

## The RF MOSFET Line 40W, 500MHz, 28V

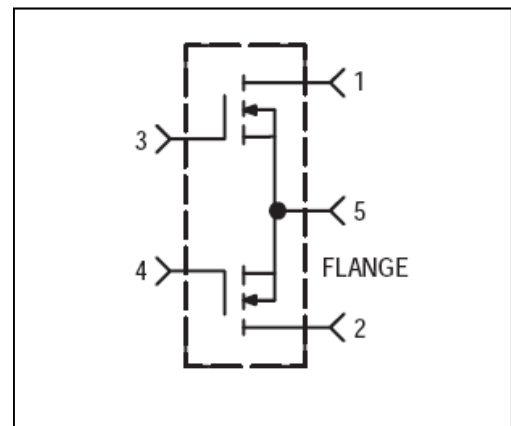
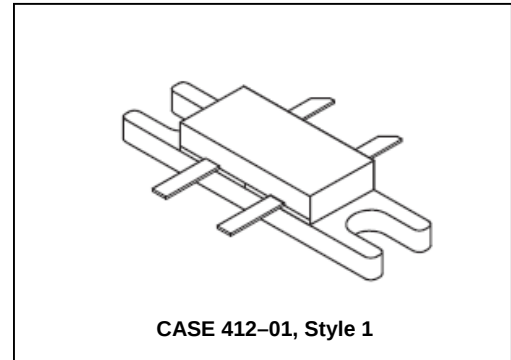
M/A-COM Products  
Released - Rev. 07.07

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

N-Channel enhancement mode MOSFET

- Push-pull configuration reduces even numbered harmonics
- Guaranteed performance at 500 MHz, 28 Vdc  
Output power = 40 W  
Gain = 14 dB  
Efficiency = 50%
- Typical performance at 175 MHz, 28 Vdc  
Output power = 40 W  
Gain = 17 dB  
Efficiency = 60%
- Excellent thermal stability, ideally suited for Class A operation
- Facilitates manual gain control, ALC and modulation techniques
- 100% tested for load mismatch at all phase angles with 30:1 VSWR
- Low Crss — 4.0 pF @ VDS = 28 V

### Product Image



### MAXIMUM RATINGS (T<sub>J</sub> = 25°C unless otherwise noted)

| Rating                                                                | Symbol           | Value       | Unit          |
|-----------------------------------------------------------------------|------------------|-------------|---------------|
| Drain-Gate Voltage                                                    | V <sub>DSS</sub> | 65          | Vdc           |
| Drain-Gate Voltage (R <sub>GS</sub> = 1.0 MΩ)                         | V <sub>DGR</sub> | 65          | Vdc           |
| Gate-Source Voltage                                                   | V <sub>GS</sub>  | ± 20        | Adc           |
| Drain Current — Continuous                                            | I <sub>D</sub>   | 8.0         | ADC           |
| Total Device Dissipation @ T <sub>C</sub> = 25°C<br>Derate above 25°C | P <sub>D</sub>   | 175<br>1.0  | Watts<br>°C/W |
| Storage Temperature Range                                             | T <sub>stg</sub> | -65 to +150 | °C            |
| Operating Junction Temperature                                        | T <sub>J</sub>   | 200         | °C            |

### THERMAL CHARACTERISTICS

|                                       |                  |     |      |
|---------------------------------------|------------------|-----|------|
| Thermal Resistance — Junction to Case | R <sub>θJC</sub> | 1.0 | °C/W |
|---------------------------------------|------------------|-----|------|

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

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

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

#### OFF CHARACTERISTICS (1)

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

#### ON CHARACTERISTICS (1)

|                                                                                 |              |     |     |     |     |
|---------------------------------------------------------------------------------|--------------|-----|-----|-----|-----|
| Gate Threshold Voltage<br>( $V_{DS} = 10\text{ Vdc}$ , $I_D = 25\text{ mA}$ )   | $V_{GS(th)}$ | 1.5 | 3.0 | 4.5 | Vdc |
| Forward Transconductance<br>( $V_{DS} = 10\text{ Vdc}$ , $I_D = 1.5\text{ A}$ ) | $g_{fs}$     | 0.9 | 1.1 | —   | mS  |

#### DYNAMIC CHARACTERISTICS (1)

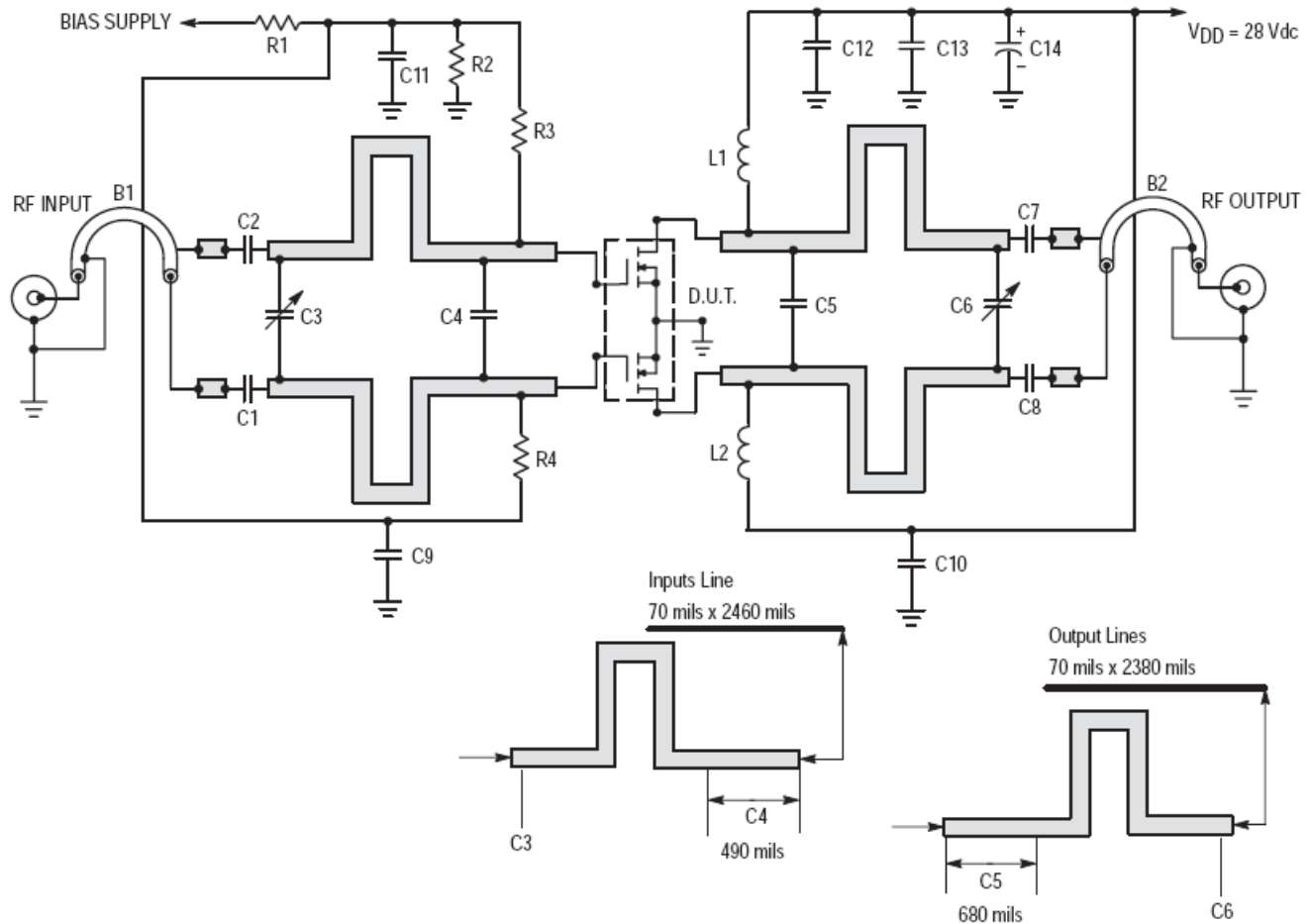
|                                                                                                               |           |   |     |   |    |
|---------------------------------------------------------------------------------------------------------------|-----------|---|-----|---|----|
| Input Capacitance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

#### FUNCTIONAL CHARACTERISTICS (2)

|                                                                                                                                                                                              |           |                                |                |   |      |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|--------------------------------|----------------|---|------|
| Common Source Power Gain<br>( $V_{DD} = 28\text{ Vdc}$ , $P_{out} = 40\text{ W}$ , $f = 500\text{ MHz}$ , $I_{DQ} = 100\text{ mA}$ )                                                         | $G_{ps}$  | 14                             | 16             | — | dB   |
| Drain Efficiency<br>( $V_{DD} = 28\text{ Vdc}$ , $P_{out} = 40\text{ W}$ , $f = 500\text{ MHz}$ , $I_{DQ} = 100\text{ mA}$ )                                                                 | $\eta$    | 50                             | 55             | — | %    |
| Electrical Ruggedness<br>( $V_{DD} = 28\text{ Vdc}$ , $P_{out} = 40\text{ W}$ , $f = 500\text{ MHz}$ , $I_{DQ} = 100\text{ mA}$ )<br>Load VSWR = 30:1, All phase angles at frequency of test | $\Psi$    | No Degradation in Output Power |                |   |      |
| Series Equivalent Input Impedance<br>( $V_{DD} = 28\text{ Vdc}$ , $P_{out} = 40\text{ W}$ , $f = 500\text{ MHz}$ , $I_{DQ} = 100\text{ mA}$ )                                                | $Z_{in}$  | —                              | $2.88 - j7.96$ | — | Ohms |
| Series Equivalent Output Impedance<br>( $V_{DD} = 28\text{ Vdc}$ , $P_{out} = 40\text{ W}$ , $f = 500\text{ MHz}$ , $I_{DQ} = 100\text{ mA}$ )                                               | $Z_{out}$ | —                              | $6.12 - j9.43$ | — | Ohms |

(1) Each transistor chip measured separately.

(2) Both transistor chips operating in a push-pull amplifier.



|                                                                               |                                                     |
|-------------------------------------------------------------------------------|-----------------------------------------------------|
| C1, C2, C7, C8                                                                | 220 pF, 100 mil Chip Capacitor, ATC                 |
| C3, C6                                                                        | 0 – 10 pF, Johanson                                 |
| C4                                                                            | 27 pF, 100 mil Chip Capacitor, ATC                  |
| C5                                                                            | 22 pF, 100 mil Chip Capacitor, ATC                  |
| C9, C10, C11, C12                                                             | 0.01 $\mu$ F Blue Capacitor                         |
| C13                                                                           | 470 pF, 100 mil Chip Capacitor, ATC                 |
| C14                                                                           | 50 $\mu$ F, 50 V Electrolytic Capacitor             |
| L1, L2                                                                        | 8 Turns #20 AWG, 0.100 mils ID                      |
| B1, B2                                                                        | 6" long, ID = 550 mils, 50 $\Omega$ Semi-Rigid Coax |
| R1                                                                            | 1.0 k $\Omega$ 1/2 Watt                             |
| R2                                                                            | 10 k $\Omega$ 1/2 Watt                              |
| R3, R4                                                                        | 45 $\Omega$ 1/2 Watt                                |
| Board Material – Teflon® Fiberglass                                           |                                                     |
| Dielectric Thickness = 0.30", $\epsilon_r$ = 2.55 Copper Clad, 2.0 oz. Copper |                                                     |

Figure 1. MRF166W 500 MHz Test Circuit Schematic

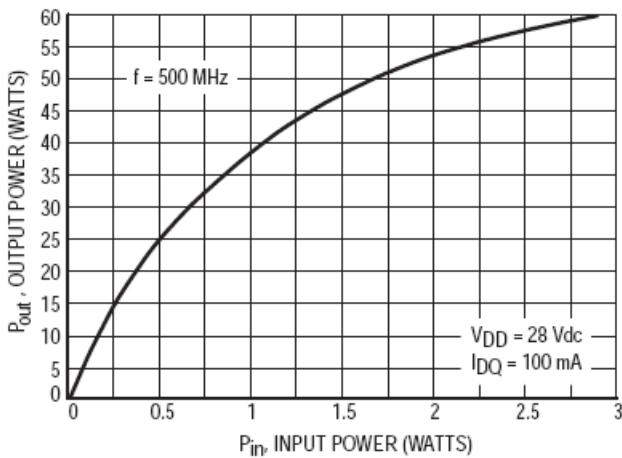


Figure 2. Output Power versus Input Power, 28 Vdc

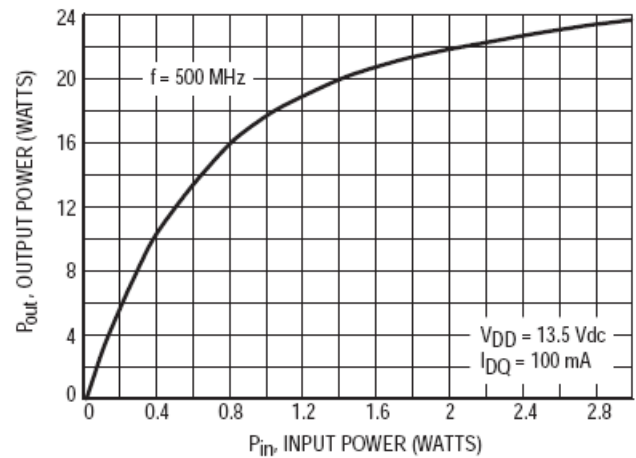


Figure 3. Output Power versus Input Power, 13.5 Vdc

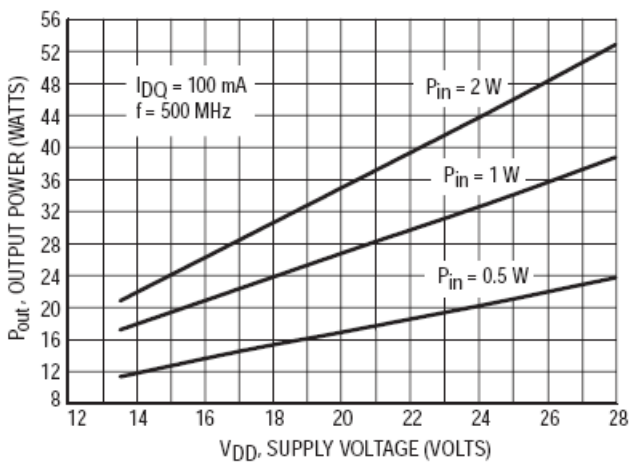


Figure 4. Output Power versus Supply Voltage

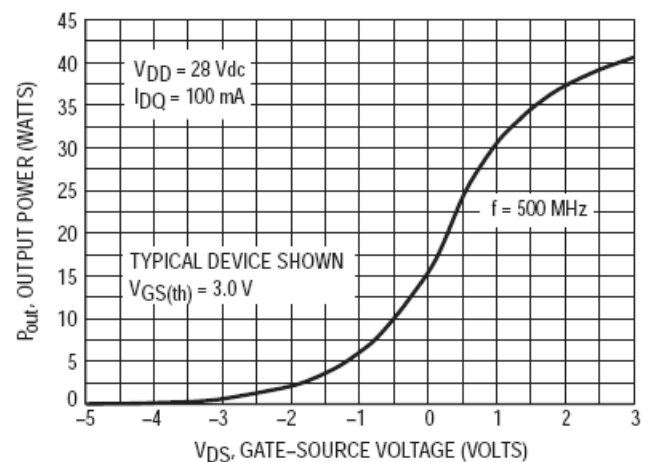


Figure 5. Output Power versus Gate Voltage

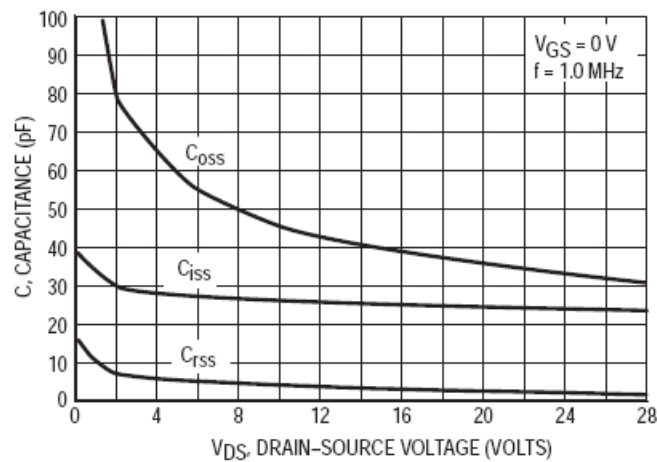
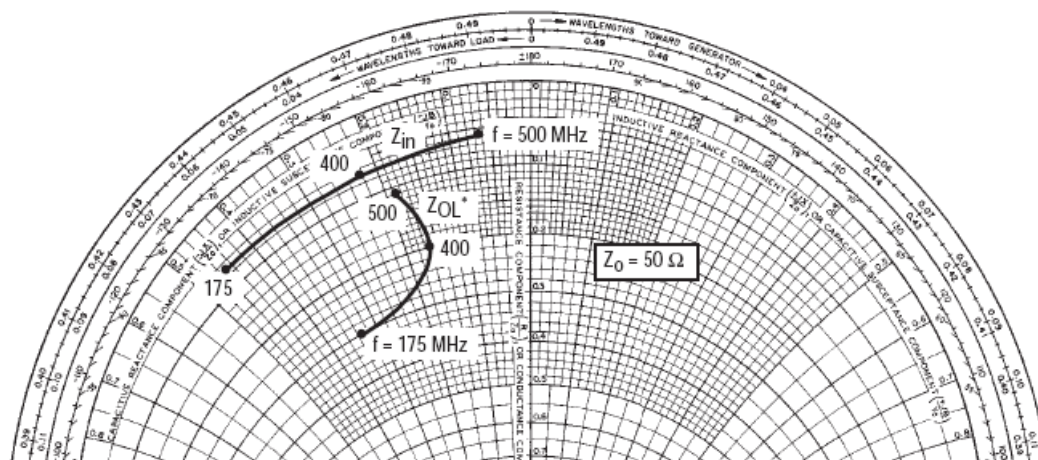


Figure 6. Capacitance versus Voltage



$V_{DD} = 28 \text{ Vdc}$ ,  $I_{DQ} = 100 \text{ mA}$ ,  $P_{out} = 40 \text{ W}$

| f<br>MHz | $Z_{in}$<br>Ohms | $Z_{OL}^*$<br>Ohms |
|----------|------------------|--------------------|
| 175      | $3.7 - j 22.4$   | $15.2 - j 16.6$    |
| 400      | $3.6 - j 10.99$  | $10.3 - j 7.99$    |
| 500      | $2.88 - j 7.96$  | $6.12 - j 9.43$    |

Table 1. Input and Output Impedances

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

NOTE: Input and output impedance values given are measured from gate to gate and drain to drain respectively.

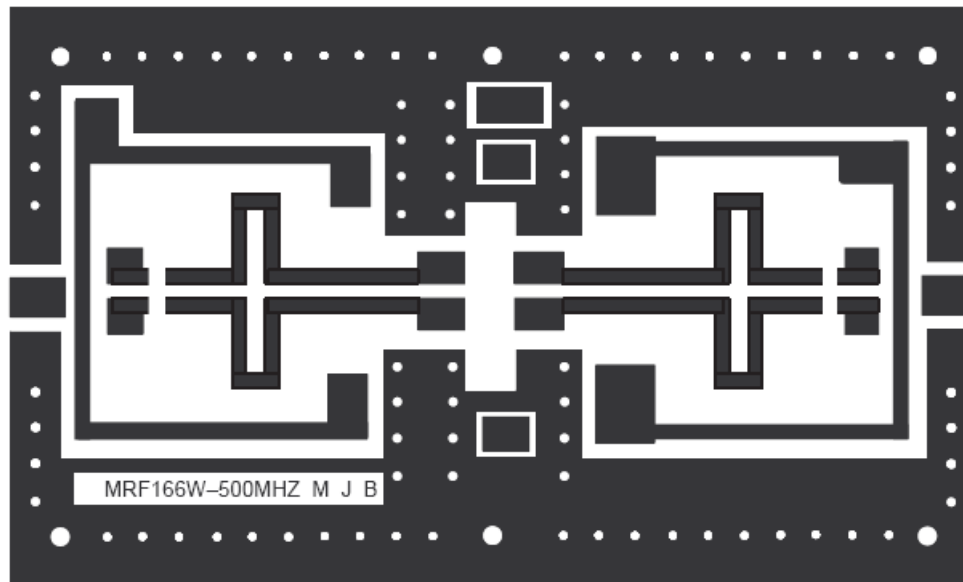
Figure 7. Series Equivalent Input/Output Impedance

# MRF166W



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NOTES: 1) 3 X 5 inch Glass Teflon® 32 Mil Board, Copper Both Sides  
2) Small Holes are 40 Mils ID and Plated Through  
3) Large Holes are 140 Mils ID and Plated Through

(Scale 1:1)

Figure 8. MRF166W Circuit Board Photomaster

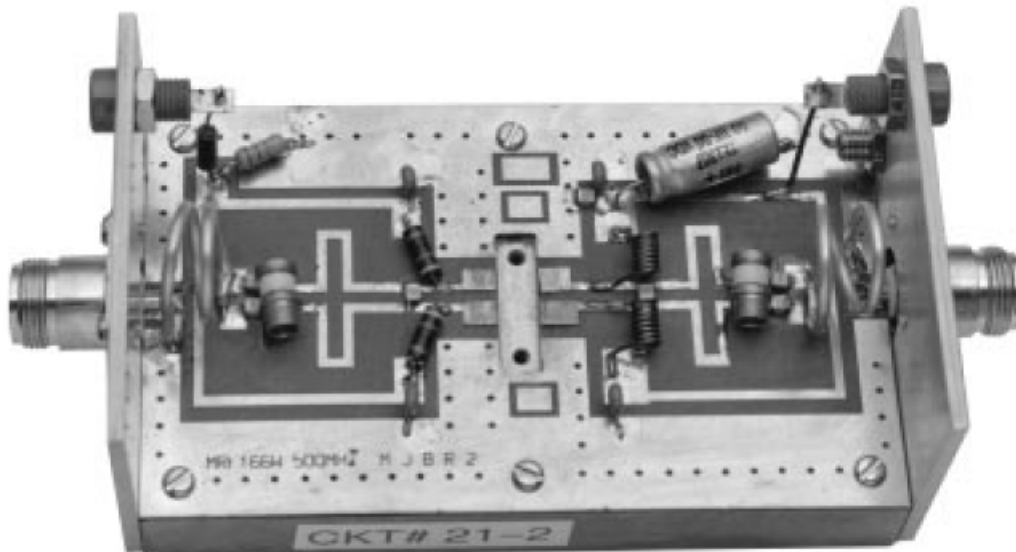


Figure 9. MRF166W Test Fixture

Table 1. Common Source S-Parameters ( $V_{DS} = 24\text{ V}$ ,  $I_D = 230\text{ mA}$ )

| 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       | 0.554           | -85  | 20.30           | 128 | 0.044           | 28  | 0.628           | -121 |
| 40       | 0.775           | -113 | 20.00           | 113 | 0.040           | 26  | 0.632           | -123 |
| 50       | 0.758           | -124 | 17.50           | 107 | 0.041           | 20  | 0.652           | -135 |
| 60       | 0.711           | -132 | 14.60           | 100 | 0.050           | 20  | 0.570           | -135 |
| 70       | 0.751           | -139 | 12.70           | 100 | 0.042           | 11  | 0.666           | -145 |
| 80       | 0.742           | -143 | 11.30           | 95  | 0.043           | 9   | 0.666           | -149 |
| 90       | 0.724           | -146 | 10.00           | 92  | 0.042           | 8   | 0.657           | -151 |
| 100      | 0.730           | -149 | 8.97            | 90  | 0.042           | 6   | 0.663           | -154 |
| 110      | 0.735           | -151 | 8.29            | 87  | 0.043           | 3   | 0.683           | -156 |
| 120      | 0.732           | -153 | 7.53            | 84  | 0.042           | 2   | 0.666           | -158 |
| 130      | 0.734           | -155 | 7.01            | 83  | 0.042           | 1   | 0.688           | -159 |
| 140      | 0.740           | -156 | 6.57            | 81  | 0.043           | 0   | 0.701           | -160 |
| 150      | 0.747           | -157 | 6.01            | 78  | 0.042           | -2  | 0.688           | -162 |
| 160      | 0.748           | -159 | 5.66            | 76  | 0.041           | -4  | 0.715           | -162 |
| 170      | 0.741           | -160 | 5.22            | 76  | 0.040           | -4  | 0.690           | -161 |
| 180      | 0.746           | -160 | 4.94            | 74  | 0.041           | -4  | 0.719           | -164 |
| 190      | 0.753           | -161 | 4.67            | 73  | 0.041           | -6  | 0.725           | -165 |
| 200      | 0.756           | -162 | 4.51            | 70  | 0.040           | -7  | 0.729           | -166 |
| 210      | 0.755           | -162 | 4.15            | 69  | 0.039           | -8  | 0.727           | -165 |
| 220      | 0.759           | -163 | 3.91            | 68  | 0.039           | -8  | 0.724           | -166 |
| 230      | 0.767           | -163 | 3.75            | 65  | 0.039           | -10 | 0.751           | -169 |
| 240      | 0.769           | -164 | 3.56            | 64  | 0.038           | -12 | 0.733           | -167 |
| 250      | 0.766           | -164 | 3.41            | 63  | 0.037           | -12 | 0.726           | -167 |
| 260      | 0.767           | -165 | 3.26            | 63  | 0.035           | -10 | 0.725           | -167 |
| 270      | 0.773           | -165 | 3.07            | 61  | 0.035           | -10 | 0.725           | -167 |
| 280      | 0.777           | -165 | 3.03            | 61  | 0.035           | -11 | 0.753           | -167 |
| 290      | 0.777           | -166 | 2.89            | 58  | 0.034           | -13 | 0.732           | -169 |
| 300      | 0.782           | -166 | 2.80            | 57  | 0.034           | -11 | 0.744           | -169 |
| 310      | 0.788           | -166 | 2.66            | 57  | 0.034           | -12 | 0.764           | -169 |
| 320      | 0.794           | -167 | 2.54            | 55  | 0.033           | -12 | 0.760           | -167 |
| 330      | 0.796           | -167 | 2.47            | 54  | 0.032           | -13 | 0.787           | -169 |
| 340      | 0.795           | -168 | 2.38            | 54  | 0.031           | -13 | 0.753           | -170 |
| 350      | 0.799           | -168 | 2.27            | 52  | 0.030           | -11 | 0.772           | -168 |
| 360      | 0.804           | -168 | 2.17            | 51  | 0.030           | -11 | 0.782           | -169 |
| 370      | 0.805           | -168 | 2.15            | 50  | 0.030           | -11 | 0.796           | -169 |
| 380      | 0.807           | -169 | 2.06            | 48  | 0.029           | -12 | 0.782           | -170 |
| 390      | 0.812           | -169 | 2.00            | 48  | 0.028           | -12 | 0.796           | -170 |
| 400      | 0.818           | -170 | 1.91            | 47  | 0.027           | -10 | 0.784           | -168 |
| 410      | 0.821           | -170 | 1.86            | 46  | 0.029           | -11 | 0.830           | -170 |
| 420      | 0.821           | -170 | 1.83            | 44  | 0.028           | -11 | 0.823           | -171 |
| 430      | 0.822           | -171 | 1.74            | 44  | 0.026           | -9  | 0.791           | -170 |
| 440      | 0.826           | -171 | 1.67            | 43  | 0.025           | -7  | 0.788           | -170 |

Table 1. Common Source S-Parameters ( $V_{DS} = 24$  V,  $I_D = 230$  mA) (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      | 0.830           | -171 | 1.68            | 42 | 0.025           | -7   | 0.820           | -170 |
| 460      | 0.831           | -172 | 1.64            | 41 | 0.026           | -10  | 0.843           | -174 |
| 470      | 0.832           | -172 | 1.54            | 41 | 0.025           | -7   | 0.827           | -173 |
| 480      | 0.835           | -173 | 1.50            | 39 | 0.024           | -3   | 0.836           | -172 |
| 490      | 0.835           | -173 | 1.43            | 38 | 0.024           | 1    | 0.835           | -171 |
| 500      | 0.823           | -174 | 1.43            | 37 | 0.025           | 3    | 0.849           | -172 |
| 600      | 0.874           | -176 | 1.12            | 29 | 0.003           | -171 | 0.873           | -176 |
| 700      | 0.910           | -179 | 0.86            | 23 | 0.013           | 89   | 0.867           | -177 |
| 800      | 0.932           | 179  | 0.74            | 18 | 0.035           | 61   | 0.904           | 178  |
| 900      | 0.966           | 176  | 0.63            | 12 | 0.029           | 68   | 0.897           | 179  |
| 1000     | 0.975           | 172  | 0.54            | 5  | 0.042           | 49   | 0.953           | 174  |

Table 2. Common Source S-Parameters ( $V_{DS} = 28\text{ V}$ ,  $I_D = 250\text{ mA}$ )

| 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    |
| 30       | 0.601           | -86  | 22.20           | 128 | 0.040           | 29  | 0.796           | -119 |
| 40       | 0.783           | -112 | 21.20           | 114 | 0.037           | 27  | 0.616           | -122 |
| 50       | 0.764           | -122 | 18.50           | 108 | 0.038           | 21  | 0.637           | -133 |
| 60       | 0.727           | -131 | 15.50           | 101 | 0.045           | 21  | 0.574           | -135 |
| 70       | 0.759           | -138 | 13.50           | 100 | 0.039           | 12  | 0.648           | -143 |
| 80       | 0.751           | -142 | 12.10           | 95  | 0.040           | 9   | 0.649           | -148 |
| 90       | 0.732           | -146 | 10.70           | 93  | 0.040           | 8   | 0.641           | -150 |
| 100      | 0.737           | -149 | 9.55            | 90  | 0.040           | 6   | 0.648           | -153 |
| 110      | 0.741           | -150 | 8.81            | 88  | 0.040           | 4   | 0.670           | -155 |
| 120      | 0.738           | -153 | 8.01            | 85  | 0.040           | 3   | 0.654           | -156 |
| 130      | 0.740           | -154 | 7.47            | 83  | 0.040           | 2   | 0.675           | -157 |
| 140      | 0.747           | -156 | 7.01            | 82  | 0.040           | 1   | 0.684           | -158 |
| 150      | 0.754           | -157 | 6.43            | 79  | 0.040           | -2  | 0.669           | -161 |
| 160      | 0.757           | -159 | 6.07            | 77  | 0.039           | -3  | 0.693           | -161 |
| 170      | 0.749           | -159 | 5.59            | 76  | 0.038           | -3  | 0.670           | -161 |
| 180      | 0.753           | -160 | 5.28            | 75  | 0.039           | -4  | 0.701           | -163 |
| 190      | 0.759           | -161 | 4.99            | 73  | 0.039           | -5  | 0.712           | -164 |
| 200      | 0.761           | -161 | 4.81            | 70  | 0.038           | -7  | 0.719           | -165 |
| 210      | 0.759           | -162 | 4.44            | 70  | 0.037           | -6  | 0.713           | -163 |
| 220      | 0.762           | -163 | 4.18            | 69  | 0.037           | -7  | 0.709           | -164 |
| 230      | 0.771           | -164 | 4.03            | 66  | 0.037           | -9  | 0.733           | -167 |
| 240      | 0.775           | -164 | 3.83            | 65  | 0.036           | -10 | 0.715           | -165 |
| 250      | 0.774           | -165 | 3.69            | 64  | 0.035           | -10 | 0.713           | -166 |
| 260      | 0.775           | -165 | 3.52            | 63  | 0.034           | -10 | 0.715           | -168 |
| 270      | 0.780           | -165 | 3.29            | 61  | 0.034           | -10 | 0.712           | -168 |
| 280      | 0.782           | -165 | 3.24            | 61  | 0.034           | -11 | 0.741           | -168 |
| 290      | 0.781           | -166 | 3.10            | 59  | 0.032           | -12 | 0.722           | -168 |
| 300      | 0.785           | -166 | 3.01            | 58  | 0.033           | -11 | 0.733           | -168 |

Table 2. Common Source S-Parameters ( $V_{DS} = 28\text{ V}$ ,  $I_D = 250\text{ mA}$ ) (continued)

| 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> | ∠    |
| 310      | 0.792           | -167 | 2.87            | 57 | 0.032           | -12 | 0.750           | -167 |
| 320      | 0.798           | -167 | 2.75            | 56 | 0.032           | -12 | 0.739           | -166 |
| 330      | 0.801           | -168 | 2.68            | 53 | 0.031           | -13 | 0.760           | -170 |
| 340      | 0.800           | -168 | 2.58            | 53 | 0.030           | -14 | 0.727           | -172 |
| 350      | 0.803           | -169 | 2.44            | 52 | 0.029           | -12 | 0.755           | -170 |
| 360      | 0.807           | -169 | 2.33            | 50 | 0.029           | -12 | 0.772           | -171 |
| 370      | 0.808           | -169 | 2.30            | 50 | 0.029           | -12 | 0.787           | -169 |
| 380      | 0.809           | -169 | 2.19            | 48 | 0.028           | -13 | 0.768           | -170 |
| 390      | 0.813           | -170 | 2.14            | 49 | 0.027           | -13 | 0.775           | -169 |
| 400      | 0.820           | -170 | 2.06            | 47 | 0.026           | -11 | 0.765           | -167 |
| 410      | 0.823           | -170 | 2.02            | 45 | 0.027           | -12 | 0.805           | -170 |
| 420      | 0.823           | -171 | 1.98            | 44 | 0.026           | -13 | 0.794           | -173 |
| 430      | 0.824           | -171 | 1.89            | 44 | 0.025           | -12 | 0.778           | -174 |
| 440      | 0.828           | -172 | 1.83            | 43 | 0.024           | -11 | 0.785           | -173 |
| 450      | 0.832           | -172 | 1.81            | 41 | 0.024           | -10 | 0.812           | -172 |
| 460      | 0.833           | -172 | 1.75            | 41 | 0.025           | -13 | 0.838           | -175 |
| 470      | 0.835           | -172 | 1.65            | 41 | 0.023           | -11 | 0.817           | -173 |
| 480      | 0.840           | -172 | 1.60            | 40 | 0.022           | -10 | 0.818           | -172 |
| 490      | 0.844           | -173 | 1.55            | 38 | 0.022           | -10 | 0.819           | -172 |
| 500      | 0.845           | -173 | 1.56            | 37 | 0.022           | -10 | 0.833           | -173 |
| 600      | 0.879           | -176 | 1.21            | 29 | 0.002           | 138 | 0.870           | -176 |
| 700      | 0.912           | -179 | 0.92            | 23 | 0.017           | 77  | 0.862           | -176 |
| 800      | 0.935           | 179  | 0.79            | 18 | 0.039           | 58  | 0.887           | 179  |
| 900      | 0.966           | 176  | 0.67            | 11 | 0.030           | 69  | 0.892           | 179  |
| 1000     | 0.974           | 172  | 0.57            | 5  | 0.043           | 49  | 0.945           | 175  |

## PACKAGE DIMENSIONS

