MA4L & MADL Series

Silicon PIN Limiter Diodes

Rev. V20

Features

- Low Insertion Loss and Noise Figure
- High Peak and Average Operating Power
- Various P1dB Compression Powers
- Low Flat Leakage Power
- Proven Reliable, Silicon Nitride Passivation
- RoHS Compliant

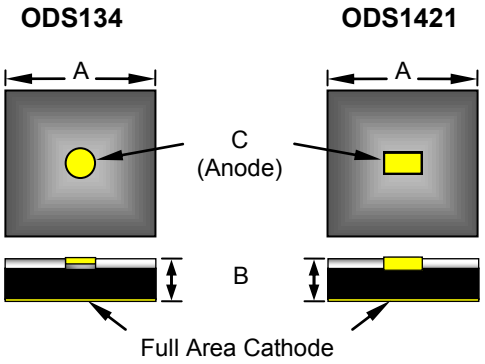
Description

The MA4L and MADL Series are silicon PIN limiter diodes with small and medium I-region lengths which are specifically designed for high signal applications. The devices are designed to provide low insertion loss, at zero bias, as well as low flat leakage power with fast signal response/recovery times. Parts are available as discrete die or assembled into a variety of surface mount or ceramic pill packages. See the Available Case Style table for the specific ceramic package styles and their availability for individual part numbers.

Applications

The MA4L and MADL Series of PIN limiter diodes are designed for use in passive limiter control circuits to protect sensitive receiver components such as low noise amplifiers (LNA), detectors, and mixers covering the 10 MHz to 18 GHz frequency range.

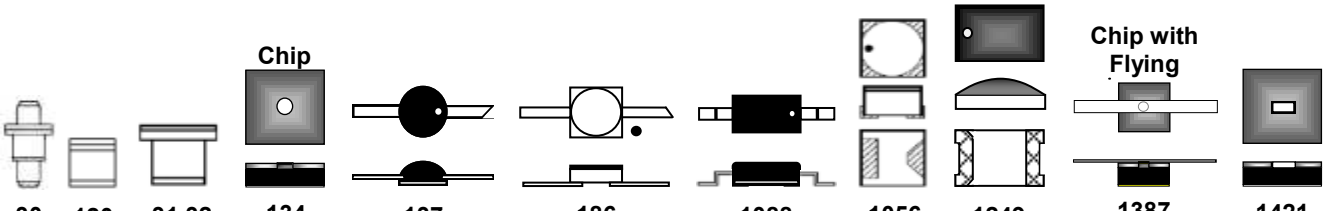
Chip Outlines[2]



ODS	Dimension	mils	mm
134, 1421	A (squared)	15 ±2	0.381 ±0.51
	B	7 ±1*	0.178 ±0.025
1421	C	2.6 x 5.8	0.067 x 0.147

2. For the MADL-000301-01340W, MADL-000301-13880G, MA4L401-134 and MADL-000401-13880G, “B” dimension, is 10 ±1 mils.

Available Packages[1]



1. Package dimensions can be found on the MACOM website.

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Un-Packaged Die Electrical Specifications @ T_A = +25°C

Part Number	*Minimum* V_{REV} *10 µA* V_R	*Maximum* V_{REV} *10 µA* V_R	*Minimum* C_{j0V} *1 MHz* pF	*Maximum* C_{j0V} *1 MHz* pF	*Maximum* $R_{S\ 10\ mA}$ *500 MHz* Ohms[3]	Nominal Characteristics			
						Carrier Lifetime I_{FOR} = +10 mA I_{REV} = -6 mA ns[3]	*I-Region Thickness* µm	*Contact Diameter* mils	*Thermal Resistance* °C/W[3]
MA4L011-134	15	35	0.08	0.18	2.10	10	2	1.2	175
MA4L021-134	20	35	0.10	0.20	2.10	10	2	1.2	175
MADL-011021-14210G	20	35	0.17	0.24	2.00	10	2	2.6 x 5.8	175
MA4L022-134	20	35	0.09	0.19	2.00	10	2	1.2	175
MADL-011009-01340W	20	35	0.16	0.23	1.50	10	2	3.0	175
MA4L031-134	30	50	0.14	0.21	2.00	20	3	1.4	150
MA4L032-134	30	50	0.13	0.20	2.50	15	3	1.5	150
MADL-011010-01340W	30	50	0.17	0.24	1.50	15	3	3.0	150
MA4L062-134	60	75	0.07	0.15	2.50	10	4	1.5	150
MADL-011011-01340W	60	75	0.05	0.17	2.30	10	4	3.0	150
MA4L101-134	100	—	—	0.15	2.00	90	13	3.5	30
MADL-000301-01340W	200	—	—	0.20	1.50	200	20	3.0	30
MA4L401-134	250	—	—	0.30	1.20	800	25	4.5	25

3. Test performed with the chip bonded into a ceramic pill package,ODS-30, mounted to an infinite heat-sink. Chip only thermal resistance is approximately 2°C/W less.

Nominal High Signal Performance[4] @ T_A = +25°C

Part Number	*Incident Peak Power for 1 dB Limiting Freq. = 9.4 GHz* dBm	*Incident Peak Power for 10 dB Limiting Freq. = 9.4 GHz* dBm	*Incident Peak Power for 15 dB Limiting Freq. = 9.4 GHz* dBm	*Recovery Time 3 dB Peak Power = 50 W* ns	*Maximum Incident Peak Power* Watts	*Maximum CW Input Power* Watts
MA4L011-134	7	30	40	10	80	2
MA4L021-134	8	31	41	15	90	3
MA4L022-134	8	31	41	15	90	3
MADL-011009-01340W	8	31	41	10	90	3
MADL-011021-14210G	8	31	41	10	90	3
MA4L031-134	10	33	43	25	125	4
MA4L032-134	11	34	44	25	125	4
MADL-011010-01340W	11	34	44	25	125	4
MA4L062-134	15	38	50	75	200	5
MADL-011011-01340W	15	38	50	75	200	5
MA4L101-134	20	45	53	100	250	6
MADL-000301-01340W	23	46	59	50	500	7
MA4L401-134	30	52	60	250	1000	10

4. *High Signal Performance*: Measured in a single shunt diode (die) configuration attached directly to the gold plated RF ground of a 50 Ω, SMA connectorized, test fixture using 2 mil thick conductive silver epoxy . Chip anode contact is thermo-compression wire bonded using a 1 mil. diameter gold wire onto a 7.2 mil thick Rogers 5880 Duroid microstrip trace. A shunt coil provides the DC return.

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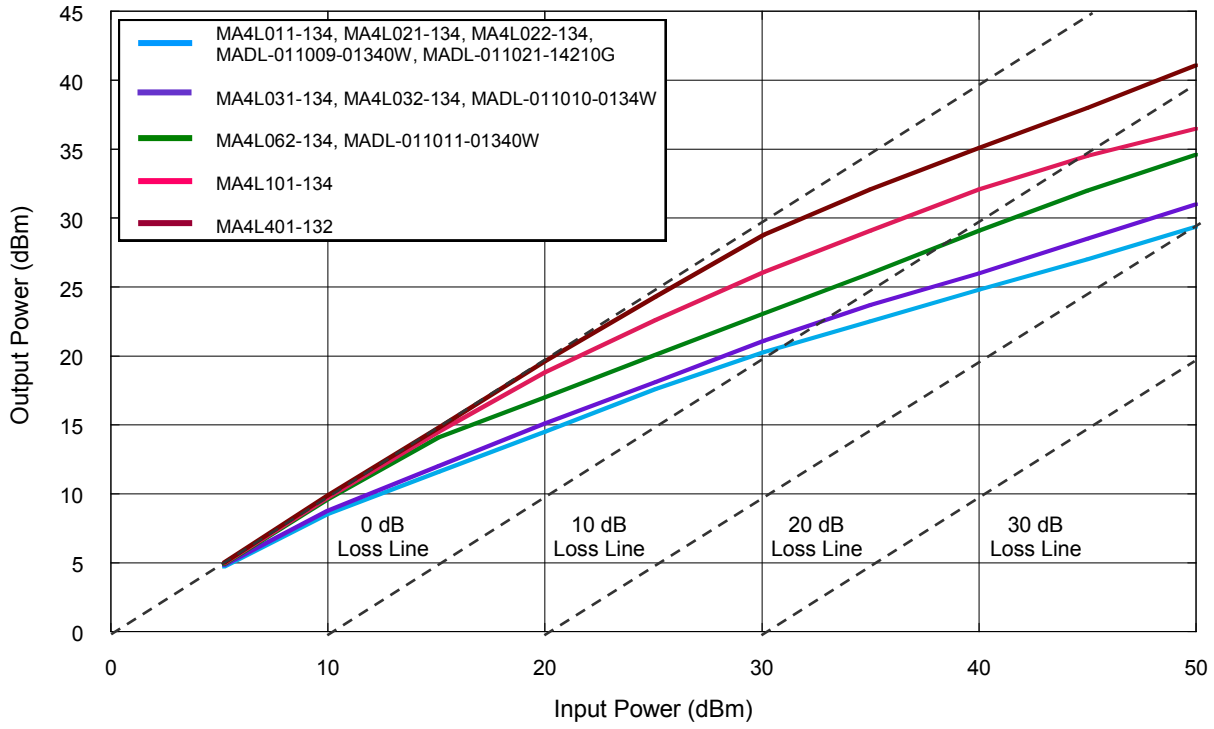
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Absolute Maximum Ratings[5] T_A = +25°C

Parameter	Absolute Maximum
Forward Current	100 mA
Operating Temperature	-55°C to +125°C
Storage Temperature	-55°C to +150°C
Junction Temperature	+175°C
RF Peak & CW Incident Power	Per Performance Table
Mounting Temperature	+320°C for 10 sec.

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

Typical High Signal Peak Power Performance in a Single Shunt 50 Ω Circuit
Frequency = 9.4 GHz, Pulse Width = 1 µs, Duty Cycle = 0.001%

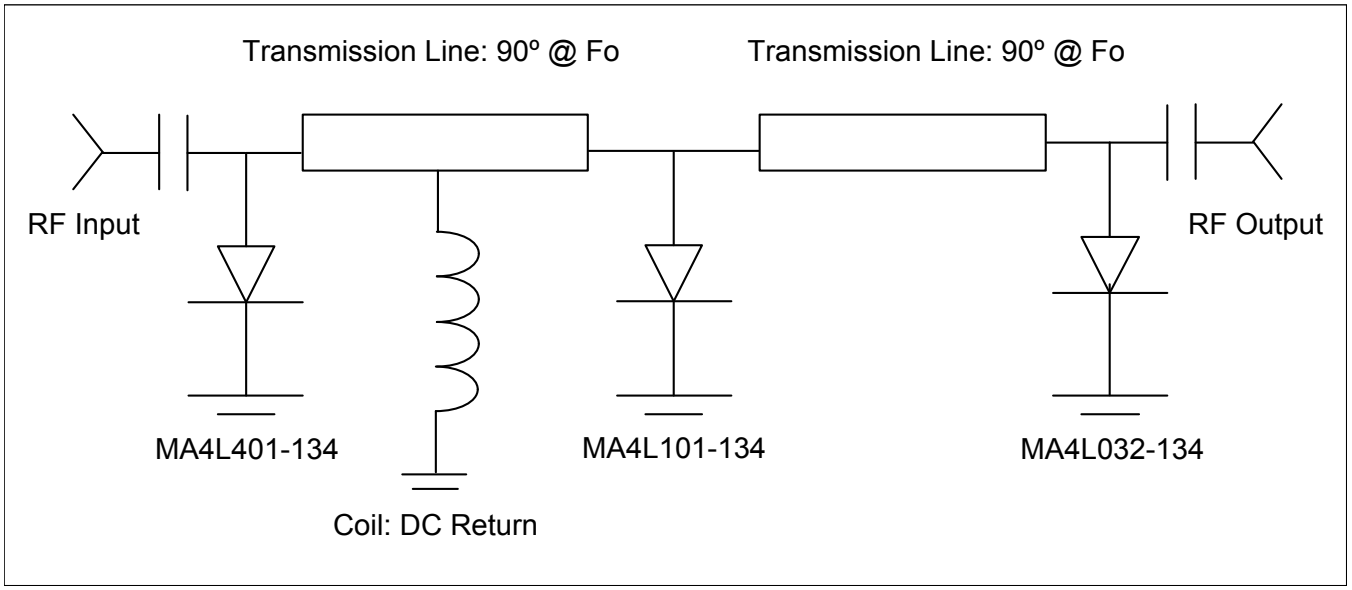


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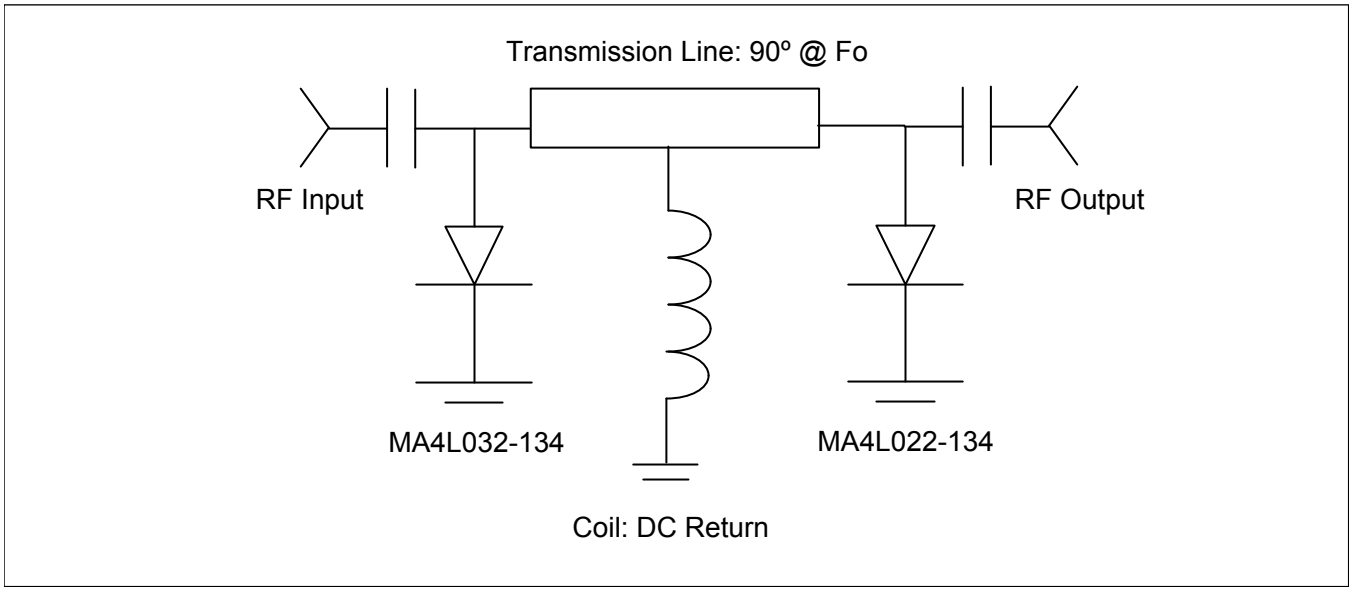
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Application Circuits

Typical 60 dBm Peak Power, 1 µS P.W., 0.001% Duty Cycle, 20 dBm Flat Leakage Limiter Circuit



Typical 50 dBm Peak Power, 1 µS P.W., 0.001% Duty Cycle, 20 dBm Flat Leakage Limiter Circuit



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Notes for Specification and Nominal High Signal Performance Tables:

***Maximum Series Resistance*:** R_S, is measured at 500 MHz in the ODS-30 package and is equivalent to the total diode resistance: R_S = Rj (Chip Junction Resistance) + R_O (Package Ohmic Resistance)

***Maximum High Signal Performance*:** Test freq.= 9.4 GHz, RF pulse width = 1.0 µS, Duty Cycle = 0.001%. Measured with a single shunt diode (die) attached directly to the gold plated RF housing ground with 2 mil thick conductive silver epoxy in a 50 Ω, SMA, connectorized test fixture. Chip anode contact is thermo-compression wire bonded using a 1 mil. diameter gold wire onto a 7.2 mil thick Rogers 5880 Duroid microstrip trace. A shunt coil provides the DC return.

***Maximum CW Incident Power*:** Measured in a 50 Ω, SMA, connectorized housing @ 4 GHz utilizing a TWT amplifier and the same single diode assembly configuration as stated above.

Die Handling and Mounting Information

Handling: All semiconductor chips should be handled with care in order to avoid damage or contamination from particulates, salts, and skin oils. For individual die, the use of plastic tipped tweezers or vacuum pick up tools is strongly recommended. Bulk handling should ensure that abrasion and mechanical shock are minimized.

Die Attach: The die have Ti-Pt-Au back and anode metal, with a final gold thickness of 1.0 µm. Die can be mounted with a gold-tin, eutectic solder perform or conductive silver epoxy. The metal RF and D.C. ground plane mounting surface must be free of contamination and should have a surface flatness or < ±2 mils.

- ***Eutectic Die Attachment Using Hot Gas Die Bonder:*** An 80/20, gold / tin eutectic solder perform is recommended with a work surface temperature of 255°C and a tool tip temperature of 220°C. When the hot gas is applied, the temperature at the tool tip should be approximately 290°C. The chip should not be exposed to a temperatures in excess of 320°C for more than 10 seconds.

- ***Eutectic Die Attachment Using Reflow Oven:*** Refer to Application Note M538 “Surface Mounting Instructions”.

- ***Epoxy Die Attachment:*** A thin, controlled amount of electrically conductive silver epoxy should be applied, approximately 1-2 mils thick to minimize ohmic and thermal resistances. A small epoxy fillet should be visible around the outer perimeter of the chip after placement to ensure full area coverage. Cure the conductive silver epoxy per the manufacturer’s schedule, typically 150˚C for 1 hour.

Wire Bonding: The chip’s top contact (anode) metallization layer is comprised of Ti/Pt/Au with a final gold thickness of 1.0 µm. Thermo-compression wedge bonding using a 0.7 or 1.0 mil diameter gold wire is recommended. The heat stage temperature should be set to approximately 200°C with a tool tip temperature of 125˚C and a force of 18 to 40 grams. Use of ultrasonic energy is not advised but if necessary should be adjusted to the minimum setting required to achieve a good bond. Excessive energy or force applied to the top contact will cause the metallization to dislodge and lift off. Automatic ball bonding may also be used.

See Application Note M541 “Bonding and Handling Procedures for Chip Diode Devices” for more detailed handling and assembly information.

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Part Numbering and Ordering Information

When ordering : Use the base part number followed by a dash plus the desired package style suffix or base part only as defined in Table I “Available Case Styles” below.

For example: The MA4L011 in the 186 style package becomes MA4L011-186 or for just the chip MA4L011-134.

Table I Available Case Styles[6]

Base Part	Available Package Styles
MA4L011	30, 31, 32, 54, 134 (chip), 137,186, 1056, 1088
MADL-000011-13880G	Base part *(MA4L011-134 chip with flying leads)*
MA4L021	31, 120, 134 (chip), 1056
MADL-011021-14210G	Base part *(MA4L021-134 chip with rectangular contact)*
MA4L022	30, 32, 120, 134 (chip), 137, 186, 1056
MADL-011009-01340W	Base part (134 chip)
MA4L031	31, 36, 134 (chip), 186, 1056
MADL-000031-13880G	Base part *(MA4L031-134 chip with flying leads)*
MA4L032	31, 32, 134 (chip), 186, 1056
MADL-000032-00300	Base part (MA4L032 chip in 30 package)
MADL-011010-01340W	Base part (134 chip)
MA4L062-134	Base part (134 chip)
MADL-000062-105600	Base part (*MA4L062 chip in 1056 package)*
MADL-000062-13880G	Base part *(MA4L062-134 chip with flying leads)*
MADL-011011-01340W	Base part (134 chip)
MA4L101	30, 134 (chip), 186
MADL-000101-13880G	Base part *(MA4L101-134 chip with flying leads)*
MA4L301	31,1056
MADL-000301-01340W	Base part (*MA4L301 chip)*
MADL-000301-13870G	Base part *(MA4L301-134 chip with flying leads)*
MA4L401	30, 31, 120,134 (chip), 1056
MADL-000401-13870G	Base part *(MA4L401-134 chip with flying leads)*

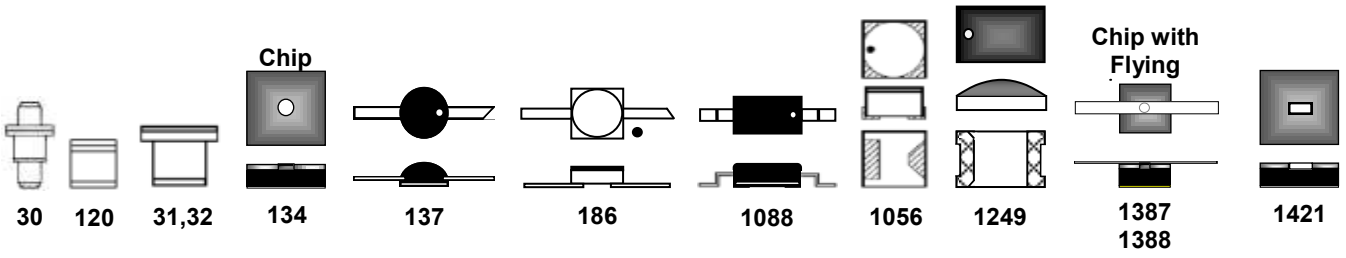
6. See Table I Associated Package Parasitics.

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Table I Associated Package Parasitics[7]

Package Style	Package Description	Nominal	
		C_{PKG} pF	L_S nH
30	Ceramic Pill	0.18	0.60
31	Ceramic Pill	0.18	0.60
32	Ceramic Pill	0.30	0.40
120	Ceramic Pill	0.13	0.40
134	Chip	—	—
137	Epoxy Encapsulated Ceramic Surface Mount with Leads	0.14	0.70
186	Ceramic Surface Mount with Leads	0.15	0.70
1056	Ceramic Surface Mount with Wrap Around Contacts	0.20	0.70
1088	Epoxy Encapsulated Ceramic Surface Mount with Leads	0.12	0.70
1387	Chip with Flying Leads	—	—
1388	Chip with Flying Leads	—	—
1421	Chip with Rectangular Contact	—	—



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