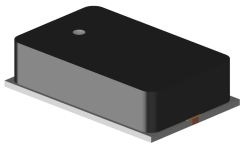
Surface Mount PIN Diode Limiter

LM102202-Q-x-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
- Wide Frequency Range (1 to 2 GHz)
- Higher Average Power Handling than Plastic-Packaged Limiters (100 W CW)
- Higher Peak Power Handling than Plastic-Packaged Limiters (1000 W CW)
- Very Low Insertion Loss (0.35 dB)
- Low Flat Leakage Power (17 dBm)
- RoHS Compliant

Applications

- Receiver protection

Description

The LM102202-Q-x-301 Surface Mount Silicon PIN Diode Limiter is a surface mount, passive two-stage power limiter which can operate over the frequency range of 1 to 2 GHz. It is manufactured using Aeroflex-Metelics proven hybrid manufacturing process incorporating PIN 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. 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 1 to 2 GHz.

The very low thermal resistance (20 ºC/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 50 dBm CW and RF peak incident power levels up to 60 dBm (25 µs pulse width, 5% duty cycle) at T_{CASE} = 85 ºC. The I layer thickness of the output stage and the design of the internal Schottky detector current source combine to produce flat leakage of 17 dBm typical and spike leakage energy of 0.5 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.

Environmental Capabilities

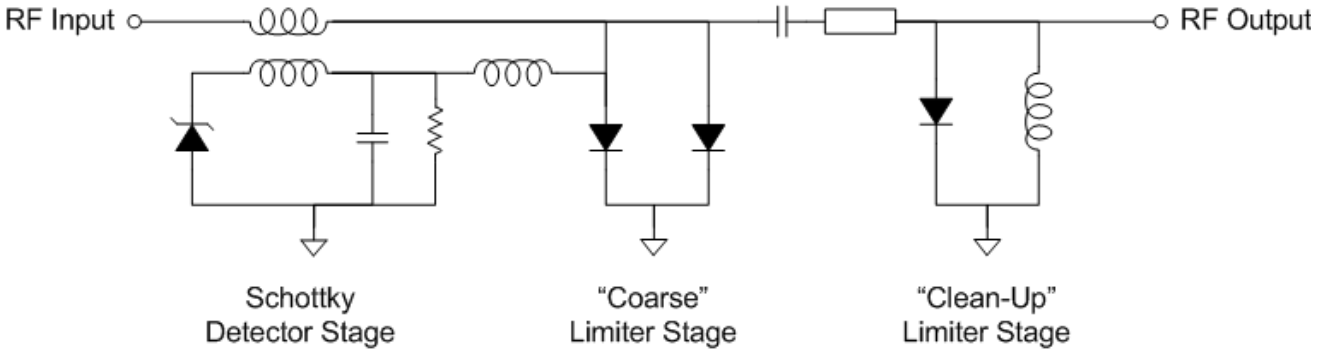
The LM102202-Q-x-301 limiter is compatible with high volume, surface mount, solder re-flow manufacturing methods. This product is durable and capable of reliably operating in military, commercial, and industrial environments The device is RoHS compliant and is available in tube or tape-reel. The LM102202-Q-x-301 limiter is capable of meeting the environmental requirements of MIL-STD-750 and MIL-STD-202.

ESD and Moisture Sensitivity Level Rating

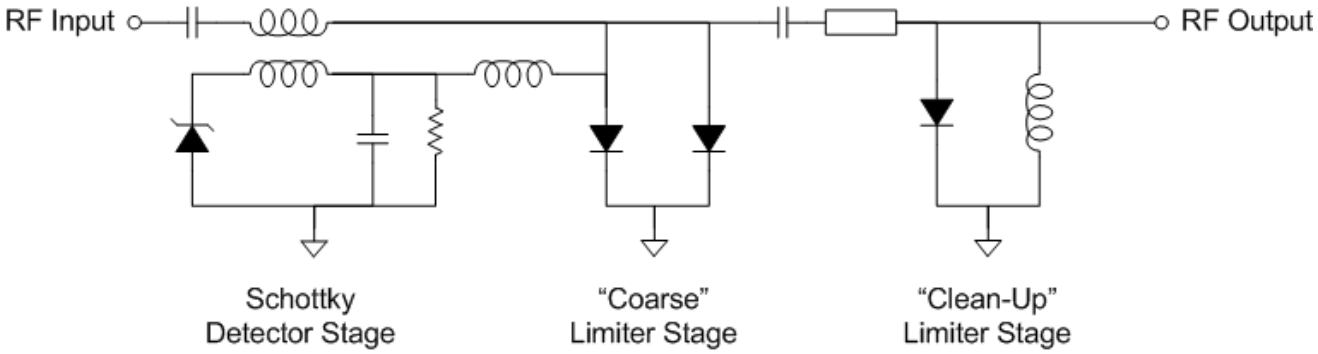
As are all semiconductor devices, PIN diode limiters are susceptible to damage from ESD events. The ESD rating for this device is Class 0 (HBM). The moisture sensitivity level rating for this device is MSL 1.

Document No. DS 13814 Rev.H, ECN 13638
Revision Date: 03/20/2014

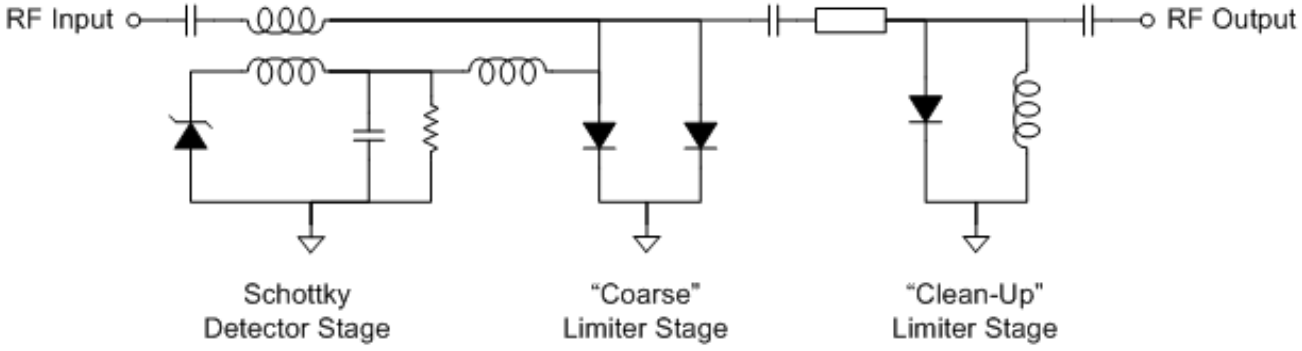
Limiter Schematic – LM102202-Q-A-301



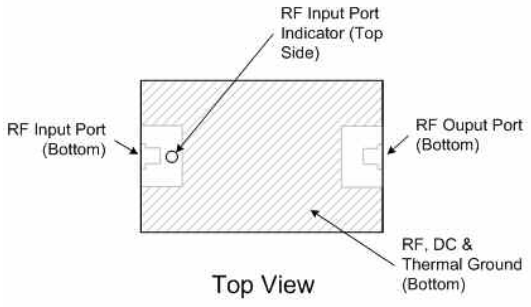
Limiter Schematic – LM102202-Q-B-301



Limiter Schematic – LM102202-Q-C-301



Pinout



Absolute Maximum Ratings

@ Z_0 = 50 Ω, T_A= +25ºC as measured in Aeroflex evaluation board (Unless Otherwise Defined)

Parameter	Conditions	Absolute Maximum Value
Operating Temperature		-65 ºC to 150 ºC
Storage Temperature		-65 ºC to 150 ºC
Junction Temperature		175 ºC
Assembly Temperature	t = 30 s	260 ºC
RF Peak Incident Power Handling	T_{CASE} = 85 ºC, source and load VSWR < 1.2:1, RF pulse width = 25 µs, duty cycle = 5%, derate linearly to 0 W at T_{CASE} = 150 ºC (note 1)	60 dBm
RF CW Incident Power Handling	T_{CASE} = 85 ºC, source and load VSWR < 1.2:1, derate linearly to 0 W at T_{CASE} = 150 ºC (note 1)	50 dBm
Θ_{JC} Thermal Resistance	Junction to bottom surface of package	25 ºC/W
RF Input & Output DC Block Capacitor Voltage Breakdown	Voltage Breakdown at 10µA	45 V DC

Notes:

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

LM102202-Q-x-301 Electrical Specifications

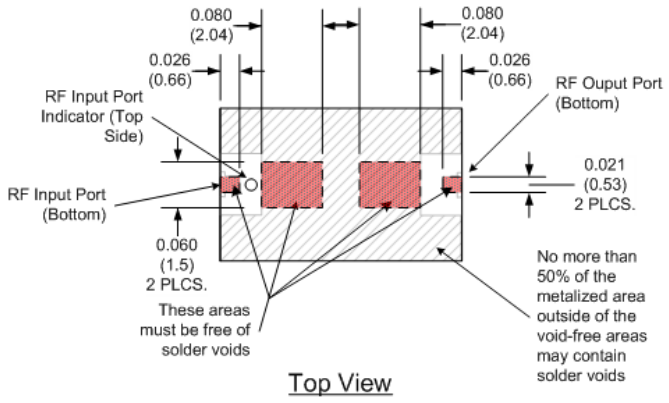
Z_0 = 50 Ω, T_A= 25ºC as measured in Aeroflex evaluation board (Unless Otherwise Defined)

Parameter	Symbol	Test Conditions	Min. Value	Typ. Value	Max. Value	Units
Frequency	F	1 GHz ≤ F ≤ 2 GHz	1		2	GHz
Insertion Loss	IL	1 GHz ≤ F ≤ 2 GHz, P_{in} = 0 dBm		0.35	0.5	dB
Insertion Loss Rate of Change vs. Operating Temperature	ΔIL	1 GHz ≤ F ≤ 2 GHz, P_{in} ≤ -10 dBm		0.005		dB/ºC
Return Loss	RL	1 GHz ≤ F ≤ 2 GHz, P_{in} = 0 dBm	18	20		dB
Input 1 dB Compression Point	IP_{1dB}	1 GHz ≤ F ≤ 2 GHz	8	10	12	dBm
2ND Harmonic	$2F_0$	P_{in} = 0 dBm, F_0 = 2.0 GHz		-50	-45	dBc
Peak Incident Power	P_{inc}(Pk)	RF Pulse Width = 25 µs, duty cycle = 5%, t_{rise} ≤ 2 µs, t_{fall} ≤ 2 µs			60	dBm
CW Incident Power	P_{inc}(CW)	1 GHz ≤ F ≤ 2 GHz			50	dBm
Flat Leakage Power	FL	P_{in} = 60 dBm peak, RF pulse width = 25 µs, duty cycle = 5%, t_{rise} ≤ 2 µs, t_{fall} ≤ 1 µs		17	19.5	dBm
Spike Leakage Energy	SL	P_{in} = 60 dBm peak, RF pulse width = 25 µs, duty cycle = 5%		0.5	0.6	erg
Recovery Time	T_R	50% falling edge of RF pulse to 1 dB IL, P_{IN} = 50 dBm peak, RF pulse width = 25 µs, duty cycle = 5%, t_{rise} ≤ 2 µs, t_{fall} ≤ 1 µs		1	3	µs
		50% falling edge of RF pulse to 1 dB IL, P_{IN} = 60 dBm peak, RF pulse width = 50 µs, duty cycle =10%, t_{rise} ≤ 2 µs, t_{fall} ≤ 1 µs		1.5	4	µs

Document No. DS 13814 Rev.H, ECN 13638
Revision Date: 03/20/2014

Criteria for Proper Mounting on PCB

When a large signal is incident upon the input of the LM102202-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.



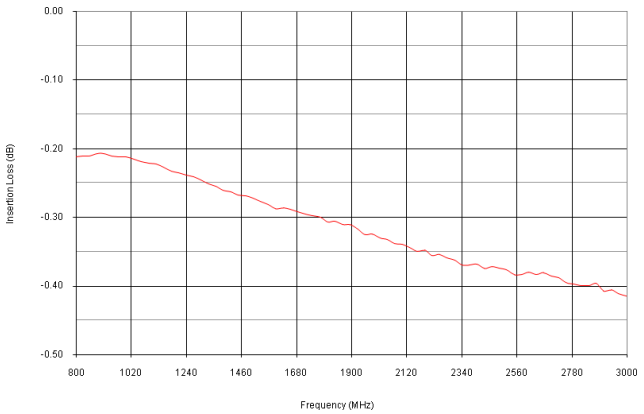
Dimensions in inches (mm).

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 LM102202-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.

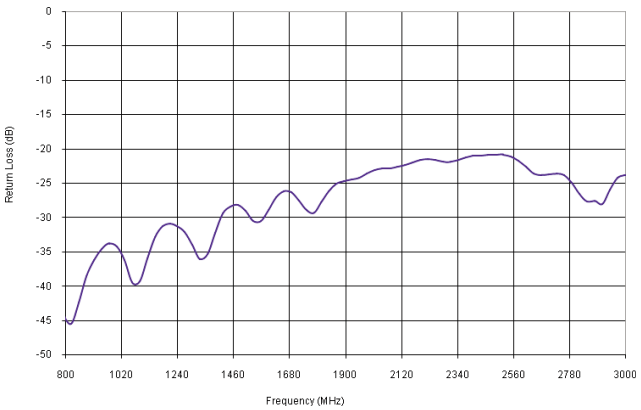
No greater than 50% of the remaining metalized area on the bottom of the package may contain solder voids.

LM102202-Q-x-301 Typical Performance

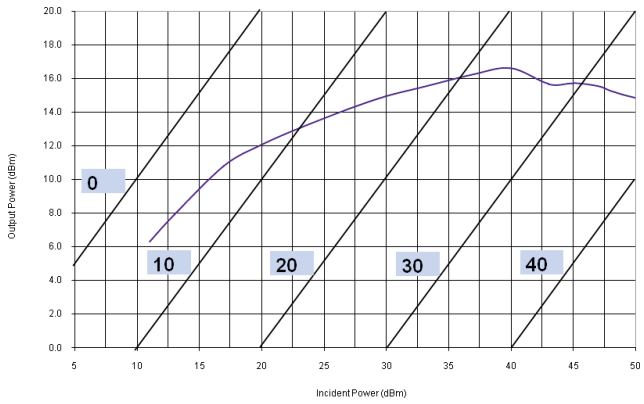
Z_0 = 50 Ω, T_{CASE} = 25°C, P_{IN} = 0 dBm as measured in the Aeroflex Metelics evaluation board (Unless Otherwise Defined)



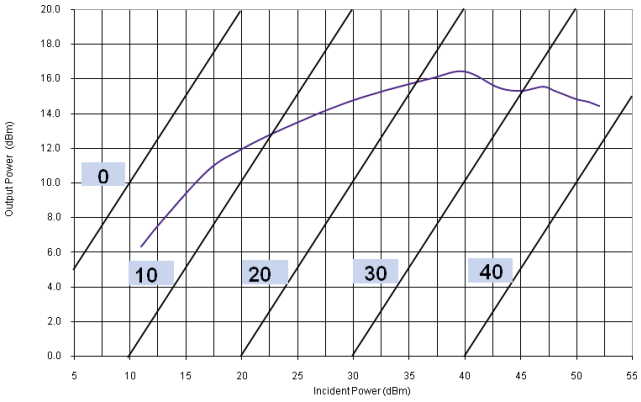
Corrected Insertion Loss vs. Frequency (insertion loss of evaluation board subtracted from overal insertion loss)



Return Loss vs. Frequency



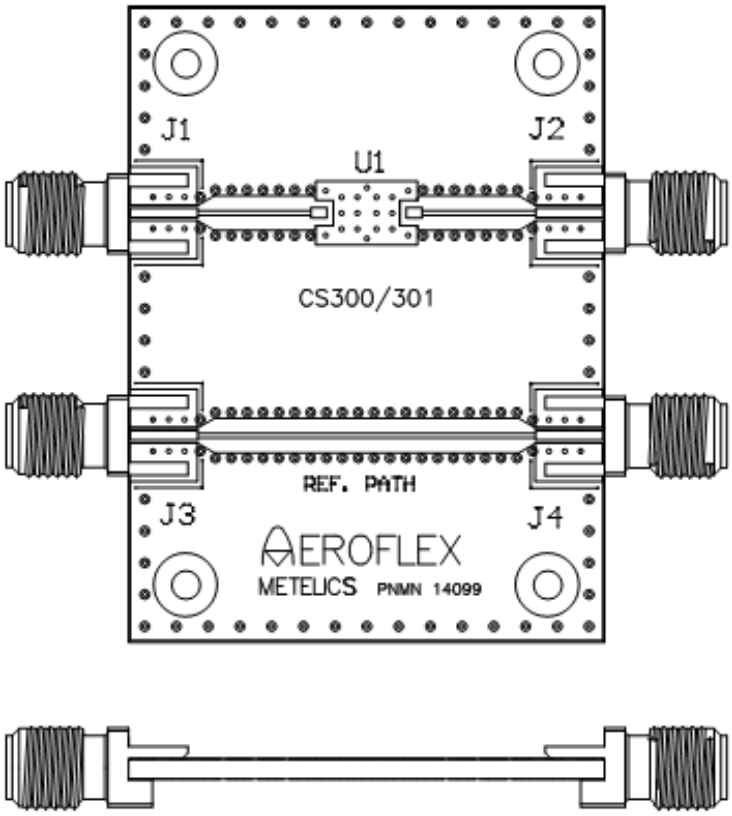
CW Output Power vs. CW Input Power



Flat Leakage Output Power vs. Input Power, Pulse width = 10 µs, Duty Cycle = 1%, f = 2 GHz

Document No. DS 13814 Rev.H, ECN 13638
Revision Date: 03/20/2014

SP2T Switch Evaluation Board Layout



The evaluation board for the LM102202-Q-x-301 is shown above. This evaluation board comprises two sections: the evaluation circuit for the LM102202-Q-C-301 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.

For LM102202-Q-A-301 external DC blocking capacitors are recommended at input and output ports. For LM102202-Q-B-301 an external DC blocking capacitor is recommended at the RF output port. LM102202-Q-C-301 contains internal DC blocking capacitors in its input and output ports and does not need external DC blocking capacitors.

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

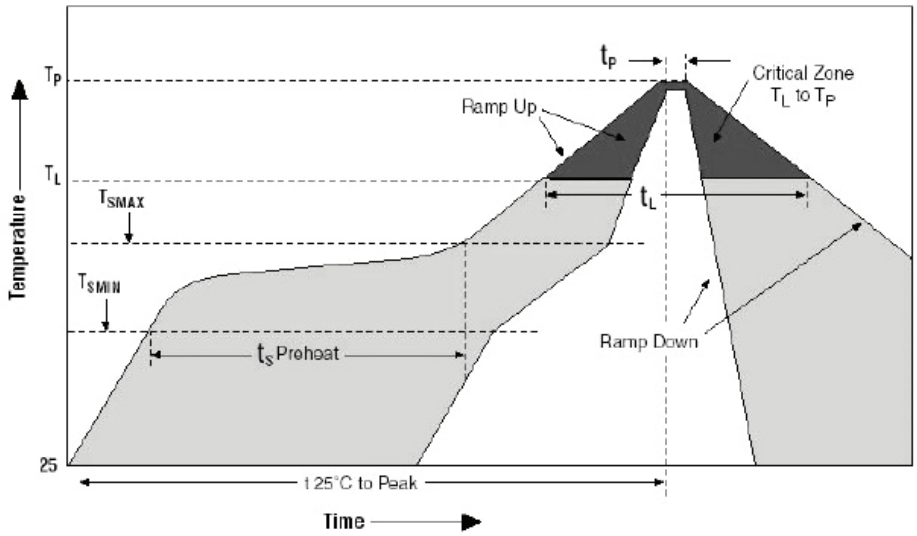
Assembly Instructions

The LM102202-Q-x-301 limiter is capable of being placed onto a circuit board by pick-and-place manufacturing equipment from tube or tape-reel dispensing. The device is 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

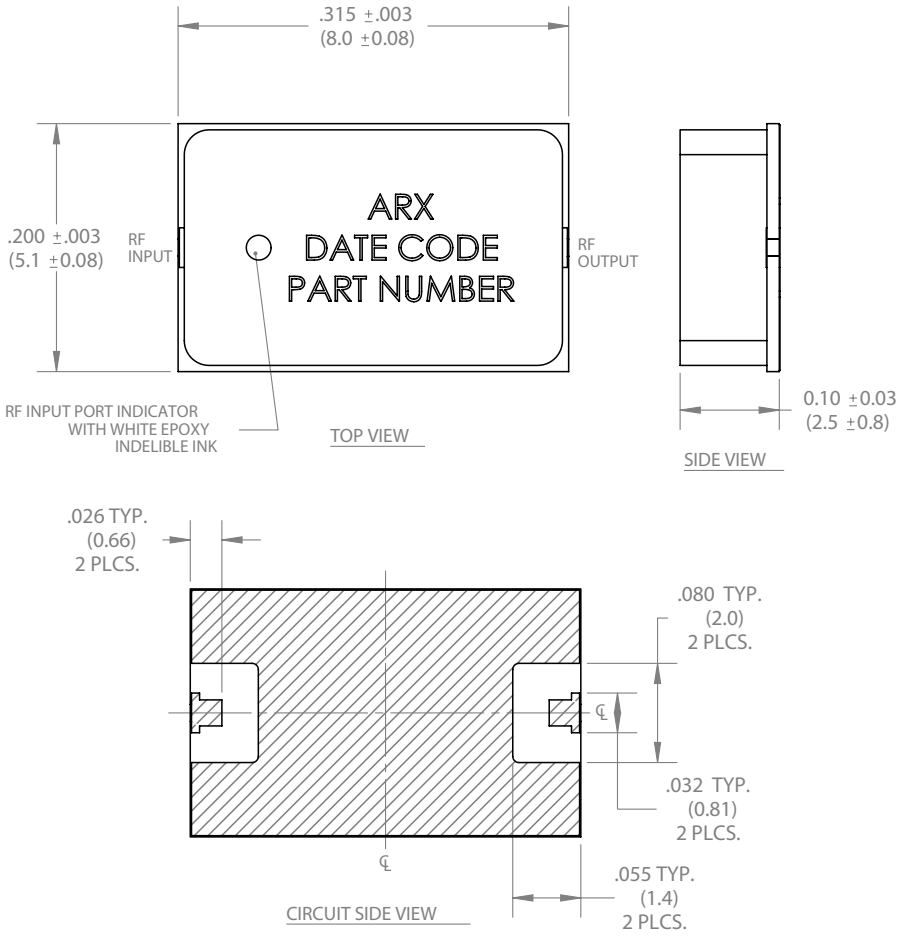
Profile Feature	SnPb Solder Assembly	Pb-Free Solder Assembly
Average Ramp-Up Rate (T_L to T_P)	3°C /second maximum	3°C /second maximum
Preheat: - Temperature Min (T_{SMIN}) - Temperature Max (T_{SMAX}) - Time (min to max)(t_S)	 100°C 150°C 60-120 s	 150°C 200°C 60-180 s
T_{SMAX} to T_L - Ramp-Up Rate		 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



Document No. DS 13814 Rev.H, ECN 13638
Revision Date: 03/20/2014

LM102202-Q-x-301 Limiter Outline (CS301)



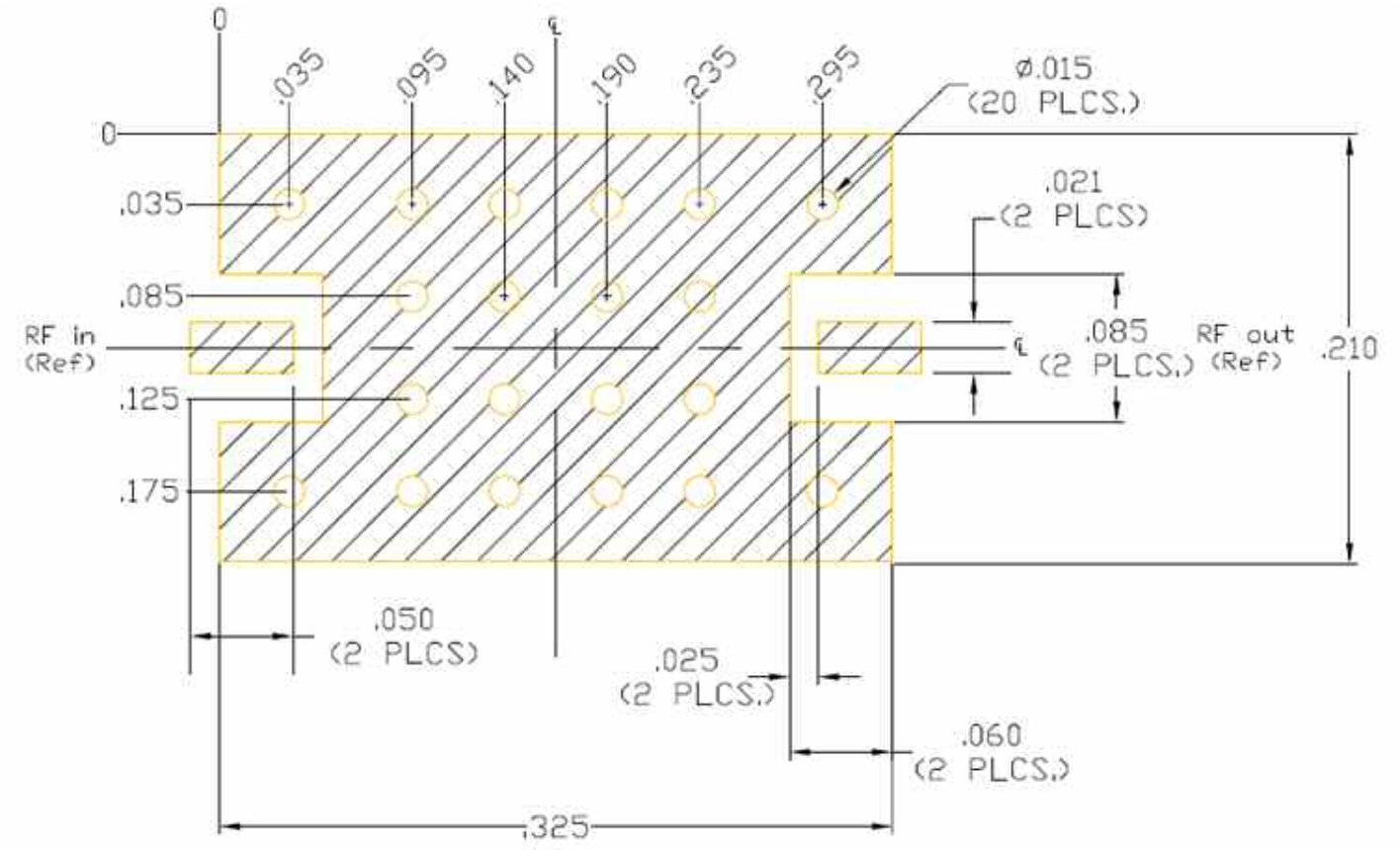
Notes

1 Substrate material: 20 mil thick aluminum nitride (AlN)

2 RF Cover: Black Ceramic

3 Top side and Back side Metallization: 50µ in. typical plated Au over Ti-Pd.

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.

Document No. DS 13814 Rev.H, ECN 13638
Revision Date: 03/20/2014

Part Number Ordering Information

Part Number	Description	Packaging
LM102202-Q-A-301-T	No DC Block Capacitor	Tube
LM102202-Q-A-301-R	No DC Block Capacitor	Tape-Reel (Quantities of 250 or 500)
LM102202-Q-A-301-W	No DC Block Capacitor	Waffle Pack
LM102202-Q-A-301-E	No DC Block Capacitor	RF Evaluation Board with Heat Sink
LM102202-Q-B-301-T	DC Block Capacitor at input end	Tube
LM102202-Q-B-301-R	DC Block Capacitor at input end	Tape-Reel (Quantities of 250 or 500)
LM102202-Q-B-301-W	DC Block Capacitor at input end	Waffle Pack
LM102202-Q-B-301-E	DC Block Capacitor at input end	RF Evaluation Board with Heat Sink
LM102202-Q-C-301-T	DC Block Capacitor at input and output end	Tube
LM102202-Q-C-301-R	DC Block Capacitor at input and output end	Tape-Reel (Quantities of 250 or 500)
LM102202-Q-C-301-W	DC Block Capacitor at input and output end	Waffle Pack
LM102202-Q-C-301-E	DC Block Capacitor at input and output end	RF Evaluation Board with Heat Sink

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