TDLM025100

Document Category: Product Specification

RF Power Limiter, 10 MHz–2.5 GHz

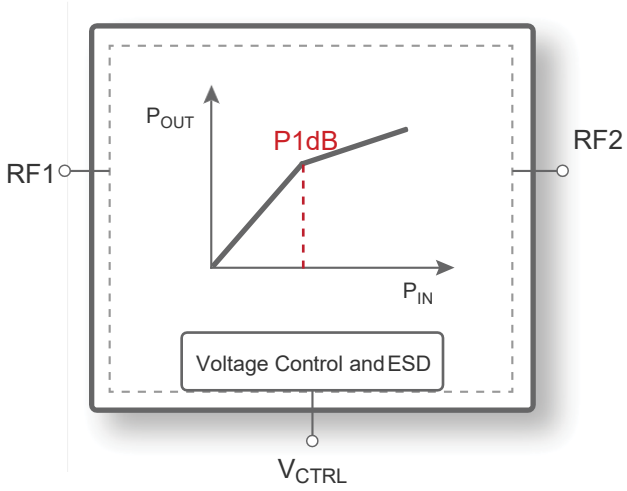
Features

- Monolithic drop-in solution with no external bias components
- Adjustable low power limiting threshold from +7 dBm to +13 dBm
- High maximum power handling of 50 dBm, 100 W pulsed
- Positive threshold control from +0V to +0.3V
- Fast response time of less than 1 ns
- Packaging – 24-pad 4 × 4 × 0.85 mm CLGA
- Qualified for use in harsh environments

Applications

- Satellite transceivers and antennas
- Sensitive orbital T/R Modules

Figure 1 • *TDLM025100 Functional Diagram*



Product Description

The TDLM025100 is a RF power limiter qualified for operating in harsh environments, including military, space , avionics and medical applications.

Unlike traditional PIN diode solutions, the TDLM025100 achieves an adjustable input 1 dB compression point or limiting threshold via a low current control voltage (V_{CTRL}), eliminating the need for external bias components such as dc blocking capacitors, RF choke inductors and bias resistors.

It delivers low insertion loss and high linearity under non-limiting power levels and extremely fast response time in a limiting event, ensuring protection of sensitive circuitry. It also offers excellent ESD rating and ESD protection.

The TDLM025100 is a monolithic solution manufactured on a ruggedized process offering the performance of GaAs with the economy and integration of conventional CMOS.

Absolute Maximum Ratings

Exceeding absolute maximum ratings listed in **Table 1** may cause permanent damage. Operation should be restricted to the limits in **Table 2**. Operation between operating range maximum and absolute maximum for extended periods may reduce reliability.

ESD Precautions

When handling this UltraCMOS® device, observe the same precautions as with any other ESD-sensitive devices. Although this device contains circuitry to protect it from damage due to ESD, precautions should be taken to avoid exceeding the rating specified in **Table 1**.

Latch-up Immunity

The TDLM025100 is immune to single event induced latch-up.

Table 1 • *Absolute Maximum Ratings for TDLM025100*

Parameter/Condition	Min	Max	Unit
Control voltage, V_{CTRL} Power limiting mode	0	3.6	V
RF input power, Pulsed(1)		50	dBm
Storage temperature range	–65	+150	°C
ESD voltage HBM, all pins(2)		7000	V
ESD voltage CDM, all pins(3)		2000	V

Notes:
1) Pulsed, 1.0% duty cycle of 10 µs pulse width in 1 ms period, 50 Ω at +25 °C.
2) Human body model (MIL-STD 883 Method 3015).
3) Charged device model (JEDEC JESD22-C101).

Recommended Operating Conditions

Table 2 lists the recommended operating conditions for the TDLM025100. Devices should not be operated outside the operating conditions listed below.

Table 2 • *Recommended Operating Conditions for TDLM025100*

Parameter	Min	Typ	Max	Unit
Control voltage, V_{CTRL}				
Power limiting mode	0		+0.3	V
Power reflecting mode	0		+3.0	V
RF input power, CW(*)			Fig. 2	dBm
Operating ambient temperature range - $T_{ambient}$	–55	+25	+105	°C
Operating max junction temperature			+150	°C

Note: * See Fig. 2.

Electrical Specifications

Table 3 provides the TDLM025100 key electrical specifications at +25 °C (Z_S = Z_L = 50 Ω), unless otherwise specified.

Table 3 • *TDLM025100 Electrical Specifications*

Parameter	Condition	Min	Typ	Max	Unit
Operation frequency*		10 MHz		2.5 GHz	As shown
Power limiting mode					
Insertion loss	1 GHz, VCTRL = 0V, Ta = -55 °C to +85 °C, Typ value is +25 °C 2 GHz, VCTRL = 0V, Ta = -55 °C to +85 °C, Typ value is +25 °C 2.5 GHz, VCTRL = 0V, Ta = -55 °C to +85 °C, Typ value is +25 °C		0.30 0.40 0.45	0.60 0.60 0.60	dB dB dB
Return loss	10 MHz–3 GHz, V_{CTRL} = 0V 3–6 GHz, V_{CTRL} = 0V		22 12		dB dB
Gain Compression with +13dBm Input Power	V_{CTRL} = 0V @ 1 GHz, 2 GHz, and 2.5 GHz Ta = -55 °C to +85 °C		0.85	1.25	dB
Leakage power(1)	V_{CTRL} = 0V, @ 1 GHz, 2 GHz, and 2.5 GHz Ta = -55 °C to +85 °C		15.8	16.9	dBm
Input IP2	V_{CTRL} = 0V @ 915 MHz V_{CTRL} = 0V @ 6 GHz		88 70		dBm dBm
Input IP3	V_{CTRL} = 0V @ 915 MHz V_{CTRL} = 0V @ 6 GHz		37 31		dBm dBm
Response time	1 GHz		0.6		ns
Recovery time(4)	1 GHz, P_{IN}, Pulse = 30 dBm		1.0		ns
Power reflecting mode(2)					
Leakage power(1)	V_{CTRL} = +3.0V @ 915 MHz		–41		dBm
Switching time(3)	State change to 10% RF		2.7		µs

Notes:

1) Measured with +30 dBm CW applied at input.
2) This mode requires the control voltage to toggle between +3.0V and 0V. At +3.0V, the limiter equivalent circuit is a low impedance to ground, reflecting most of the incident power back to the source.
3) State change is V_{CTRL} toggle from 0V to +3.0V.
4) Pulsed, 1% duty cycle of 10 µs pulse width in 1 ms period, 50 Ω @ +25 °C.

Thermal Data

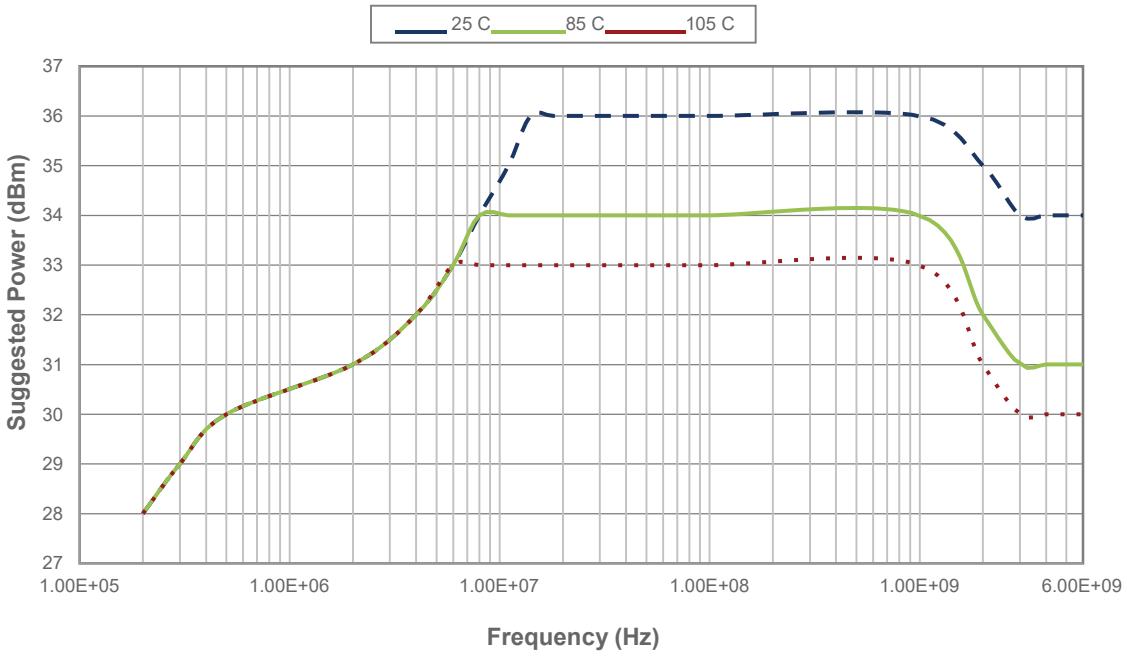
Table 4 • *Thermal Data for TDLM025100*

Parameter	Typ	Unit
Θ_{JC}, junction-to-case thermal resistance	25	°C/W

Power De-rating Curve

Figure 2 shows the power de-rating curve indicating maximum allowable operating RF input power (CW) up to the part's maximum operating ambient temperature of +105 °C. This RF input power maintains the maximum operating junction temperature requirement of +150 °C.

Figure 2 • *Power De-rating Curve, 10 MHz–6 GHz, +25 °C to +105 °C Ambient, CW, 50 Ω*(*)



Note: * High frequency CW power handling can be improved with 0.30 pF capacitive matching on input and output RF ports.

Dual Mode Operation

Power Limiting Mode

The TDLM025100 performs as a linear power limiter with adjustable P1dB/limiting threshold. The P1dB/ limiting threshold can be adjusted by changing the control voltage between 0V and +0.3V. If unbiased, or if V_{CTRL} = 0V, the TDLM025100 still offers power limiting protection.

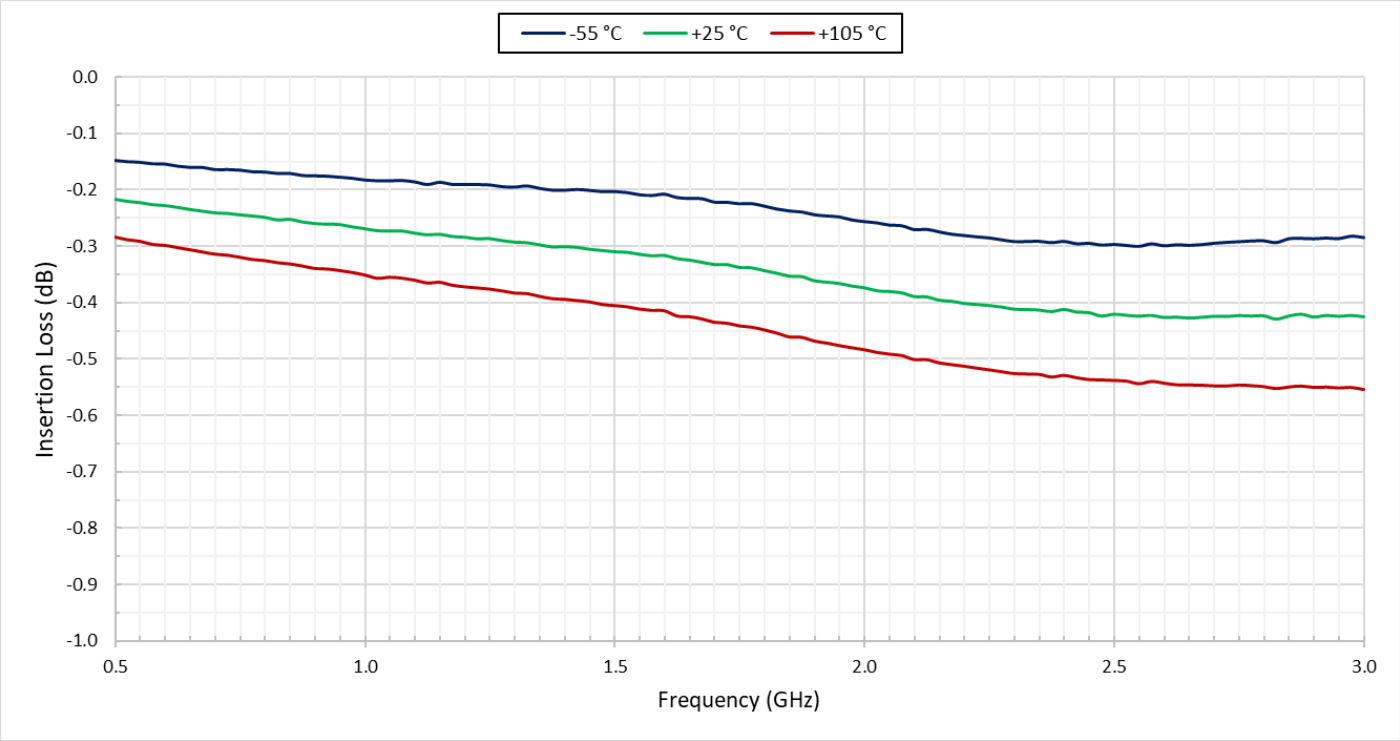
Power Reflecting Mode

Power reflecting mode requires a power detector to sample the RF input power and a microcontroller to toggle the limiter control voltage between +3.0V and 0V based on the system protection requirements. At +3.0V, the limiter impedance to ground is less than 1 Ω and most of the incident power will be reflected back to the source. At 0V, the device operates as in power limiting mode.

Typical Performance Data

Fig. 3–Figure 16 show the typical performance data at +25 °C (Z_S = Z_L = 50 Ω), unless otherwise specified.

Figure 3 • *Insertion Loss vs Temp (Soldered 24L CLGA Package)*



Note: Figures 4-17 were taken using a 12L, 3x3 mm Plastic QFN Package

Figure 4 • *Input Return Loss vs Temp*

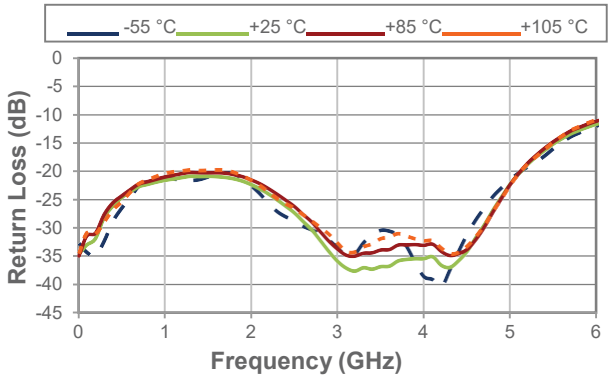


Figure 5 • *Output Return Loss vs Temp*

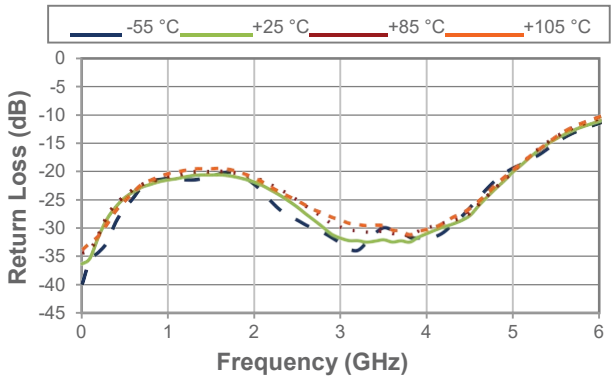


Figure 6 • P_{OUT} vs P_{IN} Over V_{CTRL} (Limiting Mode @ 915 MHz)

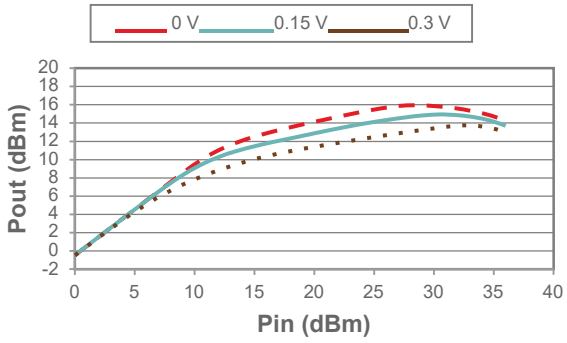


Figure 7 • P_{OUT} vs P_{IN} Over V_{CTRL} (Limiting Mode @ 6 GHz)

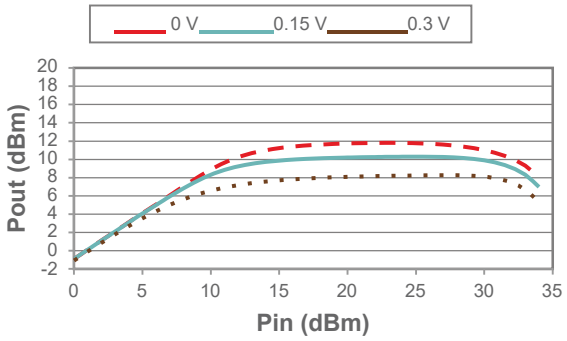


Figure 8 • P1dB vs V_{CTRL} Over Temp @ 915 MHz

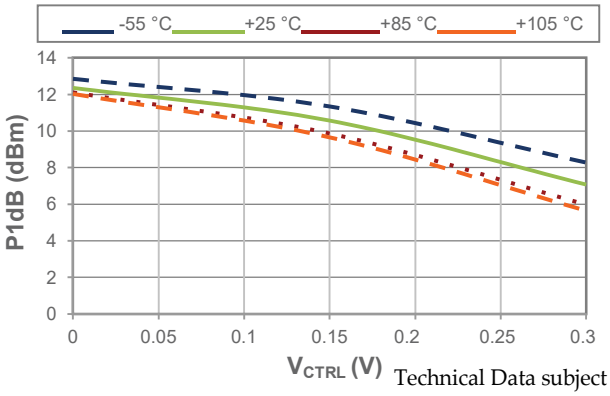


Figure 9 • P_{OUT} vs P_{IN} Over V_{CTRL} (Reflecting Mode @ 915 MHz)

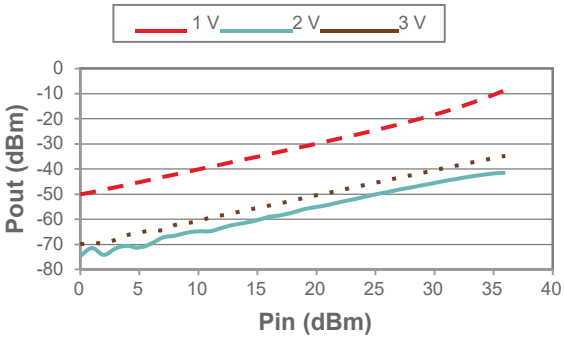


Figure 10 • P_{OUT} vs P_{IN} Over V_{CTRL} (Reflecting Mode @ 6 GHz)

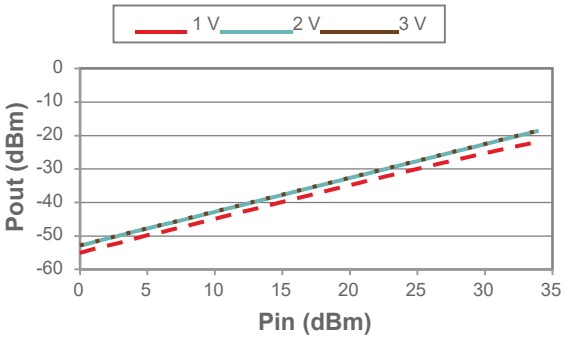


Figure 11 • P1dB vs V_{CTRL} Over Temp @ 6 GHz

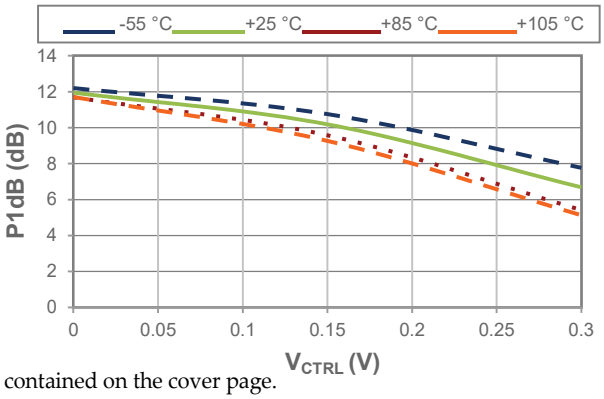


Figure 12 • *Leakage Power @ P_{MAX} vs V_{CTRL} Over Temp @ 915 MHz*

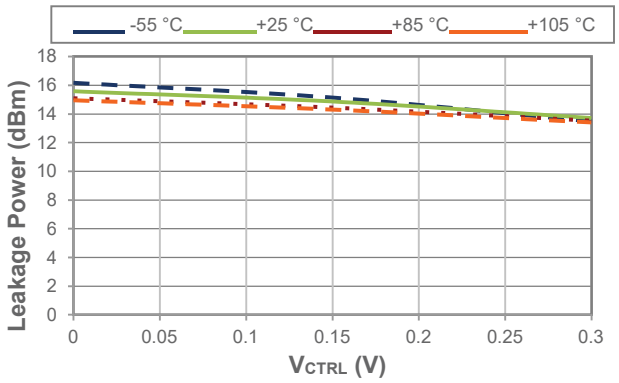


Figure 13 • *IIP2/IIP3 vs P_{IN} Over V_{CTRL} @ 915 MHz*

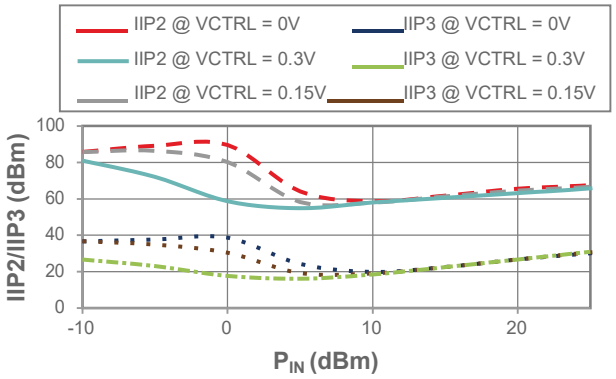


Figure 14 • *IIP2/IIP3 vs V_{CTRL} Over P_{IN} @ 915 MHz*

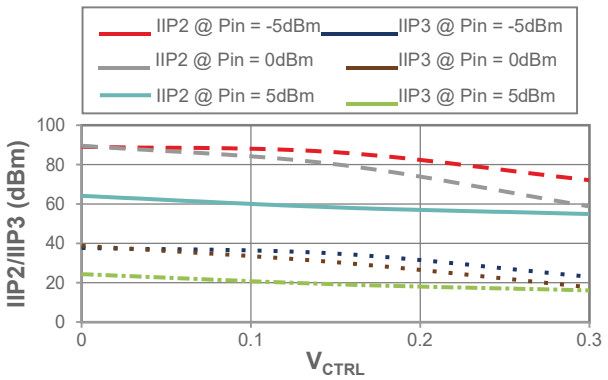


Figure 15 • *Leakage Power @ P_{MAX} vs V_{CTRL} Over Temp @ 6 GHz*

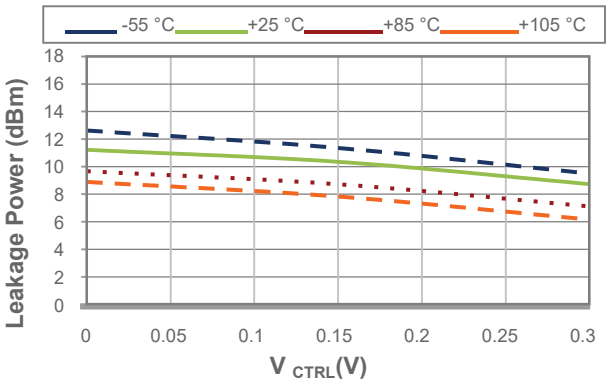


Figure 16 • *IIP2/IIP3 vs P_{IN} Over V_{CTRL} @ 6 GHz*

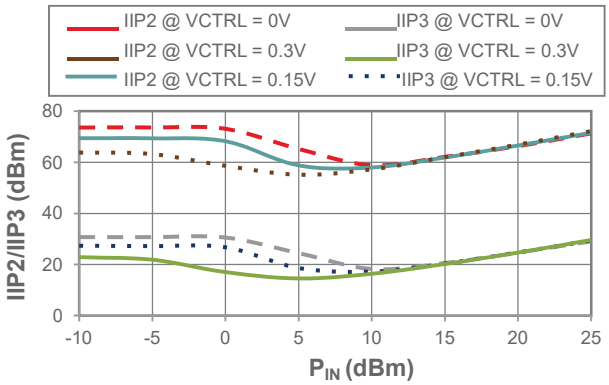
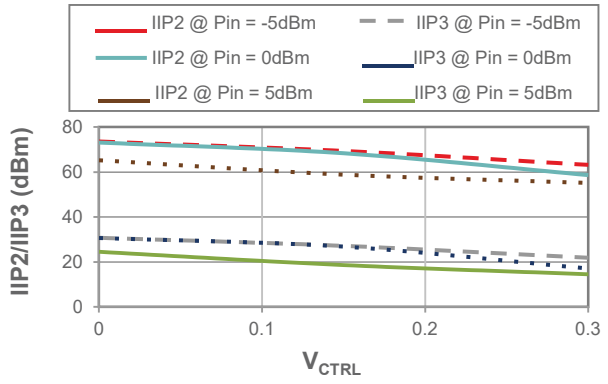


Figure 17 • *IIP2/IIP3 vs V_{CTRL} Over P_{IN} @ 6 GHz*

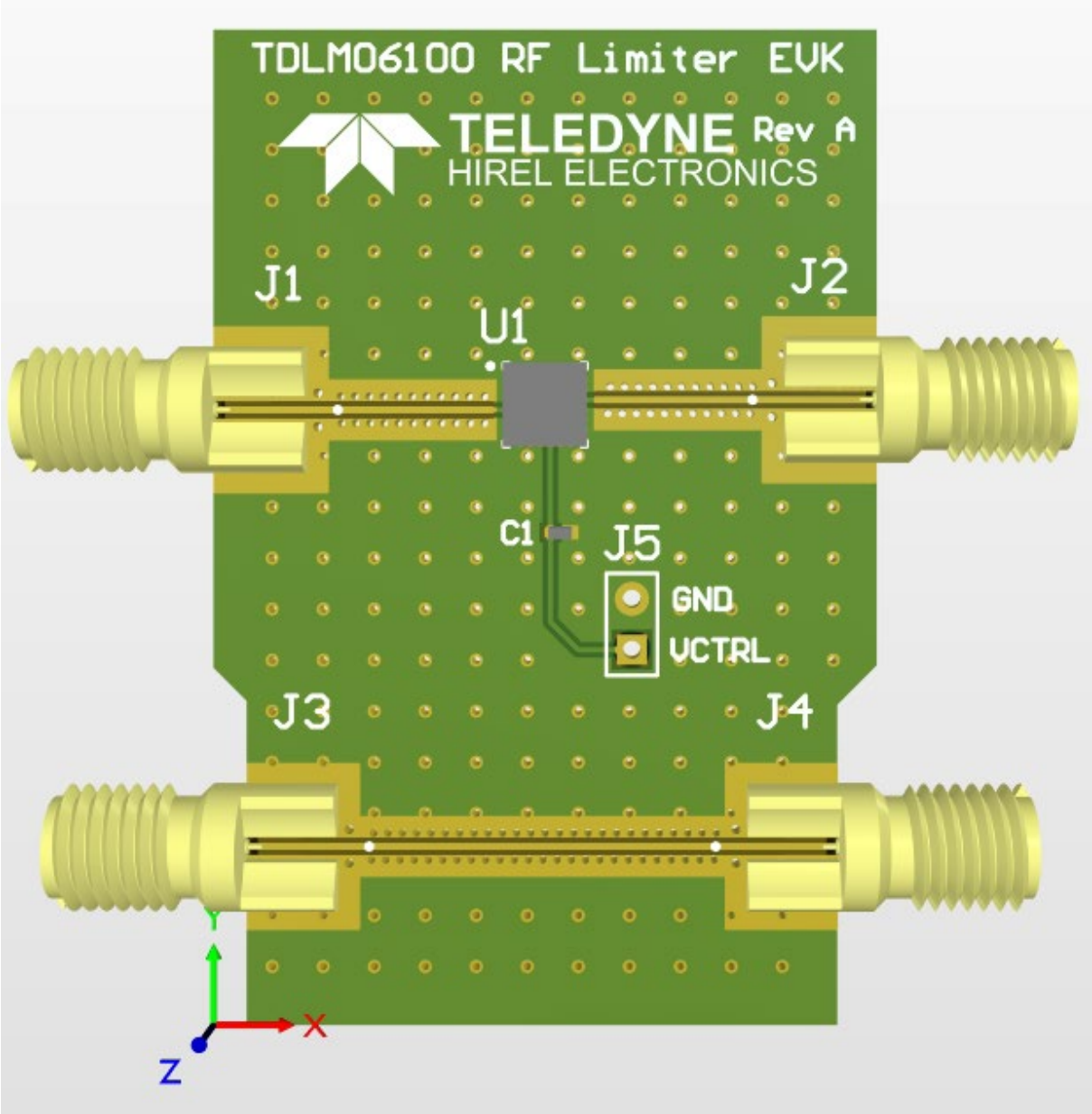


Evaluation Kit

The power limiter evaluation kit board (EVK) was designed to ease customer evaluation of Teledyne e2v HiRel's TDLM025100. The uni-directional RF input and output are connected to the RF1 and RF2 port through a 50 Ω transmission line via SMA connectors J2 and J3. A through 50 Ω transmission line is available via SMA connectors J5 and J6. This transmission line can be used to estimate the loss of the PCB over the environmental conditions being evaluated. The 2-pin connector J4 is connected to the external bias V_{CTRL}.

The board is constructed of a four metal layer material with a total thickness of 62 mils. The top RF layer is Rogers RO4350B material with a 6.6 mil RF core and ε_R = 3.66. The middle layers provide ground for the trans- mission lines. The transmission lines were designed using a coplanar wavequide with ground plane model using a trace width of 13.5 mils, trace gaps of 10 mils, and metal thickness of 2.1 mils.

Figure 18 • *Evaluation Kit Layout for TDLM025100*



Pin Information

This section provides pinout information for the TDLM025100. **Figure 19** shows the pin map of this device for the available package. **Table 5** provides a description for each pin.

Figure 19 • *Pin Configuration (Top View)*

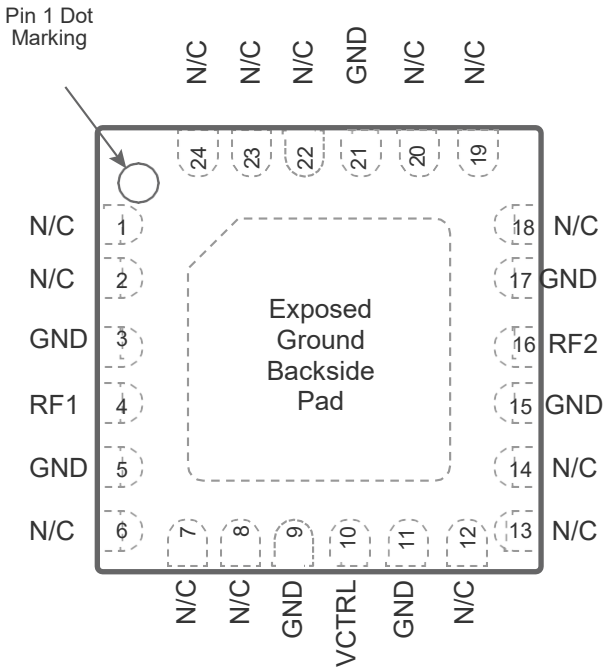


Table 5 • *Pin Descriptions for TDLM025100*

Pin No.	Pin Name	Description
3, 5, 9, 11, 15, 17, 21	GND	Ground
4	RF1(1)(3)	RF port 1
10	V_{CTRL}	Control voltage
16	RF2(1)(3)	RF port 2
1, 2, 6-8,12-14, 18-20, 22-24	N/C(2)	No connect
Pad	GND	Exposed backside pad: ground for proper operation

Notes:

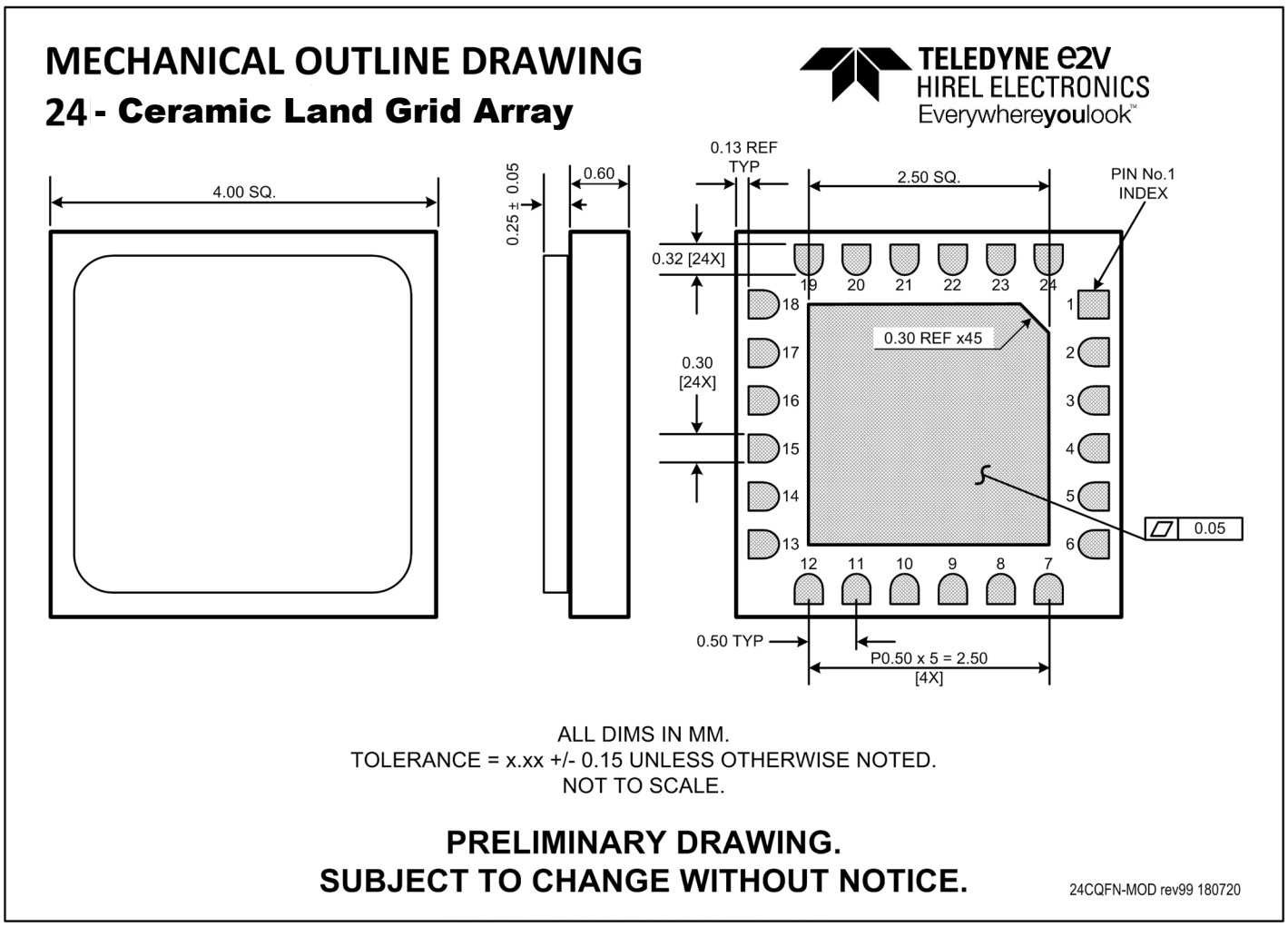
1) RF pins 4 and 16 must be at 0VDC. The RF pins do not require DC blocking capacitors for proper operation if the 0VDC requirement is met.
2) N/C pins can be grounded, if deemed necessary by the customer.
3) The limiter is not bi-directional. RF1 is the RF input and RF2 is the RF output.

Packaging Information

This section provides packaging data

Package Drawing

Figure 20 • *Package Mechanical Drawing for 24-lead 4 × 4 Ceramic LGA*



Ordering Information

Table 6 lists the available ordering codes for the TDLM025100 as well as available shipping methods.

Table 6 • *Order Codes for TDLM025100*

Order Codes	Description	Packaging	Shipping Method
TDLM025100-00	TDLM025100 Evaluation Kit	Evaluation kit (EVK)	1/box
TDLM025100-01	TDLM025100 EM Units	24-lead 4 × 4 Ceramic LGA	Trays
TDLM025100–11	TDLM025100 Flight Units	24-lead 4 × 4 Ceramic LGA	Trays

Document Categories

Advance Information

The product is in a formative or design stage. The datasheet contains design target specifications for product development. Specifications and features may change in any manner without notice.

Preliminary Specification

The datasheet contains preliminary data. Additional data may be added at a later date. Peregrine reserves the right to change specifications at any time without notice in order to supply the best possible product.

Product Specification

The datasheet contains final data. In the event Peregrine decides to change the specifications, Peregrine will notify customers of the intended changes by issuing a CNF (Customer Notification Form).

Sales Contact

For additional information, contact us at https://www.teledynedefenseelectronics.com/e2vhrel/Pages/Contact%20Us.aspx

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