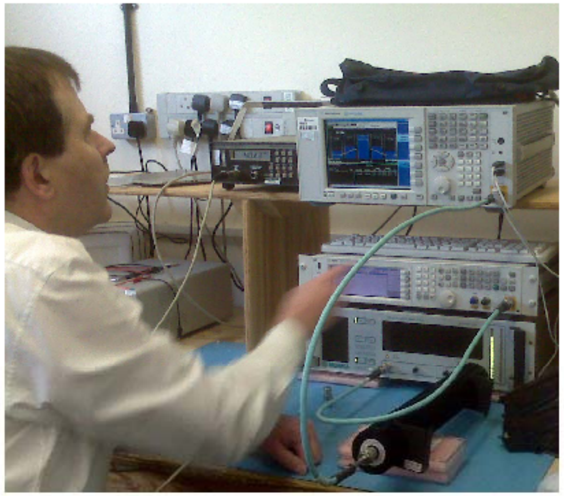
“Characterizing Products against Modern Wireless Communication Threats”

Tom Mullineaux

MILMEGA

Background

Determining Amplifier Back-Off to meet WCDMA Adjacent Channel Power Requirements



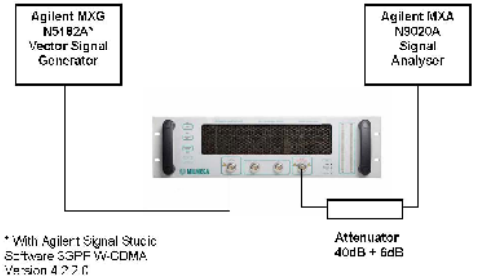
This application note provides guidance on estimating the amplifier output power back-off required to achieve a particular level of adjacent channel power ratio (ACPR). This information is useful when selecting a power amplifier for applications such as component design proving and / or production test. The information also acts as a guide when setting power levels during actual testing.
The amplifier is a 1.8-6.0GHz 50 Watt GaN amplifier that has been characterised for WCDMA performance at several frequencies across its band.
The method of data collection is explained, followed by worked examples on the use of the characterisation data.

Data Collection

The 1.8-6.0GHz 50 Watt amplifier (MILMEGA Model AS1860-50) was driven by a very clean WCDMA signal created by a Vector Signal Generator. The test signal used in all cases was WCDMA FDD Downlink Release 8, Test

Model 1 + 16 DPCH. A Signal Analyser was used to monitor the output signal from the amplifier and data was captured on the channel power achieved for various levels of ACPR. This was repeated over several frequencies across the band of the amplifier. Figure 1 shows the test set up and Figure 2 shows a screen shot of one of the collected data points. Table 1 lists the output path-loss with frequency.

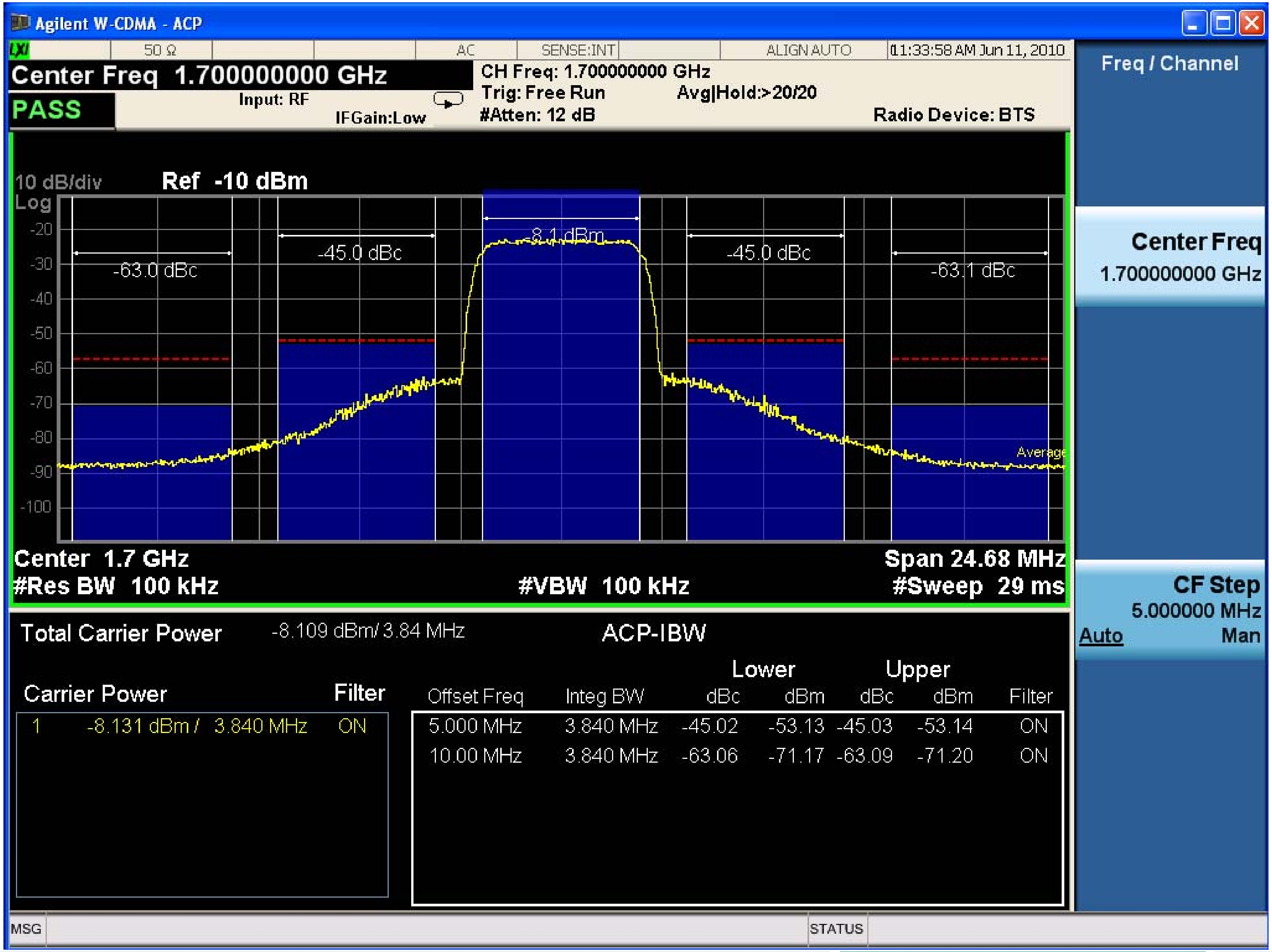
Figure 1: Test Set Up for Model AS1860-50 (1.8-6.0GHz, 50 Watts)



Centre Frequency	Input Cable Loss	Output Cable Plus Attenuator Loss
1.8 GHz	0.358 dB	46.42 dB
2.0 GHz	0.381 dB	46.47 dB
2.5 GHz	0.414 dB	46.50 dB
3.0 GHz	0.449 dB	46.60 dB
3.5 GHz	0.489 dB	46.70 dB
4.0 GHz	0.517 dB	46.60 dB
4.5 GHz	0.558 dB	46.60 dB
5.0 GHz	0.604 dB	46.70 dB
5.5 GHz	0.632 dB	46.70 dB
6.0GHz	0.670 dB	46.70 dB

Table 1: Input Cable Loss and Total Output Path-Loss

As an instance of data collection, the mean channel power shown in Figure 2 is added to the output path loss at 4.0GHz to get the power at the output of the amplifier. That is –10.9 dBm (Figure 2) plus 46.60 dB (Table 1) = 35.7dBm (3.5 Watts). A plot of the test results for various frequencies and ACPR power levels is at Figure 3.



Agilent W-CDMA - ACP
50 Ω
AC
SENSE:INT
ALIGN AUTO
11:33:58 AM Jun 11, 2010
Center Freq 1.700000000 GHz
PASS
Input: RF
IFGain:Low
CH Freq: 1.700000000 GHz
Trig: Free Run
Avg|Hold:>20/20
#Atten: 12 dB
Radio Device: BTS
10 dB/div
Log
Ref -10 dBm
-20
-30
-40
-50
-60
-70
-80
-90
-100
-63.0 dBc
-45.0 dBc
-8.1 dBm
-45.0 dBc
-63.1 dBc
Average
Center 1.7 GHz
#Res BW 100 kHz
#VBW 100 kHz
Span 24.68 MHz
#Sweep 29 ms
Total Carrier Power
-8.109 dBm/ 3.84 MHz
ACP-IBW
Carrier Power
Filter
1 -8.131 dBm / 3.840 MHz ON
Lower
Upper
Offset Freq
Integ BW
dBc
dBm
dBc
dBm
Filter
5.000 MHz 3.840 MHz -45.02 -53.13 -45.03 -53.14 ON
10.00 MHz 3.840 MHz -63.06 -71.17 -63.09 -71.20 ON
Freq / Channel
Center Freq
1.700000000 GHz
CF Step
5.000000 MHz
Auto
Man
MSG
STATUS

Classification of current threats

WLAN

WiFi

Bluetooth

Cell phones
WiMax
(Worldwide Interoperability for Microwave Access)

Protocols

GSM (GMSK)

UMTS (WCDMA)

LTE

- OFDM
- MIMO

WCDMA

Wideband

Code Division

Multiple Access

Wideband

Code Division

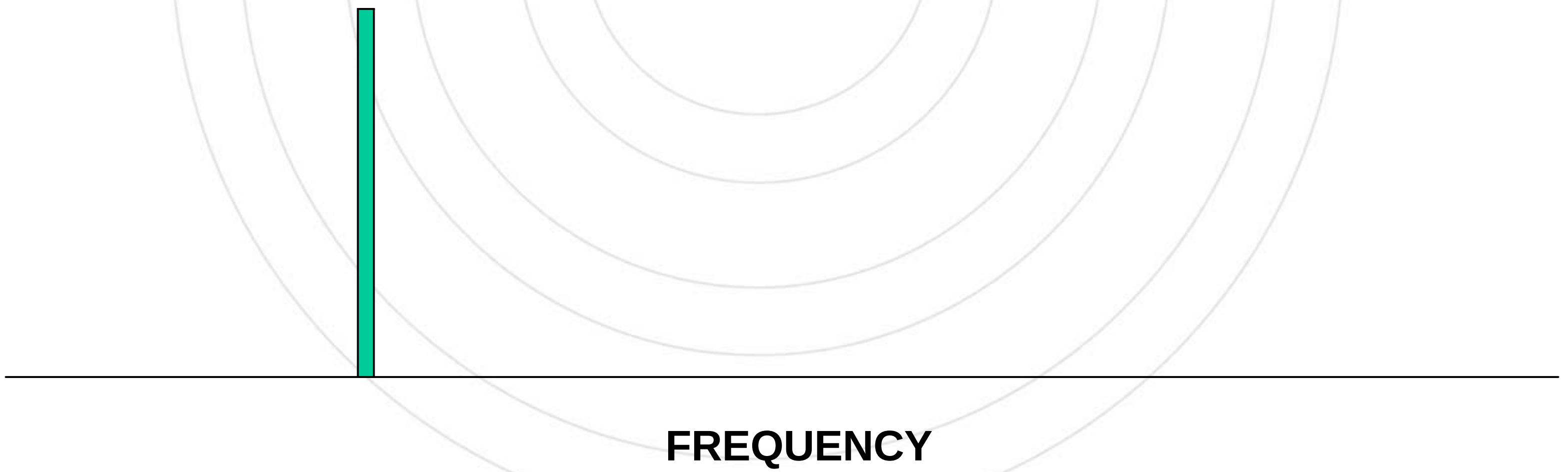
Multiple Access

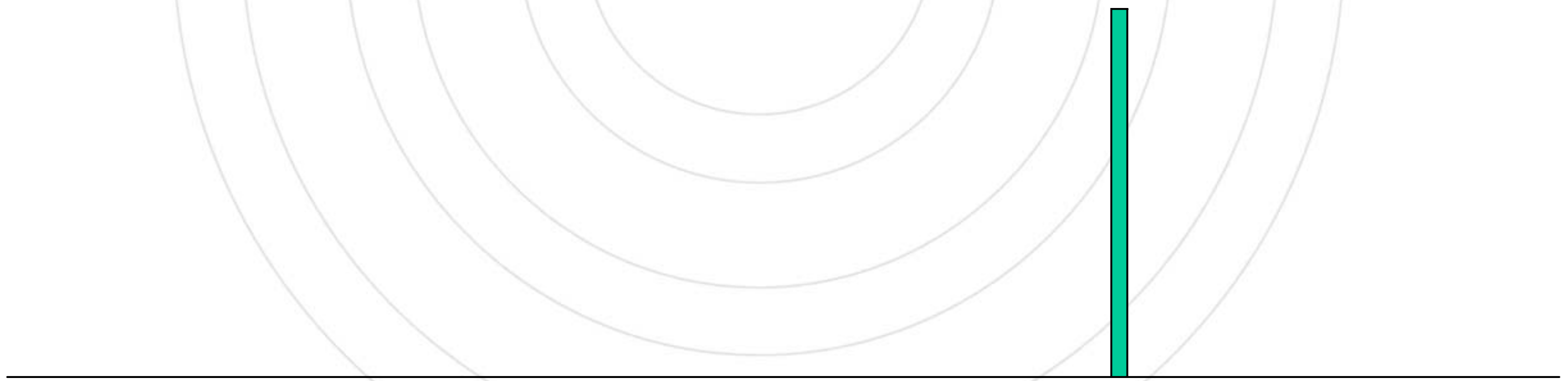
Wideband

Code Division

Multiple Access

Easy to intercept / jam





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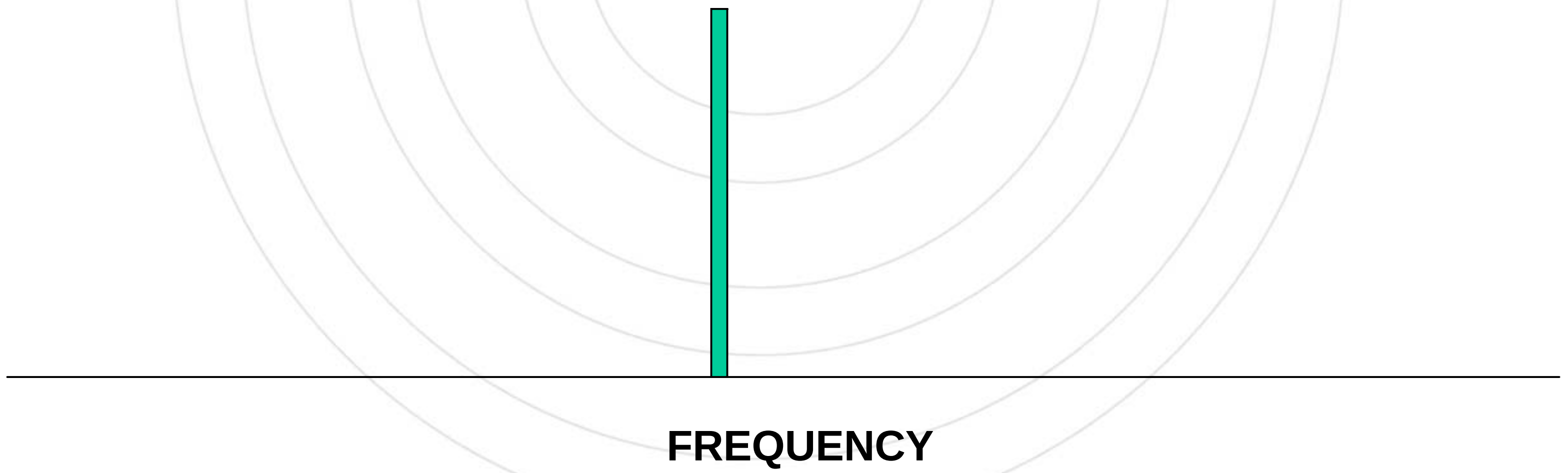
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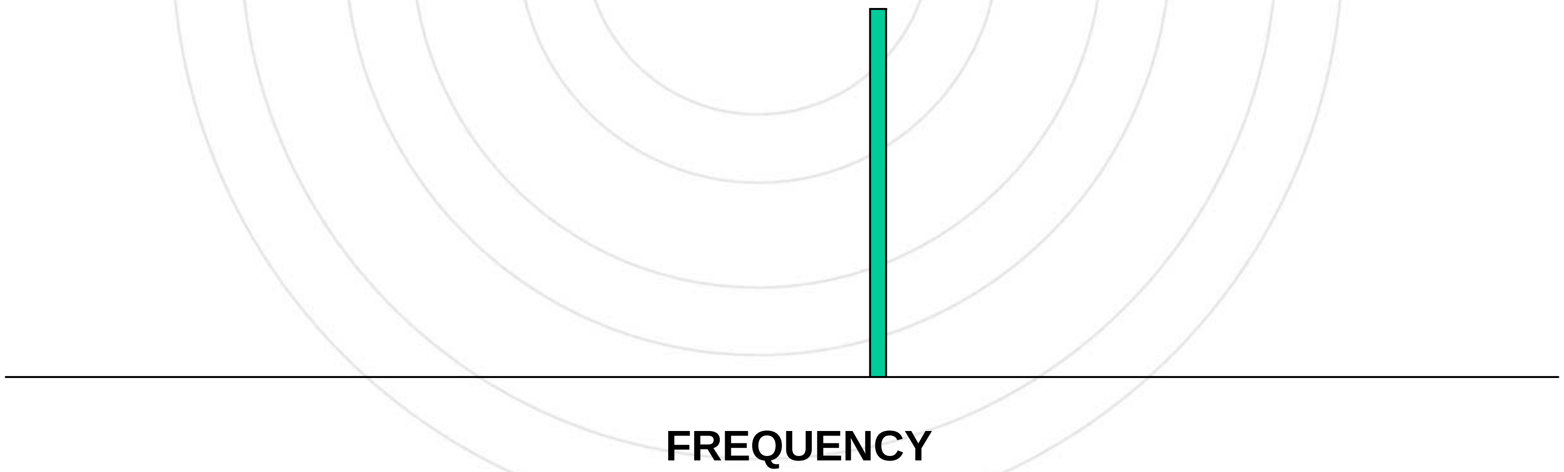
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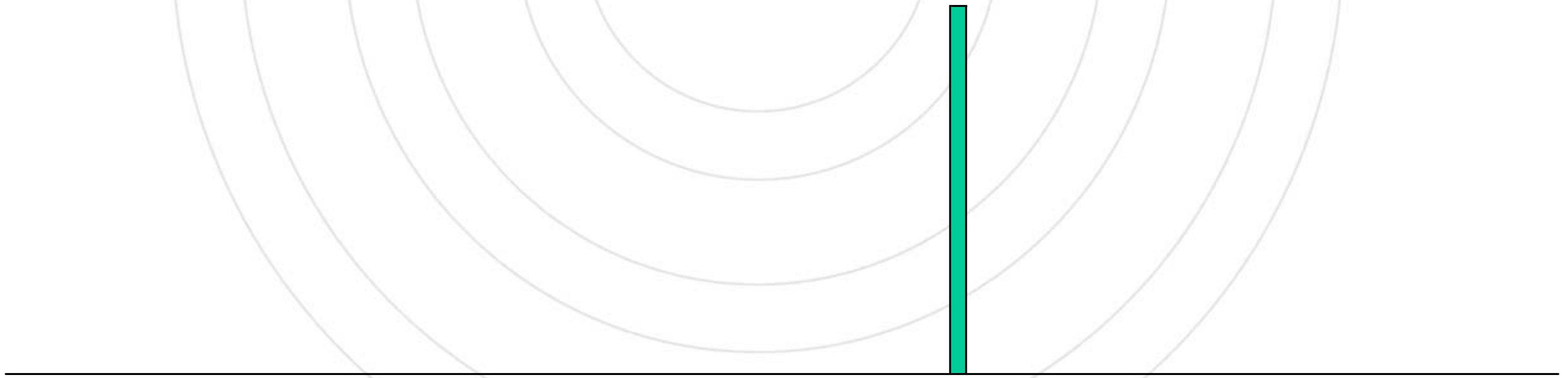

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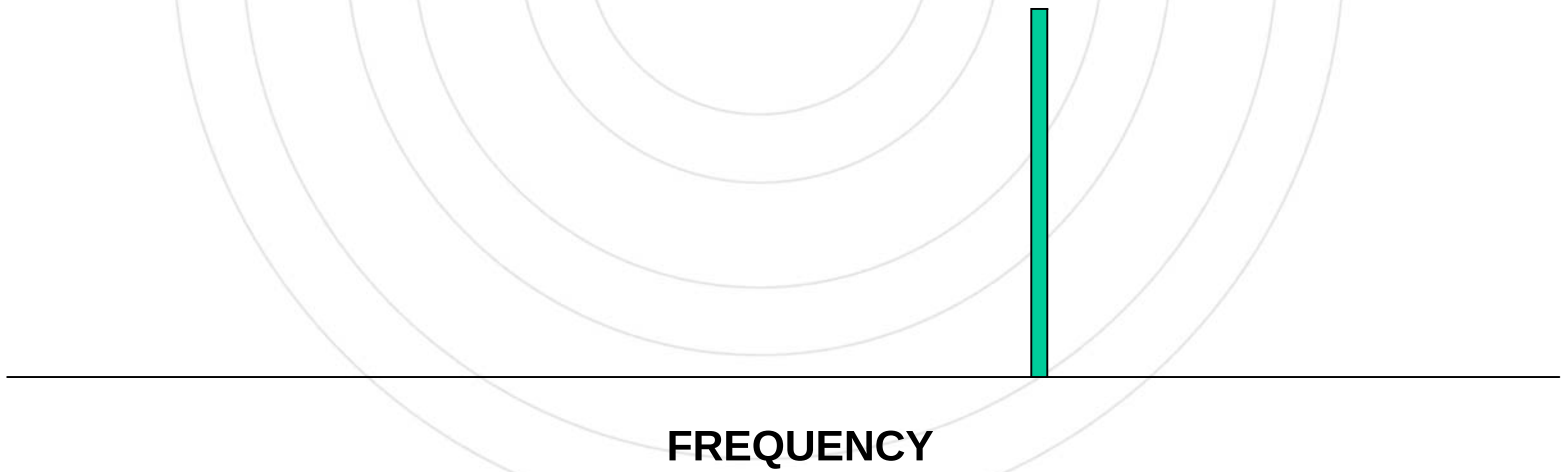
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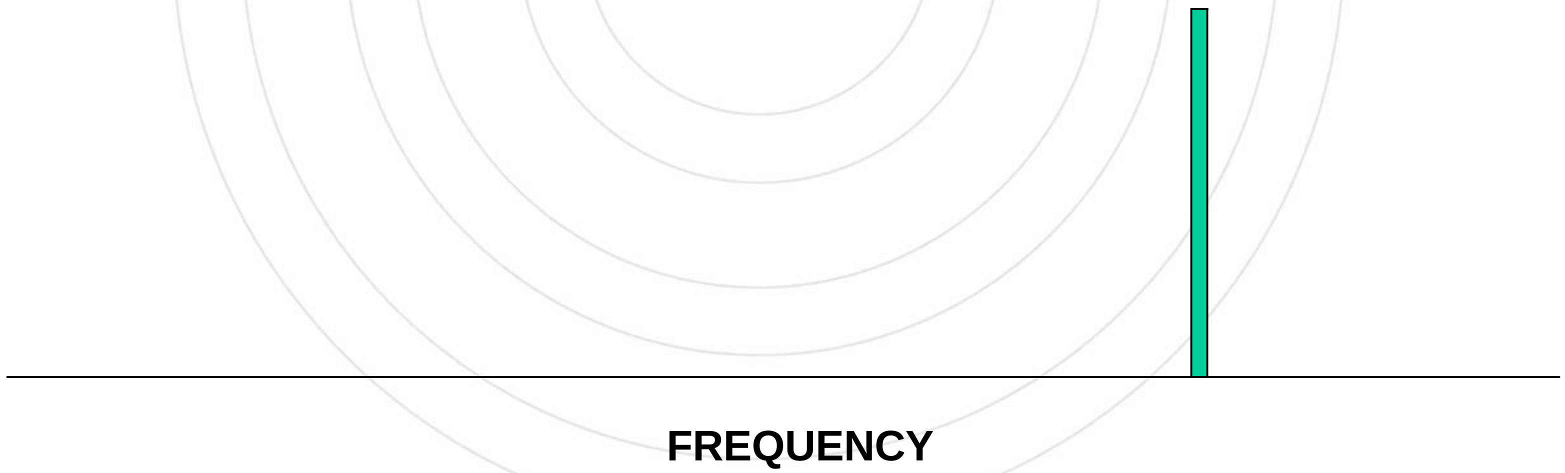
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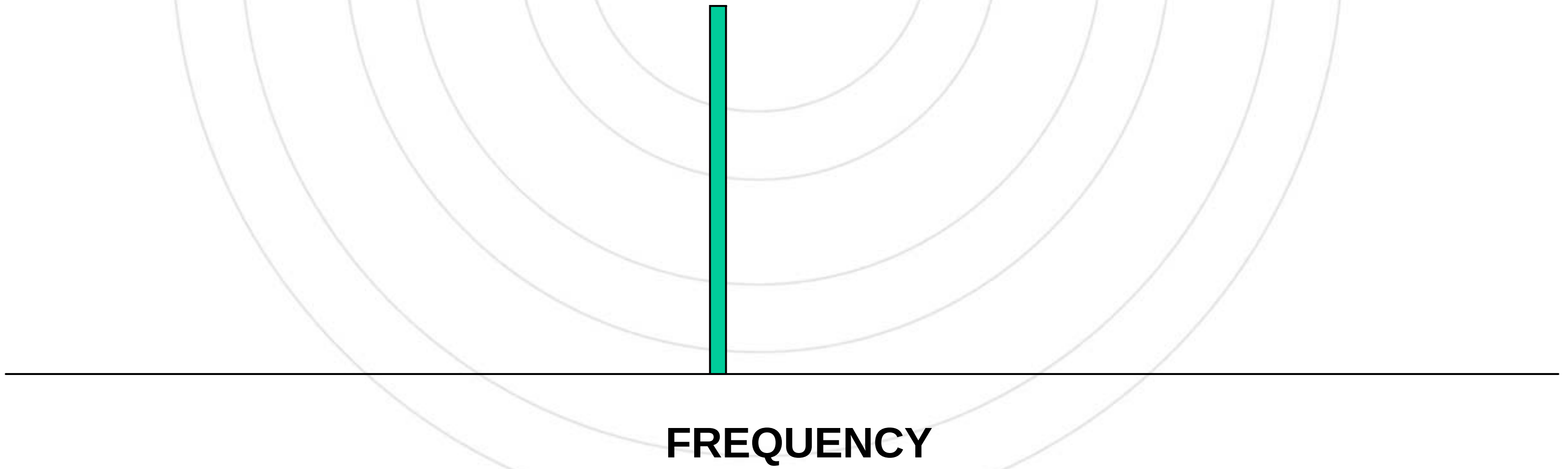
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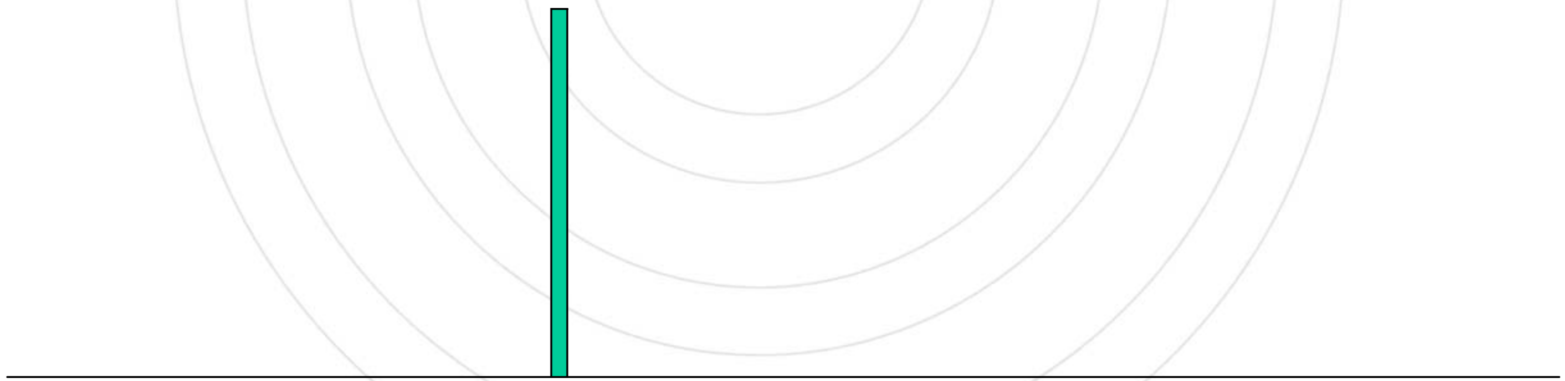

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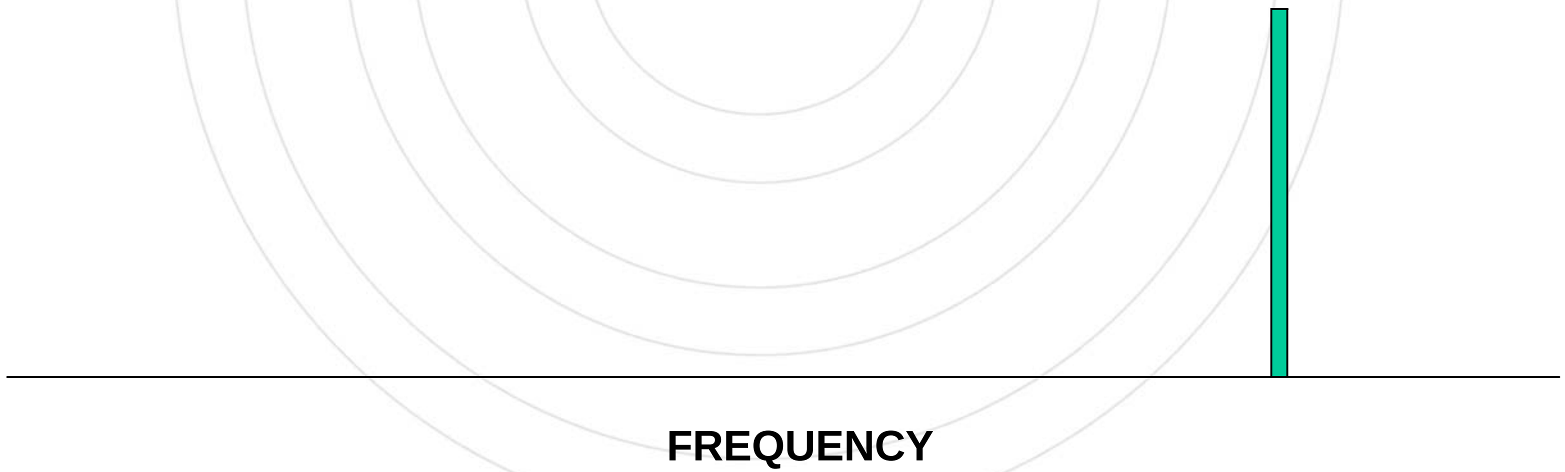
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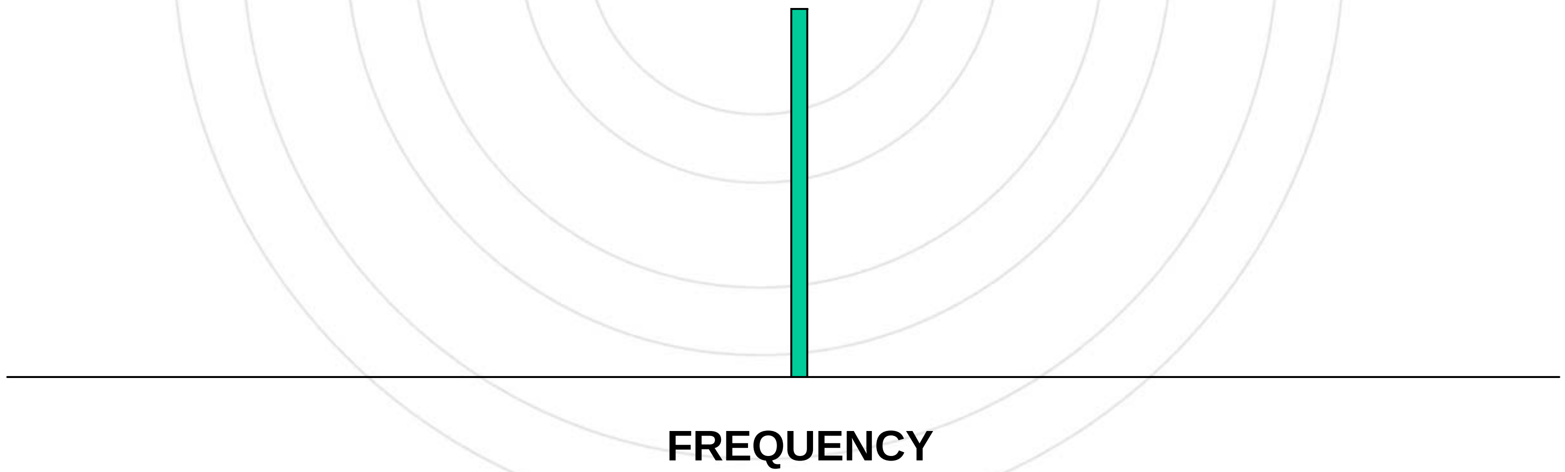
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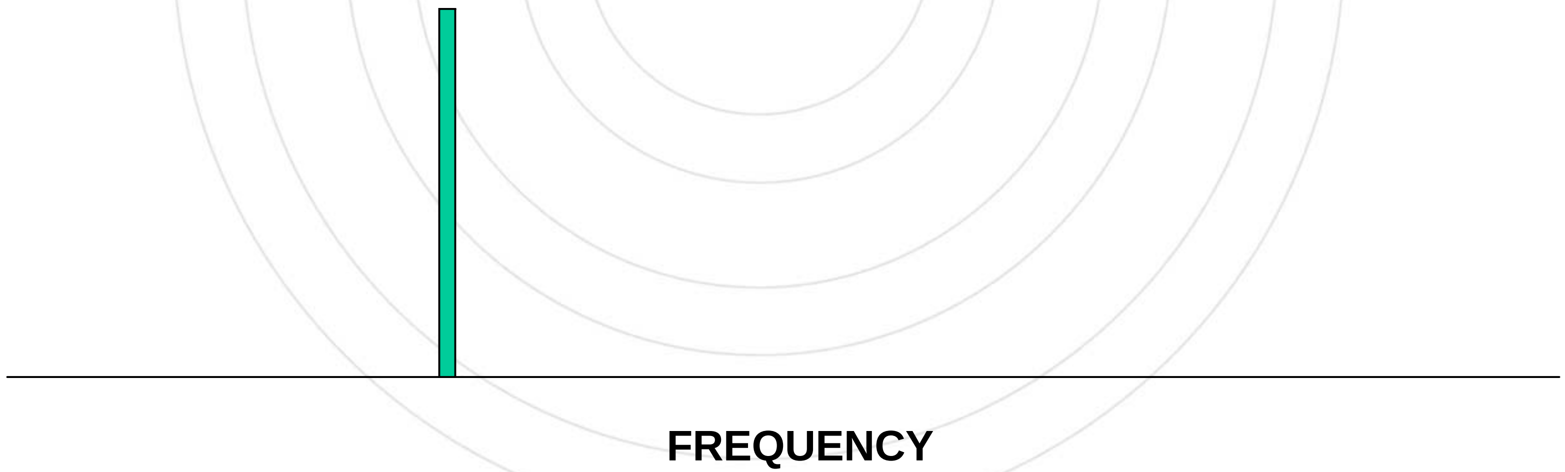
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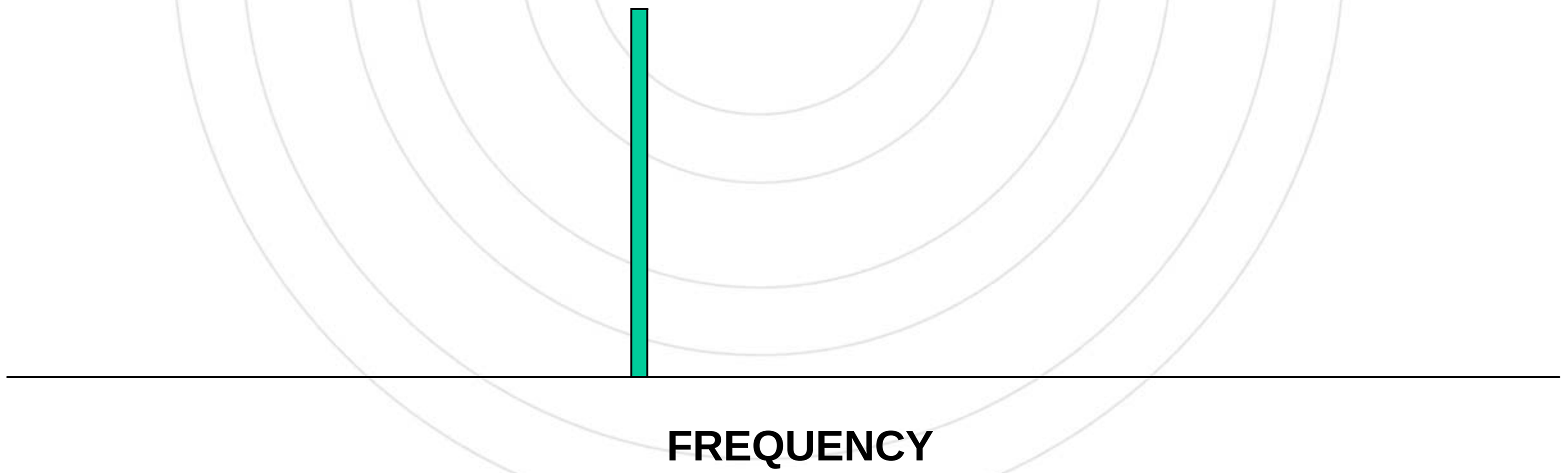
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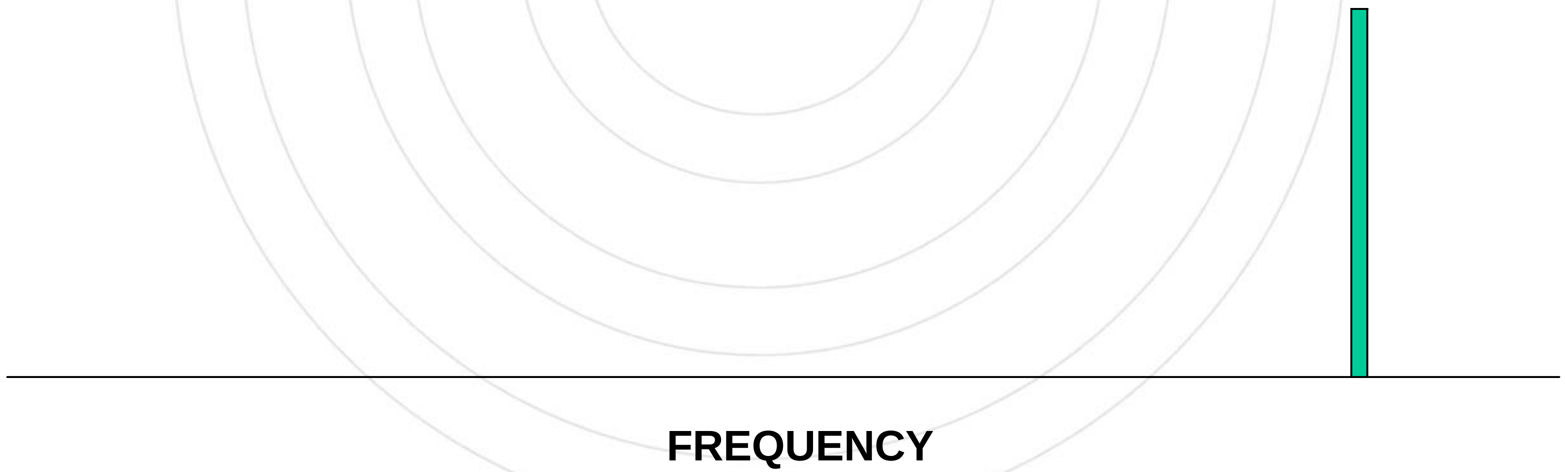
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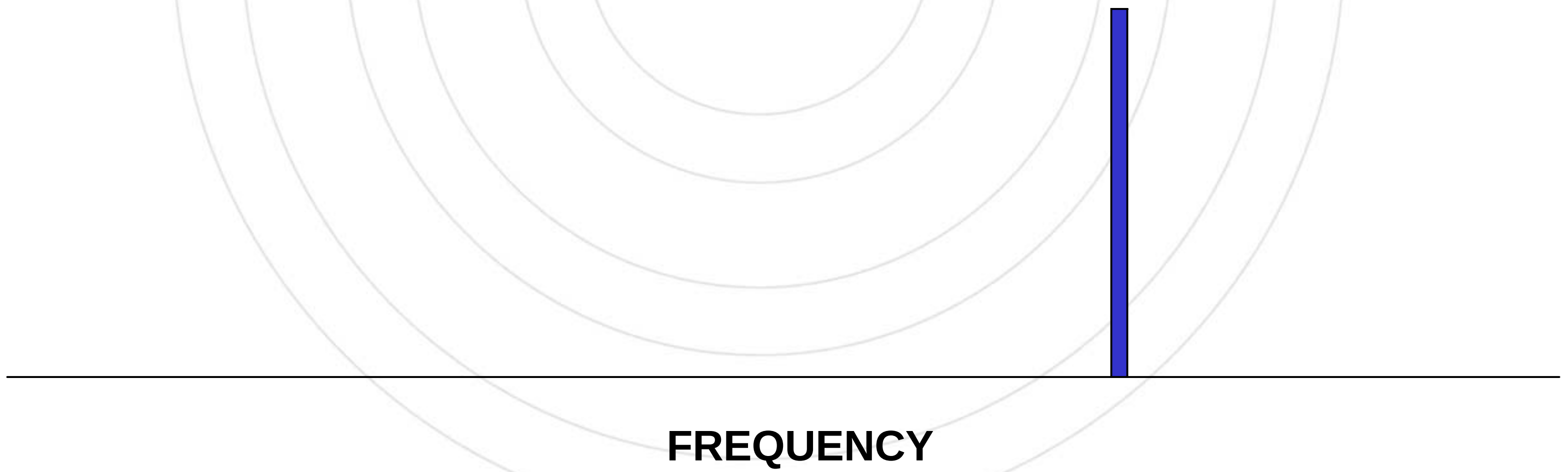
Wideband

Code Division

Multiple Access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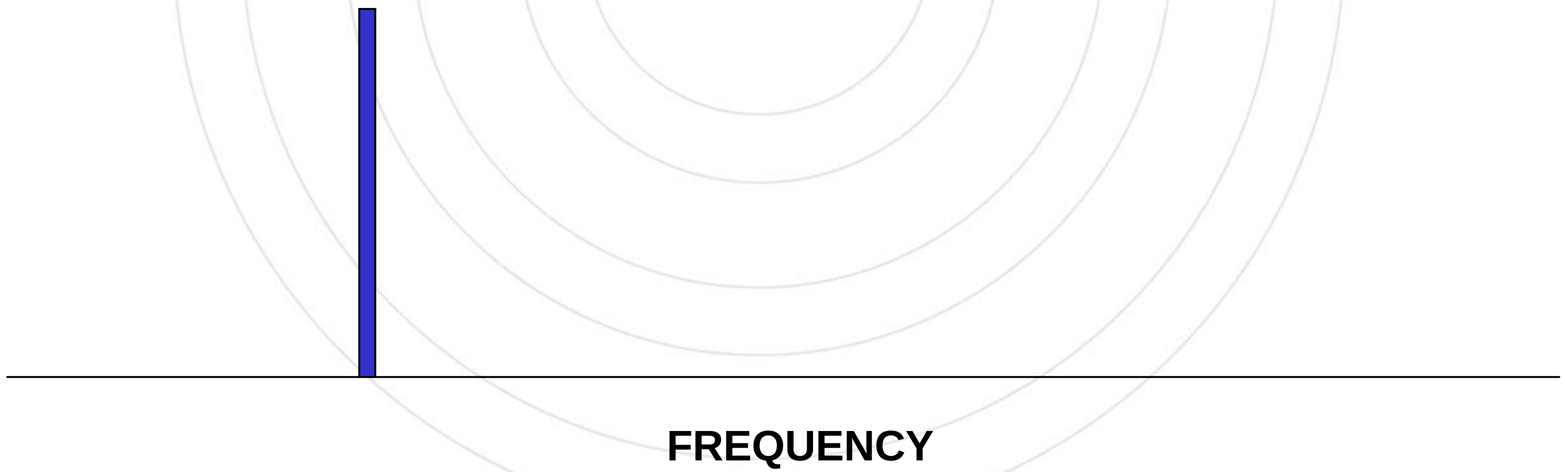
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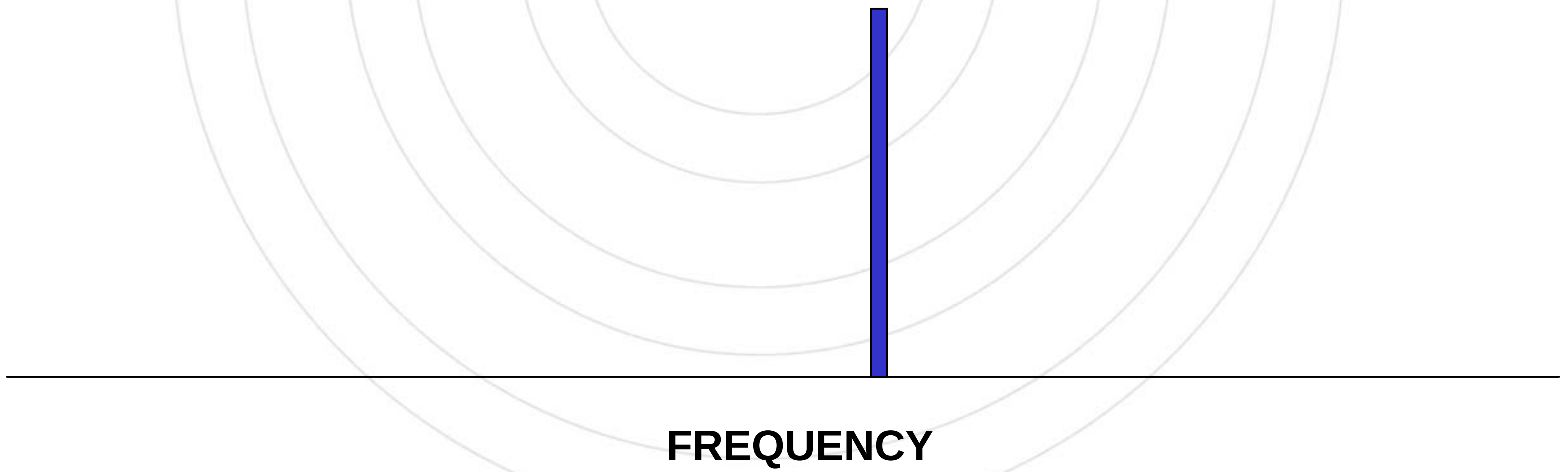
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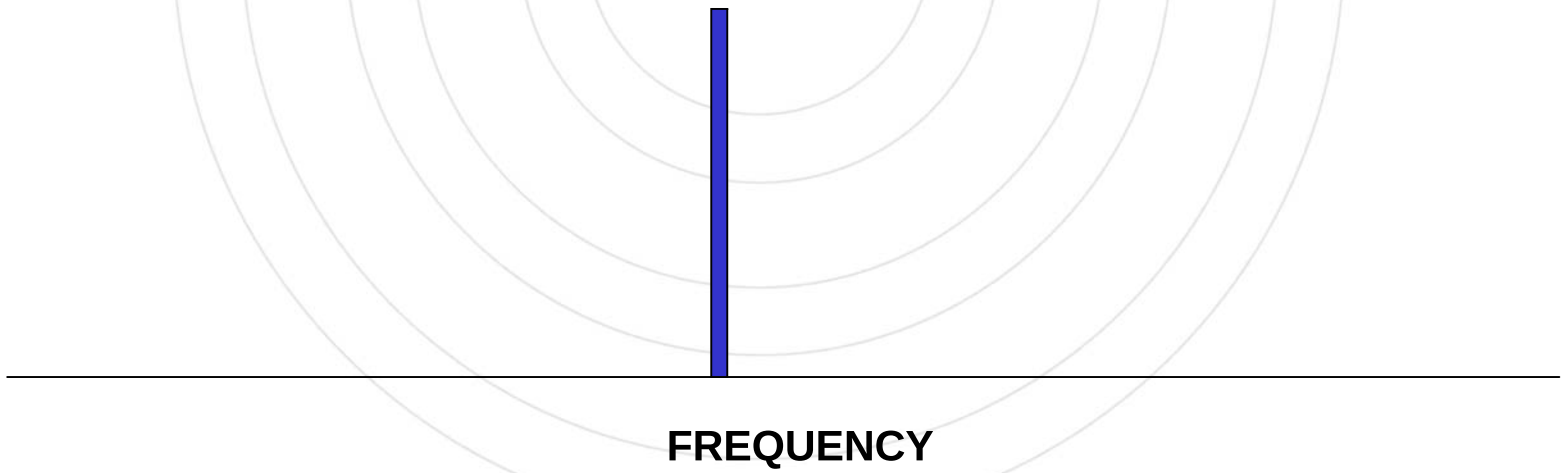
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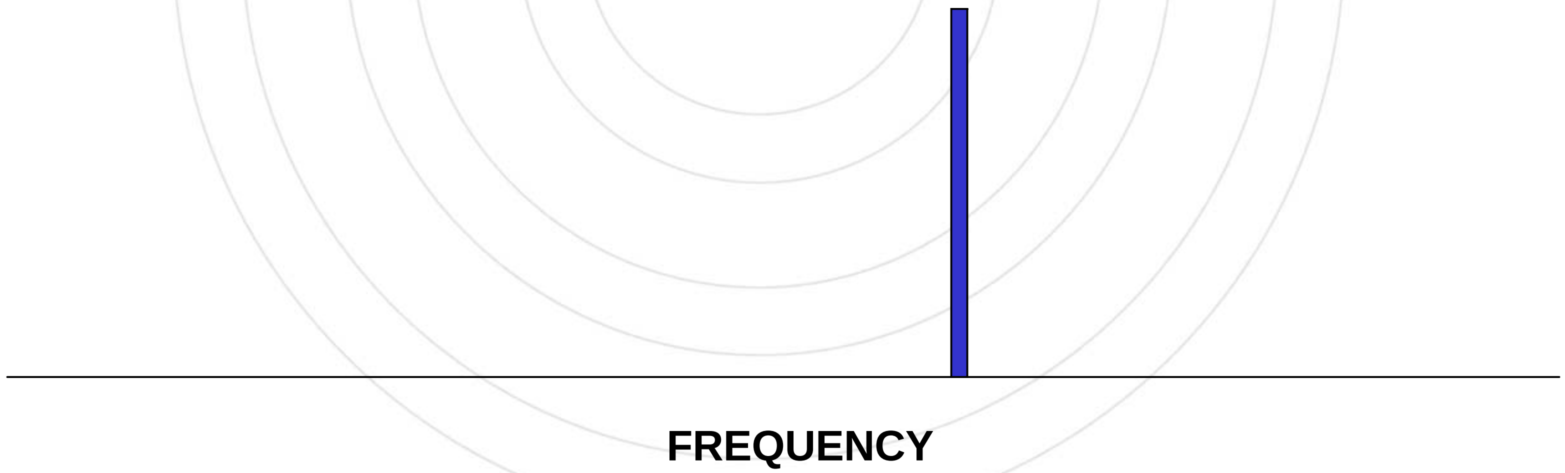
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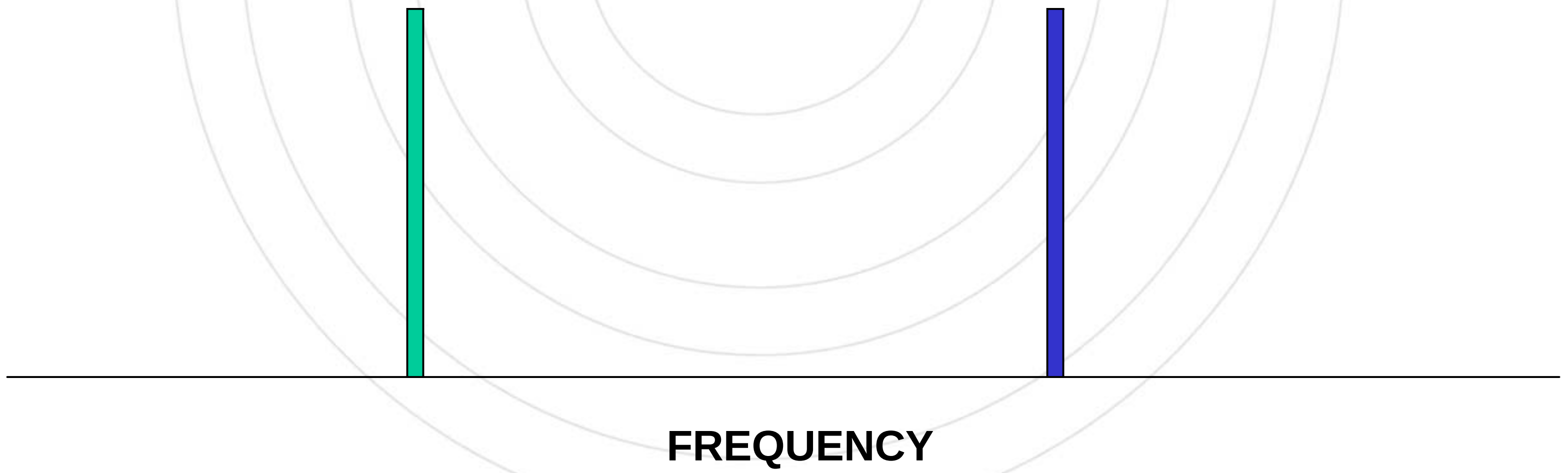
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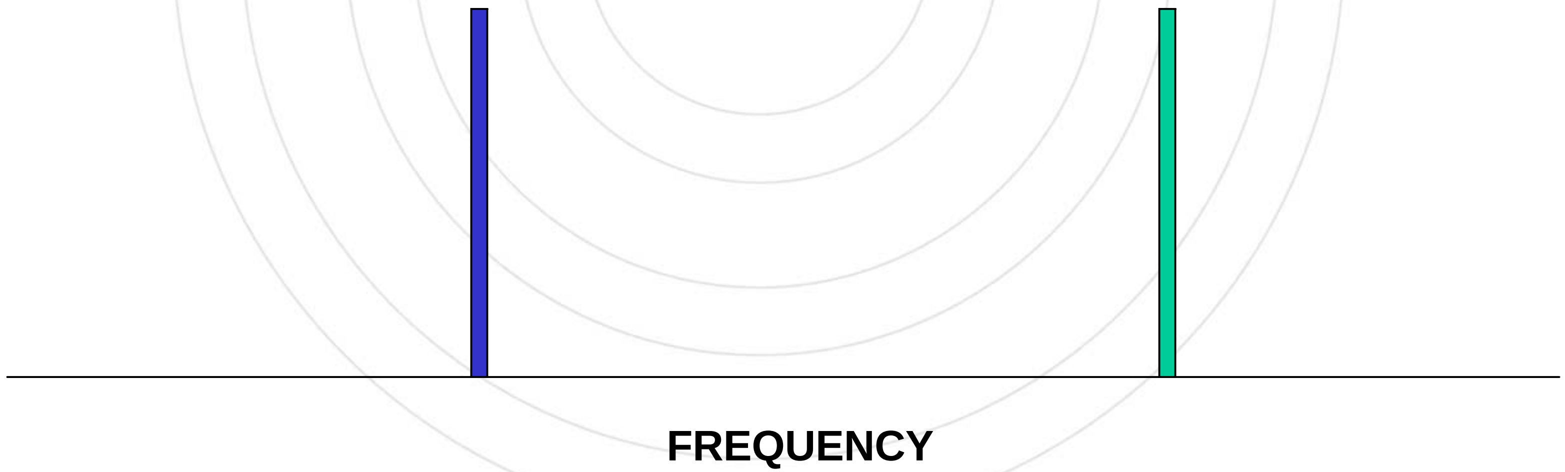
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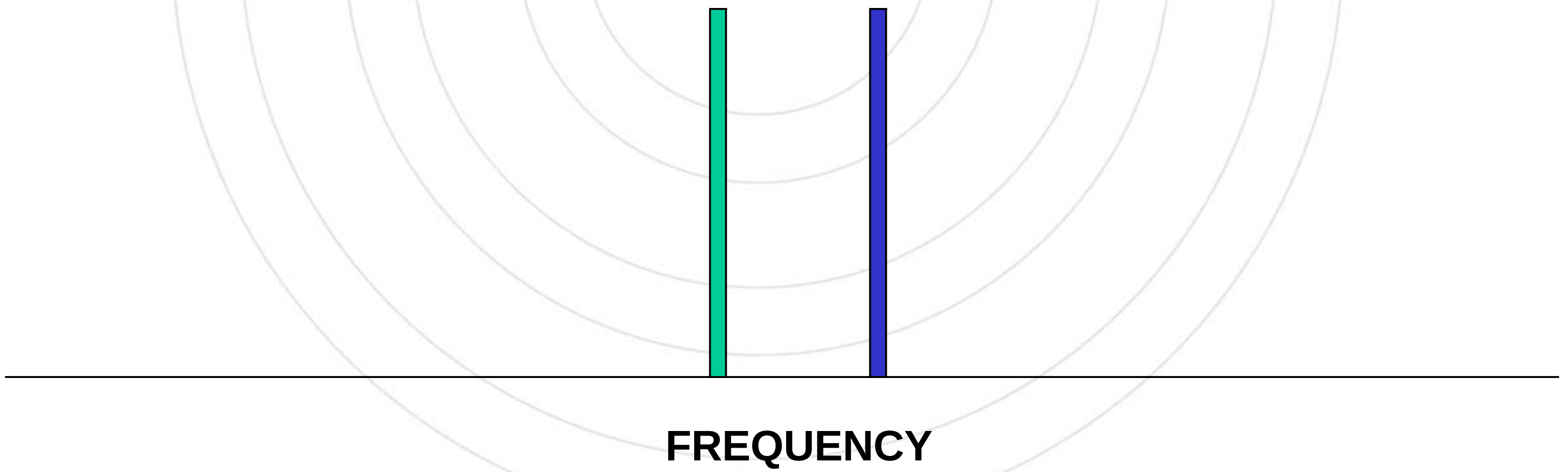
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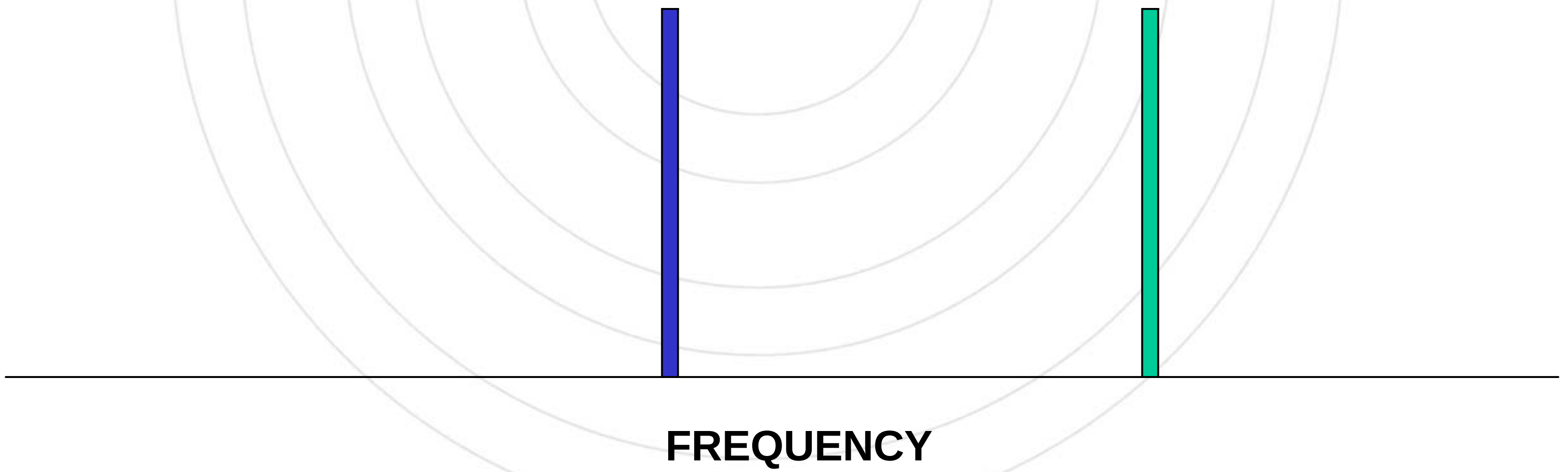
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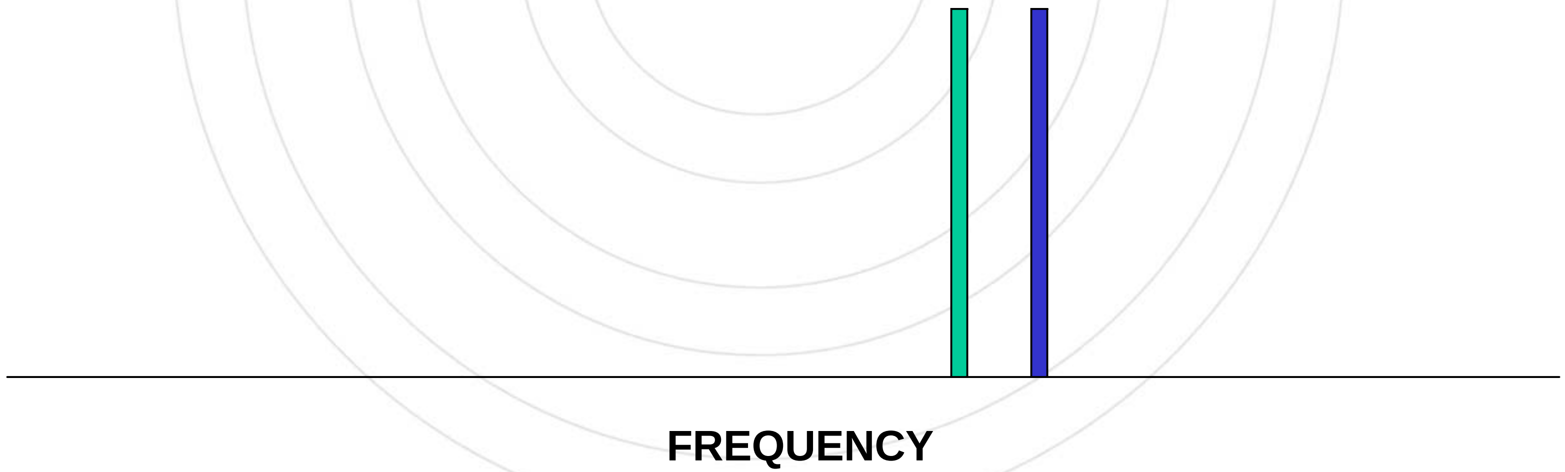
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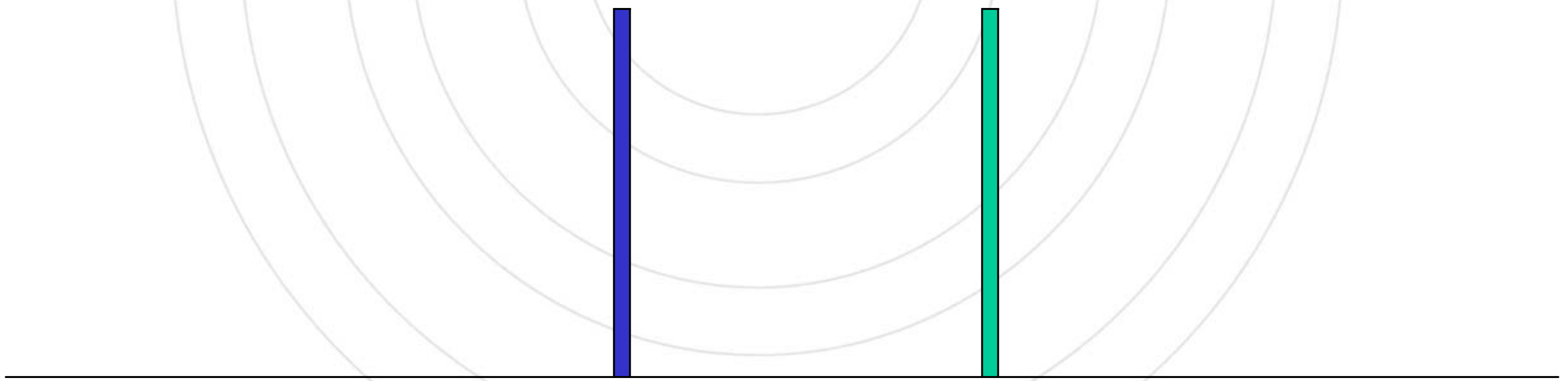

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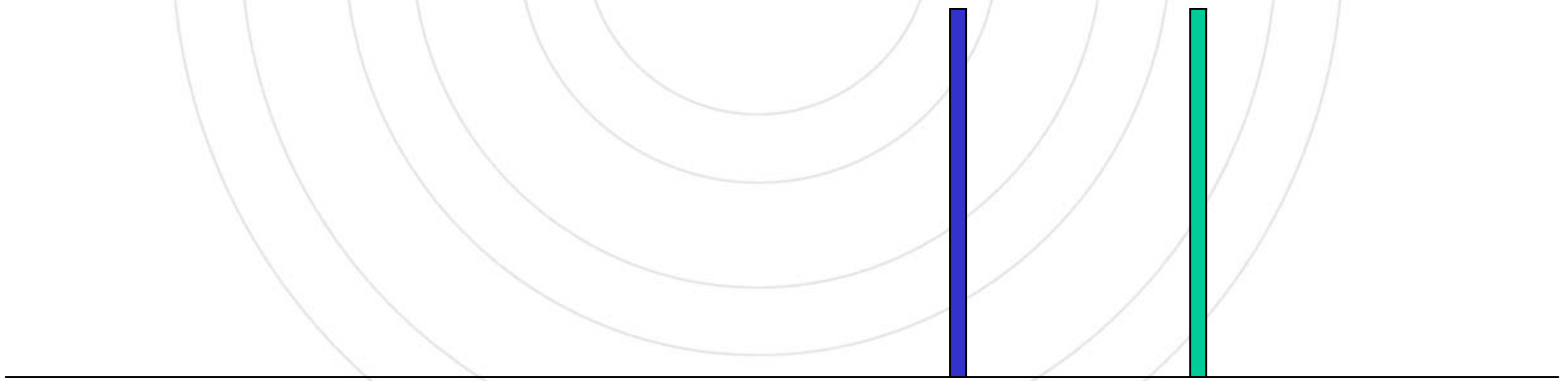

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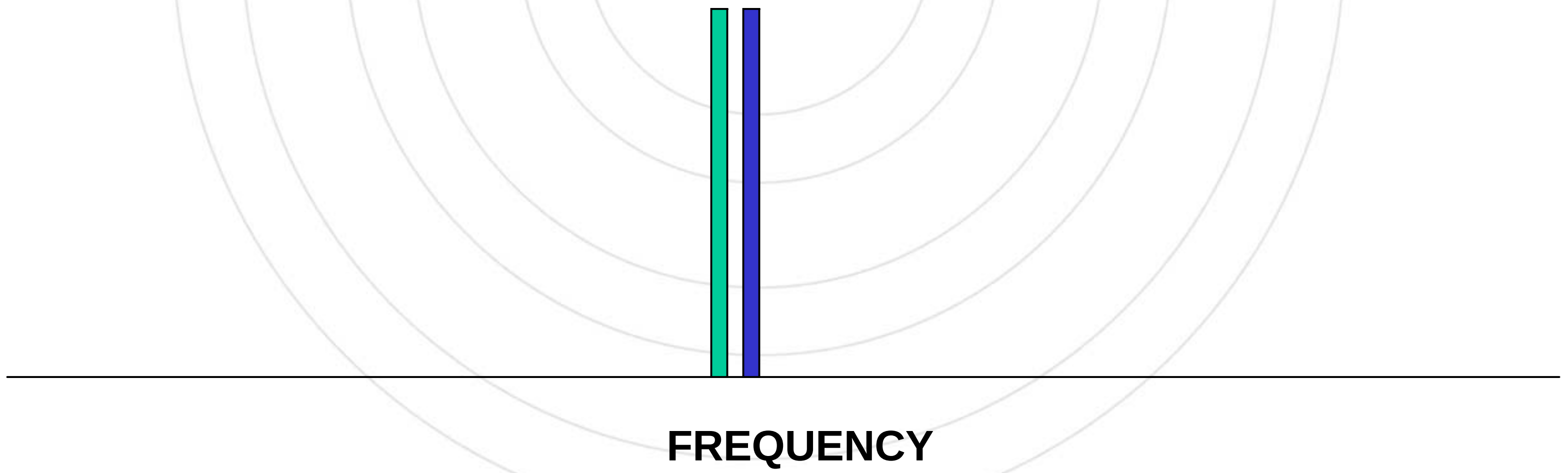
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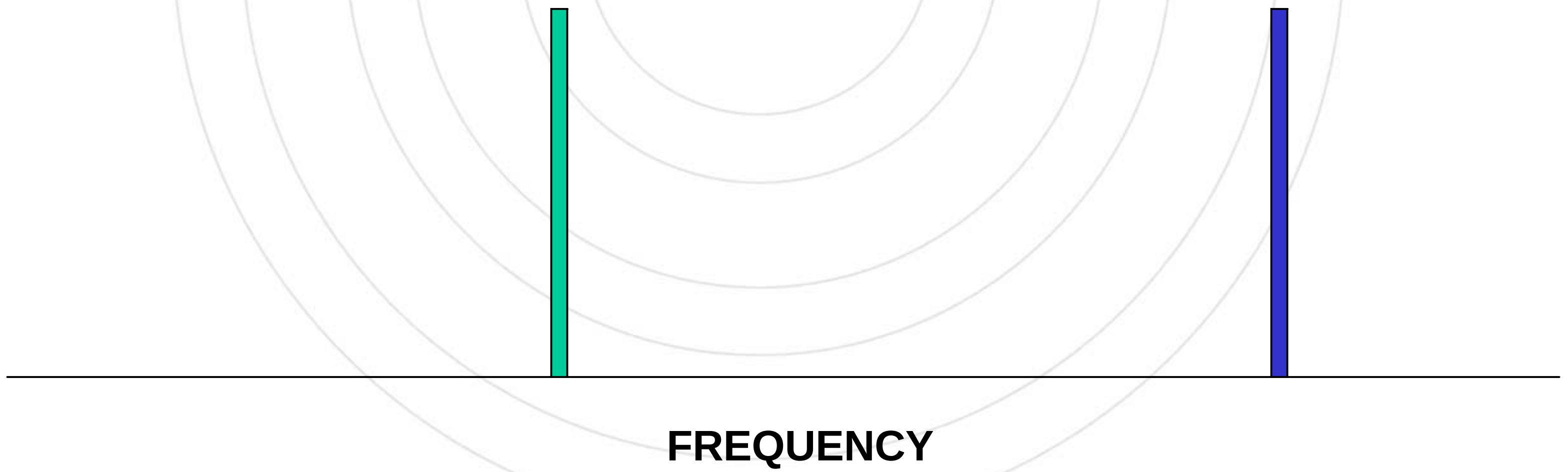
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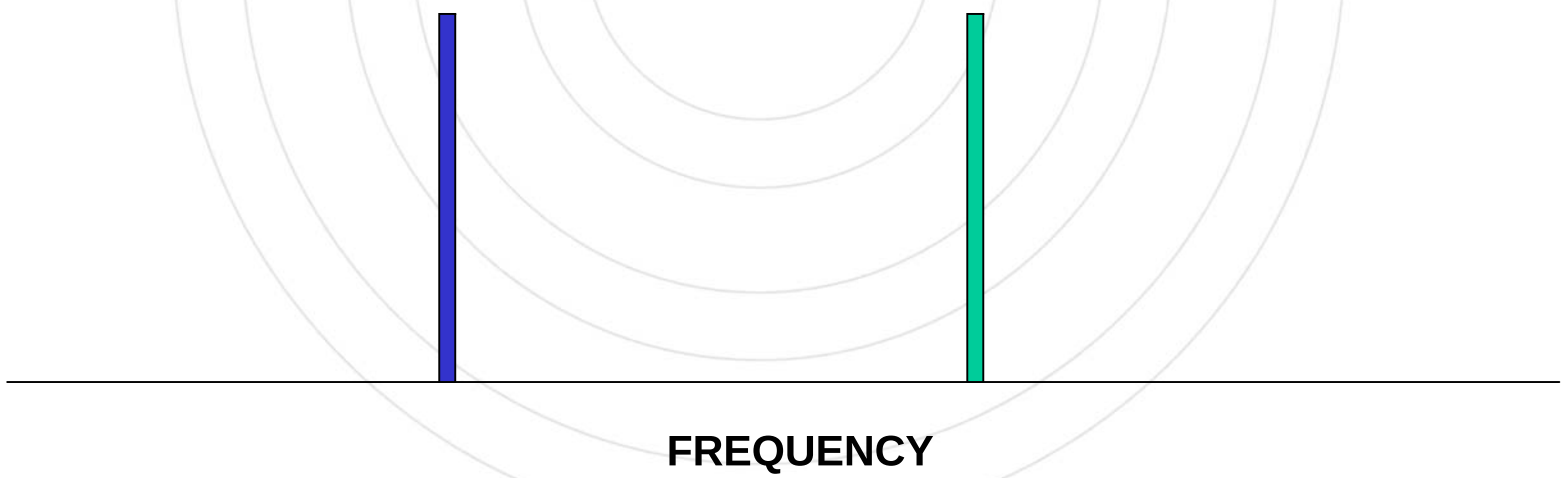
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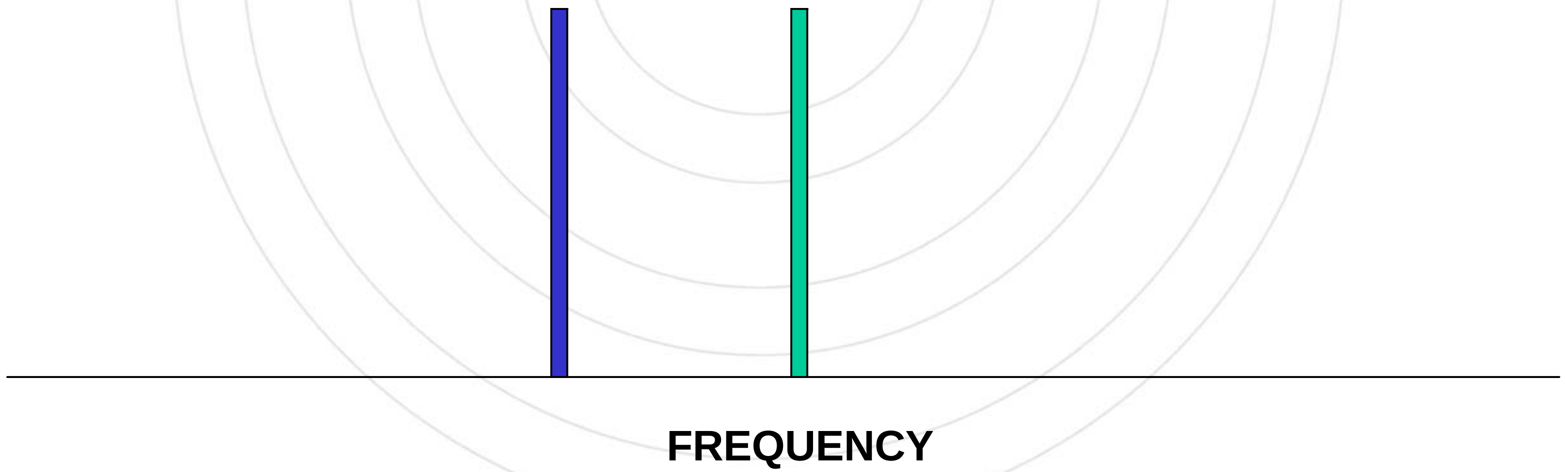
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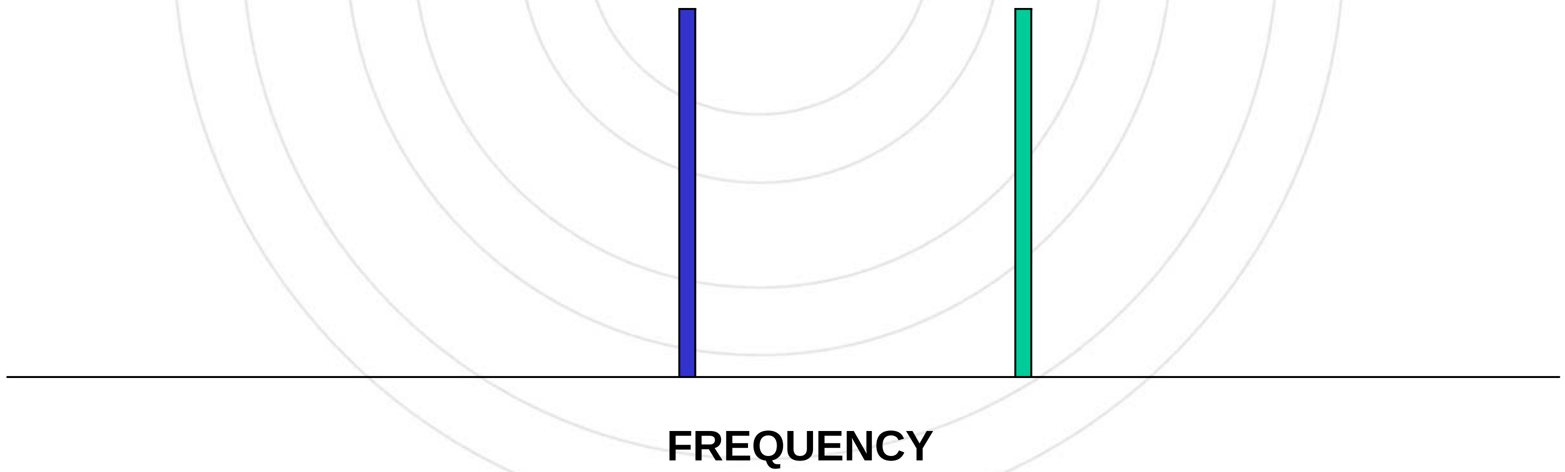
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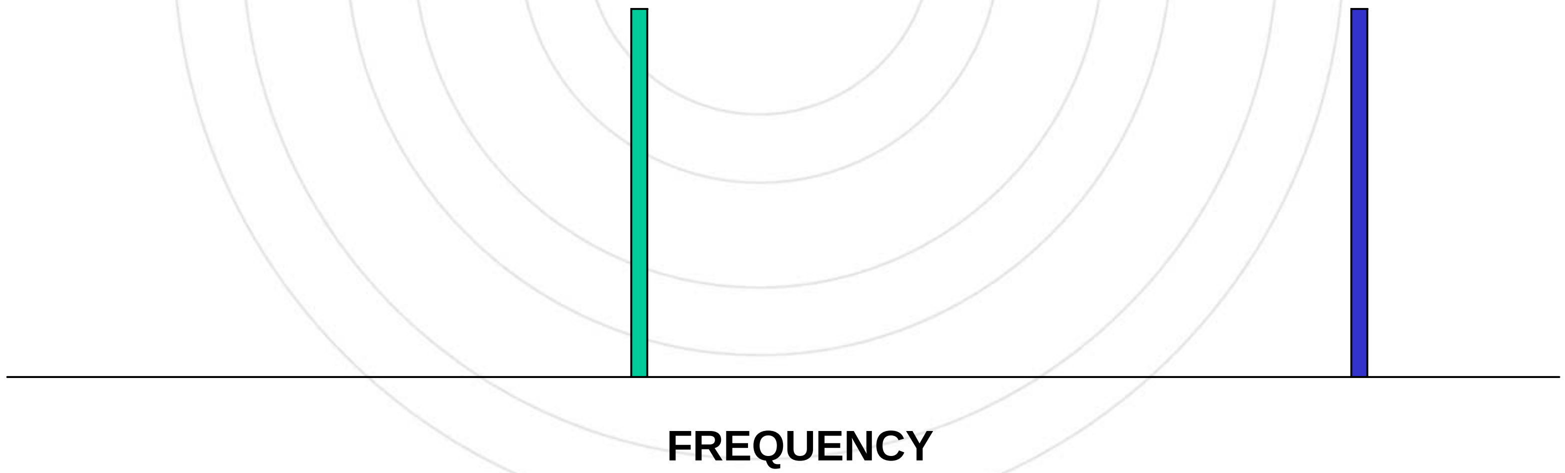
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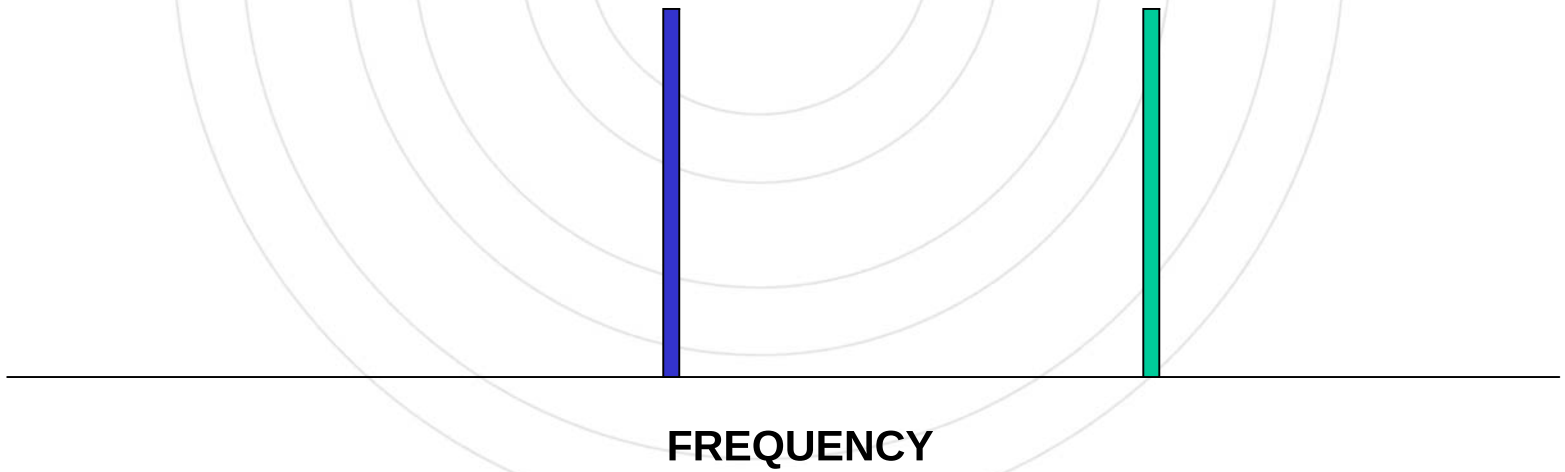
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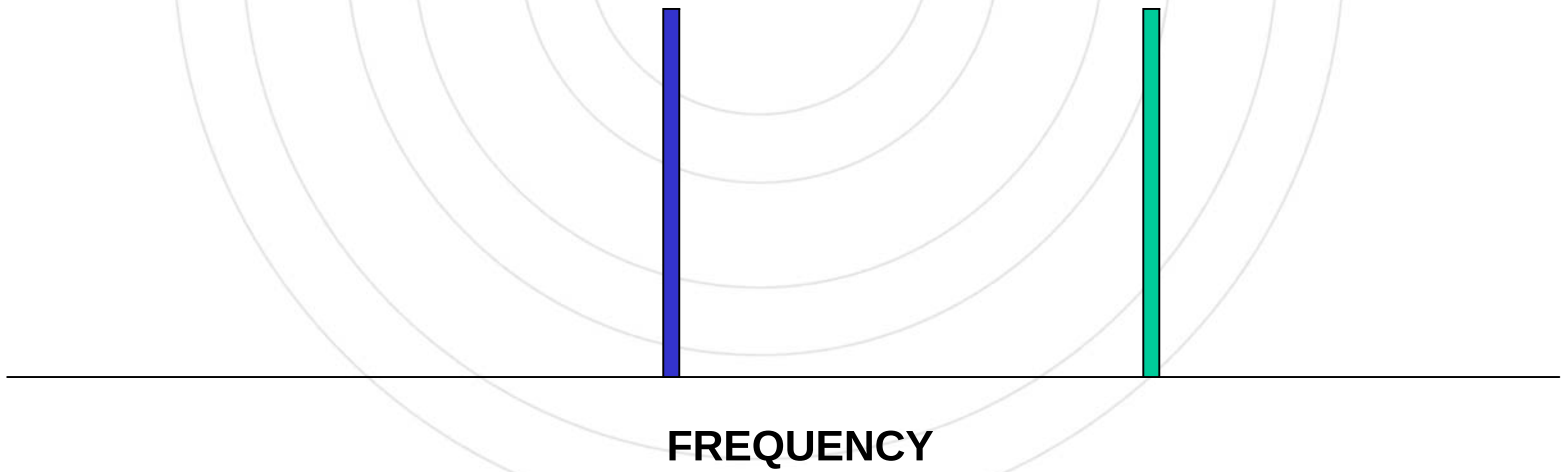
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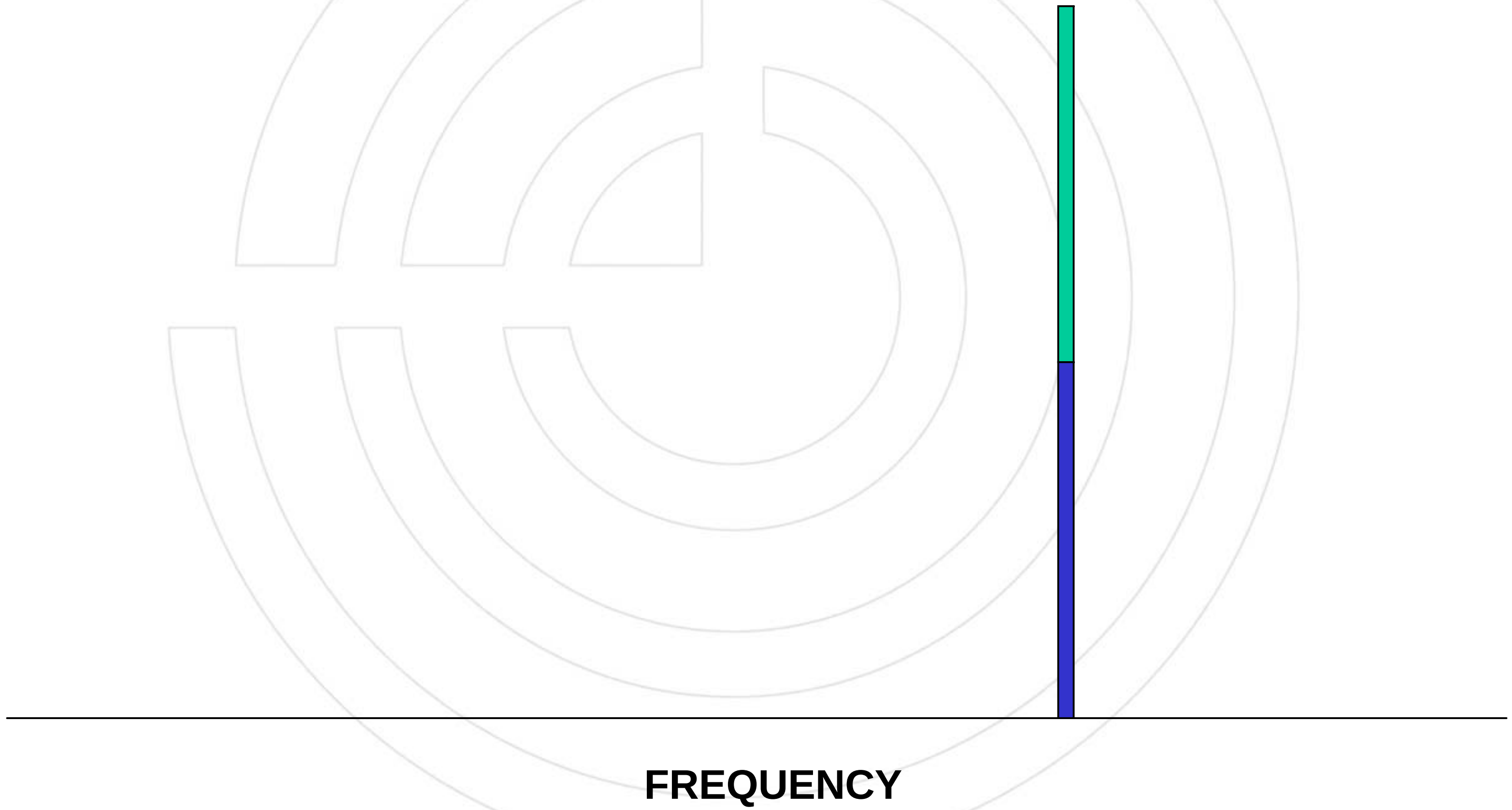
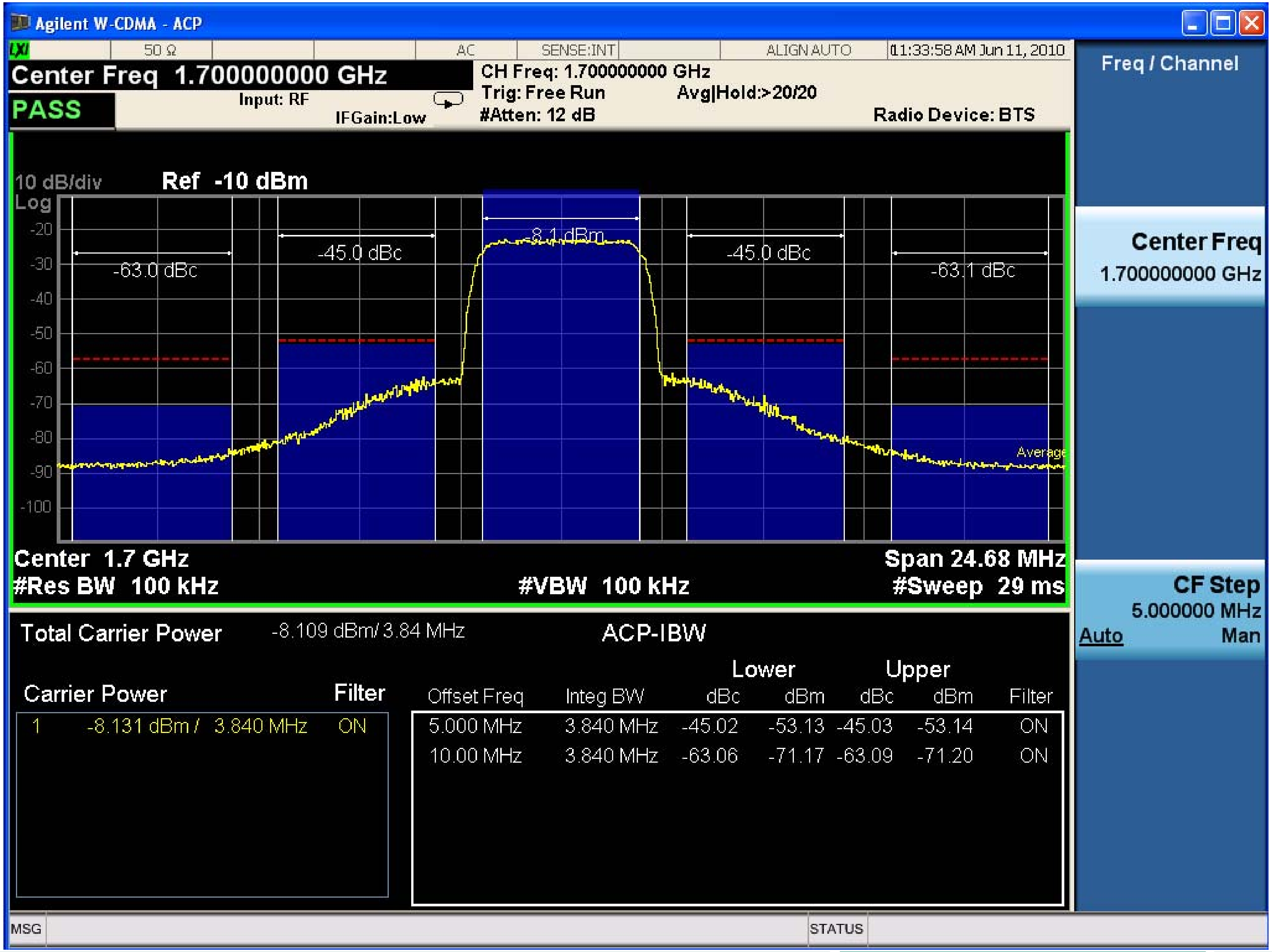

FREQUENCY

Peak to Average Ratio

What does Spectrum look like?



Agilent W-CDMA - ACP
50 Ω
AC
SENSE:INT
ALIGN AUTO
11:33:58 AM Jun 11, 2010
Center Freq 1.700000000 GHz
PASS
Input: RF
IFGain:Low
CH Freq: 1.700000000 GHz
Trig: Free Run
Avg|Hold:>20/20
#Atten: 12 dB
Radio Device: BTS
Freq / Channel
Center Freq
1.700000000 GHz
CF Step
5.000000 MHz
Auto
Man
10 dB/div
Log
Ref -10 dBm
-63.0 dBc
-45.0 dBc
-8.1 dBm
-45.0 dBc
-63.1 dBc
Average
Center 1.7 GHz
#Res BW 100 kHz
#VBW 100 kHz
Span 24.68 MHz
#Sweep 29 ms
Total Carrier Power
-8.109 dBm/ 3.84 MHz
ACP-IBW
Carrier Power
Filter
1 -8.131 dBm / 3.840 MHz ON
Lower
Upper
Offset Freq Integ BW dBc dBm dBc dBm Filter
5.000 MHz 3.840 MHz -45.02 -53.13 -45.03 -53.14 ON
10.00 MHz 3.840 MHz -63.06 -71.17 -63.09 -71.20 ON
MSG
STATUS

MILMEGA

GSM

GSM

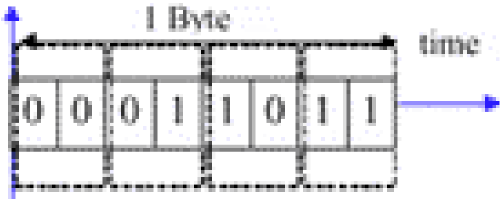
(Global System for Mobiles)

GSM

(Groupe Spécial Mobile)

GMSK

GFMSK

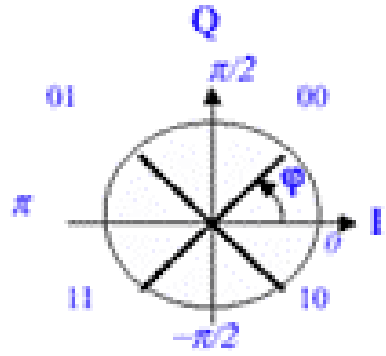


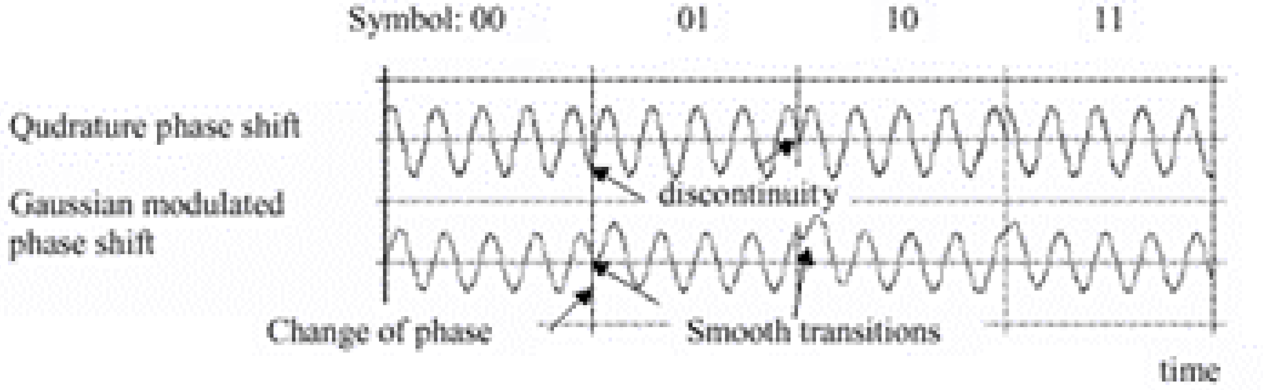
$S(t) = I(t) + Q(t)$

$I(t) = Io\ \sin(\omega t + 0 \text{ or } \pi)$

$Q(t) = Io\ \sin(\omega t + \text{or} - \pi/2)$

Symbol	I	Q	φ
00	0	π/2	π/4
01	π	π/2	3π/4
10	0	−π/2	−π/4
11	π	−π/2	−3π/4





Cell phones
2G, 2.5G, 3G, 4G

Long Term Evolution
(LTE)
2G, 2.5G, 3G, 4G

Long Term Evolution
Analog TV band now given to LTE

Frequency span now 700MHz to 5.8GHz

Hence new IEC61000-4-3

upper limit of 6GHz

	WCDMA (UMTS)	HSPA HSDPA / HSUPA	HSPA+	LTE
Max downlink speed bps	384 k	14 M	28 M	100M
Max uplink speed bps	128 k	5.7 M	11 M	50 M
Latency round trip time approx	150 ms	100 ms	50ms (max)	~10 ms
3GPP releases	Rel 99/4	Rel 5 / 6	Rel 7	Rel 8
Approx years of initial roll out	2003 / 4	2005 / 6 HSDPA 2007 / 8 HSUPA	2008 / 9	2009 / 10
Access methodology	CDMA	CDMA	CDMA	OFDMA / SC-FDMA

High Speed Packet Access	WCDMA (UMTS)	HSPA HSDPA / HSUPA	HSPA+	LTE
Max downlink speed bps	384 k	14 M	28 M	100M
Max uplink speed bps	128 k	5.7 M	11 M	50 M
Latency round trip time approx	150 ms	100 ms	50ms (max)	~10 ms
3GPP releases	Rel 99/4	Rel 5 / 6	Rel 7	Rel 8
Approx years of initial roll out	2003 / 4	2005 / 6 HSDPA 2007 / 8 HSUPA	2008 / 9	2009 / 10
Access methodology	CDMA	CDMA	CDMA	OFDMA / SC-FDMA

Evolved High Speed Packet Access	WCDMA (UMTS)	HSPA HSDPA / HSUPA	HSPA+	LTE
Max downlink speed bps	384 k	14 M	28 M	100M
Max uplink speed bps	128 k	5.7 M	11 M	50 M
Latency round trip time approx	150 ms	100 ms	50ms (max)	~10 ms
3GPP releases	Rel 99/4	Rel 5 / 6	Rel 7	Rel 8
Approx years of initial roll out	2003 / 4	2005 / 6 HSDPA 2007 / 8 HSUPA	2008 / 9	2009 / 10
Access methodology	CDMA	CDMA	CDMA	OFDMA / SC-FDMA

LTE Band Number	Uplink (MHz)	Downlink (MHz)
1	1920 - 1980	2110 - 2170
2	1850 - 1910	1930 - 1990
3	1710 - 1785	1805 -1880
4	1710 - 1755	2110 - 2155
5	824 - 849	869 - 894
6	830 - 840	875 - 885
7	**2500 - 2570**	2620 - 2690
8	880 - 915	925 - 960
9	1749.9 - 1784.9	1844.9 - 1879.9
10	1710 - 1770	2110 - 2170
11	1427.9 - 1452.9	1475.9 - 1500.9
12	**698 - 716**	728 - 746
13	777 - 787	746 - 756
14	788 - 798	758 - 768
17	704 - 716	734 - 746
18	815 - 830	860 - 875
19	830 - 845	875 - 890
20	832 - 862	791 - 821
21	1447.9 - 1462.9	1495.5 - 1510.9
22	3410 - 3500	3510 - 3600

GSM Band	Uplink (MHz)	Downlink (MHz)	Comments
380	380.2 - 389.8	390.2 - 399.8	
410	410.2 - 419.8	420.2 - 429.8	
450	450.4 - 457.6	460.4 - 467.6	
480	478.8 - 486.0	488.8 - 496.0	
710	698.0 - 716.0	728.0 - 746.0	
750	747.0 - 762.0	777.0 - 792.0	
810	806.0 - 821.0	851.0 - 866.0	
850	824.0 - 849.0	869.0 - 894.0	
900	890.0 - 915.0	935.0 - 960.0	P-GSM, i.e. Primary or standard GSM allocation
900	880.0 - 915.0	925.0 - 960.0	E-GSM, i.e. Extended GSM allocation
900	876.0 - 915	921.0 - 960.0	R-GSM, i.e. Railway GSM allocation
900	870.4 - 876.0	915.4 - 921.0	T-GSM
1800	1710.0 - 1785.0	1805.0 - 1880.0	
1900	1850.0 - 1910.0	1930.0 - 1990.0	

Classification of current threats

700MHz new LTE

800-900MHz, 1800-1900MHz, 2000-2100MHz, 2.3GHz WiMAX, 2.45GHz WLAN, 2.5GHz WiMAX, 2700MHz new LTE, 3.5GHz WLAN, WiMAX, 5.8GHz WLAN

During what time / event is the threat greatest?

During channel set up between the base station and the user equipment

Are there any test laboratories providing tests proving product immunity to complex modulation schemes?

Electromagnetic Compatibility Specification For Electrical/Electronic Components and Subsystems

Foreword

This engineering specification addresses Electromagnetic Compatibility (EMC) requirements for electrical/electronic (E/E) components and subsystems for Ford Motor Company (FMC). This specification is the direct link from ARL-09-0466. These requirements have been developed to assure compliance with present and anticipated regulations in addition to customer satisfaction regarding the EMC of vehicle E/E systems. This specification replaces ES-XW7T-1A278-AC.

EMC-CS-2009 is applicable for all E/E components/subsystems slated for use on 2013 Ford vehicle programs in addition to E/E component/subsystems whose commercial agreements are signed after October 1, 2009.

EMC-CS-2009 is available for download from the Ford EKB in addition to www.fordemc.com Corrections and/or editorial updates to this specification will be made as required and without prior notification to the user. It is recommended that the user verify they have the latest version of the specification prior to application to their E/E component/subsystem.

Information regarding differences between these specifications may be found at http://www.fordemc.com

Date	Version	Revision
9/30/2009	0	Initial Release of Specification
2/11/2010	1	Annex I updated to correct errors in measurement procedure RE 310 flow chart corrections CE 410 trigger setting correction CI 280 requirements for metallic connectors Corrections in tolerance requirements for certain tests Numerous editorial corrections. Corrected errors in Tables 16-1 and F-1 to align requirements. Updates to Figures G-1 and G-3 in Annex G. Requirement revisions for Artificial Networks

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11.6 Requirements: RF Immunity to hand portable transmitters: RI 115

The device shall operate as specified in Table 11-1 when exposed to RF electromagnetic fields as delineated in Table 11-4. RI 115 is based on the potential risk of modules being exposed to hand portable transmitters (e.g. cell phones). **Specific applicability shall be agreed with the FMC EMC department prior to testing and documented in the test plan.**

Table 11-4: RI 115 Requirements for hand portable transmitters

Band	Frequency Band (MHz)	Test severity (Watts) [1, 2]		Modulation type
		Level 1	Level 2	
8	360-480	4.5	9.0	PM, 18 Hz, 50%
9	800 - 1000	7.0	14.0	PM, 217 Hz, 12.5%
10	1600-1950	1.5	3.0	PM, 217 Hz, 12.5%
11	1950-2200	0.75	1.5	PM, 217 Hz, 12.5%
12	2400 - 2500	0.1	0.2	PM, 1600 Hz, 50%
13	2500-2700	0.25	0.5	PM, 217 Hz, 12.5%

1: Test severity levels are only valid for the antenna identified in this specification

2: NET power delivered to the input port of the antenna, which established while the antenna is 1m from any object

11.6.1 Test Verification and Test Setup

Verification of component performance shall be performed using the test setup shown in Figure 11.5. References to wiring harness and LISN are not applicable in case of modules without wiring harness (e.g. remote entry key). All tests shall be performed in an absorber lined shielded enclosure (ALSE), which conforms to ISO 11452-2.

- This test procedure makes use of a small broadband antenna positioned above the DUT and it's wiring harness to simulate electromagnetic fields generated by hand portable transmitters operating in close proximity. The result of near field immunity tests is strongly influenced by the antenna type used and for this reason only Schwarzbeck antenna SBA9113 with elements 420NJ shall be used for this test.
- The separation between the test antenna and the DUT surfaces and harnesses shall be either 5 mm or 50 mm depending on expected proximity to intentional storage locations and product type as detailed in table 11-5 below. The test antenna is positioned in step sizes specified in table 11-5 to ensure all DUT surfaces are thoroughly exposed.
- The FMC EMC department shall be consulted with respect to antenna to DUT surface separation distance and positioning steps. This information shall be documented in the component level EMC test plan. Only one test antenna to DUT height shall be used for a given device.

Table 11-5: RI 115 Separation Distances and Antenna Positioning

DUT Surface or Harness description	Antenna Distance from DUT	Antenna Positioning Steps
DUT surfaces and first 300mm of their harnesses (measured from DUT connector) which are likely to be packaged between 50 to 200 mm of **intentional** and/or **unintentional** locations where a hand portable transmitter may be located.	50 mm	100 mm
Keys and similar devices which may come in direct contact with hand portable transmitters and all other DUT surfaces and first 300mm of their harnesses which are likely to be packaged less than 50 mm from **intentional** storage locations.	5 mm	30 mm

Table 11-4: RI 115 Requirements for hand portable transmitters

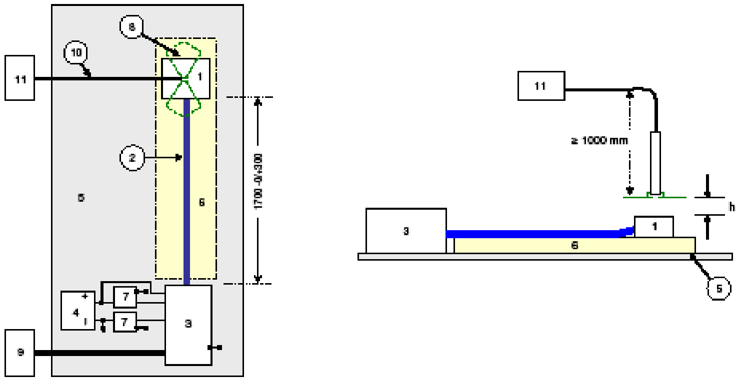
Band	Frequency Band (MHz)	Test severity (Watts) [1, 2]		Modulation type
		Level 1	Level 2	
8	360-480	4.5	9.0	PM, 18 Hz, 50%
9	800 - 1000	7.0	14.0	PM, 217 Hz, 12.5%
10	1600-1950	1.5	3.0	PM, 217 Hz, 12.5%
11	1950-2200	0.75	1.5	PM, 217 Hz, 12.5%
12	2400 -2500	0.1	0.2	PM, 1600 Hz, 50%
13	2500-2700	0.25	0.5	PM, 217 Hz, 12.5%

1: Test severity levels are only valid for the antenna identified in this specification

2: NET power delivered to the input port of the antenna, which established while the antenna is 1m from any object

- The DUT shall be powered from an automotive battery (see paragraph 4.5.4 for requirements). The battery negative terminal shall be connected to the ground plane. The battery may be located on, or under the test bench. See Annex G regarding the standard test Setup for the Load Simulator, battery and Artificial Networks.
- The test harness shall be 1700 mm (+ 300/- 0 mm) long and routed 50 mm above the ground plane on an insulated support ($\varepsilon_r \leq 1.4$) over the entire length between the DUT and the Test Fixture.
- The test bench shall include a sufficiently large ground plane, such that the plane extends beyond the test Setup by at least 100 mm on all sides.
- The distance between the test setup and all other conductive structures (such as the walls of the shielded enclosure) with the exception of the ground plane shall be ≥ 500 mm.
- The test antenna shall be mounted above the DUT and parallel to the ground plane. The DUT shall be positioned to ensure that the surface under test is facing the antenna.

Figure 11-5: RI 115 Test Setup



Key:

1. DUT
2. Test harness
3. Load Simulator
4. Automotive Battery
5. Ground Plane
6. Dielectric Support ($\varepsilon_r \leq 1.4$)
7. Artificial network
8. Test antenna (Schwarzbeck antenna SBA9113 with elements 420NJ)
9. Support Equipment
10. High quality double-shielded coaxial cable (cable can be no closer than 1000 mm to antenna elements. Place ferrite beads on cable (see Figure 11-6).
11. RF Generation Equipment (see Figure 11-6)

11.6.2 Test Procedure

Prior to testing, calibration of test setup shall be performed using a similar procedure to that delineated in Annex B of ISO 11451-3-2006. During calibration, the antenna shall be positioned such that its radiating elements are a minimum distance of 500 mm from any absorber material and 1000 mm from any object such as the DUT, the ground plane, antenna cable, and the test enclosure wall. This setup is illustrated in Figure 11-6.

The net power levels specified in Table 11-4 are based on the measured forward and reverse power. per the following equation:

$$P_{ant,NET} = A \cdot P_{meas,FWD} - \frac{1}{A} \cdot P_{meas,REFL} \qquad A = \left[\frac{P_{ant,FWD}}{P_{meas,FWD}} \right]$$

Where:

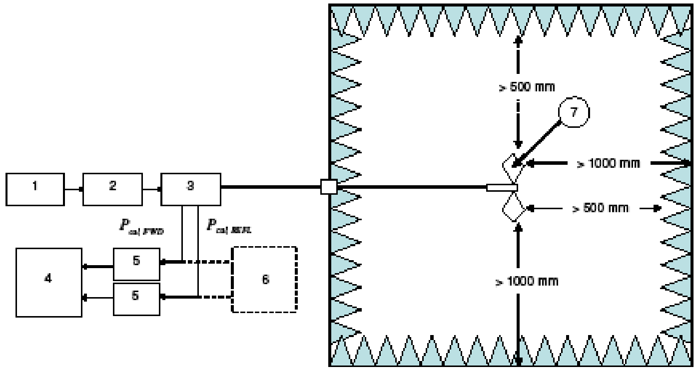
$P_{ant,\ NET}$ = the NET power, specified in Table 11-4, that is delivered to the antenna

$P_{meas,\ FWD}$ = the FOWARD power, measured at the directional coupler

$P_{meas,\ REFL}$ = *the REFLECTED power measured at the directional coupler*

A = the cable attenuation (A< 1)

Figure 11-6: RI 115 Setup for Calibration



Key:

1. Signal Generator
2. RF Amplifier
3. Directional Coupler
4. RF Power Meter
5. Peak Envelope Power Sensor
6. Spectrum Analyzer (may be used as an alternative to the power sensor)
7. Test Antenna: (Schwarzbeck antenna SBA9113 with elements 420NJ)

Although not required prior to each test, the test laboratory shall make periodic checks of the antenna's VSWR to verify that it has not changed from the manufacturers published specifications.

The methodology for selection of surfaces and harnesses to be tested, in addition to antenna to DUT test distance and antenna positioning steps is delineated in sections 11.6.2.1 and 11.6.2.2 below. This information shall be documented in the EMC test plan.

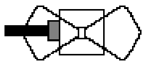
11.6.2.1 Antenna Positioning for Coupling to DUT

The usable test area of the broadband antenna is 100x100 mm when testing at a DUT-to-antenna separation of 50 mm. However, the footprint reduces to 30x30 mm when testing at 5 mm separation. It is therefore necessary to move the antenna in steps of 100 mm and 30 mm when testing at 50mm and 5mm respectively.

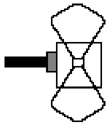
All surfaces of the DUT which are to be tested shall be partitioned to square cells of either 100x100, or 30x30 mm. The antenna shall be placed at a distance of 50 or 5 mm (specified in the test plan) and the centre of each cell shall be exposed to the centre and the elements of the antenna in two orthogonal orientations (four exposures in total). It is necessary to expose each cell to the centre and the elements of the antenna as E and H fields are in different places and move with test frequency.

The antenna shall be placed above the center of each cell, and the DUT shall be exposed to specified disturbance listed in Table 11-4 using the test sequence detailed below:

a) Place the antenna in parallel with the DUT harness and aligned with the center of the first cell and expose DUT to stress levels specified in Table 11-4.



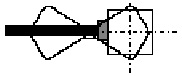
b) Repeat step a) with antenna rotated 90 degrees



c) Align antenna with the center of the next cell and repeat steps (a) and (b) until all cells have been exposed to 2 orthogonal orientation of the antenna .

Steps (d), (e) and (f) are NOT required when testing at 5mm distance.

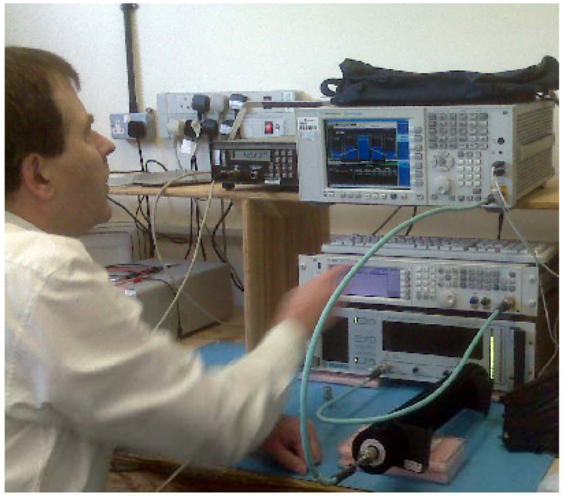
d) Move the antenna back to the first cell. Align antenna element in the center of the test cell (edges of the element aligned with the center of the cell) and expose DUT to the stress levels specified in Table 11-4.



Amplifier power back-off required for test signal integrity

MILMEGA

Determining Amplifier Back-Off to meet WCDMA Adjacent Channel Power Requirements



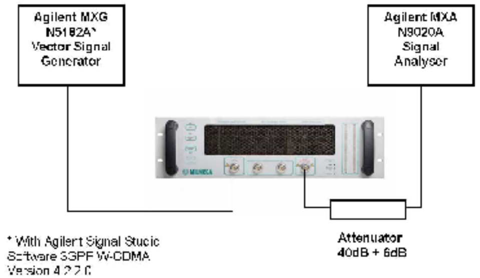
This application note provides guidance on estimating the amplifier output power back-off required to achieve a particular level of adjacent channel power ratio (ACPR). This information is useful when selecting a power amplifier for applications such as component design proving and / or production test. The information also acts as a guide when setting power levels during actual testing.
The amplifier is a 1.8-6.0GHz 50 Watt GaN amplifier that has been characterised for WCDMA performance at several frequencies across its band.
The method of data collection is explained, followed by worked examples on the use of the characterisation data.

Data Collection

The 1.8-6.0GHz 50 Watt amplifier (MILMEGA Model AS1860-50) was driven by a very clean WCDMA signal created by a Vector Signal Generator. The test signal used in all cases was WCDMA FDD Downlink Release 8, Test Model 1 + 16 DPCH. A Signal Analyser was used to monitor the output signal from the amplifier and data was captured on the channel power achieved for various levels of ACPR. This was repeated over several frequencies across the band of the amplifier. Figure 1 shows the test set up and Figure 2 shows a screen shot of one of the collected data points. Table 1 lists the output path-loss with frequency.

MILMEGA Limited Park Road, Ryde, Isle of Wight, PO33 2BE United Kingdom
Tel: +44 (0)1983 618004 Fax +44 (0) 1983 811521 sales@milmega.co.uk www.milmega.co.uk

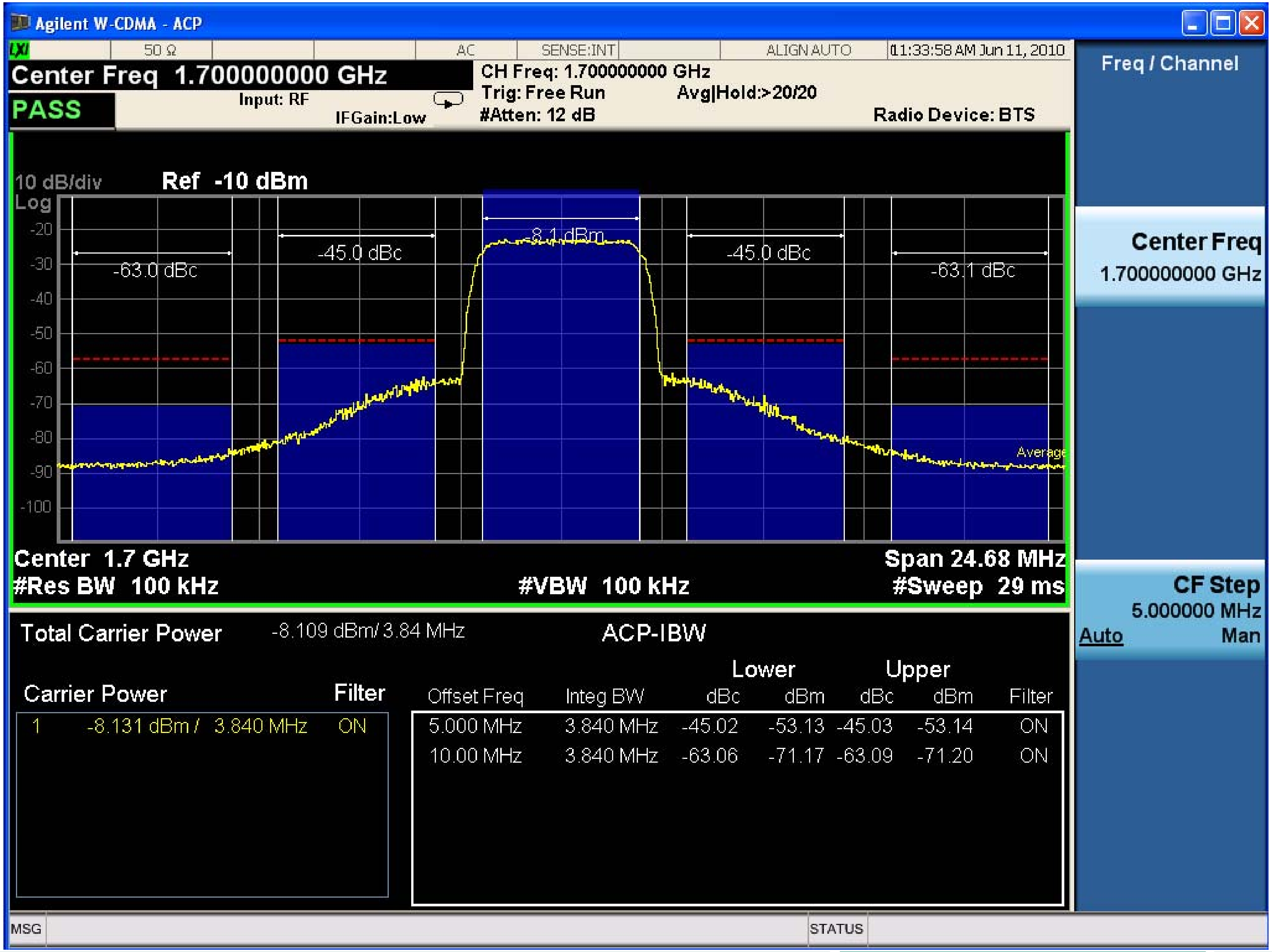
Figure 1: Test Set Up for Model AS1860-50 (1.8-6.0GHz, 50 Watts)



Centre Frequency	Input Cable Loss	Output Cable Plus Attenuator Loss
1.8 GHz	0.358 dB	46.42 dB
2.0 GHz	0.381 dB	46.47 dB
2.5 GHz	0.414 dB	46.50 dB
3.0 GHz	0.449 dB	46.60 dB
3.5 GHz	0.489 dB	46.70 dB
4.0 GHz	0.517 dB	46.60 dB
4.5 GHz	0.558 dB	46.60 dB
5.0 GHz	0.604 dB	46.70 dB
5.5 GHz	0.632 dB	46.70 dB
6.0GHz	0.670 dB	46.70 dB

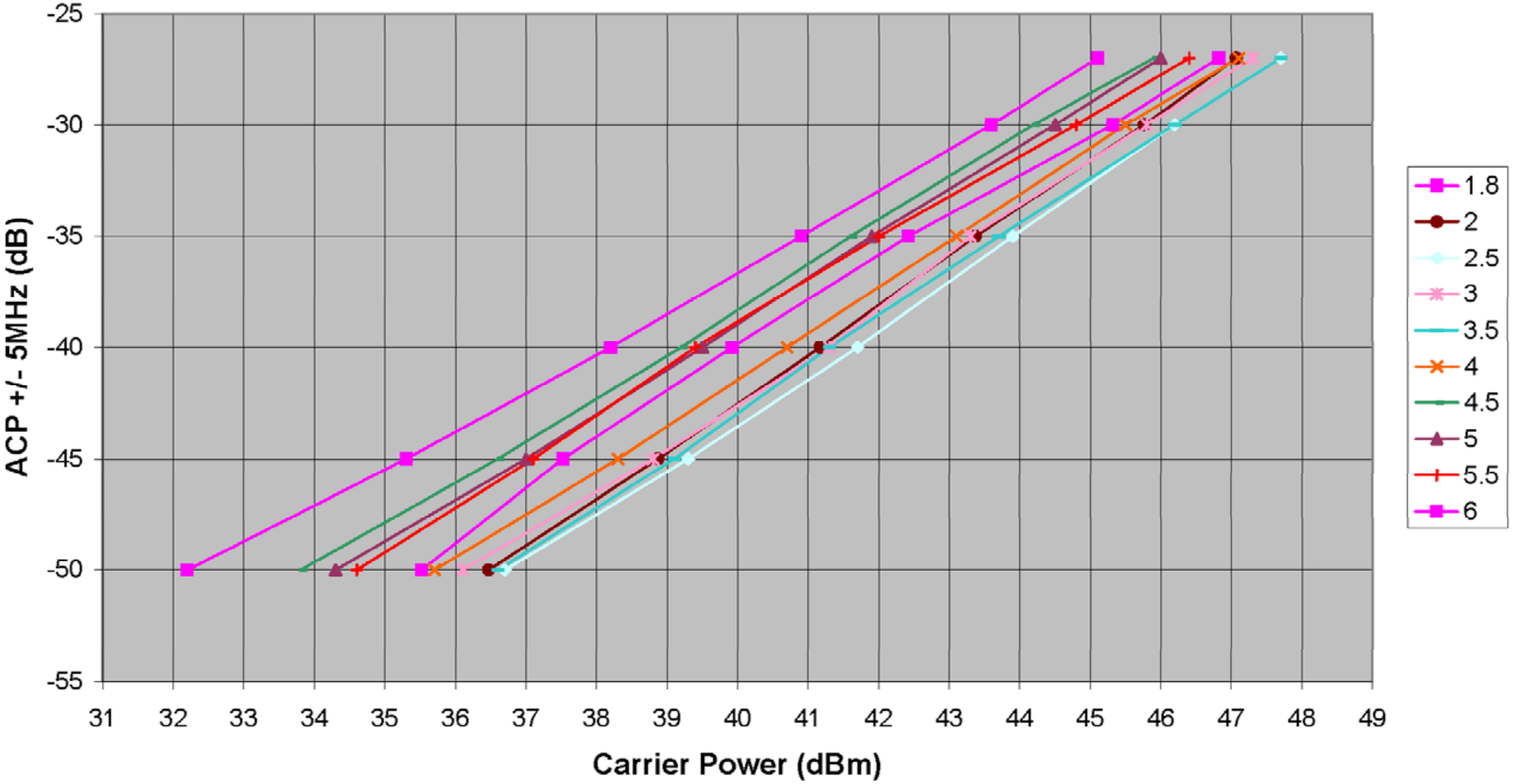
Table 1: Input Cable Loss and Total Output Path-Loss

As an instance of data collection, the mean channel power shown in Figure 2 is added to the output path loss at 4.0GHz to get the power at the output of the amplifier. That is –10.9 dBm (Figure 2) plus 46.60 dB (Table 1) = 35.7dBm (3.5 Watts). A plot of the test results for various frequencies and ACPR power levels is at Figure 3.



Agilent W-CDMA - ACP
50 Ω
AC
SENSE:INT
ALIGN AUTO
11:33:58 AM Jun 11, 2010
Center Freq 1.700000000 GHz
PASS
Input: RF
IFGain:Low
CH Freq: 1.700000000 GHz
Trig: Free Run
Avg|Hold:>20/20
#Atten: 12 dB
Radio Device: BTS
10 dB/div
Log
Ref -10 dBm
-20
-30
-40
-50
-60
-70
-80
-90
-100
-63.0 dBc
-45.0 dBc
-8.1 dBm
-45.0 dBc
-63.1 dBc
Average
Center 1.7 GHz
#Res BW 100 kHz
#VBW 100 kHz
Span 24.68 MHz
#Sweep 29 ms
Total Carrier Power
-8.109 dBm/ 3.84 MHz
ACP-IBW
Carrier Power
Filter
1 -8.131 dBm / 3.840 MHz ON
Lower
Upper
Offset Freq
Integ BW
dBc
dBm
dBc
dBm
Filter
5.000 MHz 3.840 MHz -45.02 -53.13 -45.03 -53.14 ON
10.00 MHz 3.840 MHz -63.06 -71.17 -63.09 -71.20 ON
MSG
STATUS
Freq / Channel
Center Freq
1.700000000 GHz
CF Step
5.000000 MHz
Auto
Man

AS1860-50 ACP vs Output Carrier Power



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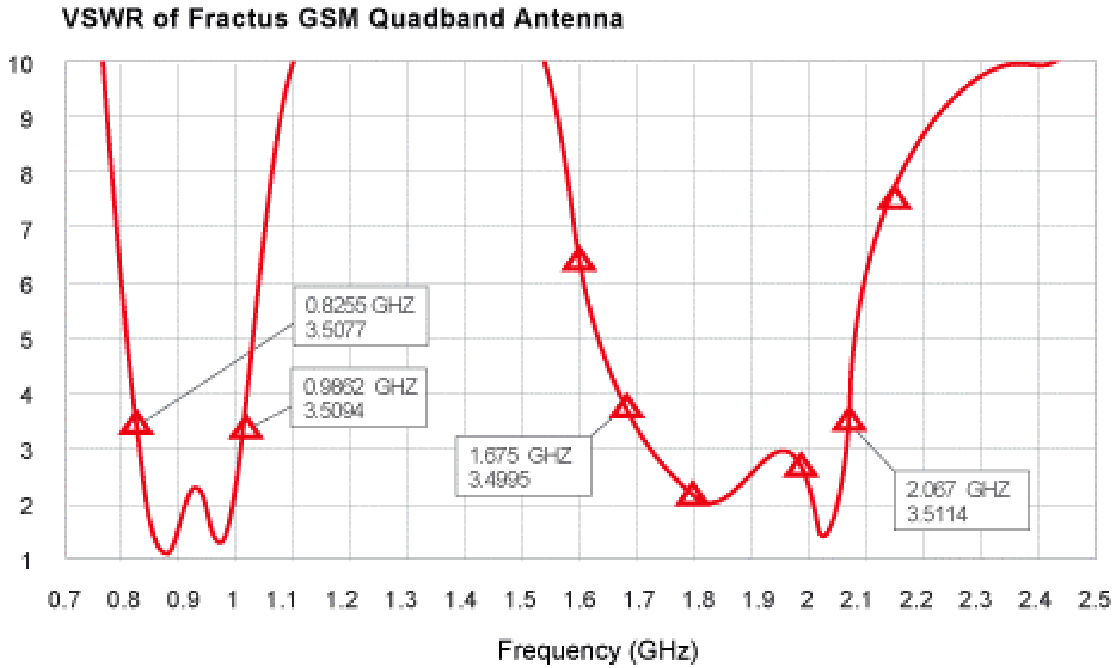
USE RF CALC

Free Issue

www.milmega.co.uk/Media Centre

Use Existing Power Amplifier (Solid State)


VSWR of Fractus GSM Quadband Antenna
10
9
8
7
6
5
4
3
2
1
0.7 0.8 0.9 1 1.1 1.2 1.3 1.4 1.5 1.6 1.7 1.8 1.9 2 2.1 2.2 2.3 2.4 2.5
Frequency (GHz)
0.8255 GHZ
3.5077
0.9862 GHZ
3.5094
1.675 GHZ
3.4995
2.067 GHZ
3.5114

Is the interfering field near-field or far-field?

Simulating the threats in an ALSE or GTEM Cell

Rental costs of signal generating equipment (Can’t get test house to do this for you)

Conclusions and summary

“Characterizing Products against Modern Wireless Communication Threats”

QUESTIONS

Tom Mullineaux