

The Wideband IC Line

RF LDMOS Wideband Integrated Power Amplifiers

The MW4IC2020M wideband integrated circuit is designed for base station applications. It uses Motorola's newest High Voltage (26 to 28 Volts) LDMOS IC technology and integrates a multi-stage structure. Its wideband On-Chip design makes it usable from 1600 to 2400 MHz. The linearity performances cover all modulations for cellular applications: GSM, GSM EDGE, TDMA, CDMA and W-CDMA.

Final Application

Typical Two-Tone Performance: $V_{DD} = 26$ Volts, $I_{DQ1} = 80$ mA, $I_{DQ2} = 200$ mA, $I_{DQ3} = 300$ mA, $P_{out} = 20$ Watts PEP, Full Frequency Band
 Power Gain — 29 dB
 IMD — -32 dBc
 Drain Efficiency — 26% (at 1805 MHz) and 20% (at 1990 MHz)

Driver Applications

Typical GSM EDGE Performance: $V_{DD} = 26$ Volts, $I_{DQ1} = 80$ mA, $I_{DQ2} = 230$ mA, $I_{DQ3} = 230$ mA, $P_{out} = 5$ Watts Avg., Full Frequency Band
 Power Gain — 29 dB
 Spectral Regrowth @ 400 kHz Offset = -66 dBc
 Spectral Regrowth @ 600 kHz Offset = -77 dBc
 EVM — 1% rms

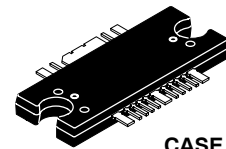
Typical CDMA Performance: $V_{DD} = 26$ Volts, $I_{DQ1} = 80$ mA, $I_{DQ2} = 240$ mA, $I_{DQ3} = 250$ mA, $P_{out} = 1$ Watt Avg., Full Frequency Band, IS-97 Pilot, Sync, Paging, Traffic Codes 8 through 13

Power Gain — 30 dB
 ACPR @ 885 kHz Offset = -61 dBc @ 30 kHz Bandwidth
 ALT1 @ 1.25 MHz Offset = -69 dBc @ 12.5 kHz Bandwidth
 ALT2 @ 2.25 MHz Offset = -59 dBc @ 1 MHz Bandwidth

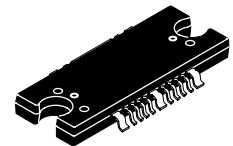
- Capable of Handling 3:1 VSWR, @ 26 Vdc, 1990 MHz, 8 Watts CW Output Power
- Characterized with Series Equivalent Large-Signal Impedance Parameters
- On-Chip Matching (50 Ohm Input, DC Blocked, >5 Ohm Output)
- Integrated Temperature Compensation with Enable/Disable Function
- On-Chip Current Mirror g_m Reference FET for Self Biasing Application (1)
- Integrated ESD Protection
- Also Available in Gull Wing for Surface Mount
- In Tape and Reel. R1 Suffix = 500 Units per 44 mm, 13 inch Reel

MW4IC2020MBR1
MW4IC2020GMBR1

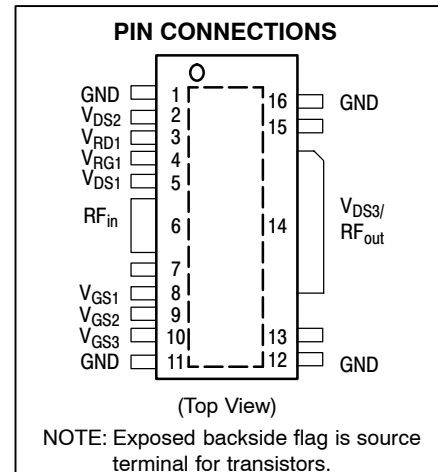
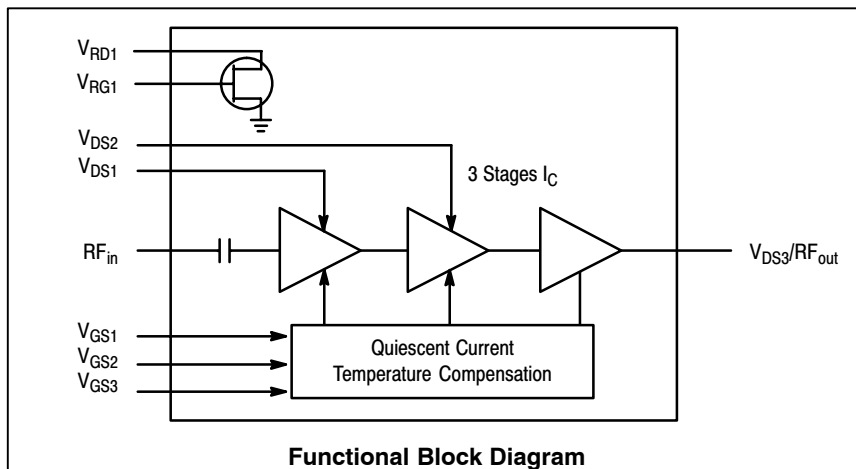
1805-1990 MHz, 20 W, 26 V
GSM/GSM EDGE, CDMA
RF LDMOS WIDEBAND
INTEGRATED POWER AMPLIFIERS



CASE 1329-09
TO-272 WB-16
PLASTIC
MW4IC2020MBR1



CASE 1329A-03
TO-272 WB-16 GULL
PLASTIC
MW4IC2020GMBR1



(1) Refer to AN1987/D, *Quiescent Current Control for the RF Integrated Circuit Device Family*. Go to <http://www.motorola.com/semiconductors/rf>. Select Documentation/Application Notes - AN1987.

Freescale Semiconductor, Inc.

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|--------------------------------|-----------|-------------|------|
| Drain-Source Voltage | V_{DSS} | 65 | Vdc |
| Gate-Source Voltage | V_{GS} | -0.5, +15 | Vdc |
| Storage Temperature Range | T_{stg} | -65 to +175 | °C |
| Operating Junction Temperature | T_J | 175 | °C |
| Input Power | P_{in} | 20 | dBm |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Value (1) | Unit |
|--------------------------------------|-----------------|--------------------|------|
| Thermal Resistance, Junction to Case | $R_{\theta JC}$ | 10.5 5.1 2.3 | °C/W |
| | | Stage 1 | |
| | | Stage 2 | |
| | | Stage 3 | |

ESD PROTECTION CHARACTERISTICS

| Test Conditions | Class |
|---------------------|--------------|
| Human Body Model | 2 (Minimum) |
| Machine Model | M3 (Minimum) |
| Charge Device Model | C5 (Minimum) |

MOISTURE SENSITIVITY LEVEL

| Test Methodology | Rating |
|------------------|--------|
| Per JESD 22-A113 | 3 |

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

| Characteristic | Symbol | Min | Typ | Max | Unit |
|----------------|--------|-----|-----|-----|------|
|----------------|--------|-----|-----|-----|------|

FUNCTIONAL TESTS (In Motorola Wideband 1805-1990 MHz Test Fixture, 50 ohm system) $V_{DD} = 26$ Vdc, $I_{DQ1} = 80$ mA, $I_{DQ2} = 200$ mA, $I_{DQ3} = 300$ mA, $P_{out} = 20$ W PEP, $f_1 = 1990$ MHz, $f_2 = 1990.1$ MHz and $f_1 = 1805$ MHz, $f_2 = 1805.1$ MHz, Two-Tone CW

| | | | | | |
|---|----------|--------------------------------------|----------|-----|-----|
| Power Gain | G_{ps} | 27 | 29 | — | dB |
| Drain Efficiency | η_D | 24 18 | 26 20 | — | % |
| | | $f_1 = 1805$ MHz, $f_2 = 1805.1$ MHz | | | |
| | | $f_1 = 1990$ MHz, $f_2 = 1990.1$ MHz | | | |
| Input Return Loss | IRL | — | — | -10 | dB |
| Intermodulation Distortion | IMD | — | -32 | -27 | dBc |
| Stability (100 mW < P_{out} < 8 W CW, Load VSWR = 3:1, All Phase Angles) | | No Spurious > -60 dBc | | | |

TYPICAL PERFORMANCES (In Motorola Test Fixture, 50 ohm system) $V_{DD} = 26$ Vdc, $I_{DQ1} = 80$ mA, $I_{DQ2} = 200$ mA, $I_{DQ3} = 300$ mA, 1805 MHz < Frequency < 1990 MHz, 1-Tone

| | | | | | |
|--|-----------------|---|--------------|---|-------|
| Saturated Pulsed Output Power ($f = 1$ kHz, Duty Cycle 10%) | P_{sat} | — | 33 | — | Watts |
| Quiescent Current Accuracy over Temperature (-10 to 85°C) | ΔI_{QT} | — | ±5 | — | % |
| Gain Flatness in 30 MHz Bandwidth @ $P_{out} = 1$ W CW | G_F | — | 0.15 | — | dB |
| Deviation from Linear Phase in 30 MHz Bandwidth @ $P_{out} = 1$ W CW 1805-1880 MHz 1930-1990 MHz | Φ | — | ±0.5 ±0.2 | — | ° |
| Delay @ $P_{out} = 1$ W CW Including Output Matching | Delay | — | 1.8 | — | ns |
| Part to Part Phase Variation @ $P_{out} = 1$ W CW | $\Phi\Delta$ | — | ±10 | — | ° |

(1) MTTF calculator available at <http://www.motorola.com/semiconductors/rf>. Select Tools/Software/Application Software/Calculators to access the MTTF calculators by product.

(continued)

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ELECTRICAL CHARACTERISTICS — continued ($T_C = 25^\circ\text{C}$ unless otherwise noted)

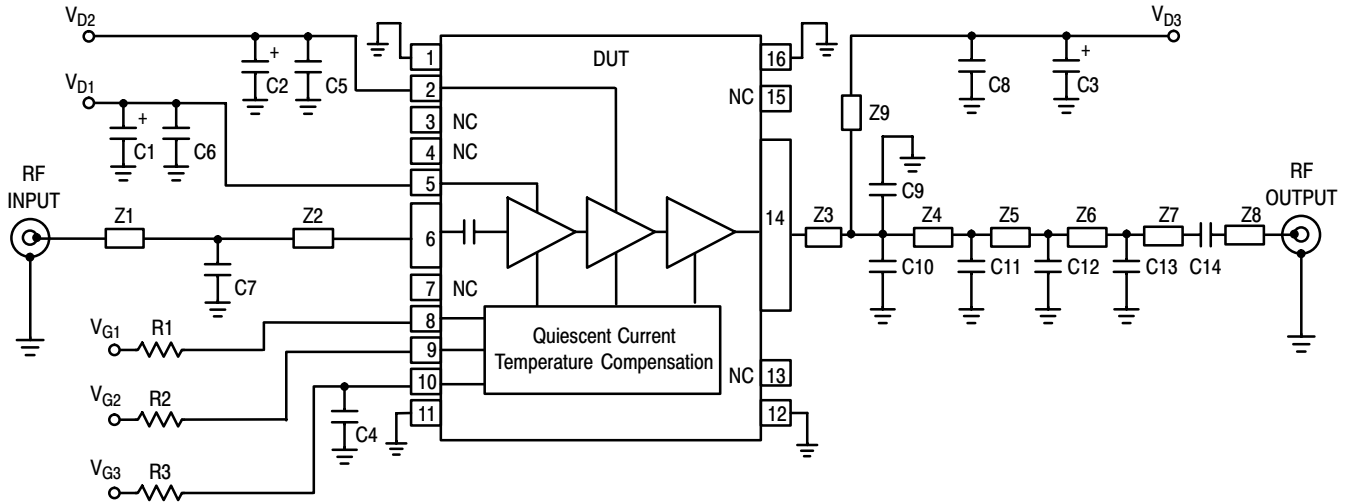
| Characteristic | Symbol | Min | Typ | Max | Unit |
|----------------|--------|-----|-----|-----|------|
|----------------|--------|-----|-----|-----|------|

TYPICAL CDMA PERFORMANCES (In Modified CDMA Test Fixture, 50 ohm system) $V_{DD} = 26\text{ Vdc}$, $I_{DQ1} = 80\text{ mA}$, $I_{DQ2} = 240\text{ mA}$, $I_{DQ3} = 250\text{ mA}$, $P_{out} = 1\text{ W Avg.}$, 11930 MHz < Frequency < 1990 MHz, 1-Tone, 9 Channel Forward Model (Pilot, Paging, Sync, Traffic Codes 8 through 13). Peak/Avg. Ratio 9.8 dB @ 0.01% Probability on CCDF.

| | | | | | |
|--|----------|---|-----|---|-----|
| Power Gain | G_{ps} | — | 30 | — | dB |
| Drain Efficiency | η_D | — | 5 | — | % |
| Adjacent Channel Power Ratio ($\pm 885\text{ kHz @ } 30\text{ kHz Bandwidth}$) | ACPR | — | -61 | — | dBc |
| Alternate 1 Channel Power Ratio ($\pm 1.25\text{ MHz @ } 12.5\text{ kHz Bandwidth}$) | ALT1 | — | -69 | — | dBc |
| Alternate 2 Channel Power Ratio ($\pm 2.25\text{ MHz @ } 1\text{ MHz Bandwidth}$) | ALT2 | — | -59 | — | dBc |

TYPICAL GSM EDGE PERFORMANCES (In Modified GSM EDGE Test Fixture, 50 ohm system) $V_{DD} = 26\text{ Vdc}$, $I_{DQ1} = 80\text{ mA}$, $I_{DQ2} = 230\text{ mA}$, $I_{DQ3} = 230\text{ mA}$, $P_{out} = 5\text{ W Avg.}$, 1805 MHz < Frequency < 1990 MHz

| | | | | | |
|-------------------------------------|----------|---|-----|---|-------|
| Power Gain | G_{ps} | — | 29 | — | dB |
| Drain Efficiency | η_D | — | 15 | — | % |
| Error Vector Magnitude | EVM | — | 1 | — | % rms |
| Spectral Regrowth at 400 kHz Offset | SR1 | — | -66 | — | dBc |
| Spectral Regrowth at 600 kHz Offset | SR2 | — | -77 | — | dBc |



| | | | |
|----|----------------------------|-----|--|
| Z1 | 1.820" x 0.087" Microstrip | Z6 | 0.303" x 0.087" Microstrip |
| Z2 | 0.245" x 0.087" Microstrip | Z7 | 0.640" x 0.087" Microstrip |
| Z3 | 0.345" x 0.236" Microstrip | Z8 | 0.334" x 0.087" Microstrip |
| Z4 | 0.327" x 0.087" Microstrip | Z9 | 1.231" x 0.043" Microstrip |
| Z5 | 0.271" x 0.087" Microstrip | PCB | Taconic TLX8-0300, 0.030", $\epsilon_r = 2.55$ |

Figure 1. MW4IC2020MBR1(GMBR1) Test Circuit Schematic

Table 1. MW4IC2020MBR1(GMBR1) Test Circuit Component Designations and Values

| Part | Description | Part Number | Manufacturer |
|------------|--------------------------------------|--------------|--------------|
| C1, C2, C3 | 10 μ F, 35 V Tantalum Capacitors | TAJE226M035 | AVX |
| C4 | 220 nF Chip Capacitor (1206) | 12065C224K28 | AVX |
| C5, C6, C8 | 6.8 pF 100B Chip Capacitors | 100B6R8CW | ATC |
| C7 | 0.5 pF 100B Chip Capacitor | 100B0R5BW | ATC |
| C9, C11 | 1.8 pF 100B Chip Capacitors | 100B1R8BW | ATC |
| C10 | 2.2 pF 100B Chip Capacitor | 100B2R2BW | ATC |
| C12 | 1 pF 100B Chip Capacitor | 100B1R0BW | ATC |
| C13 | 0.3 pF 100B Chip Capacitor | 100B0R3BW | ATC |
| C14 | 10 pF 100B Chip Capacitor | 100B100GW | ATC |
| R1, R2, R3 | 1.8 k Ω Chip Resistors (1206) | | |

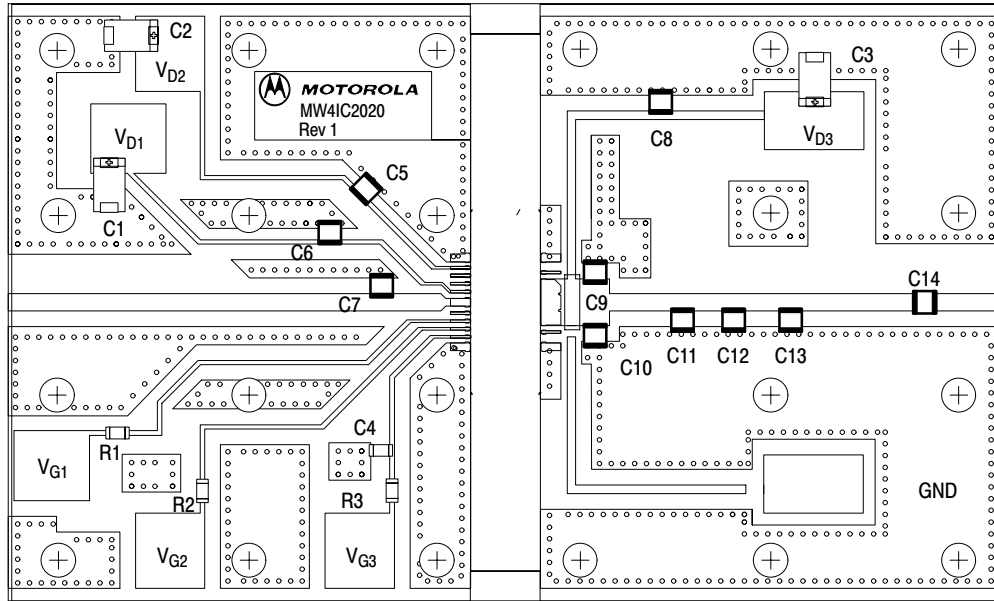


Figure 2. MW4IC2020MBR1(GMBR1) Test Circuit Component Layout

TYPICAL CHARACTERISTICS

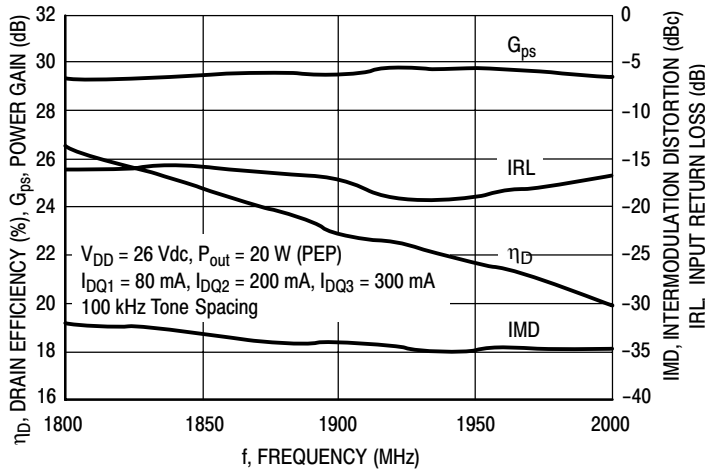


Figure 3. Two-Tone Wideband Performance

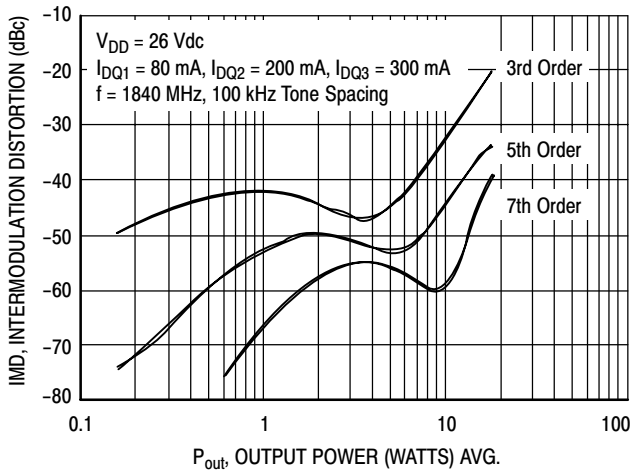


Figure 4. Intermodulation Distortion Products versus Output Power

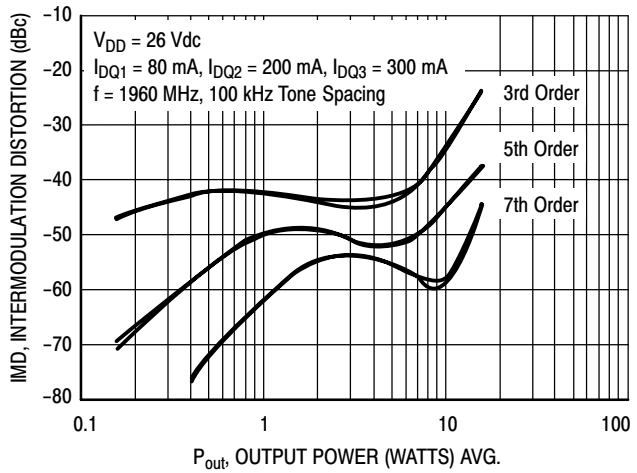


Figure 5. Intermodulation Distortion Products versus Output Power

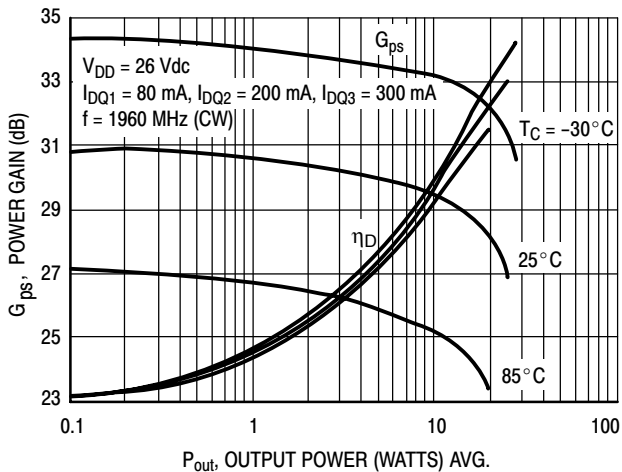


Figure 6. Power Gain and Drain Efficiency versus Output Power

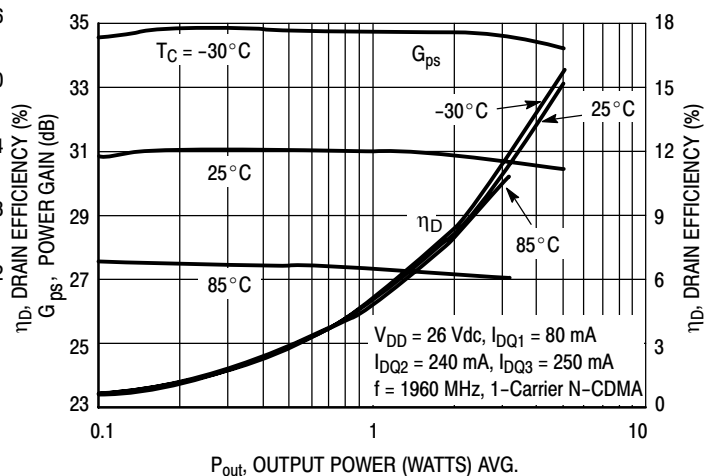


Figure 7. Power Gain and Drain Efficiency versus Output Power

TYPICAL CHARACTERISTICS

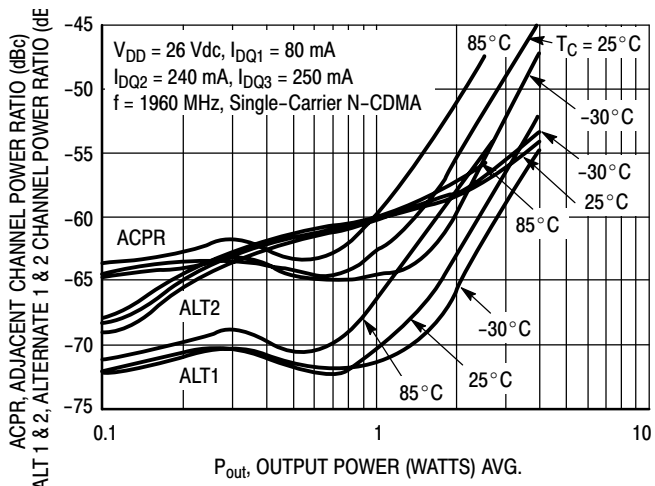


Figure 8. Alternate Channel Power Ratio, Alternate 1 and 2 Channel Power Ratio versus Output Power

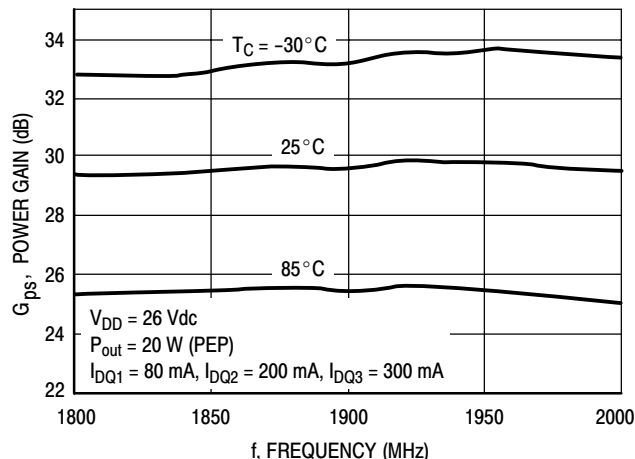


Figure 9. Power Gain versus Frequency

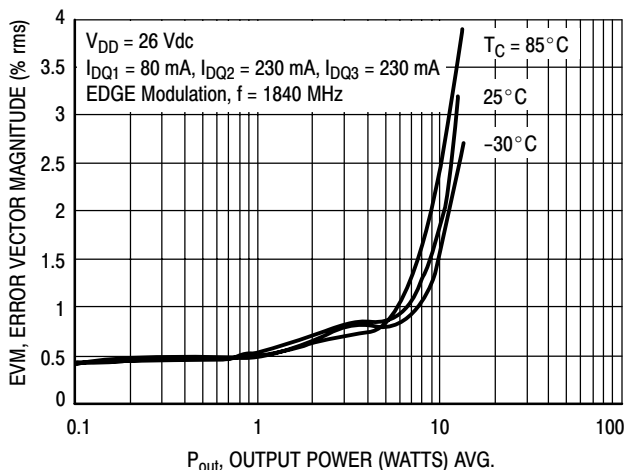


Figure 10. Error Vector Magnitude versus Output Power

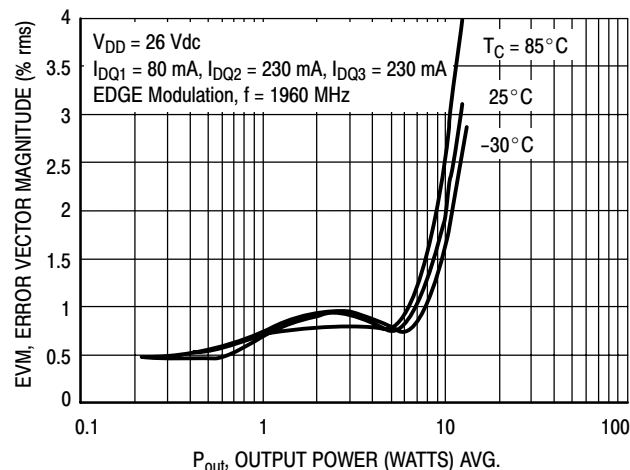


Figure 11. Error Vector Magnitude versus Output Power

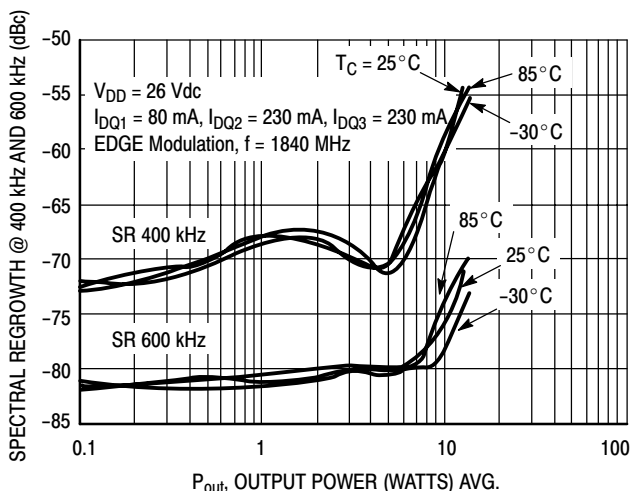


Figure 12. Spectral Regrowth at 400 and 600 kHz versus Output Power

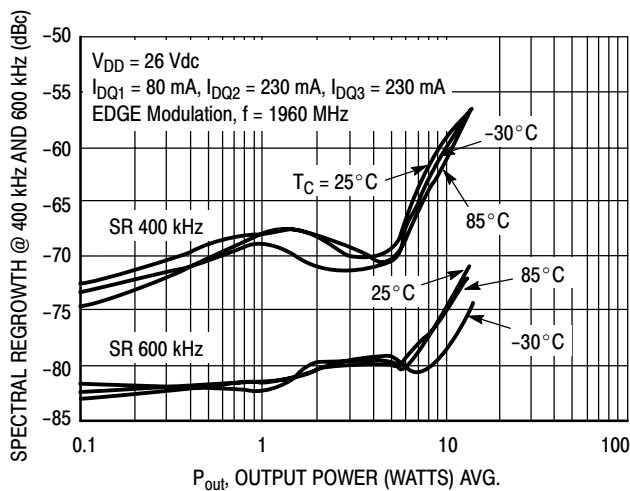
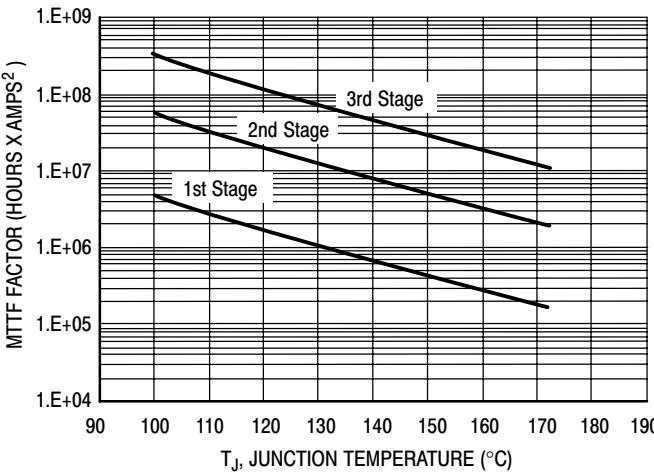


Figure 13. Spectral Regrowth at 400 and 600 kHz versus Output Power

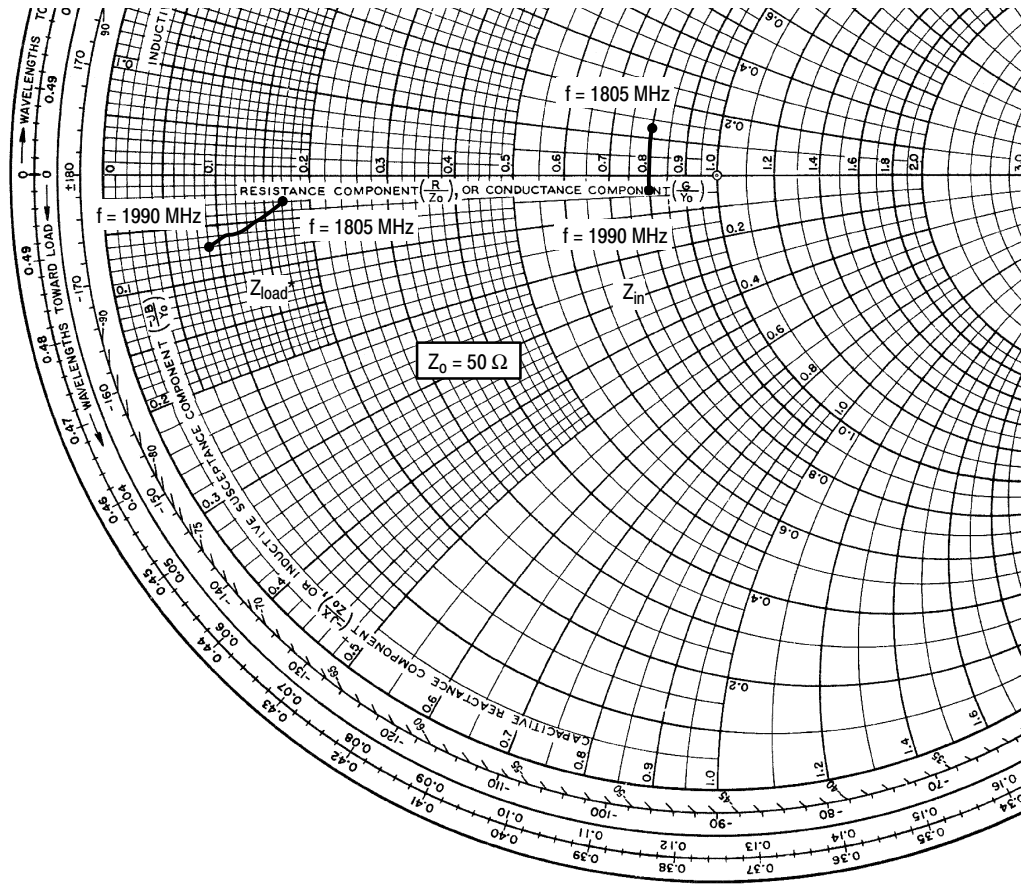
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TYPICAL CHARACTERISTICS



This above graph displays calculated MTTF in hours x ampere² 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_D² for MTTF in a particular application.

Figure 14. MTTF Factor versus Junction Temperature



$V_{DD} = 26\text{ V}$, $I_{DQ1} = 80\text{ mA}$, $I_{DQ2} = 200\text{ mA}$, $I_{DQ1} = 300\text{ mA}$, $P_{out} = 20\text{ W PEP Two-Tone CW}$

| f MHz | Z_{in} Ω | Z_{load} Ω |
|----------|----------------------|------------------------|
| 1805 | $40.00 + j6.50$ | $8.75 - j1.42$ |
| 1842 | $40.00 + j2.00$ | $7.00 - j2.70$ |
| 1880 | $40.00 - j1.50$ | $5.90 - j2.97$ |
| 1930 | $40.00 - j1.80$ | $5.46 - j3.20$ |
| 1960 | $40.00 - j2.10$ | $4.30 - j3.35$ |
| 1990 | $40.00 - j2.60$ | $4.45 - j3.30$ |

Z_{in} = Device input impedance as measured from gate to ground.

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

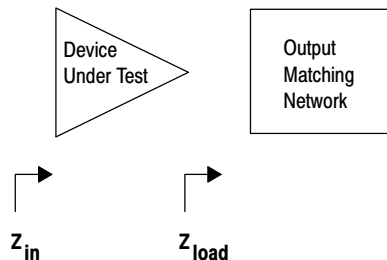
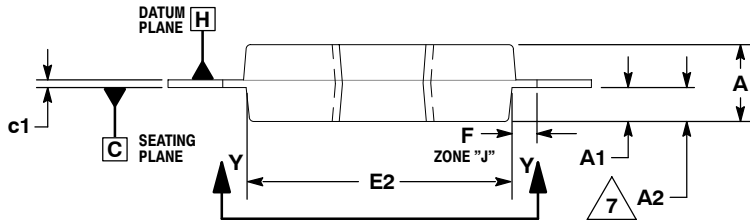
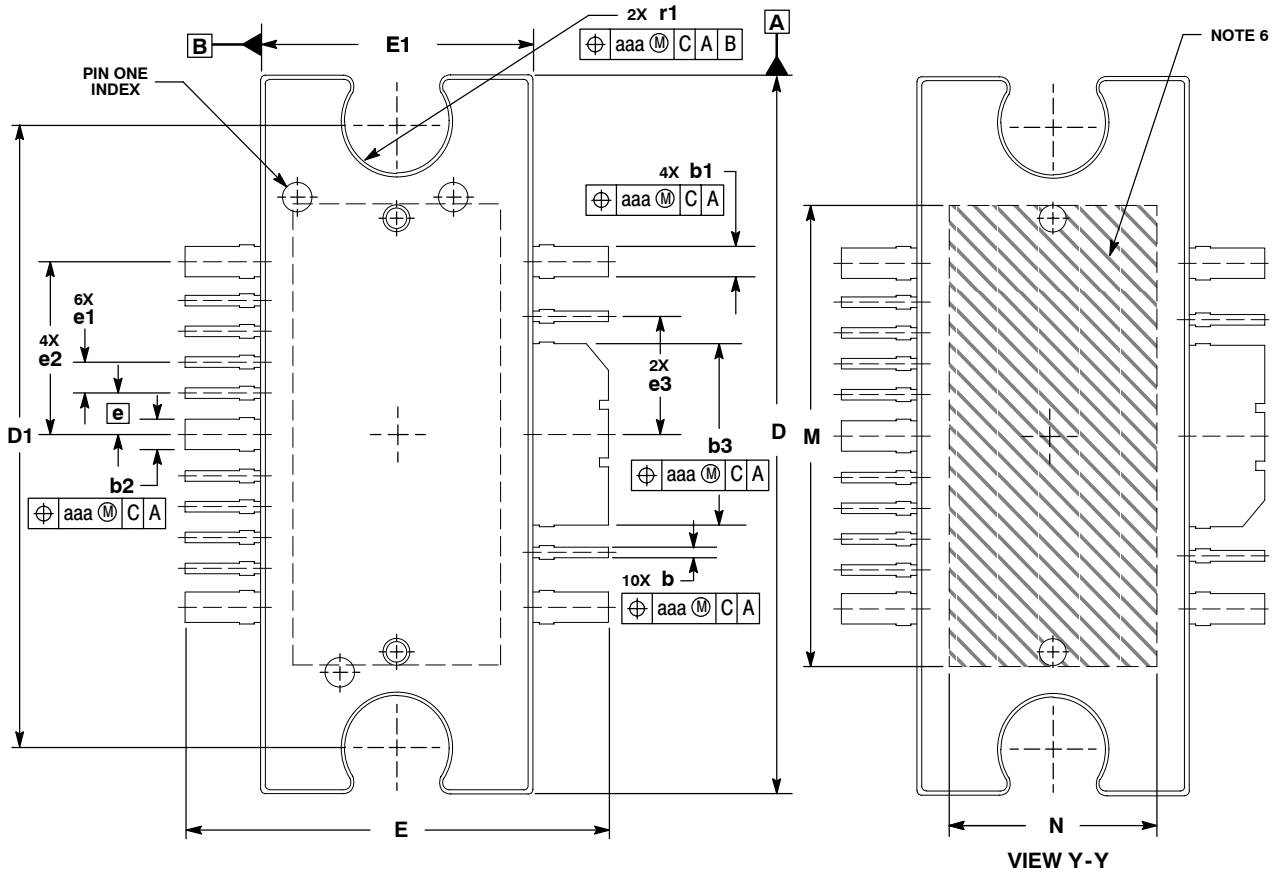


Figure 15. Series Equivalent Output Impedance

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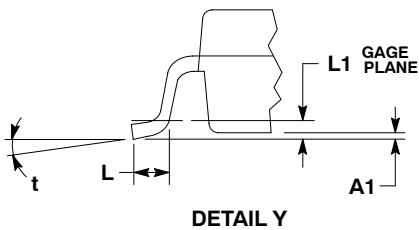
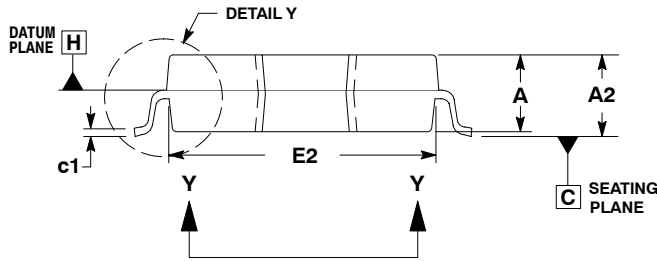
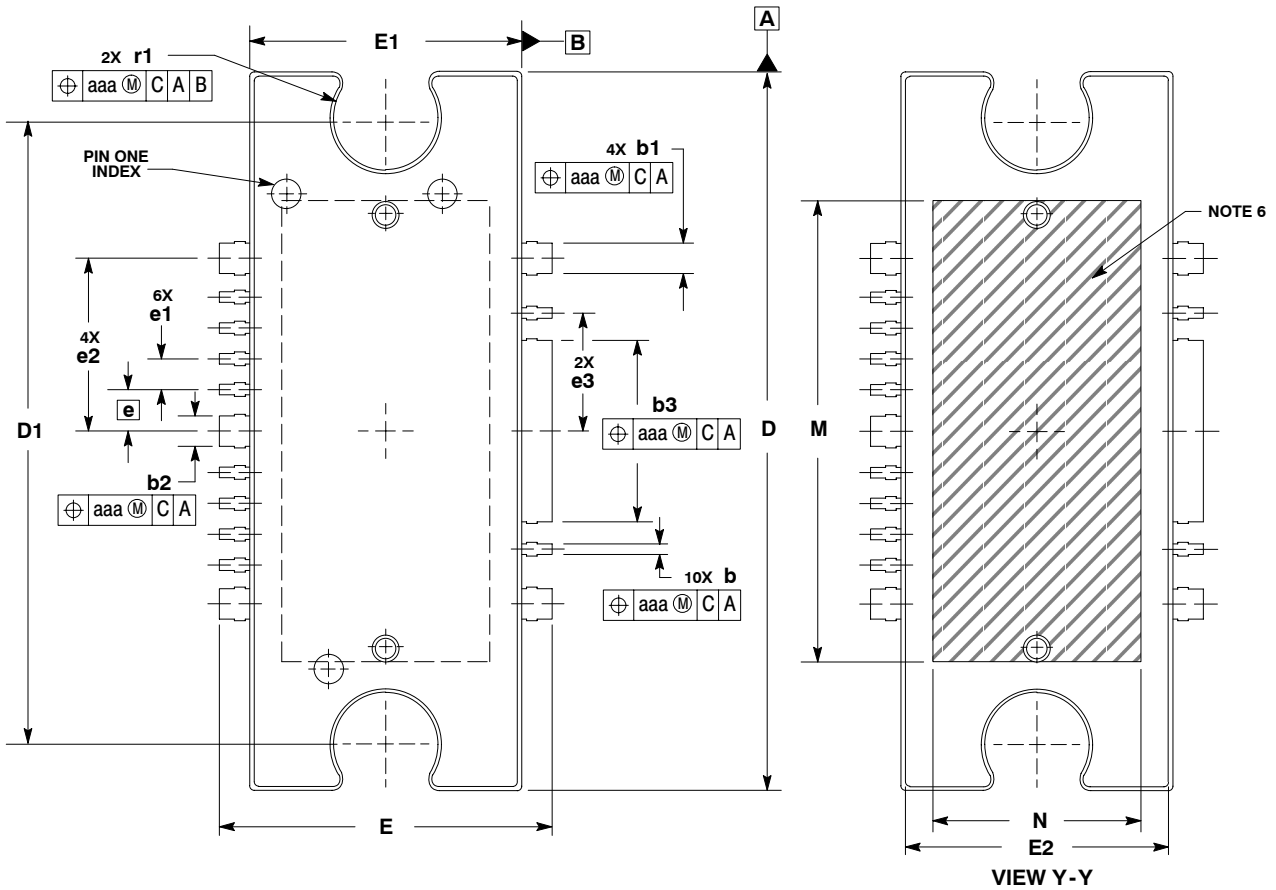
PACKAGE DIMENSIONS



- NOTES:
1. CONTROLLING DIMENSION: INCH.
 2. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M-1994.
 3. DATUM PLANE -H- IS LOCATED AT TOP OF LEAD AND IS COINCIDENT WITH THE LEAD WHERE THE LEAD EXITS THE PLASTIC BODY AT THE TOP OF THE PARTING LINE.
 4. DIMENSIONS "D" AND "E1" DO NOT INCLUDE MOLD PROTRUSION. ALLOWABLE PROTRUSION IS .006 (0.15) PER SIDE. DIMENSIONS "D" AND "E1" DO INCLUDE MOLD MISMATCH AND ARE DETERMINED AT DATUM PLANE -H-.
 5. DIMENSIONS "b", "b1", "b2" AND "b3" DO NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE .005 (0.13) TOTAL IN EXCESS OF THE "b", "b1", "b2" AND "b3" DIMENSIONS AT MAXIMUM MATERIAL CONDITION.
 6. HATCHING REPRESENTS THE EXPOSED AREA OF THE HEAT SLUG.
 7. DIM A2 APPLIES WITHIN ZONE "J" ONLY.

| DIM | INCHES | | MILLIMETERS | |
|-----|----------|------|-------------|-------|
| | MIN | MAX | MIN | MAX |
| A | .100 | .104 | 2.54 | 2.64 |
| A1 | .038 | .044 | 0.96 | 1.12 |
| A2 | .040 | .042 | 1.02 | 1.07 |
| D | .928 | .932 | 23.57 | 23.67 |
| D1 | .810 BSC | | 20.57 BSC | |
| E | .551 | .559 | 14.00 | 14.20 |
| E1 | .353 | .357 | 8.97 | 9.07 |
| E2 | .346 | .350 | 8.79 | 8.89 |
| F | .025 BSC | | 0.64 BSC | |
| M | .600 | --- | 15.24 | --- |
| N | .270 | --- | 6.86 | --- |
| b | .011 | .017 | 0.28 | 0.43 |
| b1 | .037 | .043 | 0.94 | 1.09 |
| b2 | .037 | .043 | 0.94 | 1.09 |
| b3 | .225 | .231 | 5.72 | 5.87 |
| c1 | .007 | .011 | .18 | .28 |
| e | .054 BSC | | 1.37 BSC | |
| e1 | .040 BSC | | 1.02 BSC | |
| e2 | .224 BSC | | 5.69 BSC | |
| e3 | .150 BSC | | 3.81 BSC | |
| r1 | .063 | .068 | 1.6 | 1.73 |
| aaa | .004 | | .10 | |

**CASE 1329-09
ISSUE J
TO-272 WB-16
PLASTIC
MW4IC2020MBR1**



- NOTES:
1. CONTROLLING DIMENSION: INCH.
 2. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M-1994.
 3. DATUM PLANE -H- IS LOCATED AT TOP OF LEAD AND IS COINCIDENT WITH THE LEAD WHERE THE LEAD EXITS THE PLASTIC BODY AT THE TOP OF THE PARTING LINE.
 4. DIMENSIONS "D" AND "E1" DO NOT INCLUDE MOLD PROTRUSION. ALLOWABLE PROTRUSION IS .006 (0.15) PER SIDE. DIMENSIONS "D" AND "E1" DO INCLUDE MOLD MISMATCH AND ARE DETERMINED AT DATUM PLANE -H-.
 5. DIMENSIONS "b", "b1", "b2" AND "b3" DO NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE .005 (0.13) TOTAL IN EXCESS OF THE "b", "b1", "b2" AND "b3" DIMENSIONS AT MAXIMUM MATERIAL CONDITION.
 6. HATCHING REPRESENTS THE EXPOSED AREA OF THE HEAT SINK.

| DIM | INCHES | | MILLIMETERS | |
|-----|----------|------|-------------|-------|
| | MIN | MAX | MIN | MAX |
| A | .100 | .104 | 2.54 | 2.64 |
| A1 | .001 | .004 | 0.02 | 0.10 |
| A2 | .099 | .110 | 2.51 | 2.79 |
| D | .928 | .932 | 23.57 | 23.67 |
| D1 | .810 BSC | | 20.57 BSC | |
| E | .429 | .437 | 10.90 | 11.10 |
| E1 | .353 | .357 | 8.97 | 9.07 |
| E2 | .346 | .350 | 8.79 | 8.89 |
| L | .018 | .024 | 4.90 | 5.06 |
| L1 | .01 BSC | | 0.25 BSC | |
| M | .600 | --- | 15.24 | --- |
| N | .270 | --- | 6.86 | --- |
| b | .011 | .017 | 0.28 | 0.43 |
| b1 | .037 | .043 | 0.94 | 1.09 |
| b2 | .037 | .043 | 0.94 | 1.09 |
| b3 | .225 | .231 | 5.72 | 5.87 |
| c1 | .007 | .011 | .18 | .28 |
| e | .054 BSC | | 1.37 BSC | |
| e1 | .040 BSC | | 1.02 BSC | |
| e2 | .224 BSC | | 5.69 BSC | |
| e3 | .150 BSC | | 3.81 BSC | |
| r1 | .063 | .068 | 1.6 | 1.73 |
| t | 2° | 8° | 2° | 8° |
| aaa | .004 | | .10 | |

**CASE 1329A-03
ISSUE B
TO-272 WB-16 GULL
PLASTIC
MW4IC2020GMBR1**

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