



ULTRA LOW NOISE, MEDIUM CURRENT

# D-PHEMT Transistor

## TAV1-331+

50Ω 10 to 4000 MHz

### THE BIG DEAL

- Low Noise Figure, 0.6 dB typ. at 300 MHz
- High Gain, 24.1 dB typ. at 300 MHz
- High Output IP3, +31.8 dBm typ. at 300 MHz
- Output Power at 1dB comp., +20.1 dBm typ. at 300 MHz
- Low Current, 60mA
- External biasing and matching required
- May be used as a replacement <sup>a,b</sup> for Broadcom ATF-331M4



Generic photo used for illustration purposes only

CASE STYLE: TE2769

#### +RoHS Compliant

The +Suffix identifies RoHS Compliance. See our website for methodologies and qualifications

### APPLICATIONS

- Cellular
- ISM
- GSM
- WCDMA
- WiMax
- WLAN
- UNII and HIPERLAN

### PRODUCT OVERVIEW

Mini-Circuits' TAV1-331+ is a MMIC D-PHEMT\* transistor with an operating frequency range from 10 to 4000 MHz. This model combines high gain with extremely low noise figure, resulting in lower overall system noise. Low NF and IP3 performance make it an ideal choice for sensitive receivers in communications systems. Manufactured using highly repeatable D-PHEMT\* technology, the unit comes housed in a tiny 1.4x1.2mm MCLP package. This model requires external biasing and matching.

### KEY FEATURES

Feature	Advantages
Wideband, 10 to 4000 MHz	A single device covers many wireless communications bands including cellular, ISM, GSM, WCDMA, WiMax, WLAN, and more.
High IP3 vs. DC power consumption <ul style="list-style-type: none"> <li>• +31.8 dBm at 300 MHz</li> <li>• +37.3 dBm at 4000 MHz</li> </ul>	The TAV1-331+ matches industry leading IP3 performance relative to device size and power consumption. Enhanced linearity over a broad frequency range makes the device ideal for use in: <ul style="list-style-type: none"> <li>• Driver amplifiers for complex waveform up converter paths</li> <li>• Drivers in linearized transmit systems</li> </ul>
Combines high gain (24.1 dB) with very low Noise Figure (0.6 dB)	The unique combination of high gain and low Noise Figure results in lower overall system noise.

\* Depletion mode Pseudomorphic High Electron Mobility Transistor.





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# D-PHEMT Transistor

**TAV1-331+**

Mini-Circuits

**ELECTRICAL SPECIFICATIONS AT  $T_{AMB}=25^{\circ}\text{C}$ , FREQUENCY 10 TO 4000 MHZ**

Symbol	Parameter	Condition	Min.	Typ.	Max.	Units
<b>DC Specifications</b>						
$V_{GS}$	Operational Gate Voltage	$V_{DS}=4\text{V}, I_{DS}=60\text{ mA}$	-0.96	-0.69	-0.51	V
$V_p$	Pinch-off Voltage	$V_{DS}=1.5\text{V}, I_{DS}=10\% \text{ of } I_{DSS}$		-0.81		V
$I_{DSS}$	Saturated Drain Current	$V_{DS}=4\text{V}, V_{GS}=0\text{ V}$		228		mA
$G_M$	Transconductance	$V_{DS}=4\text{V}, G_m = \Delta I_{DS} / \Delta V_{GS}$		282		mS
$I_{GDO}$	Gate to Drain Leakage Current	$V_{GD}=-5\text{V}$			1000	$\mu\text{A}$
$I_{GSS}$	Gate leakage Current	$V_{GD}=V_{GS}=-4\text{V}$			600	$\mu\text{A}$
<b>Specifications, <math>Z_0=50\text{ Ohms}</math> (Figure 1)*</b>						
NF	Noise Figure	$V_{DS}=4\text{V}, I_{DS}=60\text{ mA}$		0.9 0.6 0.5 0.6 1.0	0.8	dB
Gain	Gain	$V_{DS}=4\text{V}, I_{DS}=60\text{ mA}$	13.9	24.6 24.1 21.6 17.0 12.0	18.3	dB
OIP3	Output IP3	$V_{DS}=4\text{V}, I_{DS}=60\text{ mA}$		31.7 31.8 32.9 34.6 37.3		dBm
P1dB	Power output at 1 dB Compression	$V_{DS}=4\text{V}, I_{DS}=60\text{ mA}$	18.0	19.6 20.1 20.4 21.3 21.3		dBm
$\Theta_{JC}$	Thermal Resistance			106		$^{\circ}\text{C}/\text{W}$

\*Tested on Mini-Circuits test board TB-TAV1-331+

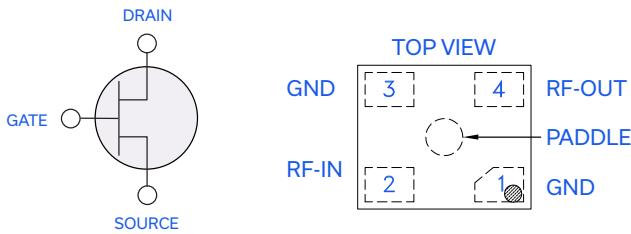


### MAXIMUM RATINGS<sup>(1)</sup>

Symbol	Parameter	Max.	Units
$V_{DS}$	Drain-Source Voltage <sup>2</sup>	5	V
$V_{GS}$	Gate-Source Voltage <sup>2</sup>	-5	V
$V_{GD}$	Gate-Drain Voltage <sup>2</sup>	-5	V
$I_{DS}$	Drain Current <sup>2</sup>	149	mA
$P_{DISS}$	Total Dissipated Power	400	mW
$P_{IN}$	RF Input Power	20	dBm
$T_{CH}$	Channel Temperature	150	°C
$T_{OP}$	Operating Temperature	-40 to 85	°C
$T_{STD}$	Storage Temperature	-65 to 150	°C

(1) Operation of this device above any one of these parameters may cause permanent damage.  
 (2) Assumes DC quiescent conditions,  $V_{GS} = -0.51\text{ V}$ ,  $V_{DS} = 4\text{ V}$ .

### SIMPLIFIED SCHEMATIC AND PIN DESCRIPTION



Function	Pin Number	Description
RF-IN	2	Gate used for RF input
RF-OUT	4	Drain used for RF output
GND	1,3 and Paddle	Source terminal and Paddle, normally connected to ground.

A. Note: Suitability for model replacement within a particular system must be determined by and is solely the responsibility of the customer based on, among other things, electrical performance criteria, stimulus conditions, and application, compatibility with other components and environmental conditions and stresses  
 B. The Broadcom ATF-331M4 part number is used for identification and comparison purposes only.



### CHARACTERIZATION TEST CIRCUIT

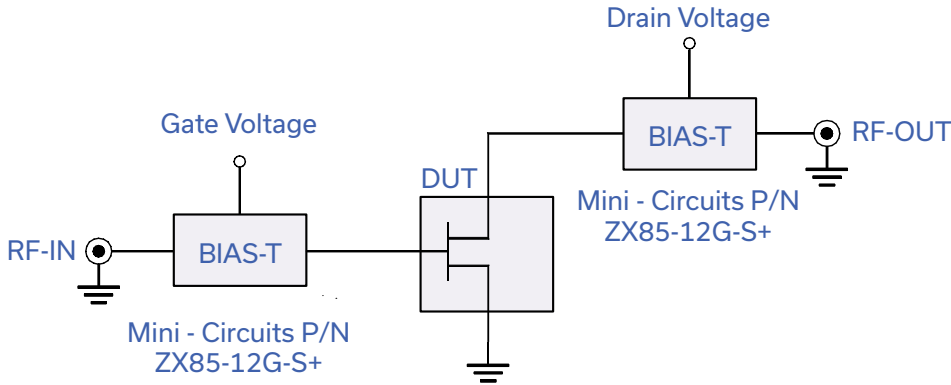


Fig 1. Block Diagram of Test Circuit used for characterization. (DUT soldered on Mini-Circuits Test Board TB-TAV1-331+)

Gain, Output power at 1dB compression (P1 dB), Noise Figure and output IP3 (OIP3) are measured using Keysight PNA-X.

Conditions:

1. Drain voltage (with reference to source, VDS)= 4V as shown.
2. Gate Voltage (with reference to source, VGS) is set to obtain desired Drain-Source current (IDS) as shown in graphs or specification table.
3. Gain: Pin= -25dBm
4. Output IP3 (OIP3): Two tones, spaced 1 MHz apart, 0 dBm/tone at output.
5. No external matching components used.

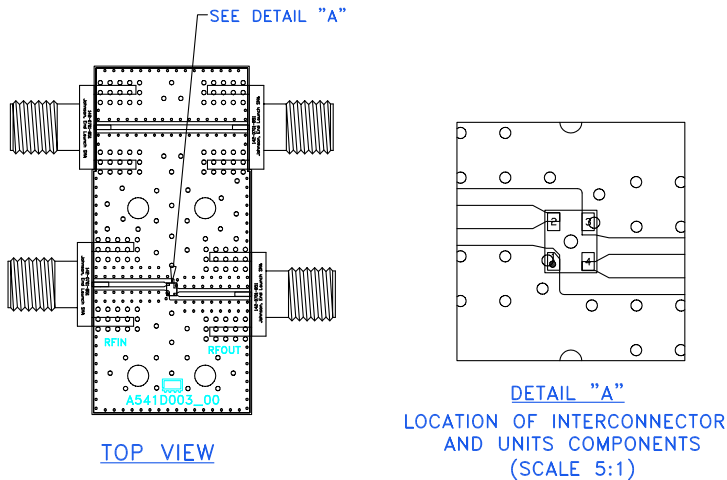
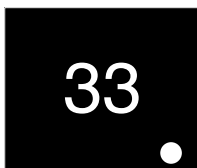


Fig 2. Test Board used for characterization, Mini-Circuits P/N TB-TAV1-331+ (Material: Rogers R04350B, Thickness: 0.01")

### PRODUCT MARKING



- ← Black body
- ← Model family designation
- ← Index over pin

Marking may contain other features or characters for internal lot control



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# D-PHEMT Transistor

## TAV1-331+

Mini-Circuits

ADDITIONAL DETAILED TECHNICAL INFORMATION IS AVAILABLE ON OUR DASH BOARD. TO ACCESS [CLICK HERE](#)

Performance Data	Data Table Swept Graphs S-Parameter (S2P Files) Data Set (.zip file)
Case Style	TE2769 Plastic package, exposed paddle, lead finish: Matte-Tin plated
Tape & Reel Standard quantities available on reel	F90 7" reels with 20, 50, 100, 200, 500,1K,2K or 3K devices
Suggested Layout for PCB Design	PL-627
Evaluation Board	TB-TAV1-331+
Environmental Ratings	ENV08T2

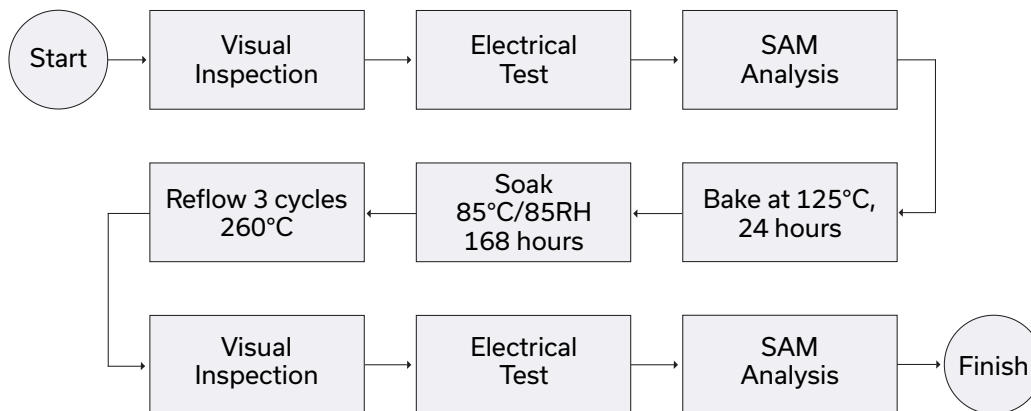
### ESD RATING

Human Body Model (HBM): Class 0 (<250V) in accordance with ANSI/ESD STM 5.1 - 2001

### MSL RATING

Moisture Sensitivity: MSL1 in accordance with IPC/JEDEC J-STD-020D

### MSL TEST FLOW CHART



- NOTES**
- A. Performance and quality attributes and conditions not expressly stated in this specification document are intended to be excluded and do not form a part of this specification document.
  - B. Electrical specifications and performance data contained in this specification document are based on Mini-Circuit's applicable established test performance criteria and measurement instructions.
  - C. The parts covered by this specification document are subject to Mini-Circuits standard limited warranty and terms and conditions (collectively, "Standard Terms"); Purchasers of this part are entitled to the rights and benefits contained therein. For a full statement of the standard. Terms and the exclusive rights and remedies thereunder, please visit Mini-Circuits' website at [www.minicircuits.com/MCLStore/terms.jsp](http://www.minicircuits.com/MCLStore/terms.jsp)



Typical Performance Data

VDS (V)	IDS (mA)						
	@ VGS=						
	-1.00V	-0.90V	-0.8V	-0.7V	-0.6V	-0.4V	-0.2V
0.0	-0.01	-0.01	0.03	0.04	-0.01	-0.12	-0.14
0.1	1.32	3.19	8.04	14.00	19.61	28.89	34.79
0.2	1.67	4.87	12.63	23.34	34.52	54.04	67.14
0.3	1.85	5.85	15.15	28.87	44.46	74.08	95.60
0.4	1.98	6.53	16.73	32.10	50.52	88.67	120.14
0.5	2.11	7.05	17.86	34.12	54.08	98.28	138.30
0.6	2.22	7.46	18.72	35.53	56.26	104.20	150.94
0.7	2.32	7.79	19.41	36.62	57.79	107.32	158.60
0.8	2.43	8.09	20.01	37.56	59.04	109.22	162.68
0.9	2.52	8.37	20.56	38.39	60.11	110.60	164.94
1.0	2.62	8.63	21.08	39.15	61.07	111.72	166.36
1.1	2.71	8.88	21.56	39.86	61.95	112.68	167.34
1.2	2.80	9.12	22.02	40.53	62.78	113.52	168.08
1.3	2.89	9.36	22.45	41.16	63.55	114.24	168.62
1.4	2.98	9.59	22.87	41.77	64.27	114.88	169.04
1.5	3.06	9.82	23.30	42.35	64.97	115.48	169.34
1.6	3.15	10.07	23.75	42.95	65.64	116.02	169.62
1.7	3.25	10.36	24.27	43.58	66.30	116.52	169.84
1.8	3.37	10.73	24.89	44.31	66.96	117.02	170.00
1.9	3.52	11.20	25.67	45.16	67.66	117.48	170.18
2.0	3.69	11.79	26.61	46.04	68.36	117.92	170.30
2.1	3.88	12.50	27.60	46.97	69.08	118.32	170.26
2.2	4.10	13.07	28.39	47.86	69.78	118.72	170.18
2.3	4.29	13.50	29.01	48.62	70.41	119.12	170.18
2.4	4.45	13.85	29.51	49.24	71.02	119.50	170.26
2.5	4.58	14.15	29.93	49.77	71.57	119.84	170.46
2.6	4.70	14.40	30.28	50.22	72.06	120.24	170.70
2.7	4.81	14.63	30.62	50.62	72.51	120.56	171.12
2.8	4.90	14.82	30.90	50.98	72.92	120.90	171.26
2.9	4.98	15.01	31.17	51.30	73.30	121.20	171.42
3.0	5.07	15.19	31.42	51.61	73.65	121.50	171.60
3.1	5.15	15.35	31.65	51.88	73.98	121.82	171.80
3.2	5.22	15.50	31.86	52.16	74.28	122.16	171.98
3.3	5.30	15.65	32.08	52.41	74.57	122.46	172.14
3.4	5.37	15.80	32.27	52.65	74.85	122.84	172.28
3.5	5.44	15.93	32.47	52.88	75.12	123.20	--
3.6	5.51	16.06	32.65	53.11	75.39	123.58	--
3.7	5.57	16.19	32.83	53.33	75.65	123.96	--
3.8	5.64	16.32	33.00	53.53	75.90	124.32	--
3.9	5.70	16.44	33.17	53.74	76.17	124.68	--
4.0	5.77	16.56	33.34	53.95	76.42	125.04	--
4.1	5.83	16.68	33.50	54.16	76.69	125.36	--
4.2	5.90	16.80	33.68	54.36	76.96	125.68	--
4.3	5.97	16.92	33.84	54.56	77.23	125.96	--
4.4	6.03	17.04	34.00	54.77	77.52	126.28	--
4.5	6.10	17.16	34.17	54.98	77.80	126.54	--
4.6	6.16	17.28	34.33	55.19	78.10	126.74	--
4.7	6.23	17.39	34.50	55.41	78.41	127.00	--
4.8	6.30	17.51	34.67	55.63	78.71	--	--
4.9	6.37	17.64	34.84	55.86	79.03	--	--
5.0	6.44	17.76	35.01	56.09	79.35	--	--



P.O. Box 350166, Brooklyn, New York 11235-0003 (718) 934-4500 • Fax (718) 332-4661 For detailed performance specs & shopping online see Mini-Circuits web site  
 The Design Engineers Search Engine Provides ACTUAL Data Instantly From MINI-CIRCUITS At: www.minicircuits.com



IF/RF MICROWAVE COMPONENTS

## Typical Performance Data

FREQ (GHz)	GAIN vs FREQ & TEMPERATURE <sup>(1)</sup> @ VDS=4V, IDS=60mA			NOISE FIGURE vs FREQ & TEMPERATURE <sup>(1)</sup> @ VDS=4V, IDS=60mA		
	-45°C	+25°C	+85°C	-45°C	+25°C	+85°C
0.01	25.03	24.80	24.25	3.77	2.19	4.50
0.05	25.00	24.77	24.23	0.83	0.55	1.03
0.10	24.94	24.72	24.18	0.50	0.40	0.62
0.20	24.78	24.57	24.03	0.51	0.45	0.60
0.30	24.55	24.33	23.80	0.56	0.48	0.62
0.40	24.26	24.01	23.49	0.43	0.36	0.48
0.50	23.91	23.65	23.14	0.49	0.43	0.55
0.60	23.51	23.24	22.75	0.52	0.41	0.57
0.70	23.08	22.80	22.33	0.41	0.39	0.49
0.80	22.65	22.35	21.89	0.57	0.51	0.62
0.90	22.20	21.88	21.44	0.52	0.40	0.56
1.00	21.74	21.42	20.98	0.47	0.39	0.49
1.10	21.30	20.97	20.54	0.56	0.45	0.60
1.20	20.85	20.52	20.10	0.58	0.49	0.62
1.30	20.41	20.08	19.66	0.57	0.48	0.64
1.40	19.98	19.64	19.24	0.63	0.52	0.70
1.50	19.56	19.22	18.83	0.66	0.52	0.73
1.60	19.16	18.82	18.44	0.57	0.57	0.64
1.70	18.78	18.44	18.05	0.52	0.42	0.64
1.80	18.39	18.05	17.67	0.60	0.42	0.66
1.90	18.04	17.70	17.31	0.55	0.45	0.65
2.00	17.70	17.35	16.97	0.57	0.44	0.70
2.10	17.37	17.02	16.63	0.61	0.49	0.70
2.20	17.05	16.69	16.31	0.59	0.48	0.72
2.30	16.74	16.38	16.00	0.63	0.44	0.79
2.40	16.44	16.08	15.70	0.59	0.37	0.68
2.50	16.16	15.79	15.42	0.73	0.53	0.96
2.60	15.87	15.50	15.13	0.73	0.52	0.83
2.70	15.61	15.24	14.86	0.80	0.64	0.92
2.80	15.36	14.98	14.60	0.96	0.72	1.00
2.90	15.12	14.73	14.35	0.85	0.59	0.97
3.00	14.88	14.49	14.11	0.87	0.65	0.96
3.10	14.64	14.25	13.87	0.74	0.51	0.89
3.20	14.40	14.01	13.64	0.70	0.56	0.95
3.30	14.18	13.79	13.41	0.78	0.59	0.95
3.40	13.95	13.56	13.18	0.78	0.58	0.95
3.50	13.74	13.35	12.97	0.74	0.57	0.94
3.60	13.53	13.14	12.76	0.76	0.69	1.01
3.70	13.31	12.92	12.55	0.85	0.73	0.97
3.80	13.10	12.71	12.35	0.87	0.67	1.00
3.90	12.90	12.52	12.16	0.85	0.67	1.04
4.00	12.70	12.33	11.97	0.90	0.72	1.11

<sup>(1)</sup> Includes test board loss

<sup>(2)</sup> Drain current was allowed to increase during compression measurement

## Typical Performance Data

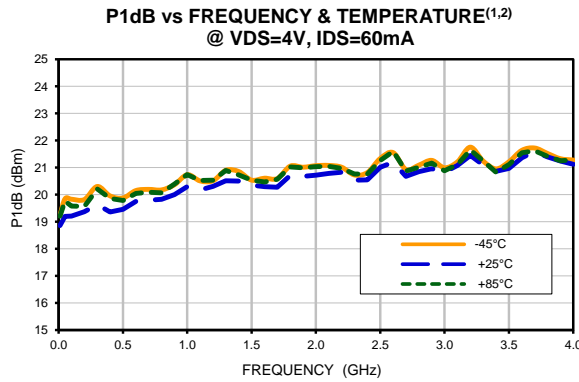
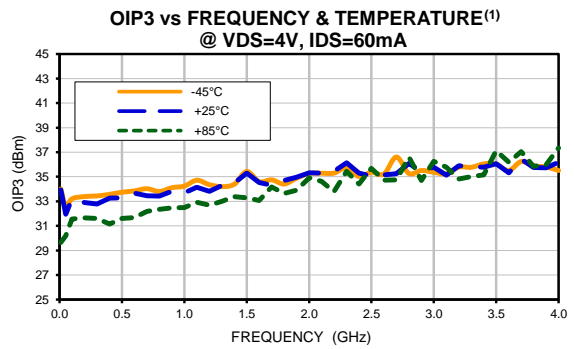
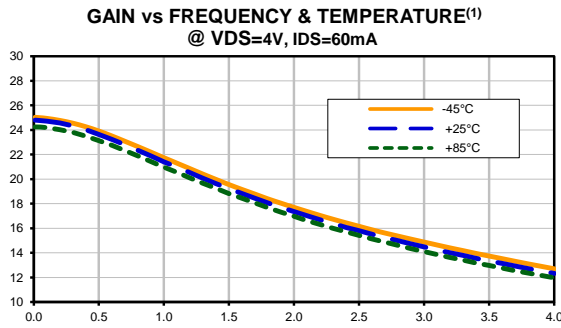
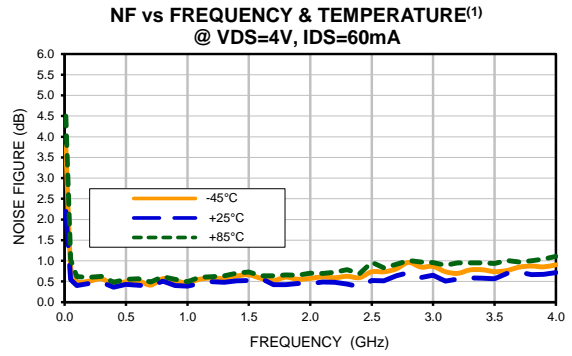
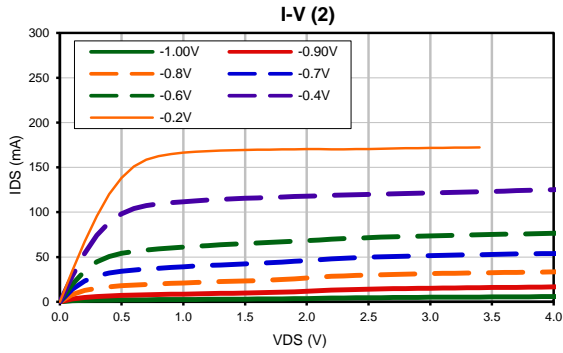
FREQ (GHz)	OIP3 vs FREQ & TEMPERATURE <sup>(1)</sup> @ VDS=4V, IDS=60mA			P1dB vs FREQ & TEMPERATURE <sup>(1,2)</sup> @ VDS=4V, IDS=60mA		
	-45°C	+25°C	+85°C	-45°C	+25°C	+85°C
0.01	34.01	33.94	29.65	19.24	18.86	19.20
0.05	32.57	31.95	30.18	19.85	19.19	19.76
0.10	33.21	33.19	31.56	19.83	19.20	19.58
0.20	33.39	32.89	31.65	19.82	19.37	19.57
0.30	33.44	32.79	31.61	20.30	19.64	20.21
0.40	33.57	33.25	31.14	19.95	19.36	19.86
0.50	33.74	33.29	31.61	19.88	19.46	19.79
0.60	33.85	33.67	31.67	20.15	19.75	20.05
0.70	34.03	33.46	32.18	20.20	19.79	20.09
0.80	33.80	33.43	32.36	20.18	19.83	20.07
0.90	34.11	33.81	32.46	20.37	20.00	20.39
1.00	34.24	33.70	32.49	20.74	20.30	20.74
1.10	34.72	34.14	32.92	20.51	20.18	20.53
1.20	34.36	33.82	32.69	20.51	20.31	20.53
1.30	34.20	34.30	33.00	20.90	20.52	20.89
1.40	34.39	34.48	33.39	20.85	20.50	20.73
1.50	35.43	35.30	33.28	20.54	20.36	20.54
1.60	34.60	34.54	33.06	20.61	20.29	20.47
1.70	34.75	34.32	34.18	20.59	20.27	20.57
1.80	34.41	34.71	33.65	21.05	20.71	21.02
1.90	34.89	34.97	33.91	21.01	20.67	20.99
2.00	35.27	35.33	34.91	21.07	20.72	21.03
2.10	35.29	35.29	34.63	21.08	20.79	21.05
2.20	35.30	35.44	33.79	21.01	20.83	20.97
2.30	35.73	36.15	35.44	20.73	20.54	20.76
2.40	35.02	35.29	34.40	20.82	20.55	20.77
2.50	35.37	35.05	35.69	21.34	21.01	21.26
2.60	35.23	35.16	34.72	21.55	21.19	21.60
2.70	36.61	35.24	34.75	20.93	20.67	20.87
2.80	35.27	36.08	36.59	21.09	20.84	21.01
2.90	35.51	35.40	34.71	21.27	20.96	21.16
3.00	35.37	35.77	36.26	20.99	20.83	20.88
3.10	35.24	35.14	35.79	21.21	21.08	21.11
3.20	35.79	35.91	34.83	21.75	21.45	21.65
3.30	35.77	35.82	35.00	21.24	21.10	21.25
3.40	36.05	35.78	35.16	20.95	20.86	20.83
3.50	36.04	36.06	37.12	21.21	20.97	21.11
3.60	35.50	35.32	36.18	21.64	21.36	21.55
3.70	36.24	36.44	37.06	21.72	21.59	21.62
3.80	35.89	35.76	35.85	21.52	21.39	21.42
3.90	35.80	35.73	35.99	21.33	21.24	21.25
4.00	35.51	36.19	37.35	21.28	21.13	21.28

<sup>(1)</sup> Includes test board loss

<sup>(2)</sup> Drain current was allowed to increase during compression measurement



Typical Performance Curves

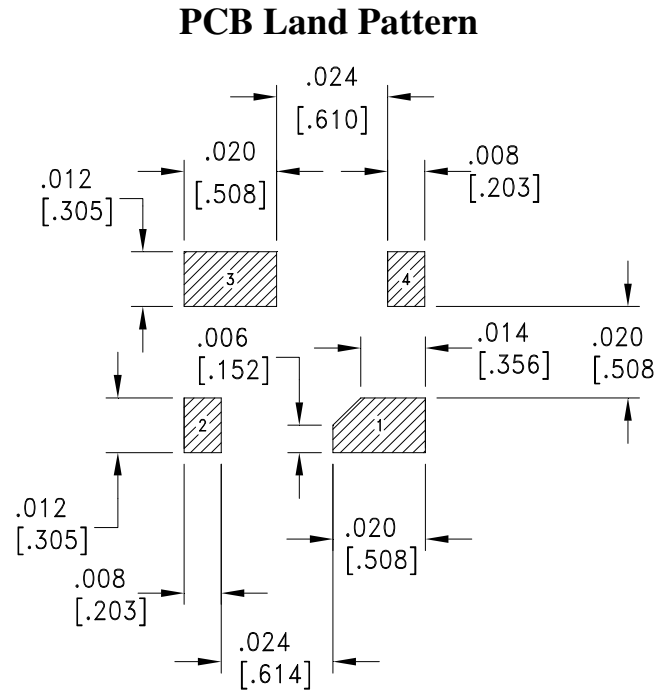
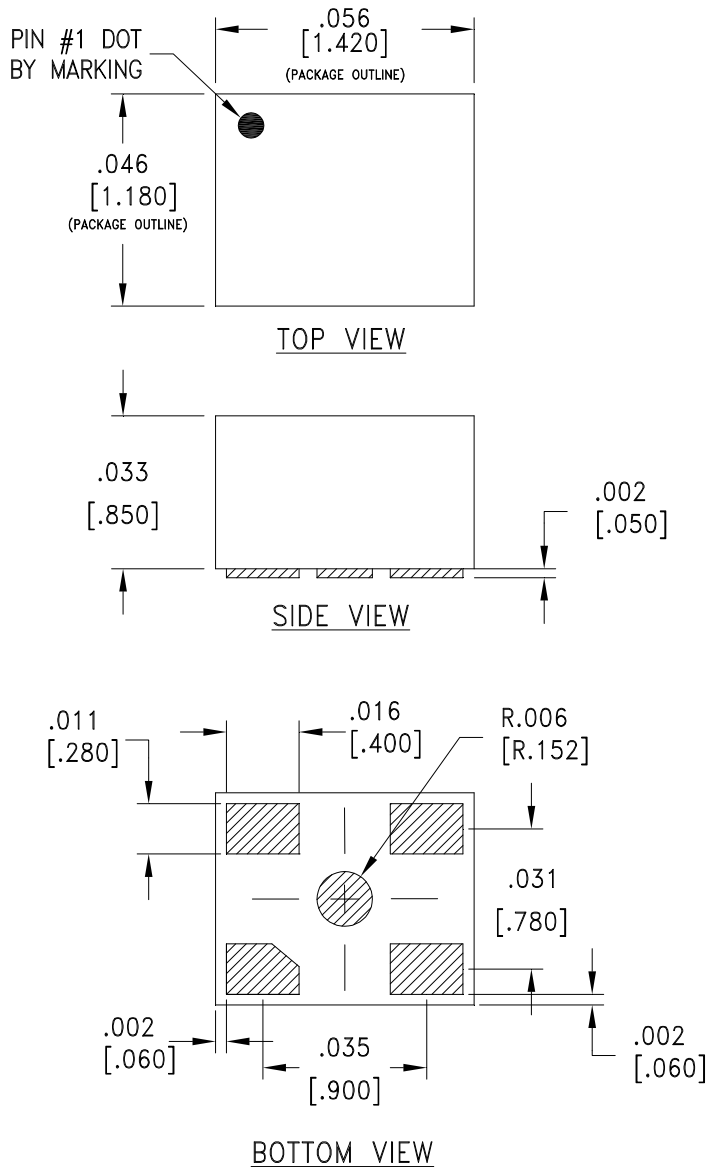


<sup>(1)</sup> Includes test board loss

<sup>(2)</sup> Drain current was allowed to increase during compression measurement

## Outline Dimensions

TE2769



Suggested Layout,  
Tolerance to be within  $\pm .002$

Weight: .0047 grams

Dimensions are in inches (mm). Tolerances: 2 Pl.  $\pm .01$ ; 3 Pl.  $\pm .005$

### Notes:

1. Case material: Plastic.
2. Termination finish:

For RoHS Case Styles: Matte-Tin plate.



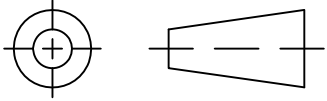
P.O. Box 350166, Brooklyn, New York 11235-0003 (718) 934-4500 Fax (718) 332-4661 For detailed performance specs & shopping online see Mini-Circuits web site



The Design Engineers Search Engine Provides ACTUAL Data Instantly From MINI-CIRCUITS At: [www.minicircuits.com](http://www.minicircuits.com)

RF/IF MICROWAVE COMPONENTS

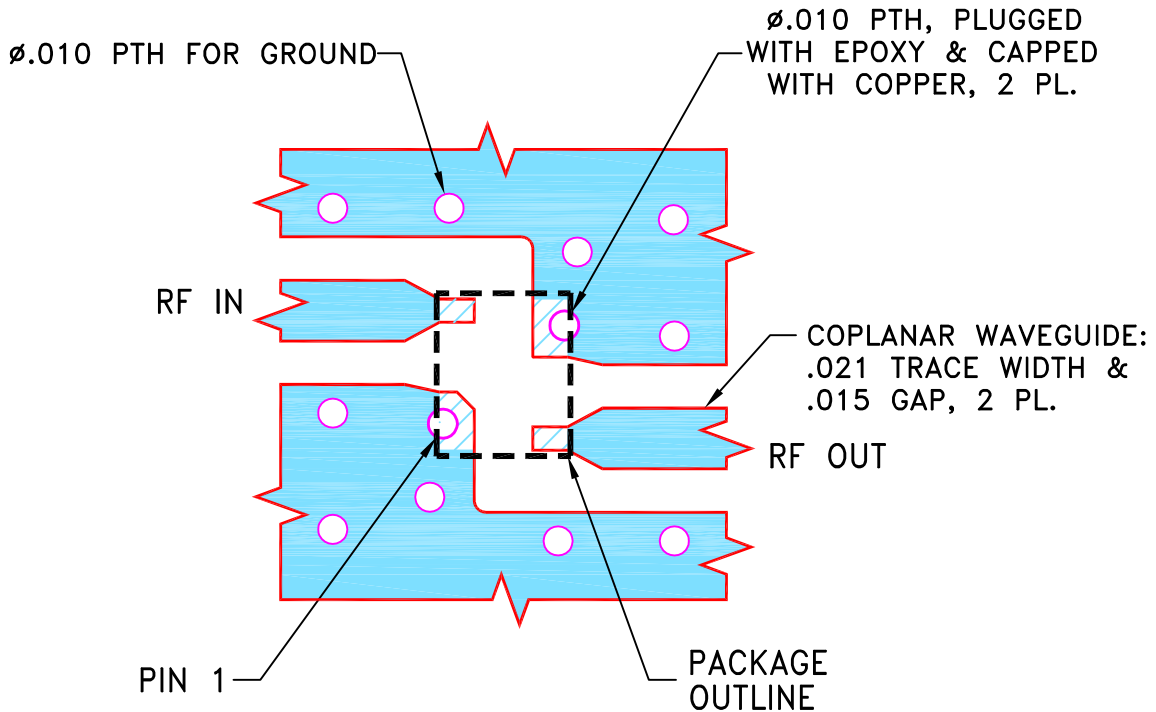
THIRD ANGLE PROJECTION



REVISIONS

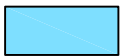
REV OR	ECN No.	DESCRIPTION	DATE	DR	AUTH
	M172675	NEW RELEASE	02/18/19	ITG	WIL. P

SUGGESTED MOUNTING CONFIGURATION  
FOR TE2769 CASE STYLE, "04AM06" PIN CODE

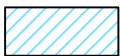


**NOTES:**

- TRACE WIDTH & GAP ARE SHOWN FOR ROGERS RO4350B WITH DIELECTRIC THICKNESS .010"±.001". COPPER: 1/2 OZ. EACH SIDE.  
 FOR OTHER MATERIALS TRACE WIDTH & GAP MAY NEED TO BE MODIFIED.
- BOTTOM SIDE OF THE PCB IS CONTINUOUS GROUND PLANE.



DENOTES PCB COPPER LAYOUT WITH SMOBC (SOLDER MASK OVER BARE COPPER).



DENOTES COPPER LAND PATTERN FREE OF SOLDER MASK.

UNLESS OTHERWISE SPECIFIED	INITIALS		DATE
DIMENSIONS ARE IN INCHES TOLERANCES ON: 2 PL DECIMALS ± 3 PL DECIMALS ± .005 ANGLES ± FRACTIONS ±	DRAWN	ITG	02/15/19
	CHECKED	GF	02/18/19
	APPROVED	WILSON P	02/18/19



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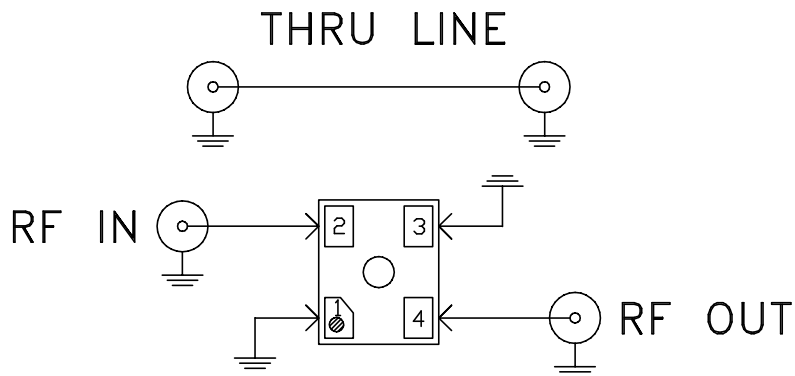
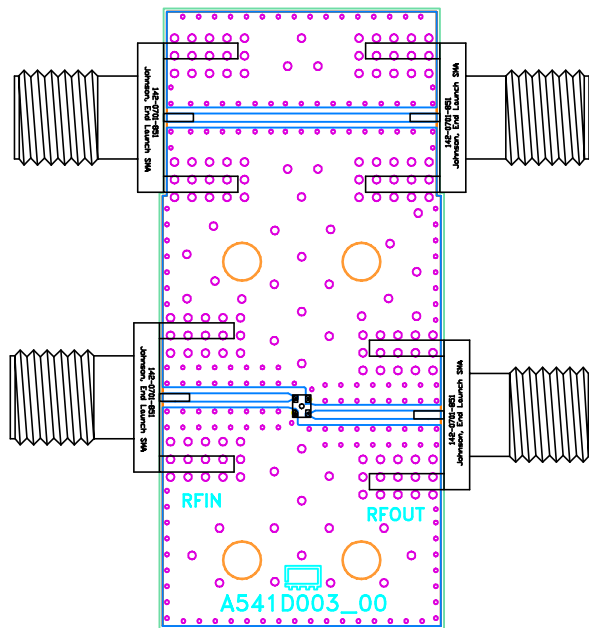
13 Neptune Avenue  
 Brooklyn NY 11235

PL, 04AM06, TE2769, TB-TAV1-331+

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SIZE A	CODE IDENT 15542	DRAWING NO: 98-PL-627	REV: OR
FILE: 98PL627	SCALE: 15:1	SHEET: 1 OF 1	

# Evaluation Board and Circuit




Function	Pad
RF IN	2
RF OUT	4
GND	1,3

Schematic Diagram

## NOTES:

1. 50 Ohm SMA Female Connectors.
2. PCB Material: Roger R04350B or equivalent, Dielectric constant=3.5, Thickness=0.010 inch

 **Mini-Circuits®**

All Mini-Circuits products are manufactured under exacting quality assurance and control standards, and are capable of meeting published specifications after being subjected to any or all of the following physical and environmental test.

Specification	Test/Inspection Condition	Reference/Spec
Operating Temperature	-45° to 85°C or -40° to 85°C Ambient Environment	Individual Model Data Sheet
Storage Temperature	-65° to 150° C Ambient Environment	Individual Model Data Sheet
Thermal Shock	-55° to 100°C, 100 cycles	MIL-STD-202, Method 107, Condition A-3, except +100°C
Mechanical Shock	1.5Kg, 0.5 ms, 5 shock pulses, Y1 direction only	MIL-STD-883, Method 2002, Condition B, except Y1 direction only
Vibration (Variable Frequency)	50g peak	MIL-STD-883, Method 2007, Condition B
Autoclave	15 psig, 100% RH, 121°C, 96 hours	JESD22-A102, Condition C
HAST	130°C, 85% RH, 96 hours	JESD22-A110
Solderability	10X Magnification	J-STD-002, Para 4.2.5, Test S, 95% Coverage
Solder Reflow Heat	Sn-Pb Eutetic Process: 240°C peak Pb-Free Process: 260°C peak	J-STD-020, Table 4-1, 4-2 and 5-2; Figure 5-1
Moisture Sensitivity: Level 1	Bake at 125°C for 24 hours Soak at 85°C/85% RH for 168 hours, Reflow 3 cycles at 260°C peak	J-STD-020
Marking Resistance to Solvents	Isopropyl alcohol + mineral spirits at 25°C; terpene defluxer at 25°C; distilled water + proylene glycol monomethyl ether +	MIL-STD-202, Method 215



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<b>Specification</b>	<b>Test/Inspection Condition</b>	<b>Reference/Spec</b>
	monoethanolamine at 63°C to 70°C	