



Testing PTC 220 or ITC 220 Radios Using the Freedom Communications System Analyzers

NOTE: This document is a high-level overview of the PTC-ITCR test capabilities of FREEDOM Communications System Analyzers. For a much more in-depth Application Note, visit www.freedomcte.com/PTC and submit the form to request more information.

PTC Background

Two major technical architectures have emerged in the USA for PTC (Positive Train Control) operation:

- ITCR – Interoperable Electronic Train Management System (I-ETMS)
- ACSES – Advanced Civil Speed Enforcement System

Although both systems are used as PTC (Positive Train Control) the two systems are very different and not interoperable. Operational PTC Systems are designed to prevent the following events:

- 1) Train-to-train collisions.
- 2) Over-speed derailments.
- 3) Injuries to workers as the result of unauthorized incursions by train into a work zone.
- 4) Movement of a train through an improperly aligned switch

To achieve the desired goals all parts of the PTC system must be operating at optimal performance. In the event of component failure, it is critical that faults be located and corrected as quickly as possible. The radio is utilized in I-ETMS systems for over the air communications between on-board and wayside radios.

To this end the R8000 family of Communications System Analyzers support the test and troubleshooting of PTC-ITCR. This document is an overview of FREEDOM PTC-ITCR radio test using FREEDOM analyzers

PTC-ITCR radios are manufactured by Meteorcomm LLC and CalAmp. Meteorcomm radios are branded “PTC 220” and CalAmp radios are branded “ITC 220.” The required radio commands and test equipment setup is the same for both radios. For the rest of this document both radios will be referred to as “PTC radio”. For any alignment requirements of the PTC radios the user should consult the appropriate manufacture documentation.

XTermW Software

The radio manufacturer provides a software program to assist in configuration and testing of the PTC radios. The XTermW program must be utilized to configure the radio's channels and functions. For information about setup and utilization of the XTermW software please contact the radio manufacture.

Radio Configuration

To enable the R8000/R8100 to test the radio in PTC mode the user must use the XTermW software to configure the channels and settings of the radio

NOTE: Detailed setup instructions including required XTermW commands are available in the full Application Note which may be obtained by request at www.freedomcte.com/PTC

The example screenshots that follow were created using an R8100 configured with the PTC-ITCR Test Package option (R8-PTC_ITCR) connected to a PTC wayside radio. All screen shots will show an R8100, however an R8000 configured with the PTC-ITCR option can perform the same measurements.

There are three PTC radio types:

Base, Locomotive and Wayside. The examples below will show results from a Wayside radio.



Power and Antenna connection on PTC wayside radio

Radio Transmitter Tests

The following tests use DQPSK for power measurement and spectrum analysis.

A laptop is utilized to run the XTermW software. An ethernet cable needs to be connected between the laptop and the “MAINT” port on the PTC radio.



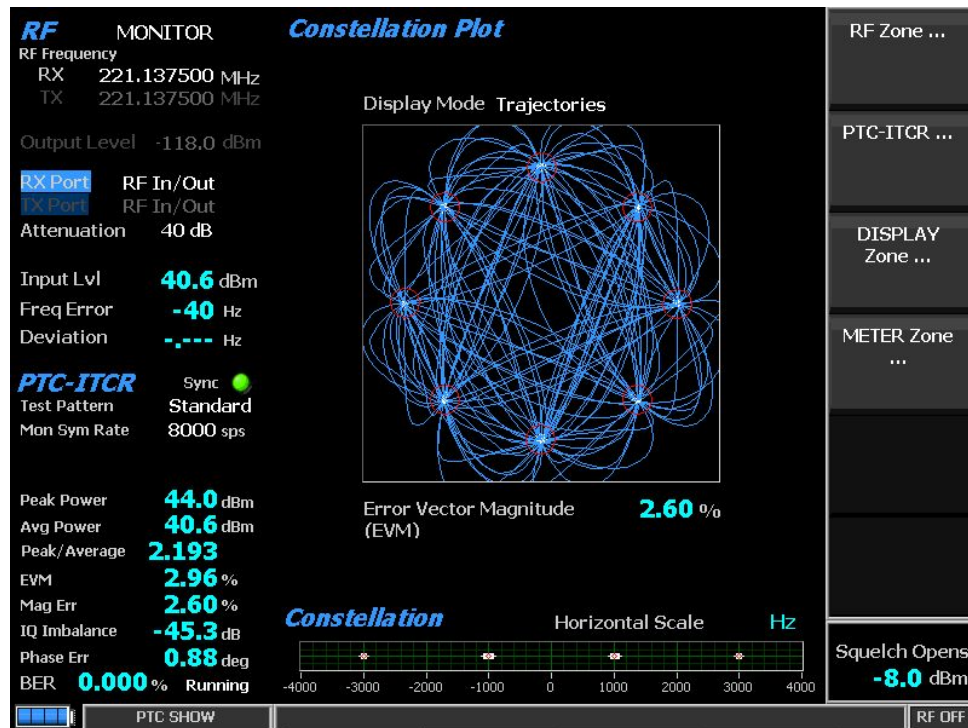
Ethernet connection on Wayside radio

Connect an RF cable from the “ANT” port on the Wayside radio to the “RF In/Out” port of the R8100.

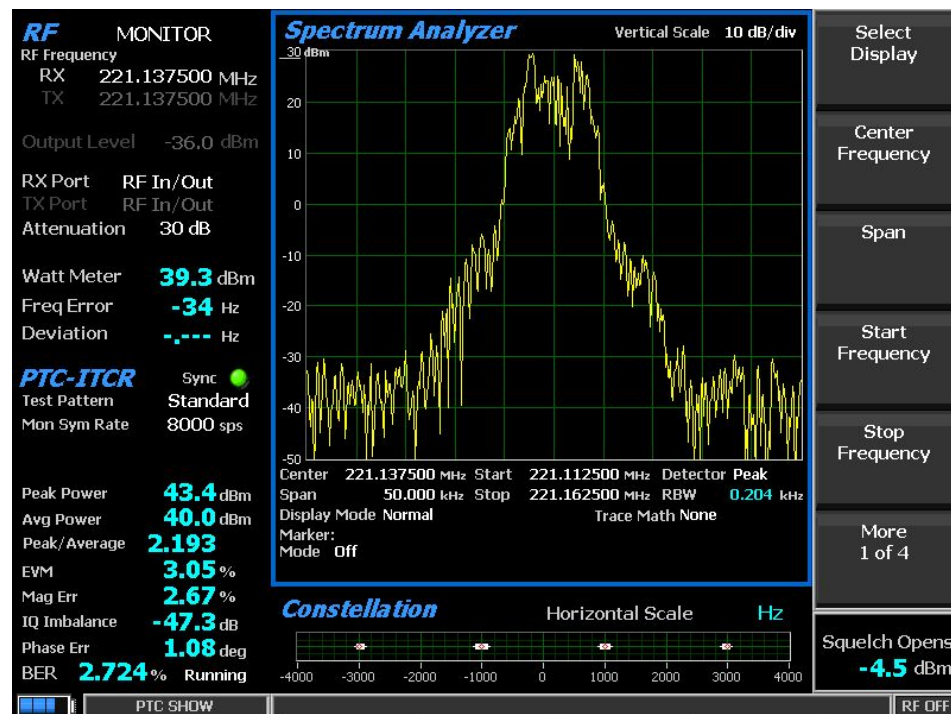


RF connection between Wayside and R8100

When the R8100 is properly configured the user will see the following screens:



Constellation plot

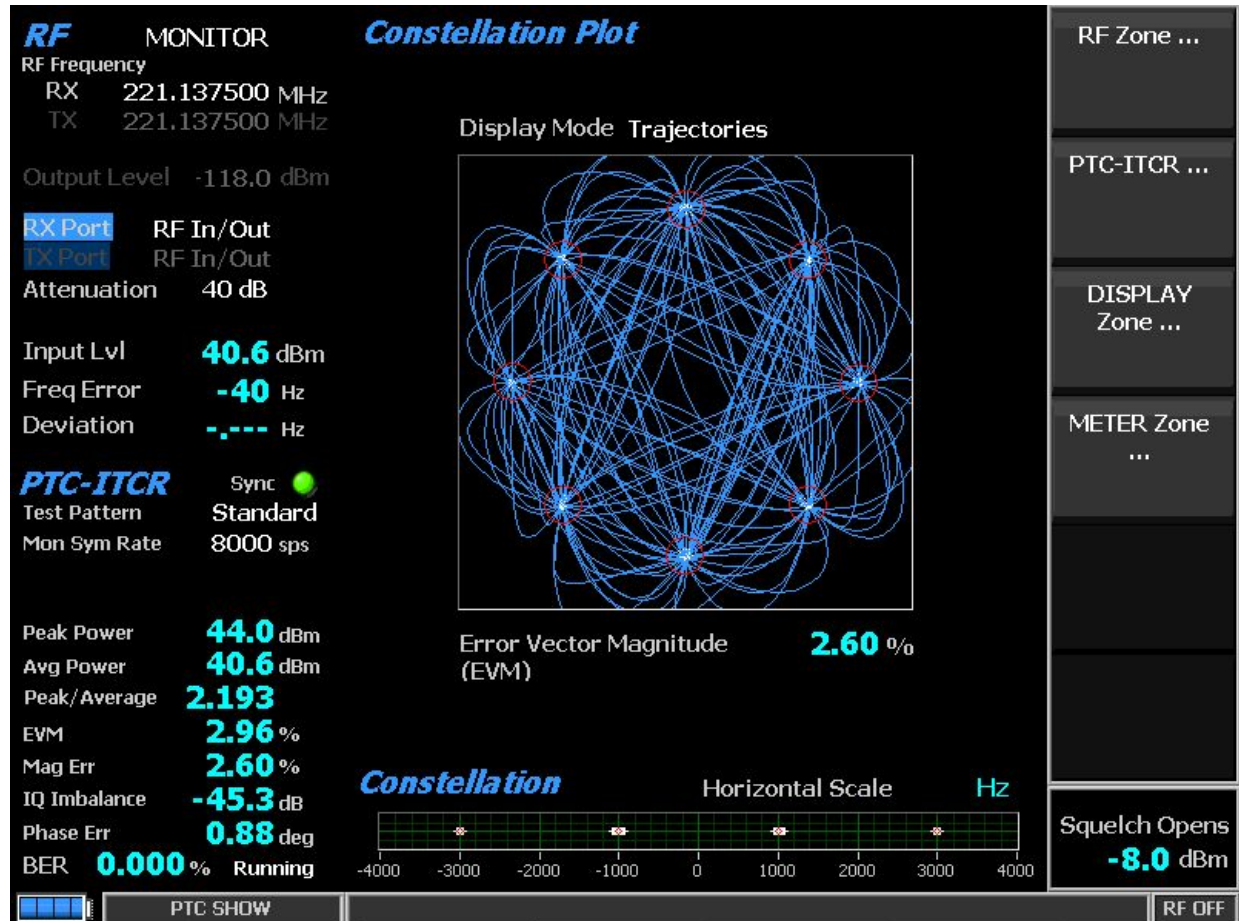


Spectrum Analyzer Plot

Transmit measurements and DQPSK waveform verification on the R8000/R8100

The R8100 provides measurements of the TX physical layer quality and power. Using XTermW the user puts the PTC radio into a test mode that is nearly identical to its operational mode, except the payload frame contains a test pattern.

The screen shot below shows an example of the measurement information available on the R8100



PTC measurements and Constellation Plot

The screen above contains a good deal of information on the signal quality of the radio. The RF Zone (top left corner) indicates the frequency error of the transmission. It is important to note that frequency error must be determined before an accurate measurement of error vector magnitude can be made.

NOTE: Detailed Center-Frequency, EVM and Power Level Tolerance information is available in the full Application Note which may be obtained by request at www.freedomcte.com/PTC

The PTC-ITCR zone in lower left is where majority of measurements are shown. The first and most important item is "Sync". All physical layer measurements are made after Sync is acquired. If Sync

is NOT green you will not have good information. If Sync cannot be acquired, troubleshooting will be needed.

NOTE: High-level troubleshooting suggestions are included in the full Application Note which may be obtained by request at www.freedomcte.com/PTC

After Sync is acquired and frequency error has settled then all remaining measurements will be accurate.

- a) Peak power
- b) Average power
- c) Peak/Average ratio
- d) EVM (see table 4)
- e) Magnitude Error
- f) IQ Imbalance
- g) Phase Error

Bit Error rate (BER) can also be calculated based on the PN9 pattern transmitted from the radio to the R8100. To see the result the calculation must be "Running". This is enabled by selected the "BER Test" soft key in the PTC-ITCR zone and switching to Start.

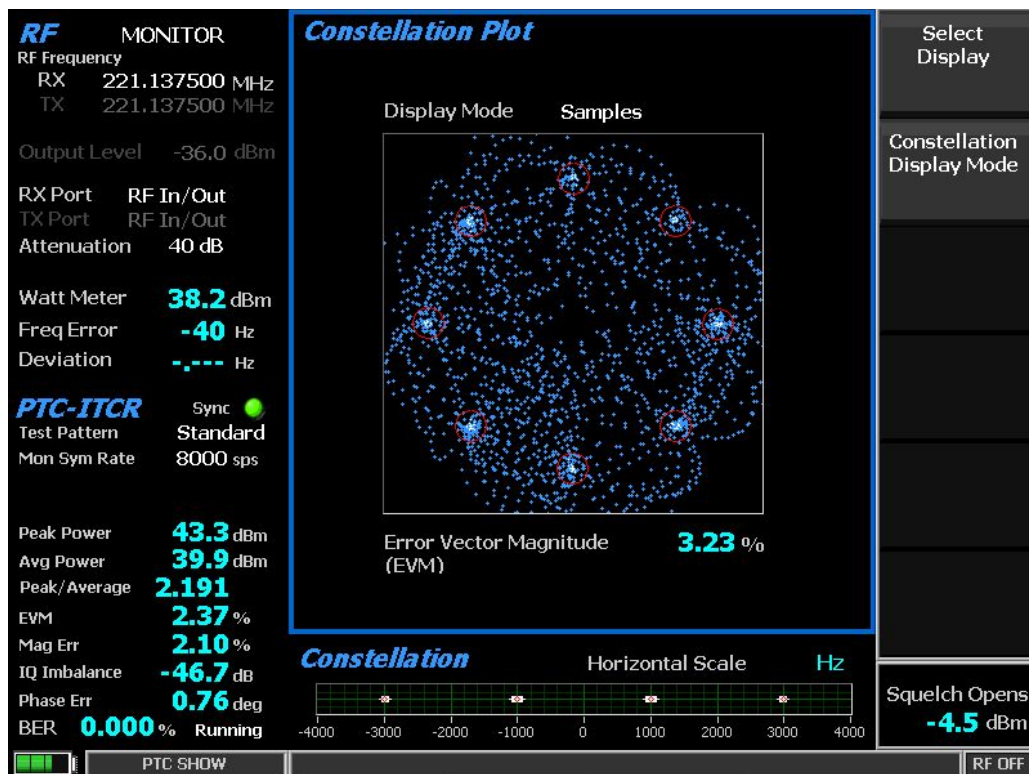
For a strong TX signal the BER should always be 0.000% (zero). If during the test sequence, there are periodic jumps of BER that is an indication that something is wrong with the transmitted signal and further investigation is needed.

The linear constellation plot in lower right corner should display four small tight groupings as shown in the accompanying screen shots. If there are issues in the modulation you may see short "bursts" of scattered values across the scale.

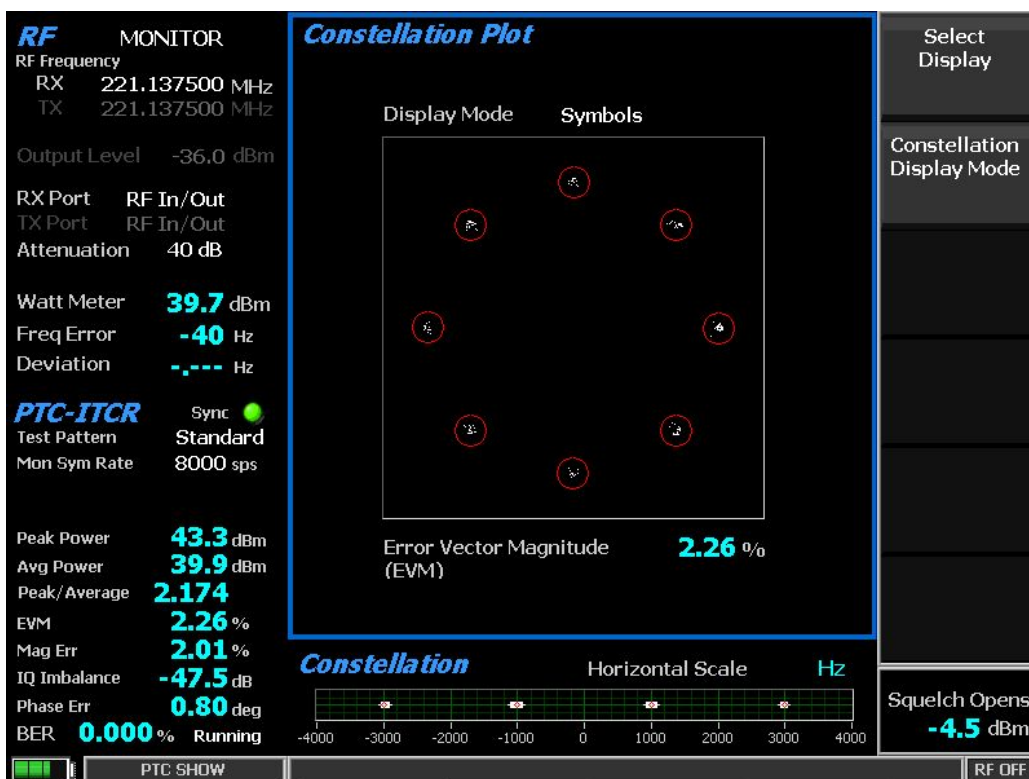
The Display Zone in top right shows the constellation plot in trajectory mode as well as the calculated EVM. There are three display modes available which can be selected while in the display zone: Symbols, Samples and Trajectories. Screenshots 5 and 6 show examples of each additional mode.

Under PTC test mode the display zone has options to present the transmitted signals several different ways. Options are:

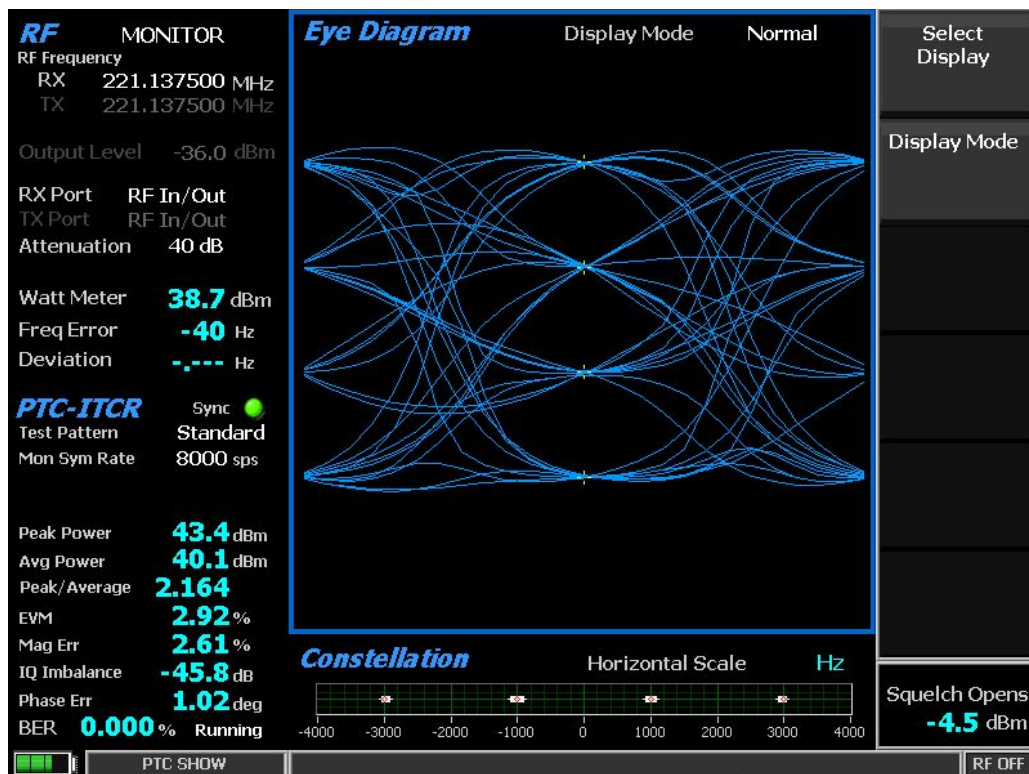
- a) Spectrum Analyzer
- b) Eye Diagram (Modes: Normal and Fade away)
- c) Power profile with adjustable scales and markers
- d) Constellation Plot (Modes: Symbols, Samples, Trajectories)
- e) Distribution Plot



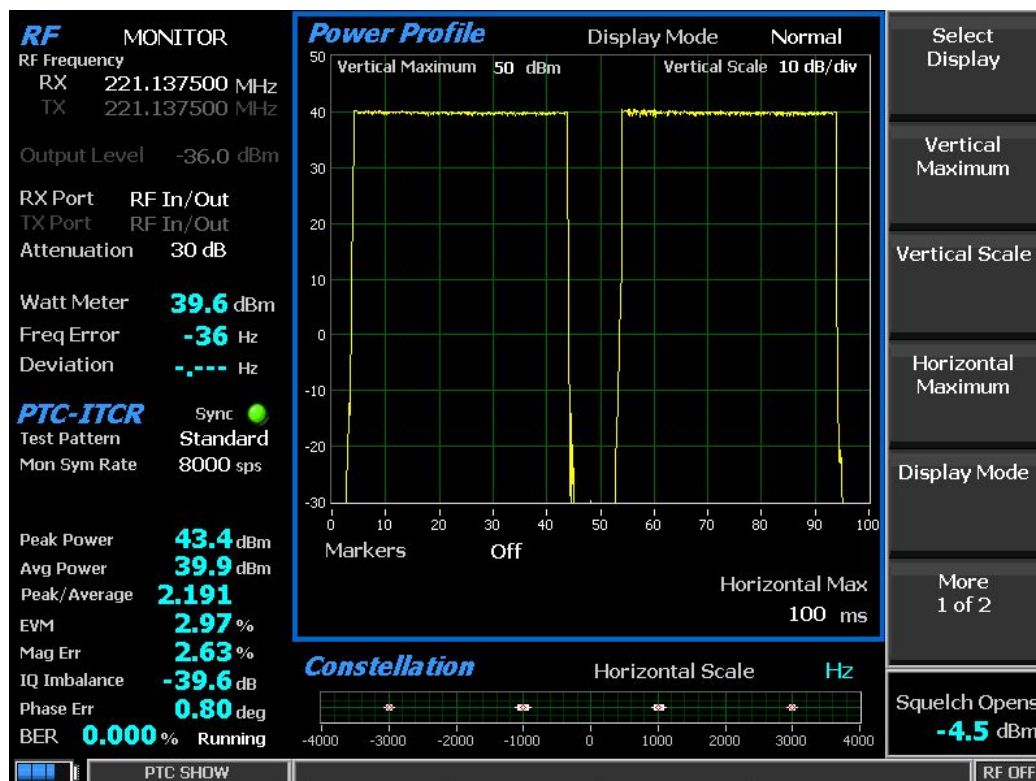
Constellation plot with samples



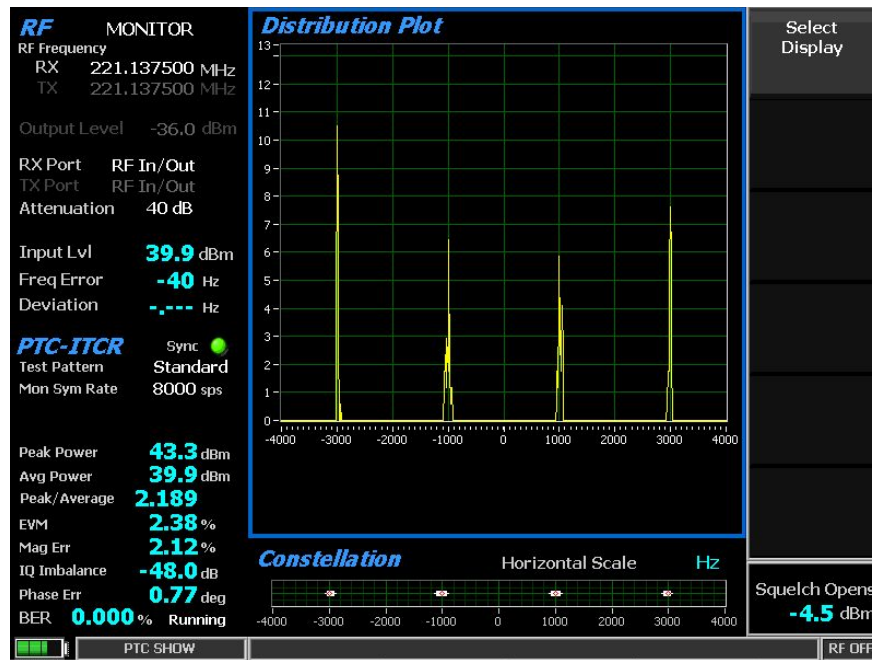
Constellation plot with symbols



Eye Diagram



Power Profile



Distribution Plot

PTC Radio Receiver Port Sensitivity Testing

The R8100 can also test the minimum receiver sensitivity level with or without FEC using a PN9 pattern to radio BER test.

Performing the sensitivity test

- 1) With the BER test running on the radio, decrease the output level in 0.5 dB steps while watching BER in XTermW
- 2) Continue to decrease the output level until BER is reporting errors greater than 1E-4
- 3) Slowly increase amplitude by 0.5 dB until BER errors are less than 1E-4 (reading will be in E-5 range)
- 4) Wait 5-10 seconds to verify consistent BER

Test results are acceptable if output power level is less than performance values set by the manufacture.

NOTE: Detailed Instructions for testing wayside, Base and Locomotive radios are including in the full application note, which may be obtained by request at www.freedomcte.com/PTC

Conclusion

This brief overview is intended ONLY to provide an overview of the test capabilities of FREEDOM analyzers with PTC-ITCR radios. A much more detailed application note is available for those working with PTC radios. The user should consult this document, referenced frequently in this overview, when conducting actual tests.