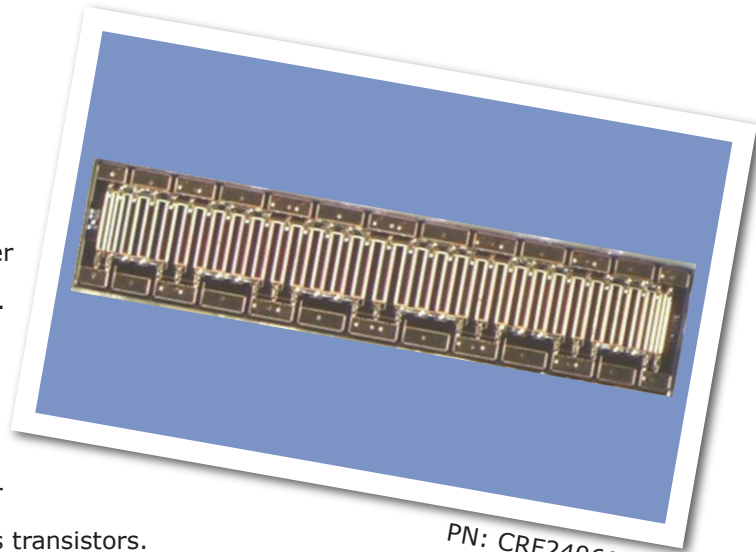


CRF24060D

60 W SiC RF Power MESFET Die

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.



PN: CRF24060D

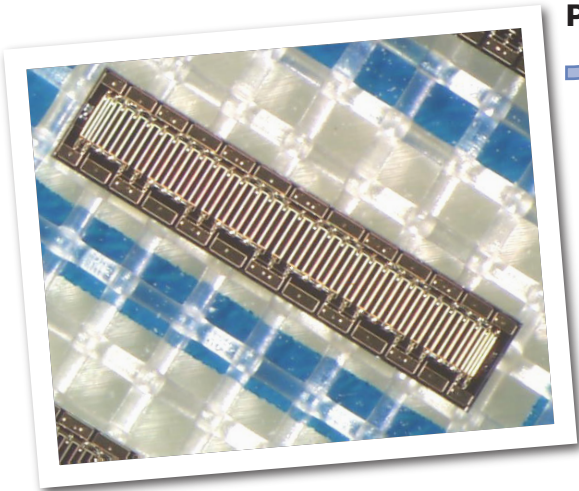
FEATURES

- 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.



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

¹Eutectic 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	$V_{DS} = 10\text{ V}, I_D = 2.5\text{ mA}$
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	$V_{DS} = 48\text{ V}, I_D = 2000\text{ mA}$
RF Characteristics						
Gain	G_{SS}	10	13	-	dB	$V_{DD} = 48\text{ V}, I_{DQ} = 2000\text{ mA}, f = 1500\text{ MHz}$
Power Output at 1 dB Compression	P_{1dB}	50	60	-	W	$V_{DD} = 48\text{ V}, I_{DQ} = 2000\text{ mA}, f = 1500\text{ MHz}$
Drain Efficiency ^{1,2}	η	40	45	-	%	$V_{DD} = 48\text{ V}, I_{DQ} = 2000\text{ mA}, f = 1500\text{ MHz}, P_{OUT} = P_{1dB}$
Intermodulation Distortion	IMD_3	-	-31	-	dBc	$V_{DD} = 48\text{ V}, I_{DQ} = 2000\text{ mA}, f_1 = 1000.0\text{ MHz}, f_2 = 1000.1\text{ MHz}, P_{OUT} = 50\text{ W PEP}$
Output Mismatch Stress	VSWR	10:1	-	-	-	No damage at all phase angles $V_{DD} = 48\text{ V}, I_{DQ} = 2000\text{ mA}, f = 1000\text{ MHz}, P_{OUT} = 50\text{ W CW}$
Dynamic Characteristics						
Input Capacitance	C_{DS}	-	9.5	-	pF	$V_{DS} = 48\text{ V}, V_{gs} = -16\text{ V}, f = 1\text{ MHz}$
Output Capacitance	C_{GS}	-	6.5	-	pF	$V_{DS} = 48\text{ V}, V_{gs} = -16\text{ V}, f = 1\text{ MHz}$
Reverse Transfer Capacitance	C_{GD}	-	2.2	-	pF	$V_{DS} = 48\text{ V}, V_{gs} = -16\text{ V}, f = 1\text{ MHz}$

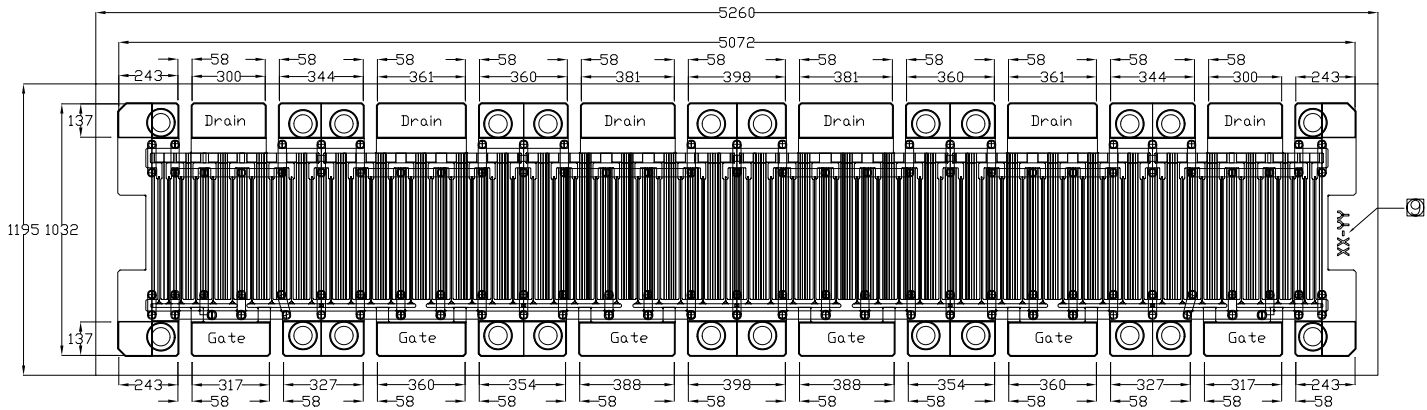
Notes:

¹ Drain Efficiency = P_{OUT}/P_{DC}

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



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:

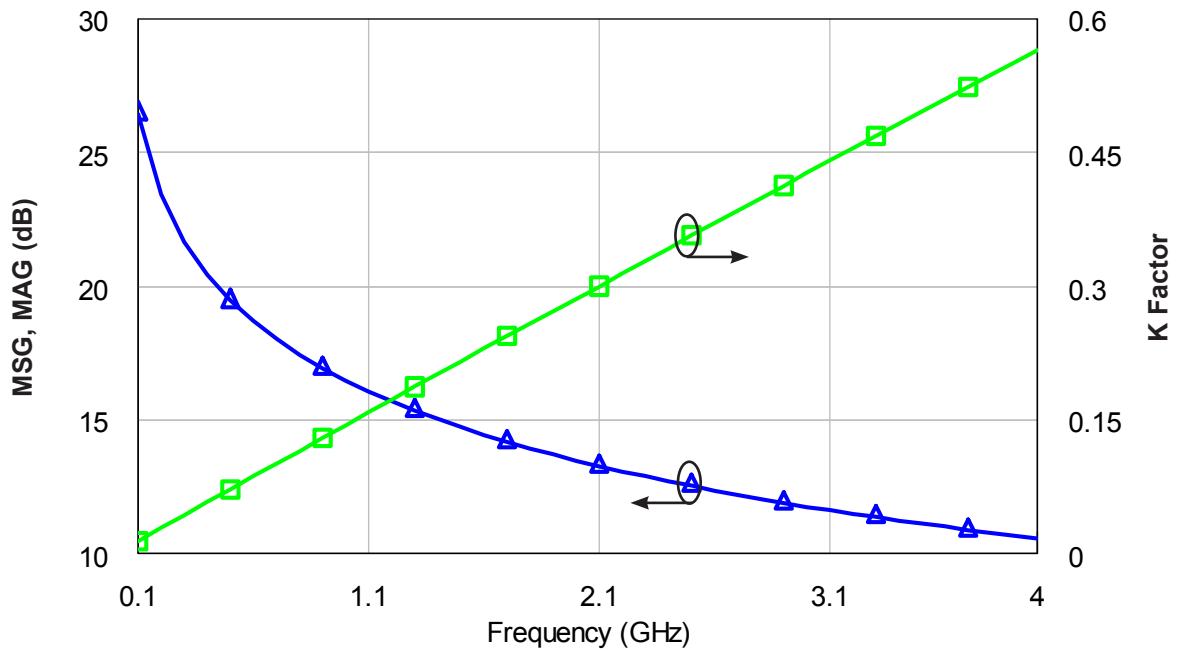
- Recommended solder is AuSn (80/20) solder. Refer to Cree's website for the Eutectic Die Bond Procedure application note at www.cree.com/wireless.
- Vacuum collet is the preferred method of pick-up.
- The backside of the die is the source (ground) contact.
- Use the die label for the correct orientation.
- 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.



Typical Performance

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

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



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



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



Typical Die 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	0.95891 / -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



Typical Die 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	0.95949 / -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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