

# Receiver Blocking and What to Do About It



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CSI TELECOMMUNICATIONS, Inc  
April 7, 2015

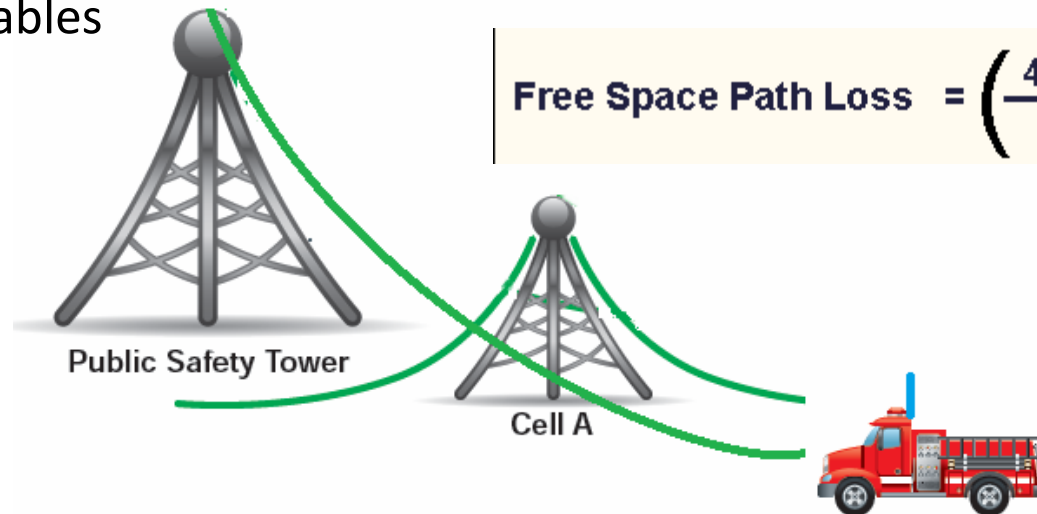
# What are the Symptoms?

- Conventional Repeaters
  - Intermittent Receive
  - Transmit okay
- Trunked Repeaters
  - “Bonk”, No Transmit or Receive



# Blocking, the Near Far Problem

- Power drops 6 dB for every 2X distance
  - Becoming common to get 80 dB difference 4G Near to Far
    - 80 dB is the performance of most portables



$$\text{Free Space Path Loss} = \left( \frac{4 \pi d f}{c} \right)^2$$

# TIA Receiver Blocking Performance

ANSI/TIA-102.CAAB-D

## 3.1.19 Blocking Rejection

Applicable method of measurement and definition are described in [102.CAAA] clause 2.1.19.

### Standard

The blocking rejection ratio shall be at least that specified in Table 13.

Table 13 - Blocking rejection

Receiver Class	Mobile	Portable	Base Station
A	90 dB	80 dB	90 dB
B	80 dB	70 dB	80 dB

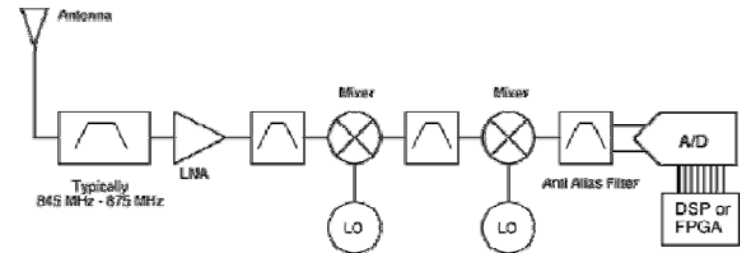
9

- CW Test signals vs. 4G signals



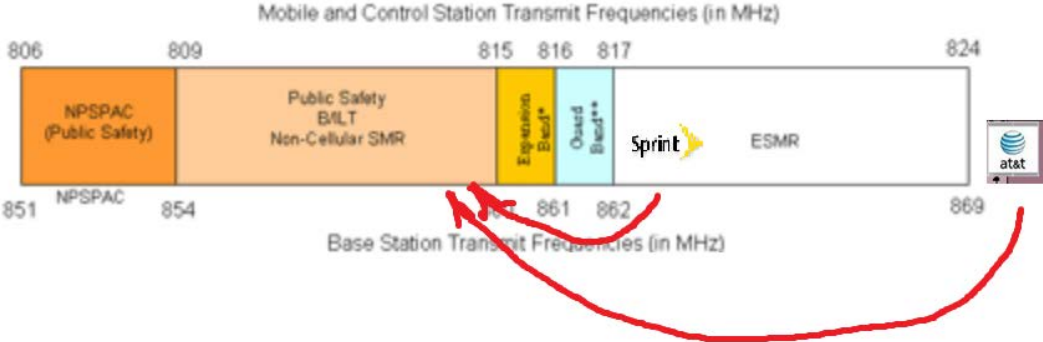
# What Causes Receiver Blocking?

- Receiver Design (Filtering)
  - What Countries Served by model?
- Overload of Preamplifier
  - TOI of Semiconductor
    - Compression (reduced sensitivity)
    - IM products
- Overload of Mixer
  - LO Drive
- ADC Overload
  - Clipping of Desired Data on Interference peaks

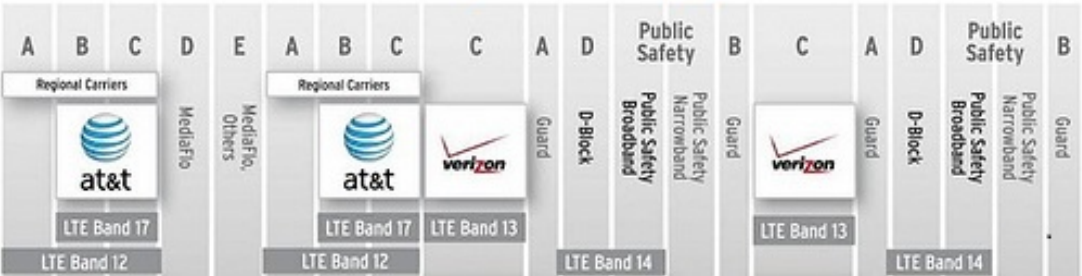


# Common Blocking Frequencies

- 800 MHz

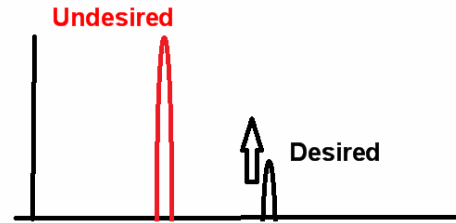


- 700 MHz

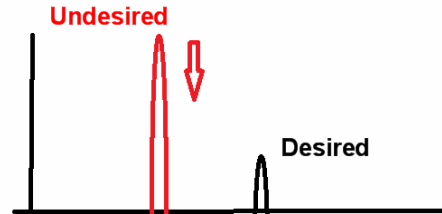


# What Can you do?

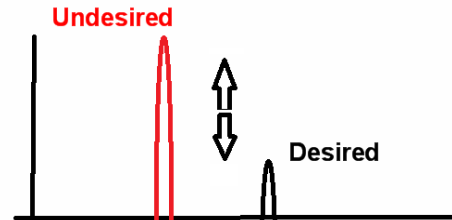
- More Desired Signal



- Lower Blocker Level

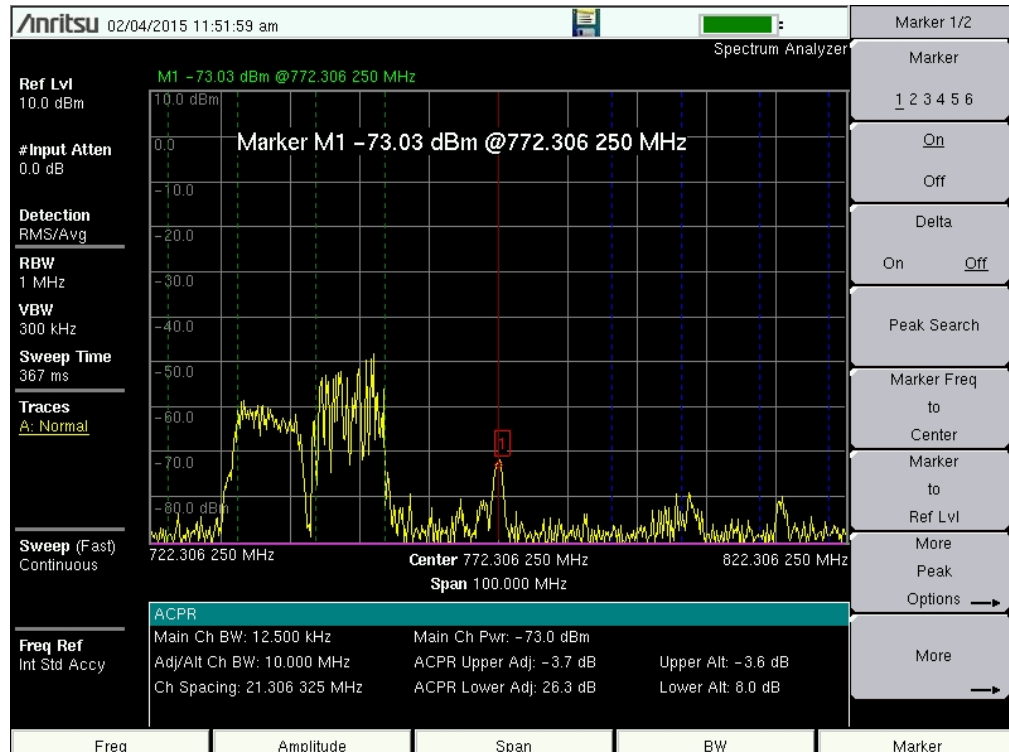


- Better Receivers



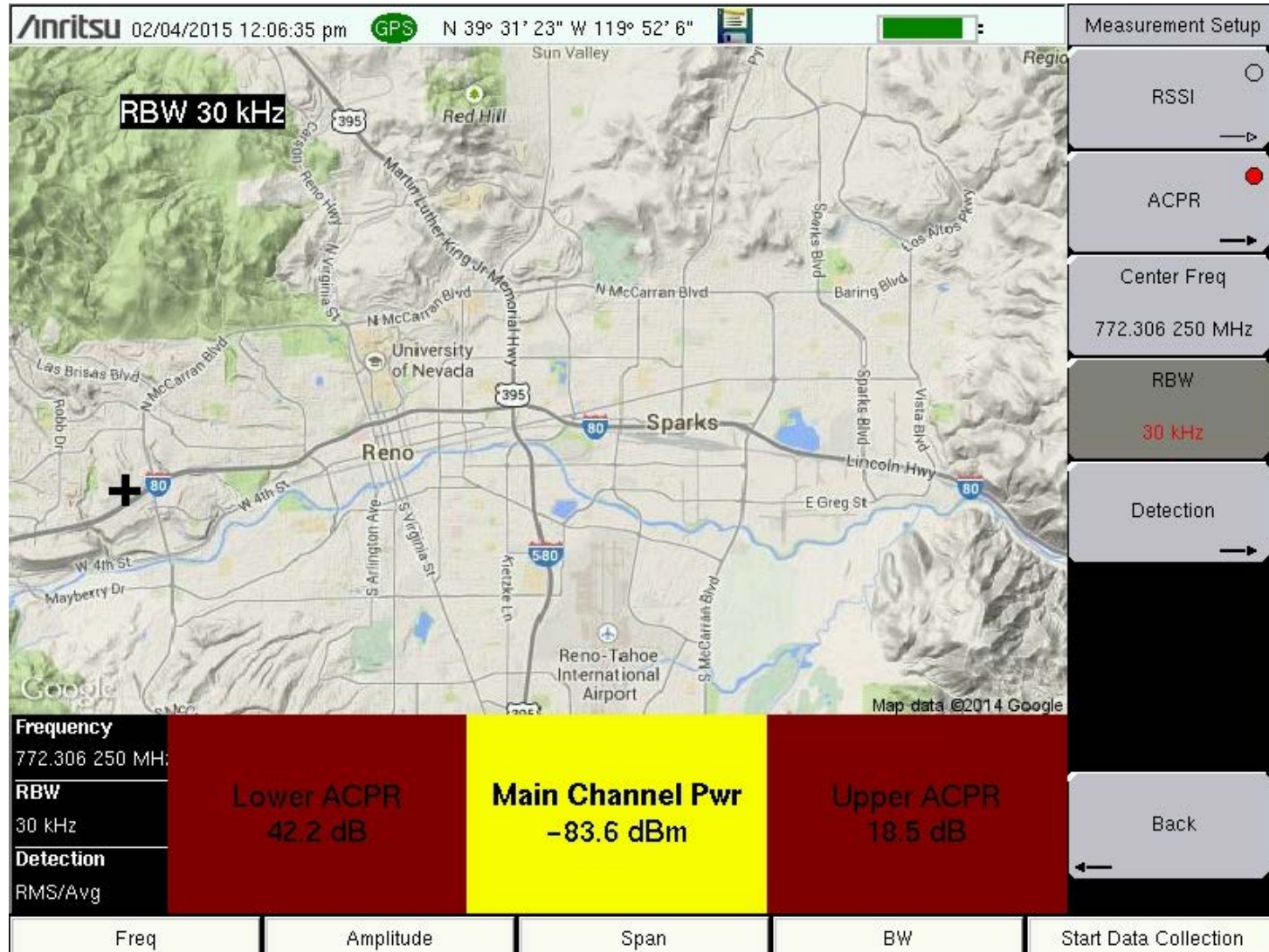
# Making Measurements

- What are the relative levels over the coverage area?
- ACPR coverage mapping

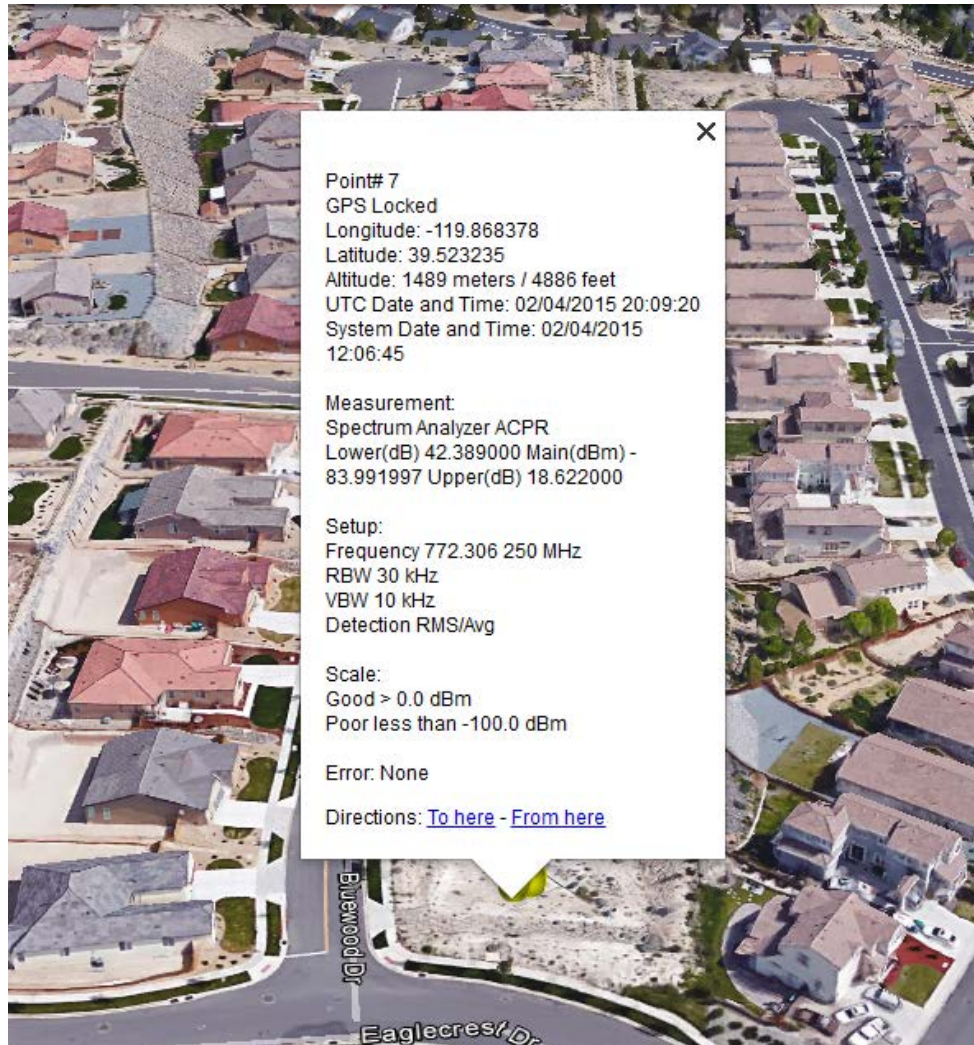




# ACPR Mapping



# ACPR Mapping

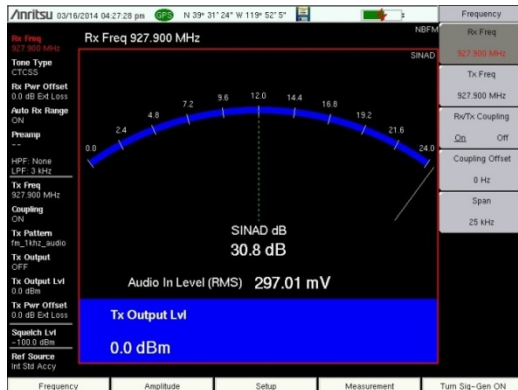


# ACPR Mapping

#Pt	GPS Statu	Longitude	Latitude(Y	Altitude	UTC Date	UTC Time	System Da	System Ti	Measurement					
Point# 1	GPS Locke	-119.868	39.52325	1489 mete	2/4/2015	20:09:12	2/4/2015	12:06:38	Spectrum ACPR	Lower(dB)	42.23	Main(dBn	-83.608	
Point# 2	GPS Locke	-119.868	39.52325	1489 mete	2/4/2015	20:09:12	2/4/2015	12:06:38	Spectrum ACPR	Lower(dB)	41.4	Main(dBn	-83.808	
Point# 3	GPS Locke	-119.868	39.52325	1489 mete	2/4/2015	20:09:13	2/4/2015	12:06:38	Spectrum ACPR	Lower(dB)	41.4	Main(dBn	-83.808	
Point# 4	GPS Locke	-119.868	39.52324	1489 mete	2/4/2015	20:09:19	2/4/2015	12:06:44	Spectrum ACPR	Lower(dB)	39.496	Main(dBn	-83.992	
Point# 5	GPS Locke	-119.868	39.52324	1489 mete	2/4/2015	20:09:19	2/4/2015	12:06:45	Spectrum ACPR	Lower(dB)	39.496	Main(dBn	-83.992	
Point# 6	GPS Locke	-119.868	39.52324	1489 mete	2/4/2015	20:09:19	2/4/2015	12:06:45	Spectrum ACPR	Lower(dB)	39.496	Main(dBn	-83.992	
Point# 7	GPS Locke	-119.868	39.52324	1489 mete	2/4/2015	20:09:20	2/4/2015	12:06:45	Spectrum ACPR	Lower(dB)	42.389	Main(dBn	-83.992	
Point# 8	GPS Locke	-119.868	39.52324	1489 mete	2/4/2015	20:09:20	2/4/2015	12:06:45	Spectrum ACPR	Lower(dB)	41.614	Main(dBn	-83.216	
Point# 9	GPS Locke	-119.868	39.52324	1489 mete	2/4/2015	20:09:20	2/4/2015	12:06:45	Spectrum ACPR	Lower(dB)	41.614	Main(dBn	-83.216	
Point# 10	GPS Locke	-119.868	39.52324	1489 mete	2/4/2015	20:09:20	2/4/2015	12:06:46	Spectrum ACPR	Lower(dB)	41.614	Main(dBn	-83.216	
Point# 11	GPS Locke	-119.868	39.52324	1489 mete	2/4/2015	20:09:20	2/4/2015	12:06:46	Spectrum ACPR	Lower(dB)	40.546	Main(dBn	-83.216	
Point# 12	GPS Locke	-119.868	39.52323	1489 mete	2/4/2015	20:09:21	2/4/2015	12:06:46	Spectrum ACPR	Lower(dB)	40.584	Main(dBn	-83.2	
Point# 13	GPS Locke	-119.868	39.52323	1489 mete	2/4/2015	20:09:21	2/4/2015	12:06:46	Spectrum ACPR	Lower(dB)	40.584	Main(dBn	-83.2	
Point# 14	GPS Locke	-119.868	39.52323	1489 mete	2/4/2015	20:09:21	2/4/2015	12:06:46	Spectrum ACPR	Lower(dB)	40.584	Main(dBn	-83.2	
Point# 15	GPS Locke	-119.868	39.52323	1489 mete	2/4/2015	20:09:21	2/4/2015	12:06:47	Spectrum ACPR	Lower(dB)	40.229	Main(dBn	-83.2	
Point# 16	GPS Locke	-119.868	39.52323	1489 mete	2/4/2015	20:09:21	2/4/2015	12:06:47	Spectrum ACPR	Lower(dB)	39.249	Main(dBn	-82.988	
Point# 17	GPS Locke	-119.868	39.52322	1489 mete	2/4/2015	20:09:22	2/4/2015	12:06:47	Spectrum ACPR	Lower(dB)	39.249	Main(dBn	-82.988	
Point# 18	GPS Locke	-119.868	39.52322	1489 mete	2/4/2015	20:09:22	2/4/2015	12:06:47	Spectrum ACPR	Lower(dB)	39.249	Main(dBn	-82.988	
<APP_DATA_END>														

# SINAD Mapping

- What are the relative levels over the coverage area?
  - Your Channel NBFM 12.5 kHz 1 kHz test tone
- SINAD coverage mapping



# SINAD Mapping

Anritsu 02/05/2015 07:03:31 am GPS N 39° 31' 23" W 119° 52' 5"

**Mapping Type Selector**

- RSSI
- THD
- SINAD
- External SINAD**

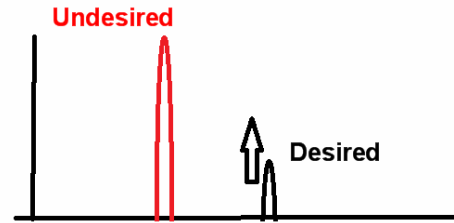
**Coverage Mapping**

- Save/Recall
- Points/Map →
- Mapping Type
- External SINAD
- Legend
- Setup →
- Display Type
  - Map
  - Graph
- Point
- Distance/Time
- Setup →
- Back

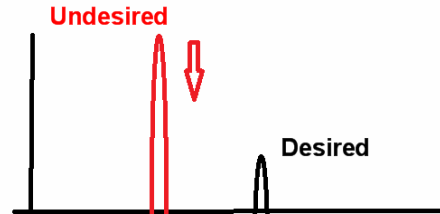
<b>Rx Freq</b> 772.306 250 MHz	Excellent: $\geq 30.00$ dB	Fair: $\geq 12.00$ dB	<b>External SINAD</b> <b>33.9 dB</b>  12.00 dB 30.00 dB	
<b>Tone Type</b> CTCSS	Very Good: $\geq 24.00$ dB	Poor: $< 12.00$ dB		
<b>Auto Rx Range</b> ON	Good: $\geq 18.00$ dB			
Frequency	Amplitude	Setup	Measurement	Start Data Collection

# What Can you do?

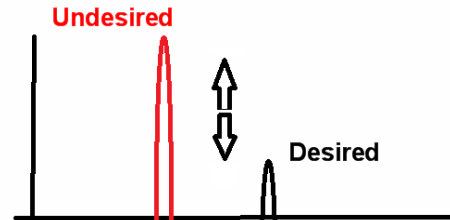
- More Desired Signal



- Lower Blocker Level

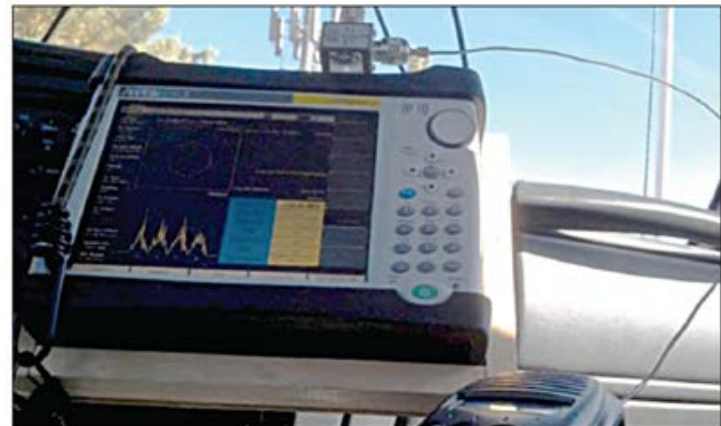
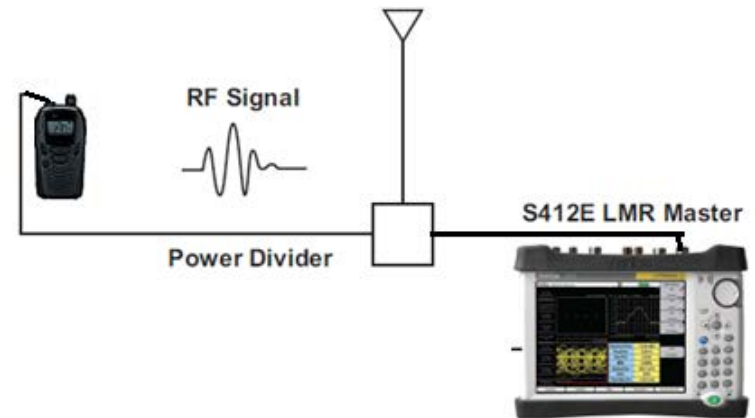


- Better Receivers



# How much more desired?

- Sum external antenna with Blocker with Desired signal from signal generator
- Increase Desired level until BER is  $< 5\%$



*S412E LMR Master mounted on a vehicle dashboard.*

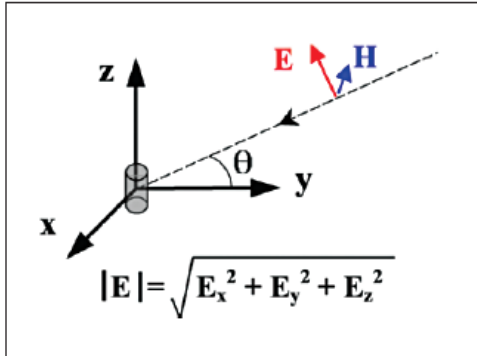
# How Much Less Undesired?

- Measure Field Strength
  - FCC NPRM FCC 14-181
    - 40 dB $\mu$ V/m
- Channel loaded with traffic?
  - Assess and extrapolate
- File Complaint with Undesired
- Present case with defensible accuracy
  - Calibrated antenna
  - No Nearby Metal (vehicle)

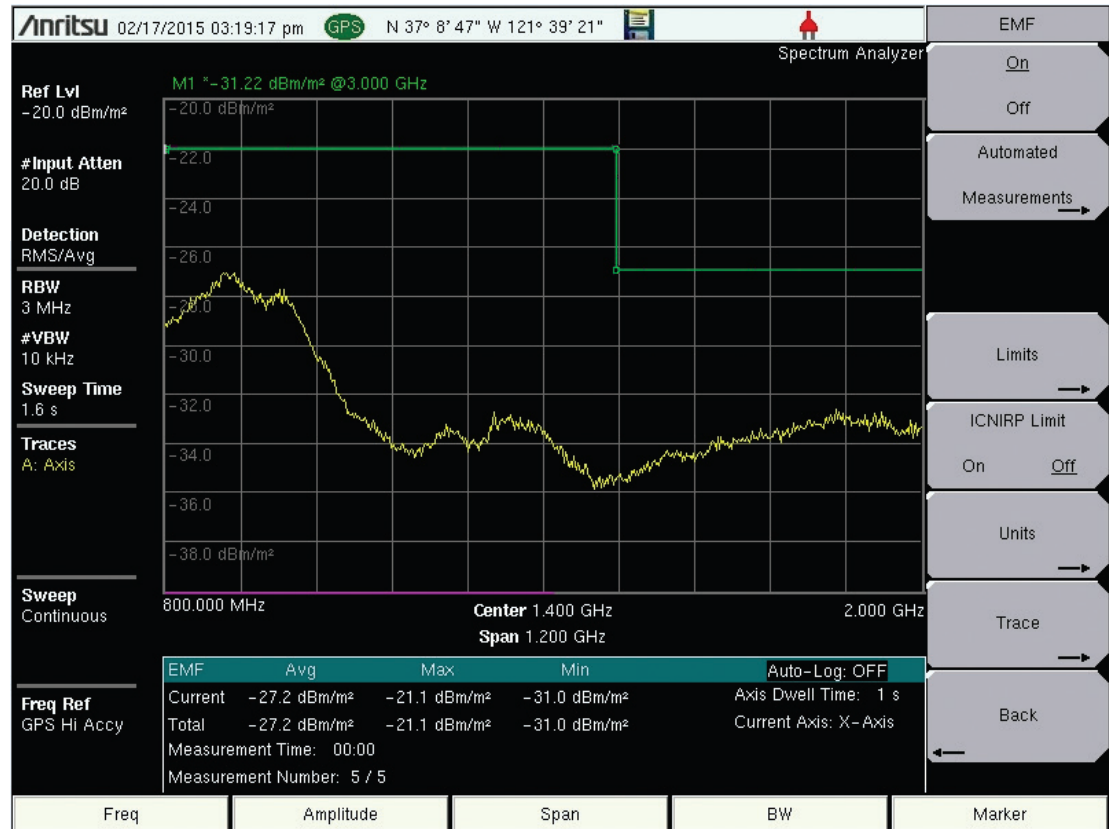




# EMF Measurements



Total measurement given by formula shown



# EMF Measurements

Anritsu 08/09/2013 04:51:53 pm LTE  
EMF

Center Freq  
751.000 MHz

Channel  
--

Reference Source  
Int Std Accy

Power Offset  
0.0 dB Ext Loss

Auto Range  
On

BW  
10 MHz

Cyclic Prefix  
Normal

EVM Mode  
Auto: --

Sync Type  
Normal (SS)

Index	Cell ID (Grp, Sec)	RS (Act)	P-SS (Avg/Meas)	S-SS (Avg/Meas)
1	205 (68, 1)	499.56 uV/m	329.39 uV/m	341.31 uV/m
2	206 (68, 2)	1.89 mV/m	1.38 mV/m	1.42 mV/m
Total		2.39 mV/m	1.71 mV/m	1.77 mV/m

Field Strength(Ex Avg) 22.22 mV/m

Field Strength(Total Ex Avg) 24.87 mV/m

Auto-Log: ON

Current Axis X-Axis

Measurement Time 01:02 Current Test Status Pass

Measurement# 5/5 Final Test Status Pass

EMF Measurement On Off

Measurement Time 60 s

# of Measurements 5

Auto Logging On Off

Measurement Parameters

EMF Units dBm/m2 V/m

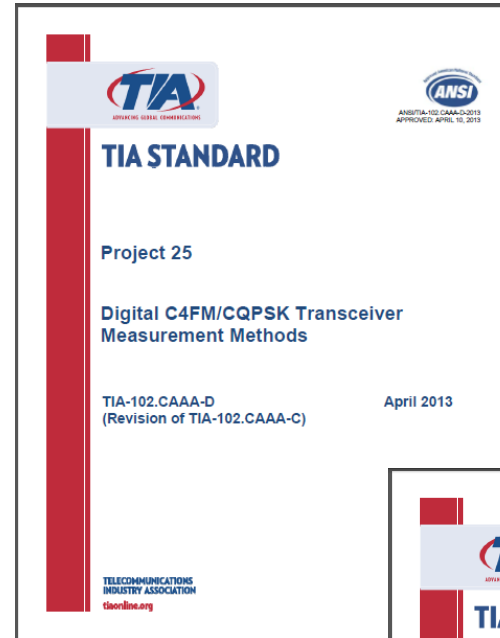
Limits 6.02 V/m

Back

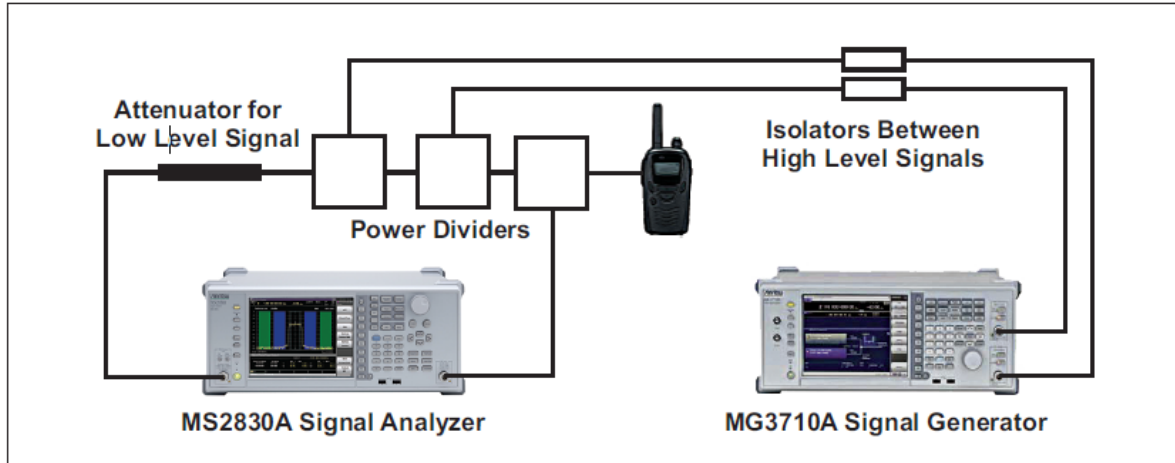
Freq Amplitude Setup Measurements Marker

# Better Receivers?

- TIA 102 and 603 procedures
- Move receive frequencies away from undesired



# Receiver Testing



Attenuator for Low Level Signal

Power Dividers

Isolators Between High Level Signals

MS2830A Signal Analyzer

MG3710A Signal Generator

Application Note

Anritsu

## Receiver Testing with the Anritsu MS2830A Signal Analyzer, MG3710A Vector Signal Generator, and S412E LMR Master™

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### Introduction – Receivers in the New Narrowbanded RF Space

Public safety receivers are built to perform in the harshest environments. Physically they appear to be up to any challenge. Some even work under water. Unfortunately, it is not easy to see how they will perform in a harsh RF environment. Narrowbanding moves adjacent channel performance to a new level. New spectrum allocations push public safety radios up in frequency near 3G and 4G transmissions. Digital radios such as those that utilize the ATSC Project 25 (aka P25) standard must to interference differently from analog radios.

Figures 1 and 2 show likely spectrum scenarios where public safety P25 radios are close in frequency to 3G and 4G transmissions. This white paper discusses the common test procedures for analog and digital receivers and proposes new procedures that can better predict digital receiver performance under the emerging narrowband spectrum allocations.

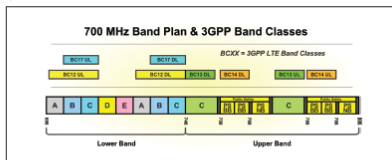


Figure 1. New 700 MHz Band Plan/Partial TD-SCDMA

RadioResource
July 2013

## Interference Mitigation in Crowded Spectrum

Broadband data services could cause interference problems, but new testing technology can facilitate the design and manufacture of improved receivers.

By Tom Brinkman

More wireless systems will be operating in close proximity in frequency, space and time to meet the increasing demand for wireless data. This increased density requires more care in optimizing wireless system bandwidth. Unfortunately, the FCC has regulated bandwidth with transmitter emission specifications, but receiver performance was left to the system designers. Recent experience in adding broadband data services to the spectrum have resulted in legacy spectrum neighbors complaining about interference, even when the new transmitters fully complied with emission regulations. This is because legacy receiver designs were not prepared for their new neighbors.

The Middle Class Tax Relief and Job Creation Act of 2012 accelerated

quired a study on efforts to ensure transmission systems are designed and operated to not compromise reasonable use of adjacent spectrum, with a focus on receiver performance, as critical to increasing the use of spectrum. Based on the study, 500 megahertz of new broadband spectrum is to be allocated by 2021. As regulation push for more spectrum use, they consider plans new services in bands not previously allocated to that category of services.

The FCC is proposing and requiring common criteria for "interference-free" policy that sets legacy systems to expect changes in neighboring spectrum. These established criteria, called burn chain thresholds, on in-band and out-of-band interfering signals must be exceeded before a radio system can claim that it is experiencing harmful interference.

Public safety systems will be impacted by these spectrum changes. Broadband data systems typically use many low transmitter sites, and public safety systems typically require a distant high-site signal can be overloaded by the nearby wireless data transmitters. Therefore, public safety receivers that cannot reject interference signals

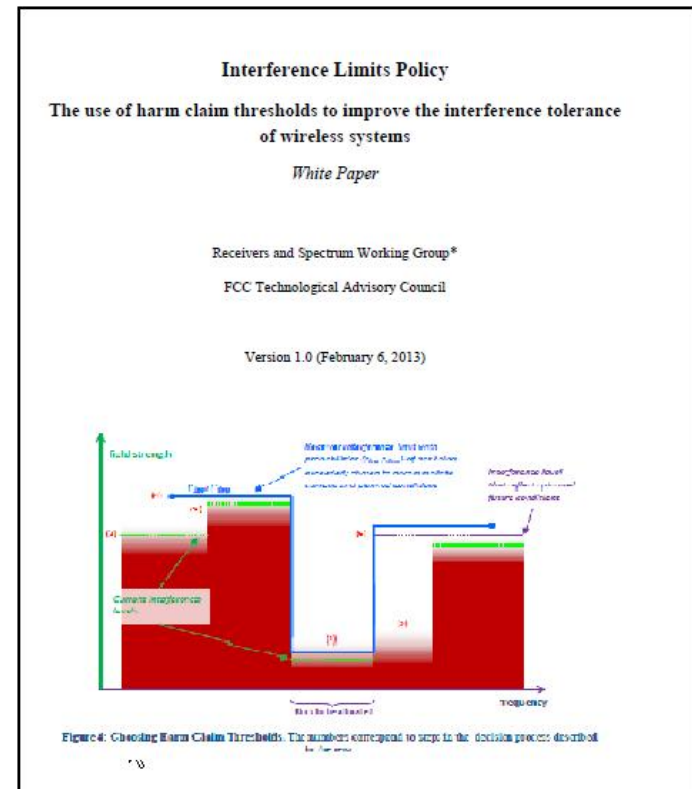
Have claim thresholds benefit the FCC, wireless system operators and radio manufacturers by providing greater clarity about the environments that are, and are not, critical in design. They can help service providers better understand the baseline regulatory and radio-interference control goals forward. The approach also facilitates decisions about system

# Receiver Settings

- Front End Attenuator in AGC.

# Trends

- More 4G, More Crowding, More Problems
- Different Rules
  - Harm Claim Thresholds
    - “A receiver operator could only make a claim for harmful interference if the aggregate signal strengths from neighbors exceeded the harm claim threshold.



# Trends

- More 4G, More Crowding, More Problems
  - Different Rules
- Better Receivers

Federal Communications Commission		FCC 14-181
Before the Federal Communications Commission Washington, D.C. 20554		
In the Matter of	)	
Amendment of Parts 1 and 22 of the Commission's Rules with Regard to the Cellular Service	)	WT Docket No. 12-40
Including Changes in Licensing of Unreserved Area	)	RM No. 11510
Amendment of the Commission's Rules with Regard to Reallocation of Part 24 to Part 27	)	
Interim Restrictions and Procedures for Cellular Service Applications	)	
Amendment of Parts 0.1 and 22 of the Commission's Rules with Regard to Frequency Coordination for the Cellular Service	)	
Amendment of the Commission's Rules Governing Radiated Power Limits for the Cellular Service	)	RM No. 11660
<b>REPORT AND ORDER AND FURTHER NOTICE OF PROPOSED RULEMAKING</b>		
Adopted: November 7, 2014		Released: November 10, 2014
Comment Date: (30 days after publication in the Federal Register)		
Reply Comment Date: (60 days after publication in the Federal Register)		
By the Commission:		
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# Questions?

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