.

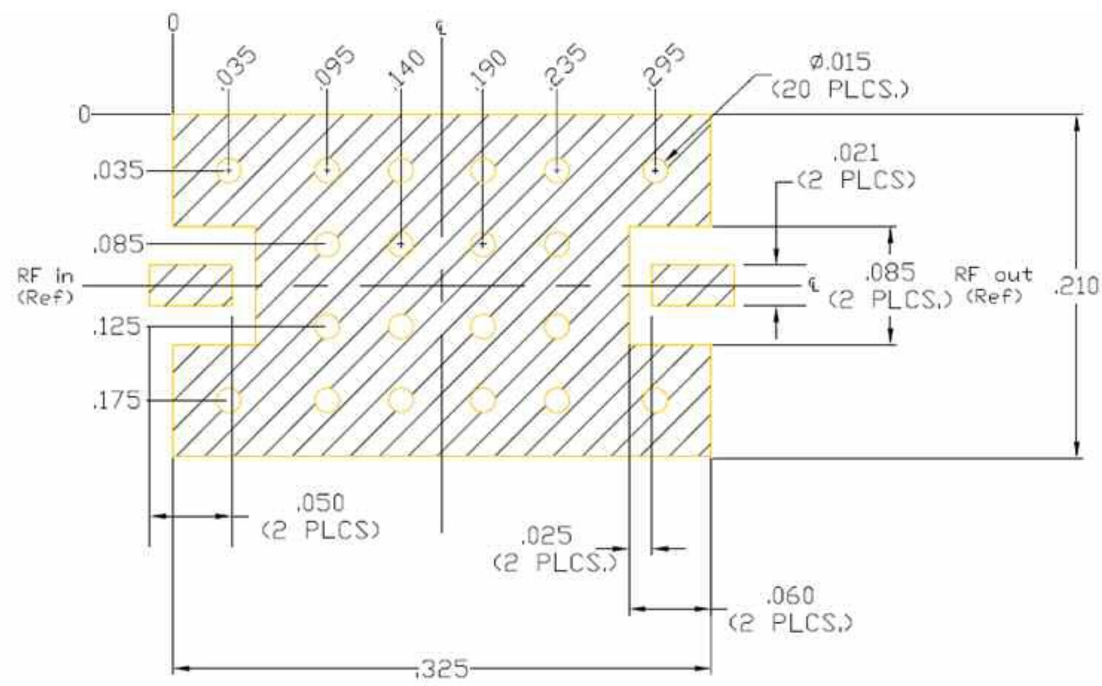
## Environmental Capabilities

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

## Assembly Instructions

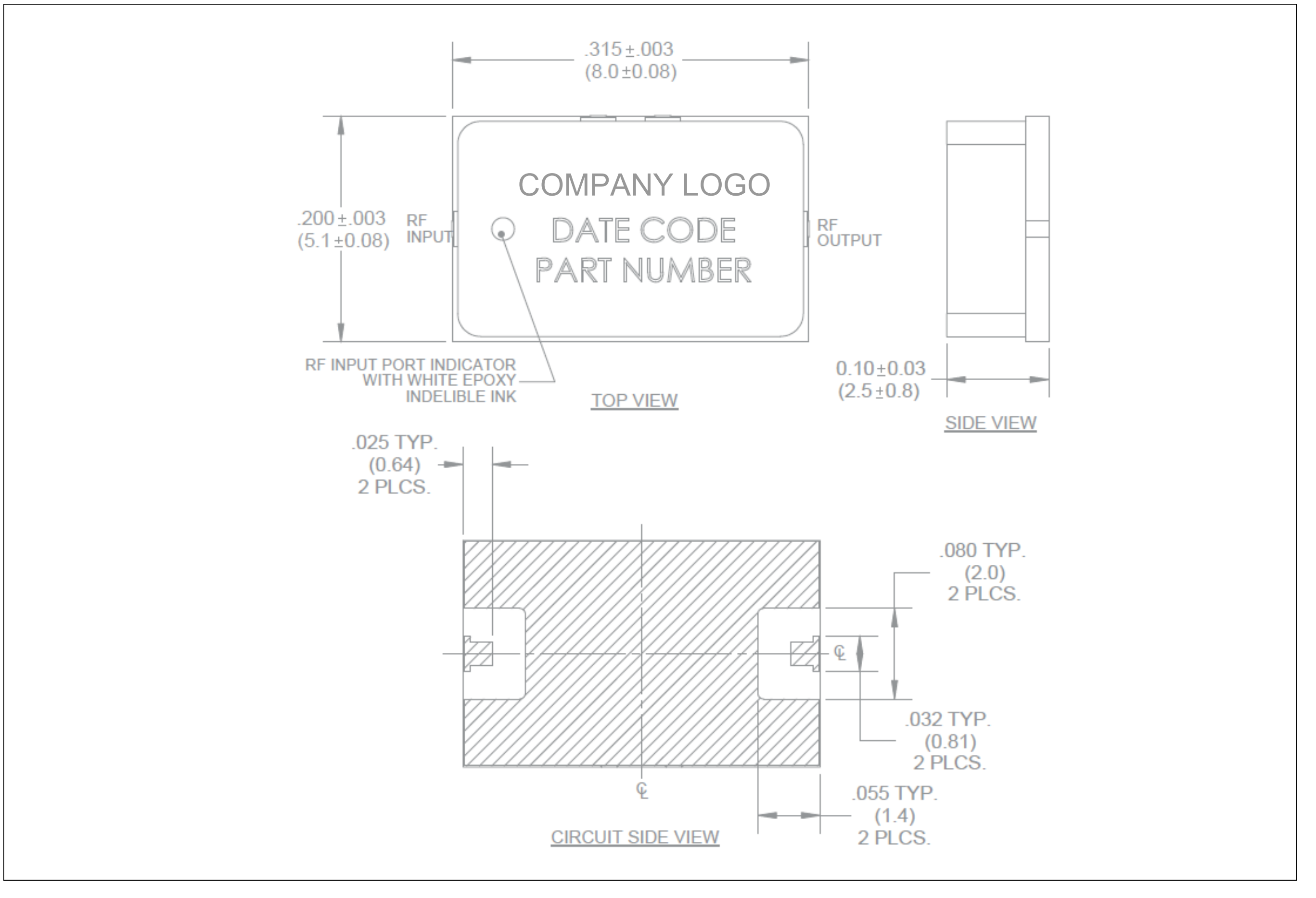
This device may be placed onto circuit boards with pick and place manufacturing equipment from tape & reel. The devices are attached to the circuit using conventional solder re-flow or wave soldering procedures with RoHS type or Sn 60 / Pb 40 type solders.

## 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.

## Outline Drawing, Case Style 301 (CS301)




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