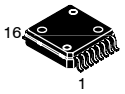
Document Number: MHV5IC1810N
Rev. 1, 3/2011

RoHS

RF LDMOS Wideband Integrated Power Amplifier

MHV5IC1810NR2

**1805–1990 MHz, 5 W AVG., 28 V
GSM/GSM EDGE
RF LDMOS WIDEBAND
INTEGRATED POWER AMPLIFIER**



**CASE 978-03
PFP-16
PLASTIC**

The MHV5IC1810N wideband integrated circuit is designed with on-chip matching that makes it usable from 1805 to 1990 MHz. This multi-stage structure is rated for 24 to 32 Volt operation and covers all typical cellular base station modulation formats.

Final Application

- Typical Two-Tone Performance: V_{DD} = 28 Volts, I_{DQ1} = 120 mA, I_{DQ2} = 90 mA, P_{out} = 5 Watts Avg., Full Frequency Band (1805–1880 MHz or 1930–1990 MHz)
  - Power Gain — 29 dB
  - Power Added Efficiency — 29%
  - IMD — –34 dBc

Driver Application

- Typical GSM EDGE Performance: V_{DD} = 28 Volts, I_{DQ1} = 105 mA, I_{DQ2} = 95 mA, P_{out} = 35 dBm, Full Frequency Band (1805–1880 MHz or 1930–1990 MHz)
  - Power Gain — 29 dB
  - Spectral Regrowth @ 400 kHz Offset = –67 dBc
  - Spectral Regrowth @ 600 kHz Offset = –76 dBc
  - EVM — 1.1% rms
- Capable of Handling 3:1 VSWR, @ 28 Vdc, 1990 MHz, 10 Watts CW Output Power
- Stable into a 3:1 VSWR. All Spurs Below –60 dBc @ 100 mW to 10 W CW P_{out}.

Features

- Characterized with Series Equivalent Large-Signal Impedance Parameters and Common Source Parameters
- On-Chip Matching (50 Ohm Input, >5 Ohm Output)
- Integrated Quiescent Current Temperature Compensation with Enable/Disable Function
- On-Chip Current Mirror g_m Reference FET for Self Biasing Application (1)
- Integrated ESD Protection
- RoHS Compliant
- In Tape and Reel. R2 Suffix = 1500 Units, 16 mm Tape Width, 13 inch Reel.

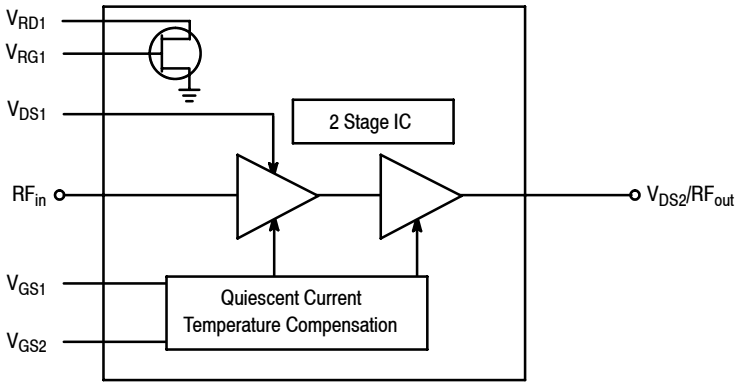
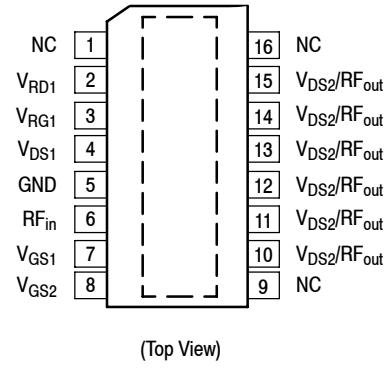


Figure 1. Functional Block Diagram



(Top View)

Note: Exposed backside flag is source terminal for transistors.

Figure 2. Pin Connections

1. Refer to AN1987, *Quiescent Current Control for the RF Integrated Circuit Device Family.* Go to http://www.freescale.com/rf. Select Documentation/Application Notes - AN1987.

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freescale semiconductor

Table 1. Maximum Ratings

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DSS}	-0.5, +65	Vdc
Gate-Source Voltage	V_{GS}	-0.5, +12	Vdc
Storage Temperature Range	T_{stg}	-65 to +150	°C
Operating Junction Temperature	T_J	150	°C
Input Power	P_{in}	12	dBm

Table 2. Thermal Characteristics

Characteristic		Symbol	Value (1)	Unit
Thermal Resistance, Junction to Case		$R_{\theta JC}$		°C/W
Final Application (P_{out} = 10 W CW)	Stage 1, 28 Vdc, I_{DQ1} = 120 mA		9.2	
	Stage 2, 28 Vdc, I_{DQ2} = 90 mA		3.3	
Driver Application (P_{out} = 2.25 W CW)	Stage 1, 28 Vdc, I_{DQ1} = 120 mA		10	
	Stage 2, 28 Vdc, I_{DQ2} = 90 mA		3.5	

Table 3. ESD Protection Characteristics

Test Methodology	Class
Human Body Model (per JESD22-A114)	0 (Minimum)
Machine Model (per EIA/JESD22-A115)	A (Minimum)
Charge Device Model (per JESD22-C101)	III (Minimum)

Table 4. Moisture Sensitivity Level

Test Methodology	Rating	Package Peak Temperature	Unit
Per JESD22-A113, IPC/JEDEC J-STD-020	3	260	°C

Table 5. Electrical Characteristics (T_A = 25°C unless otherwise noted)

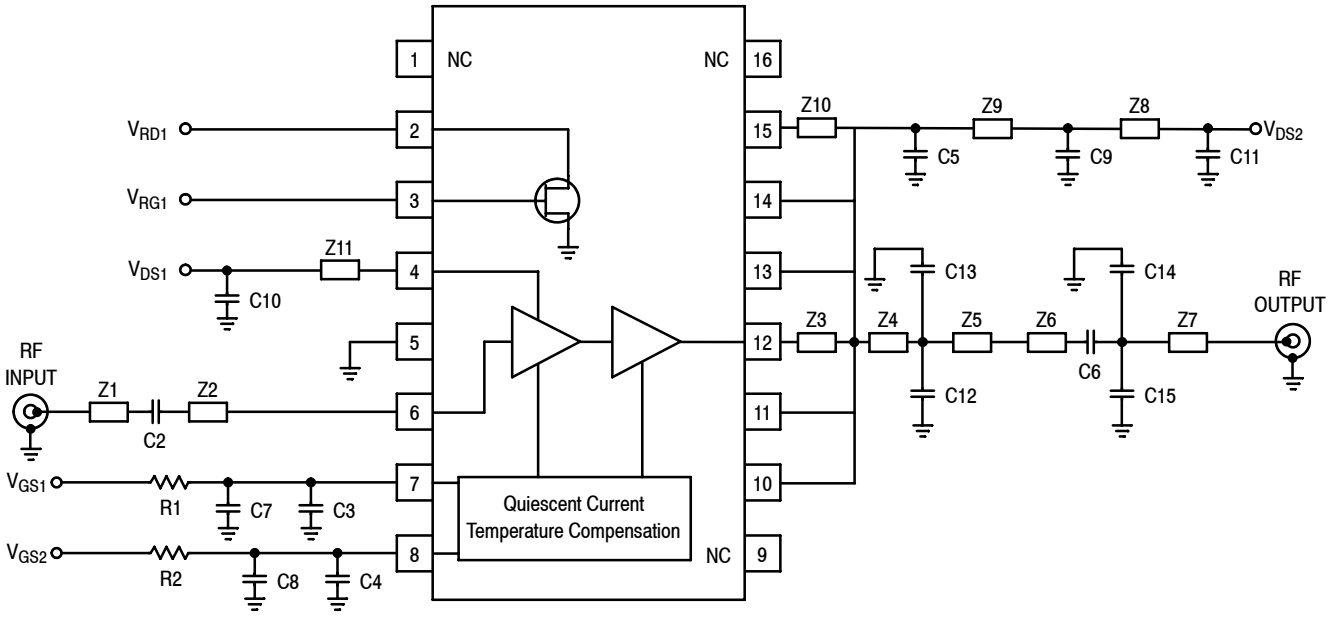
Characteristic	Symbol	Min	Typ	Max	Unit
Functional Tests (In Freescale Wideband 1930-1990 MHz Test Fixture, 50 ohm system) V_{DD} = 28 Vdc, I_{DQ1} = 120 mA, I_{DQ2} = 90 mA, P_{out} = 5 W Avg., f1 = 1990 MHz, f2 = 1990.1 MHz, Two-Tone Test					
Power Gain	G_{ps}	26.5	29	—	dB
Power Added Efficiency	PAE	25	29	—	%
Intermodulation Distortion	IMD	—	-34	-27	dBc
Input Return Loss	IRL	—		-10	dB
Typical Two-Tone Performances (In Freescale Test Fixture, 50 ohm system) V_{DD} = 28 Vdc, I_{DQ1} = 120 mA, I_{DQ2} = 90 mA, P_{out} = 5 W Avg., 1805-1880 MHz					
Power Gain	G_{ps}	—	29	—	dB
Power Added Efficiency	PAE	—	29	—	%
Intermodulation Distortion	IMD	—	-34	—	dBc
Input Return Loss	IRL	—	-15	—	dB
Typical GSM EDGE Performances (In Freescale GSM EDGE Test Fixture, 50 ohm system) V_{DD} = 28 Vdc, I_{DQ1} = 105 mA, I_{DQ2} = 95 mA, P_{out} = 3.2 W Avg., 1805-1880 MHz or 1930-1990 MHz EDGE Modulation					
Power Gain	G_{ps}	—	29	—	dB
Error Vector Magnitude	EVM	—	1.1	—	% rms
Spectral Regrowth at 400 kHz Offset	SR1	—	-67	—	dBc
Spectral Regrowth at 600 kHz Offset	SR2	—	-76	—	dBc

1. Refer to AN1955, *Thermal Measurement Methodology of RF Power Amplifiers.* Go to http://www.freescale.com/rf. Select Documentation/Application Notes - AN1955.

(continued)

Table 5. Electrical Characteristics (T_A = 25°C unless otherwise noted) **(continued)**

Characteristic	Symbol	Min	Typ	Max	Unit
Typical CW Performances (In Freescale CW Test Fixture, 50 ohm system) V_{DD} = 28 Vdc, I_{DQ1} = 120 mA, I_{DQ2} = 90 mA, P_{out} = 2.25 W Avg., 1805–1990 MHz					
Power Gain	G_{ps}	—	29	—	dB
Power Added Efficiency	PAE	—	19	—	%
Input Return Loss	IRL	—	-13	—	dB



Z1	0.120″ x 0.044″ Microstrip	Z7	0.273″ x 0.044″ Microstrip
Z2	0.257″ x 0.044″ Microstrip	Z8	0.917″ x 0.050″ Microstrip
Z3	0.130″ x 0.170″ Microstrip	Z9	0.304″ x 0.050″ Microstrip
Z4	0.067″ x 0.122″ Microstrip	Z10	0.710″ x 0.050″ Microstrip
Z5	0.127″ x 0.122″ Microstrip	Z11	1.296″ x 0.400″ Microstrip
Z6	0.355″ x 0.084″ Microstrip	PCB	Rogers 4350, 0.020″, ε_r = 3.50

Figure 3. MHV5IC1810NR2 Test Circuit Schematic — 1930-1990 MHz

Table 6. MHV5IC1810NR2 Test Circuit Component Designations and Values — 1930-1990 MHz

Part	Description	Part Number	Manufacturer
C2	22 pF Chip Capacitor	ATC100A220GT500XT	ATC
C3, C4, C5, C6	8.2 pF Chip Capacitors	ATC100A8R2CT500XT	ATC
C7, C8, C9	10 nF Chip Capacitors	08055C103KAT	AVX
C10, C11	6.8 μF Chip Capacitors	C4532X5R1H685MT	TDK
C12, C13	3.3 pF Chip Capacitors	ATC100A3R3BT500XT	ATC
C14, C15	0.5 pF Chip Capacitors	ATC100A0R5BT500XT	ATC
R1, R2	1 kΩ, 1/8 W Chip Resistors	CRCW1K00FKEA	Vishay

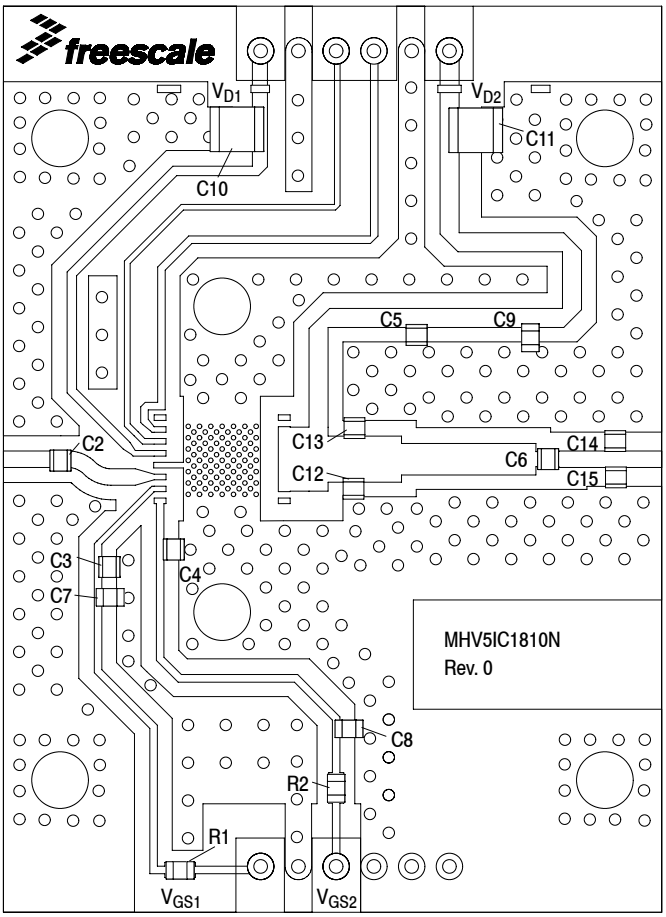


Figure 4. MHV5IC1810NR2 Test Circuit Component Layout — 1930-1990 MHz

TYPICAL CHARACTERISTICS — 1930–1990 MHz

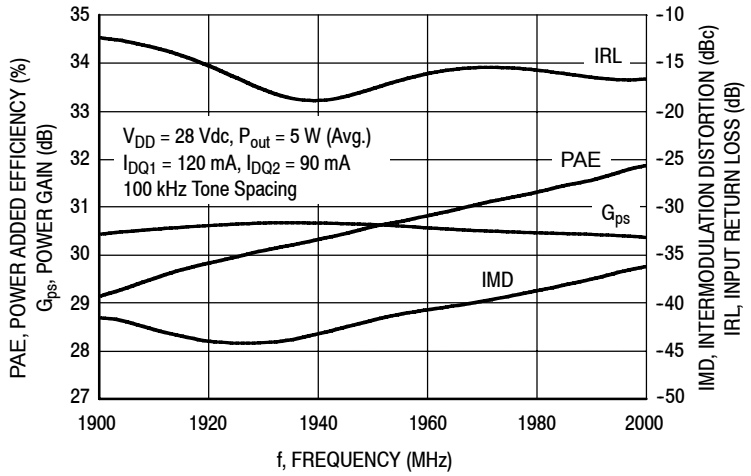


Figure 5. Two-Tone Wideband Performance @ P_{out} = 5 Watts (Avg.)

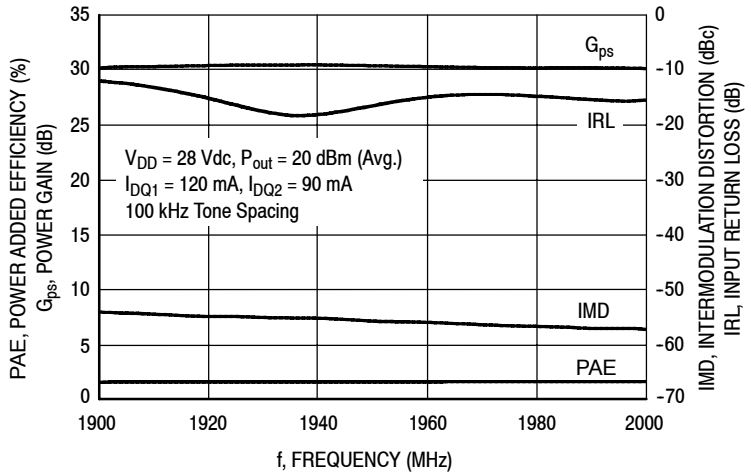


Figure 6. Two-Tone Wideband Performance @ P_{out} = 20 dBm (Avg.)

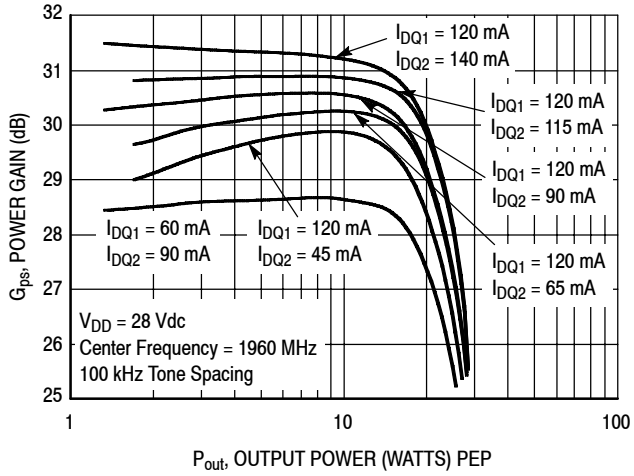


Figure 7. Two-Tone Power Gain versus Output Power

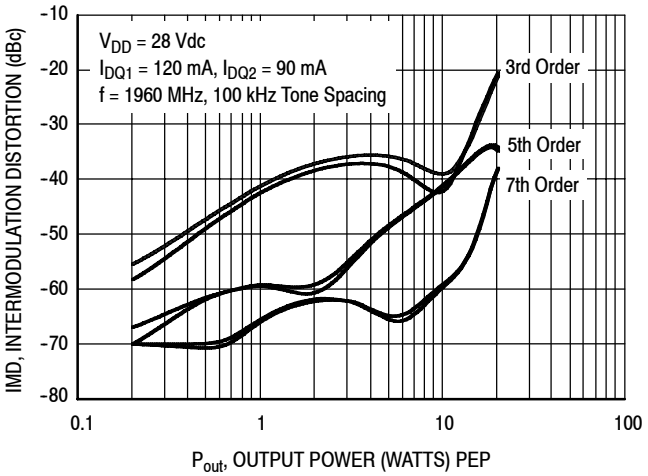


Figure 8. Intermodulation Distortion Products versus Output Power

TYPICAL CHARACTERISTICS — 1930–1990 MHz

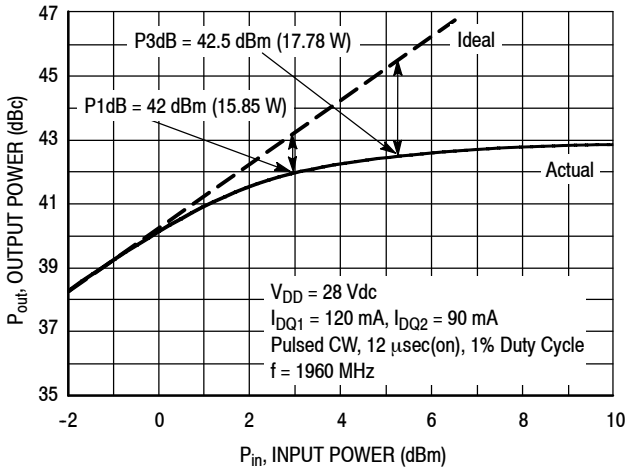


Figure 9. Pulse CW Output Power versus Input Power

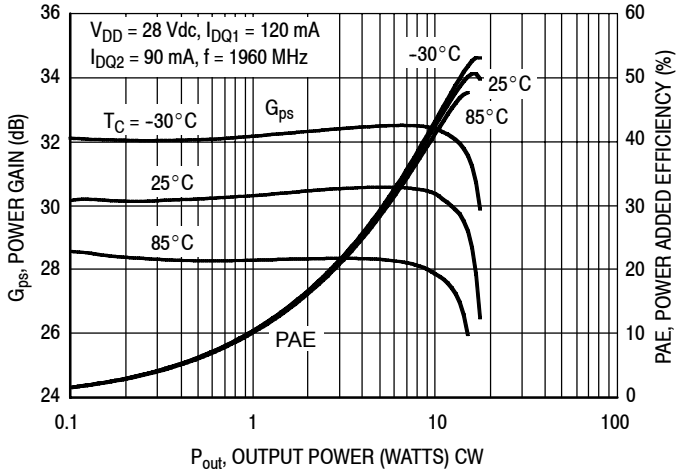


Figure 10. Power Gain and Power Added Efficiency versus CW Output Power

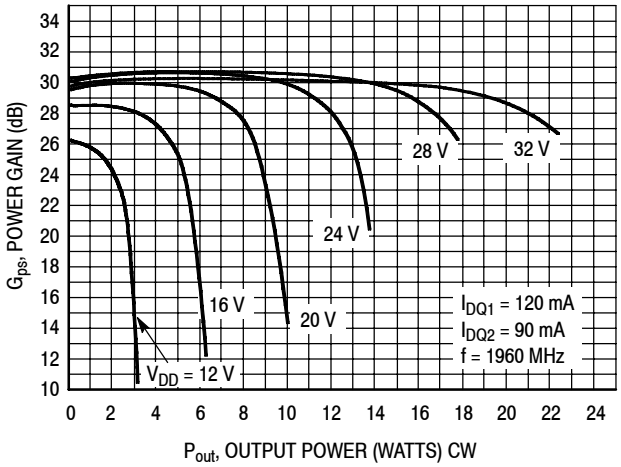


Figure 11. Power Gain versus Output Power

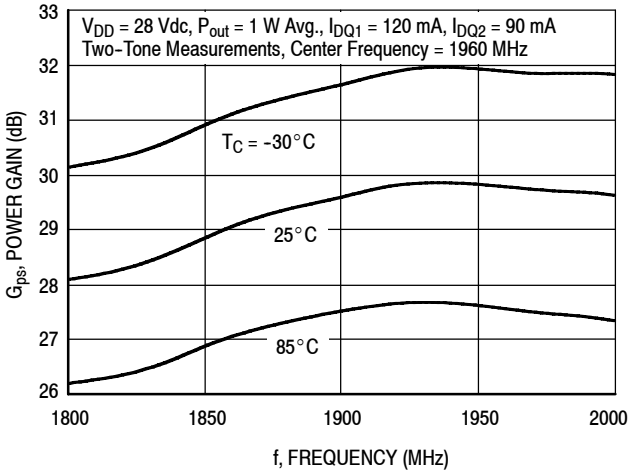


Figure 12. Power Gain versus Frequency

TYPICAL CHARACTERISTICS — 1930–1990 MHz

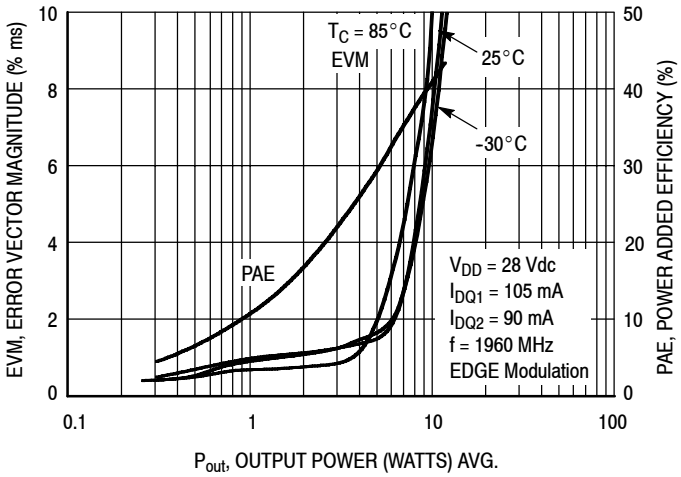


Figure 13. EVM and Power Added Efficiency versus Output Power

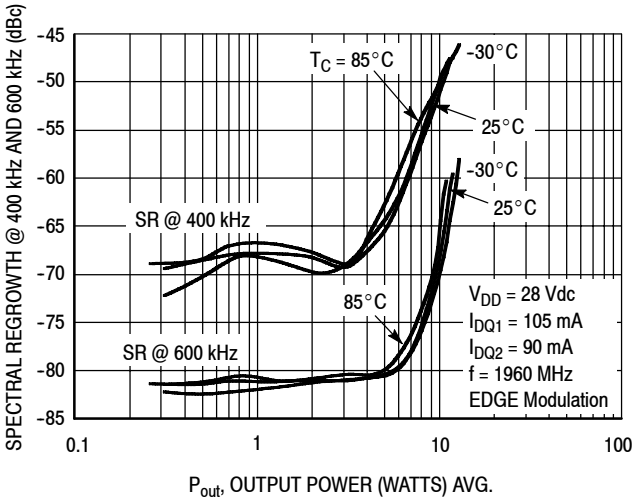
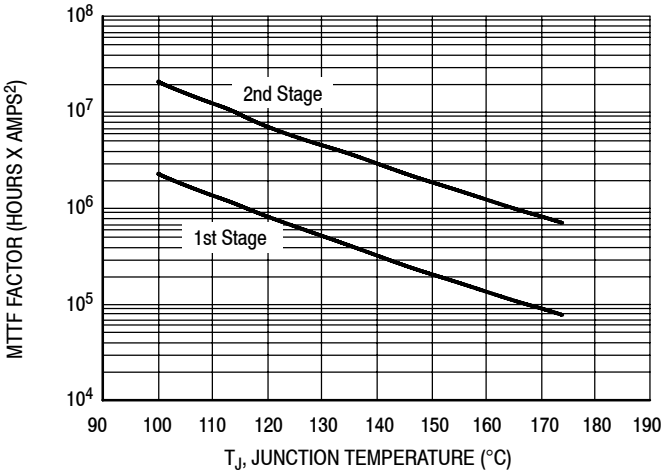


Figure 14. Spectral Regrowth at 400 and 600 kHz versus Output Power



This above graph displays calculated MTTF in hours x ampere^2 drain current. Life tests at elevated temperatures have correlated to better than ±10% of the theoretical prediction for metal failure. Divide MTTF factor by I_D^2 for MTTF in a particular application.

Figure 15. MTTF Factor versus Junction Temperature

GSM TEST SIGNAL

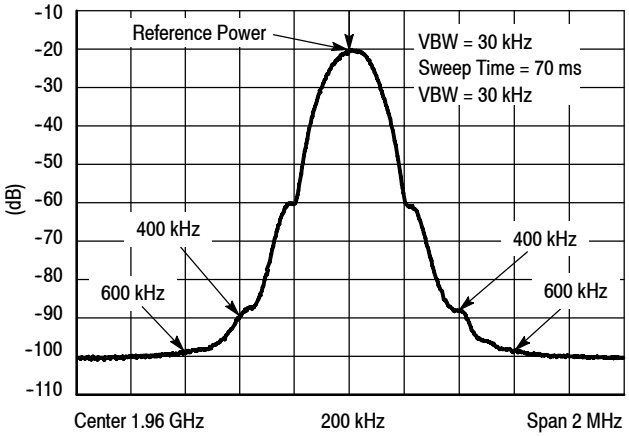
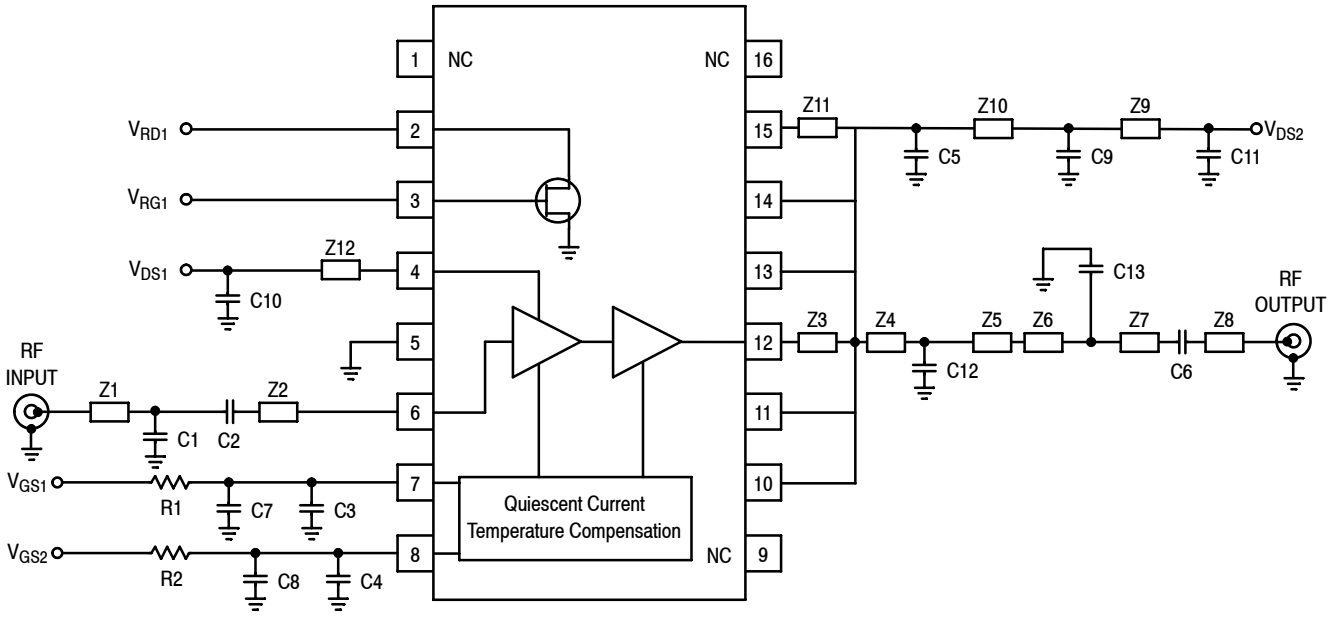


Figure 16. EDGE Spectrum



Z1	0.120″ x 0.044″ Microstrip	Z8	0.273″ x 0.044″ Microstrip
Z2	0.257″ x 0.044″ Microstrip	Z9	0.917″ x 0.050″ Microstrip
Z3	0.130″ x 0.170″ Microstrip	Z10	0.304″ x 0.050″ Microstrip
Z4	0.070″ x 0.122″ Microstrip	Z11	0.710″ x 0.050″ Microstrip
Z5	0.125″ x 0.122″ Microstrip	Z12	1.296″ x 0.400″ Microstrip
Z6	0.095″ x 0.084″ Microstrip	PCB	Rogers 4350, 0.020″, ε_r = 3.50
Z7	0.260″ x 0.085″ Microstrip		

Figure 17. MHV5IC1810NR2 Test Circuit Schematic — 1805–1880 MHz

Table 7. MHV5IC1810NR2 Test Circuit Component Designations and Values — 1805–1880 MHz

Part	Description	Part Number	Manufacturer
C1	0.8 pF Chip Capacitor	ATC100A0R8BT500XT	ATC
C2	27 pF Chip Capacitor	ATC100A270GT500XT	ATC
C3, C4, C5, C6	8.2 pF Chip Capacitors	ATC100A8R2CT500XT	ATC
C7, C8, C9	10 nF Chip Capacitors	08055C103KAT	AVX
C10, C11	6.8 μF Chip Capacitors	C4532X5R1H685MT	TDK
C12, C13	3.3 pF Chip Capacitors	ATC100A3R3BT500XT	ATC
R1, R2	1 kΩ, 1/8 W Chip Resistors	CRCW1K00FKEA	Vishay

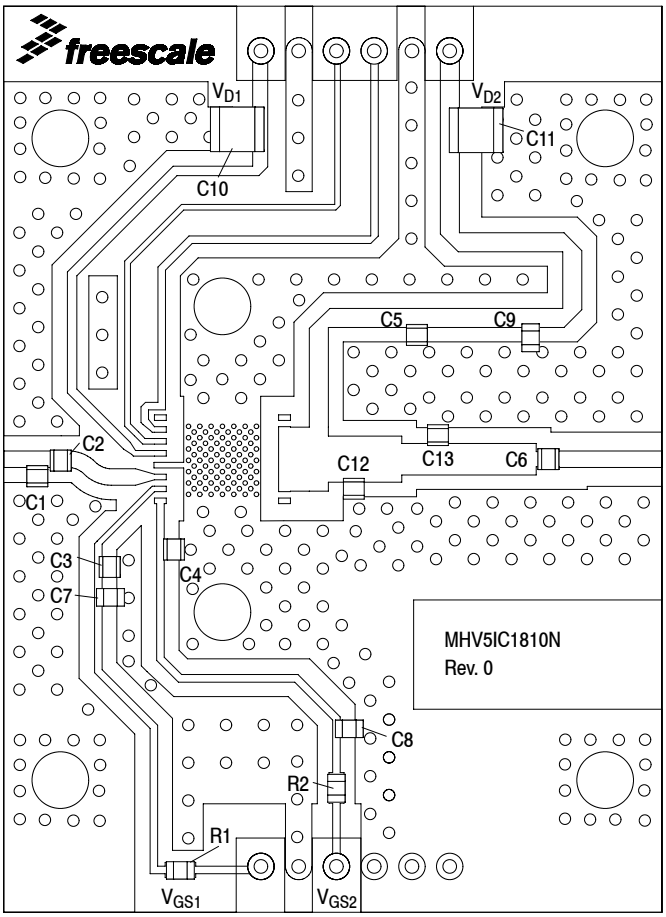


Figure 18. MHV5IC1810NR2 Test Circuit Component Layout — 1805–1880 MHz

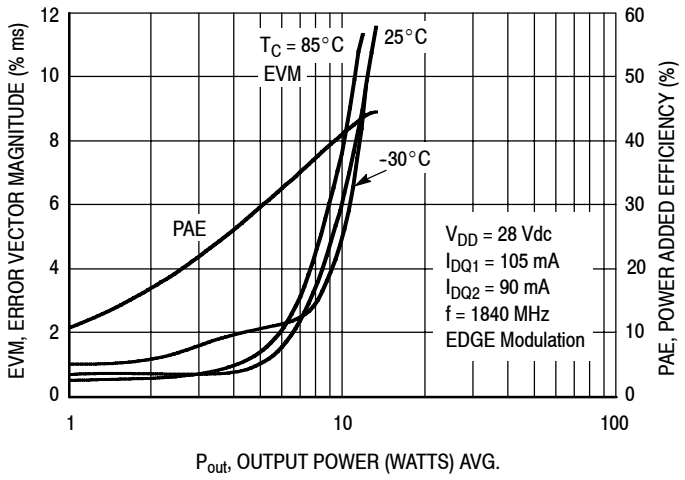


Figure 19. Spectral Regrowth at 400 and 600 kHz versus Output Power

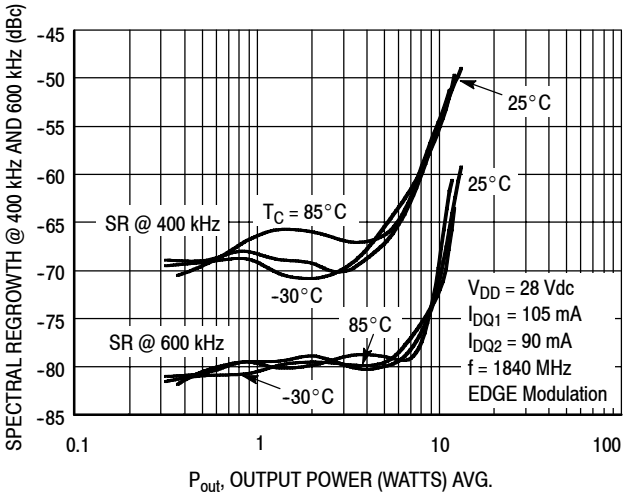
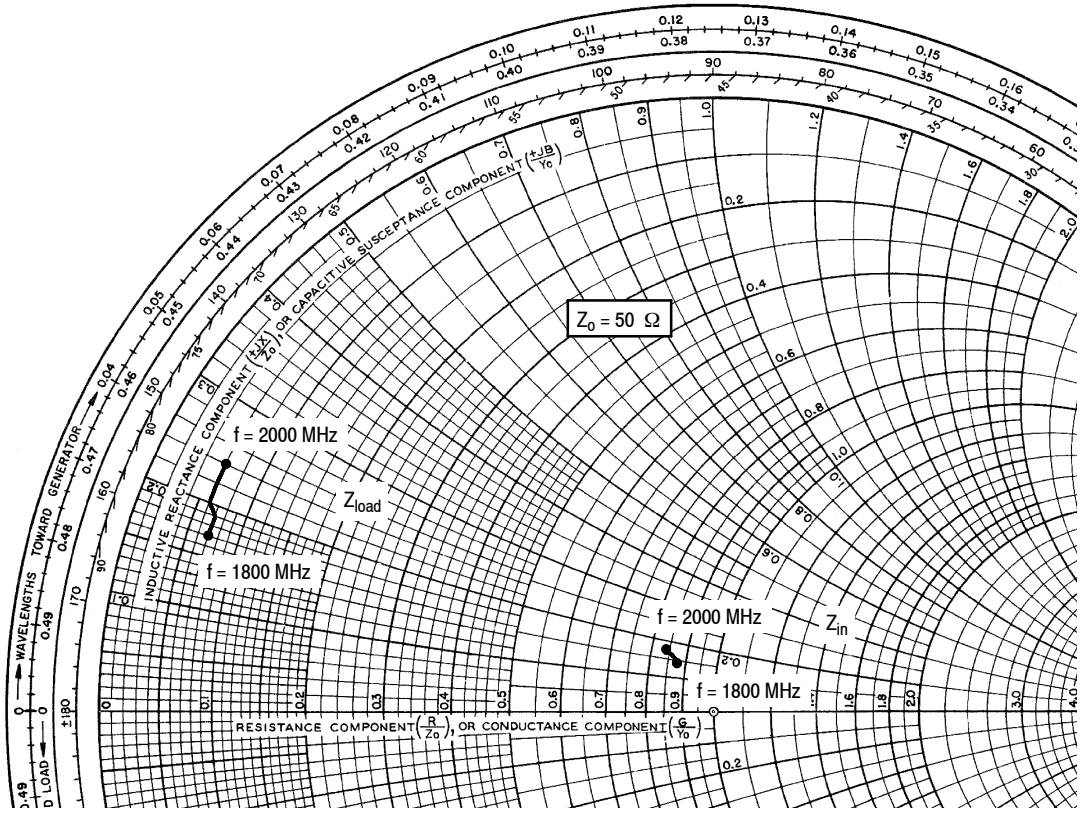


Figure 20. Spectral Regrowth at 400 and 600 kHz versus Output Power



V_{DD} = 28 Vdc, I_{DQ1} = 120 mA, I_{DQ2} = 90 mA, P_{out} = 5 W Avg.

f MHz	Z_{in} Ω	Z_{load} Ω
1800	43.82 + j6.83	3.49 + j8.58
1820	43.67 + j7.10	3.43 + j8.96
1840	43.50 + j7.34	3.36 + j9.33
1860	43.31 + j7.55	3.31 + j9.68
1880	43.13 + j7.76	3.24 + j10.04
1900	42.96 + j7.96	3.19 + j10.38
1920	42.76 + j8.15	3.14 + j10.72
1940	42.56 + j8.34	3.07 + j11.03
1960	42.36 + j8.50	3.04 + j11.36
1980	42.16 + j8.65	2.99 + j11.65
2000	41.97 + j8.79	2.94 + j11.94

Z_{in} = Test circuit impedance as measured from gate to ground.

Z_{load} = Test circuit impedance as measured from drain to ground.

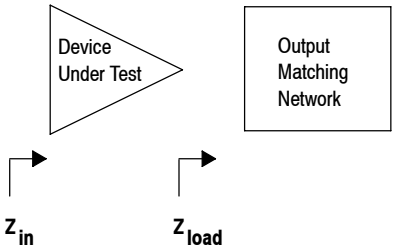
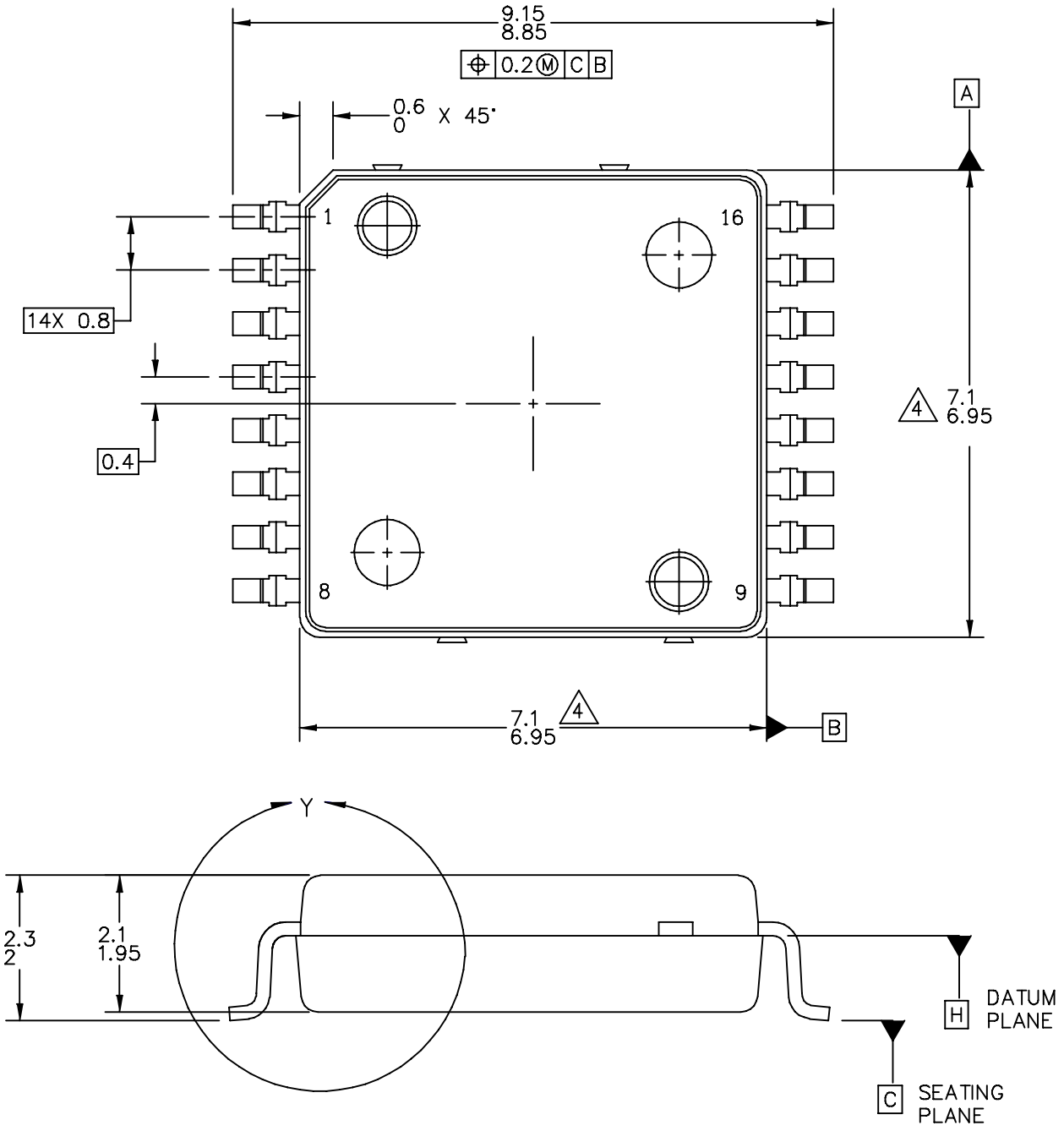


Figure 21. Series Equivalent Input and Load Impedance

PACKAGE DIMENSIONS



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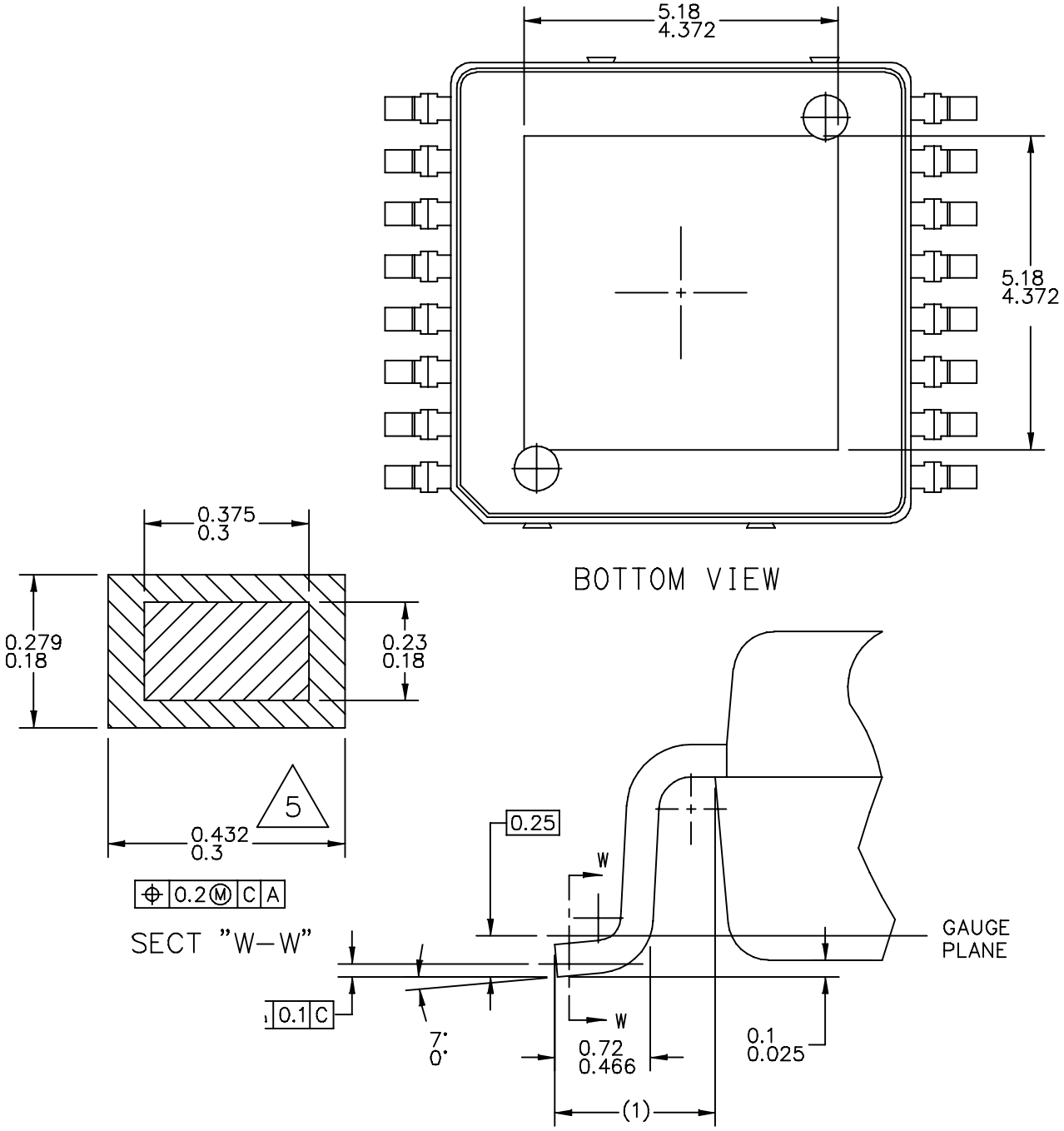
	STANDARD: NON-JEDEC	



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	CASE NUMBER: 978–03	05 APR 2005
	STANDARD: NON–JEDEC	

NOTES:

1. CONTROLLING DIMENSION: MILLIMETER

2. DIMENSIONS AND TOLERANCES PER ASME Y14.5M–1994.

3. DATUM PLANE –H– IS LOCATED AT BOTTOM OF LEAD AND IS COINCIDENT WITH THE LEAD WHERE THE LEAD EXITS THE PLASTIC BODY AT THE BOTTOM OF THE PARTING LINE.

4. THESE DIMENSIONS DO NOT INCLUDE MOLD PROTRUSION. ALLOWABLE PROTRUSION IS 0.250 PER SIDE. THESE DIMENSIONS DO INCLUDE MOLD MISMATCH AND ARE DETERMINED AT DATUM PLANE –H–.

5. THIS DIMENSION DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.127 TOTAL IN EXCESS OF THIS DIMENSION AT MAXIMUM MATERIAL CONDITION.

6. DATUMS –A– AND –B– TO BE DETERMINED AT DATUM PLANE –H–.

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	STANDARD: NON–JEDEC	

PRODUCT DOCUMENTATION

Refer to the following documents, Tools and software to aid your design process.

Application Notes

- AN1955: Thermal Measurement Methodology of RF Power Amplifiers
- AN1987: Quiescent Current Control for the RF Integrated Circuit Device Family

Engineering Bulletins

- EB212: Using Data Sheet Impedances for RF LDMOS Devices

REVISION HISTORY

The following table summarizes revisions to this document.

Revision	Date	Description
1	Mar. 2011	• Figs. 3 and 17, Test Circuit Schematic, redrawn to reflect correct trace lengths and trace length measurements, p. 4, 9 • Updated Part Numbers in Tables 6, 7, Component Designations and Values, to RoHS compliant part numbers, p. 4, 9 • Added Product Documentation and Revision History, p. 16

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