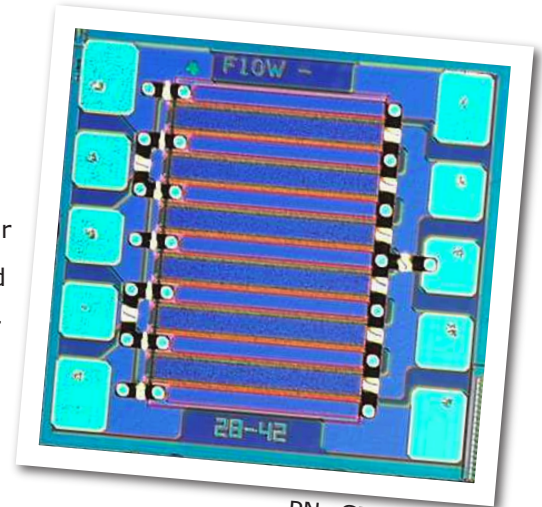


# CRF24010D

## 10 W SiC RF Power MESFET Die

Cree's CRF24010 is a 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 power density and wider bandwidths compared to Si and GaAs transistors.



PN: CRF24010D

### FEATURES

- 15 dB Small Signal Gain
- 10 W Minimum  $P_{1dB}$
- 48 V Operation
- High Breakdown Voltage
- High Temperature Operation
- Up to 5 GHz Operation
- High Efficiency

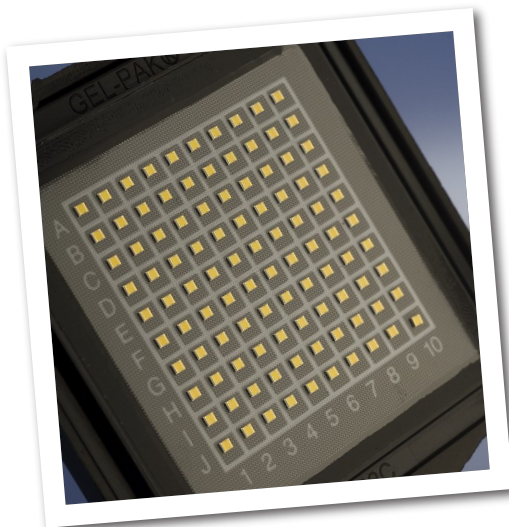
### APPLICATIONS

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



### Packaging Information

- Bare die are shipped in Gel-Pak® containers.
- Non-adhesive tacky membrane immobilizes die during shipment.





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

Parameter	Symbol	Rating	Units
Drain-source Voltage	$V_{DSS}$	120	VDC
Gate-source Voltage	$V_{GS}$	-20, +3	VDC
Storage Temperature	$T_{STG}$	-55, 150	°C
Operating Junction Temperature	$T_J$	255	°C
Thermal Resistance, Junction to Case <sup>1</sup>	$R_{\theta JC}$	5.6	°C/W
Mounting Temperature (30 seconds)	$T_S$	320	°C

<sup>1</sup>Eutectic die attach using 80/20 AuSn mounted to a 40 mil thick CuMoCu carrier.

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## Electrical Characteristics ( $T_c = 25^\circ C$ )

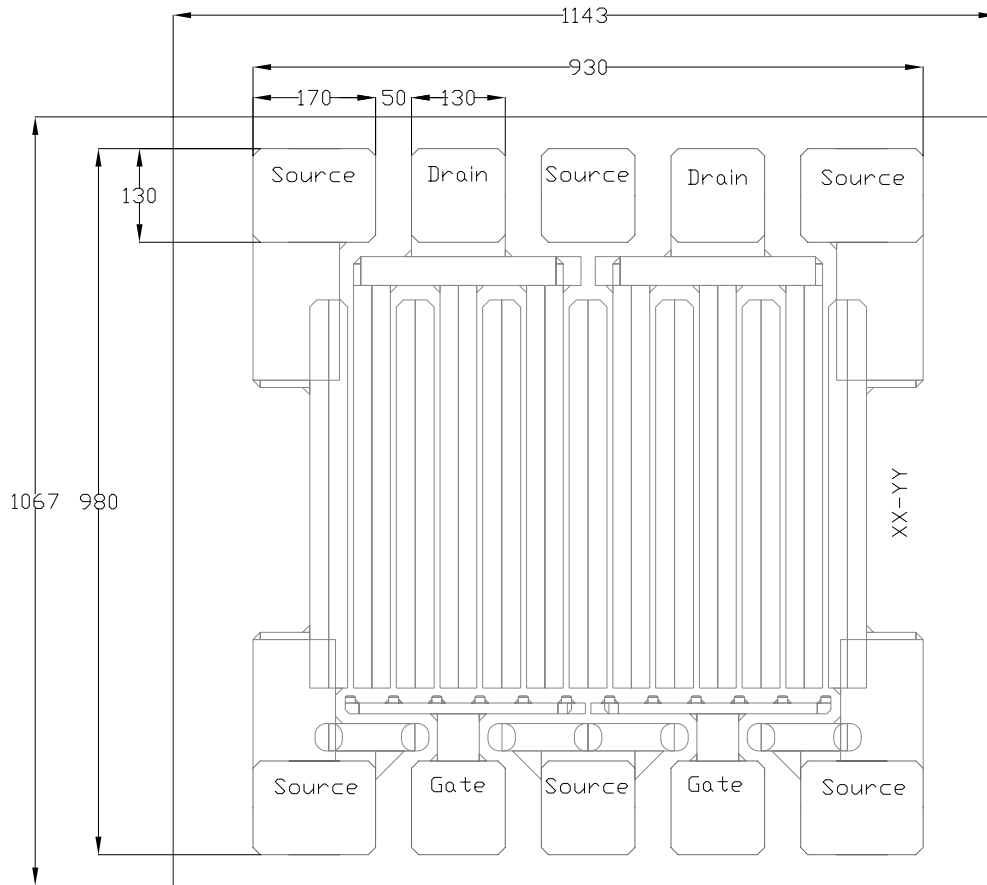
Characteristics	Symbol	Min.	Typ.	Max.	Units	Conditions
<b>DC Characteristics</b>						
Gate Threshold Voltage	$V_{GS(th)}$	-12	-10	-	VDC	$V_{DS} = 10 V, I_D = 0.5 mA$
Gate Quiescent Voltage	$V_{GS(Q)}$	-	-9	-	VDC	$V_{DS} = 48 V, I_D = 250 mA$
Zero Gate Voltage Drain Current	$I_{DSS}$	1.2	1.5	1.8	A	$V_{DS} = 10 V, V_{GS} = 0 V$
Drain-Source Breakdown Voltage	$V_{(BR)DSS}$	100	-	-	VDC	$V_{GS} = -18 V, I_D = 10 mA$
Forward Transconductance	$g_m$	140	160	-	mS	$V_{DS} = 48 V, I_D = 250 mA$
<b>RF Characteristics</b>						
Gain	$G_{SS}$	13	15	-	dB	$V_{DD} = 48 V, I_{DQ} = 500 mA, f = 2000 MHz$
Power Output at 1 dB Compression	$P_{1dB}$	10	12	-	W	$V_{DD} = 48 V, I_{DQ} = 500 mA, f = 2000 MHz$
Drain Efficiency <sup>1,2</sup>	$\eta$	40	45	-	%	$V_{DD} = 48 V, I_{DQ} = 250 mA, f = 2000 MHz$ $P_{OUT} = P_{1dB}$
Intermodulation Distortion	$IMD_3$	-	-31	-	dBc	$V_{DD} = 48 V, I_{DQ} = 250 mA$ $f1 = 2000.0 MHz, f2 = 2000.1 MHz$ $P_{OUT} = 10 W PEP$
Minimum Noise Figure	$NF_{min}$	-	3.1	-	dB	$V_{DD} = 48 V, I_{DQ} = 500 mA, f = 2000 MHz$
Output Mismatch Stress	VSWR	10:1	-	-	-	No damage at all phase angles $V_{DD} = 48 V, I_{DQ} = 500 mA, f = 2000 MHz$ $P_{OUT} = 10 W CW$
<b>Dynamic Characteristics</b>						
Input Capacitance	$C_{ISS}$	-	1.9	-	pF	$V_{DS} = 48 V, V_{GS} = -16 V, f = 1 MHz$
Output Capacitance	$C_{OSS}$	-	1.3	-	pF	$V_{DS} = 48 V, V_{GS} = -16 V, f = 1 MHz$
Reverse Transfer Capacitance	$C_{RSS}$	-	0.44	-	pF	$V_{DS} = 48 V, V_{GS} = -16 V, f = 1 MHz$

Notes:

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

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

## DIE Dimensions (units in microns)



Overall die size 1143 x 1067 (+/-25) microns, die thickness 300 microns  
 All pads must be bonded for electrical connection (sources not connected to backside metal).

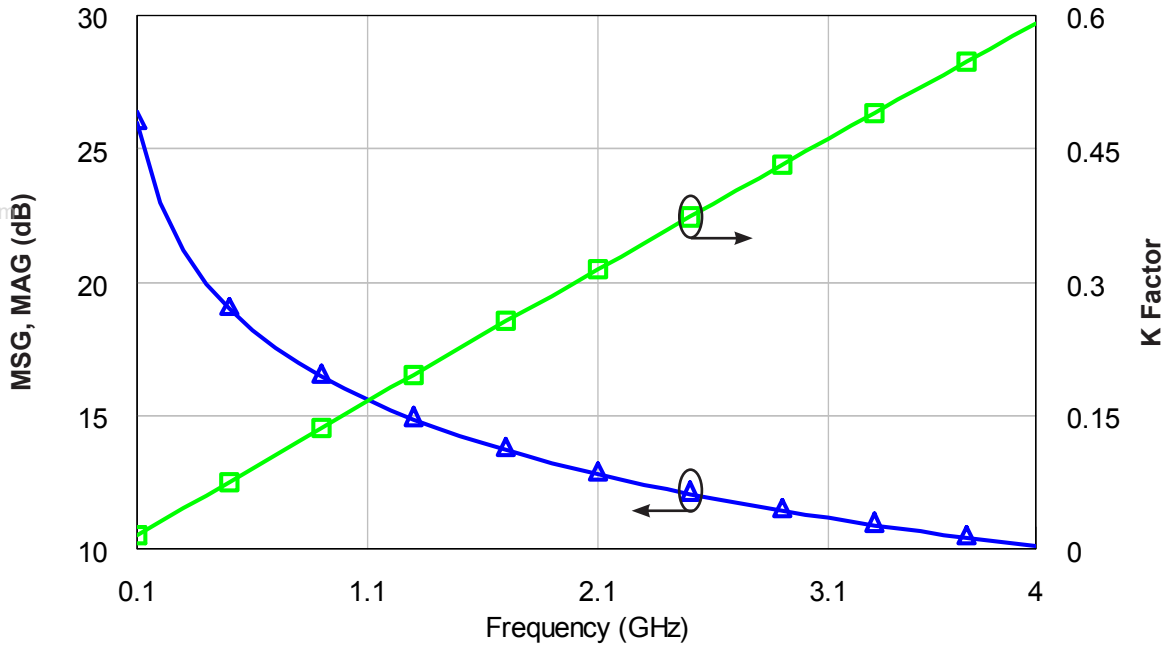
### Assembly Notes:

- Recommended solder is AuSn (80/20) solder. Refer to Cree's website for the Eutectic Die Bond Procedure application note at [www.cree.com/wireless](http://www.cree.com/wireless).
- Vacuum collet is the preferred method of pick-up.
- Die back side gold plating is 5 microns thick minimum.
- Use caution to prevent air bridge damage.
- Thermosonic ball or wedge bonding are the preferred connection methods.
- Gold wire must be used for connections.

## Typical Performance

### Maximum Stable Gain, Maximum Available Gain and K Factor of the CRF24010D

$$V_{DD} = 48 \text{ V}, I_{DQ} = 500 \text{ mA}$$



Intrinsic die parameters - reference planes at centers of gate and drain bonding pads. No wire bonds assumed.



**Typical Die S-Parameters (Small Signal,  $V_{DS} = 48\text{ V}$ ,  $I_{DQ} = 100\text{ mA}$ , magnitude / angle)**

Frequency	S(1,1)	S(2,1)	S(1,2)	S(2,2)
100.0MHz	0.99267 / -20.318	7.3595 / 167.29	0.022007 / 77.767	0.21373 / -34.427
200.0MHz	0.97487 / -39.393	6.9690 / 155.39	0.041676 / 66.345	0.24838 / -61.654
300.0MHz	0.95169 / -56.399	6.4362 / 144.80	0.057726 / 56.240	0.28699 / -81.339
400.0MHz	0.92819 / -71.036	5.8598 / 135.68	0.070063 / 47.592	0.32133 / -95.582
500.0MHz	0.90720 / -83.393	5.3038 / 127.90	0.079249 / 40.293	0.34943 / -106.11
600.0MHz	0.88969 / -93.743	4.7982 / 121.26	0.086009 / 34.138	0.37185 / -114.06
700.0MHz	0.87559 / -102.41	4.3520 / 115.56	0.090980 / 28.909	0.38986 / -120.19
800.0MHz	0.86443 / -109.70	3.9633 / 110.59	0.094652 / 24.418	0.40462 / -124.97
900.0MHz	0.85567 / -115.87	3.6261 / 106.20	0.097381 / 20.511	0.41706 / -128.78
1.000GHz	0.84882 / -121.13	3.3334 / 102.28	0.099416 / 17.069	0.42785 / -131.83
1.100GHz	0.84349 / -125.66	3.0784 / 98.737	0.100930 / 14.000	0.43750 / -134.32
1.200GHz	0.83935 / -129.58	2.8551 / 95.493	0.102060 / 11.233	0.44633 / -136.37
1.300GHz	0.83616 / -133.00	2.6585 / 92.497	0.102890 / 8.7128	0.45461 / -138.07
1.400GHz	0.83374 / -136.02	2.4845 / 89.705	0.103470 / 6.3968	0.46250 / -139.51
1.500GHz	0.83192 / -138.69	2.3297 / 87.084	0.103870 / 4.2514	0.47012 / -140.72
1.600GHz	0.83061 / -141.07	2.1910 / 84.608	0.104120 / 2.2500	0.47757 / -141.76
1.700GHz	0.82972 / -143.21	2.0664 / 82.256	0.104240 / 0.3715	0.48490 / -142.67
1.800GHz	0.82916 / -145.13	1.9537 / 80.009	0.104260 / -1.4013	0.49216 / -143.46
1.900GHz	0.82890 / -146.88	1.8514 / 77.855	0.104190 / -3.0824	0.49937 / -144.16
2.000GHz	0.82888 / -148.47	1.7582 / 75.783	0.104040 / -4.6831	0.50655 / -144.79
2.100GHz	0.82907 / -149.93	1.6728 / 73.781	0.103830 / -6.2130	0.51372 / -145.36
2.200GHz	0.82944 / -151.27	1.5945 / 71.844	0.103560 / -7.6798	0.52088 / -145.88
2.300GHz	0.82996 / -152.51	1.5223 / 69.964	0.103240 / -9.0901	0.52803 / -146.37
2.400GHz	0.83062 / -153.66	1.4556 / 68.136	0.102880 / -10.449	0.53518 / -146.82
2.500GHz	0.83139 / -154.73	1.3937 / 66.354	0.102480 / -11.763	0.54231 / -147.25
2.600GHz	0.83226 / -155.72	1.3362 / 64.616	0.102050 / -13.034	0.54943 / -147.66
2.700GHz	0.83321 / -156.66	1.2826 / 62.918	0.101590 / -14.266	0.55653 / -148.06
2.800GHz	0.83425 / -157.54	1.2326 / 61.256	0.101090 / -15.462	0.56361 / -148.44
2.900GHz	0.83534 / -158.37	1.1857 / 59.628	0.100580 / -16.626	0.57065 / -148.82
3.000GHz	0.83650 / -159.15	1.1418 / 58.032	0.100040 / -17.758	0.57766 / -149.18
3.100GHz	0.83771 / -159.89	1.1005 / 56.467	0.099479 / -18.862	0.58463 / -149.55
3.200GHz	0.83896 / -160.60	1.0617 / 54.929	0.098901 / -19.939	0.59154 / -149.90
3.300GHz	0.84024 / -161.27	1.0250 / 53.418	0.098306 / -20.989	0.59841 / -150.26
3.400GHz	0.84156 / -161.92	0.99039 / 51.932	0.097697 / -22.016	0.60522 / -150.61
3.500GHz	0.84291 / -162.53	0.95764 / 50.471	0.097075 / -23.020	0.61196 / -150.97
3.600GHz	0.84427 / -163.12	0.92662 / 49.033	0.096440 / -24.001	0.61863 / -151.32
3.700GHz	0.84566 / -163.69	0.89720 / 47.616	0.095794 / -24.962	0.62523 / -151.67
3.800GHz	0.84705 / -164.24	0.86925 / 46.221	0.095139 / -25.903	0.63176 / -152.02
3.900GHz	0.84846 / -164.77	0.84268 / 44.847	0.094475 / -26.825	0.63820 / -152.38
4.000GHz	0.84988 / -165.28	0.81739 / 43.492	0.093804 / -27.728	0.64457 / -152.73



**Typical Die S-Parameters (Small Signal,  $V_{DS} = 48\text{ V}$ ,  $I_{DQ} = 250\text{ mA}$ , magnitude / angle)**

Frequency	S(1,1)	S(2,1)	S(1,2)	S(2,2)
100.0MHz	0.99189 / -21.939	8.4860 / 166.58	0.021161 / 77.031	0.17500 / -46.177
200.0MHz	0.97244 / -42.339	7.9748 / 154.15	0.039769 / 65.054	0.23158 / -76.017
300.0MHz	0.94793 / -60.239	7.2952 / 143.28	0.054564 / 54.646	0.28669 / -94.931
400.0MHz	0.92397 / -75.374	6.5808 / 134.09	0.065617 / 45.910	0.33137 / -107.91
500.0MHz	0.90330 / -87.935	5.9095 / 126.40	0.073639 / 38.667	0.36554 / -117.30
600.0MHz	0.88653 / -98.303	5.3125 / 119.92	0.079419 / 32.650	0.39141 / -124.32
700.0MHz	0.87333 / -106.88	4.7948 / 114.42	0.083602 / 27.600	0.41127 / -129.69
800.0MHz	0.86307 / -114.02	4.3502 / 109.67	0.086655 / 23.304	0.42690 / -133.87
900.0MHz	0.85513 / -120.02	3.9687 / 105.51	0.088904 / 19.595	0.43957 / -137.18
1.000GHz	0.84898 / -125.10	3.6404 / 101.81	0.090572 / 16.346	0.45018 / -139.83
1.100GHz	0.84421 / -129.45	3.3565 / 98.471	0.091814 / 13.463	0.45935 / -141.98
1.200GHz	0.84053 / -133.21	3.1093 / 95.428	0.092735 / 10.873	0.46751 / -143.74
1.300GHz	0.83769 / -136.47	2.8927 / 92.624	0.093412 / 8.5216	0.47495 / -145.20
1.400GHz	0.83552 / -139.34	2.7017 / 90.016	0.093899 / 6.3653	0.48188 / -146.42
1.500GHz	0.83389 / -141.88	2.5323 / 87.571	0.094235 / 4.3715	0.48846 / -147.45
1.600GHz	0.83270 / -144.14	2.3811 / 85.262	0.094449 / 2.5140	0.49480 / -148.32
1.700GHz	0.83186 / -146.16	2.2455 / 83.070	0.094564 / 0.77226	0.50097 / -149.07
1.800GHz	0.83132 / -147.98	2.1231 / 80.977	0.094596 / -0.87042	0.50703 / -149.71
1.900GHz	0.83103 / -149.63	2.0123 / 78.970	0.094558 / -2.4275	0.51301 / -150.27
2.000GHz	0.83095 / -151.14	1.9114 / 77.039	0.094461 / -3.9099	0.51895 / -150.77
2.100GHz	0.83105 / -152.51	1.8192 / 75.174	0.094313 / -5.3268	0.52487 / -151.21
2.200GHz	0.83130 / -153.78	1.7346 / 73.367	0.094313 / -5.3268	0.53078 / -151.61
2.300GHz	0.83169 / -154.94	1.6568 / 71.612	0.093888 / -7.9928	0.53668 / -151.97
2.400GHz	0.83219 / -156.02	1.5849 / 69.905	0.093621 / -9.2534	0.54259 / -152.30
2.500GHz	0.83279 / -157.03	1.5183 / 68.240	0.093323 / -10.472	0.54850 / -152.61
2.600GHz	0.83348 / -157.97	1.4565 / 66.615	0.092997 / -11.653	0.55442 / -152.91
2.700GHz	0.83425 / -158.84	1.3989 / 65.024	0.092646 / -12.798	0.56034 / -153.18
2.800GHz	0.83509 / -159.67	1.3452 / 63.467	0.092272 / -13.912	0.56626 / -153.45
2.900GHz	0.83598 / -160.45	1.2949 / 61.940	0.091878 / -14.996	0.57218 / -153.71
3.000GHz	0.83693 / -161.18	1.2477 / 60.441	0.091464 / -16.052	0.57809 / -153.96
3.100GHz	0.83793 / -161.88	1.2034 / 58.968	0.091034 / -17.083	0.58400 / -154.21
3.200GHz	0.83897 / -162.54	1.1617 / 57.520	0.090587 / -18.090	0.58989 / -154.45
3.300GHz	0.84005 / -163.17	1.1224 / 56.097	0.090127 / -19.074	0.59577 / -154.69
3.400GHz	0.84116 / -163.77	1.0852 / 54.695	0.089653 / -20.037	0.60162 / -154.93
3.500GHz	0.84230 / -164.34	1.0501 / 53.314	0.089167 / -20.980	0.60744 / -155.18
3.600GHz	0.84346 / -164.90	1.0168 / 51.953	0.088670 / -21.903	0.61324 / -155.42
3.700GHz	0.84464 / -165.43	0.98524 / 50.611	0.088162 / -22.809	0.61900 / -155.66
3.800GHz	0.84584 / -165.94	0.95526 / 49.288	0.087646 / -23.697	0.62472 / -155.91
3.900GHz	0.84706 / -166.43	0.92673 / 47.982	0.087120 / -24.568	0.63039 / -156.16
4.000GHz	0.84829 / -166.90	0.89958 / 46.694	0.086587 / -25.423	0.63603 / -156.41



**Typical Die S-Parameters (Small Signal,  $V_{DS} = 48\text{ V}$ ,  $I_{DQ} = 500\text{ mA}$ , magnitude / angle)**

Frequency	S(1,1)	S(2,1)	S(1,2)	S(2,2)
100.0MHz	0.9908 / -23.969	9.7872 / 165.59	0.020995 / 76.032	0.16990 / -54.425
200.0MHz	0.9690 / -45.966	9.1031 / 152.45	0.039053 / 63.323	0.24179 / -84.694
300.0MHz	0.9428 / -64.866	8.2244 / 141.21	0.052919 / 52.530	0.30581 / -102.83
400.0MHz	0.9183 / -80.486	7.3337 / 131.93	0.062908 / 43.686	0.39018 / -123.87
500.0MHz	0.8981 / -93.182	6.5231 / 124.31	0.06993 / 36.506	0.39018 / -123.87
600.0MHz	0.8822 / -103.48	5.8205 / 118.01	0.074861 / 30.639	0.41619 / -130.40
700.0MHz	0.8701 / -111.88	5.2235 / 112.71	0.078359 / 25.777	0.43558 / -135.36
800.0MHz	0.8609 / -118.79	4.7187 / 108.17	0.080873 / 21.679	0.45046 / -139.21
900.0MHz	0.8538 / -124.55	4.2908 / 104.22	0.082703 / 18.167	0.46229 / -142.25
1.000GHz	0.8484 / -129.40	3.9260 / 100.72	0.084048 / 15.106	0.47201 / -144.67
1.100GHz	0.8443 / -133.52	3.6128 / 97.580	0.085041 / 12.401	0.48027 / -146.64
1.200GHz	0.8412 / -137.07	3.3418 / 94.719	0.085773 / 9.9770	0.48752 / -148.24
1.300GHz	0.8387 / -140.15	3.1055 / 92.085	0.086307 / 7.7804	0.49406 / -149.50
1.400GHz	0.8369 / -142.84	2.8980 / 89.637	0.086688 / 5.7693	0.50009 / -150.67
1.500GHz	0.8355 / -145.22	2.7145 / 87.343	0.086948 / 3.9113	0.50577 / -151.60
1.600GHz	0.8345 / -147.33	2.5513 / 85.177	0.087112 / 2.1814	0.51121 / -152.38
1.700GHz	0.8338 / -149.22	2.4051 / 83.120	0.087196 / 0.5597	0.51648 / -153.04
1.800GHz	0.8334 / -150.92	2.2736 / 81.155	0.087214 / -0.9697	0.52164 / -153.62
1.900GHz	0.8332 / -152.46	2.1546 / 79.270	0.087177 / -2.4198	0.52673 / -154.11
2.000GHz	0.8331 / -153.86	2.0465 / 77.455	0.087092 / -3.8007	0.53178 / -154.54
2.100GHz	0.8332 / -155.14	1.9478 / 75.700	0.086967 / -5.1213	0.53681 / -154.92
2.200GHz	0.8334 / -156.31	1.8575 / 74.000	0.086806 / -6.3880	0.54183 / -155.26
2.300GHz	0.8338 / -157.40	1.7744 / 72.347	0.086613 / -7.6083	0.54686 / -155.56
2.400GHz	0.8342 / -158.40	1.6977 / 70.737	0.086392 / -8.7856	0.55191 / -155.83
2.500GHz	0.8347 / -159.34	1.6268 / 69.166	0.086147 / -9.9246	0.55696 / -156.08
2.600GHz	0.8353 / -160.21	1.5609 / 67.630	0.085878 / -11.029	0.56204 / -156.32
2.700GHz	0.8360 / -161.03	1.4996 / 66.127	0.085589 / -12.102	0.56713 / -156.53
2.800GHz	0.8367 / -161.80	1.4424 / 64.652	0.085281 / -13.146	0.57224 / -156.74
2.900GHz	0.8375 / -162.52	1.3890 / 63.206	0.084956 / -14.163	0.57736 / -156.94
3.000GHz	0.8383 / -163.20	1.3389 / 61.784	0.084616 / -15.155	0.58250 / -157.13
3.100GHz	0.8392 / -163.85	1.2918 / 60.387	0.084261 / -16.124	0.58764 / -157.32
3.200GHz	0.8401 / -164.46	1.2475 / 59.011	0.083892 / -17.072	0.59279 / -157.50
3.300GHz	0.8411 / -165.05	1.2058 / 57.656	0.083511 / -18.000	0.59794 / -157.69
3.400GHz	0.8420 / -165.61	1.1663 / 56.321	0.083119 / -18.908	0.60309 / -157.87
3.500GHz	0.8430 / -166.14	1.1291 / 55.005	0.082716 / -19.799	0.60823 / -158.05
3.600GHz	0.8441 / -166.65	1.0937 / 53.707	0.082303 / -20.672	0.61337 / -158.20
3.700GHz	0.8451 / -167.14	1.0602 / 52.425	0.081881 / -21.530	0.61849 / -158.42
3.800GHz	0.8462 / -167.62	1.0284 / 51.160	0.081451 / -22.371	0.62359 / -158.61
3.900GHz	0.8473 / -168.07	0.9982 / 49.910	0.081012 / -23.199	0.62868 / -158.80
4.000GHz	0.8484 / -168.52	0.9693 / 48.675	0.080567 / -24.011	0.63374 / -158.99



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