

# **Extensible Software for Automated Testing of Public Safety P25 Land Mobile Radios**

Presented by:

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# Public Safety Land Mobile Radio (LMR)<sup>2</sup>



# ***Project 25 Digital LMR***

- About Project 25
  - Formed in 1989 by APCO in conjunction with the Telecommunications Industry association (TIA)
  - Response to FCC mandate to narrow bands from 25 kHz to 12.5 kHz and 6.25 kHz BW
  - Not the only digital LMR technology, but it's the only open standard in the United States
  - Attempt to overcome shortcomings of Project 16 analog trunking standard
  - But it's not without its own problems...



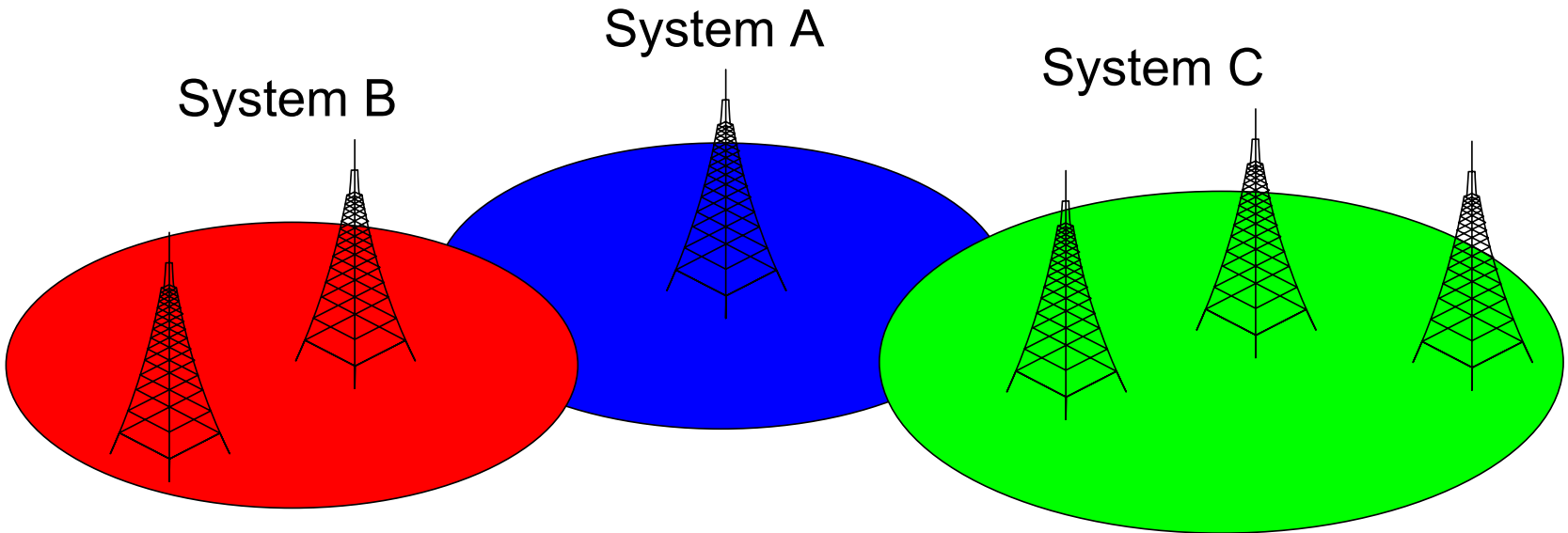
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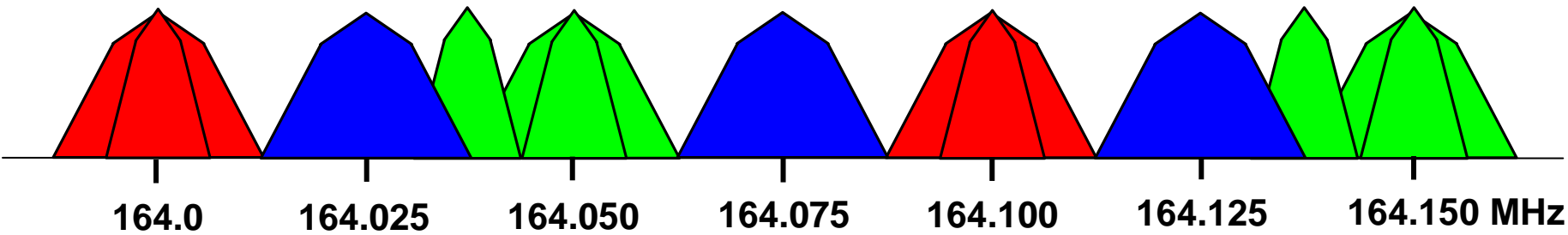
# ***Project 25 Digital LMR***

- Issues of non-interoperability and non-conformance pester Project 25
- Congress mandates a P25 compliance program; manufacturers say it should include:
  - Interoperability testing (functional testing between manufacturers and models)
  - Conformance testing (to required message format and protocol standards)
  - Performance testing

# Three federal systems



**System B goes narrowband**  
**System C goes narrowband**



# ***Common Air Interface Testing***

- Subscriber unit performance testing in accordance with TIA-102.CAAA
  - ITS developing reference implementation of P25 Radio Performance Measurements (RPM)
  - Consists of a series of automated procedures to test both transmitter and receiver performance
  - ITS will seek acceptance from manufacturers on RPM implementation—then to be used to accredit labs
  - Accredited laboratories will test radios and produce reports. Manufacturers will publish results.
  - Testing slated to begin this year



# ***P25 Receiver Measurements***

- **2.1.4 Reference Sensitivity**
- **2.1.5 Faded Reference Sensitivity**
- **2.1.6 Signal Delay Spread Capability**
- **2.1.7 Adjacent Channel Rejection**
- **2.1.8 Co-Channel Rejection**
- **2.1.9 Spurious Response Rejection**
- **2.1.10 Intermodulation Rejection**
- **2.1.11 Signal Displacement Bandwidth**
- **2.1.17 Late Entry Unsquelch Delay**
- **2.1.18 Receiver Throughput Delay**

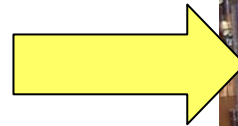
# ***P25 Transmitter Measurements***

- **2.2.5 Modulation Emission Spectrum**
- **2.2.8 Unwanted Emissions: Adjacent Channel Power Ratio**
- **2.2.9 Intermodulation Attenuation**
- **2.2.12 TX Power & Encoder Attack Time**
- **2.2.14 Transmitter Throughput Delay**
- **2.2.15 Frequency Deviation for C4FM**
- **2.2.16 Modulation Fidelity**
- **2.2.18 Transient Frequency Behavior**

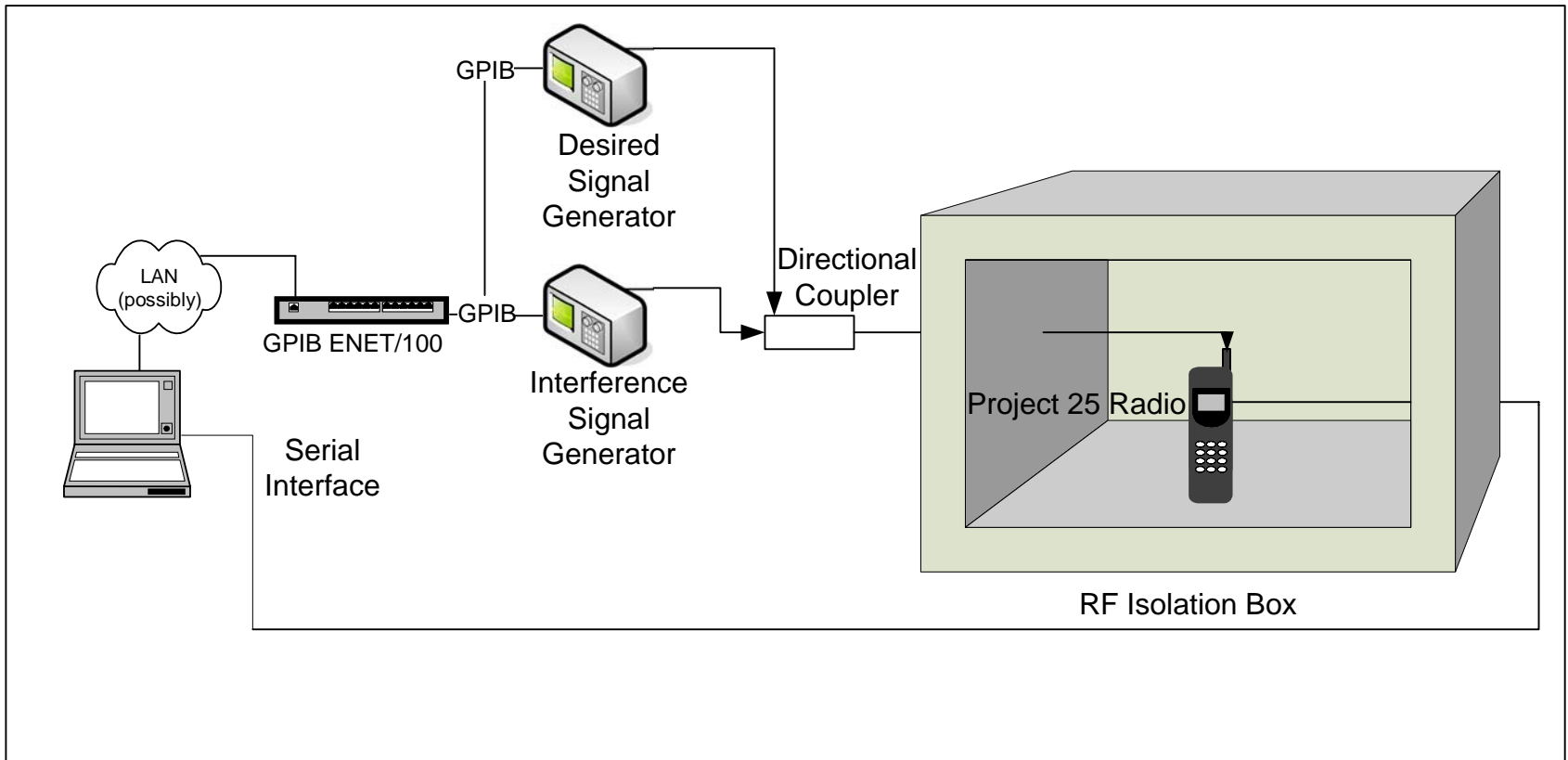


# ***Test Suite***

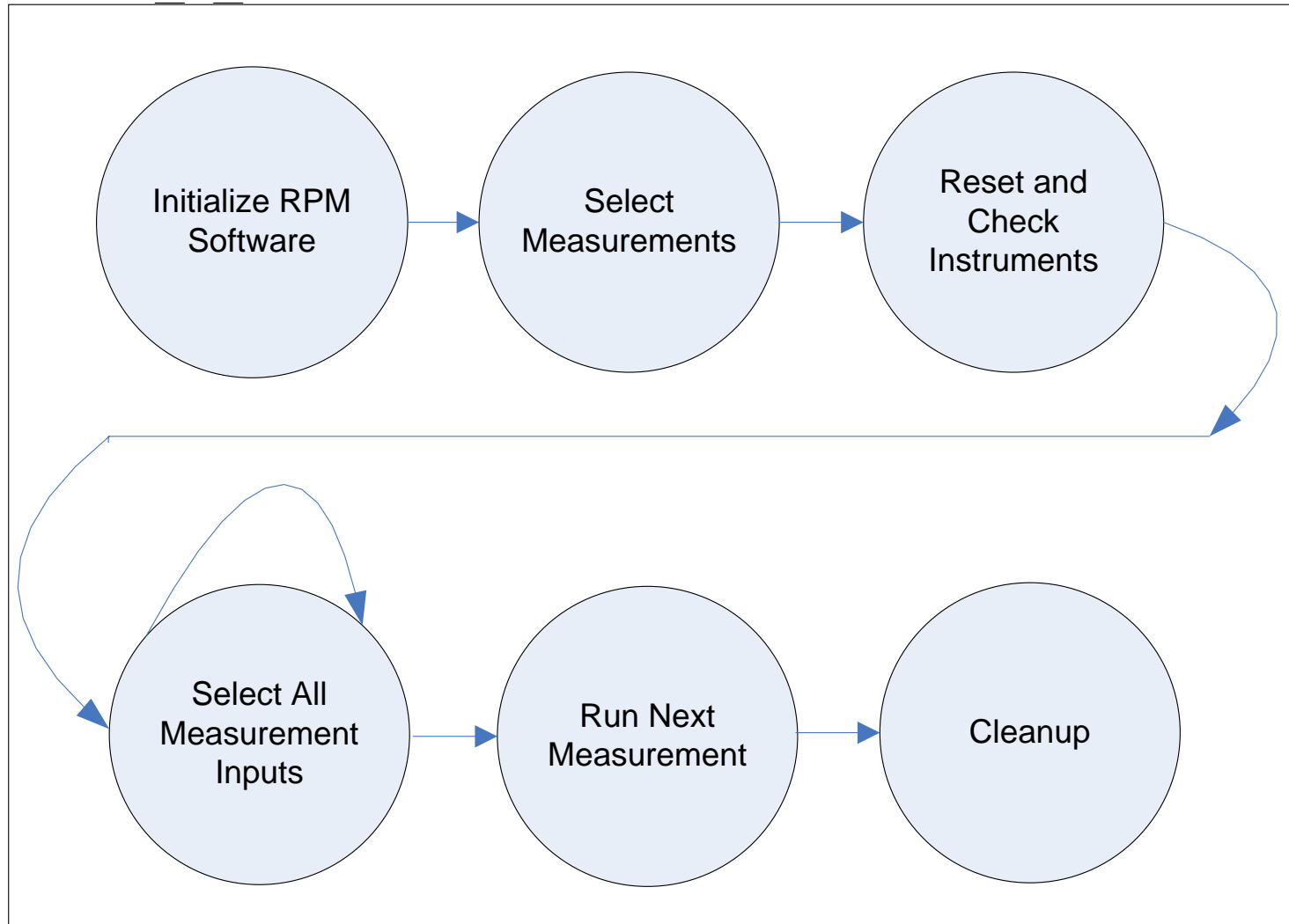
- RF Shielded Enclosure
- Desired Signal Source
- Undesired Signal Source
- Combiner
- Automated Test Computer



# Spurious Response Equip Diagram



# Software Flowchart



# ***Software Requirements***

- Documentation: requirements, design documents, test plans, and bug-tracking
- Database storage of instrument commands, measurement parameters, and results
- Code Templates for creating new instrument drivers and new measurements
- Object oriented design, event loops, and state machines for clarity, code-reuse, and modularity
- Core RPM structure easily extensible

# ***Spurious Response Algorithm***

- Find Reference Sensitivity power ( $P_{ref}$ ) with desired signal generator at carrier freq., add 3 dBm.
- Set the interferer signal generator to:  
 $P_{ref} + SRR + 6 \text{ dBm}$
- Loop through interf. freq.: 0.22 MHz – 1 GHz, 10 kHz step, exclude carrier freq.  $\pm 50 \text{ kHz}$
- If  $BER > 5\%$ , step interf. freq. from  $-0.05\text{kHz}$  to  $+0.05\text{kHz}$ , 1 kHz steps, find max BER freq.
- Set to max BER freq., find interf. power ( $P_{spur}$ ) for  $BER = 5\%$ , find spurious rej. =  $P_{spur} - P_{ref}$

# Sample Meas. - Spurious Response

DRSRR Main GUI.vi Front Panel

File Edit View Project Operate Tools Window Help

## Spurious Response Rejection

BER Values for Current Interf. Freq. and Power

Item Num	BER [%]	Running Mean BER	Running Std. Dev. BER
1	3.935185	3.935185	0.000000
2	3.472222	3.703704	0.327364
3	3.530093	3.645833	0.252251
4	3.356481	3.573495	0.251697
5	3.645833	3.587963	0.220364

Refer. Sens. Power with Path Loss [dB]: -120

Upper Freq Exclusion [MHz]: 153.55

Lower Freq Exclusion [MHz]: 153.45

Current Interf. Freq [MHz]: 53.66

Current Interf. Power with Path Loss [dB]: -34

Current Number of BER Points to Collect: 5

Current Interf. Modulation: C4FM

Measurement State: Scanning

Last 5

Item Num	BER [%]	Running Mean BER	Running Std. Dev. BER
5	3.645833	3.587963	0.220364

Spurious Response Rejection (SRR), FM Modulation (Power Includes Path Loss)

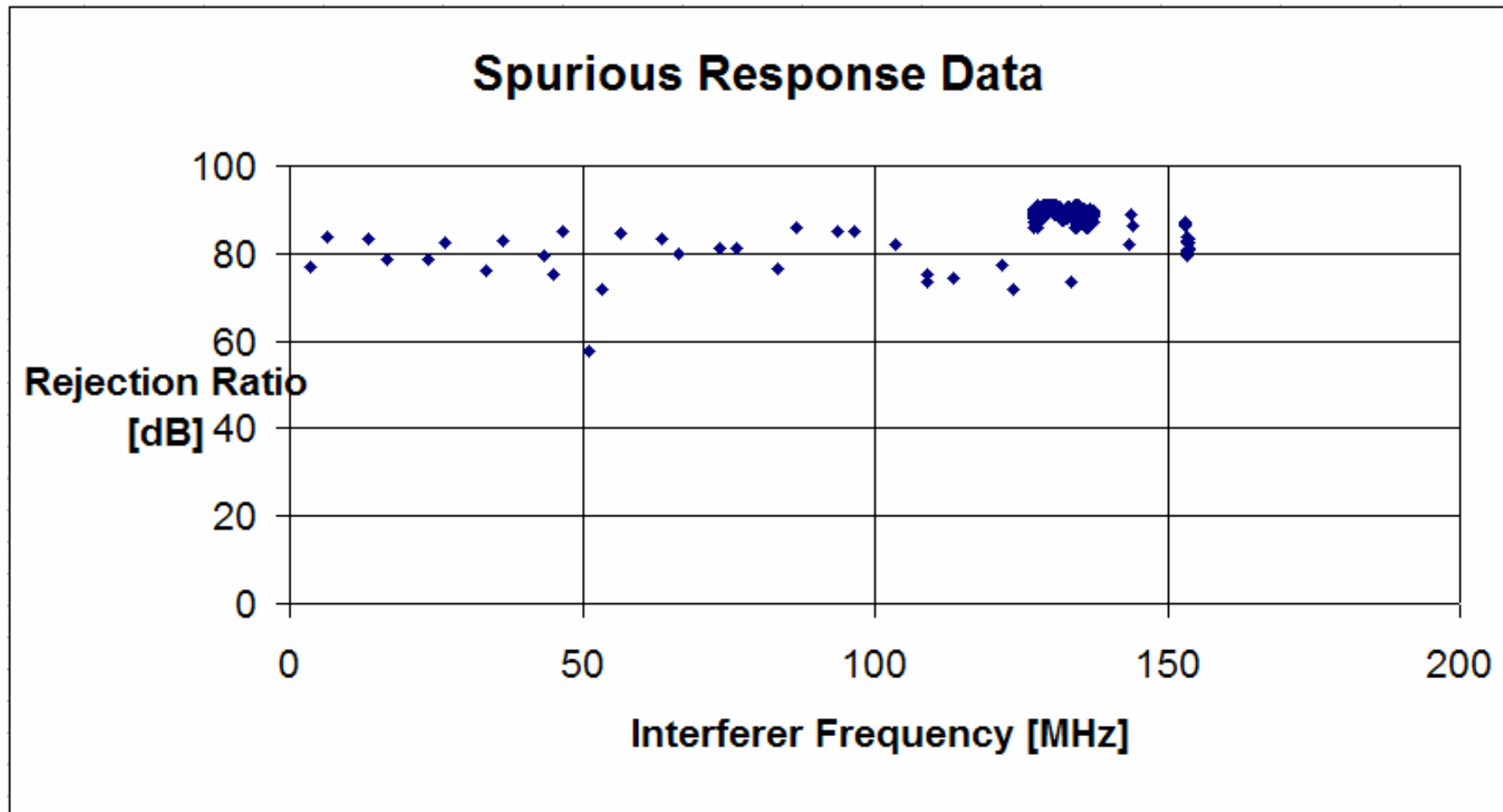
Item Num	Interf Freq [MHz]	Rej. Ratio [dB]	# Interf Points	Interf Power [dB]
1	23.498000	78.500000	50	-41.500000
2	26.502000	82.400000	50	-37.600000
3	33.498000	76.200000	50	-43.800000
4	36.502000	83.100000	50	-36.900000
5	43.498000	79.400000	50	-40.600000
6	45.002000	75.200000	50	-44.800000
7	46.502000	85.200000	50	-34.800000
8	51.167000	57.800000	50	-62.200000
9	53.498000	72.000000	50	-48.000000

Status: Setting Up Serial Connection...

Pause Cancel



# Spurious Response Results



# ***Sponsor Acknowledgements***

- Department of Homeland Security's SAFECOM Program
- Federal Partnership for Interoperable Communications
- Department of Justice CommTech Program
- NIST's Office of Law Enforcement Standards (OLES)



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- Ken Tilley, Technical Writer

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