ULTRA LOW NOISE, MEDIUM CURRENT

D-PHEMT Transistor

SAV-331+

50Ω 10-4000 MHz

THE BIG DEAL

- Low Noise Figure, 0.5 dB typ. at 300 MHz
- Gain, 24.1 dB typ. at 300 MHz
- High Output IP3, +32.3 dBm typ. at 300 MHz
- Output Power at 1dB comp., +19.6 dBm typ. at 300 MHz
- Low Current, 60mA
- External biasing and matching required

Generic photo used for illustration purposes only

CASE STYLE: MMM1362

+RoHS Compliant

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

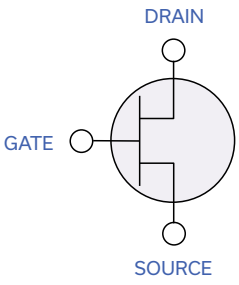
APPLICATIONS

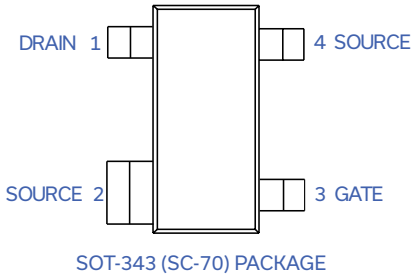
- Cellular
- ISM
- GSM
- WCDMA
- WiMax
- WLAN
- UNII and HIPERLAN

PRODUCT OVERVIEW

Mini-Circuits' SAV-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 4-lead SOT-343 package. This model requires external biasing and matching.

SIMPLIFIED SCHEMATIC AND PIN DESCRIPTION





SOT-343 (SC-70) PACKAGE

Function	Pin Number	Description
Source	2 & 4	Source terminal, normally connected to ground
Gate	3	Gate used for RF Input
Drain	1	Drain used for RF output

* Depletion mode Pseudomorphic High Electron Mobility Transistor.

REV. B
ECO-010314
SAV-331+
RS/CP/AM
211022

ELECTRICAL SPECIFICATIONS AT T_{AMB}=25°C, FREQUENCY 10 TO 4000 MHZ

Symbol	Parameter	Condition		Min.	Typ.	Max.	Units
DC Specifications							
V_{GS}	Operational Gate Voltage	V_{DS}=4V, I_{DS}=60 mA		-0.96	-0.69	-0.51	V
V_p	Pinch-off Voltage	V_{DS}=1.5 V, I_{DS}= 10% of Idss			-0.81		V
I_{DSS}	Saturated Drain Current	V_DS=4V, V_{GS}=0 V			228		µA
G_M	Transconductance	V_{DS}=4V, Gm=Δ I_{DS}/ΔV_P		— — — — —	— — 282 — —	— — — — —	mS
I_{GDO}	Gate to Drain Leakage Current	V_{GD}=5V				1000	uA
I_{GSS}	Gate leakage Current	V_{GD}=V_{GS}=-4V				600	µA
Specifications, Z0=50 Ohms (Figure 1)*							
NF	Noise Figure	V_{DS}=4V, I_{DS}=60 mA	f=40 MHz		0.9		dB
			f=300 MHz		0.5		
			f=900 MHz		0.4		
			f=2000 MHz		0.5	0.8	
			f=4000 MHz		0.9		
Gain	Gain	V_{DS}=4V, I_{DS}=60 mA	f=40 MHz		24.6		dB
			f=300 MHz		24.1		
			f=900 MHz		21.3		
			f=2000 MHz	13.9	16.6	18.3	
			f=4000 MHz		11.5		
OIP3	Output IP3	V_{DS}=4V, I_{DS}=60 mA	f=40 MHz		30.9		dBm
			f=300 MHz		32.3		
			f=900 MHz		33.5		
			f=2000 MHz		35.5		
			f=4000 MHz		38.7		
P1dB	Power output at 1 dB Compression	V_{DS}=4V, I_{DS}=60 mA	f=40 MHz		19.1		dBm
			f=300 MHz		19.6		
			f=900 MHz	18.0	20.2		
			f=2000 MHz	18.9	21.1		
			f=4000 MHz		21.8		
Θ_{JC}	Thermal Resistance				109		°C/W

* Tested on Mini-Circuits TB-471+ test board

MAXIMUM RATINGS(1)

Symbol	Parameter	Max.	Units
V_{DS}	Drain-Source Voltage(2)	5	V
V_{GS}	Gate-Source Voltage(2)	-5	V
V_{GD}	Gate-Drain Voltage(2)	-5	V
I_{DS}	Drain Current(2)	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, Vgs = -0.51 V, Vds = 4 V.

CHARACTERIZATION TEST CIRCUIT

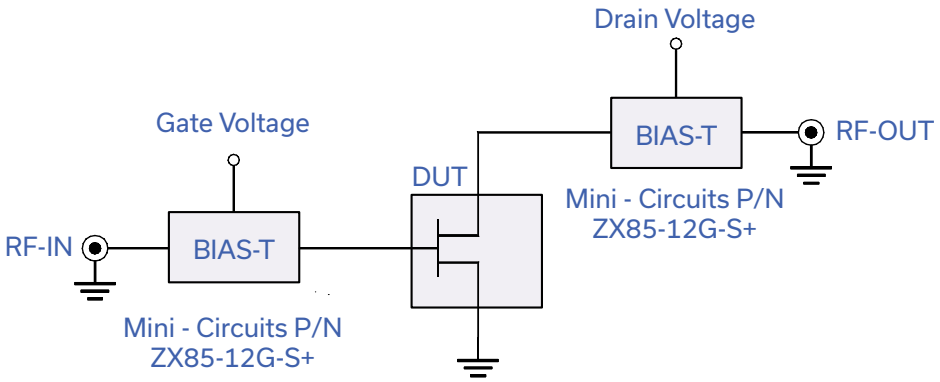


Fig 1. Block Diagram of Test Circuit used for characterization. (DUT soldered on Mini-Circuits Test Board TB-471+)

Gain, Output power at 1dB compression (P1 dB) and output IP3 (OIP3) are measured using R&S Network Analyzer ZVA-24. Noise Figure 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.

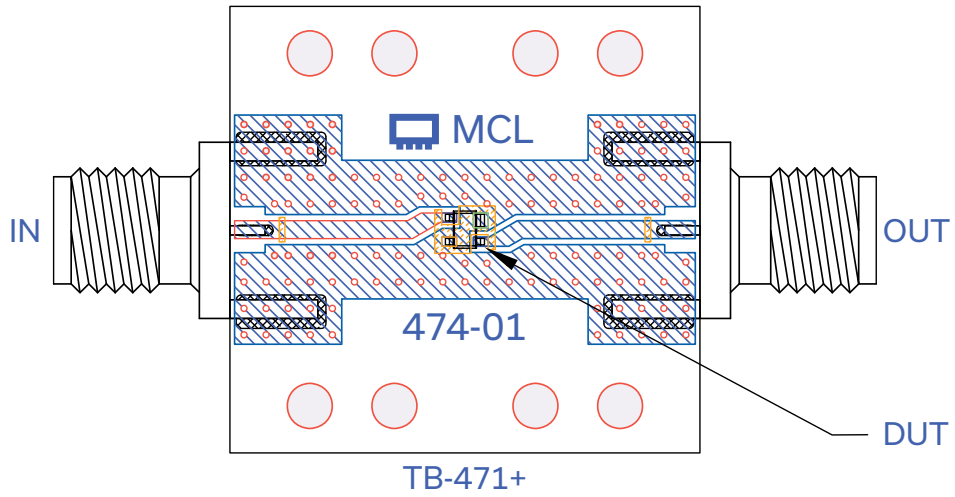
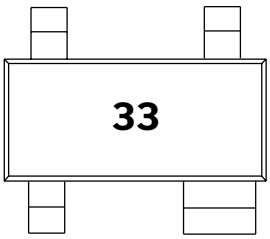


Fig 2. Test Board used for characterization, Mini-Circuits P/N TB-471+ (Material: Rogers 4350, Thickness: 0.02")

PRODUCT MARKING



D-PHEMT Transistor

SAV-331+

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	MMM1362 Plastic molded SOT-343 (SC-70) style package, lead finish: matte-tin
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-300
Evaluation Board	TB-471+
Environmental Ratings	ENV08T2

ESD RATING

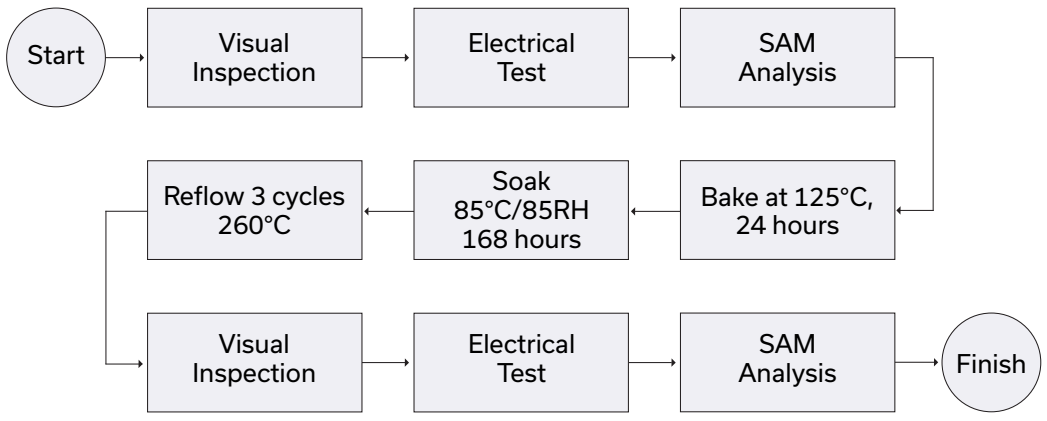
Human Body Model (HBM): Class 0 (<250V) in accordance with ANSI/ESD STM 5.1 - 2001

Machine Model (MM): Class M1 (40 V) in accordance with ANSI/ESD STM 5.2 - 1999

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

Typical Performance Data

VDS (V)	IDS[2] (mA) @ VGS=						
	-1.00V	-0.90V	-0.8V	-0.7V	-0.6V	-0.4V	-0.2V
0.00	-0.01	-0.01	0.03	0.04	-0.01	-0.12	-0.14
0.10	1.32	3.19	8.04	14.00	19.61	28.89	34.79
0.20	1.67	4.87	12.63	23.34	34.52	54.04	67.14
0.30	1.85	5.85	15.15	28.87	44.46	74.08	95.598
0.40	1.98	6.53	16.73	32.10	50.52	88.67	120.14
0.50	2.11	7.05	17.86	34.12	54.08	98.28	138.3
0.60	2.22	7.46	18.72	35.53	56.26	104.20	150.94
0.70	2.32	7.79	19.41	36.62	57.79	107.32	158.6
0.80	2.43	8.09	20.01	37.56	59.04	109.22	162.68
0.90	2.52	8.37	20.56	38.39	60.11	110.60	164.94
1.00	2.62	8.63	21.08	39.15	61.07	111.72	166.36
1.10	2.71	8.88	21.56	39.86	61.95	112.68	167.34
1.20	2.80	9.12	22.02	40.53	62.78	113.52	168.08
1.30	2.89	9.36	22.45	41.16	63.55	114.24	168.62
1.40	2.98	9.59	22.87	41.77	64.27	114.88	169.04
1.50	3.06	9.82	23.30	42.35	64.97	115.48	169.34
1.60	3.15	10.07	23.75	42.95	65.64	116.02	169.62
1.70	3.25	10.36	24.27	43.58	66.30	116.52	169.84
1.80	3.37	10.73	24.89	44.31	66.96	117.02	170.00
1.90	3.52	11.20	25.67	45.16	67.66	117.48	170.18
2.00	3.69	11.79	26.61	46.04	68.36	117.92	170.30
2.10	3.88	12.50	27.60	46.97	69.08	118.32	170.26
2.20	4.10	13.07	28.39	47.86	69.78	118.72	170.18
2.30	4.29	13.50	29.01	48.62	70.41	119.12	170.18
2.40	4.45	13.85	29.51	49.24	71.02	119.50	170.26
2.50	4.58	14.15	29.93	49.77	71.57	119.84	170.46
2.60	4.70	14.40	30.28	50.22	72.06	120.24	170.70
2.70	4.81	14.63	30.62	50.62	72.51	120.56	171.12
2.80	4.90	14.82	30.90	50.98	72.92	120.90	171.26
2.90	4.98	15.01	31.17	51.30	73.30	121.20	171.42
3.00	5.07	15.19	31.42	51.61	73.65	121.50	171.60
3.10	5.15	15.35	31.65	51.88	73.98	121.82	171.80
3.20	5.22	15.50	31.86	52.16	74.28	122.16	171.98
3.30	5.30	15.65	32.08	52.41	74.57	122.46	172.14
3.40	5.37	15.80	32.27	52.65	74.85	122.84	172.28
3.50	5.44	15.93	32.47	52.88	75.12	123.20	--
3.60	5.51	16.06	32.65	53.11	75.39	123.58	--
3.70	5.57	16.19	32.83	53.33	75.65	123.96	--
3.80	5.64	16.32	33.00	53.53	75.90	124.32	--
3.90	5.70	16.44	33.17	53.74	76.17	124.68	--
4.00	5.77	16.56	33.34	53.95	76.42	125.04	--
4.10	5.83	16.68	33.50	54.16	76.69	125.36	--
4.20	5.90	16.80	33.68	54.36	76.96	125.68	--
4.30	5.97	16.92	33.84	54.56	77.23	125.96	--
4.40	6.03	17.04	34.00	54.77	77.52	126.28	--
4.50	6.10	17.16	34.17	54.98	77.80	126.54	--
4.60	6.16	17.28	34.33	55.19	78.10	126.74	--
4.70	6.23	17.39	34.50	55.41	78.41	127.00	--
4.80	6.30	17.51	34.67	55.63	78.71	--	--
4.90	6.37	17.64	34.84	55.86	79.03	--	--
5.00	6.44	17.76	35.01	56.09	79.35	--	--

Typical Performance Data

FREQ (GHz)	GAIN vs FREQ & TEMPERATURE[1] @ VDS=4V, IDS=60mA			NOISE FIGURE vs FREQ & TEMPERATURE [1] @ VDS=4V, IDS=60mA		
	-45°C	+25°C	+85°C	-45°C	+25°C	+85°C
0.01	24.87	24.53	24.13	2.76	4.40	5.38
0.05	24.81	24.49	24.09	0.54	0.78	1.08
0.10	24.78	24.47	24.07	0.40	0.48	0.65
0.20	24.60	24.28	23.90	0.39	0.46	0.57
0.30	24.34	24.01	23.63	0.45	0.52	0.62
0.40	24.00	23.66	23.26	0.29	0.36	0.46
0.50	23.59	23.24	22.84	0.38	0.45	0.55
0.60	23.15	22.79	22.40	0.35	0.42	0.52
0.70	22.67	22.30	21.92	0.31	0.40	0.49
0.80	22.17	21.81	21.44	0.39	0.45	0.57
0.90	21.68	21.31	20.94	0.31	0.40	0.52
1.00	21.18	20.82	20.46	0.32	0.42	0.52
1.10	20.69	20.33	19.98	0.35	0.46	0.56
1.20	20.21	19.85	19.51	0.36	0.46	0.56
1.30	19.74	19.38	19.06	0.40	0.48	0.61
1.40	19.29	18.93	18.62	0.41	0.52	0.65
1.50	18.85	18.50	18.19	0.38	0.49	0.61
1.60	18.44	18.09	17.79	0.36	0.47	0.61
1.70	18.04	17.69	17.39	0.39	0.50	0.64
1.80	17.66	17.31	17.02	0.37	0.51	0.65
1.90	17.29	16.94	16.65	0.42	0.55	0.70
2.00	16.94	16.59	16.31	0.35	0.49	0.62
2.10	16.61	16.26	15.97	0.37	0.51	0.64
2.20	16.29	15.94	15.65	0.37	0.51	0.65
2.30	15.98	15.62	15.33	0.34	0.50	0.66
2.40	15.68	15.32	15.03	0.39	0.54	0.72
2.50	15.39	15.03	14.74	0.44	0.70	0.78
2.60	15.12	14.76	14.46	0.46	0.62	0.81
2.70	14.86	14.49	14.19	0.52	0.67	0.87
2.80	14.60	14.23	13.93	0.54	0.74	0.91
2.90	14.34	13.97	13.66	0.55	0.73	0.90
3.00	14.10	13.73	13.42	0.51	0.68	0.86
3.10	13.86	13.48	13.17	0.51	0.71	0.89
3.20	13.62	13.24	12.92	0.55	0.73	0.94
3.30	13.39	13.01	12.69	0.53	0.72	0.94
3.40	13.17	12.79	12.47	0.51	0.73	0.95
3.50	12.94	12.56	12.24	0.55	0.78	0.99
3.60	12.72	12.34	12.01	0.54	0.78	1.00
3.70	12.50	12.12	11.79	0.58	0.82	1.02
3.80	12.28	11.90	11.57	0.62	0.84	1.08
3.90	12.06	11.68	11.35	0.61	0.85	1.11
4.00	11.85	11.47	11.14	0.65	0.89	1.15

[1] Includes test board loss

[2] Drain current was allowed to increase during compression measurement

Typical Performance Data

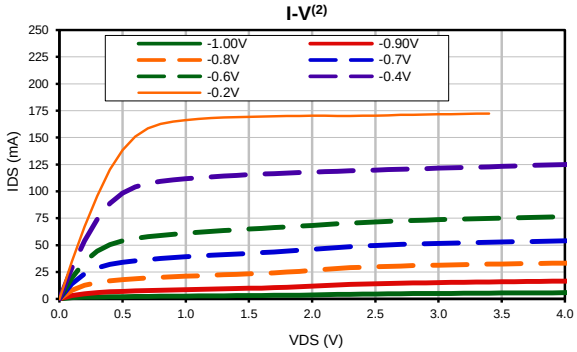
FREQ (GHz)	OIP3 vs FREQ & TEMPERATURE [1] @ VDS=4V, IDS=60mA			P1dB vs FREQ & TEMPERATURE[1,2] @ VDS=4V, IDS=60mA		
	-45°C	+25°C	+85°C	-45°C	+25°C	+85°C
0.01	31.39	30.90	30.00	18.42	19.24	19.17
0.05	31.86	32.06	31.61	18.56	19.39	19.67
0.10	32.32	32.33	31.65	18.73	19.53	19.65
0.20	32.25	32.28	31.63	18.97	19.63	19.74
0.30	32.13	32.08	31.69	18.91	19.90	20.00
0.40	32.26	32.19	31.73	19.02	19.96	19.93
0.50	32.94	32.93	32.04	19.06	19.78	19.75
0.60	32.47	32.80	32.05	19.37	20.11	20.21
0.70	32.86	33.08	32.51	19.34	20.05	20.04
0.80	32.90	33.10	32.54	19.63	20.28	20.26
0.90	33.30	33.59	32.83	19.69	20.37	20.38
1.00	33.36	33.72	32.97	19.83	20.50	20.50
1.10	33.14	33.48	32.81	20.06	20.59	20.72
1.20	32.97	33.47	32.91	20.19	20.71	20.73
1.30	34.17	34.30	33.31	20.21	20.57	20.58
1.40	33.46	34.29	33.08	20.34	20.82	20.84
1.50	33.62	34.21	33.42	20.47	20.84	20.88
1.60	34.17	34.58	33.44	20.35	20.79	20.82
1.70	34.93	35.40	34.55	20.25	20.55	20.58
1.80	35.17	35.87	34.99	20.57	21.01	21.03
1.90	34.45	34.68	34.15	20.66	21.10	21.13
2.00	35.02	35.53	34.74	20.78	21.20	21.12
2.10	35.03	35.48	34.81	20.76	21.20	21.13
2.20	34.84	35.97	35.35	20.69	21.08	21.00
2.30	35.79	36.16	35.23	20.83	21.10	21.13
2.40	35.80	36.55	35.53	20.79	21.04	20.95
2.50	35.69	36.72	35.15	21.13	21.39	21.31
2.60	35.03	36.38	35.75	21.06	21.31	21.33
2.70	34.83	34.99	35.93	21.09	21.43	21.33
2.80	36.19	37.30	35.44	21.17	21.39	21.29
2.90	35.90	36.82	36.31	21.10	21.31	21.21
3.00	36.03	37.01	36.34	21.15	21.38	21.37
3.10	35.97	36.99	36.43	21.44	21.65	21.53
3.20	36.05	37.26	36.47	21.44	21.68	21.56
3.30	36.53	37.82	37.48	21.13	21.33	21.32
3.40	36.21	38.21	36.68	21.45	21.55	21.54
3.50	36.01	37.74	36.87	21.51	21.73	21.72
3.60	36.13	38.09	37.49	21.11	21.20	21.19
3.70	35.62	37.64	36.84	21.36	21.57	21.46
3.80	36.57	38.41	37.49	21.46	21.55	21.54
3.90	36.74	38.97	37.86	21.39	21.60	21.49
4.00	36.87	38.97	37.43	21.62	21.71	21.71

[1] Includes test board loss

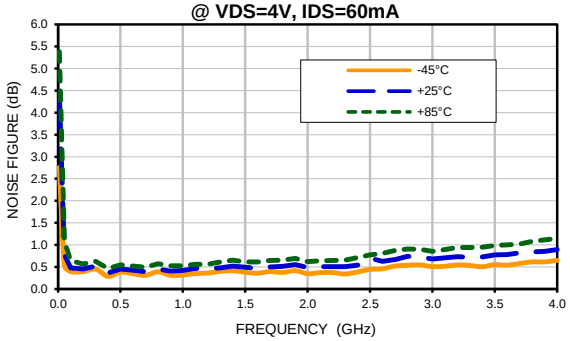
[2] Drain current was allowed to increase during compression measurement

Typical Performance Curves

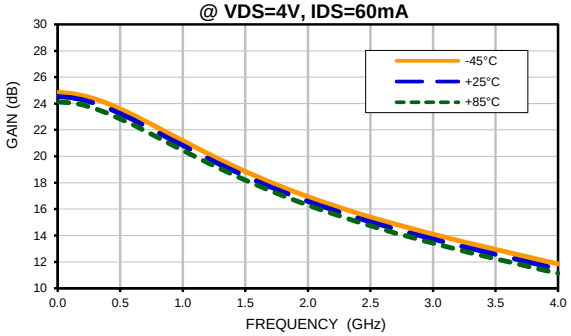
I-V[2]



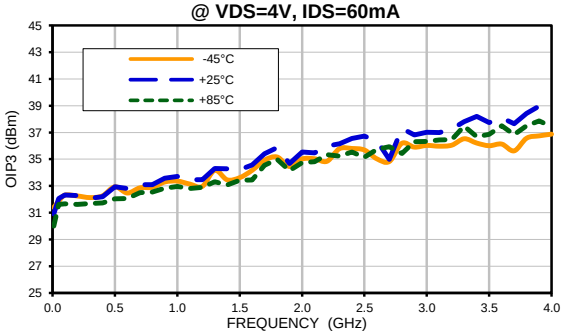
NF vs FREQUENCY & TEMPERATURE[1] @ VDS=4V, IDS=60mA



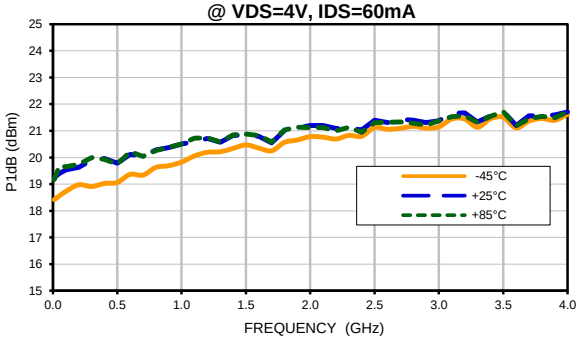
GAIN vs FREQUENCY & TEMPERATURE[1] @ VDS=4V, IDS=60mA



OIP3 vs FREQUENCY & TEMPERATURE[1] @ VDS=4V, IDS=60mA



P1dB vs FREQUENCY & TEMPERATURE[1,2] @ VDS=4V, IDS=60mA



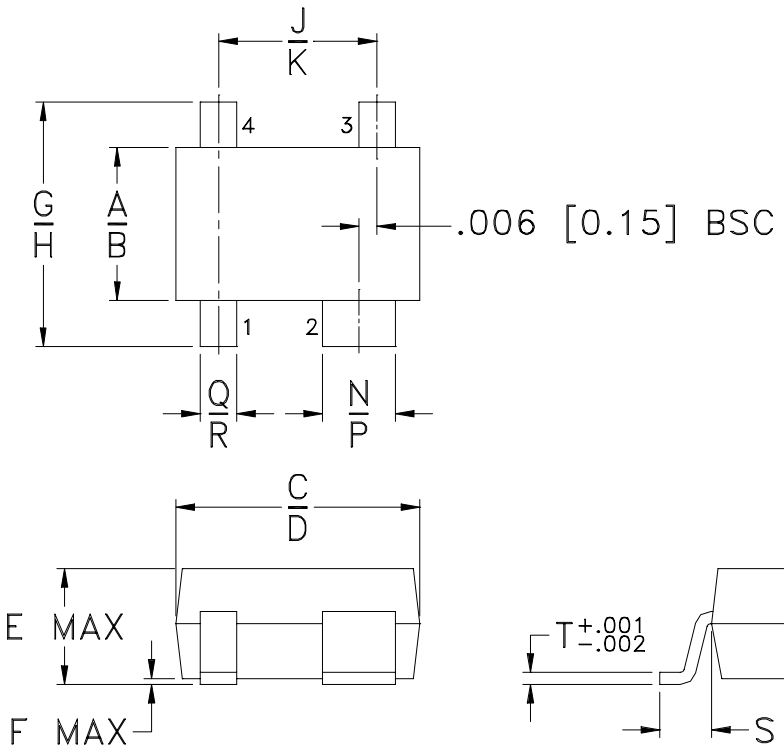
[1] Includes test board loss

[2] Drain current was allowed to increase during compression measurement

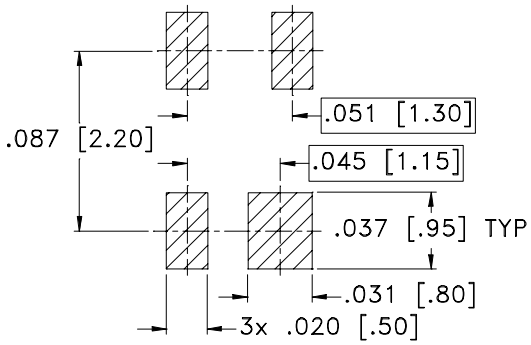
Case Style MMM

MMM1362

Outline Dimensions



PCB Land Pattern



Suggested Layout,
Tolerance to be within ±.002

CASE #.	A	B	C	D	E	F	G	H	J	K	L	M	N	P
MMM1362	.045 (1.15)	.053 (1.35)	.073 (1.85)	.089 (2.25)	.043 (1.10)	.004 (0.10)	.071 (1.80)	.094 (2.40)	.046 (1.17)	.056 (1.43)	- -	- -	.022 (0.55)	.028 (0.70)

CASE #.	Q	R	S	T	WT, GRAM
MMM1362	.010 (0.25)	.016 (0.40)	.017 (0.43)	.006 (0.15)	.007

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

Notes:

1. Case material: Plastic.
2. Termination finish:
   For RoHS Case Styles: Matte Tin plate.

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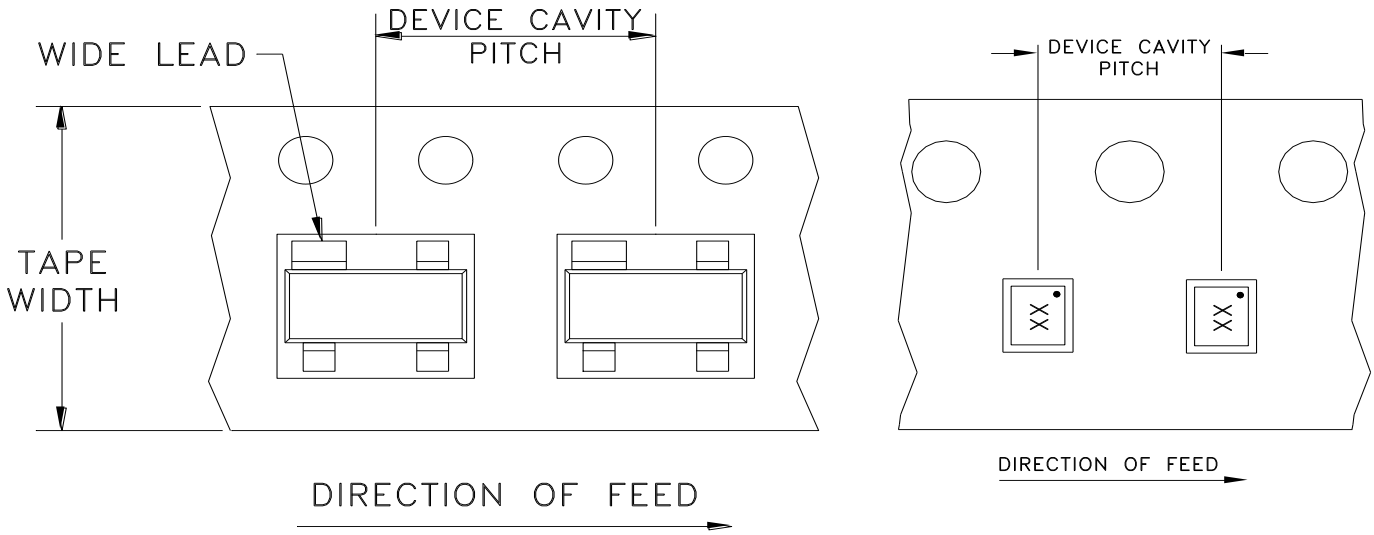
Tape & Reel Packaging TR-F90

DEVICE ORIENTATION IN T&R



Applicable Case Style

MMM1362 **NONE**

Tape Width, mm	Device Cavity Pitch, mm	Reel Size, inches	Devices per Reel	
8	4	7	Small quantity standards (see note)	20
				50
				100
				200
				500
				1000
		7	Standards	2000
				3000

Note: Please Consult individual model data sheet to determine device per reel availability.

Applicable Case Styles

Mini-Circuits carrier tape materials provide protection from ESD (Electro-Static Discharge) during handling and transportation. Tapes are static dissipative and comply with industry standards EIA-481/EIA-541.

Go to: www.minicircuits.com/pages/pdfs/tape.pdf

MZ4532C

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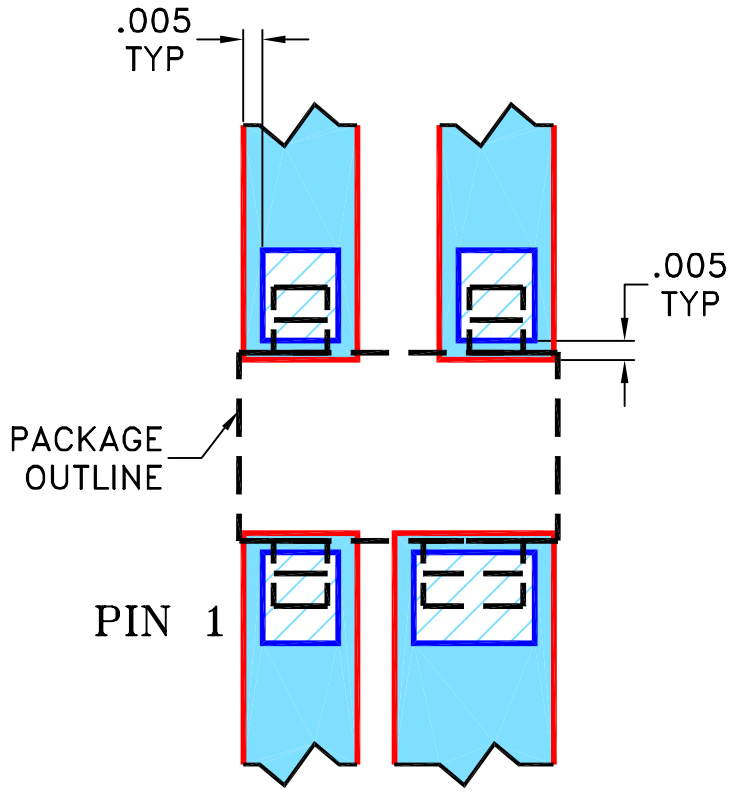
THIRD ANGLE PROJECTION

REVISIONS					
REV	ECN No.	DESCRIPTION	DATE	DR	AUTH
OR	M121884	NEW RELEASE	03/10/09	AV	TH

SUGGESTED MOUNTING CONFIGURATION FOR MMM1362 CASE STYLE, "04AM02" PIN CODE



NOTES:

1. TRACE WIDTH IS SHOWN FOR REFERENCE ONLY. ACTUAL LINE WIDTH IS A FUNCTION OF SPECIFIC MATCHING CIRCUIT.
2. BOTTOM SIDE OF THE PCB IS CONTINUOUS GROUND PLANE.
3. 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	DRAWN	AV	03/09/09
TOLERANCES ON:	CHECKED	IL	03/10/09
2 PL DECIMALS ±	APPROVED	TH	03/10/09
3 PL DECIMALS ± .005			
ANGLES ±			
FRACTIONS ±			

ASHEETA1.DWG REV:A DATE:01/12/95

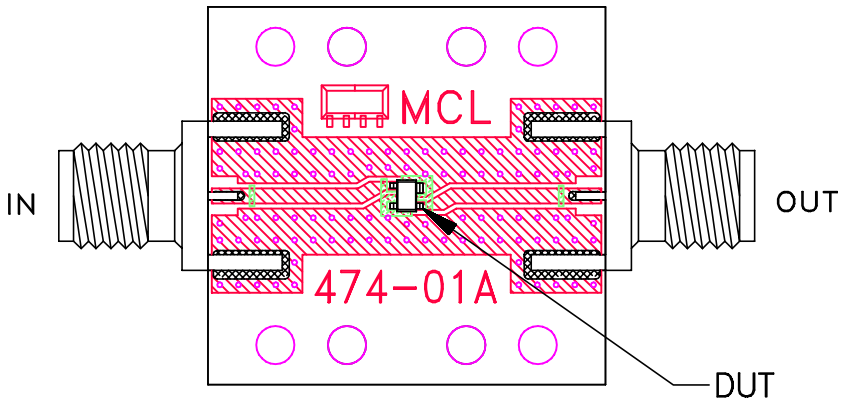
Mini-Circuits® 13 Neptune Avenue Brooklyn NY 11235

PL, 04AM02, FG873, SAV

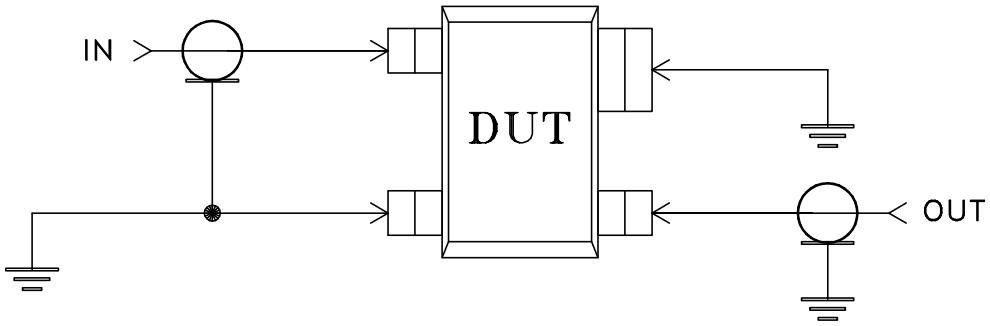
SIZE	CODE IDENT	DRAWING NO:	REV:
A	15542	98-PL-300	OR

FILE:	SCALE:	SHEET:
98PL300	20:1	1 OF 1

Characterization Test Board



TB-471+



Schematic Diagram

Notes:

1. 50 Ohm SMA Female connectors.
2. PCB Material: Rogers RO4350B or its equivalent, Dielectric Constant=3.5, Thickness=.020"

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Environmental Specifications **ENV08T2**

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

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
	monoethanolamine at 63°C to 70°C	