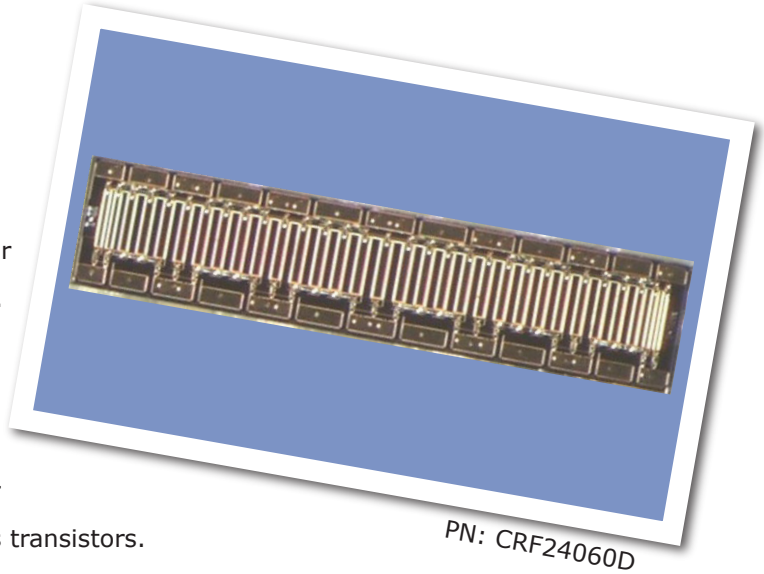
CRF24060D

60 W SiC RF Power MESFET Die


PN: CRF24060D

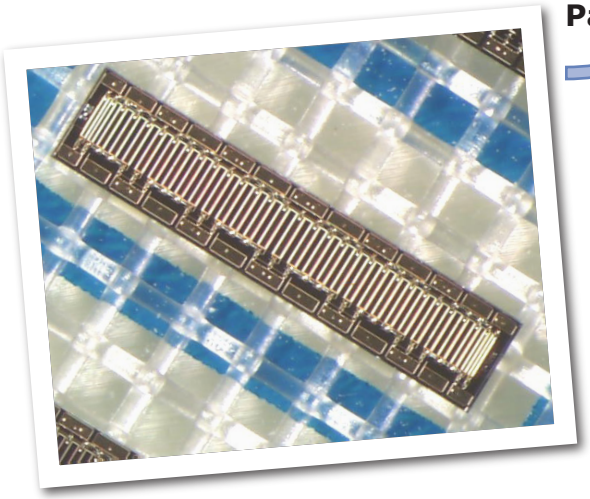
Cree's CRF24060 is a silicon carbide (SiC) RF power Metal-Semiconductor Field-Effect Transistor (MESFET). SiC has superior properties compared to silicon or gallium arsenide, including higher breakdown voltage, higher saturated electron drift velocity, and higher thermal conductivity. SiC MESFETs offer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

FEATURES

- 13 dB Small Signal Gain at 1.5 GHz
- 60 W Typical 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.

Rev 1.1 – November 2006

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[1]	$R_{\theta JC}$	1.4	˚C/W
Mounting Temperature (30 seconds)	T_S	320	˚C

[1]Eutectic die attach using 80/20 AuSn mounted to a 60 mil thick CuMoCu carrier.

Electrical Characteristics (TC = 25˚C)

(Measured using eutectic die attach with 80/20 AuSn solder mounted to a 60 mil thick CuMoCu carrier)

Characteristics	Symbol	Min.	Typ.	Max.	Units	Conditions
DC Characteristics						
Gate Threshold Voltage	$V_{GS(th)}$	-13	-10	–	VDC	V_{DS} = 10 V, I_D = 2.5 mA
Gate Quiescent Voltage	$V_{GS(Q)}$	–	-7	–	VDC	V_{DS} = 48 V, I_D = 2000 mA
Zero Gate Voltage Drain Current	I_{DSS}	6.0	7.5	9.0	A	V_{DS} = 10 V, V_{GS} = 0 V
Drain-Source Breakdown Voltage	$V_{(BR)DSS}$	100	–	–	VDC	V_{GS} = -18, I_D = 50 mA
Forward Transconductance	g_m	700	800	–	mS	V_{DS} = 48 V, I_D = 2000 mA
RF Characteristics						
Gain	G_{SS}	10	13	–	dB	V_{DD} = 48 V, I_{DQ} = 2000 mA, f = 1500 MHz
Power Output at 1 dB Compression	P_{1dB}	50	60	–	W	V_{DD} = 48 V, I_{DQ} = 2000 mA, f = 1500 MHz
Drain Efficiency[1,2]	η	40	45	–	%	V_{DD} = 48 V, I_{DQ} = 2000 mA, f = 1500 MHz P_{OUT} = P_{1dB}
Intermodulation Distortion	IMD_3	–	-31	–	dBc	V_{DD} = 48 V, I_{DQ} = 2000 mA f1 = 1000.0 MHz, f2 = 1000.1 MHz P_{OUT} = 50 W PEP
Output Mismatch Stress	VSWR	10:1	–	–	–	No damage at all phase angles V_{DD} = 48 V, I_{DQ} = 2000 mA, f = 1000 MHz P_{OUT} = 50 W CW
Dynamic Characteristics						
Input Capacitance	C_{DS}	–	9.5	–	pF	V_{DS} = 48 V, V_{gs} = -16 V, f = 1 MHz
Output Capacitance	C_{GS}	–	6.5	–	pF	V_{DS} = 48 V, V_{gs} = -16 V, f = 1 MHz
Reverse Transfer Capacitance	C_{GD}	–	2.2	–	pF	V_{DS} = 48 V, V_{gs} = -16 V, f = 1 MHz

Notes:

[1] Drain Efficiency = P_{OUT}/P_{DC}

[2] Power Added Efficiency (PAE) = $(P_{OUT}-P_{IN}) / P_{DC}$

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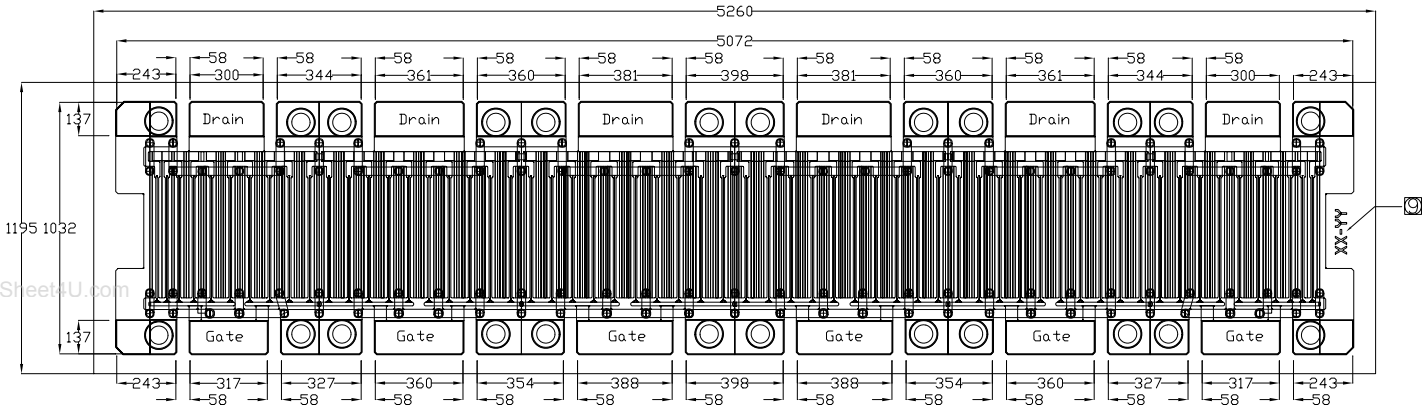
DIE Dimensions (units in microns)



Overall die size 5260 x 1195 microns, die thickness 100 microns
All pads must be bonded for electrical connection.

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.
- Vacuum collet is the preferred method of pick-up.
- The backside of the die is the source (ground) contact.
- Use the die label for the correct orientation.
- Die back side plating is 5 microns thick gold minimum.
- Use caution to prevent air bridge damage.
- Thermosonic ball or wedge bonding is the preferred connection method.
- Gold wire shall be used for connections.
- Use caution not to probe on the vias.

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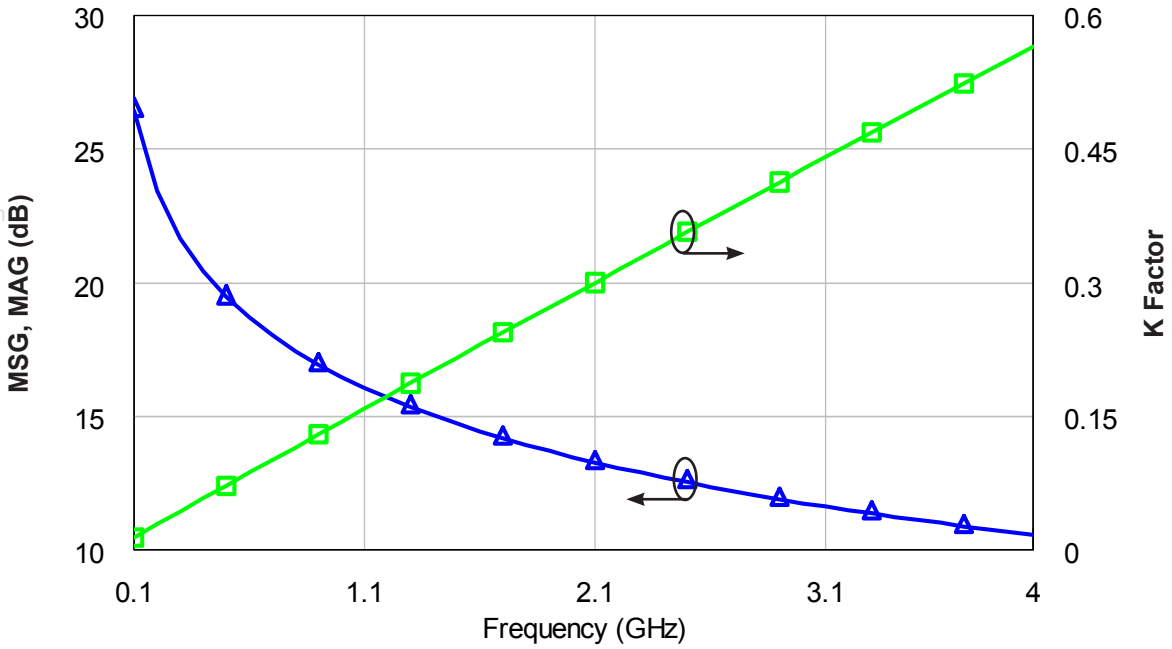
Typical Performance

Maximum Stable Gain, Maximum Available Gain and K Factor of the CRF24060D

V_{DD} = 48 V, I_{DQ} = 2000 mA



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

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

Frequency	S(1,1)	S(2,1)	S(1,2)	S(2,2)
100.0MHz	0.95715 / -101.01	8.9085 / 126.61	0.027027 / 37.088	0.71294 / -169.08
200.0MHz	0.93931 / -135.11	5.2813 / 107.99	0.032043 / 18.949	0.77416 / -172.52
300.0MHz	0.93437 / -149.10	3.6570 / 99.343	0.033278 / 10.779	0.79111 / -174.23
400.0MHz	0.93262 / -156.47	2.7776 / 93.930	0.033695 / 5.8455	0.79825 / -175.06
500.0MHz	0.93198 / -160.96	2.2320 / 89.916	0.033837 / 2.3103	0.80238 / -175.48
600.0MHz	0.93183 / -163.98	1.8616 / 86.629	0.033856 / -0.49809	0.80539 / -175.68
700.0MHz	0.93197 / -166.13	1.5938 / 83.770	0.033805 / -2.8795	0.80797 / -175.74
800.0MHz	0.93227 / -167.74	1.3912 / 81.184	0.033710 / -4.9867	0.81040 / -175.74
900.0MHz	0.93270 / -168.98	1.2324 / 78.789	0.033581 / -6.9049	0.81283 / -175.68
1.000GHz	0.93323 / -169.97	1.1046 / 76.531	0.033425 / -8.6855	0.81530 / -175.60
1.100GHz	0.93384 / -170.77	0.99935 / 74.378	0.033248 / -10.361	0.81787 / -175.49
1.200GHz	0.93451 / -171.44	0.91118 / 72.310	0.033050 / -11.953	0.82052 / -175.38
1.300GHz	0.93524 / -171.99	0.83618 / 70.311	0.032836 / -13.475	0.82328 / -175.26
1.400GHz	0.93602 / -172.47	0.77156 / 68.372	0.032607 / -14.939	0.82613 / -175.14
1.500GHz	0.93684 / -172.88	0.71528 / 66.484	0.032363 / -16.352	0.82906 / -175.03
1.600GHz	0.93770 / -173.24	0.66580 / 64.643	0.032107 / -17.719	0.83207 / -174.91
1.700GHz	0.93858 / -173.55	0.62194 / 62.844	0.031840 / -19.044	0.83515 / -174.80
1.800GHz	0.93949 / -173.83	0.58280 / 61.085	0.031563 / -20.330	0.83828 / -174.70
1.900GHz	0.94042 / -174.09	0.54764 / 59.362	0.031277 / -21.580	0.84145 / -174.61
2.000GHz	0.94137 / -174.31	0.51588 / 57.674	0.030983 / -22.796	0.84466 / -174.53
2.100GHz	0.94233 / -174.52	0.48705 / 56.020	0.030682 / -23.979	0.84789 / -174.45
2.200GHz	0.94330 / -174.71	0.46076 / 54.397	0.030375 / -25.131	0.85112 / -174.38
2.300GHz	0.94427 / -174.88	0.43669 / 52.806	0.030062 / -26.253	0.85437 / -174.32
2.400GHz	0.94525 / -175.05	0.41458 / 51.245	0.029746 / -27.345	0.85760 / -174.27
2.500GHz	0.94622 / -175.20	0.39420 / 49.713	0.029426 / -28.409	0.86082 / -174.23
2.600GHz	0.94720 / -175.34	0.37536 / 48.209	0.029103 / -29.446	0.86401 / -174.19
2.700GHz	0.94816 / -175.47	0.35790 / 46.734	0.028778 / -30.456	0.86718 / -174.17
2.800GHz	0.94912 / -175.60	0.34167 / 45.285	0.028451 / -31.439	0.87031 / -174.15
2.900GHz	0.95007 / -175.72	0.32656 / 43.863	0.028124 / -32.397	0.87340 / -174.13
3.000GHz	0.95101 / -175.84	0.31245 / 42.467	0.027796 / -33.330	0.87644 / -174.13
3.100GHz	0.95194 / -175.95	0.29926 / 41.096	0.027468 / -34.239	0.87944 / -174.13
3.200GHz	0.95286 / -176.06	0.28691 / 39.749	0.027141 / -35.124	0.88238 / -174.14
3.300GHz	0.95375 / -176.16	0.27532 / 38.428	0.026815 / -35.987	0.88526 / -174.15
3.400GHz	0.95464 / -176.26	0.26442 / 37.129	0.026491 / -36.826	0.88809 / -174.17
3.500GHz	0.95550 / -176.36	0.25417 / 35.854	0.026168 / -37.644	0.89086 / -174.19
3.600GHz	0.95635 / -176.45	0.24451 / 34.601	0.025848 / -38.440	0.89357 / -174.22
3.700GHz	0.95719 / -176.54	0.23539 / 33.371	0.025530 / -39.215	0.89622 / -174.25
3.800GHz	0.95800 / -176.63	0.22678 / 32.162	0.025215 / -39.970	0.89880 / -174.28
3.900GHz	0.95880 / -176.72	0.21864 / 30.974	0.024902 / -40.705	0.90132 / -174.32
4.000GHz	0.95958 / -176.80	0.21093 / 29.807	0.024593 / -41.421	0.90378 / -174.36

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Typical Die S-Parameters (Small Signal, V_{DS} = 48 V, I_{DQ} = 1000 mA, magnitude / angle)

Frequency	S(1,1)	S(2,1)	S(1,2)	S(2,2)
100.0MHz	0.95891 / -104.19	9.3337 / 125.32	0.024361 / 35.778	0.74246 / -170.26
200.0MHz	0.94349 / -137.38	5.4630 / 107.34	0.028516 / 18.252	0.79756 / -173.48
300.0MHz	0.93935 / -150.77	3.7704 / 99.161	0.029518 / 10.533	0.81232 / -175.04
400.0MHz	0.93788 / -157.79	2.8610 / 94.100	0.029859 / 5.9282	0.81839 / -175.81
500.0MHz	0.93731 / -162.07	2.2987 / 90.374	0.029982 / 2.6594	0.82178 / -176.21
600.0MHz	0.93715 / -164.94	1.9177 / 87.339	0.030008 / 0.081238	0.82416 / -176.41
700.0MHz	0.93721 / -166.99	1.6427 / 84.708	0.029981 / -2.0930	0.82613 / -176.50
800.0MHz	0.93740 / -168.52	1.4349 / 82.336	0.029919 / -4.0091	0.82795 / -176.52
900.0MHz	0.93770 / -169.71	1.2723 / 80.140	0.029832 / -5.7489	0.82974 / -176.50
1.000GHz	0.93807 / -170.65	1.1414 / 78.072	0.029725 / -7.3612	0.83155 / -176.44
1.100GHz	0.93850 / -171.42	1.0338 / 76.100	0.029602 / -8.8773	0.83342 / -176.37
1.200GHz	0.93898 / -172.06	0.94374 / 74.205	0.029463 / -10.318	0.83535 / -176.28
1.300GHz	0.93951 / -172.60	0.86715 / 72.371	0.029312 / -11.696	0.83736 / -176.19
1.400GHz	0.94008 / -173.05	0.80122 / 70.589	0.029149 / -13.024	0.83945 / -176.10
1.500GHz	0.94068 / -173.45	0.74382 / 68.853	0.028975 / -14.306	0.84162 / -176.00
1.600GHz	0.94131 / -173.79	0.69339 / 67.156	0.028791 / -15.549	0.84385 / -175.90
1.700GHz	0.94198 / -174.09	0.64870 / 65.495	0.028598 / -16.757	0.84614 / -175.81
1.800GHz	0.94266 / -174.36	0.60882 / 63.866	0.028397 / -17.933	0.84849 / -175.72
1.900GHz	0.94337 / -174.60	0.57301 / 62.269	0.028188 / -19.079	0.85090 / -175.63
2.000GHz	0.94409 / -174.82	0.54066 / 60.699	0.028188 / -19.079	0.85334 / -175.55
2.100GHz	0.94483 / -175.02	0.51128 / 59.158	0.027749 / -21.287	0.85582 / -175.47
2.200GHz	0.94483 / -175.02	0.48449 / 57.642	0.027521 / -22.352	0.85833 / -175.40
2.300GHz	0.94634 / -175.36	0.45996 / 56.151	0.027288 / -23.393	0.86086 / -175.34
2.400GHz	0.94711 / -175.52	0.43741 / 54.685	0.027050 / -24.410	0.86340 / -175.28
2.500GHz	0.94789 / -175.66	0.41661 / 53.243	0.026809 / -25.404	0.86595 / -175.23
2.600GHz	0.94867 / -175.79	0.39737 / 51.824	0.026563 / -26.376	0.86851 / -175.18
2.700GHz	0.94945 / -175.92	0.37952 / 50.427	0.026315 / -27.326	0.87106 / -175.14
2.800GHz	0.95023 / -176.03	0.36291 / 49.052	0.026064 / -28.254	0.87360 / -175.10
2.900GHz	0.95101 / -176.15	0.34743 / 47.699	0.025812 / -29.162	0.87614 / -175.08
3.000GHz	0.95178 / -176.25	0.33297 / 46.367	0.025557 / -30.049	0.87865 / -175.05
3.100GHz	0.95255 / -176.35	0.31943 / 45.056	0.025301 / -30.916	0.88114 / -175.03
3.200GHz	0.95332 / -176.45	0.30672 / 43.766	0.025045 / -31.764	0.88361 / -175.02
3.300GHz	0.95407 / -176.55	0.29479 / 42.496	0.024788 / -32.592	0.88605 / -175.01
3.400GHz	0.95482 / -176.64	0.28356 / 41.245	0.024530 / -33.401	0.88845 / -175.01
3.500GHz	0.95557 / -176.72	0.27298 / 40.014	0.024273 / -34.192	0.89083 / -175.01
3.600GHz	0.95630 / -176.81	0.26299 / 38.802	0.024016 / -34.965	0.89317 / -175.02
3.700GHz	0.95702 / -176.89	0.25355 / 37.609	0.023760 / -35.720	0.89547 / -175.03
3.800GHz	0.95773 / -176.97	0.24461 / 36.434	0.023505 / -36.458	0.89773 / -175.04
3.900GHz	0.95843 / -177.05	0.23615 / 35.277	0.023251 / -37.179	0.89995 / -175.06
4.000GHz	0.95843 / -177.05	0.22813 / 34.138	0.022998 / -37.883	0.90213 / -175.08

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Frequency	S(1,1)	S(2,1)	S(1,2)	S(2,2)
100.0MHz	0.95949 / -108.95	9.9164 / 123.17	0.022412 / 33.611	0.76603 / -170.90
200.0MHz	0.94641 / -140.66	5.6948 / 106.07	0.025741 / 16.953	0.81571 / -174.11
300.0MHz	0.94306 / -153.13	3.9112 / 98.475	0.026515 / 9.7970	0.82842 / -175.59
400.0MHz	0.94188 / -159.63	2.9628 / 93.803	0.026777 / 5.5651	0.83354 / -176.32
500.0MHz	0.94142 / -163.58	2.3791 / 90.373	0.026873 / 2.5747	0.83633 / -176.71
600.0MHz	0.94128 / -166.23	1.9846 / 87.581	0.026894 / 0.22293	0.83826 / -176.91
700.0MHz	0.94132 / -168.12	1.7004 / 85.161	0.026876 / -1.7569	0.83982 / -177.01
800.0MHz	0.94146 / -169.53	1.4858 / 82.978	0.026831 / -3.5000	0.84124 / -177.05
900.0MHz	0.94168 / -170.63	1.3180 / 80.956	0.026767 / -5.0819	0.84262 / -177.04
1.000GHz	0.94196 / -171.51	1.1832 / 79.051	0.026688 / -6.5481	0.84401 / -177.01
1.100GHz	0.94228 / -172.22	1.0724 / 77.232	0.026597 / -7.9274	0.84545 / -176.96
1.200GHz	0.94265 / -172.81	0.97967 / 75.482	0.026494 / -9.2389	0.84693 / -176.89
1.300GHz	0.94306 / -173.31	0.90091 / 73.786	0.026382 / -10.496	0.84848 / -176.82
1.400GHz	0.94349 / -173.73	0.83314 / 72.136	0.026260 / -11.707	0.85009 / -176.74
1.500GHz	0.94396 / -174.10	0.77418 / 70.526	0.026129 / -12.879	0.85176 / -176.66
1.600GHz	0.94445 / -174.42	0.72239 / 68.950	0.025991 / -14.018	0.85349 / -176.58
1.700GHz	0.94497 / -174.70	0.67653 / 67.404	0.025845 / -15.126	0.85528 / -176.50
1.800GHz	0.94550 / -174.95	0.63562 / 65.887	0.025693 / -16.207	0.85713 / -176.42
1.900GHz	0.94606 / -175.17	0.59888 / 64.395	0.025534 / -17.262	0.85902 / -176.34
2.000GHz	0.94663 / -175.37	0.56570 / 62.927	0.025369 / -18.294	0.86095 / -176.27
2.100GHz	0.94722 / -175.55	0.53557 / 61.482	0.025199 / -19.304	0.86293 / -176.19
2.200GHz	0.94782 / -175.72	0.50810 / 60.059	0.025024 / -20.292	0.86493 / -176.13
2.300GHz	0.94843 / -175.87	0.48294 / 58.656	0.024844 / -21.260	0.86697 / -176.06
2.400GHz	0.94905 / -176.01	0.45981 / 57.274	0.024659 / -22.208	0.86903 / -176.01
2.500GHz	0.94968 / -176.15	0.43848 / 55.911	0.024471 / -23.137	0.87110 / -175.95
2.600GHz	0.95032 / -176.27	0.41873 / 54.568	0.024280 / -24.048	0.87320 / -175.90
2.700GHz	0.95096 / -176.38	0.40040 / 53.243	0.024085 / -24.940	0.87530 / -175.86
2.800GHz	0.95160 / -176.49	0.38335 / 51.937	0.023888 / -25.815	0.87741 / -175.82
2.900GHz	0.95225 / -176.59	0.36744 / 50.649	0.023688 / -26.672	0.87951 / -175.78
3.000GHz	0.95290 / -176.69	0.35257 / 49.378	0.023486 / -27.512	0.88162 / -175.75
3.100GHz	0.95355 / -176.78	0.33863 / 48.125	0.023282 / -28.336	0.88372 / -175.72
3.200GHz	0.95419 / -176.87	0.32555 / 46.889	0.023077 / -29.143	0.88581 / -175.70
3.300GHz	0.95484 / -176.95	0.31325 / 45.670	0.022870 / -29.934	0.88789 / -175.68
3.400GHz	0.95548 / -177.04	0.30167 / 44.467	0.022663 / -30.708	0.88996 / -175.67
3.500GHz	0.95611 / -177.11	0.29074 / 43.281	0.022454 / -31.468	0.89201 / -175.66
3.600GHz	0.95674 / -177.19	0.28042 / 42.112	0.022245 / -32.211	0.89404 / -175.65
3.700GHz	0.95737 / -177.26	0.27065 / 40.958	0.022036 / -32.940	0.89605 / -175.65
3.800GHz	0.95799 / -177.34	0.26140 / 39.820	0.021827 / -33.654	0.89803 / -175.65
3.900GHz	0.95861 / -177.41	0.25263 / 38.697	0.021618 / -34.353	0.89999 / -175.66
4.000GHz	0.95921 / -177.47	0.24430 / 37.590	0.021410 / -35.037	0.90192 / -175.66

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