

Surface Mount PIN Diode Limiter

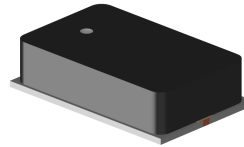
LM202402-Q-E-301 & LM202402-Q-F-301

Data Sheet



Features

- Surface Mount Limiter in Compact Package:
 - 8 mm L x 5 mm W x 2.5 mm H
- Incorporates PIN Limiter Diodes, DC Blocks, Schottky Diode & DC Return
- Higher Peak Power Handling than Plastic-Packaged Limiters (1000 W Peak)
- Higher Average Power Handling than Plastic-Packaged Limiters (100 W CW)
- Very Low Insertion Loss (0.5 dB) , Low Flat Leakage Power (17 dBm)
- RoHS Compliant



Applications

- Receiver protection.

Description

The LM202402-Q-E-301 and LM202402-Q-F-301 are surface mount, two-stage silicon PIN diode limiters which can operate over the frequency range of 2 GHz to 4 GHz. They are manufactured using Aeroflex/Metelics proven hybrid manufacturing process incorporating PIN diodes, Schottky diodes and passive devices integrated onto a ceramic substrate. This low profile, compact (8 mm L x 5 mm W x 2.5 mm H), surface mount component, offers outstanding small and large signal performance. The LM202402-Q-E-301 comprises a DC block at its input, shunt PIN limiter diodes driven by a Schottky diode detector stage, and an antiparallel pair of a limiter PIN diode and a Schottky detector diode at its output. The LM202402-Q-F-301 comprises all these components as well as a DC block at its output.

The very low thermal resistance ($< 20\text{ }^{\circ}\text{C/W}$, from the input limiter PIN diode junctions to the package mounting surface) of the PIN diodes in this device enables it to reliably handle RF incident power levels up to 50 dBm CW and RF peak incident power levels up to 60 dBm (25 μs pulse width, 1% duty cycle) at $T_{\text{CASE}} = 85\text{ }^{\circ}\text{C}$. The I layer thickness of the output stage is selected to produce flat leakage of 15 dBm typical and spike leakage energy of 0.5 ergs, typical. No external control signals are required.

Environmental Capabilities

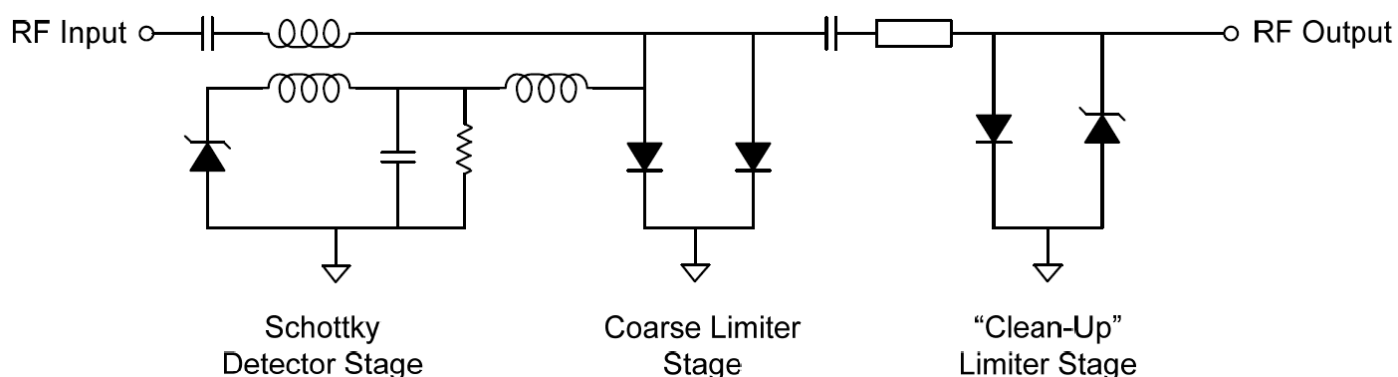
LM202402-Q-E-301 & LM202402-Q-F-301 limiters are ideal for 2 to 4 GHz radar, IED jammers and LTE-TDD base station applications. These devices are compatible with high volume, surface mount, solder re-flow manufacturing methods, are durable, reliable, and capable of operating reliably in military, commercial, and industrial environments. The LM202402-Q-E-301 & LM202402-Q-F-301 limiters are RoHS compliant and are available in tube and tape-reel. LM202402-Q-E-301 & LM202402-Q-F-301 limiters are capable of meeting the environmental requirements of MIL-STD-750 and MIL-STD-202.



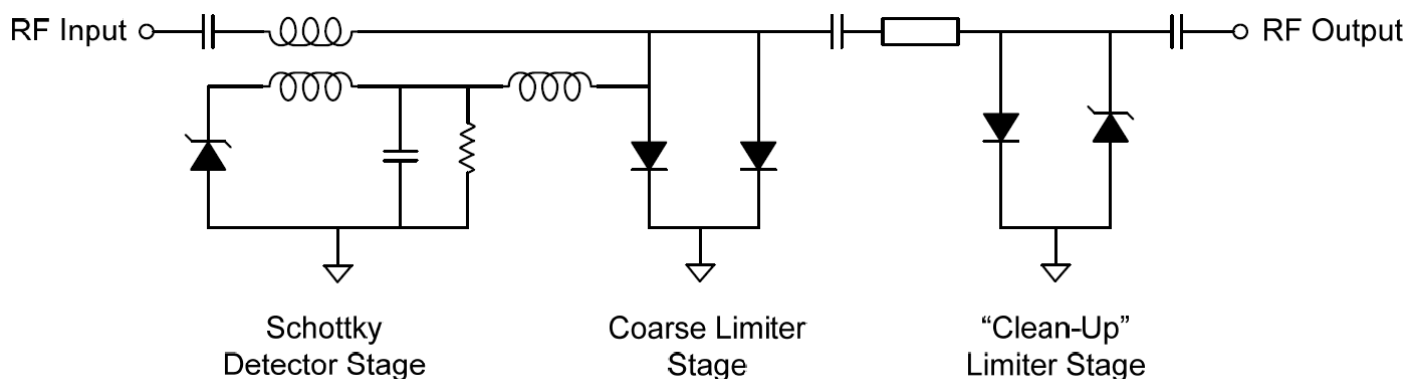
ESD and Moisture Sensitivity Level Rating

As are all semiconductor devices, PIN and Schottky diodes are susceptible to damage from ESD events. The ESD rating for LM202402-Q-E-301 & LM202402-Q-F-301 is Class 0 (HBM). The moisture sensitivity level rating for this device is MSL 1.

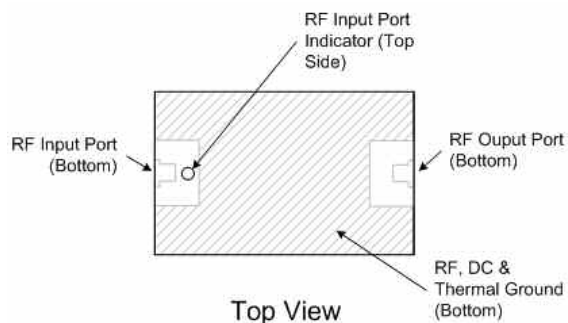
Limiter Schematic - LM202402-Q-E-301



Limiter Schematic - LM202402-Q-F-301



Pinout



Absolute Maximum Ratings

@ $Z_0 = 50 \Omega$, $T_A = +25^\circ\text{C}$ as measured in Aeroflex evaluation board (Unless Otherwise Defined)

| Parameter | Conditions | Absolute Maximum Value |
|---|--|------------------------|
| Operating Temperature | | -65 °C to 150 °C |
| Storage Temperature | | -65 °C to 150 °C |
| Junction Temperature | | 175 °C |
| Assembly Temperature | $t = 10 \text{ s}$ | 260 °C for 10 s |
| RF Peak Incident Power Handling | $T_{\text{CASE}} = 85^\circ\text{C}$, source and load VSWR < 1.2:1, RF pulse width = 25 μs , duty cycle = 5%, derate linearly to 0 W at $T_{\text{CASE}} = 150^\circ\text{C}$ (note 1) | 60 dBm |
| RF CW Incident Power Handling | $T_{\text{CASE}} = 85^\circ\text{C}$, source and load VSWR < 1.2:1, derate linearly to 0 W at $T_{\text{CASE}} = 150^\circ\text{C}$ (note 1) | 50 dBm |
| Θ_{JC} Thermal Resistance | Junction to bottom surface of package | 40 °C/W |

Notes:

1 T_{CASE} is defined as the temperature of the bottom surface of the package

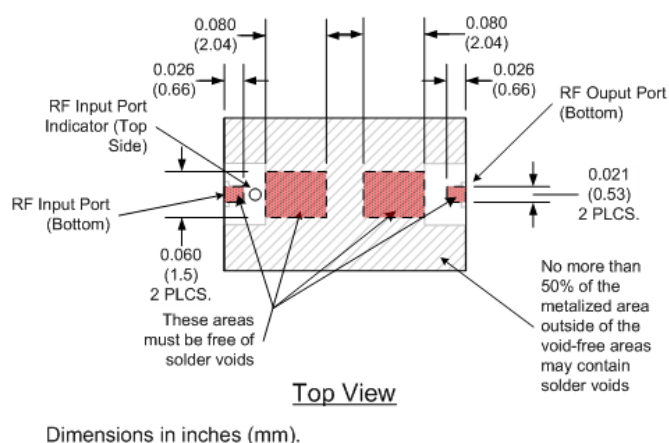
LM202402-Q-E-301 & LM202402-Q-F-301 Electrical Specifications

$Z_0 = 50 \Omega$, $T_A = 25^\circ\text{C}$ as measured in Aeroflex evaluation board (Unless Otherwise Defined)

| Parameter | Symbol | Test Conditions | Min. Value | Typ. Value | Max. Value | Units |
|------------------------------|-----------------------------|--|------------|------------|------------|---------------|
| Frequency | F | | 2 | | 4 | GHz |
| Insertion Loss | IL | $2 \text{ GHz} \leq F \leq 4 \text{ GHz}$, $P_{\text{IN}} = -10 \text{ dBm}$ | | 0.5 | 0.7 | dB |
| Return Loss | RL | $2 \text{ GHz} \leq F \leq 4 \text{ GHz}$, $P_{\text{IN}} = -10 \text{ dBm}$ | 12 | 14 | | dB |
| Input 1 dB Compression Point | $\text{IP}_{1\text{dB}}$ | $2 \text{ GHz} \leq F \leq 4 \text{ GHz}$ | 0 | 8 | 11 | dBm |
| 2 ND Harmonic | $2F_0$ | $P_{\text{IN}} = -10 \text{ dBm}$ $F_0 = 3.0 \text{ GHz}$ | | -40 | -30 | dBc |
| Peak Incident Power | $P_{\text{inc}}(\text{Pk})$ | RF Pulse Width = 25 μs , duty cycle = 1%, $t_{\text{rise}} \leq 3 \mu\text{s}$, $t_{\text{fall}} \leq 3 \mu\text{s}$ | | | 60 | dBm |
| CW Incident Power | $P_{\text{inc}}(\text{CW})$ | $2 \text{ GHz} \leq F \leq 4 \text{ GHz}$ | | | 50 | dBm |
| Flat Leakage Power | FL | 60 dBm, RF pulse width = 25 μs , duty cycle = 0.01, $t_{\text{rise}} \leq 3 \mu\text{s}$, $t_{\text{fall}} \leq 3 \mu\text{s}$ | | 15 | 17 | dBm |
| Spike Leakage Energy | SL | $P_{\text{IN}} = 60 \text{ dBm}$ peak, RF pulse width = 25 μs , duty cycle = 0.01 | | 0.5 | 0.7 | erg |
| Recovery Time | T_R | 50% falling edge of RF pulse to 1 dB IL, $P_{\text{IN}} = 60$ dBm peak, RF pulse width = 25 μs , duty cycle = 0.01, $t_{\text{rise}} \leq 3 \mu\text{s}$, $t_{\text{fall}} \leq 3 \mu\text{s}$ | | 3 | 5 | μs |

Criteria for Proper Mounting on PCB

When a large signal is incident upon the input of the LM202402-Q-E-301 or LM202402-Q-F-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.

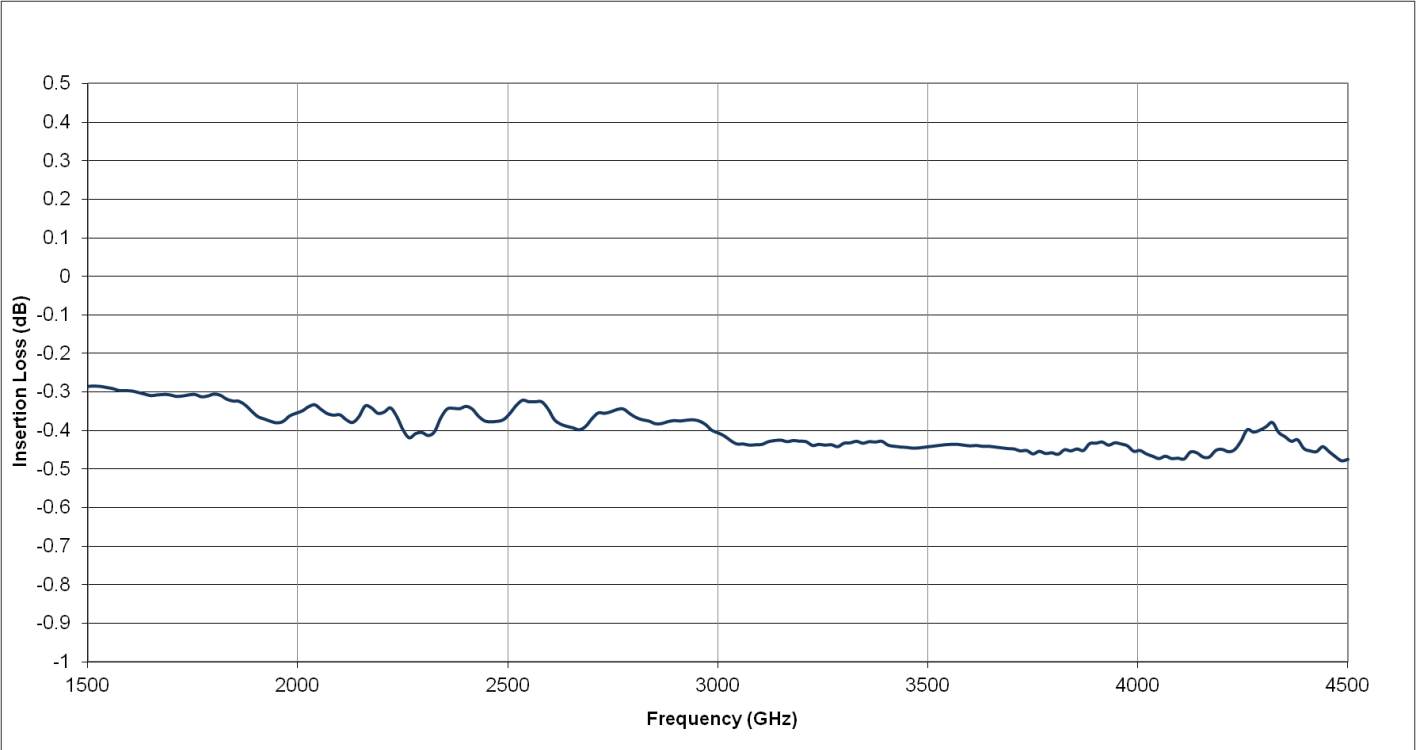


For these reasons, it is imperative that there are no voids in the electrical and thermal paths directly under the coarse limiter diodes. Care must be taken when mounting the LM202402-Q-E-301 and LM202402-Q-F-301 to avoid voids in the solder joint in the area along the lengthwise axis of the package, under and between the filled vias in the AIN 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.

LM202402-Q-F-301 Typical Performance

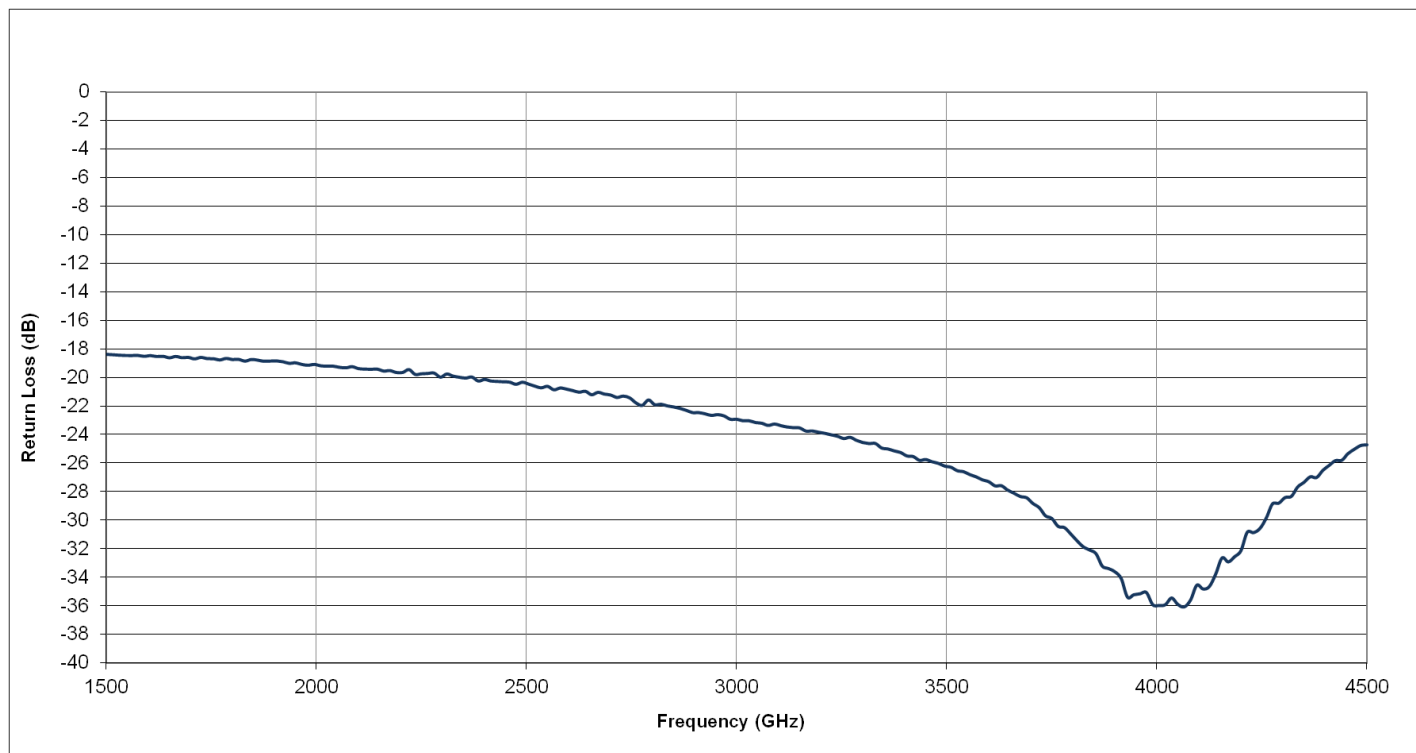
$Z_0 = 50 \Omega$, $T_{CASE} = 25 \text{ }^\circ\text{C}$, $P_{IN} = -10 \text{ dBm}$ as measured in the Aeroflex Metelics evaluation board
(Unless Otherwise Defined)



Insertion Loss vs Frequency

LM202402-Q-F-301 Typical Performance

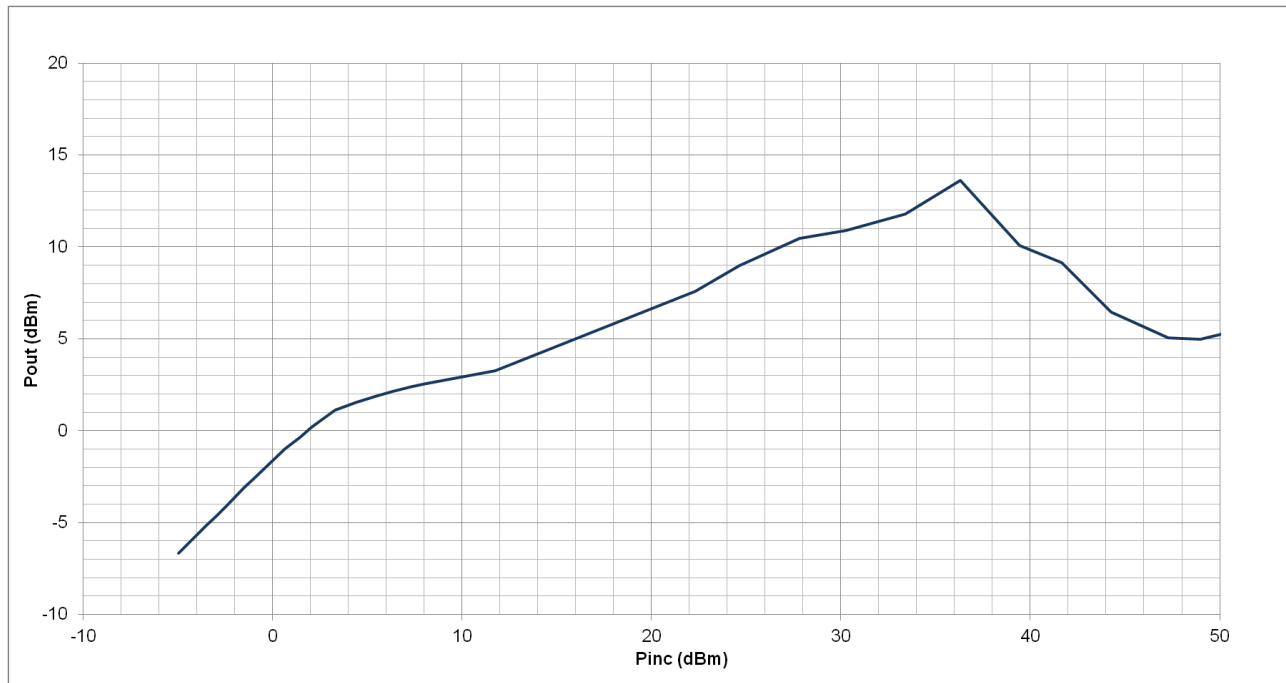
$Z_0 = 50 \Omega$, $T_{CASE} = 25^\circ\text{C}$, $P_{IN} = -10 \text{ dBm}$ as measured in the Aeroflex Metelics evaluation board
(Unless Otherwise Defined)



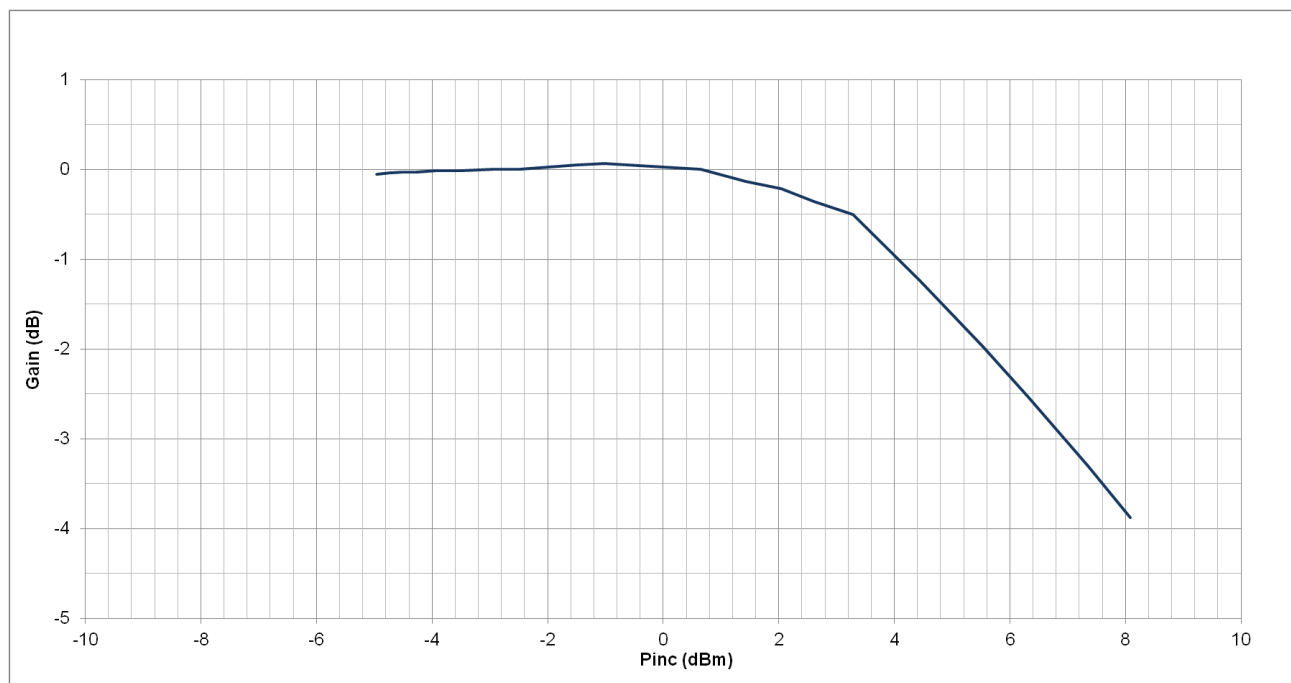
Return Loss vs Frequency

LM202402-Q-F-301 Typical Performance

$Z_0 = 50 \Omega$, $T_{CASE} = 25^\circ\text{C}$, $P_{IN} = -10 \text{ dBm}$ as measured in the Aeroflex Metelics evaluation board
(Unless Otherwise Defined)

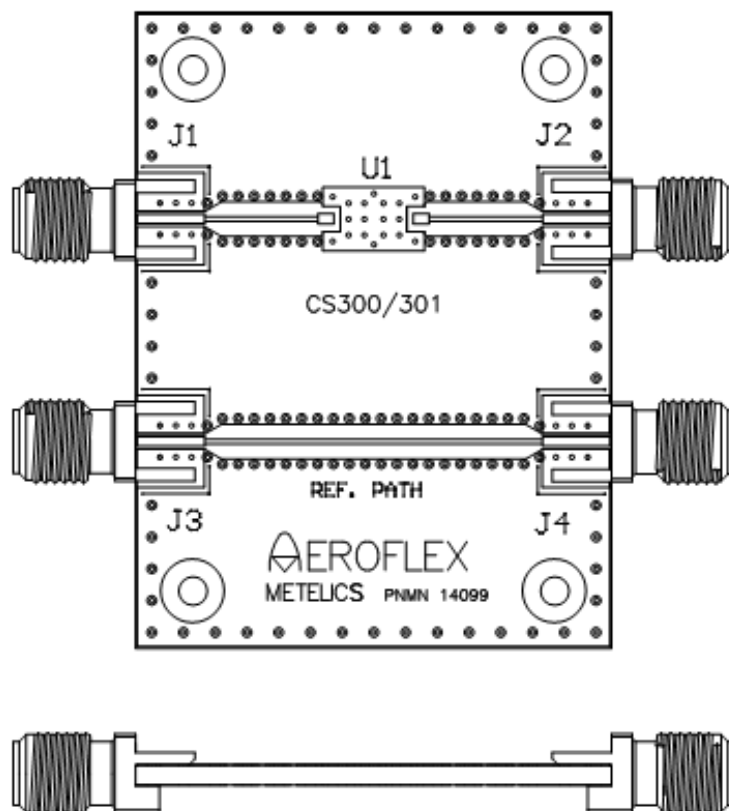


Pin vs Pout



P1 dB Compression Point

Limiter Evaluation Board Layout



The evaluation board for the LM202402-Q-E-301 and LM202402-Q-F-301 limiters 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-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.

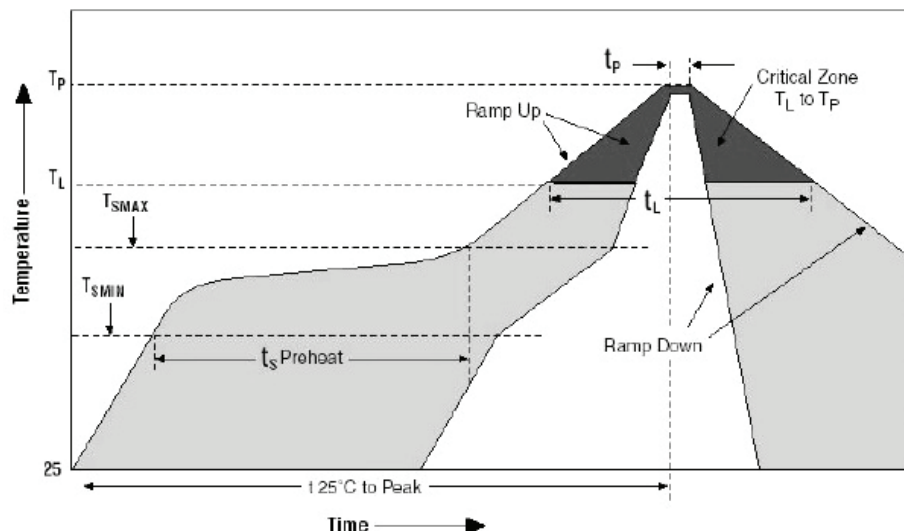
Assembly Instructions

The LM202402-Q-E-301 & LM202402-Q-F-301 limiter modules are capable of being placed onto a circuit board by pick-and-place manufacturing equipment from tube or tape-reel dispensing. Devices are attached to the circuit board using conventional solder re-flow or wave soldering procedures with RoHS type or Sn60/Pb40 type solders per the recommended time-temperature profile shown below.

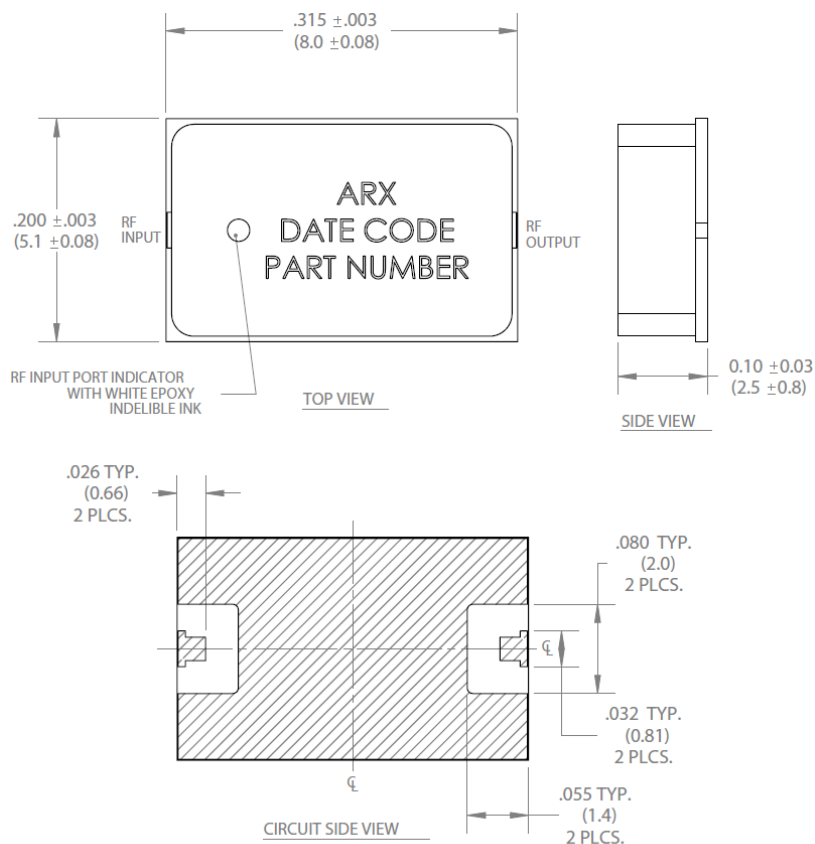
Table 1. Time-Temperature Profile for Sn60/Pb40 or RoHS Type Solders

| Profile Feature | SnPb Solder Assembly | Pb-Free Solder Assembly |
|--|----------------------------|----------------------------|
| Average Ramp-Up Rate (T_L to T_P) | 3°C /second maximum | 3°C /second maximum |
| Preheat: - Temperature Min (T_{SMIN}) - Temperature Max (T_{SMAX}) - Time (min to max)(t_s) | 100°C 150°C 60-120 s | 150°C 200°C 60-180 s |
| T_{SMAX} to T_L - Ramp-Up Rate | | 3°C/s maximum |
| Time Maintained Above: - Temperature (T_L) - Time (t_L) | 183°C 60-150 s | 217°C 60-150 s |
| Peak temperature (T_P) | 225 +0/-5°C | 260 +0/-5°C |
| Time Within 5°C of Actual Peak Temperature (t_p) | 10 – 30 s | 20 – 40 s |
| Ramp-Down Rate | 6°C /s maximum | 6°C /s maximum |
| Time 25°C to Peak Temperature | 6 minutes maximum | 8 minutes maximum |

Figure 1. Solder Re-Flow Time-Temperature Profile



Limiter Module Outline (CS301)



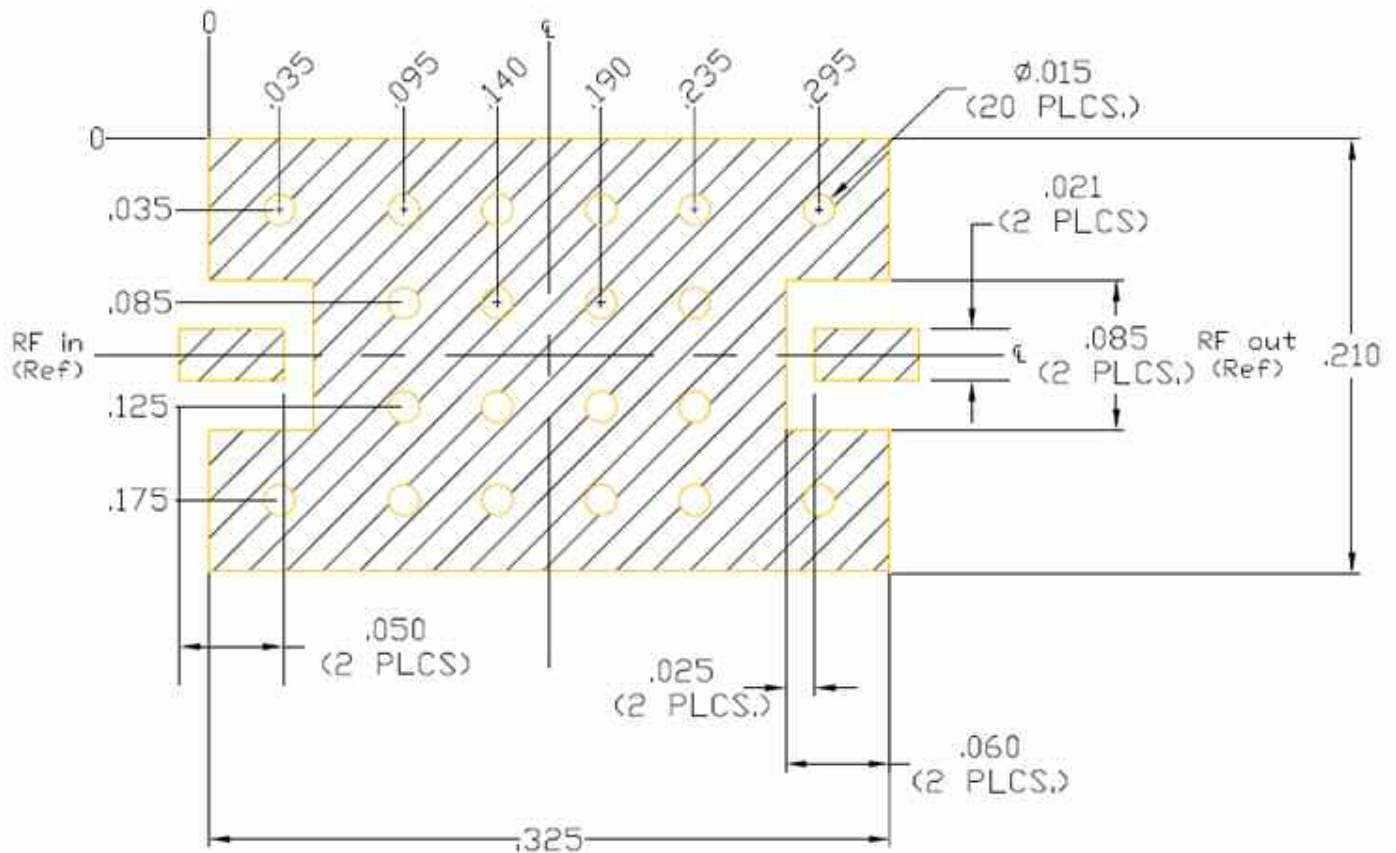
Notes

- Substrate material : 20 mils thick Aluminum Nitride (AlN)
- RF Cover : Black Ceramic
- Back side Metallization : 10 - 20 Micro Inches typical plated Au over Ti-Pd.

PIN Diode Limiter



RF Circuit Solder Footprint for Case Style 301 (CS301)



Notes:

- 1 Recommended PCB material is Rogers 4350, 10 mils THK.
- 2 Hatched area is RF, DC, and thermal ground. Vias should be solid copper filled and gold plated for optimum heat transfer from backside of limiter module through circuit vias to thermal ground.

Part Number Ordering Information

| Part Number | Description | Packaging |
|--------------------|---|--------------------------------------|
| LM202402-Q-E-301-T | DC Block Capacitor at RF Input Port Only. | Tube |
| LM202402-Q-E-301-R | DC Block Capacitor at RF Input Port Only. | Tape-Reel (Quantities of 250 or 500) |
| LM202402-Q-E-301-W | DC Block Capacitor at RF Input Port Only. | Waffle Pack |
| LM202402-Q-E-301-E | DC Block Capacitor at RF Input Port Only. | RF Evaluation Board with Heat Sink |
| LM202402-Q-F-301-T | DC Block Capacitor at RF Input & Output Port. | Tube |
| LM202402-Q-F-301-R | DC Block Capacitor at RF Input & Output Port. | Tape-Reel (Quantities of 250 or 500) |
| LM202402-Q-F-301-W | DC Block Capacitor at RF Input & Output Port. | Waffle Pack |
| LM202402-Q-F-301-E | DC Block Capacitor at RF Input & Output Port. | RF Evaluation Board with Heat Sink |

Aeroflex / Metelics, Inc.

54 Grenier Field Road, Londonderry, NH 03053
 Tel: (603) 641-3800
 Sales: (888) 641-SEMI (7364)
 Fax: (603)-641-3500

975 Stewart Drive, Sunnyvale, CA 94085
 Tel: (408) 737-8181
 Fax: (408) 733-7645

www.aeroflex.com/metelics

metelics-sales@eroflex.com

Aeroflex / Metelics, Inc. reserves the right to make changes to any products and services herein at any time without notice. Consult Aeroflex or an authorized sales representative to verify that the information in this data sheet is current before using this product. Aeroflex does not assume any responsibility or liability arising out of the application or use of any product or service described herein, except as expressly agreed to in writing by Aeroflex; nor does the purchase, lease, or use of a product or service from Aeroflex convey a license under any patent rights, copyrights, trademark rights, or any other of the intellectual rights of Aeroflex or of third parties.

Copyright 2012 Aeroflex / Metelics. All rights reserved.

ISO 9001:2008 certified companies



Our passion for performance is defined by three attributes represented by these three icons: solution-minded, performance-driven and customer-focused.