



## RF Power LDMOS Transistors

### High Ruggedness N-Channel Enhancement-Mode Lateral MOSFETs

Designed for mobile two-way radio applications with frequencies from 136 to 520 MHz. The high gain, ruggedness and broadband performance of these devices make them ideal for large-signal, common source amplifier applications in mobile radio equipment.

**Typical Performance:** (13.6 Vdc,  $T_A = 25^\circ\text{C}$ , CW)

| Frequency (MHz) | $G_{ps}$ (dB) | $\eta_{ID}$ (%) | $P_{1dB}$ (W) |
|-----------------|---------------|-----------------|---------------|
| 380–450 (1,3)   | 18.3          | 64.1            | 31            |
| 450–520 (2,3)   | 17.7          | 62.0            | 31            |
| 520 (4)         | 17.7          | 71.4            | 33            |

#### Load Mismatch/Ruggedness

| Frequency (MHz) | Signal Type | VSWR                      | $P_{out}$ (W)       | Test Voltage | Result                |
|-----------------|-------------|---------------------------|---------------------|--------------|-----------------------|
| 520 (4)         | CW          | >65:1 at all Phase Angles | 47 (3 dB Overdrive) | 17           | No Device Degradation |

1. Measured in 380–450 MHz UHF wideband reference circuit.
2. Measured in 450–520 MHz UHF wideband reference circuit.
3. The values shown are the minimum measured performance numbers across the indicated frequency range.
4. Measured in 520 MHz narrowband test circuit.

#### Features

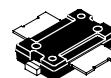
- Characterized for Operation from 136 to 520 MHz
- Unmatched Input and Output Allowing Wide Frequency Range Utilization
- Integrated ESD Protection
- Integrated Stability Enhancements
- Wideband — Full Power Across the Band:
  - 136–174 MHz
  - 380–450 MHz
  - 450–520 MHz
- 225°C Capable Plastic Package
- Exceptional Thermal Performance
- High Linearity for: TETRA, SSB, LTE
- Cost-effective Over-molded Plastic Packaging
- In Tape and Reel. R1 Suffix = 500 Units, 24 mm Tape Width, 13 inch Reel.

#### Typical Applications

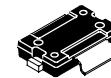
- Output Stage VHF Band Mobile Radio
- Output Stage UHF Band Mobile Radio

**AFT05MS031NR1  
AFT05MS031GNR1**

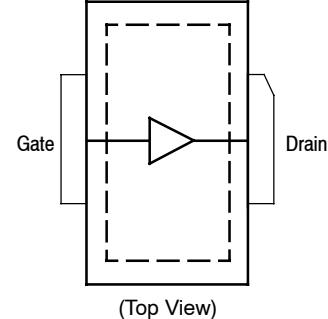
**136–520 MHz, 31 W, 13.6 V  
WIDEBAND  
RF POWER LDMOS TRANSISTORS**



TO-270-2  
PLASTIC  
AFT05MS031NR1



TO-270-2 GULL  
PLASTIC  
AFT05MS031GNR1



Note: The backside of the package is the source terminal for the transistor.

**Figure 1. Pin Connections**

**Table 1. Maximum Ratings**

| Rating   | Symbol    | Value       | Unit      |
|--|-----------|-------------|-----------|
| Drain-Source Voltage   | $V_{DSS}$ | -0.5, +40   | Vdc       |
| Gate-Source Voltage  | $V_{GS}$  | -6.0, +12   | Vdc       |
| Operating Voltage  | $V_{DD}$  | 17, +0      | Vdc       |
| Storage Temperature Range  | $T_{stg}$ | -65 to +150 | °C        |
| Total Device Dissipation @ $T_C = 25^\circ\text{C}$<br>Derate above $25^\circ\text{C}$ | $P_D$     | 294<br>1.47 | W<br>W/°C |
| Operating Junction Temperature (1,2)   | $T_J$     | 225         | °C        |

**Table 2. Thermal Characteristics**

| Characteristic  | Symbol          | Value (2,3) | Unit |
|---|-----------------|-------------|------|
| Thermal Resistance, Junction to Case<br>Case Temperature $79^\circ\text{C}$ , 31 W CW, $I_{DQ} = 10 \text{ mA}$ , 520 MHz | $R_{\theta JC}$ | 0.67        | °C/W |

**Table 3. ESD Protection Characteristics**

| Test Methodology                      | Class             |
|---------------------------------------|-------------------|
| Human Body Model (per JESD22-A114)    | 2, passes 2500 V  |
| Machine Model (per EIA/JESD22-A115)   | A, passes 100 V   |
| Charge Device Model (per JESD22-C101) | IV, passes 2000 V |

**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** ( $T_A = 25^\circ\text{C}$  unless otherwise noted)

| Characteristic  | Symbol              | Min | Typ  | Max | Unit             |
|---|---------------------|-----|------|-----|------------------|
| <b>Off Characteristics</b>  |                     |     |      |     |                  |
| Zero Gate Voltage Drain Leakage Current<br>( $V_{DS} = 40 \text{ Vdc}$ , $V_{GS} = 0 \text{ Vdc}$ )   | $I_{DSS}$           | —   | —    | 2   | $\mu\text{A dc}$ |
| Zero Gate Voltage Drain Leakage Current<br>( $V_{DS} = 13.6 \text{ Vdc}$ , $V_{GS} = 0 \text{ Vdc}$ ) | $I_{DSS}$           | —   | —    | 1   | $\mu\text{A dc}$ |
| Gate-Source Leakage Current<br>( $V_{GS} = 5 \text{ Vdc}$ , $V_{DS} = 0 \text{ Vdc}$ )                | $I_{GSS}$           | —   | —    | 600 | $n\text{A dc}$   |
| <b>On Characteristics</b>   |                     |     |      |     |                  |
| Gate Threshold Voltage<br>( $V_{DS} = 10 \text{ Vdc}$ , $I_D = 115 \mu\text{A dc}$ )                  | $V_{GS(\text{th})}$ | 1.6 | 2.1  | 2.6 | Vdc              |
| Drain-Source On-Voltage<br>( $V_{GS} = 10 \text{ Vdc}$ , $I_D = 1.2 \text{ Adc}$ )                    | $V_{DS(\text{on})}$ | —   | 0.13 | —   | Vdc              |
| Forward Transconductance<br>( $V_{GS} = 10 \text{ Vdc}$ , $I_D = 7.5 \text{ Adc}$ )                   | $g_{fs}$            | —   | 5.8  | —   | S                |

1. Continuous use at maximum temperature will affect MTTF.
2. MTTF calculator available at <http://www.freescale.com/rf>. Select Software & Tools/Development Tools/Calculators to access MTTF calculators by product.
3. Refer to AN1955, *Thermal Measurement Methodology of RF Power Amplifiers*. Go to <http://www.freescale.com/rf>. Select Documentation/Application Notes - AN1955.

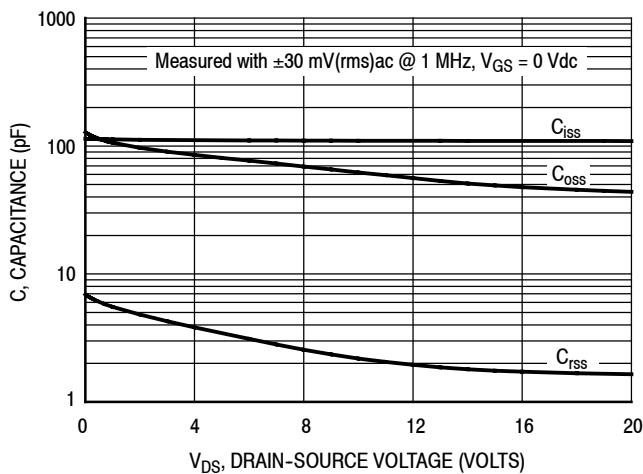
(continued)

**Table 5. Electrical Characteristics** ( $T_A = 25^\circ\text{C}$  unless otherwise noted) (continued)

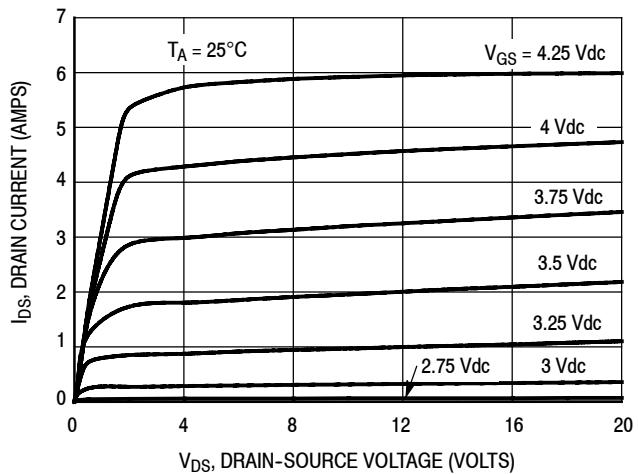
| Characteristic  | Symbol      | Min                       | Typ                    | Max                    | Unit                  |
|---|-------------|---------------------------|------------------------|------------------------|-----------------------|
| <b>Dynamic Characteristics</b>  |             |                           |                        |                        |                       |
| Reverse Transfer Capacitance<br>( $V_{DS} = 13.6 \text{ Vdc} \pm 30 \text{ mV(rms)}$ )ac @ 1 MHz, $V_{GS} = 0 \text{ Vdc}$ )  | $C_{rss}$   | —                         | 1.6                    | —                      | pF                    |
| Output Capacitance<br>( $V_{DS} = 13.6 \text{ Vdc} \pm 30 \text{ mV(rms)}$ )ac @ 1 MHz, $V_{GS} = 0 \text{ Vdc}$ )  | $C_{oss}$   | —                         | 49.5                   | —                      | pF                    |
| Input Capacitance<br>( $V_{DS} = 13.6 \text{ Vdc}$ , $V_{GS} = 0 \text{ Vdc} \pm 30 \text{ mV(rms)}$ )ac @ 1 MHz)   | $C_{iss}$   | —                         | 109                    | —                      | pF                    |
| <b>Functional Tests</b> (1) (In Freescale Narrowband Test Fixture, 50 ohm system) $V_{DD} = 13.6 \text{ Vdc}$ , $I_{DQ} = 10 \text{ mA}$ , $P_{out} = 31 \text{ W}$ , $f = 520 \text{ MHz}$ |             |                           |                        |                        |                       |
| Common-Source Amplifier Power Gain  | $G_{ps}$    | 16.5                      | 17.7                   | 19.0                   | dB                    |
| Drain Efficiency  | $\eta_D$    | 70.0                      | 71.4                   | —                      | %                     |
| <b>Load Mismatch/Ruggedness</b> (In Freescale Test Fixture, 50 ohm system, $I_{DQ} = 10 \text{ mA}$ )   |             |                           |                        |                        |                       |
| Frequency (MHz)   | Signal Type | VSWR                      | $P_{out}$ (W)          | Test Voltage, $V_{DD}$ | Result                |
| 520   | CW          | >65:1 at all Phase Angles | 47<br>(3 dB Overdrive) | 17                     | No Device Degradation |

1. Measurement made with device in straight lead configuration before any lead forming operation is applied. Lead forming is used for gull wing (GN) parts.

## TYPICAL CHARACTERISTICS

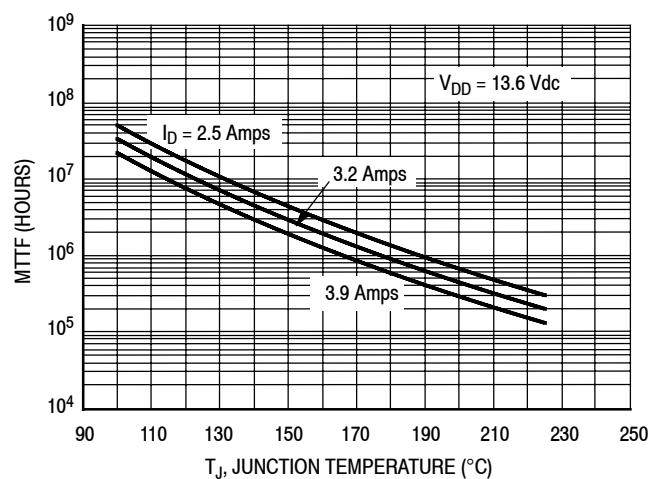


**Figure 2. Capacitance versus Drain-Source Voltage**



Note: Measured with both sides of the transistor tied together.

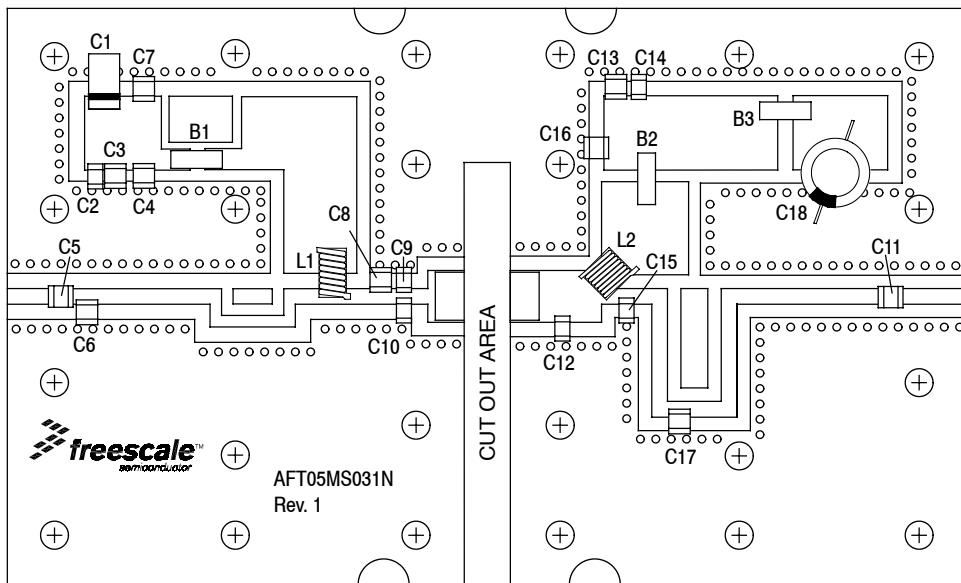
**Figure 3. Drain Current versus Drain-Source Voltage**



Note: MTTF value represents the total cumulative operating time under indicated test conditions.

**Figure 4. MTTF versus Junction Temperature - CW**

## 520 MHz NARROWBAND PRODUCTION TEST FIXTURE

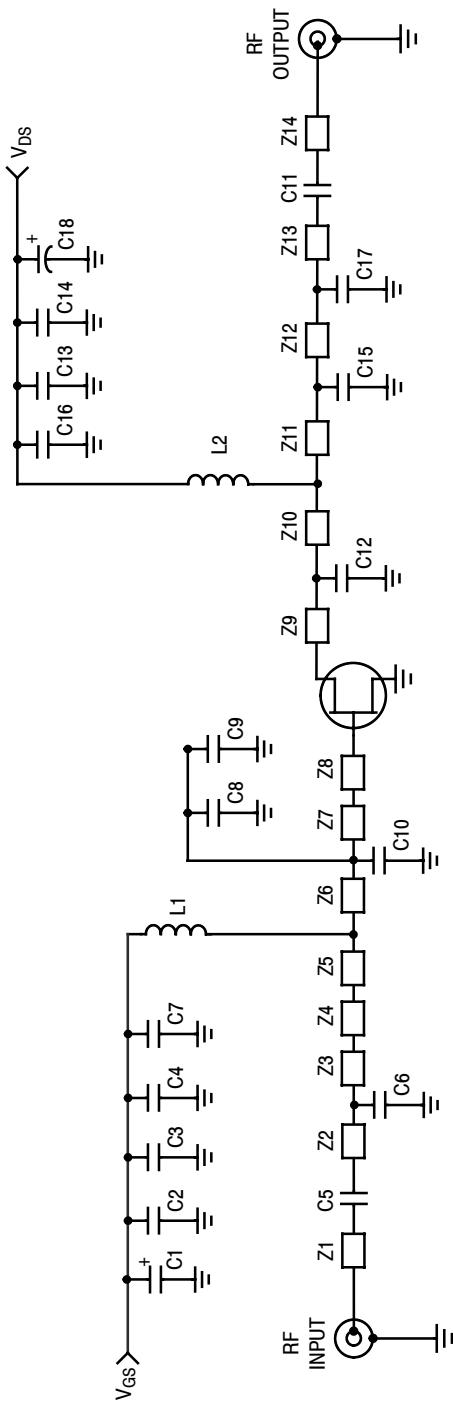


**Figure 5. AFT05MS031NR1 Narrowband Test Circuit Component Layout — 520 MHz**

**Table 6. AFT05MS031NR1 Narrowband Test Circuit Component Designations and Values — 520 MHz**

| Part              | Description                              | Part Number       | Manufacturer     |
|-------------------|--|-------------------|------------------|
| B1, B2, B3        | RF Beads, Long                           | 2743021447        | Fair-Rite        |
| C1                | 22 $\mu$ F, 35 V Tantalum Capacitor      | T491X226K035AT    | Kemet            |
| C2, C14           | 0.01 $\mu$ F Chip Capacitors             | C0805C103K5RAC    | Kemet            |
| C3, C13           | 0.1 $\mu$ F Chip Capacitors              | CDR33BX104AKWS    | Kemet            |
| C4                | 200 pF Chip Capacitor                    | ATC100B201JT300XT | ATC              |
| C5                | 6.2 pF Chip Capacitor                    | ATC100B6R2JT500XT | ATC              |
| C6                | 3.9 pF Chip Capacitor                    | ATC100B3R9JT500XT | ATC              |
| C7, C16           | 180 pF Chip Capacitors                   | ATC100B181JT200XT | ATC              |
| C8                | 10 pF Chip Capacitor                     | ATC100B100JT500XT | ATC              |
| C9, C10, C11, C12 | 36 pF Chip Capacitors                    | ATC100B360JT500XT | ATC              |
| C15               | 27 pF Chip Capacitor                     | ATC100B270JT500XT | ATC              |
| C17               | 7.5 pF Chip Capacitor                    | ATC100B7R5JT500XT | ATC              |
| C18               | 470 $\mu$ F, 63 V Electrolytic Capacitor | SME63V471M12X25LL | United Chemi-Con |
| L1                | 43 nH, 10 Turn Inductor                  | B10TJLC           | Coilcraft        |
| L2                | 56 nH Inductor                           | 1812SMS-56NJLC    | Coilcraft        |
| PCB               | 0.030", $\epsilon_r = 2.55$              | AD255A            | Arlon            |

**AFT05MS031NR1 AFT05MS031GNR1**



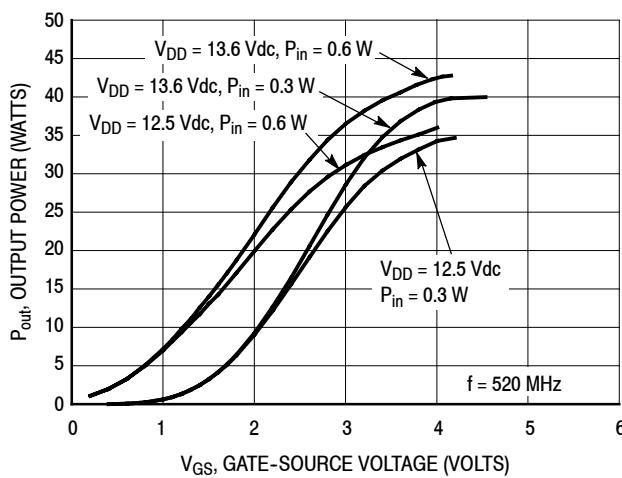
**Figure 6. AFT05MS031NR1 Narrowband Test Circuit Schematic — 520 MHz**

**Table 7. AFT05MS031NR1 Narrowband Test Circuit Microstrips — 520 MHz**

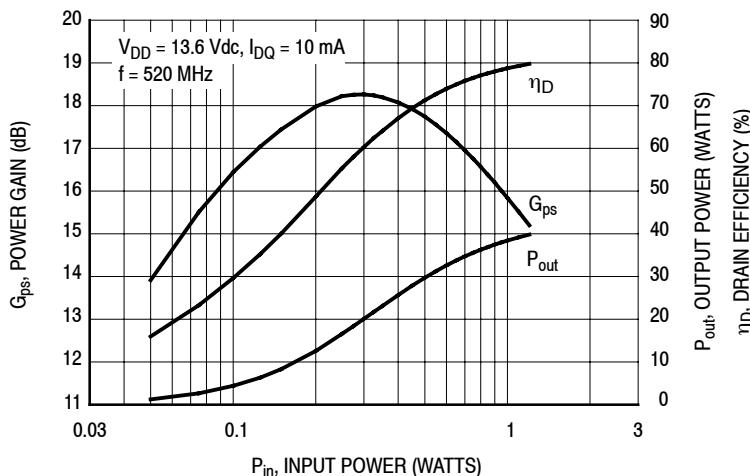
| Microstrip | Description                 |
|------------|-----------------------------|
| Z1         | 0.199" x 0.082" Microstrip  |
| Z2         | 0.017" x 0.082" Microstrip  |
| Z3*        | 0.670" x 0.082" Microstrip  |
| Z4*        | 0.560" x 0.060" Microstrip  |
| Z5*        | 0.370" x 0.082" Microstrip  |
| Z6         | 0.079" x 0.082" Microstrip  |
| Z7         | 0.352" x 0.082" Microstrip  |
| Z8         | 0.190" x 0.270" Microstrip  |
| Z9         | 0.257" x 0.275" Microstrip  |
| Z10        | 0.145" x 0.275" Microstrip  |
| Z11        | 0.091" x 0.082" Microstrip  |
| Z12*       | 0.1322" x 0.082" Microstrip |
| Z13*       | 0.1420" x 0.082" Microstrip |
| Z14        | 0.315" x 0.082" Microstrip  |

\* Line length includes microstrip bends

## TYPICAL CHARACTERISTICS — 520 MHz



**Figure 7. Output Power versus Gate-Source Voltage**



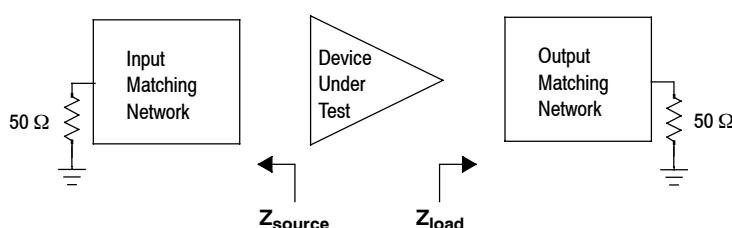
**Figure 8. Power Gain, Output Power and Drain Efficiency versus Input Power**

$V_{DD} = 13.6 \text{ Vdc}$ ,  $I_{DQ} = 10 \text{ mA}$ ,  $P_{out} = 31 \text{ W Avg.}$

| $f$<br>MHz | $Z_{source}$<br>$\Omega$ | $Z_{load}$<br>$\Omega$ |
|------------|--------------------------|------------------------|
| 520        | $0.72 + j1.77$           | $1.54 + j0.80$         |

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

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



**Figure 9. Narrowband Series Equivalent Source and Load Impedance — 520 MHz**

## 380–450 MHz UHF WIDEBAND REFERENCE CIRCUIT, 50 OHM SYSTEM

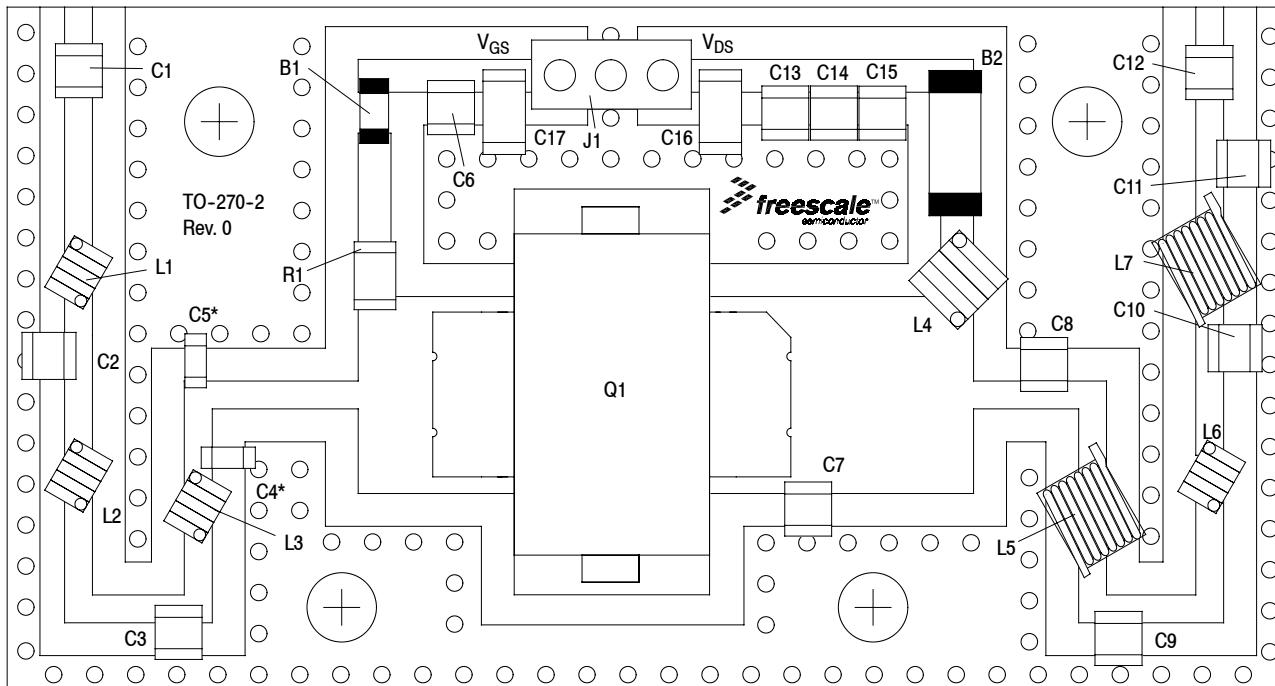
**Table 8. 380–450 MHz UHF Wideband Performance** (13.6 Vdc,  $I_{DQ} = 100$  mA,  $T_A = 25^\circ\text{C}$ , CW)

| Frequency<br>(MHz) | $G_{ps}$<br>(dB) | $\eta_D$<br>(%) | $P_{1dB}$<br>(W) |
|--------------------|------------------|-----------------|------------------|
| 380                | 18.7             | 64.1            | 31               |
| 420                | 18.6             | 67.0            | 31               |
| 450                | 18.3             | 68.1            | 31               |

**Table 9. Load Mismatch/Ruggedness** (In Freescale Reference Circuit)

| Frequency<br>(MHz) | Signal<br>Type | VSWR                         | $P_{out}$<br>(W)       | Test Voltage, $V_{DD}$ | Result                   |
|--------------------|----------------|------------------------------|------------------------|------------------------|--------------------------|
| 420                | CW             | >65:1 at all<br>Phase Angles | 62<br>(3 dB Overdrive) | 17                     | No Device<br>Degradation |

## 380-450 MHz UHF WIDEBAND REFERENCE CIRCUIT

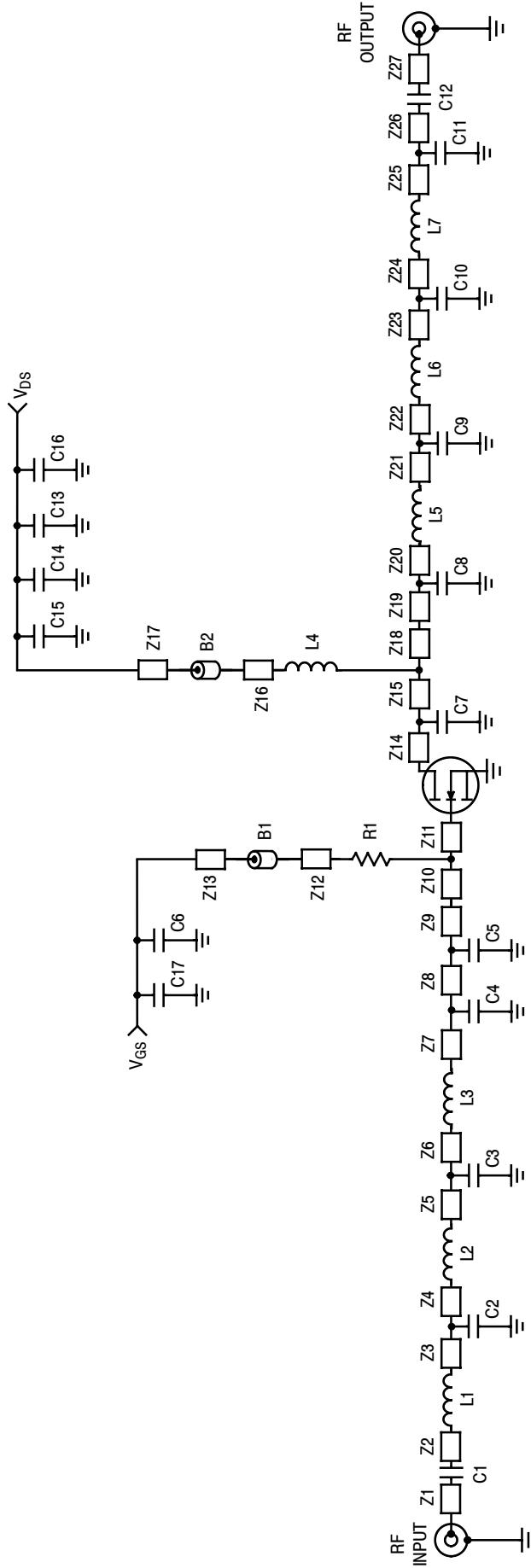


**Figure 10. AFT05MS031NR1 UHF Wideband Reference Circuit Component Layout — 380-450 MHz**

**Table 10. AFT05MS031NR1 UHF Wideband Reference Circuit Component Designations and Values — 380-450 MHz**

| Part           | Description                       | Part Number        | Manufacturer    |
|----------------|-----------------------------------|--------------------|-----------------|
| B1             | Low Current Ferrite Bead          | 2508051107Y0       | Fair-Rite       |
| B2             | High Current Ferrite Bead         | 2518065007Y6       | Fair-Rite       |
| C1, C5         | 56 pF Chip Capacitors             | ATC600F560JT250XT  | ATC             |
| C2             | 3.9 pF Chip Capacitor             | ATC600F3R9BT250XT  | ATC             |
| C3             | 18 pF Chip Capacitor              | ATC600F180JT250XT  | ATC             |
| C4             | 47 pF Chip Capacitor              | ATC600F470JT250XT  | ATC             |
| C6, C12, C15   | 240 pF Chip Capacitors            | ATC600F241JT250XT  | ATC             |
| C7             | 24 pF Chip Capacitor              | ATC600F240JT250XT  | ATC             |
| C8             | 68 pF Chip Capacitor              | ATC600F680JT250XT  | ATC             |
| C9             | 27 pF Chip Capacitor              | ATC600F270JT250XT  | ATC             |
| C10            | 8.2 pF Chip Capacitor             | ATC600F8R2BT250XT  | ATC             |
| C11            | 3.0 pF Chip Capacitor             | ATC600F3R0BT250XT  | ATC             |
| C13            | 0.1 $\mu$ F Chip Capacitor        | GRM21BR71H104KA01B | Murata          |
| C14            | 1 $\mu$ F Chip Capacitor          | GRM21BR71H105KA12L | Murata          |
| C16, C17       | 10 $\mu$ F Chip Capacitors        | GRM31CR61H106KA12L | Murata          |
| J1             | 3 Pin Connector                   | AMP-9-146305-0     | TE Connectivity |
| L1, L2, L3, L6 | 5.5 nH Inductors                  | 0806SQ-5N5GLC      | Coilcraft       |
| L4             | 17 nH Inductor                    | 0908SQ-17NGLC      | Coilcraft       |
| L5             | 1.65 nH Inductor                  | 0906-2KLC          | Coilcraft       |
| L7             | 2.55 nH Inductor                  | 0906-3JLC          | Coilcraft       |
| Q1             | RF Power LDMOS Transistor         | AFT05MS031NR1      | Freescale       |
| R1             | 62 $\Omega$ , 1/4 W Chip Resistor | RG2012N-620-BT1    | Susumu          |
| PCB            | 0.020", $\epsilon_r = 4.9$        | S1000-2, FR4       | Shengyi         |

**AFT05MS031NR1 AFT05MS031GNR1**



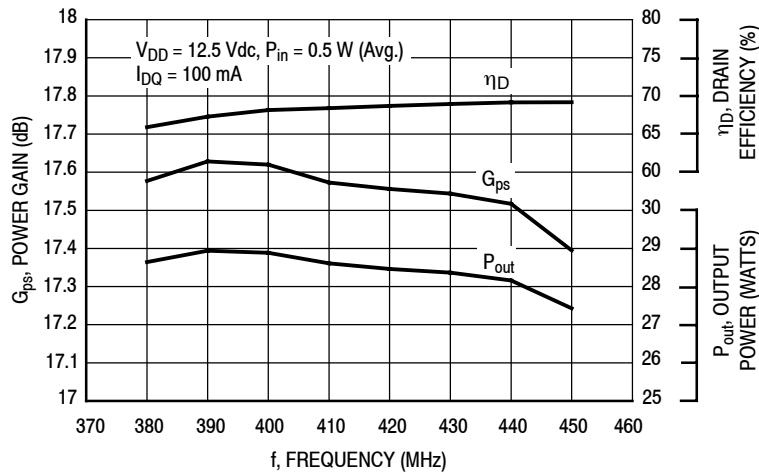
**Figure 11. AFT05MS031NR1 UHF Wideband Reference Circuit Schematic — 380–450 MHz**

**Table 11. AFT05MS031NR1 UHF Wideband Reference Circuit Microstrips — 380–450 MHz**

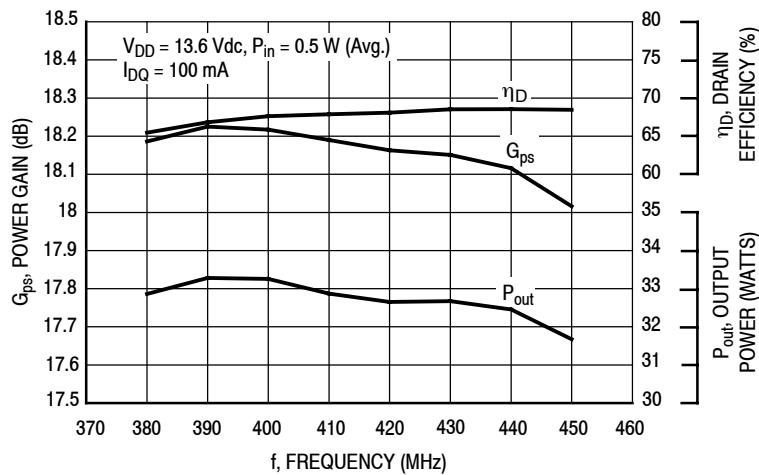
| Microstrip | Description                | Microstrip | Description                |
|------------|----------------------------|------------|----------------------------|
| Z1, Z27    | 0.034" x 0.060" Microstrip | Z9         | 0.034" x 0.178" Microstrip |
| Z2         | 0.034" x 0.200" Microstrip | Z10        | 0.034" x 0.048" Microstrip |
| Z3         | 0.034" x 0.056" Microstrip | Z11        | 0.034" x 0.142" Microstrip |
| Z4         | 0.034" x 0.154" Microstrip | Z12, Z16   | 0.034" x 0.149" Microstrip |
| Z5*        | 0.034" x 0.237" Microstrip | Z13, Z17*  | 0.034" x 0.085" Microstrip |
| Z6*        | 0.034" x 0.234" Microstrip | Z14        | 0.034" x 0.090" Microstrip |
| Z7         | 0.034" x 0.010" Microstrip | Z15        | 0.034" x 0.186" Microstrip |
| Z8, Z24    | 0.034" x 0.083" Microstrip | Z18        | 0.034" x 0.044" Microstrip |

\* Line length includes microstrip bends

**TYPICAL CHARACTERISTICS — 380-450 MHz UHF WIDEBAND  
REFERENCE CIRCUIT**

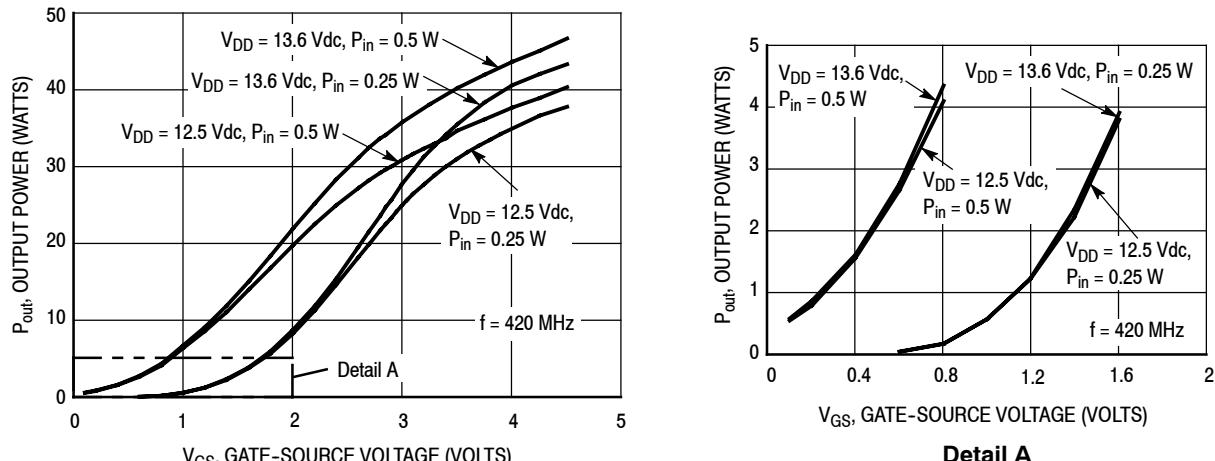


**Figure 12. Power Gain, Output Power and Drain Efficiency versus Frequency at a Constant Input Power — 12.5 V**

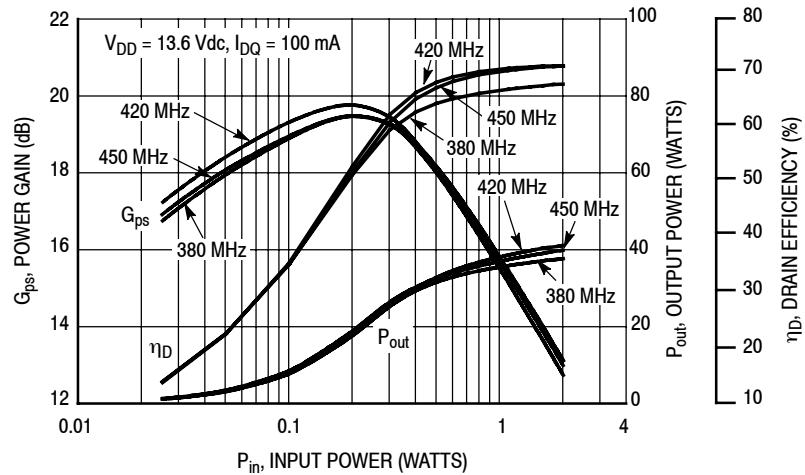


**Figure 13. Power Gain, Output Power and Drain Efficiency versus Frequency at a Constant Input Power — 13.6 V**

**TYPICAL CHARACTERISTICS — 380–450 MHz UHF WIDEBAND  
REFERENCE CIRCUIT**

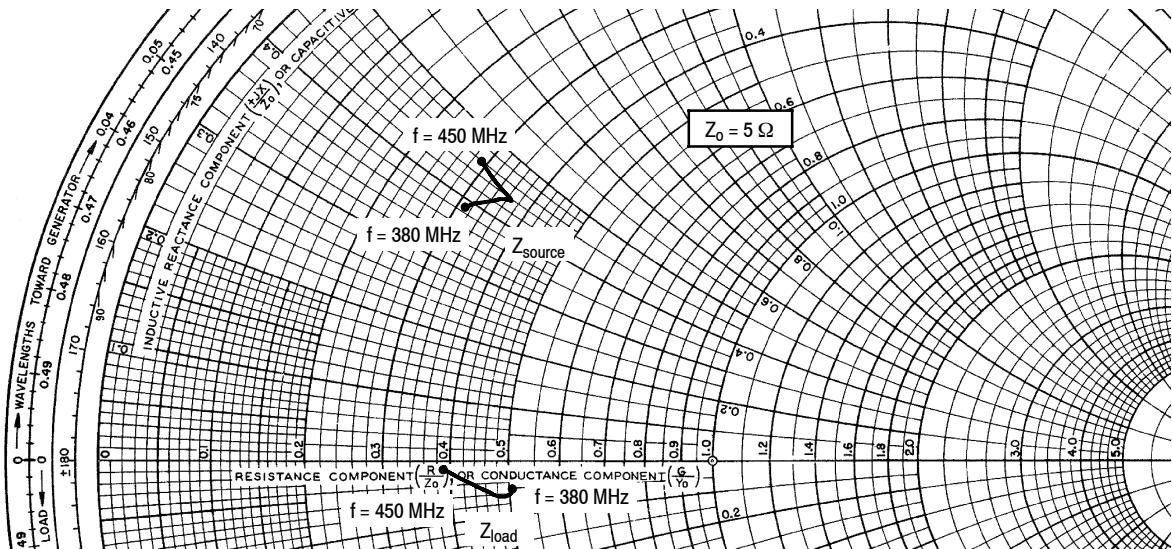


**Figure 14. Output Power versus Gate-Source Voltage**



**Figure 15. Power Gain, Output Power and Drain Efficiency versus Input Power and Frequency**

## 380-450 MHz UHF WIDEBAND REFERENCE CIRCUIT



$V_{DD} = 13.6$  Vdc,  $I_{DQ} = 10$  mA,  $P_{out} = 31$  W Avg.

| $f$<br>MHz | $Z_{source}$<br>$\Omega$ | $Z_{load}$<br>$\Omega$ |
|------------|--------------------------|------------------------|
| 380        | $1.57 + j1.94$           | $2.53 - j0.27$         |
| 390        | $1.66 + j2.07$           | $2.53 - j0.26$         |
| 400        | $1.74 + j2.16$           | $2.56 - j0.27$         |
| 410        | $1.79 + j2.20$           | $2.49 - j0.29$         |
| 420        | $1.79 + j2.21$           | $2.38 - j0.28$         |
| 430        | $1.74 + j2.21$           | $2.26 - j0.24$         |
| 440        | $1.62 + j2.23$           | $2.11 - j0.16$         |
| 450        | $1.45 + j2.29$           | $1.95 - j0.05$         |

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

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

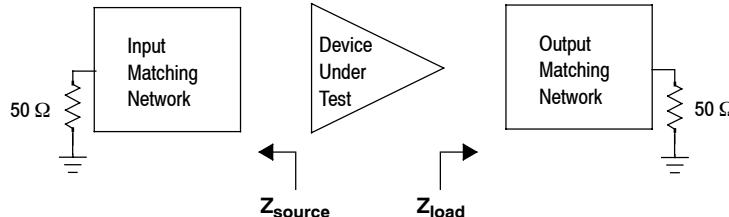


Figure 16. UHF Wideband Series Equivalent Source and Load Impedance — 380-450 MHz

## 450–520 MHz UHF WIDEBAND REFERENCE CIRCUIT, 50 OHM SYSTEM

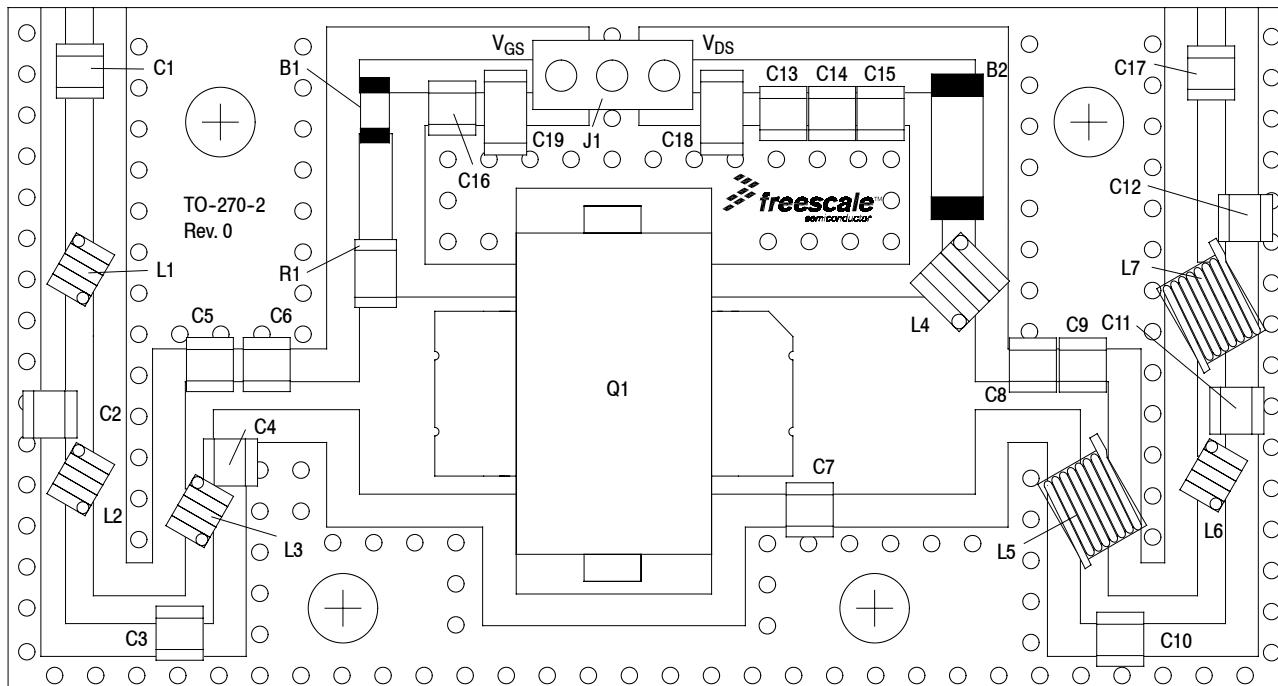
**Table 12. 450–520 MHz UHF Wideband Performance** (13.6 Vdc,  $I_{DQ} = 100$  mA,  $T_A = 25^\circ\text{C}$ , CW)

| Frequency<br>(MHz) | $G_{ps}$<br>(dB) | $\eta_D$<br>(%) | $P_{1dB}$<br>(W) |
|--------------------|------------------|-----------------|------------------|
| 450                | 17.7             | 62.0            | 31               |
| 490                | 18.7             | 63.8            | 31               |
| 520                | 17.9             | 67.0            | 31               |

**Table 13. Load Mismatch/Ruggedness** (In Freescale Reference Circuit)

| Frequency<br>(MHz) | Signal<br>Type | VSWR                         | $P_{out}$<br>(W)       | Test Voltage, $V_{DD}$ | Result                   |
|--------------------|----------------|------------------------------|------------------------|------------------------|--------------------------|
| 490                | CW             | >65:1 at all<br>Phase Angles | 62<br>(3 dB Overdrive) | 17                     | No Device<br>Degradation |

## 450-520 MHz UHF WIDEBAND REFERENCE CIRCUIT

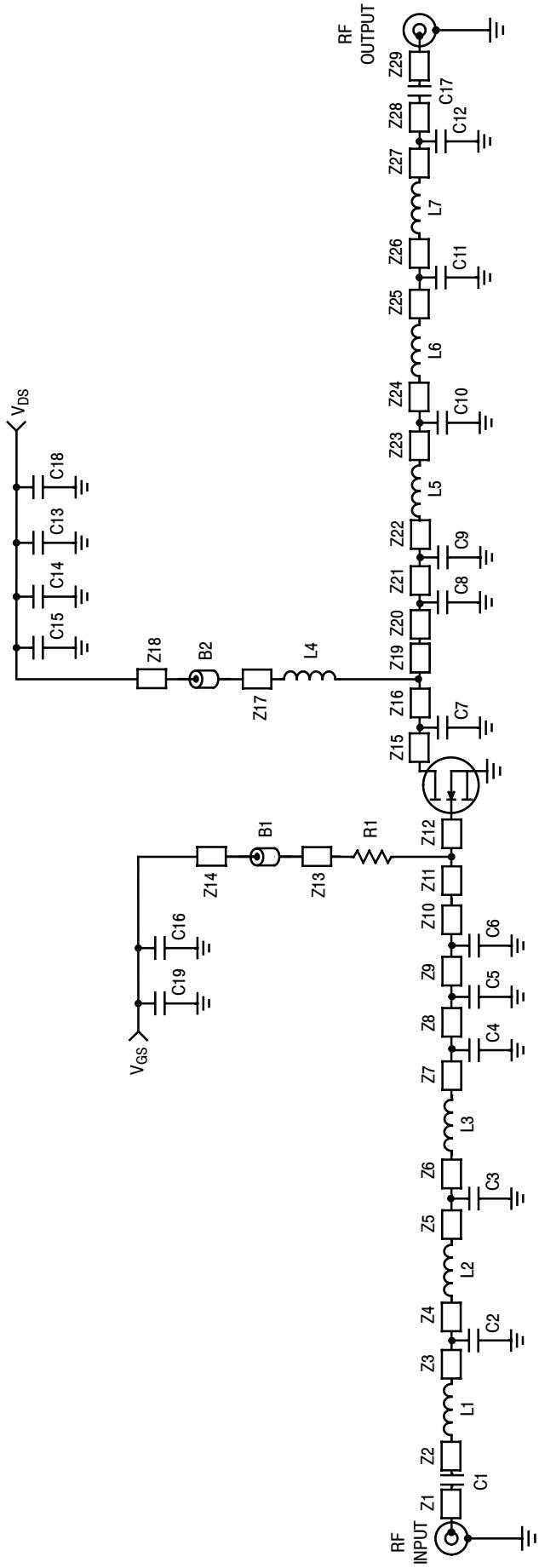


**Figure 17. AFT05MS031NR1 UHF Wideband Reference Circuit Component Layout — 450-520 MHz**

**Table 14. AFT05MS031NR1 UHF Wideband Reference Circuit Component Designations and Values — 450-520 MHz**

| Part          | Description                       | Part Number        | Manufacturer    |
|---------------|-----------------------------------|--------------------|-----------------|
| B1            | Low Current Ferrite Bead          | 2508051107Y0       | Fair-Rite       |
| B2            | High Current Ferrite Bead         | 2518065007Y6       | Fair-Rite       |
| C1            | 56 pF Chip Capacitor              | ATC600F560JT250XT  | ATC             |
| C2            | 2.7 pF Chip Capacitor             | ATC600F2R7BT250XT  | ATC             |
| C3            | 12 pF Chip Capacitor              | ATC600F120JT250XT  | ATC             |
| C4, C9        | 27 pF Chip Capacitors             | ATC600F270JT250XT  | ATC             |
| C5, C8        | 33 pF Chip Capacitors             | ATC600F330JT250XT  | ATC             |
| C6            | 39 pF Chip Capacitor              | ATC600F390JT250XT  | ATC             |
| C7, C10       | 18 pF Chip Capacitors             | ATC600F180JT250XT  | ATC             |
| C11           | 8.2 pF Chip Capacitor             | ATC600F8R2BT250XT  | ATC             |
| C12           | 1.8 pF Chip Capacitor             | ATC600F1R8BT250XT  | ATC             |
| C13           | 0.1 $\mu$ F Chip Capacitor        | GRM21BR71H104KA01B | Murata          |
| C14           | 1 $\mu$ F Chip Capacitor          | GRM21BR71H105KA12L | Murata          |
| C15, C16, C17 | 240 pF Chip Capacitors            | ATC600F241JT250XT  | ATC             |
| C18, C19      | 10 $\mu$ F Chip Capacitors        | GRM31CR61H106KA12L | Murata          |
| J1            | 3 Pin Connector                   | AMP-9-146305-0     | TE Connectivity |
| L1, L3        | 6.0 nH Inductors                  | 0806SQ-6N0GLC      | Coilcraft       |
| L2, L6        | 5.5 nH Inductors                  | 0806SQ5N5GLC       | Coilcraft       |
| L4            | 17 nH Inductor                    | 0908SQ-17NGLC      | Coilcraft       |
| L5, L7        | 1.65 nH Inductors                 | 0906-2KLC          | Coilcraft       |
| Q1            | RF Power LDMOS Transistor         | AFT05MS031NR1      | Freescale       |
| R1            | 62 $\Omega$ , 1/4 W Chip Resistor | RG2012N-620-BT1    | Susumu          |
| PCB           | 0.020", $\epsilon_r = 4.9$        | S1000-2, FR4       | Shengyi         |

**AFT05MS031NR1 AFT05MS031GNR1**



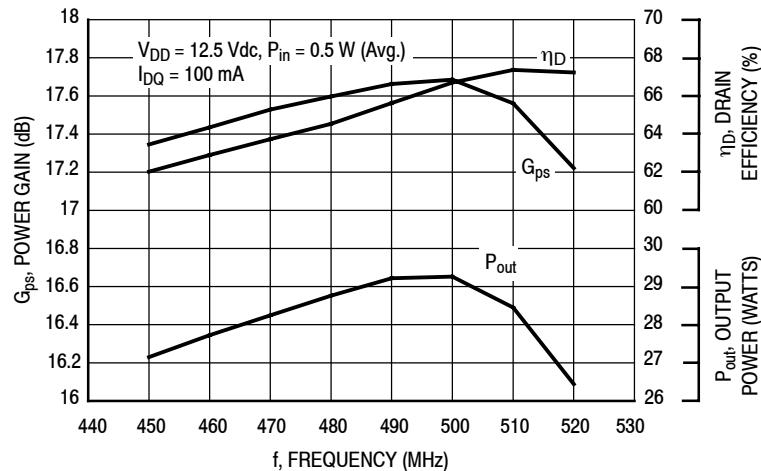
**Figure 18. AFT05MS031NR1 UHF Wideband Reference Circuit Schematic — 450-520 MHz**

**Table 15. AFT05MS031NR1 UHF Wideband Reference Circuit Microstrips — 450-520 MHz**

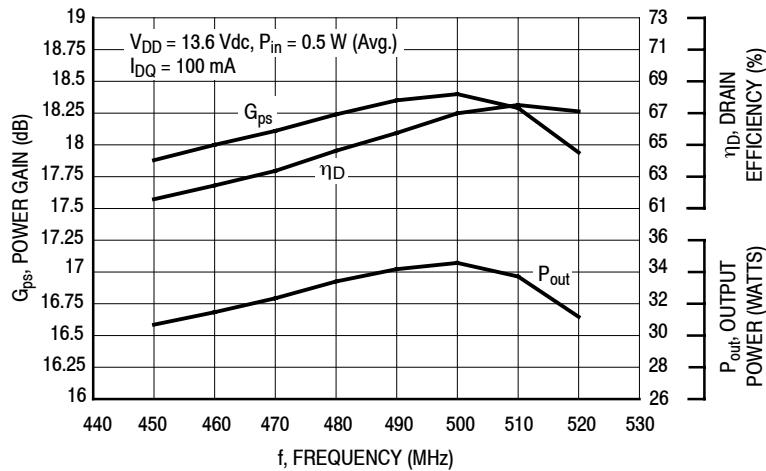
| Microstrip  | Description                 |
|-------------|-----------------------------|
| Z1, Z9, Z29 | 0.034" x 0.060" Microstrip  |
| Z2          | 0.034" x 0.200" Microstrip  |
| Z3          | 0.034" x 0.128" Microstrip  |
| Z4          | 0.034" x 0.054" Microstrip  |
| Z5*         | 0.034" x 0.202" Microstrip  |
| Z6*         | 0.034" x 0.160" Microstrip  |
| Z7, Z21     | 0.034" x 0.010" Microstrip  |
| Z8          | 0.034" x 0.115" Microstrip  |
| Z10         | 0.034" x 0.150" Microstrip  |
| Z11         | 0.240" x 0.010" Microstrip  |
| Z12         | 0.240" x 0.180" Microstrip  |
| Z13, Z17    | 0.034" x 0.149" Microstrip  |
| Z14         | 0.034" x 0.084" Microstrip  |
| Z15         | 0.240" x 0.054" Microstrip  |
| Z16         | 0.240" x 0.170" Microstrip  |
| Z19         | 0.240" x 0.044" Microstrip  |
| Z20         | 0.034" x 0.057" Microstrip  |
| Z22         | 0.034" x 0.176" Microstrip  |
| Z23*        | 0.034" x 0.118" Microstrip* |
| Z24*        | 0.034" x 0.295" Microstrip* |
| Z25         | 0.034" x 0.018" Microstrip  |
| Z26         | 0.034" x 0.177" Microstrip  |
| Z27         | 0.034" x 0.022" Microstrip  |
| Z28         | 0.034" x 0.188" Microstrip  |
| Z18         | 0.034" x 0.184" Microstrip  |

\* Line length includes microstrip bonds

**TYPICAL CHARACTERISTICS — 450-520 MHz UHF WIDEBAND  
REFERENCE CIRCUIT**

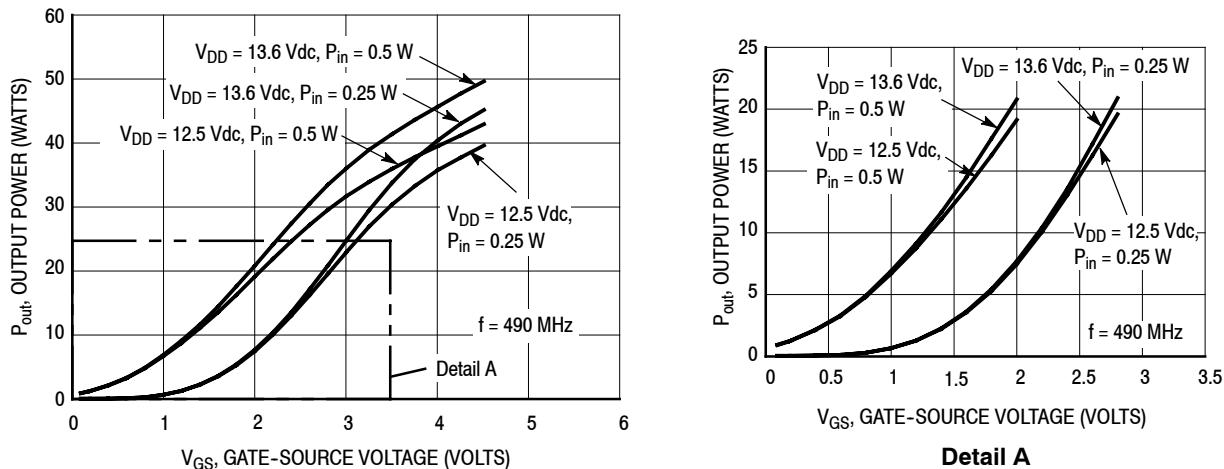


**Figure 19. Power Gain, Drain Efficiency and Output Power versus Frequency at a Constant Input Power — 12.5 V**

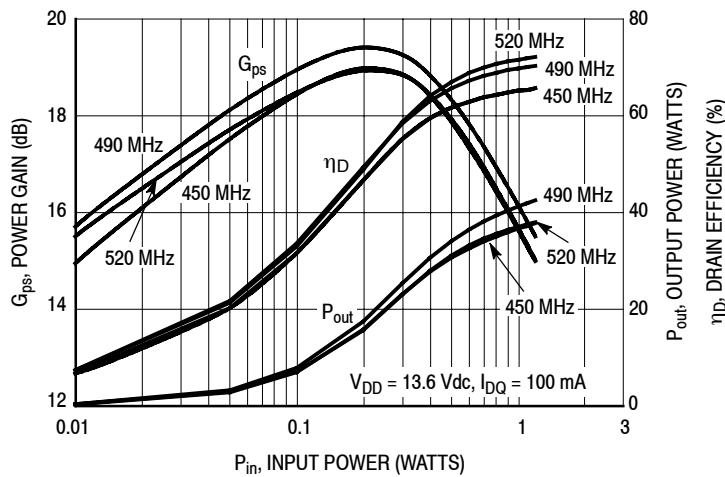


**Figure 20. Power Gain, Drain Efficiency and Output Power versus Frequency at a Constant Input Power — 13.6 V**

**TYPICAL CHARACTERISTICS — 450–520 MHz UHF WIDEBAND  
REFERENCE CIRCUIT**

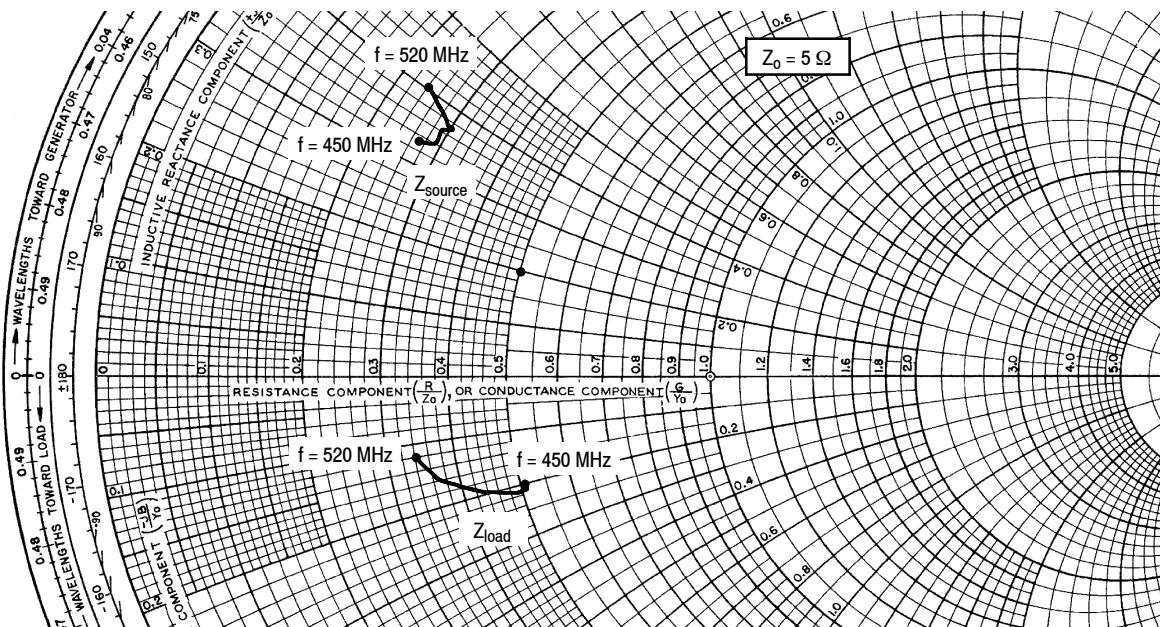


**Figure 21. Output Power versus Gate-Source Voltage**



**Figure 22. Power Gain, Output Power and Drain Efficiency versus Input Power and Frequency**

## 450-520 MHz UHF WIDEBAND REFERENCE CIRCUIT



$V_{DD} = 13.6 \text{ Vdc}, I_{DQ} = 100 \text{ mA}, P_{out} = 31 \text{ W Avg.}$

| $f$<br>MHz | $Z_{source}$<br>$\Omega$ | $Z_{load}$<br>$\Omega$ |
|------------|--------------------------|------------------------|
| 450        | $1.37 + j1.64$           | $2.57 - j1.01$         |
| 460        | $1.43 + j1.72$           | $2.49 - j1.03$         |
| 470        | $1.47 + j1.79$           | $2.38 - j1.03$         |
| 480        | $1.49 + j1.83$           | $2.26 - j1.01$         |
| 490        | $1.47 + j1.86$           | $2.11 - j0.95$         |
| 500        | $1.41 + j1.89$           | $1.97 - j0.87$         |
| 510        | $1.32 + j1.93$           | $1.82 - j0.76$         |
| 520        | $1.20 + j1.99$           | $1.68 - j0.62$         |

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

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

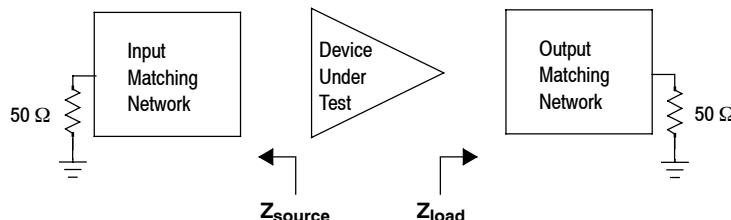
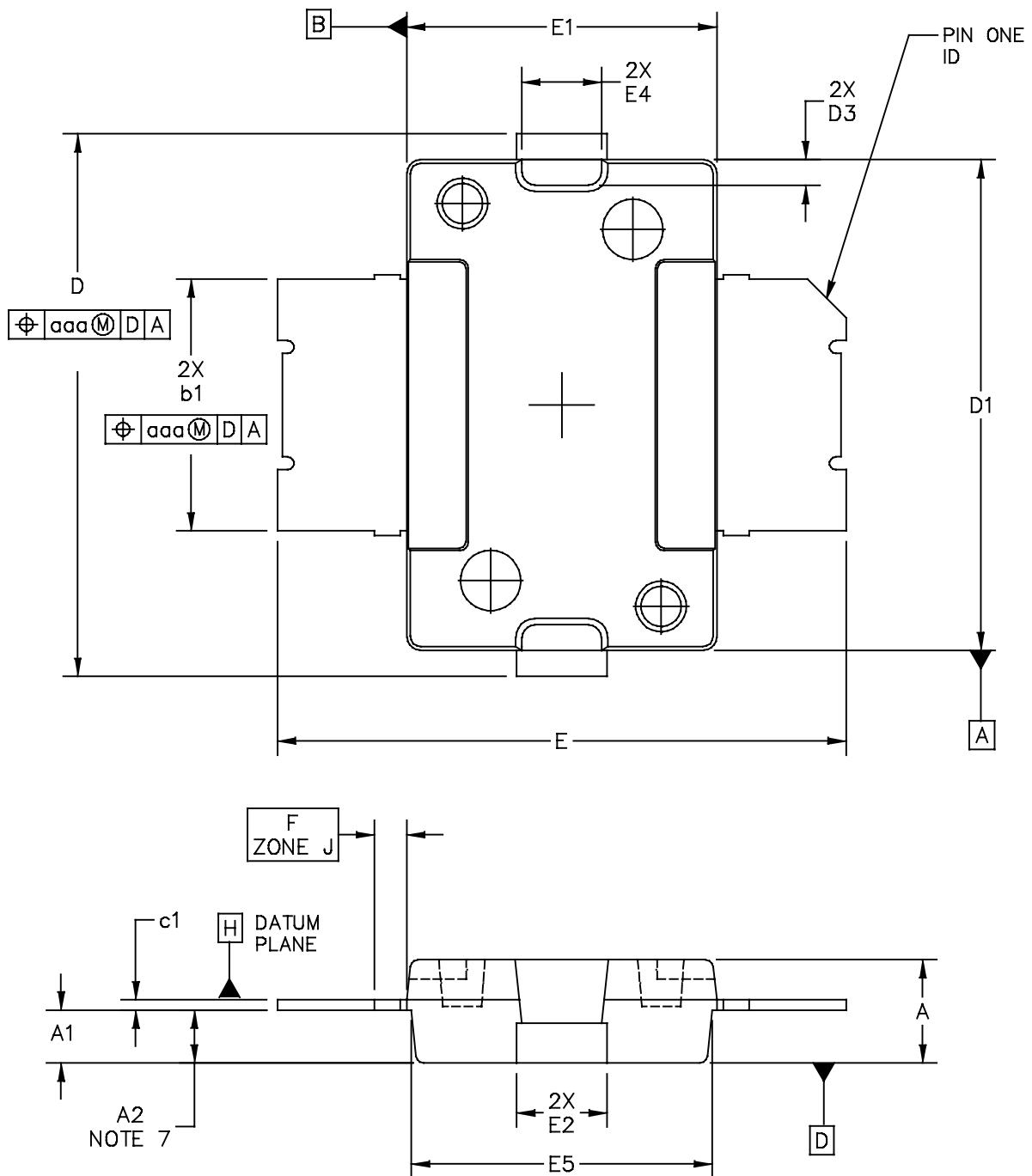


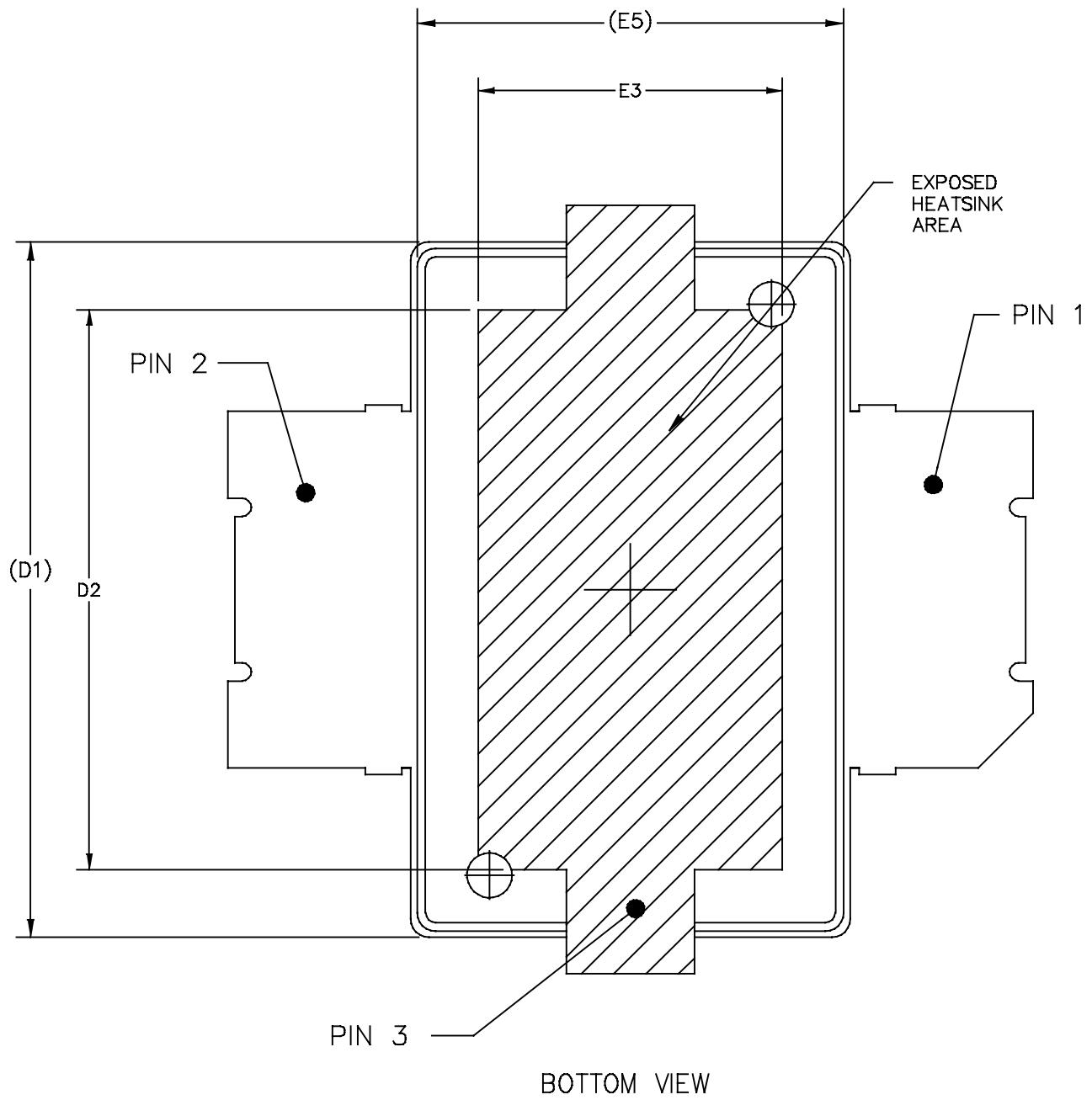
Figure 23. UHF Wideband Series Equivalent Source and Load Impedance — 450-520 MHz

### PACKAGE DIMENSIONS



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|---|--|---|----------------------------|
| TITLE:<br><br>TO-270<br>SURFACE MOUNT                   |  | DOCUMENT NO: 98ASH98117A<br><br>CASE NUMBER: 1265-09<br><br>STANDARD: JEDEC TO-270 AA | REV: K<br><br>29 JUN 2007  |

AFT05MS031NR1 AFT05MS031GNR1



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|---|-------------------------|---------------------------|----------------------------|----------------------|
| TITLE:  | TO-270<br>SURFACE MOUNT | DOCUMENT NO: 98ASH98117A  | REV: K                     | CASE NUMBER: 1265-09 |
|   |                         |                           |                            | 29 JUN 2007          |
|   |                         | STANDARD: JEDEC TO-270 AA |                            |                      |

AFT05MS031NR1 AFT05MS031GNR1

NOTES:

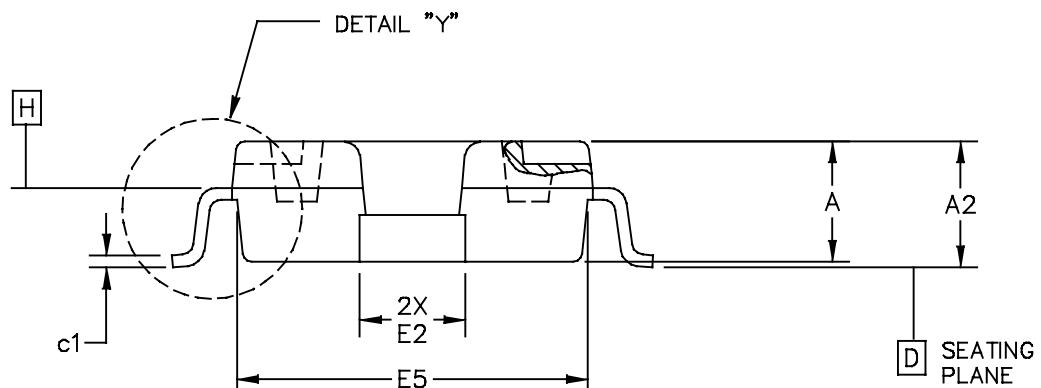
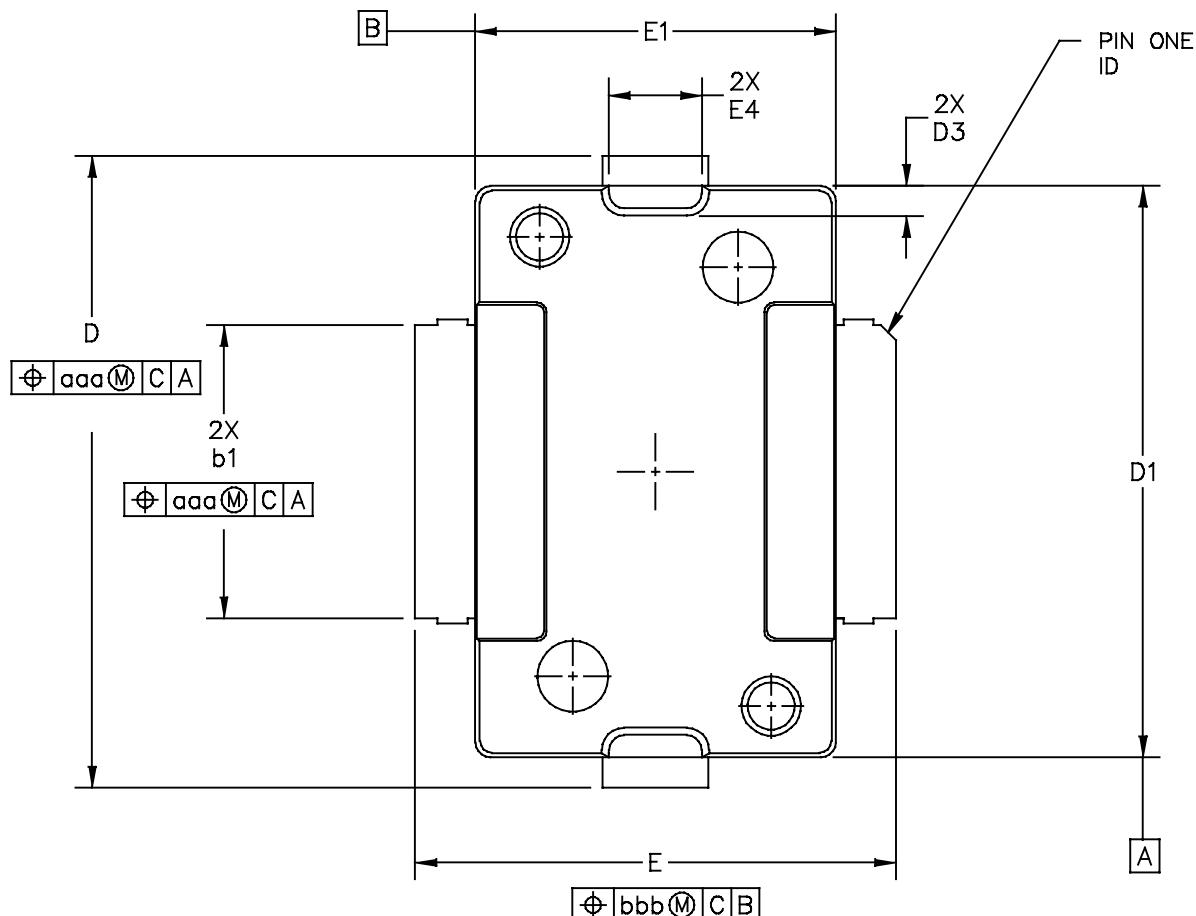
1. CONTROLLING DIMENSION: INCH
2. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M-1994.
3. DATUM PLANE -H- IS LOCATED AT TOP OF LEAD AND IS COINCIDENT WITH THE LEAD WHERE THE LEAD EXITS THE PLASTIC BODY AT THE TOP OF THE PARTING LINE.
4. DIMENSIONS "D1" AND "E1" DO NOT INCLUDE MOLD PROTRUSION. ALLOWABLE PROTRUSION IS .006 PER SIDE. DIMENSIONS "D1" AND "E1" DO INCLUDE MOLD MISMATCH AND ARE DETERMINED AT DATUM PLANE -H-.
5. DIMENSION "b1" DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE .005 TOTAL IN EXCESS OF THE "b1" DIMENSION AT MAXIMUM MATERIAL CONDITION.
6. DATUMS -A- AND -B- TO BE DETERMINED AT DATUM PLANE -H-.
7. DIMENSION "A2" APPLIES WITHIN ZONE "J" ONLY.
8. DIMENSIONS "D" AND "E2" DO NOT INCLUDE MOLD PROTRUSION. OVERALL LENGTH INCLUDING MOLD PROTRUSION SHOULD NOT EXCEED 0.430 INCH FOR DIMENSION "D" AND 0.080 INCH FOR DIMENSION "E2". DIMENSIONS "D" AND "E2" DO INCLUDE MOLD MISMATCH AND ARE DETERMINED AT DATUM PLANE -D-.

STYLE 1:

PIN 1 – DRAIN  
 PIN 2 – GATE  
 PIN 3 – SOURCE

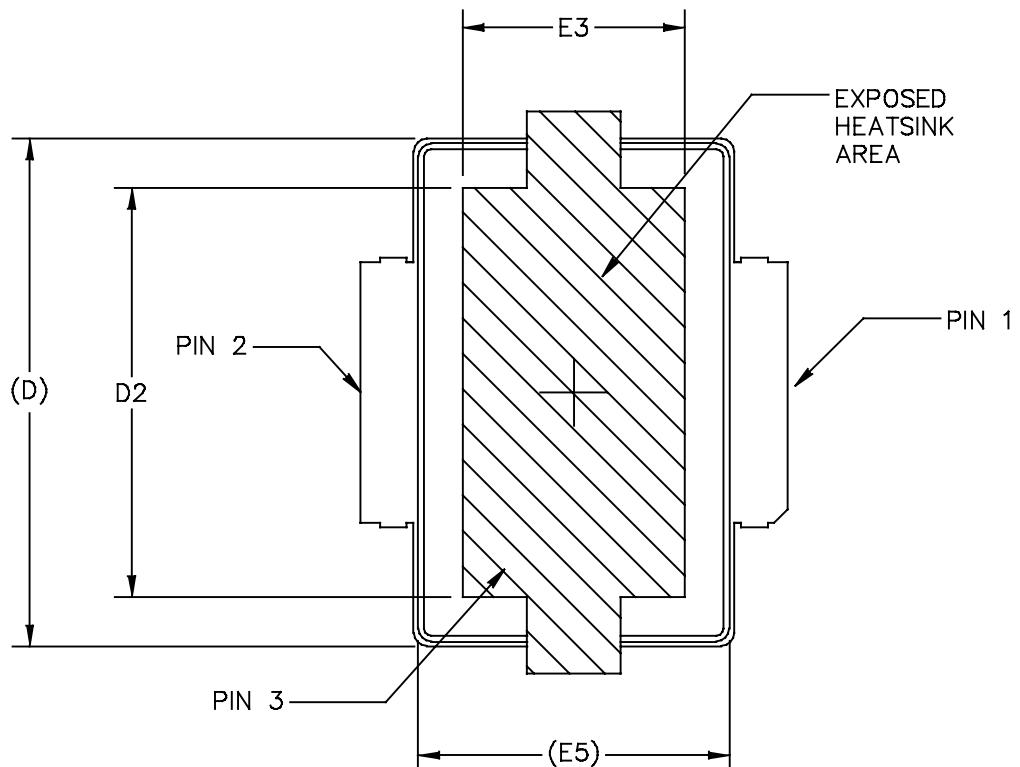
| DIM | INCH |       | MILLIMETER |       | DIM | INCH |      | MILLIMETER |      |
|-----|------|-------|------------|-------|-----|------|------|------------|------|
|     | MIN  | MAX   | MIN        | MAX   |     | MIN  | MAX  | MIN        | MAX  |
| A   | .078 | .082  | 1.98       | 2.08  | F   | .025 | BSC  | 0.64       | BSC  |
| A1  | .039 | .043  | 0.99       | 1.09  | b1  | .193 | .199 | 4.90       | 5.06 |
| A2  | .040 | .042  | 1.02       | 1.07  | c1  | .007 | .011 | 0.18       | 0.28 |
| D   | .416 | .424  | 10.57      | 10.77 | aaa |      | .004 |            | 0.10 |
| D1  | .378 | .382  | 9.60       | 9.70  |     |      |      |            |      |
| D2  | .290 | ----- | 7.37       | ----- |     |      |      |            |      |
| D3  | .016 | .024  | 0.41       | 0.61  |     |      |      |            |      |
| E   | .436 | .444  | 11.07      | 11.28 |     |      |      |            |      |
| E1  | .238 | .242  | 6.04       | 6.15  |     |      |      |            |      |
| E2  | .066 | .074  | 1.68       | 1.88  |     |      |      |            |      |
| E3  | .150 | ----- | 3.81       | ----- |     |      |      |            |      |
| E4  | .058 | .066  | 1.47       | 1.68  |     |      |      |            |      |
| E5  | .231 | .235  | 5.87       | 5.97  |     |      |      |            |      |

|   |   |                            |
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| TITLE:<br><br>TO-270<br>SURFACE MOUNT                   | DOCUMENT NO: 98ASH98117A<br><br>CASE NUMBER: 1265-09<br><br>STANDARD: JEDEC TO-270 AA | REV: K<br><br>29 JUN 2007  |

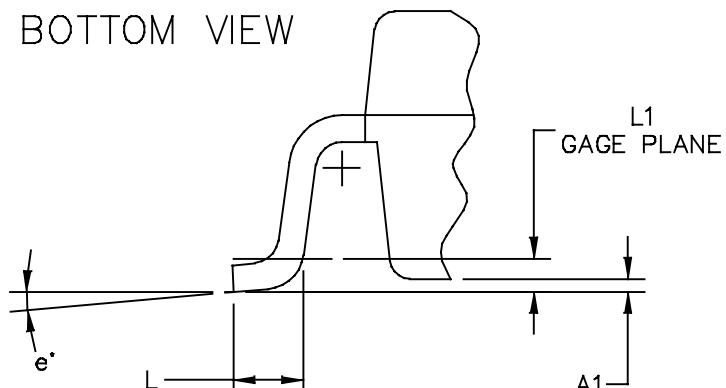


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| TITLE:<br>TO-270<br>GULL WING                           |  | DOCUMENT NO: 98ASA99301D  | REV: C                     |  |
|   |  | CASE NUMBER: 1265A-03     | 02 JUL 2007                |  |
|   |  | STANDARD: JEDEC TO-270 BA |                            |  |

AFT05MS031NR1 AFT05MS031GNR1



BOTTOM VIEW



DETAIL "Y"

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|---|--|--|----------------------------|--|
| TITLE:<br>TO-270<br>GULL WING                           |  | DOCUMENT NO: 98ASA99301D<br>CASE NUMBER: 1265A-03<br>STANDARD: JEDEC TO-270 BA | REV: C<br>02 JUL 2007      |  |

NOTES:

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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 "D1" AND "E1" DO NOT INCLUDE MOLD PROTRUSION. ALLOWABLE PROTRUSION IS .006 PER SIDE. DIMENSIONS "D1" AND "E1" DO INCLUDE MOLD MISMATCH AND ARE DETERMINED AT DATUM PLANE -H-.
5. DIMENSION b1 DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE .005 TOTAL IN EXCESS OF THE b1 DIMENSION AT MAXIMUM MATERIAL CONDITION.
6. DATUMS -A- AND -B- TO BE DETERMINED AT DATUM PLANE -H-.
7. DIMENSIONS "D" AND "E2" DO NOT INCLUDE MOLD PROTRUSION. ALLOWABLE PROTRUSION IS .003 PER SIDE. DIMENSIONS "D" AND "E2" DO INCLUDE MOLD MISMATCH AND ARE DETERMINED AT DATUM PLANE -D-.

STYLE 1:

PIN 1 – DRAIN  
 PIN 2 – GATE  
 PIN 3 – SOURCE

| DIM   | INCH |      | MILLIMETER         |       | DIM                       | INCH                       |      | MILLIMETER  |      |  |  |  |  |
|---|------|------|--------------------|-------|---------------------------|----------------------------|------|-------------|------|--|--|--|--|
|   | MIN  | MAX  | MIN                | MAX   |                           | MIN                        | MAX  | MIN         | MAX  |  |  |  |  |
| A   | .078 | .082 | 1.98               | 2.08  | L                         | .018                       | .024 | 0.46        | 0.61 |  |  |  |  |
| A1  | .001 | .004 | 0.02               | 0.10  | L1                        | .01 BSC                    |      | 0.25 BSC    |      |  |  |  |  |
| A2  | .077 | .088 | 1.96               | 2.24  | b1                        | .193                       | .199 | 4.90        | 5.06 |  |  |  |  |
| D   | .416 | .424 | 10.57              | 10.77 | c1                        | .007                       | .011 | 0.18        | 0.28 |  |  |  |  |
| D1  | .378 | .382 | 9.60               | 9.70  | e                         | 2°                         | 8°   | 2°          | 8°   |  |  |  |  |
| D2  | .290 | –    | 7.37               | –     | aaa                       | .004                       |      | 0.10        |      |  |  |  |  |
| D3  | .016 | .024 | 0.41               | 0.61  |                           |                            |      |             |      |  |  |  |  |
| E   | .316 | .324 | 8.03               | 8.23  |                           |                            |      |             |      |  |  |  |  |
| E1  | .238 | .242 | 6.04               | 6.15  |                           |                            |      |             |      |  |  |  |  |
| E2  | .066 | .074 | 1.68               | 1.88  |                           |                            |      |             |      |  |  |  |  |
| E3  | .150 | –    | 3.81               | –     |                           |                            |      |             |      |  |  |  |  |
| E4  | .058 | .066 | 1.47               | 1.68  |                           |                            |      |             |      |  |  |  |  |
| E5  | .231 | .235 | 5.87               | 5.97  |                           |                            |      |             |      |  |  |  |  |
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| TITLE:<br><br>TO-270<br>GULL WING                       |      |      |                    |       | DOCUMENT NO: 98ASA99301D  |                            |      | REV: C      |      |  |  |  |  |
|   |      |      |                    |       | CASE NUMBER: 1265A-03     |                            |      |             |      |  |  |  |  |
|   |      |      |                    |       | STANDARD: JEDEC TO-270 BA |                            |      | 02 JUL 2007 |      |  |  |  |  |

AFT05MS031NR1 AFT05MS031GNR1

## PRODUCT DOCUMENTATION, SOFTWARE AND TOOLS

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

### Application Notes

- AN1907: Solder Reflow Attach Method for High Power RF Devices in Over-Molded Plastic Packages
- AN1955: Thermal Measurement Methodology of RF Power Amplifiers
- AN3263: Bolt Down Mounting Method for High Power RF Transistors and RFICs in Over-Molded Plastic Packages
- AN3789: Clamping of High Power RF Transistors and RFICs in Over-Molded Plastic Packages

### Engineering Bulletins

- EB212: Using Data Sheet Impedances for RF LDMOS Devices

### Software

- Electromigration MTTF Calculator
- RF High Power Model
- .s2p File

### Development Tools

- Printed Circuit Boards

For Software and Tools, do a Part Number search at <http://www.freescale.com>, and select the “Part Number” link. Go to the Software & Tools tab on the part’s Product Summary page to download the respective tool.

## REVISION HISTORY

The following table summarizes revisions to this document.

| Revision | Date      | Description                     |
|----------|-----------|---------------------------------|
| 0        | June 2012 | • Initial Release of Data Sheet |

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- Поставка более 17-ти миллионов наименований электронных компонентов;
- Поставка сложных, дефицитных, либо снятых с производства позиций;
- Оперативные сроки поставки под заказ (от 5 рабочих дней);
- Экспресс доставка в любую точку России;
- Техническая поддержка проекта, помошь в подборе аналогов, поставка прототипов;
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- Подбор оптимального решения, техническое обоснование при выборе компонента;
- Подбор аналогов;
- Консультации по применению компонента;
- Поставка образцов и прототипов;
- Техническая поддержка проекта;
- Защита от снятия компонента с производства.



#### Как с нами связаться

Телефон: 8 (812) 309 58 32 (многоканальный)

Факс: 8 (812) 320-02-42

Электронная почта: [org@eplast1.ru](mailto:org@eplast1.ru)

Адрес: 198099, г. Санкт-Петербург, ул. Калинина, дом 2, корпус 4, литера А.