CMPA601J025D

25 W, 6.0 - 18.0 GHz, GaN MMIC, Power Amplifier

Cree's CMPA601J025D is a gallium nitride (GaN) High Electron Mobility Transistor (HEMT) based monolithic microwave integrated circuit (MMIC). GaN has superior properties compared to silicon or gallium arsenide, including higher breakdown voltage, higher saturated electron drift velocity and higher thermal conductivity. GaN HEMTs also offer greater power density and wider bandwidths compared to Si and GaAs transistors. This MMIC enables very wide bandwidths.

Typical Performance Over 6.0 - 18.0 GHz (T_c = 25˚C)

Parameter	6.0 GHz	10.0 GHz	14.0 GHz	18.0 GHz	Units
Small Signal Gain	31.8	36.0	29.4	33.0	dB
Output Power[1]	44.0	47.2	44.0	44.1	dBm
Output Power[1]	25.3	52.8	25.2	25.5	W
Power Gain[1]	18.0	21.2	18.0	18.1	dB
Power Added Efficiency[1]	37.0	42.8	18.2	21.4	%

[1]Note: Measured CW at P_{IN} = 26 dBm

Features

- > 30 dB Typical Small Signal Gain
- 35 W Typical P_{SAT}
- Operation up to 22 V
- High Breakdown Voltage
- High Temperature Operation
- Size 0.157 x 0.239 x 0.003 inches

Applications

- Jamming Amplifiers
- Test Equipment Amplifiers
- Broadband Amplifiers
- Radar Amplifiers

Rev 0.1 – November 2019

Absolute Maximum Ratings (not simultaneous) at 25˚C

Parameter	Symbol	Rating	Units	Conditions
Drain-source Voltage	V_{DSS}	84	V_{DC}	25˚C
Gate-source Voltage	V_{GS}	-10, +2	V_{DC}	25˚C
Storage Temperature	T_{STG}	-55, +150	˚C	
Operating Junction Temperature	T_J	225	˚C	
Maximum Forward Gate Current	I_{GMAX}	11	mA	25˚C
Maximum Drain Current[1]	I_{DMAX}	0.6	A	Stage 1, 25˚C
Maximum Drain Current[1]	I_{DMAX}	1.68	A	Stage 2, 25˚C
Maximum Drain Current[1]	I_{DMAX}	3.6	A	Stage 3, 25˚C
Thermal Resistance, Junction to Case (packaged)[2]	$R_{\theta JC}$	1.32	˚C/W	Note 3
Thermal Resistance, Junction to Back of MMIC	$R_{\theta JC}$	1.08	˚C/W	Note 4
Mounting Temperature (30 seconds)	T_S	320	˚C	30 seconds

Note[1] Current limit for long term, reliable operation
Note[2] Eutectic die attach using .5 mil thick 80/20 AuSn mounted to a 40 mil thick aluminum diamond (k=500 W/m-K) shim sized 2 mil larger than the die on each side.
Note[3] Operating conditions: 121 watts total power dissipated and 65°C isothermal bottom of shim. Junction to case thermal resistance is based on the hottest junction down to the 65°C isothermal bottom of shim.
Note[4] Operating conditions: same as note 3. Junction to back of MMIC thermal resistance is based on the hottest junction down to the peak temperature of the back side of the MMIC.

Electrical Characteristics (Frequency = 6.0 GHz to 18.0 GHz unless otherwise stated; T_C = 25˚C)

Characteristics	Symbol	Min.	Typ.	Max.	Units	Conditions
DC Characteristics[1]						
Gate Threshold	V_{TH}	-4	-3	-2	V	V_{DS} = 10 V, I_D = 17.5 mA
Drain-Source Breakdown Voltage	V_{BD}	84	100	–	V	V_{GS} = -8 V, I_D = 17.5 mA
RF Characteristics[2]						
Small Signal Gain	S21	26.4	–	–	dB	V_{DD} = 22 V, I_{DQ} = 0.8 A, P_{IN} = -10 dBm, Freq = 6 - 11 GHz
Small Signal Gain	S21	23.8	–	–	dB	V_{DD} = 22 V, I_{DQ} = 0.8 A, P_{IN} = -10 dBm, Freq = 11 - 18 GHz
Input Return Loss	S11	–	–	-7.6	dB	V_{DD} = 22 V, I_{DQ} = 0.8 A, P_{IN} = -10 dBm, Freq = 6 - 14 GHz
Input Return Loss	S11	–	–	-5.8	dB	V_{DD} = 22 V, I_{DQ} = 0.8 A, P_{IN} = -10 dBm, Freq = 14 - 18 GHz
Output Return Loss	S22	–	–	-2.5	dB	V_{DD} = 22 V, I_{DQ} = 0.8 A, P_{IN} = -10 dBm, Freq = 6 - 10 GHz
Output Return Loss	S22	–	–	-4.0	dB	V_{DD} = 22 V, I_{DQ} = 0.8 A, P_{IN} = -10 dBm, Freq = 10 - 18 GHz
Output Power	P_{OUT1}	42.9	43.8	–	dBm	V_{DD} = 22 V, I_{DQ} = 0.8 A, P_{IN} = 23 dBm, Freq = 6 GHz
Output Power	P_{OUT2}	42.3	44.6	–	dBm	V_{DD} = 22 V, I_{DQ} = 0.8 A, P_{IN} = 23 dBm, Freq = 9.5 GHz
Output Power	P_{OUT3}	44.3	45.8	–	dBm	V_{DD} = 22 V, I_{DQ} = 0.8 A, P_{IN} = 23 dBm, Freq = 14 GHz
Output Power	P_{OUT4}	44.0	45.6	–	dBm	V_{DD} = 22 V, I_{DQ} = 0.8 A, P_{IN} = 23 dBm, Freq = 18 GHz
Power Added Efficiency	PAE_1	31.3	36.5	–	%	V_{DD} = 22 V, I_{DQ} = 0.8 A, P_{IN} = 23 dBm, Freq = 6 GHz
Power Added Efficiency	PAE_2	18.0	27.0	–	%	V_{DD} = 22 V, I_{DQ} = 0.8 A, P_{IN} = 23 dBm, Freq = 9.5 GHz
Power Added Efficiency	PAE_3	18.2	25.4	–	%	V_{DD} = 22 V, I_{DQ} = 0.8 A, P_{IN} = 23 dBm, Freq = 14 GHz
Power Added Efficiency	PAE_4	18.3	27.1	–	%	V_{DD} = 22 V, I_{DQ} = 0.8 A, P_{IN} = 23 dBm, Freq = 18 GHz
Output Mismatch Stress	VSWR	–	5 : 1	–	Ψ	No damage at all phase angles, V_{DD} = 22 V, I_{DQ} = 0.8 A, P_{OUT} = 25 W CW

Notes:
[1] Scaled from PCM data.
[2] All data pulse tested on-wafer with Pulse Width = 10 μs, Duty Cycle = 1%

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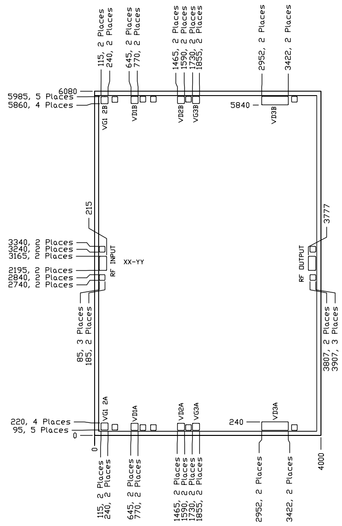
Die Dimensions (units in microns)



Overall die size 4000 x 6080 (+0/-50) microns, die thickness 75 (+/-10) microns.
All Gate and Drain pads must be wire bonded for electrical connection.

Pad Number	Function	Description	Pad Size (in)	Note
1	RF IN	RF Input pad. Matched to 50 ohm. The DC impedance ~ 0 ohm due to matching circuit.	130 x 250	4
2	VG1&2_A	Gate control for stage 1&2A. VG = -1.5 to -2.5 V.	125 x 125	1,2
3	VG1&2_B	Gate control for stage 1&2B. VG = -1.5 to -2.5 V.	125 x 125	1,2
4	VD1_A	Drain supply for stage 1A. VD = 22 V.	125 x 125	1
5	VD1_B	Drain supply for stage 1B. VD = 22 V.	125 x 125	1
6	VD2_A	Drain supply for stage 2A. VD = 22 V.	125 x 125	1
7	VD2_B	Drain supply for stage 2B. VD = 22 V.	125 x 125	1
8	VG3_A	Gate control for stage 3A. VG = -1.5 to -2.5 V.	125 x 125	1,3
9	VG3_B	Gate control for stage 3B. VG = -1.5 to -2.5 V.	125 x 125	1,3
10	VD3_A	Drain supply for stage 3A. VD = 22 V.	470 x 150	1
11	VD3_B	Drain supply for stage 3B. VD = 22 V.	470 x 150	1
12	RF OUT	RF Output pad. Matched to 50 ohm.	130 x 250	4

Notes:

[1] Attach bypass capacitor to pads 2-11 per application circuit.

[2] VG1&2_A and VG1&2_B are connected internally so it would be enough to connect either one for proper operation.

[3] VG3_A and VG3_B are connected internally so it would be enough to connect either one for proper operation.

[4] The RF Input and Output pad have a ground-signal-ground with a nominal pitch of 10 mil (250 um). The RF ground pads are 100 x 100 microns.

Die Assembly Notes:

- Recommended solder is AuSn (80/20) solder. Refer to Cree's website for the Eutectic Die Bond Procedure application note at http://www.cree.com/~/media/Files/Cree/RF/Application%20Notes/Appnote%202%20Eutectic.pdf
- Vacuum collet is the preferred method of pick-up.
- The backside of the die is the Source (ground) contact.
- Die back side gold plating is 5 microns thick minimum.
- Thermosonic ball or wedge bonding are the preferred connection methods.
- Gold wire must be used for connections.
- Use the die label (XX-YY) for correct orientation.

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Figure 1. - Small Signal S-parameters
CMPA601J025D in Test Fixture
V_{DD} = 22 V, I_{DQ} = 0.8 A, Temp = 25°C

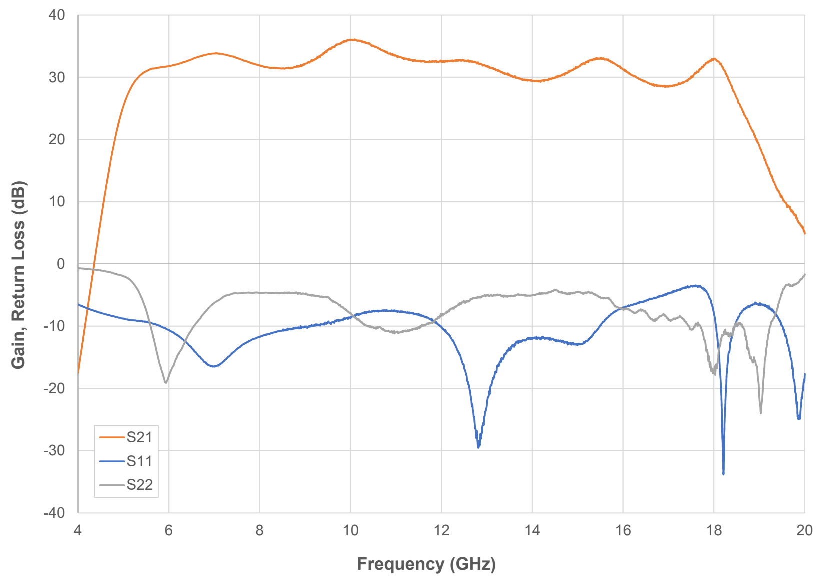

Figure 2. - CW @ P_{IN}=25 dBm
CMPA601J025D in Test Fixture
V_{DD} = 22 V, I_{DQ} = 0.8 A, Temp = 25°C

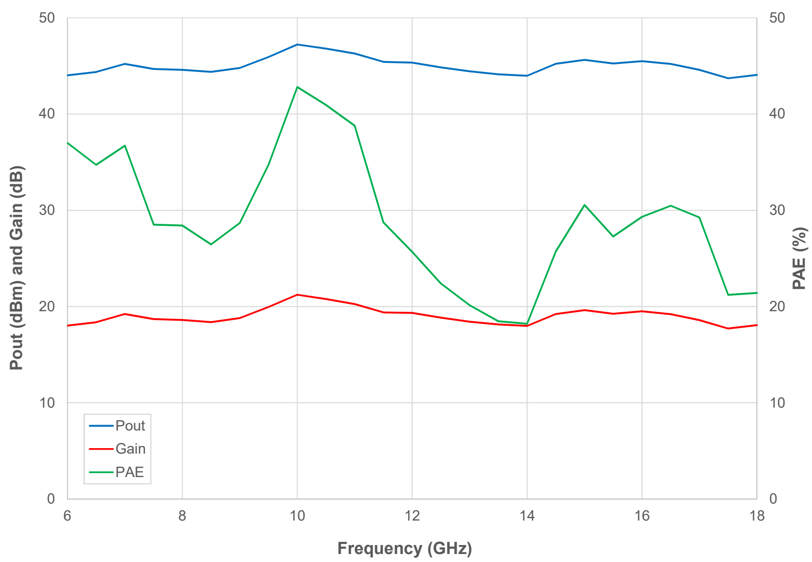

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Figure 3. - CW Power Sweep @ 6 GHz
CMPA601J025D in Test Fixture
V_{DD} = 22 V, I_{DQ} = 0.8 A, Temp = 25°C

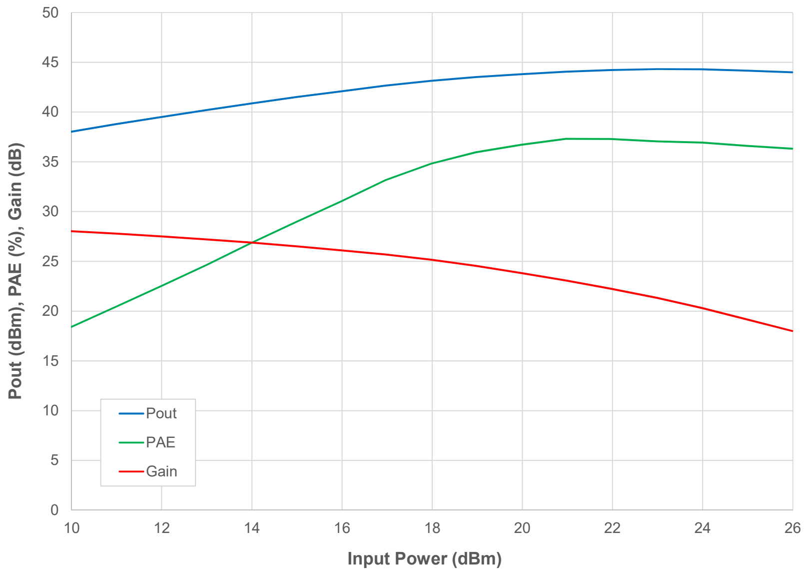
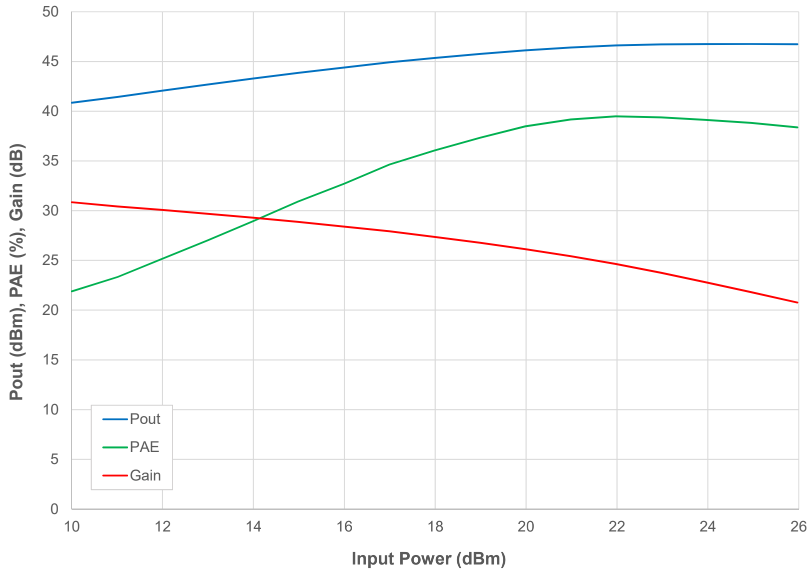


Figure 4. - CW Power Sweep @ 10 GHz
CMPA601J025D in Test Fixture
V_{DD} = 22 V, I_{DQ} = 0.8 A, Temp = 25°C



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CMPA601J025D Typical Performance

Figure 5. - CW Power Sweep @ 14 GHz
CMPA601J025D in Test Fixture
V_{DD} = 22 V, I_{DQ} = 0.8 A, Temp = 25°C

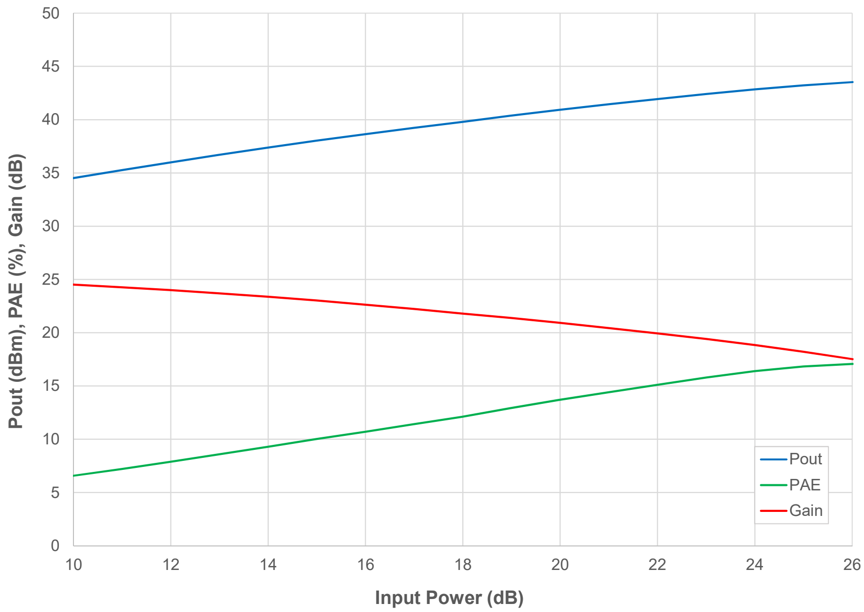
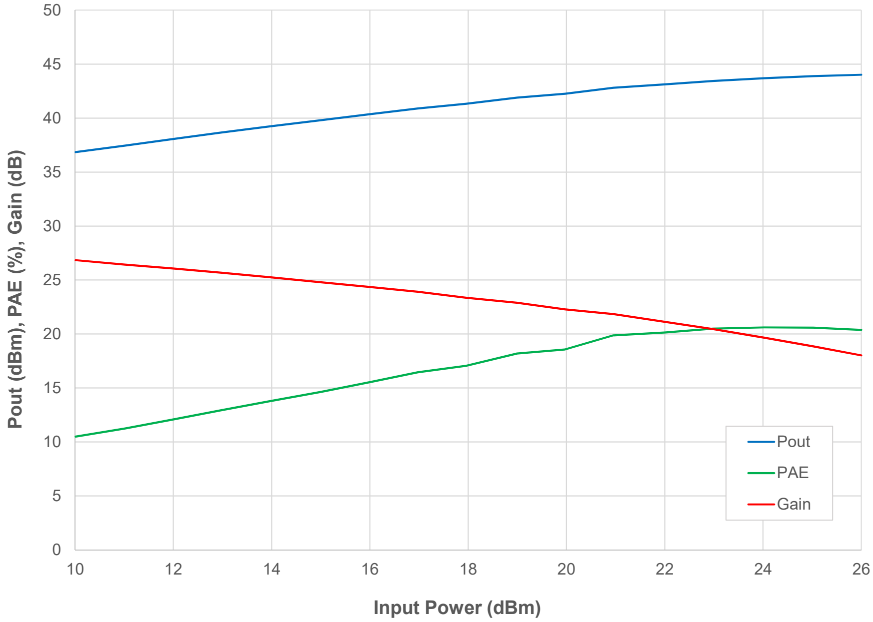


Figure 6. - CW Power Sweep @ 18 GHz
CMPA601J025D in Test Fixture
V_{DD} = 22 V, I_{DQ} = 0.8 A, Temp = 25°C



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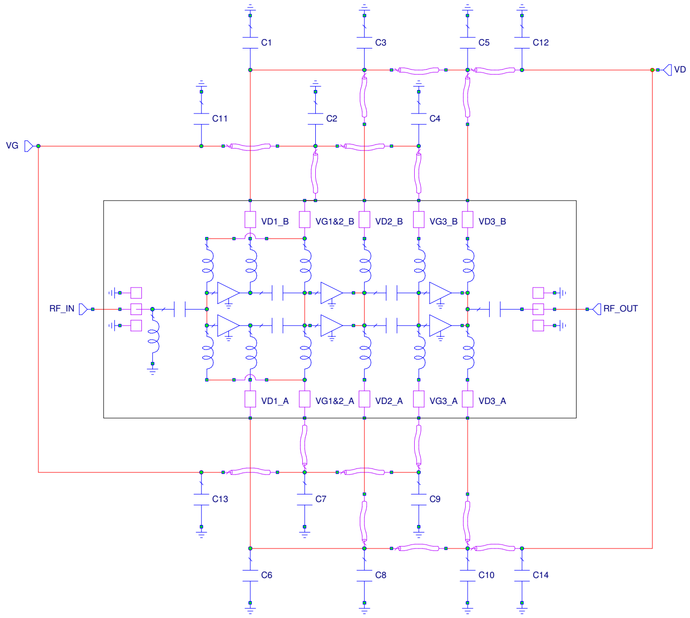
Block Diagram Showing Additional Capacitors for Operation Over 6.0 to 18.0 GHz



Designator	Description	Quantity
C1,C2,C3,C4,C5,C6,C7,C8,C9,C10	CAP, 56pF, +/-10%, SINGLE LAYER, 0.035”	10
C11,C12,C13,C14	CAP, 560pF, +/-10%, SINGLE LAYER, 0.050”	4

Notes:

[1] The input, output and decoupling capacitors should be attached as close as possible to the die- typical distance is 5 to 10 mils with a maximum of 15 mils.

[2] The MMIC die and capacitors should be connected with 1 mil gold bond wires.

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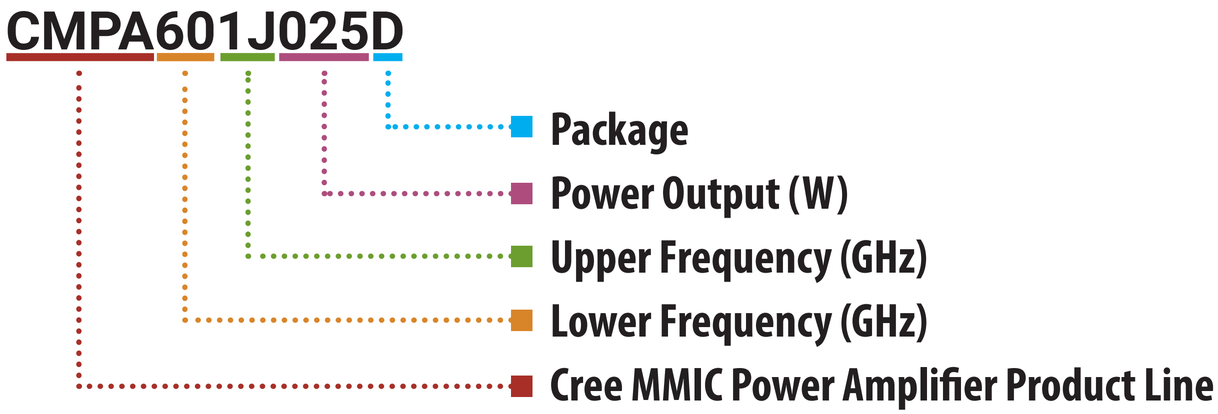
Part Number System



Parameter	Value	Units
Lower Frequency	6.0	GHz
Upper Frequency[1]	18.0	GHz
Power Output	25	W
Package	Bare Die	-

Table 1.

Note[1]: Alpha characters used in frequency code indicate a value greater than 9.9 GHz. See Table 2 for value.

Character Code	Code Value
A	0
B	1
C	2
D	3
E	4
F	5
G	6
H	7
J	8
K	9
Examples:	1A = 10.0 GHz 2H = 27.0 GHz

Table 2.

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