

## The RF MOSFET Line 20W, 500MHz, 28V

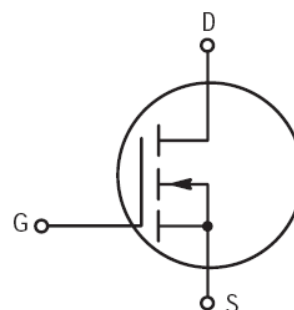
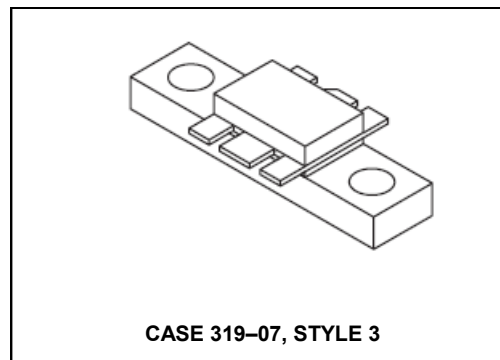
Rev. V1

Designed primarily for wideband large-signal output and driver from 30–500MHz.

N-Channel enhancement mode MOSFET

- MRF166C — Guaranteed performance at 500 MHz, 28 Vdc  
Output power = 20 W  
Gain = 13.5 dB  
Efficiency = 50%
- Replacement for industry standards such as MRF136, V2820, BLF244, SD1902, and ST1001
- 100% tested for load mismatch at all phase angles with 30:1 VSWR
- Facilitates manual gain control, ALC and modulation techniques
- Excellent thermal stability, ideally suited for Class A operation
- Low Crss — 4.0 pF @ VDS = 28 V

### Product Image



### MAXIMUM RATINGS

| Rating                                                                                 | Symbol    | Value      | Unit                         |
|----------------------------------------------------------------------------------------|-----------|------------|------------------------------|
| Drain–Gate Voltage                                                                     | $V_{DSS}$ | 65         | Vdc                          |
| Drain–Gate Voltage<br>( $R_{GS} = 1.0\text{ M}\Omega$ )                                | $V_{DGR}$ | 65         | Vdc                          |
| Gate–Source Voltage                                                                    | $V_{GS}$  | $\pm 20$   | Adc                          |
| Drain Current — Continuous                                                             | $I_D$     | 4.0        | Adc                          |
| Total Device Dissipation @ $T_C = 25^\circ\text{C}$<br>Derate Above $25^\circ\text{C}$ | $P_D$     | 70<br>0.4  | Watts<br>W/ $^\circ\text{C}$ |
| Storage Temperature Range                                                              | $T_{stg}$ | –65 to 150 | $^\circ\text{C}$             |
| Operating Junction Temperature                                                         | $T_J$     | 200        | $^\circ\text{C}$             |

### THERMAL CHARACTERISTICS

| Characteristic                       | Symbol          | Max | Unit               |
|--------------------------------------|-----------------|-----|--------------------|
| Thermal Resistance, Junction to Case | $R_{\theta JC}$ | 2.5 | $^\circ\text{C/W}$ |

**NOTE — CAUTION** — MOS devices are susceptible to damage from electrostatic charge. Reasonable precautions in handling and packaging MOS devices should be observed.

## The RF MOSFET Line 20W, 500MHz, 28V

Rev. V1

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

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

#### OFF CHARACTERISTICS

|                                                                                       |               |    |   |     |               |
|---------------------------------------------------------------------------------------|---------------|----|---|-----|---------------|
| Drain-Source Breakdown Voltage<br>( $V_{GS} = 0\text{ V}$ , $I_D = 5.0\text{ mA}$ )   | $V_{(BR)DSS}$ | 65 | — | —   | V             |
| Zero Gate Voltage Drain Current<br>( $V_{DS} = 28\text{ V}$ , $V_{GS} = 0\text{ V}$ ) | $I_{DSS}$     | —  | — | 0.5 | mA            |
| Gate-Source Leakage Current<br>( $V_{GS} = 20\text{ V}$ , $V_{DS} = 0\text{ V}$ )     | $I_{GSS}$     | —  | — | 1.0 | $\mu\text{A}$ |

#### ON CHARACTERISTICS

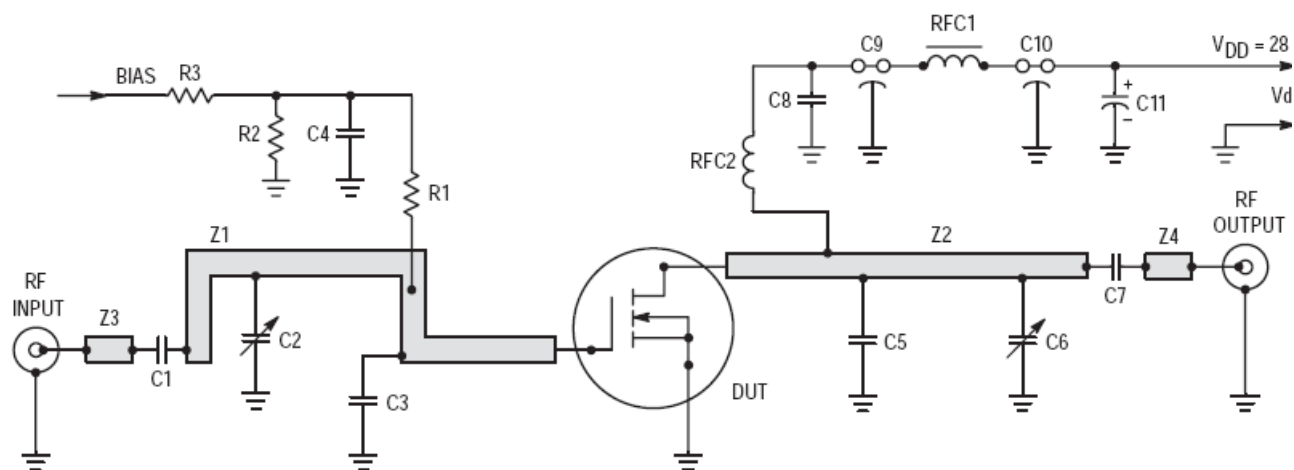
|                                                                               |              |     |     |     |      |
|-------------------------------------------------------------------------------|--------------|-----|-----|-----|------|
| Gate Threshold Voltage<br>( $V_{DS} = 10\text{ V}$ , $I_D = 25\text{ mA}$ )   | $V_{GS(th)}$ | 1.5 | 3.0 | 4.5 | V    |
| Forward Transconductance<br>( $V_{DS} = 10\text{ V}$ , $I_D = 1.5\text{ A}$ ) | $g_{fs}$     | 0.8 | 1.1 | —   | mhos |

#### DYNAMIC CHARACTERISTICS

|                                                                                                           |           |   |     |   |    |
|-----------------------------------------------------------------------------------------------------------|-----------|---|-----|---|----|
| Input Capacitance<br>( $V_{DS} = 28\text{ V}$ , $V_{GS} = 0\text{ V}$ , $f = 1.0\text{ MHz}$ )            | $C_{iss}$ | — | 28  | — | pF |
| Output Capacitance<br>( $V_{DS} = 28\text{ V}$ , $V_{GS} = 0\text{ V}$ , $f = 1.0\text{ MHz}$ )           | $C_{oss}$ | — | 30  | — | pF |
| Reverse Transfer Capacitance<br>( $V_{DS} = 28\text{ V}$ , $V_{GS} = 0\text{ V}$ , $f = 1.0\text{ MHz}$ ) | $C_{rss}$ | — | 4.0 | — | pF |

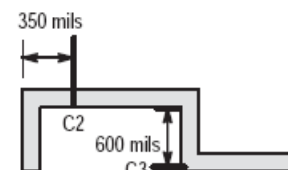
#### FUNCTIONAL CHARACTERISTICS

|                                                                                                                                                                       |          |                                |    |   |    |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|--------------------------------|----|---|----|
| Common Source Power Gain<br>( $V_{DD} = 28\text{ V}$ , $P_{out} = 20\text{ W}$ , $f = 500\text{ MHz}$ , $I_{DQ} = 25\text{ mA}$ )                                     | $G_{ps}$ | 13.5                           | 16 | — | dB |
| Drain Efficiency<br>( $V_{DD} = 28\text{ V}$ , $P_{out} = 20\text{ W}$ , $f = 500\text{ MHz}$ , $I_{DQ} = 25\text{ mA}$ )                                             | $\eta$   | 50                             | 55 | — | %  |
| Electrical Ruggedness<br>( $V_{DD} = 28\text{ V}$ , $P_{out} = 20\text{ W}$ , $f = 500\text{ MHz}$ , $I_{DQ} = 25\text{ mA}$ ,<br>Load VSWR 30:1 at All Phase Angles) | $\psi$   | No Degradation in Output Power |    |   |    |

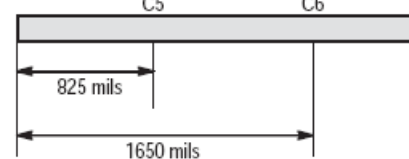


|                |                                                                                              |
|----------------|----------------------------------------------------------------------------------------------|
| C1, C7         | 200 pF, Chip Capacitor                                                                       |
| C2, C6         | 2–10 pF, Trimmer Capacitor, Johansen                                                         |
| C3             | 27 pF, ATC 100 mil Chip Capacitor                                                            |
| C4, C8         | 0.1 $\mu$ F, Chip Capacitor                                                                  |
| C5             | 15 pF, ATC 100 mil Chip Capacitor                                                            |
| C9, C10        | 680 pF, Feedthru Capacitor                                                                   |
| C11            | 50 $\mu$ F, 50 V, Electrolytic Capacitor                                                     |
| R1             | 120 $\Omega$ , 1/2 W Resistor                                                                |
| R2             | 10 k $\Omega$ , 1/2 W Resistor                                                               |
| R3             | 1 k $\Omega$ , 1/2 W Resistor                                                                |
| RFC1           | Ferroxcube VK200 19/4B                                                                       |
| RFC2           | 10 Turns AWG #18, 0.125" I.D., Enameled                                                      |
| Board Material | 0.062" Teflon <sup>®</sup> Fiberglass<br>1 oz. Copper Clad Both Sides<br>$\epsilon_r = 2.56$ |

Z1 0.120" x 3.3", Microstrip Line



Z2 0.120" x 2.1", Microstrip Line



Z3, Z4 0.120" x 0.25", Microstrip Line

Figure 1. MRF166C 500 MHz Test Circuit

## TYPICAL CHARACTERISTICS

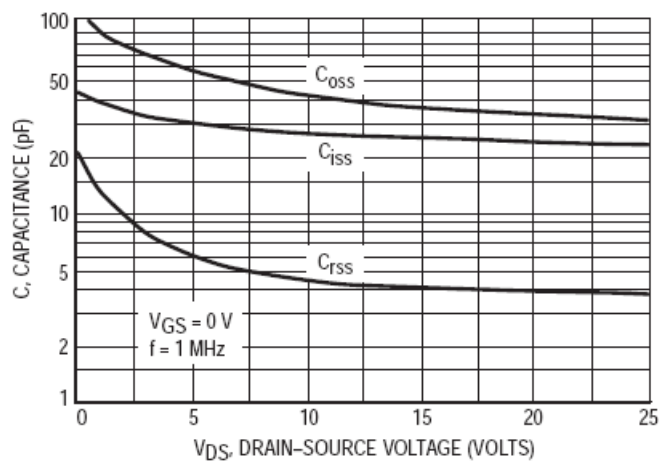


Figure 2. Capacitance versus Drain-Source Voltage

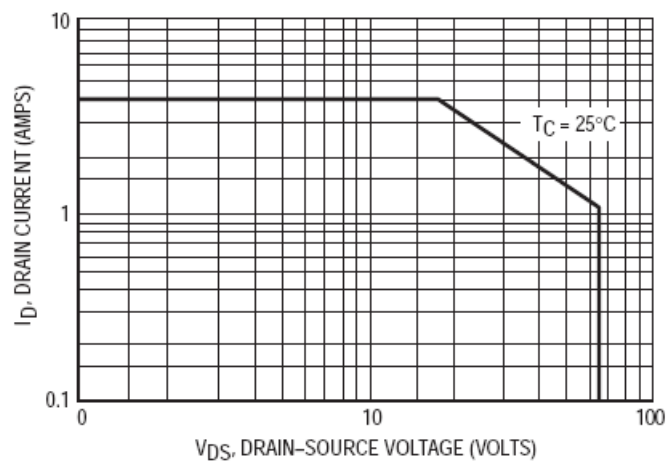


Figure 3. DC Safe Operating Area

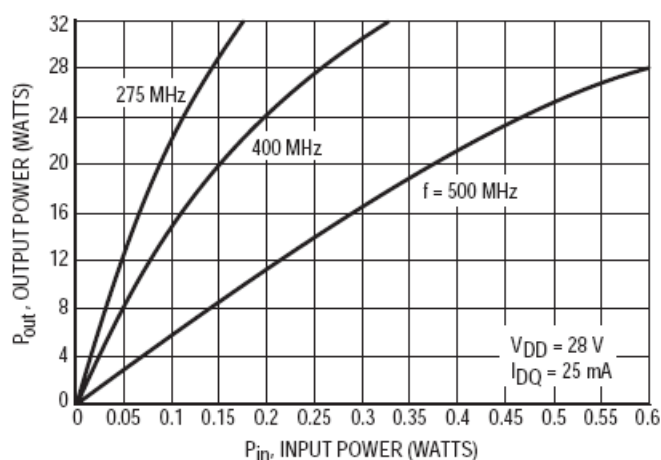


Figure 4. Output Power versus Input Power

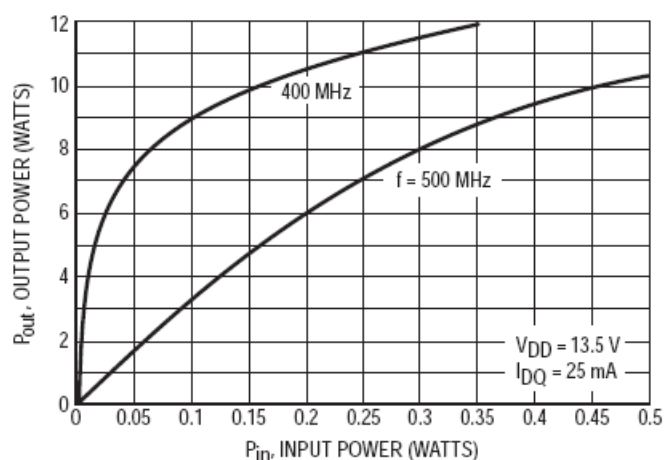


Figure 5. Output Power versus Input Power

## TYPICAL CHARACTERISTICS

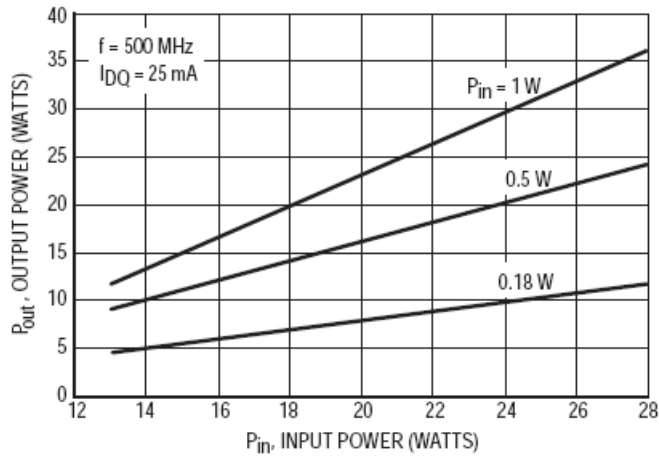


Figure 6. Output Power versus Supply Voltage

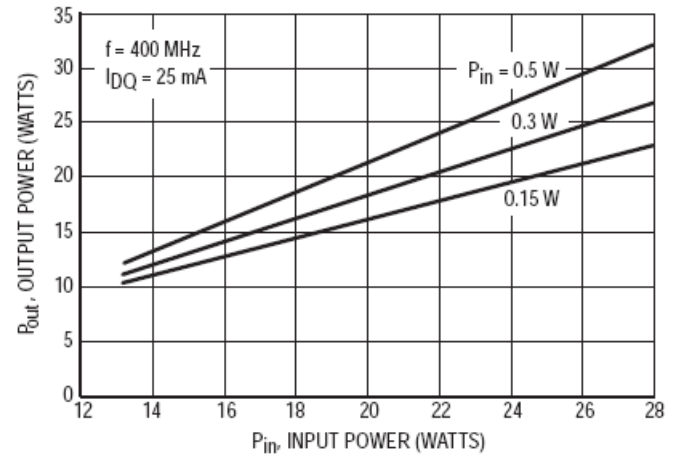
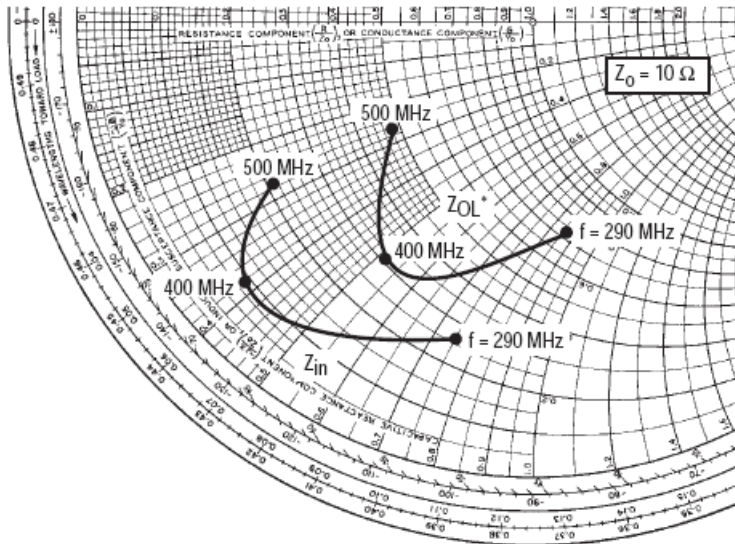


Figure 7. Output Power versus Supply Voltage



$V_{DD} = 28\text{ V}$ ,  $I_{DQ} = 25\text{ mA}$ ,  $P_{out} = 20\text{ Watts}$

| f<br>MHz | $Z_{in}$<br>Ohms | $Z_{OL}^*$<br>Ohms |
|----------|------------------|--------------------|
| 500      | $2.09 - j2.77$   | $4.87 - j2.63$     |
| 400      | $0.93 - j3.80$   | $3.09 - j5.24$     |
| 290      | $2.63 - j7.58$   | $7.35 - j8.67$     |

$Z_{OL}^*$  = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.

Figure 8. Series Equivalent Input and Output Impedance

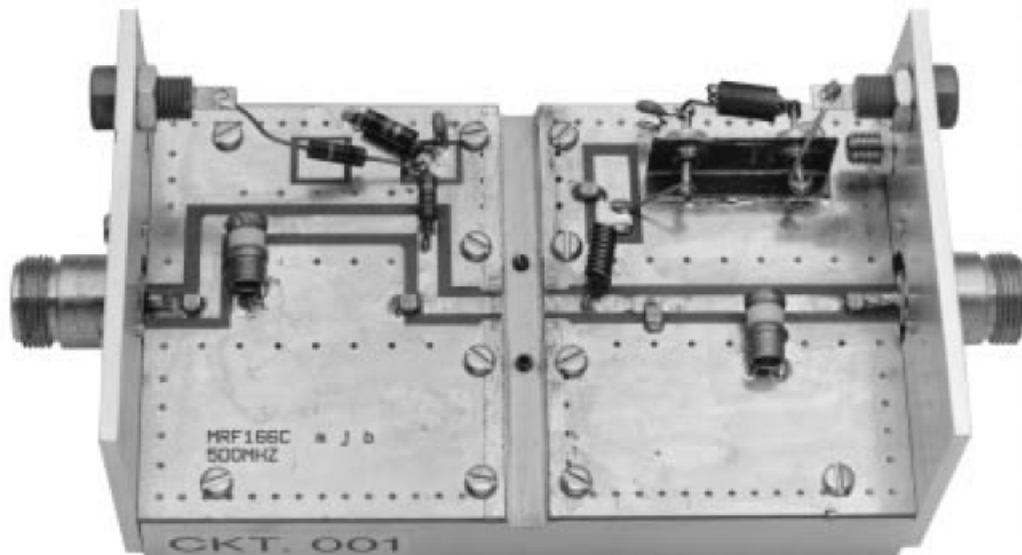


Figure 9. MRF166C Test Fixture

Table 1. Common Source S-Parameters ( $V_{DS} = 12.5\text{ V}$ ,  $I_D = 1.25\text{ A}$ )

| f<br>MHz | S <sub>11</sub> |      | S <sub>21</sub> |     | S <sub>12</sub> |    | S <sub>22</sub> |      |
|----------|-----------------|------|-----------------|-----|-----------------|----|-----------------|------|
|          | S <sub>11</sub> | ∠    | S <sub>21</sub> | ∠   | S <sub>12</sub> | ∠  | S <sub>22</sub> | ∠    |
| 30       | 0.840           | -142 | 22.59           | 105 | 0.025           | 20 | 0.727           | -155 |
| 40       | 0.836           | -151 | 17.4            | 100 | 0.025           | 17 | 0.743           | -161 |
| 50       | 0.832           | -156 | 14.1            | 97  | 0.026           | 15 | 0.751           | -164 |
| 60       | 0.829           | -159 | 12.0            | 94  | 0.026           | 14 | 0.764           | -166 |
| 70       | 0.826           | -162 | 10.4            | 91  | 0.026           | 14 | 0.763           | -168 |
| 80       | 0.822           | -164 | 9.09            | 90  | 0.026           | 14 | 0.763           | -169 |
| 90       | 0.818           | -165 | 8.07            | 89  | 0.027           | 14 | 0.765           | -170 |
| 100      | 0.819           | -167 | 7.28            | 87  | 0.027           | 14 | 0.774           | -171 |
| 110      | 0.821           | -168 | 6.61            | 85  | 0.027           | 14 | 0.773           | -172 |
| 120      | 0.821           | -169 | 6.00            | 83  | 0.026           | 15 | 0.771           | -172 |
| 130      | 0.820           | -169 | 5.56            | 83  | 0.027           | 16 | 0.778           | -172 |
| 140      | 0.818           | -170 | 5.22            | 82  | 0.027           | 17 | 0.785           | -172 |
| 150      | 0.820           | -170 | 4.86            | 80  | 0.027           | 17 | 0.786           | -173 |
| 160      | 0.821           | -171 | 4.52            | 79  | 0.027           | 17 | 0.781           | -173 |
| 170      | 0.820           | -171 | 4.23            | 79  | 0.027           | 20 | 0.774           | -172 |
| 180      | 0.820           | -171 | 4.03            | 78  | 0.027           | 20 | 0.799           | -173 |
| 190      | 0.820           | -172 | 3.86            | 76  | 0.027           | 20 | 0.799           | -174 |
| 200      | 0.821           | -172 | 3.62            | 75  | 0.027           | 20 | 0.784           | -175 |
| 210      | 0.822           | -173 | 3.39            | 75  | 0.027           | 22 | 0.780           | -174 |
| 220      | 0.823           | -173 | 3.25            | 74  | 0.027           | 24 | 0.795           | -173 |
| 230      | 0.825           | -173 | 3.12            | 72  | 0.028           | 23 | 0.823           | -175 |
| 240      | 0.827           | -173 | 2.96            | 71  | 0.026           | 24 | 0.791           | -175 |
| 250      | 0.827           | -174 | 2.83            | 70  | 0.027           | 26 | 0.789           | -174 |
| 260      | 0.827           | -174 | 2.71            | 70  | 0.026           | 27 | 0.791           | -174 |
| 270      | 0.829           | -174 | 2.62            | 69  | 0.027           | 28 | 0.801           | -174 |
| 280      | 0.831           | -174 | 2.52            | 68  | 0.027           | 29 | 0.807           | -175 |
| 290      | 0.832           | -174 | 2.42            | 66  | 0.027           | 30 | 0.788           | -175 |
| 300      | 0.832           | -174 | 2.32            | 66  | 0.027           | 32 | 0.792           | -175 |
| 310      | 0.831           | -174 | 2.25            | 66  | 0.027           | 33 | 0.797           | -174 |
| 320      | 0.833           | -175 | 2.18            | 65  | 0.027           | 34 | 0.810           | -174 |
| 330      | 0.836           | -175 | 2.10            | 63  | 0.028           | 35 | 0.812           | -175 |
| 340      | 0.837           | -175 | 2.00            | 62  | 0.027           | 35 | 0.789           | -176 |
| 350      | 0.838           | -175 | 1.95            | 62  | 0.028           | 39 | 0.806           | -173 |
| 360      | 0.839           | -175 | 1.90            | 61  | 0.028           | 39 | 0.817           | -174 |
| 370      | 0.840           | -176 | 1.84            | 60  | 0.028           | 40 | 0.817           | -175 |
| 380      | 0.843           | -176 | 1.77            | 59  | 0.028           | 41 | 0.811           | -175 |
| 390      | 0.845           | -176 | 1.71            | 59  | 0.028           | 42 | 0.805           | -175 |
| 400      | 0.846           | -176 | 1.66            | 58  | 0.029           | 46 | 0.801           | -172 |
| 410      | 0.846           | -176 | 1.64            | 57  | 0.030           | 46 | 0.845           | -174 |
| 420      | 0.847           | -176 | 1.59            | 56  | 0.030           | 46 | 0.836           | -176 |
| 430      | 0.848           | -176 | 1.52            | 56  | 0.030           | 47 | 0.823           | -176 |
| 440      | 0.850           | -176 | 1.48            | 56  | 0.030           | 49 | 0.816           | -174 |

Table 1. Common Source S-Parameters ( $V_{DS} = 12.5$  V,  $I_D = 1.25$  A) (continued)

| f<br>MHz | S <sub>11</sub> |      | S <sub>21</sub> |    | S <sub>12</sub> |    | S <sub>22</sub> |      |
|----------|-----------------|------|-----------------|----|-----------------|----|-----------------|------|
|          | S <sub>11</sub> | φ    | S <sub>21</sub> | φ  | S <sub>12</sub> | φ  | S <sub>22</sub> | φ    |
| 450      | 0.851           | -176 | 1.47            | 54 | 0.032           | 51 | 0.851           | -174 |
| 460      | 0.853           | -177 | 1.42            | 53 | 0.032           | 48 | 0.849           | -178 |
| 470      | 0.853           | -177 | 1.37            | 53 | 0.031           | 51 | 0.830           | -176 |
| 480      | 0.856           | -177 | 1.34            | 53 | 0.032           | 53 | 0.834           | -176 |
| 490      | 0.857           | -177 | 1.32            | 52 | 0.033           | 54 | 0.841           | -175 |
| 500      | 0.859           | -177 | 1.28            | 51 | 0.034           | 54 | 0.847           | -175 |
| 600      | 0.857           | 178  | 0.988           | 41 | 0.032           | 73 | 0.877           | 180  |
| 700      | 0.884           | 176  | 0.789           | 34 | 0.047           | 65 | 0.881           | 179  |
| 800      | 0.881           | 173  | 0.684           | 30 | 0.031           | 83 | 0.890           | 174  |
| 900      | 0.890           | 172  | 0.580           | 26 | 0.069           | 71 | 0.885           | 176  |
| 1000     | 0.897           | 170  | 0.503           | 24 | 0.090           | 60 | 0.931           | 173  |

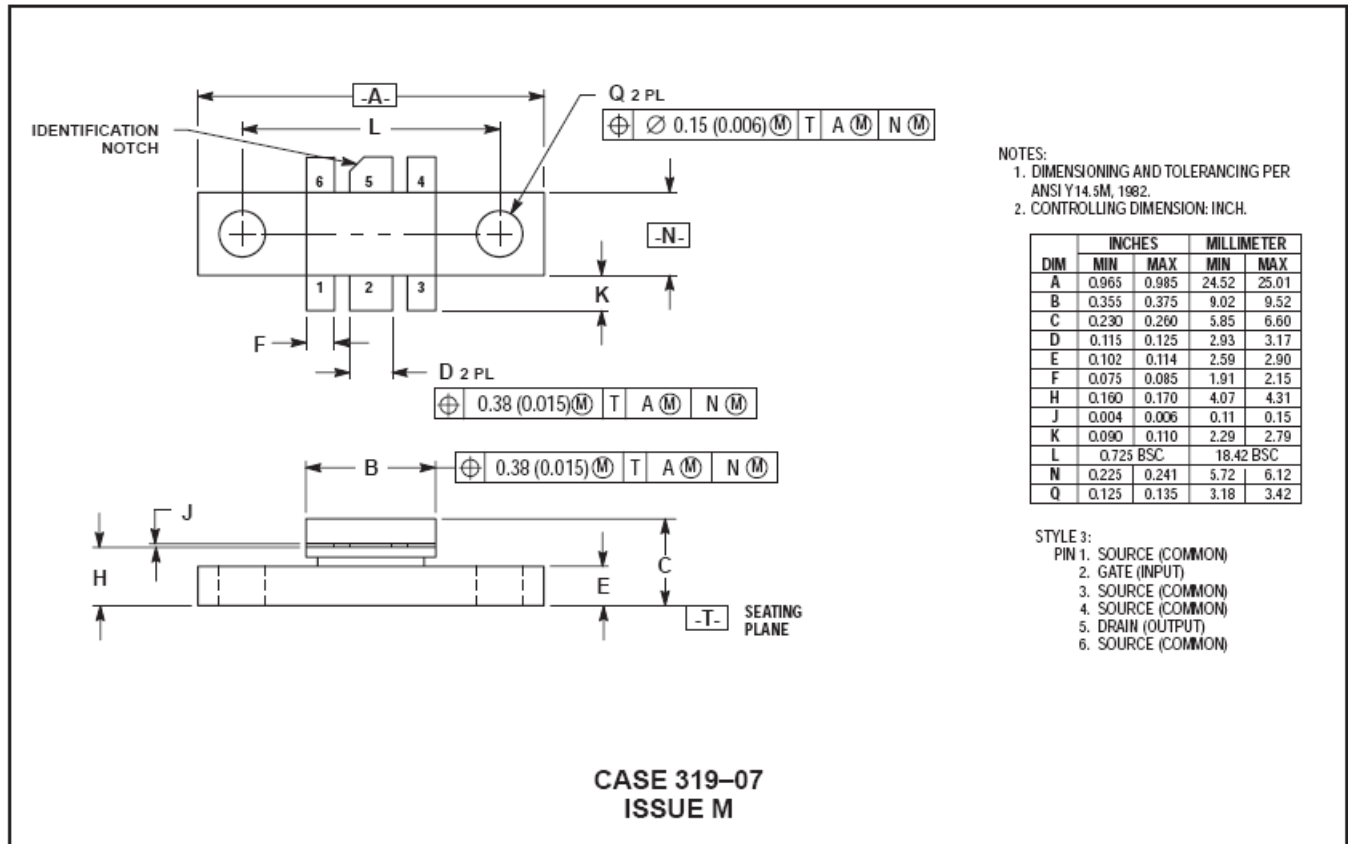
Table 2. Common Source S-Parameters ( $V_{DS} = 28\text{ V}$ ,  $I_D = 1.25\text{ A}$ )

| f<br>MHz | S <sub>11</sub> |      | S <sub>21</sub> |     | S <sub>12</sub> |    | S <sub>22</sub> |      |
|----------|-----------------|------|-----------------|-----|-----------------|----|-----------------|------|
|          | S <sub>11</sub> | ∠    | S <sub>21</sub> | ∠   | S <sub>12</sub> | ∠  | S <sub>22</sub> | ∠    |
| 30       | 0.842           | -125 | 29.6            | 113 | 0.024           | 28 | 0.586           | -136 |
| 40       | 0.831           | -136 | 23.2            | 106 | 0.025           | 22 | 0.607           | -145 |
| 50       | 0.822           | -143 | 19.0            | 101 | 0.026           | 19 | 0.613           | -151 |
| 60       | 0.816           | -148 | 16.2            | 98  | 0.026           | 17 | 0.626           | -155 |
| 70       | 0.812           | -152 | 14.1            | 95  | 0.027           | 16 | 0.635           | -157 |
| 80       | 0.806           | -155 | 12.4            | 92  | 0.026           | 15 | 0.643           | -159 |
| 90       | 0.801           | -157 | 11.1            | 90  | 0.027           | 14 | 0.650           | -160 |
| 100      | 0.802           | -159 | 9.97            | 88  | 0.027           | 13 | 0.656           | -161 |
| 110      | 0.805           | -161 | 9.04            | 86  | 0.027           | 13 | 0.654           | -163 |
| 120      | 0.805           | -162 | 8.22            | 84  | 0.026           | 13 | 0.654           | -163 |
| 130      | 0.803           | -163 | 7.59            | 83  | 0.026           | 14 | 0.663           | -163 |
| 140      | 0.801           | -164 | 7.09            | 82  | 0.026           | 14 | 0.673           | -164 |
| 150      | 0.803           | -165 | 6.61            | 80  | 0.026           | 14 | 0.675           | -164 |
| 160      | 0.804           | -165 | 6.16            | 79  | 0.026           | 14 | 0.674           | -164 |
| 170      | 0.803           | -166 | 5.77            | 78  | 0.026           | 16 | 0.672           | -164 |
| 180      | 0.804           | -166 | 5.49            | 77  | 0.026           | 17 | 0.697           | -164 |
| 190      | 0.806           | -166 | 5.25            | 75  | 0.026           | 16 | 0.700           | -165 |
| 200      | 0.806           | -167 | 4.92            | 73  | 0.025           | 16 | 0.688           | -166 |
| 210      | 0.807           | -168 | 4.60            | 73  | 0.025           | 17 | 0.680           | -165 |
| 220      | 0.809           | -168 | 4.40            | 72  | 0.025           | 19 | 0.689           | -165 |
| 230      | 0.812           | -168 | 4.21            | 70  | 0.025           | 19 | 0.713           | -167 |
| 240      | 0.814           | -169 | 3.99            | 69  | 0.024           | 20 | 0.701           | -167 |
| 250      | 0.815           | -169 | 3.83            | 68  | 0.024           | 21 | 0.707           | -166 |
| 260      | 0.816           | -169 | 3.66            | 67  | 0.024           | 22 | 0.711           | -166 |
| 270      | 0.818           | -169 | 3.52            | 66  | 0.024           | 23 | 0.715           | -166 |
| 280      | 0.821           | -169 | 3.39            | 65  | 0.025           | 24 | 0.718           | -167 |
| 290      | 0.822           | -170 | 3.25            | 63  | 0.024           | 26 | 0.708           | -168 |
| 300      | 0.823           | -170 | 3.11            | 62  | 0.023           | 28 | 0.715           | -167 |

Table 2. Common Source S-Parameters ( $V_{DS} = 28\text{ V}$ ,  $I_D = 1.25\text{ A}$ ) (continued)

| f<br>MHz | S <sub>11</sub> |      | S <sub>21</sub> |    | S <sub>12</sub> |    | S <sub>22</sub> |      |
|----------|-----------------|------|-----------------|----|-----------------|----|-----------------|------|
|          | S <sub>11</sub> | φ    | S <sub>21</sub> | φ  | S <sub>12</sub> | φ  | S <sub>22</sub> | φ    |
| 310      | 0.822           | -170 | 2.99            | 62 | 0.023           | 29 | 0.725           | -166 |
| 320      | 0.825           | -170 | 2.89            | 61 | 0.024           | 31 | 0.734           | -166 |
| 330      | 0.828           | -171 | 2.78            | 60 | 0.024           | 33 | 0.736           | -167 |
| 340      | 0.830           | -171 | 2.66            | 59 | 0.024           | 33 | 0.724           | -168 |
| 350      | 0.832           | -171 | 2.59            | 58 | 0.024           | 37 | 0.739           | -166 |
| 360      | 0.834           | -171 | 2.52            | 57 | 0.024           | 39 | 0.757           | -166 |
| 370      | 0.836           | -171 | 2.44            | 56 | 0.023           | 39 | 0.755           | -167 |
| 380      | 0.839           | -172 | 2.34            | 55 | 0.023           | 38 | 0.745           | -167 |
| 390      | 0.840           | -172 | 2.26            | 54 | 0.024           | 40 | 0.738           | -168 |
| 400      | 0.841           | -172 | 2.19            | 54 | 0.024           | 46 | 0.735           | -166 |
| 410      | 0.842           | -172 | 2.14            | 53 | 0.025           | 46 | 0.787           | -167 |
| 420      | 0.844           | -172 | 2.09            | 51 | 0.026           | 46 | 0.790           | -168 |
| 430      | 0.845           | -173 | 1.99            | 51 | 0.027           | 49 | 0.777           | -168 |
| 440      | 0.846           | -173 | 1.93            | 51 | 0.026           | 52 | 0.770           | -167 |
| 450      | 0.849           | -173 | 1.91            | 49 | 0.027           | 53 | 0.794           | -167 |
| 460      | 0.853           | -173 | 1.84            | 48 | 0.027           | 51 | 0.803           | -171 |
| 470      | 0.855           | -173 | 1.77            | 47 | 0.027           | 54 | 0.787           | -170 |
| 480      | 0.857           | -174 | 1.72            | 47 | 0.027           | 57 | 0.789           | -169 |
| 490      | 0.857           | -174 | 1.68            | 47 | 0.027           | 56 | 0.796           | -168 |
| 500      | 0.859           | -174 | 1.64            | 46 | 0.029           | 57 | 0.802           | -169 |
| 600      | 0.862           | -179 | 1.18            | 33 | 0.036           | 77 | 0.851           | -173 |
| 700      | 0.893           | 178  | 0.921           | 26 | 0.043           | 75 | 0.856           | -175 |
| 800      | 0.890           | 175  | 0.771           | 22 | 0.043           | 78 | 0.880           | -178 |
| 900      | 0.895           | 173  | 0.635           | 17 | 0.065           | 74 | 0.882           | -178 |
| 1000     | 0.905           | 171  | 0.544           | 14 | 0.086           | 69 | 0.931           | 178  |

## PACKAGE DIMENSIONS



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