

# CRF24060

## 60 W, SiC RF Power MESFET

Cree's CRF24060 is an unmatched silicon carbide (SiC) RF power Metal-Semiconductor Field-Effect Transistor (MESFET). SiC has superior properties compared to silicon or gallium arsenide, including higher breakdown voltage, higher saturated electron drift velocity, and higher thermal conductivity. SiC MESFETs offer greater efficiency, greater power density, and wider bandwidths compared to Si and GaAs transistors.



Package Type: 440193  
PN: CRF24060F

### FEATURES

- 13 dB Small Signal Gain
- High Efficiency
- 50 W minimum  $P_{1dB}$
- Up to 2400 MHz Operation
- 48 V Operation
- High Breakdown Voltage
- High Temperature Operation

### APPLICATIONS

- Wideband Military Communications
- Secure Comms for Homeland Defense
- Class A, A/B Amplifiers
- TDMA, EDGE, CDMA, W-CDMA
- Broadband Amplifiers
- MMDS

### Typical Performance

- Drain Efficiency of 45% at 1500 MHz at 60 W  $P_{OUT}$
- IMD -31 dBc at 1000 MHz at 50 W PEP
- 13 dB Small Signal Gain at 1500 MHz
- 60 W @  $P_{1dB}$  at 1500 MHz
- 80 W  $P_{3dB}$  at 1500 MHz

Note: Measured in amplifier circuit CRF24060-TB at  $V_{DS} = 48$  V,  $I_{DQ} = 2000$  mA.





## Absolute Maximum Ratings (not simultaneous) at 25 °C Case Temperature

Parameter	Symbol	Rating	Units
Drain-source Voltage	$V_{DSS}$	120	Volts
Gate to source Voltage	$V_{GS}$	-20, +3	Volts
Storage Temperature	$T_{STG}$	-55, +150	°C
Operating Junction Temperature	$T_J$	255	°C
Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.4	°C/W
Screw Torque	T	80	in-oz
Soldering Temperature	$T_S$	225	°C

## Electrical Characteristics ( $T_C = 25^\circ\text{C}$ )

Characteristics	Symbol	Min.	Typ.	Max.	Units	Conditions
<b>DC Characteristics<sup>3</sup></b>						
Gate Threshold Voltage	$V_{GS(th)}$	-13	-10	-	VDC	$V_{DS} = 10\text{ V}, I_D = 2.5\text{ mA}$
Gate Quiescent Voltage	$V_{GS(Q)}$	-	-7	-	VDC	$V_{DS} = 48\text{ V}, I_D = 2000\text{ mA}$
Zero Gate Voltage Drain Current	$I_{DSS}$	6.0	7.5	9.0	A	$V_{DS} = 10\text{ V}, V_{GS} = 0\text{ V}$
Drain-Source Breakdown Voltage	$V_{(BR)DSS}$	100	-	-	VDC	$V_{GS} = -18\text{ V}, I_D = 50\text{ mA}$
Forward Transconductance	$g_m$	700	800	-	mS	$V_{DS} = 48\text{ V}, I_D = 2000\text{ mA}$
Case Operating Temperature	$T_C$	-30	-	125	°C	
<b>RF Characteristics</b>						
Gain	$G_{SS}$	10	13	-	dB	$V_{DD} = 48\text{ V}, I_{DQ} = 2000\text{ mA}, f = 1100\text{ MHz}$
Power Output at 1 dB Compression	$P_{1dB}$	50	60	-	W	$V_{DD} = 48\text{ V}, I_{DQ} = 2000\text{ mA}, f = 1100\text{ MHz}$
Power Output at 3 dB Compression	$P_{3dB}$	-	80	-	W	$V_{DD} = 48\text{ V}, I_{DQ} = 2000\text{ mA}, f = 1100\text{ MHz}$
Drain Efficiency <sup>1,2</sup>	$\eta$	40	45	-	%	$V_{DD} = 48\text{ V}, I_{DQ} = 2000\text{ mA}, f = 1100\text{ MHz}, P_{OUT} = P_{1dB}$
Intermodulation Distortion	$IMD_3$	-	-31	-	dBc	$V_{DD} = 48\text{ V}, I_{DQ} = 2000\text{ mA}, f_1 = 1000\text{ MHz}, f_2 = 1000.1\text{ MHz}, P_{OUT} = 50\text{ W PEP}$
Output Mismatch Stress	VSWR	10 : 1	-	-	$\Psi$	No damage at all phase angles, $V_{DD} = 48\text{ V}, I_{DQ} = 2000\text{ mA}, f = 1000\text{ MHz}, P_{OUT} = 50\text{ W CW}$
<b>Dynamic Characteristics</b>						
Input Capacitance	$C_{DS}$	-	5.0	-	pF	$V_{DS} = 48\text{ V}, V_{GS} = -16\text{ V}, f = 1\text{ MHz}$
Output Capacitance	$C_{GS}$	-	15	-	pF	$V_{DS} = 48\text{ V}, V_{GS} = -16\text{ V}, f = 1\text{ MHz}$
Reverse Transfer Capacitance	$C_{GD}$	-	2.8	-	pF	$V_{DS} = 48\text{ V}, V_{GS} = -16\text{ V}, f = 1\text{ MHz}$

Notes:

<sup>1</sup> Drain Efficiency =  $P_{OUT} / P_{DC}$

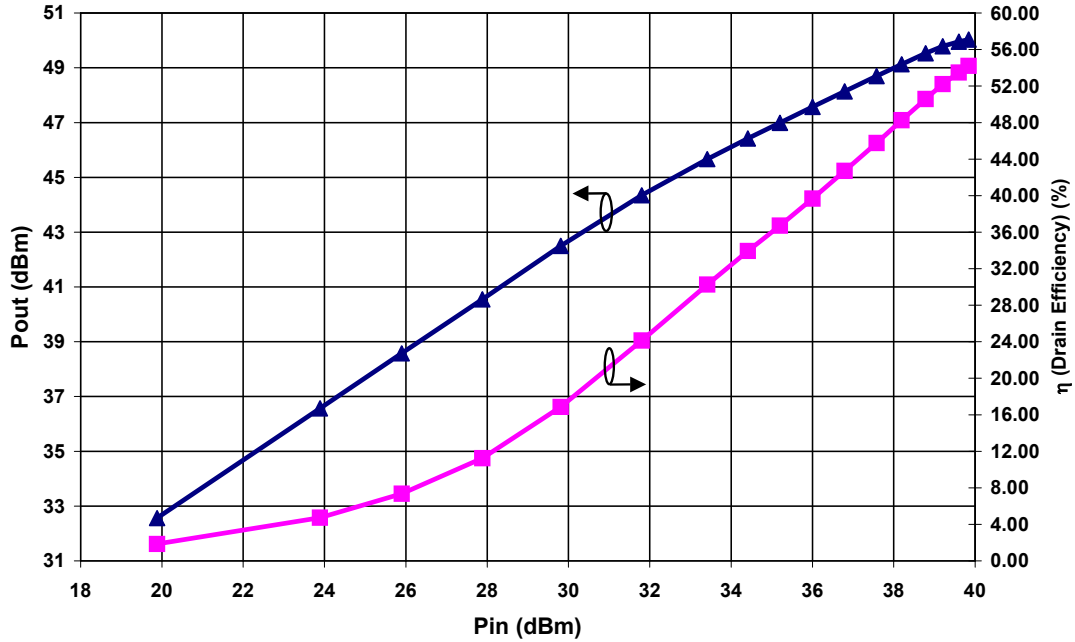
<sup>2</sup> Power Added Efficiency (PAE) =  $(P_{OUT} - P_{IN}) / P_{DC}$

<sup>3</sup> Measured on wafer prior to packaging.

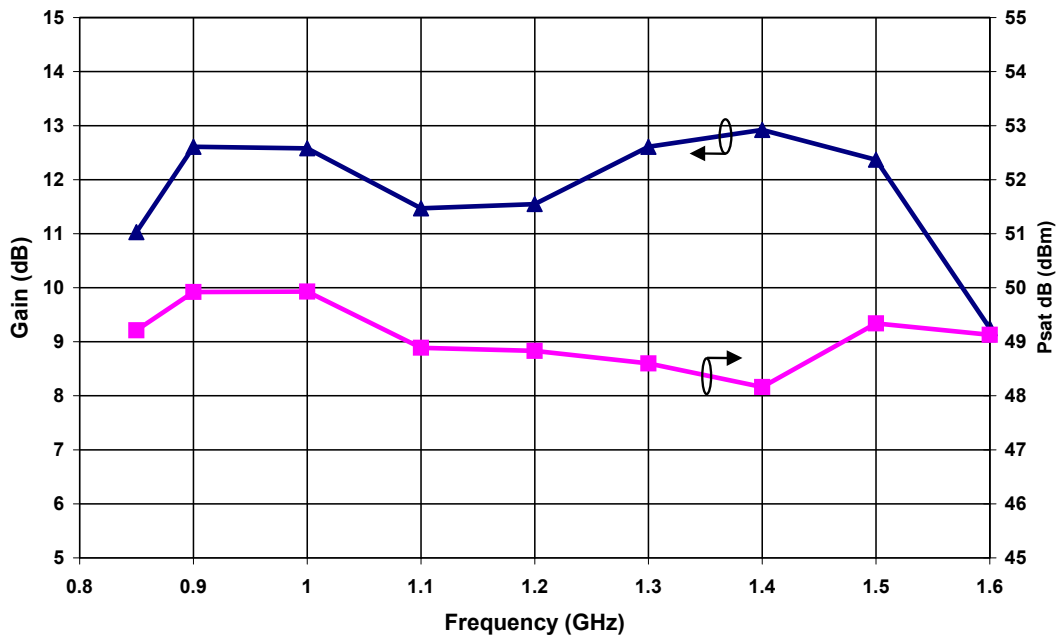


Typical Performance ( $T_c = 25^\circ C$ ,  $V_{DS} = 48 V$ ,  $I_{DQ} = 2000 mA$  in Flange Package)

### Typical Power Performance Swept CW Data vs Power at 1000 MHz



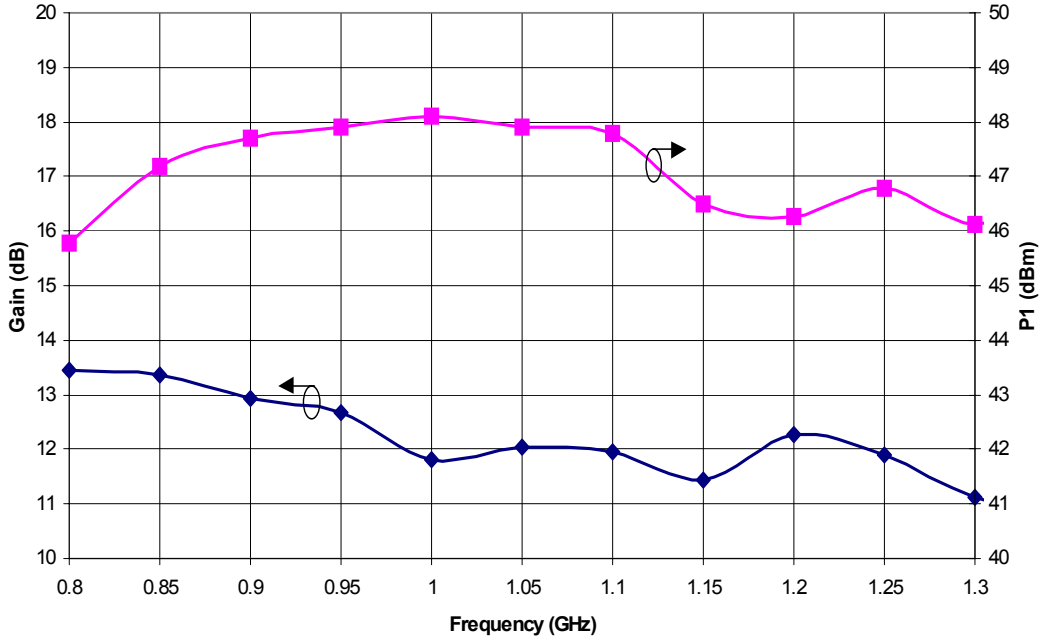
### Typical Wideband Performance Swept CW Data vs Frequency



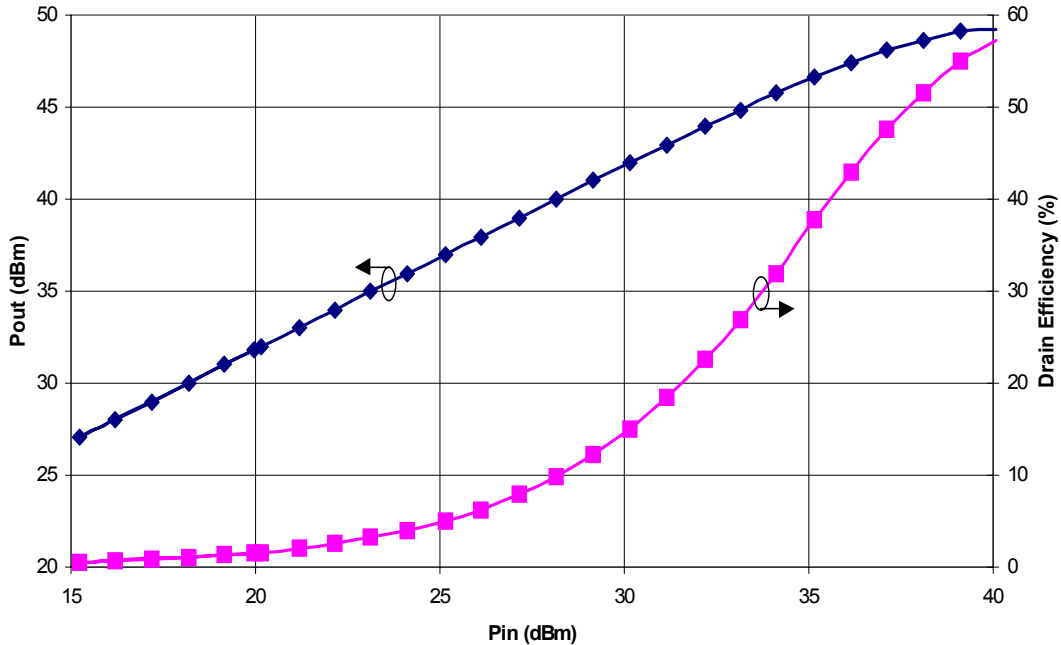


Typical Performance ( $V_{DS} = 48\text{ V}$ ,  $I_{DQ} = 2000\text{ mA}$  in the Flange Package)

Typical CW Gain and P1dB vs Frequency



CW Power Sweep at 1.0 GHz





**Typical Package S-Parameters**  
**(Small Signal,  $V_{DS} = 48\text{ V}$ ,  $I_{DQ} = 2000\text{ mA}$ , magnitude / angle)**

Frequency	S(1,1)	S(2,1)	S(1,2)	S(2,2)
100.0MHz	0.938 / -118.952	11.369 / 117.037	0.027 / 27.543	0.733 / -167.222
200.0MHz	0.924 / -147.861	6.296 / 100.583	0.030 / 11.594	0.786 / -173.220
300.0MHz	0.921 / -159.138	4.291 / 92.762	0.031 / 4.279	0.798 / -175.909
400.0MHz	0.919 / -165.208	3.247 / 87.448	0.031 / -0.529	0.803 / -177.489
500.0MHz	0.919 / -169.113	2.610 / 83.182	0.031 / -4.290	0.806 / -178.595
600.0MHz	0.919 / -171.919	2.183 / 79.451	0.031 / -7.515	0.807 / -179.462
700.0MHz	0.919 / -174.094	1.878 / 76.032	0.031 / -10.429	0.809 / 179.805
800.0MHz	0.919 / -175.877	1.648 / 72.813	0.031 / -13.144	0.810 / 179.152
900.0MHz	0.919 / -177.401	1.470 / 69.730	0.031 / -15.722	0.811 / 178.547
1.000GHz	0.919 / -178.747	1.328 / 66.746	0.031 / -18.201	0.812 / 177.972
1.100GHz	0.919 / -179.968	1.212 / 63.837	0.032 / -20.607	0.813 / 177.413
1.200GHz	0.919 / 178.901	1.116 / 60.986	0.032 / -22.954	0.814 / 176.861
1.300GHz	0.919 / 177.835	1.036 / 58.182	0.032 / -25.254	0.815 / 176.310
1.400GHz	0.919 / 176.816	0.967 / 55.418	0.032 / -27.516	0.816 / 175.755
1.500GHz	0.920 / 175.830	0.908 / 52.686	0.032 / -29.746	0.817 / 175.192
1.600GHz	0.920 / 174.867	0.858 / 49.982	0.032 / -31.948	0.818 / 174.618
1.700GHz	0.920 / 173.917	0.813 / 47.301	0.033 / -34.128	0.819 / 174.029
1.800GHz	0.920 / 172.974	0.775 / 44.640	0.033 / -36.288	0.820 / 173.425
1.900GHz	0.920 / 172.032	0.741 / 41.996	0.033 / -38.432	0.821 / 172.802
2.000GHz	0.920 / 171.086	0.711 / 39.365	0.033 / -40.563	0.821 / 172.158
2.100GHz	0.920 / 170.130	0.685 / 36.744	0.034 / -42.685	0.821 / 171.492
2.200GHz	0.920 / 169.160	0.661 / 34.131	0.034 / -44.800	0.822 / 170.802
2.300GHz	0.919 / 168.172	0.641 / 31.522	0.035 / -46.911	0.822 / 170.086
2.400GHz	0.919 / 167.163	0.623 / 28.915	0.035 / -49.022	0.823 / 169.342
2.500GHz	0.919 / 166.127	0.607 / 26.305	0.035 / -51.135	0.823 / 168.568
2.600GHz	0.918 / 165.062	0.594 / 23.689	0.036 / -53.255	0.823 / 167.762
2.700GHz	0.918 / 163.962	0.582 / 21.064	0.037 / -55.386	0.823 / 166.921
2.800GHz	0.917 / 162.824	0.572 / 18.426	0.037 / -57.530	0.822 / 166.043
2.900GHz	0.916 / 161.642	0.564 / 15.770	0.038 / -59.694	0.821 / 165.125
3.000GHz	0.915 / 160.412	0.557 / 13.091	0.039 / -61.880	0.820 / 164.164

Download this s-parameter file in ".s2p" format at [http://www.cree.com/products/wireless\\_s-parameters.asp](http://www.cree.com/products/wireless_s-parameters.asp)

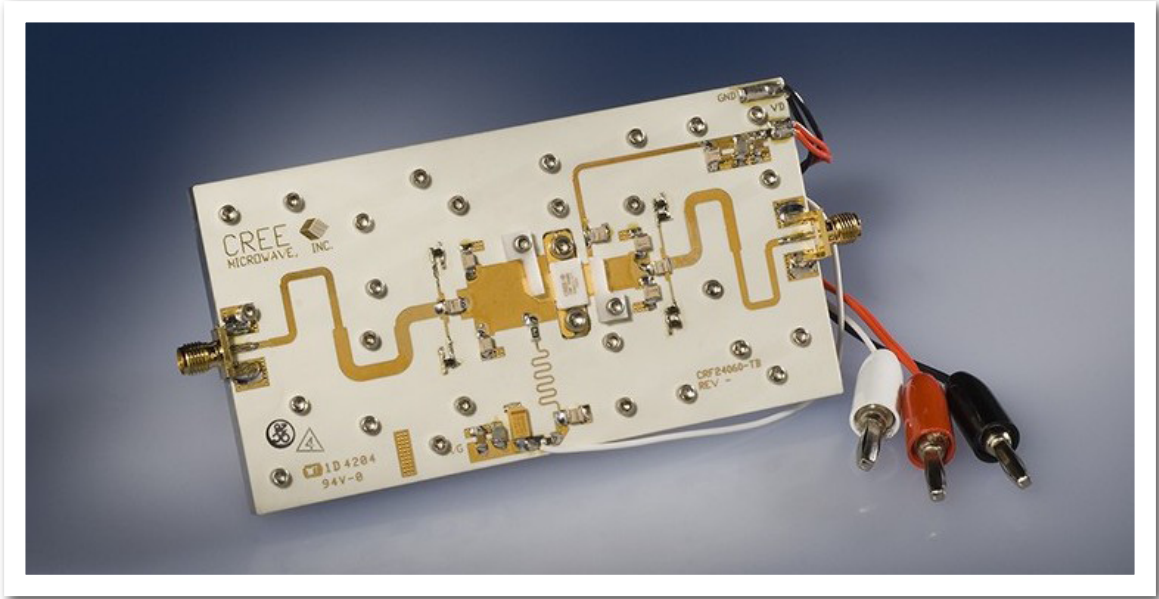


**Typical Package S-Parameters**  
**(Small Signal,  $V_{DS} = 48\text{ V}$ ,  $I_{DQ} = 1000\text{ mA}$ , magnitude / angle)**

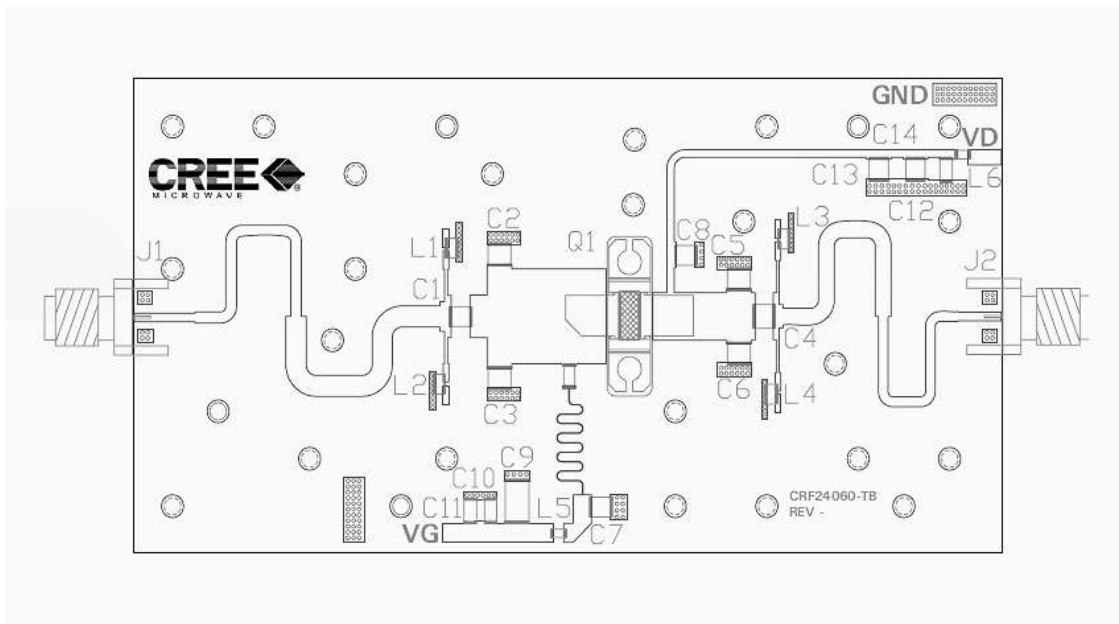
Frequency	S(1,1)	S(2,1)	S(1,2)	S(2,2)
100.0MHz	0.927 / -116.548	11.083 / 117.528	0.033 / 28.066	0.682 / -162.593
200.0MHz	0.909 / -146.266	6.173 / 100.326	0.037 / 11.402	0.745 / -170.406
300.0MHz	0.904 / -157.893	4.209 / 91.937	0.038 / 3.552	0.760 / -173.673
400.0MHz	0.903 / -164.137	3.182 / 86.138	0.038 / -1.708	0.767 / -175.463
500.0MHz	0.903 / -168.127	2.554 / 81.430	0.038 / -5.879	0.771 / -176.632
600.0MHz	0.903 / -170.973	2.132 / 77.286	0.039 / -9.485	0.774 / -177.490
700.0MHz	0.903 / -173.162	1.829 / 73.477	0.039 / -12.756	0.777 / -178.179
800.0MHz	0.904 / -174.945	1.602 / 69.888	0.039 / -15.808	0.780 / -178.772
900.0MHz	0.905 / -176.460	1.424 / 66.455	0.039 / -18.705	0.783 / -179.309
1.000GHz	0.906 / -177.792	1.282 / 63.140	0.039 / -21.483	0.785 / -179.817
1.100GHz	0.906 / -178.998	1.167 / 59.919	0.039 / -24.169	0.788 / 179.689
1.200GHz	0.907 / 179.888	1.070 / 56.776	0.039 / -26.777	0.791 / 179.195
1.300GHz	0.908 / 178.839	0.989 / 53.699	0.039 / -29.319	0.794 / 178.696
1.400GHz	0.909 / 177.835	0.920 / 50.680	0.039 / -31.803	0.797 / 178.185
1.500GHz	0.910 / 176.863	0.861 / 47.714	0.039 / -34.236	0.800 / 177.657
1.600GHz	0.911 / 175.912	0.809 / 44.794	0.039 / -36.623	0.803 / 177.111
1.700GHz	0.912 / 174.974	0.764 / 41.917	0.039 / -38.968	0.806 / 176.543
1.800GHz	0.912 / 174.040	0.725 / 39.077	0.039 / -41.277	0.809 / 175.952
1.900GHz	0.913 / 173.105	0.690 / 36.272	0.039 / -43.551	0.811 / 175.335
2.000GHz	0.914 / 172.165	0.659 / 33.498	0.039 / -45.796	0.814 / 174.693
2.100GHz	0.914 / 171.213	0.632 / 30.751	0.040 / -48.014	0.816 / 174.023
2.200GHz	0.915 / 170.247	0.608 / 28.027	0.040 / -50.210	0.819 / 173.325
2.300GHz	0.915 / 169.262	0.587 / 25.323	0.040 / -52.387	0.821 / 172.596
2.400GHz	0.916 / 168.255	0.568 / 22.635	0.040 / -54.549	0.823 / 171.837
2.500GHz	0.916 / 167.221	0.552 / 19.959	0.041 / -56.701	0.824 / 171.046
2.600GHz	0.916 / 166.157	0.537 / 17.290	0.041 / -58.846	0.826 / 170.220
2.700GHz	0.916 / 165.058	0.525 / 14.625	0.042 / -60.988	0.827 / 169.358
2.800GHz	0.916 / 163.922	0.514 / 11.959	0.042 / -63.134	0.828 / 168.459
2.900GHz	0.916 / 162.742	0.505 / 9.286	0.043 / -65.287	0.829 / 167.519
3.000GHz	0.915 / 161.514	0.497 / 6.601	0.044 / -67.452	0.829 / 166.536

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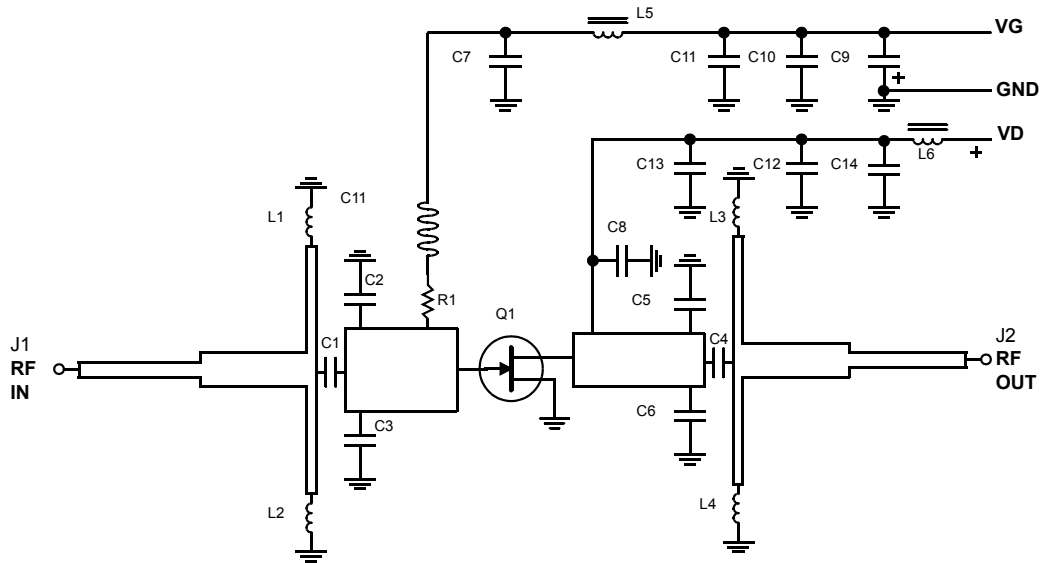
## CRF24060-TB Demonstration Test Fixture



## CRF24060-TB Demonstration Test Fixture Diagram



## CRF24060-TB Demonstration Test Fixture Schematic



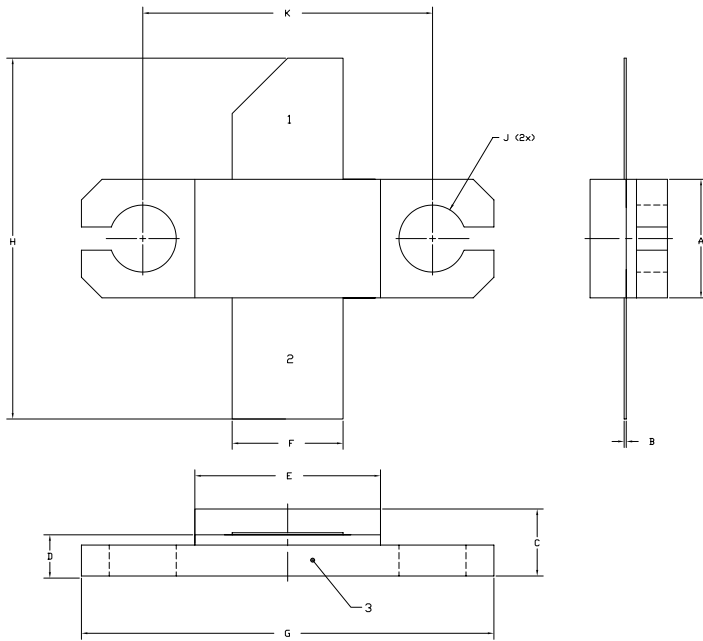
## CRF24060-TB Demonstration Test Fixture Bill of Materials

Designator	Description	Qty
C1	CAP, 10pF, DILABS C17AH, 100F, 7UXL	1
C2,C3	CAP, 3.9pF, DILABS C17AH, 3R9B, 7UXL	2
C4	CAP, 8.2pF, DILABS C17AH, 8R2A, 7UXL	1
C5,C6	CAP, 2.7pF, DILABS C17AH, 2R7A, 4UXL	2
C7,C8,C13	CAP, 30pF, DILABS C17AH, 300M, 7UXL	3
C9	CAP, 10uF, 25V, TANTALUM	1
C10,C12	CAP, 180pF, DILABS C17AH, 181J, 3UX	2
C11,C14	CAP, 0.1uF, 100V, 1206, CERAMIC	2
R1	RES, 27 OHM, 0.1W, 1206	1
L1,L2, L3,L4	MICROSPRING, 3T, COILCRAFT, 0906-3J	4
L5,L6	FERRITE, MURATA BLM21P220SG	2
J1,J2	CONNECTOR, SMA, FLANGE MOUNT, FEMALE	2
Q1	CRF24060	1

Note: Some values may differ due to substitution in the event of temporarily unavailable parts.



# Product Dimensions - CRF24060F (Package Type — 440193)



**NOTES:**

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. ADHESIVE FROM LID MAY EXTEND A MAXIMUM OF 0.020" BEYOND EDGE OF LID.
4. LID MAY BE MISALIGNED TO THE BODY OF THE PACKAGE BY A MAXIMUM OF 0.008" IN ANY DIRECTION.
5. ALL PLATED SURFACES ARE NI/AU

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.225	0.235	5.72	5.97
B	0.004	0.006	0.10	0.15
C	0.125	0.135	3.18	3.43
D	0.077	0.087	1.96	2.21
E	0.355	0.365	9.02	9.27
F	0.210	0.220	5.33	5.59
G	0.795	0.805	20.19	20.45
H	0.670	0.730	17.02	18.54
J	ø .130		3.30	
k	0.562		14.28	

- PIN 1. GATE  
 PIN 2. DRAIN  
 PIN 3. SOURCE



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