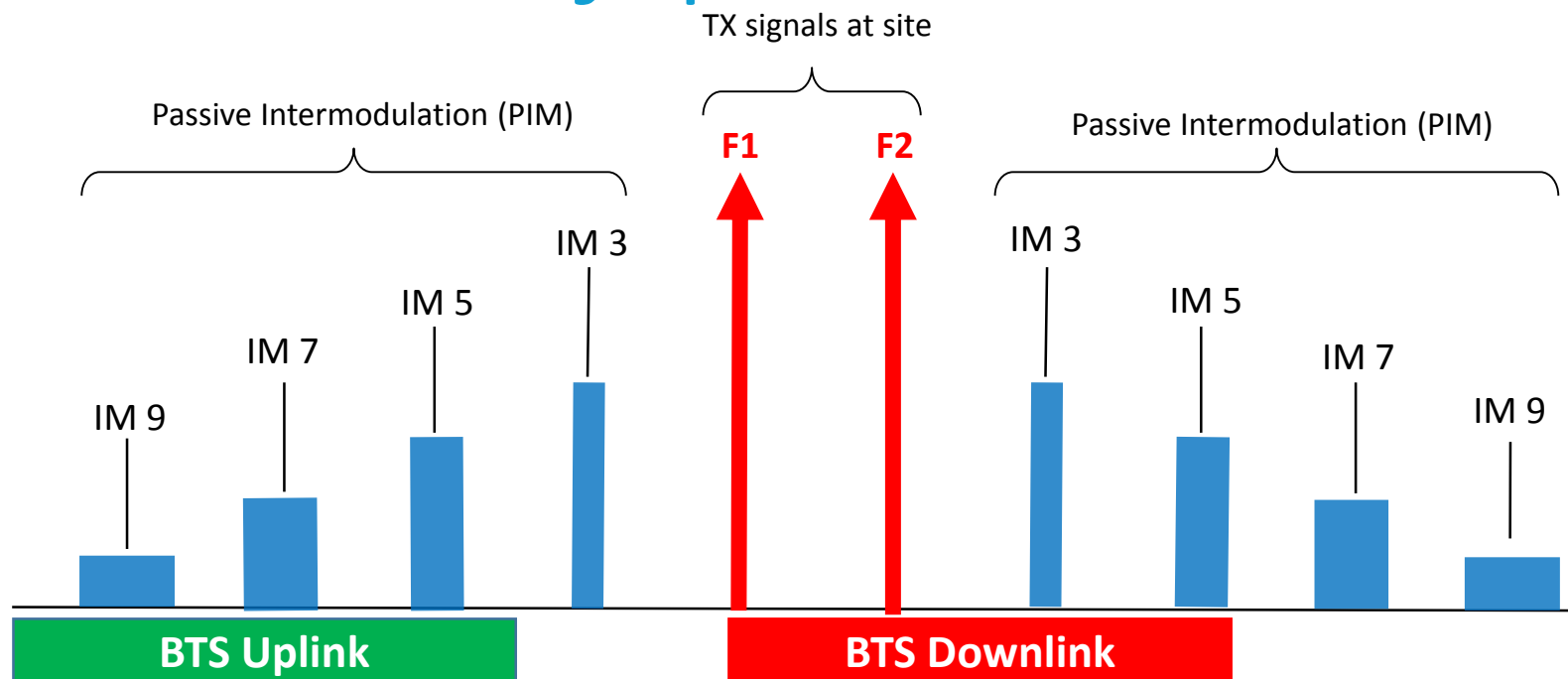


PIM

Lokalizace a odstranění příčin pasivních intermodulací v anténních systémech a jejich okolí

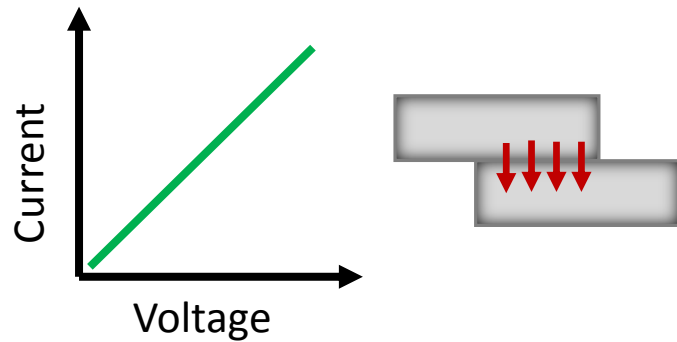
Jak vznikají pasivní intermodulace



- PIM = interference
- PIM = new frequencies generated by Tx signals at a cell site when they encounter “non-linear” junctions in the RF path
- PIM falling in an operator’s uplink can elevate the noise floor:
 - Dropped calls
 - Access failures
 - Slower data rates

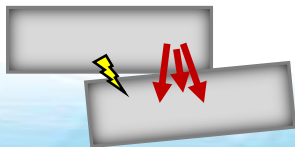
Co je nelinearita

Linear junctions



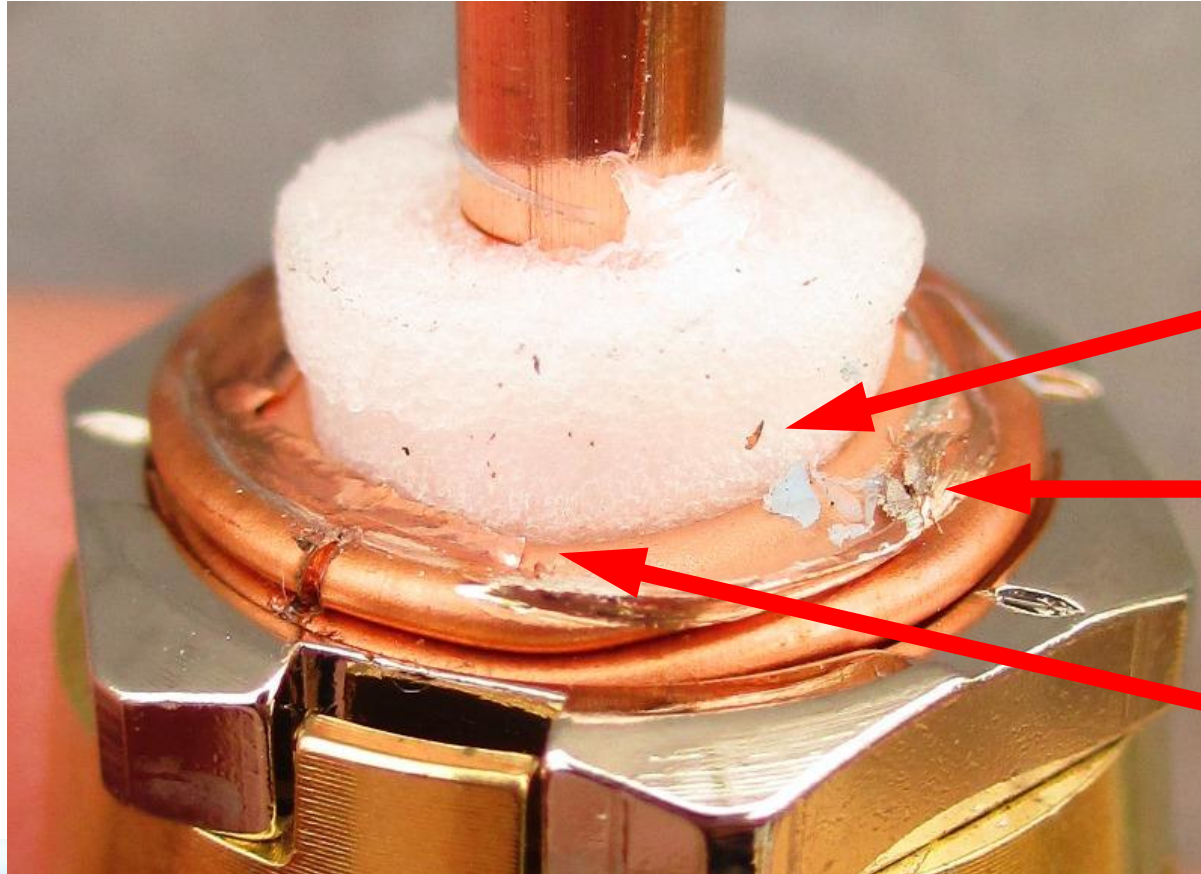
- Current increases linearly with applied voltage
- High pressure, metal-to-metal contacts
- Welded or soldered connections.

Non-Linear junctions



- Current does not increase linearly with voltage
- Low pressure, metal-to-metal contacts
- Oxide layers on metal surfaces
- Arcing across small air gaps or cracks

Nelinearity v anténních systémech



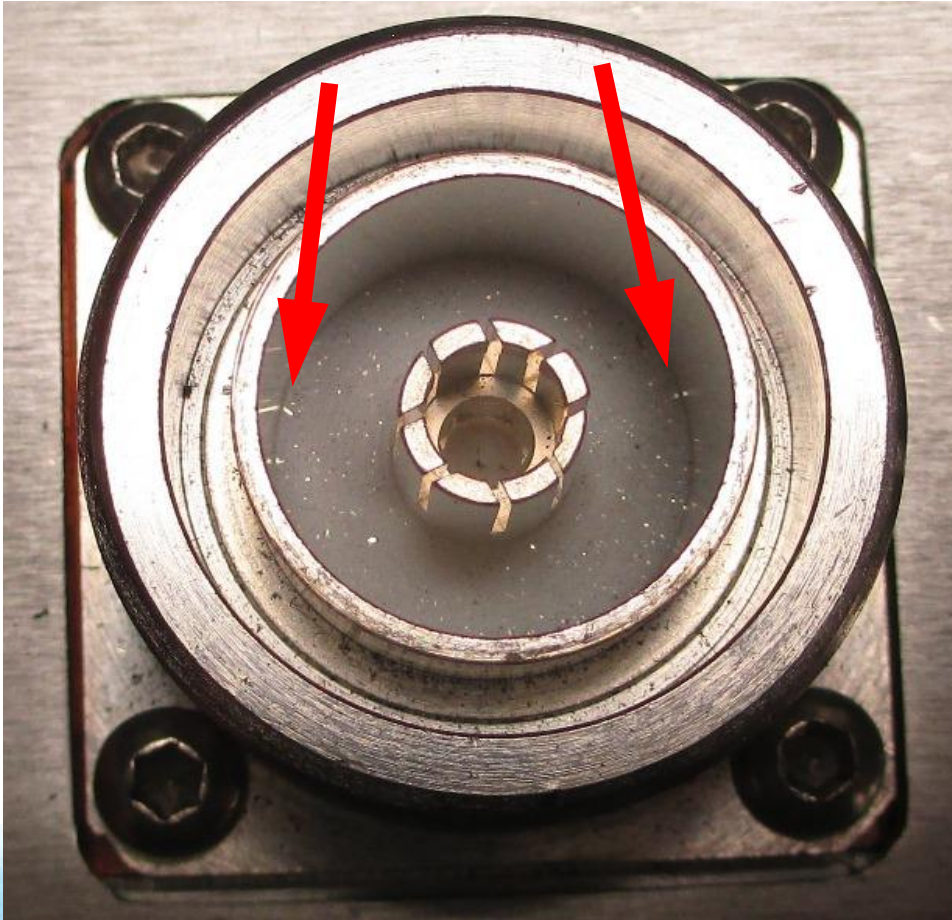
Poor connector
termination

Metal flakes

Loose copper

Metal folded
on itself

Nelinearity v anténních systémech

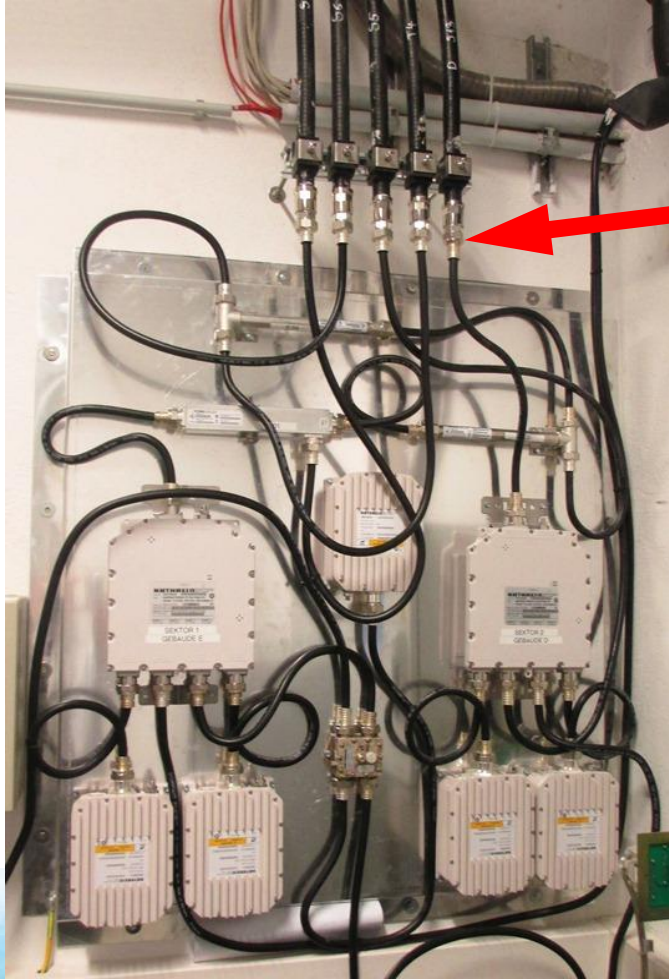


Metal flakes inside
connector

Touching inner
conductor

Touching outer
conductor

Nelinearity v anténních systémech



Connectors only hand
tightened

Must be torqued with at
torque wrench



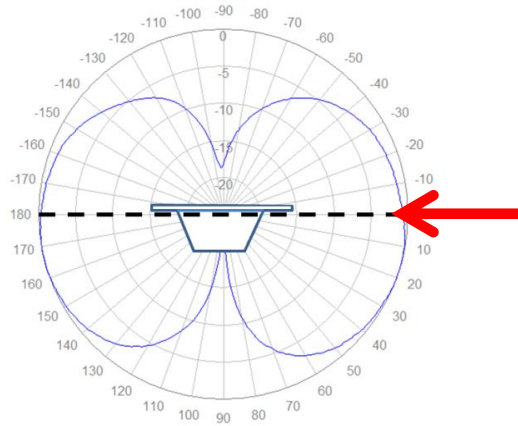
Nelinearity v anténních systémech



Rusty mounting
brackets

Metal objects in
front of antennas

Nelinearity v anténních systémech



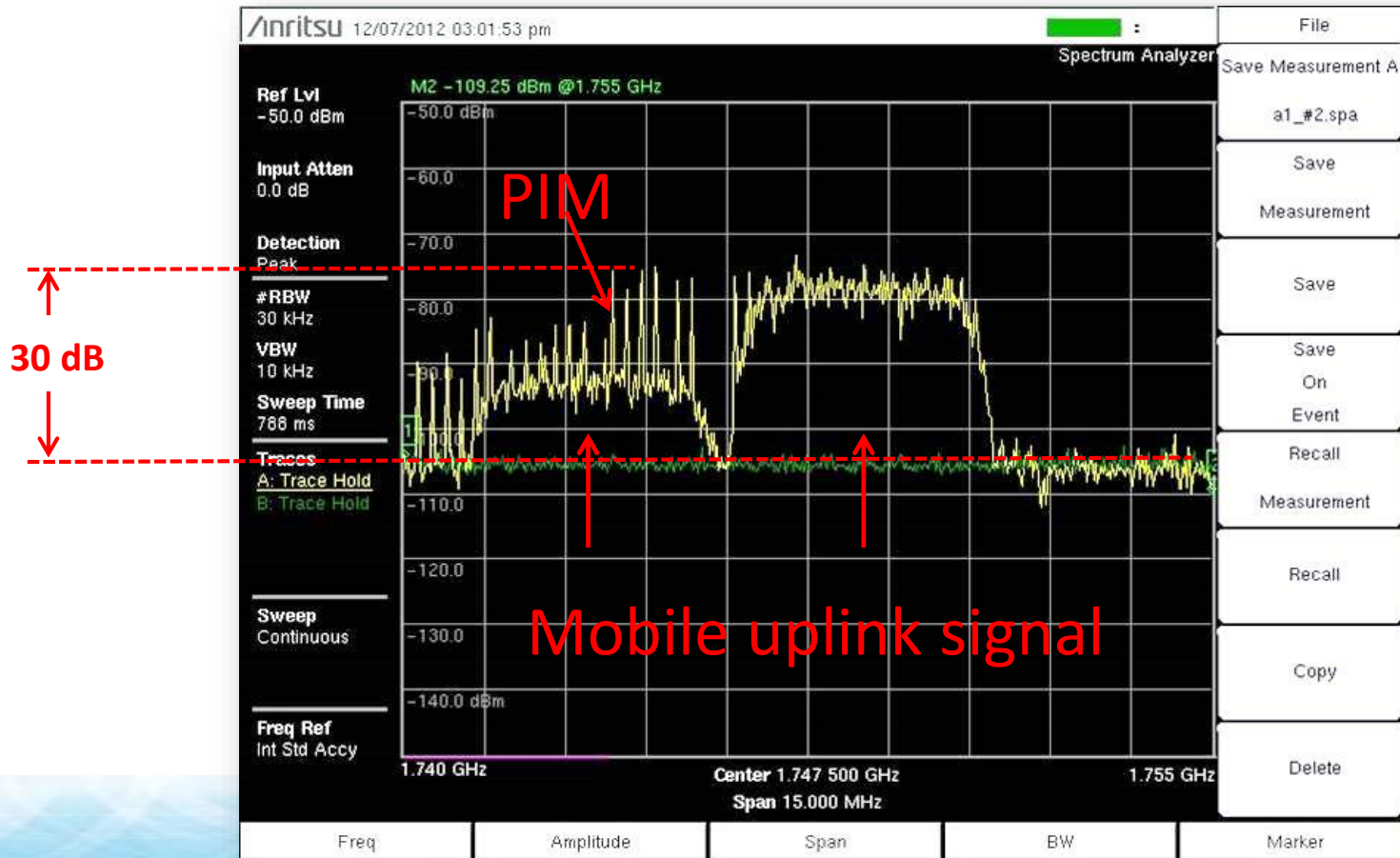
Antennas flush
mounted to
ceiling

External PIM Sources

- Fire suppression pipes
- Air handling ductwork
- Metal hangers
- Lighting fixtures
- Ceiling tile frames
- Etc., etc., etc.

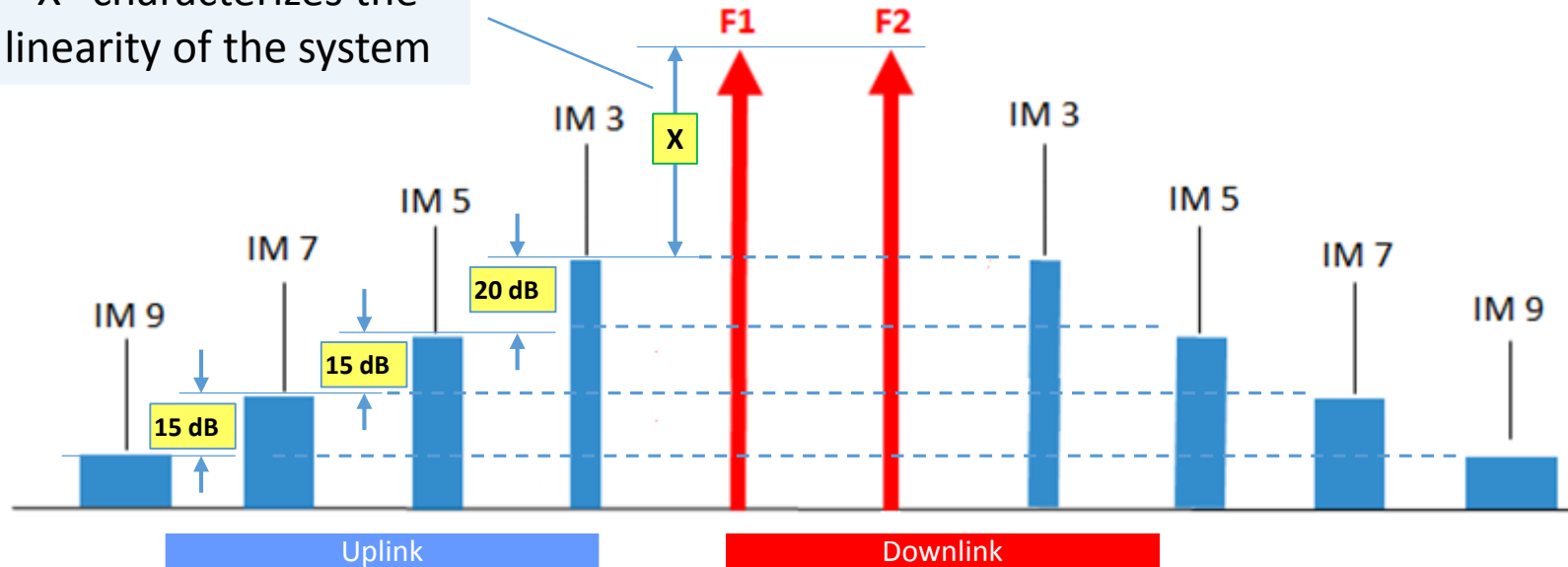


Měření spektrálním analyzátozem



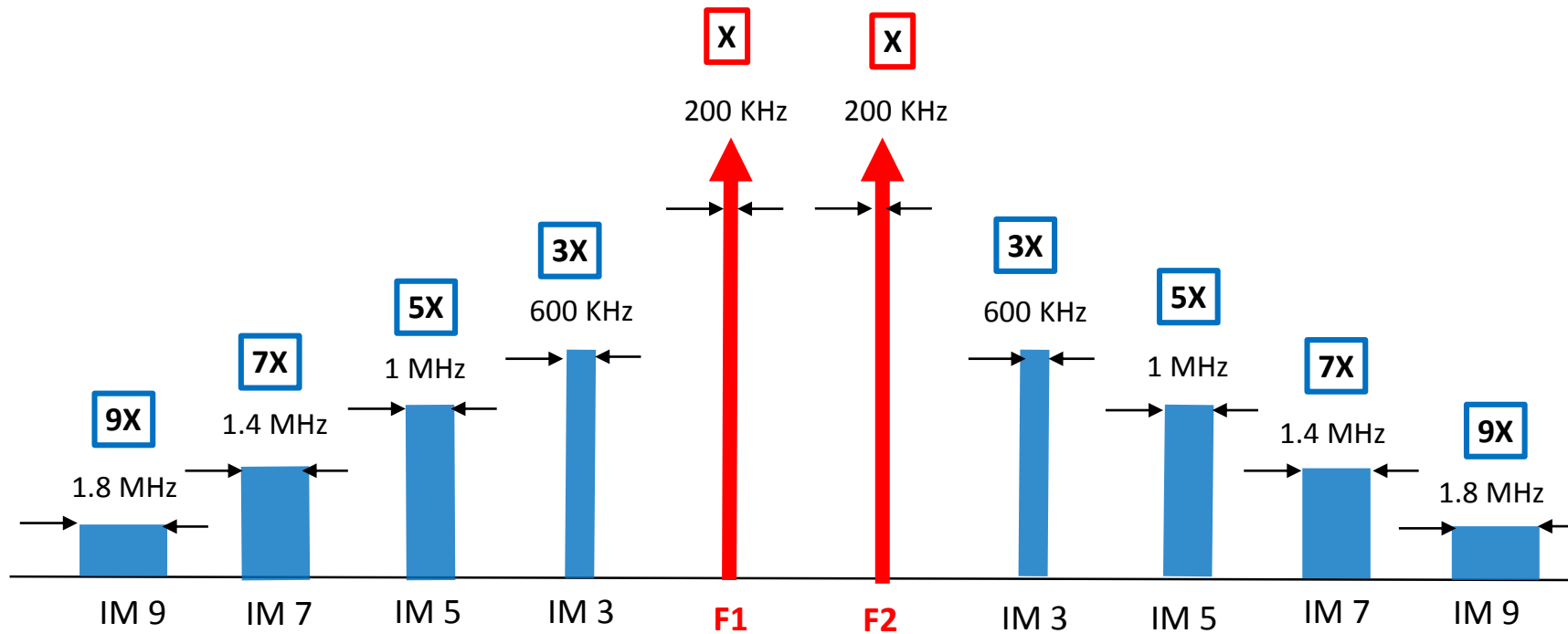
Amplituda PIM

“X” characterizes the linearity of the system



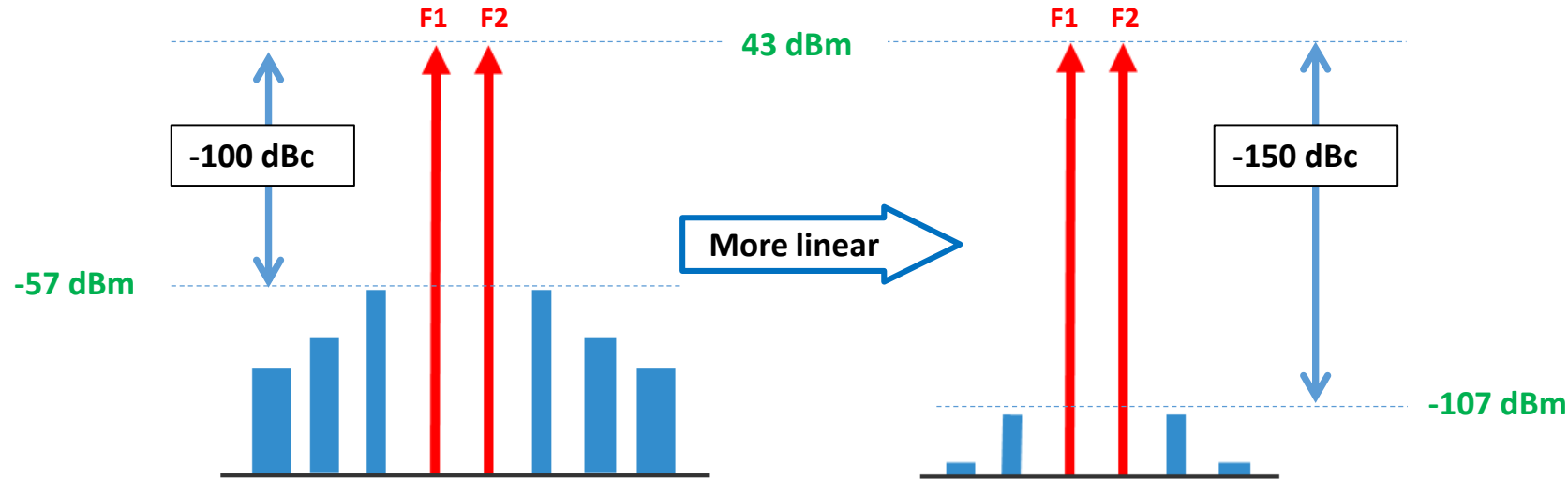
- Low order IM products (IM3 & IM5) are higher magnitude than high order products (IM7, IM9, etc)
- Higher magnitude = more likely to cause interference
- Does not mean IM7, IM9, etc. are never a problem... just less likely

Šířka pásma PIM



- PIM bandwidth increases as carrier bandwidth increases
- PIM bandwidth increase with PIM order

Jak odstranit nelinearity



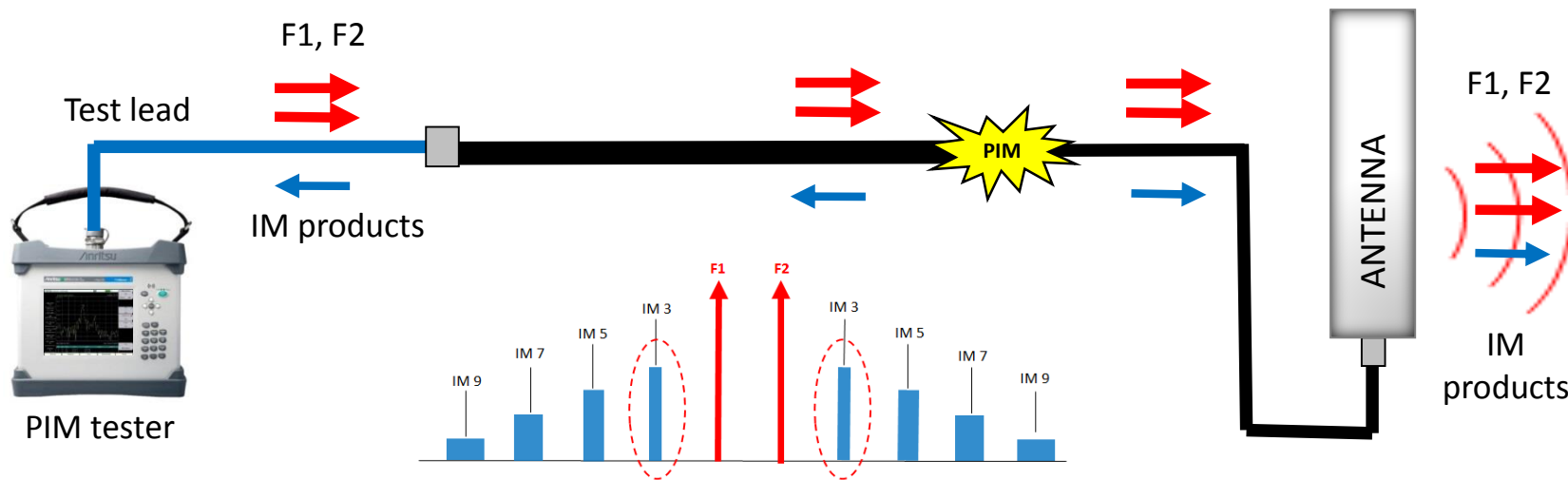
Improving linearity reduces PIM

- Loose RF connector
- Metal flakes in connectors
- Braided cables
- Antenna near PIM source

More linear

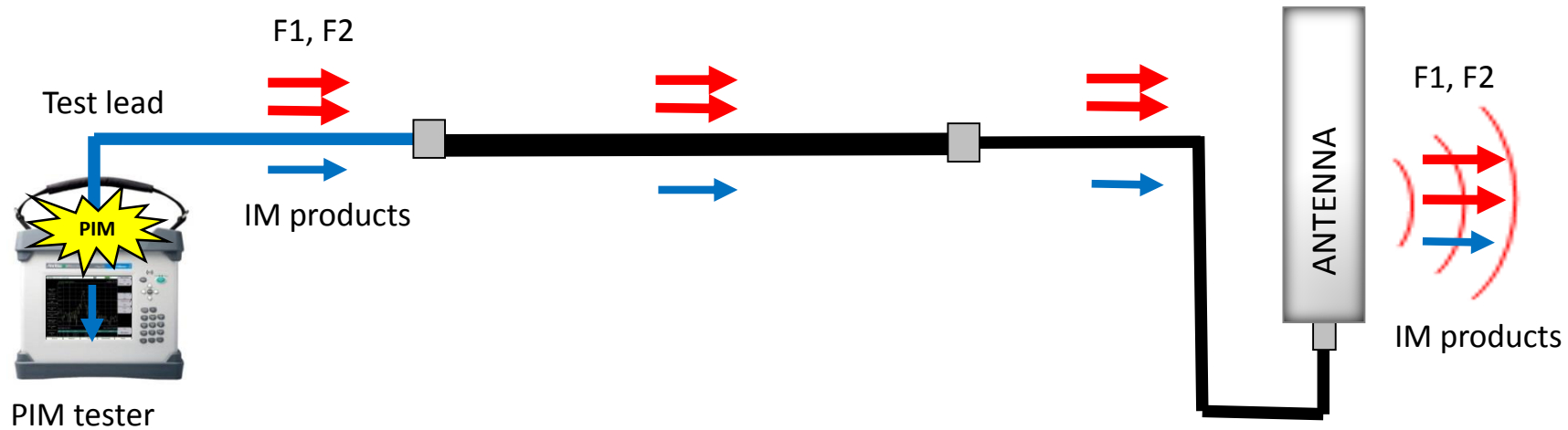
- Tight RF connector
- Connectors clean
- Corrugated cables
- Antenna re-located

Jak se nelinearita změří



- With a PIM tester!
- Inject two CW test signals at a known magnitude
- Measure 3rd order intermodulation product (IM3)
- IM3 “characterizes” the linearity of the system
 - If IM3 is low = linearity is good
 - If IM3 is high = linearity is poor

I analyzátor může generovat PIM

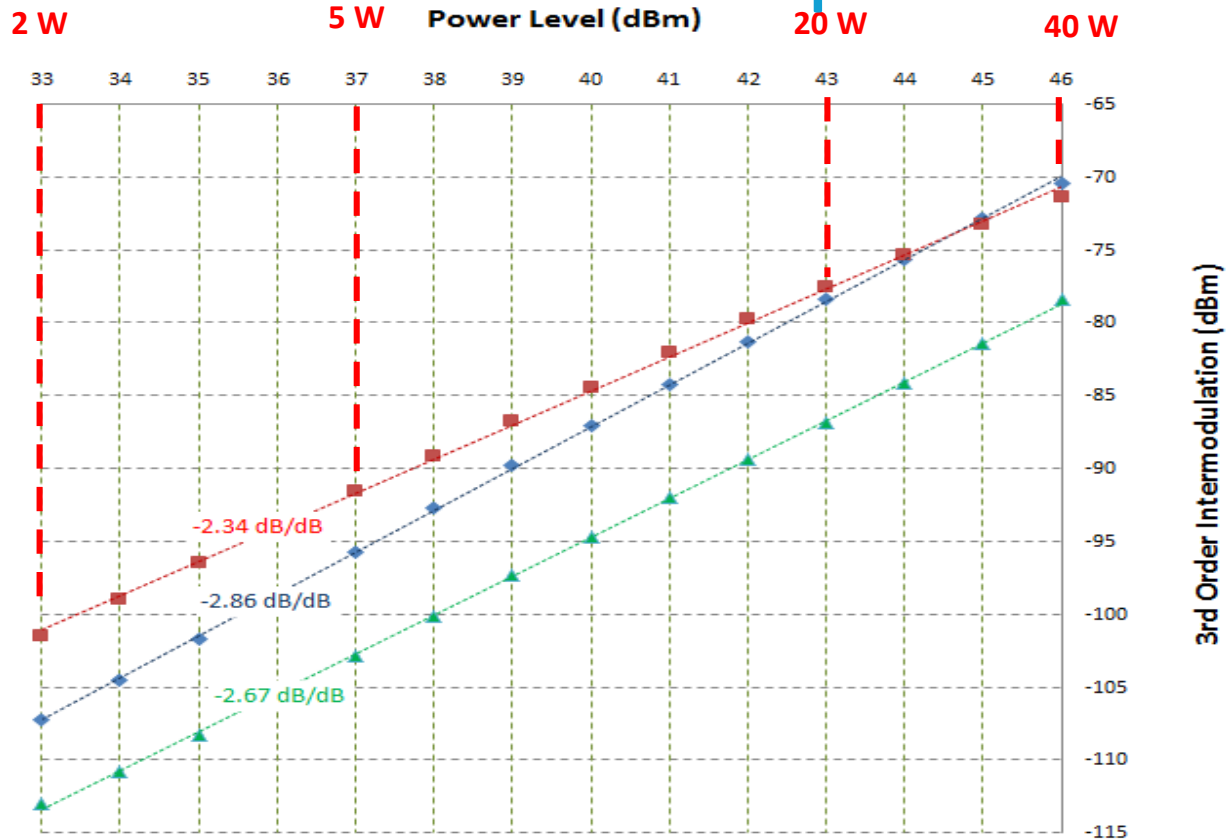


- Take good care of your equipment
- Verify PIM performance daily before use
- Test equipment PIM must be 10 dB lower than the system you will test

Example: Customer spec: <-140 dBc (<-97 dBm)

Test equipment: <-150 dBc (<-107 dBm)

Závislost na amplitudě vstupu



- PIM level increases as power increases
- IM3 typically increases is 2.2 to 2.8 dB for each 1 dB increase in power
- Different PIM sources behave differently
- PIM vs. Power shown above for PIM standard, jumper cable & antenna

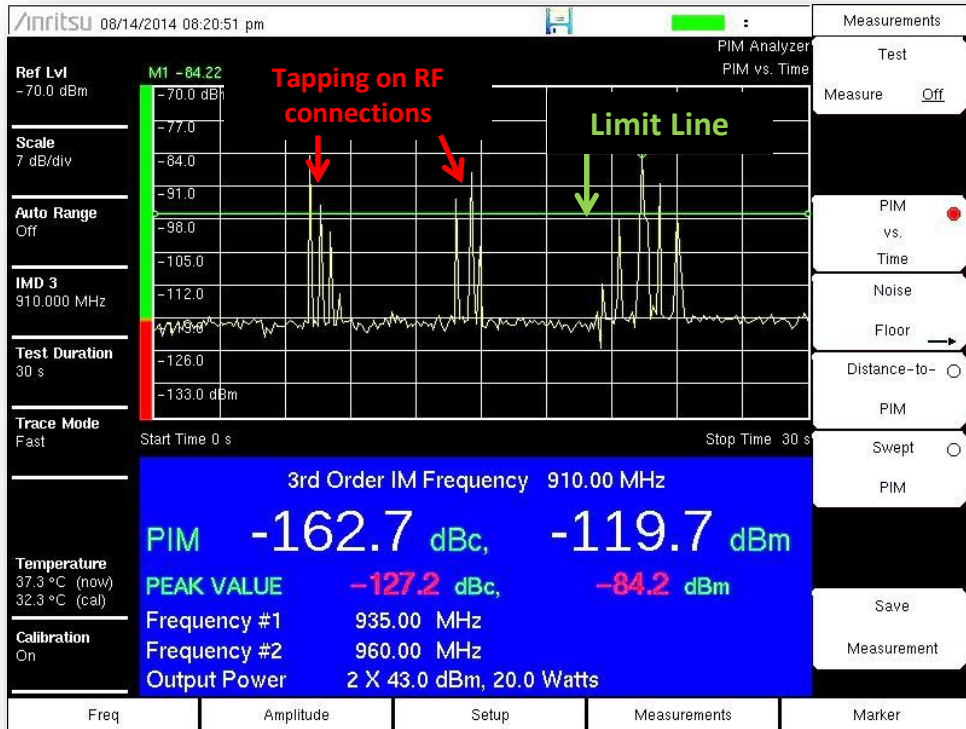
PIM Master – wifi ovládání



- Control PIM Master using web browser software on Wi-Fi enabled device (tablet, phone, laptop PC)
- Safari 6, Internet Explorer 10, Chrome 30, FireFox 23 (or later)
- Firmware v1.15 (or greater)
- ZyXEL MWR102 router (or equiv.)
- Range: >100m (328FT) line-of-site

See Application Note 11410-00784 for step-by-step instructions

PIM v závislosti na čase

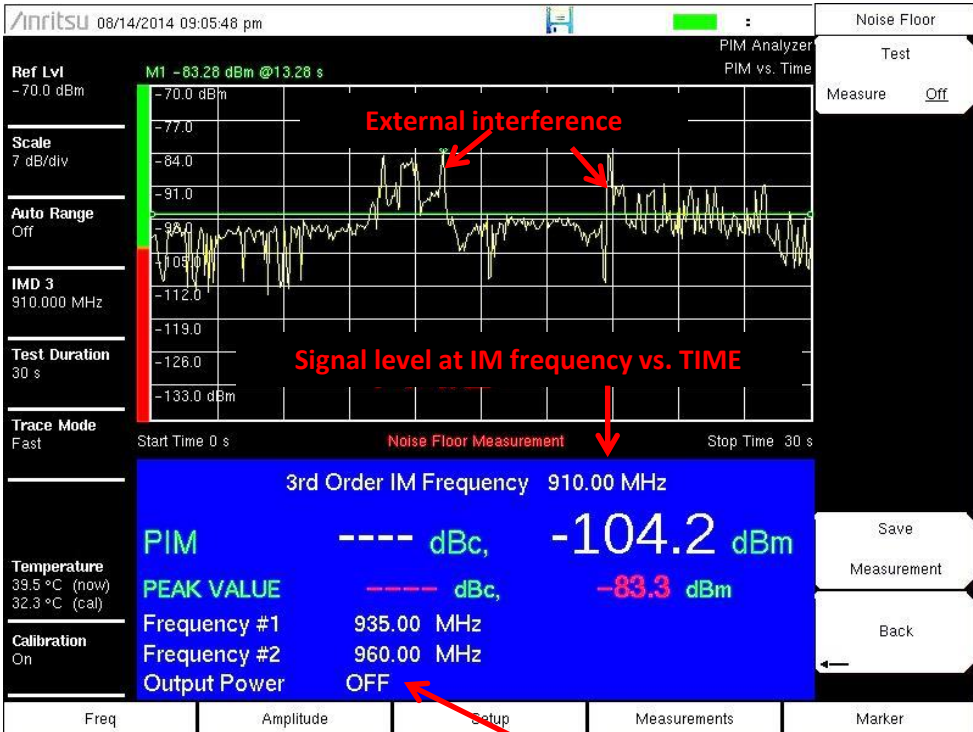


- F1 and F2 fixed
- PIM magnitude vs. time
- Visual indication of PIM stability
- Peak PIM held for Pass/Fail
- Used for dynamic PIM testing



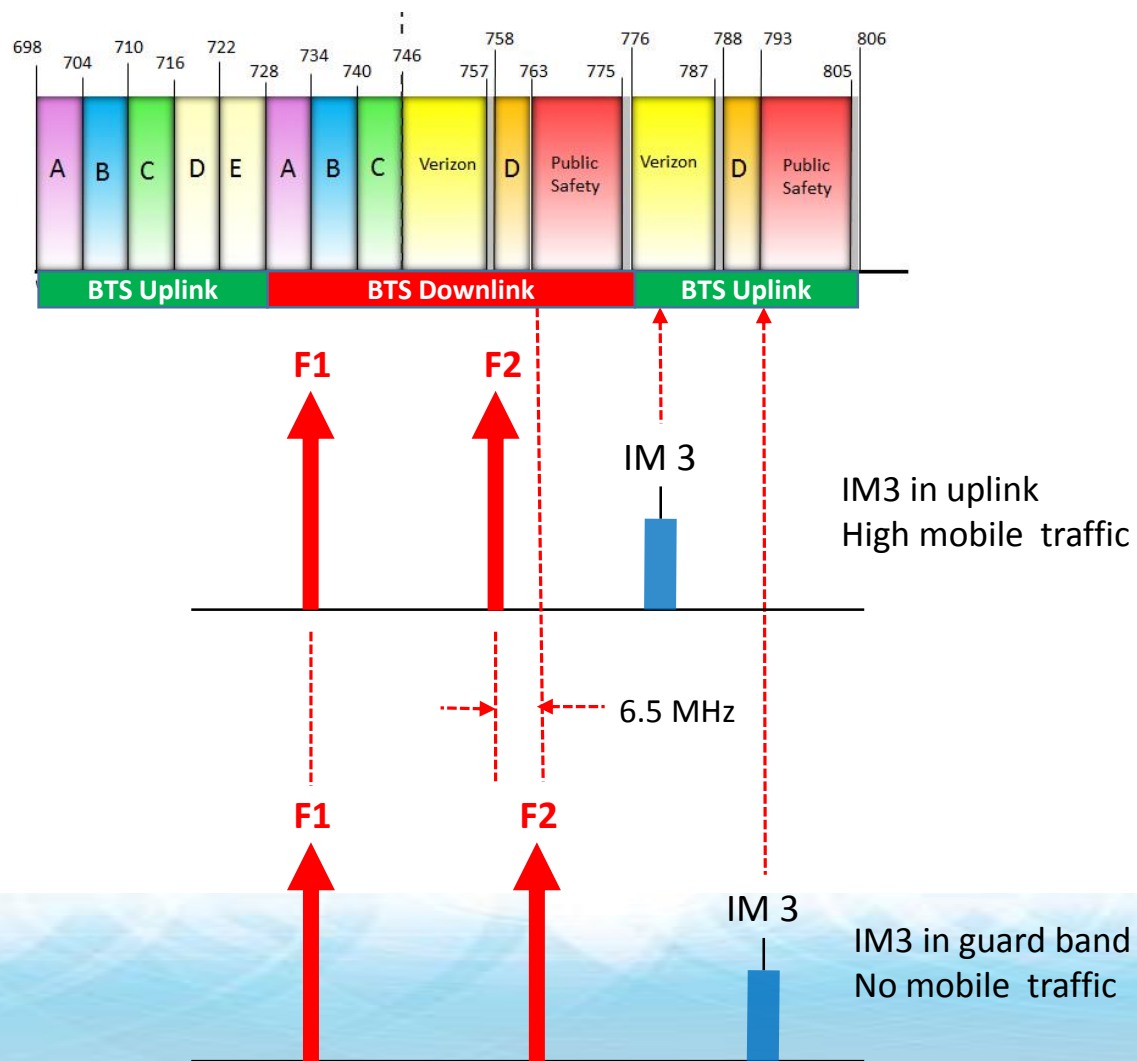
Šumové pozadí – první test

- Measures IM frequency with transmitters turned OFF
- Verify no external interference
- If interference:
 - Turn off all cell phones
 - Change test frequencies

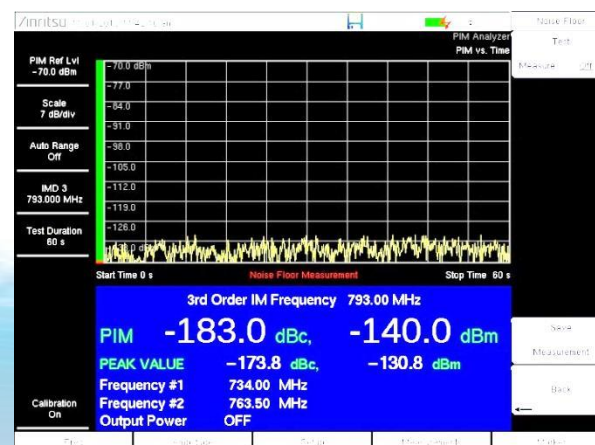
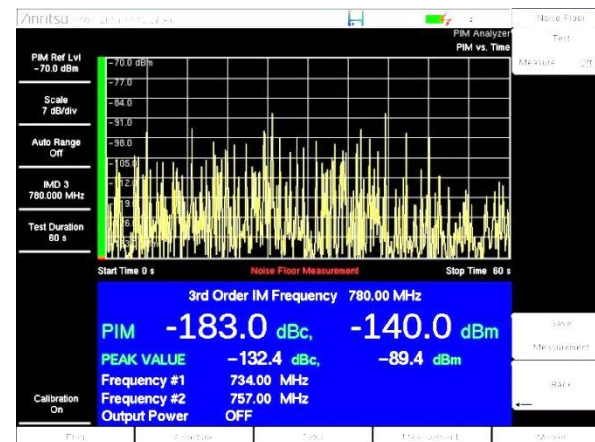


Test tones OFF

Posun mimo oblast citlivosti

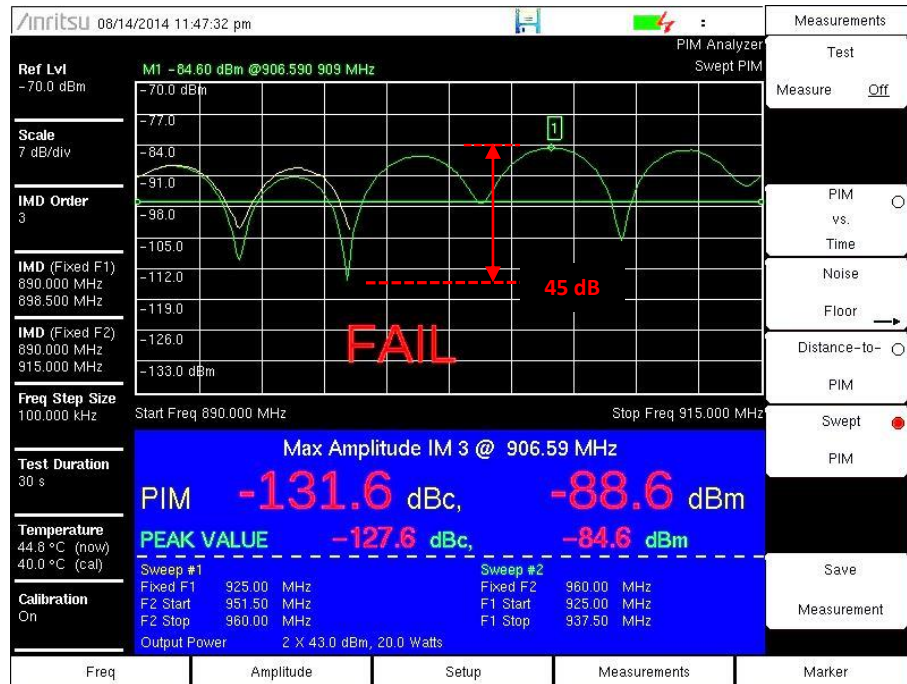


- F2 moved 6.5 MHz
- Noise reduced 60 dB



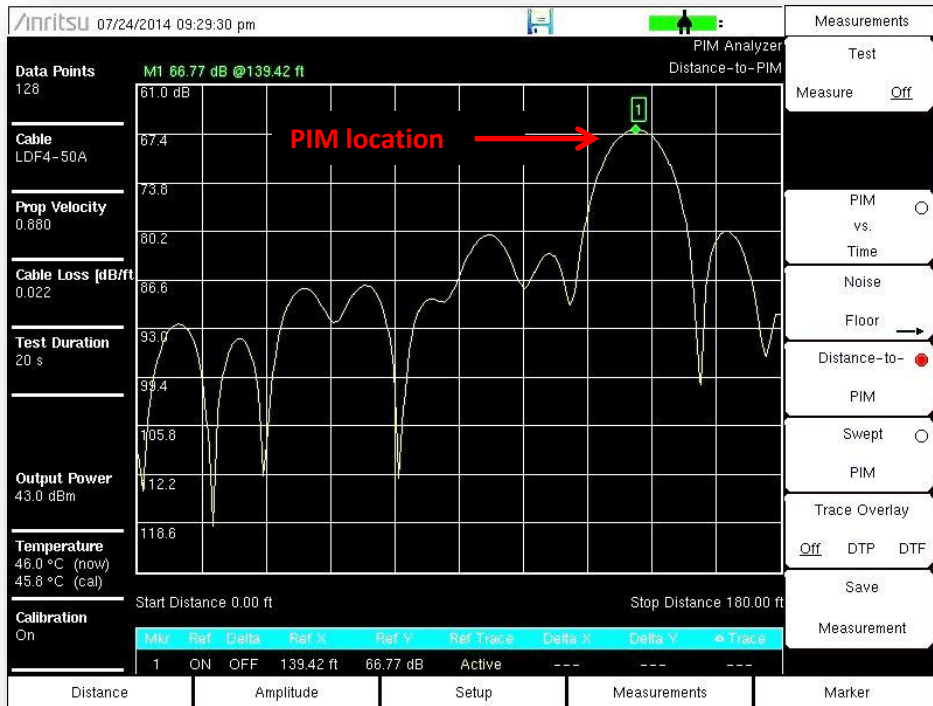
Rozmítané měření PIM

Multiple PIM signals on a line combining in
and out of phase



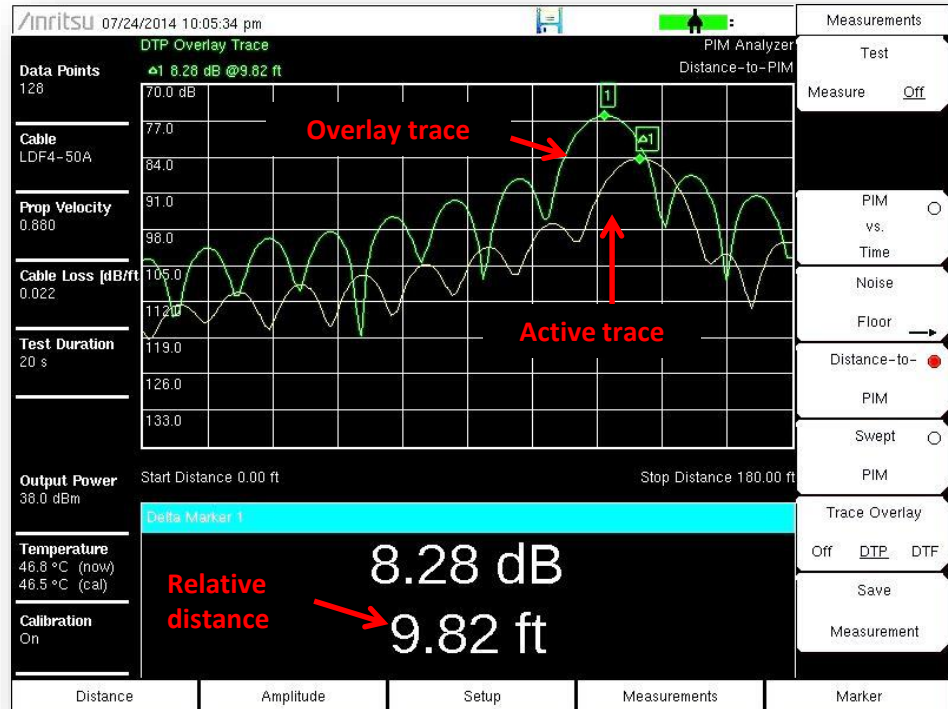
- F1 fixed, F2 swept
- F2 fixed, F1 swept
- PIM magnitude vs. frequency
- Shows worst case PIM level
- 30 dB variation due to phasing!

DTP – Distance to PIM



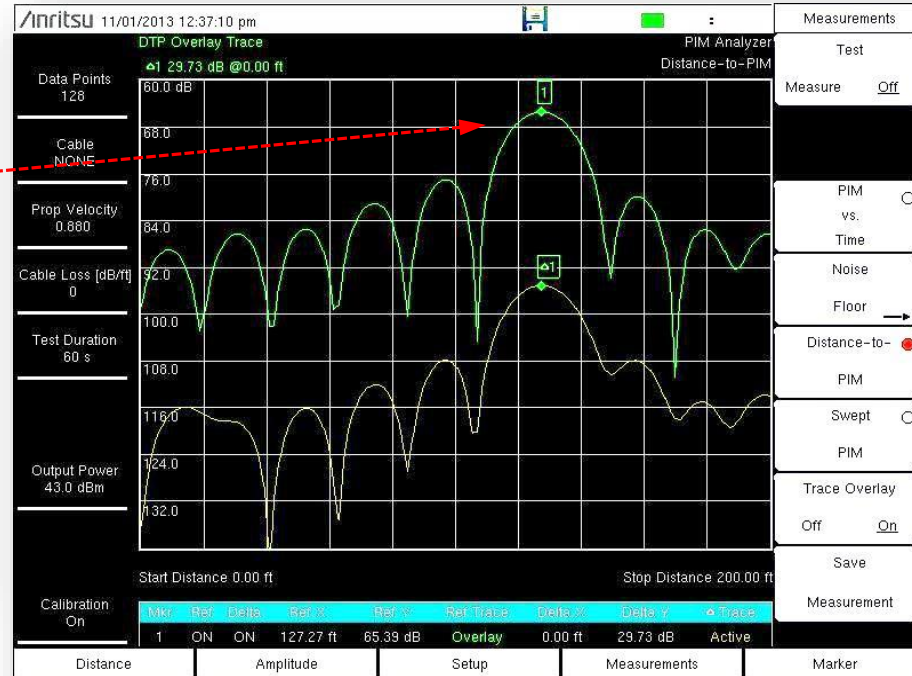
- F1 fixed, F2 swept
- PIM magnitude vs. distance
- The fastest way to locate PIM
- See PIM beyond the antenna
- 6 markers + marker table

Překrytí DTP náměrů



- Compare two DTP measurements
- Automatically displays distance between peaks
- Useful for:
 - Showing “before” & “after” results
 - Identifying PIM beyond the antenna
- Saving the measurement keeps both traces for reports

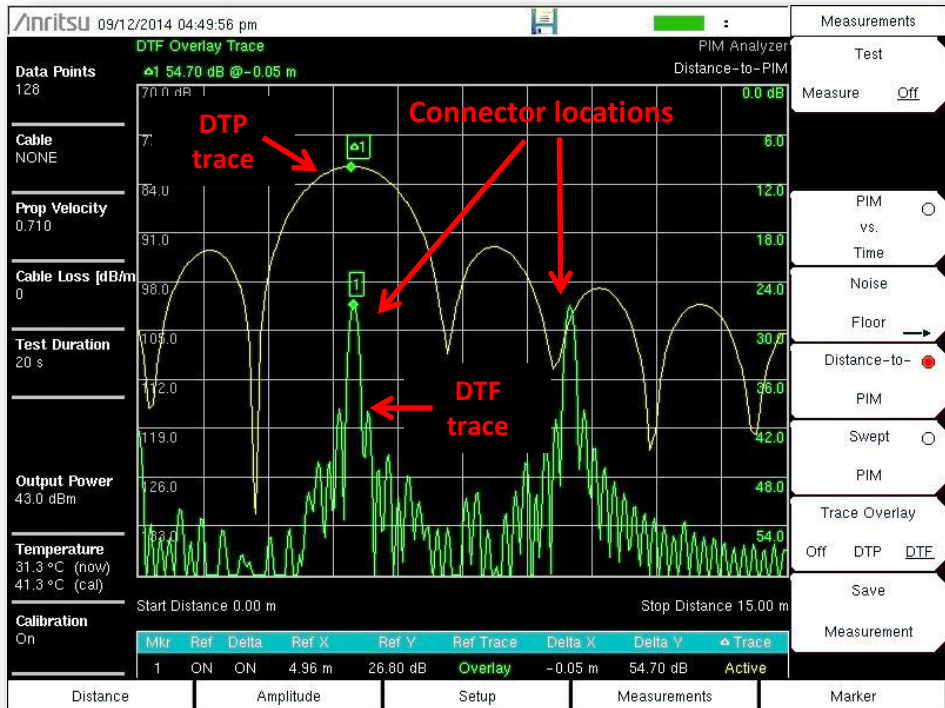
Kovová vata jako marker



Steel wool as
“PIM marker”

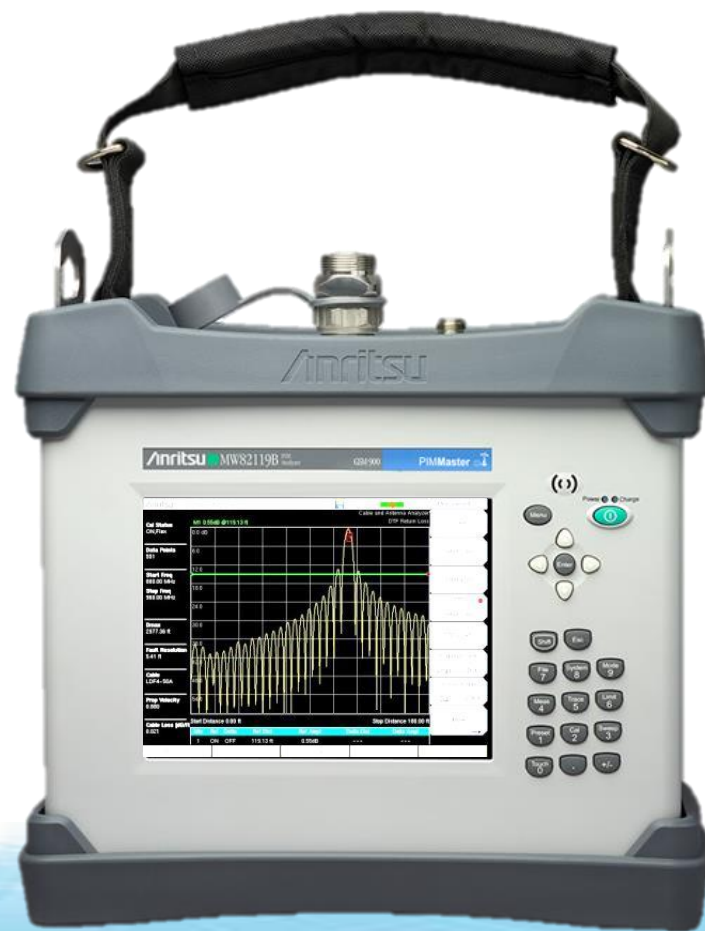
- Green trace = DTP with steel wool on antenna radome
- Yellow trace = DTP with steel wool removed
- Both peaks occur at the same location (Δ distance = 0 ft)
- PIM source is at the antenna aperture
- The antenna is bad

DTP / DTF překrytí

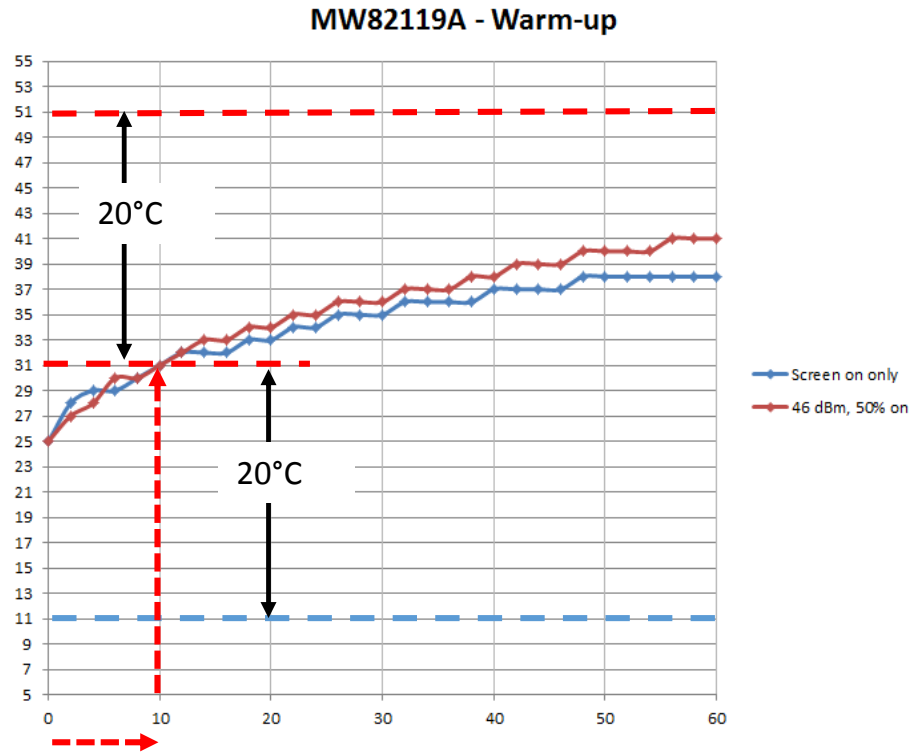


- Compare DTP to previously recorded DTF measurement
- PIM often occurs at RF connections
- DTF provides a “map” showing connector locations
- Use high resolution DTF to help identify PIM location.

Kalibrace přístroje



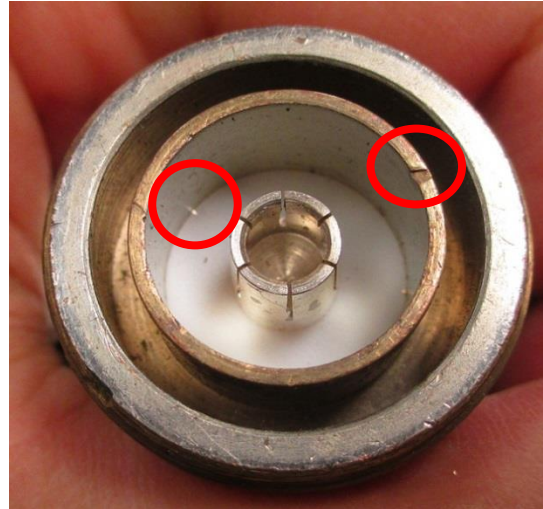
Krok 1 – zahřátí



- Turn on MW82119A
- Warm-up 10 minutes before calibration
- New calibration required after 20°C temp change

Warm-up

Nepodceňujte čistotu



- Clean RF connectors with alcohol wipe
- Push wipe with non-metallic stick
- Remove all metal flakes inside connector
- Visually inspect connectors for damage

Kontrola nastavení

SHIFT <6>

Setup

High (37-46 dBm)
Output Power
43.0 dBm

Low (25-37 dBm)
Output Power
33.0 dBm

Test Duration
60 s

Trace Mode
Fast Low Noise

PIM Aid

Frequency

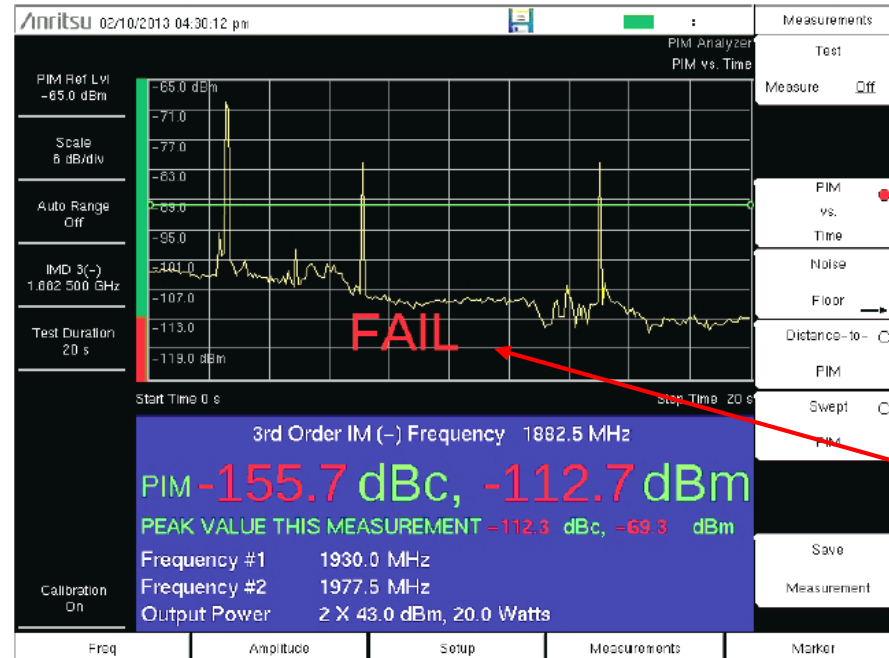
Carrier F1
1.930 GHz

Carrier F2
1.990 GHz

Intermod Order
3rd 5th 7th

High/Low
Band Select
High Low

PIM Aid



Limit

Limit

Upper Lower

On

Off

Amplitude

-100 dBm

Limit Alarm

On Off

Pass Indicator

On Off

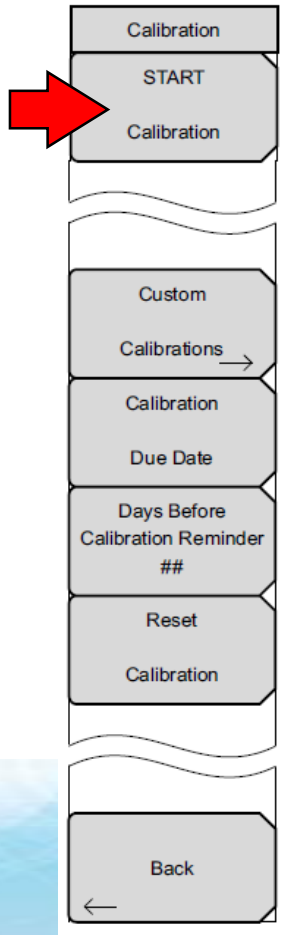
Set Default Limit

- Previous test settings remain active until changed
- Set-up files can be saved / recalled to save time

Kalibrace krok za krokem

SHIFT

<2>



Step 1 screen instructions

Attention

TO CALIBRATE:

1. Connect a PIM standard to TEST PORT.
2. Connect a Low PIM Termination onto the PIM Standard.

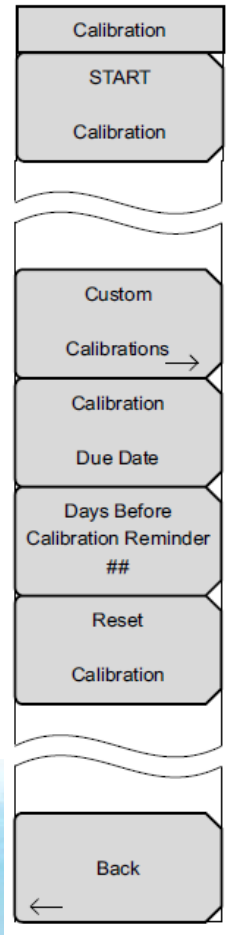
****Note****
Before calibration verify:
– Power Level
– Test Frequencies (F1, F2)
– IM Order
Changing these parameters may require re-calibration.

3. Press ENTER to Calibrate or ESCAPE to Exit.

- Either PIM standard (910 or 1775 MHz) can be used for calibration



Kalibrace krok za krokem



Step 2 screen instructions

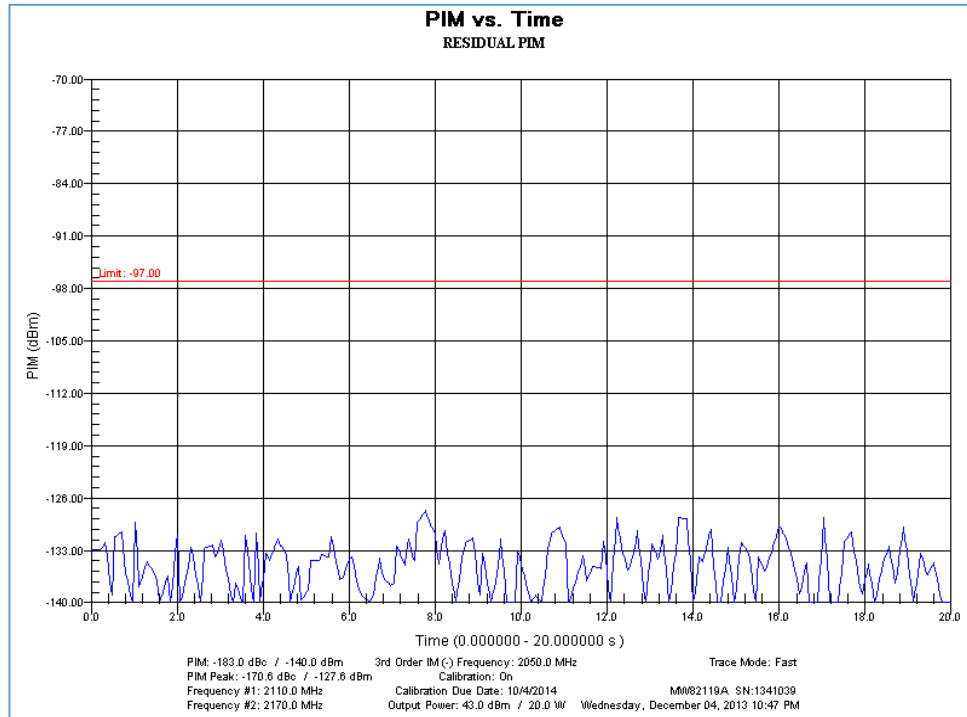
Attention

1. Remove the PIM Standard and Low PIM Termination from the TEST PORT.
2. Re-connect ONLY the Low PIM Termination to the TEST PORT.
3. Press ENTER to Calibrate or ESCAPE to Exit.

- This step must be low PIM
- No metal flakes in connector during calibration
- Connectors must be tight for this step

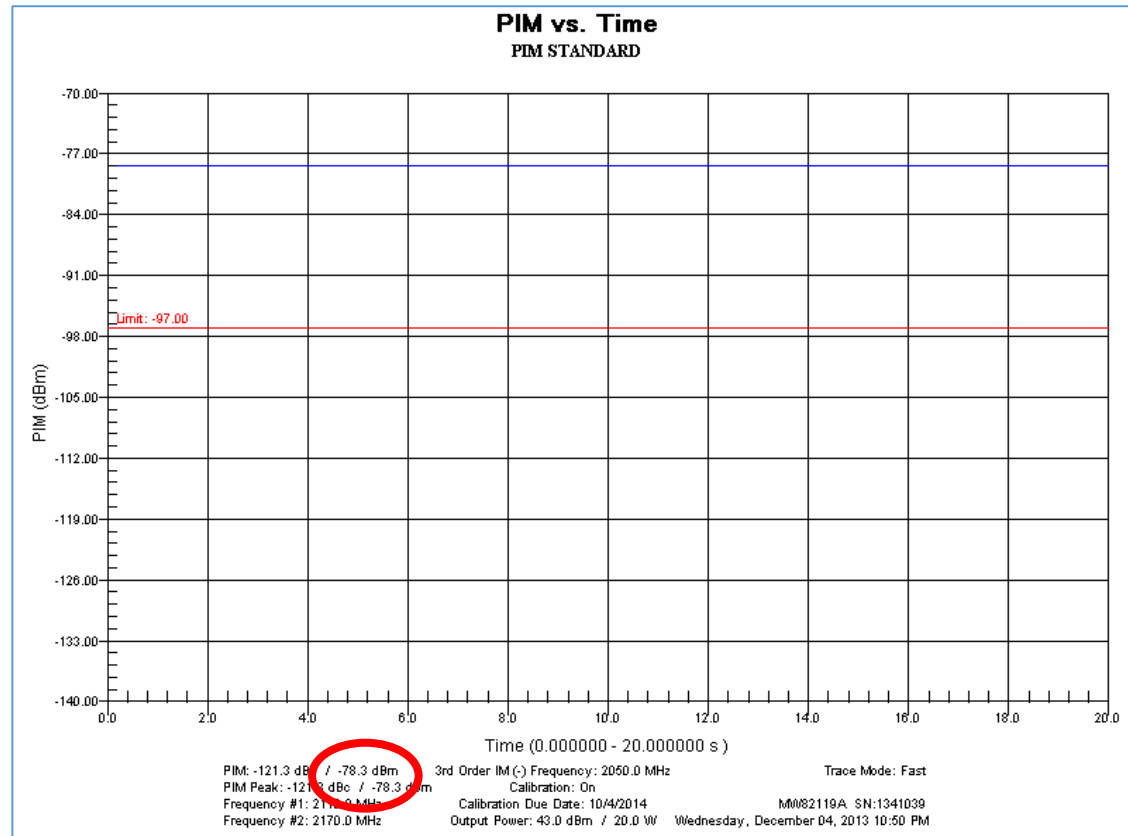


Ověření vlastní PIM



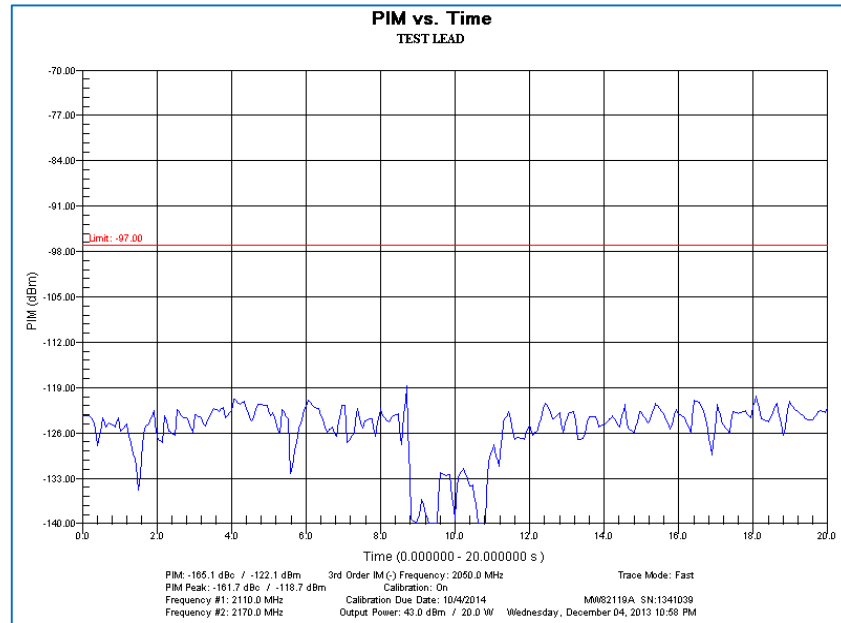
- Measure PIM vs. TIME with low PIM termination attached to instrument
- Lightly tap termination with rubber end of wrench
- PIM must remain 10 dB lower than limit

Ověření PIM standardem



- Measure PIM standard
- Verify measurement = expected value ± 3 dB

Ověření měřicího kabelu



- You test lead will eventually wear out!
- Attach test lead to instrument
- Attach low PIM termination to other end
- Lightly flex cable at connectors
- PIM must remain 10 dB lower than limit
- Save results

Stavový diagram měřicí procedury

