VIAVI

CX300 ComXpert

Communication Service Monitor

P25 Option Guide

VIAVI Solutions
1-844-GO-VIAVI
www.viavisolutions.com

CX300 ComXpert
Communications Service Monitor
P25 Option Guide

22146777 Rev. 002

VIAVI Solutions
1-844-GO-VIAVI
www.viavisolutions.com

This page intentionally left blank.

Notice

Every effort was made to ensure that the information in this manual was accurate at the time of release. However, information is subject to change without notice, and VIAVI reserves the right to provide an addendum to this manual with information not available at the time that this manual was created.

Copyright/Trademarks

Patent Information

Patented as described at **www.viavisolutions.com/patents**

Copyright Release

Terms and conditions

Specifications, terms, and conditions are subject to change without notice. The provision of hardware, services, and/or software are subject to VIAVI's standard terms and conditions, available at www.viavisolutions.com/en/terms-and-conditions.

Declaration of Conformity

VIAVI recommends keeping a copy of the Declaration of Conformity that shipped with the unit with the test set at all times.

Warranty Information

Warranty information for this product is available on the VIAVI website at https://www.viavisolutions.com/en-us/warranty-information.

Federal Communications Commission (FCC) Notice

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

This equipment was tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference, in which case you will be required to correct the interference at your own expense.

The authority to operate this equipment is conditioned by the requirements that no modifications be made to the equipment unless the changes or modifications are expressly approved by VIAVI.

ALERT

- To comply with FCC RF Exposure compliance requirements, a separation distance of at least 20 cm must be maintained between the antenna of this device and all persons.
- This transmitter must not be co-located in conjunction with any other antenna or transmitter.

Industry Canada Requirements

This device complies with Industry Canada's license-exempt RSSs. Operation is subject to the following two conditions: 1) This device may not cause interference; and, 2) This device must accept any interference, including interference that may cause undesired operation of the device.

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes: 1) l'appareil ne doit pas produire de brouillage; et, 2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

EU WEEE and Battery Directives

This product, and the batteries used to power the product, should not be disposed of as unsorted municipal waste and should be collected separately and disposed of according to your national regulations.

VIAVI has established a take-back processes in compliance with the EU Waste Electrical and Electronic Equipment (WEEE) Directive, 2012/19/EU, and the EU Battery Directive, 2006/66/EC.

Instructions for returning waste equipment and batteries to VIAVI can be found in the WEEE section of VIAVI's Standards and Policies web page.

If you have questions concerning disposal of your equipment or batteries, contact the VIAVI WEEE Program Management team at WEEE.EMEA@VIAVISolutions.com.

EU REACH

Article 33 of EU REACH regulation (EC) No 1907/2006 requires article suppliers to provide information if a listed Substances of Very High Concern (SVHC) is present in an article above a certain threshold.

For information on the presence of REACH SVHCs in VIAVI products, see the Hazardous Substance Control section of VIAVI's Standards and Policies web page.

EU CE Marking Directives (LV, EMC, RoHS, RE)

This product conforms with all applicable CE marking directives. Please see EU Declaration of Conformity for details.

EMC Directive Compliance

This product was tested and conforms to the EMC Directive, 2014/30/EU for electromagnetic compatibility.

UK Declaration of Conformity

This product conforms with all applicable UKCA marking directives. Please request UK Declaration of Conformity for further details.

China RoHS Materials Declaration

The China RoHS Materials Declaration is shipped with the product when required.

California Proposition 65

California Proposition 65, officially known as the Safe Drinking Water and Toxic Enforcement Act of 1986, was enacted in November 1986 with the aim of protecting individuals in the state of California and the state's drinking water and environment from excessive exposure to chemicals known to the state to cause cancer, birth defects or other reproductive harm.

For the VIAVI position statement on the use of Proposition 65 chemicals in VIAVI products, see the Hazardous Substance Control section of VIAVI's Standards and Policies web page.

Korea Certification

A급 기기 (업무용 방송통신기자재) Class A Equipment (Industrial Broadcasting & Communications Equipment).	이 기기는 업무용(A급) 전자파적합기기로서 판매자 또는 사용자는 이 점을 주의하시기 바라며, 가정외의 지역에서 사용하는 것을 목적으로 합니다. This equipment is **Industrial (Class A) electromagnetic wave suitability equipment** and seller or user should take notice of it, and this equipment is to be used in the places except for home.

Ordering information

This manual is a product of the VIAVI Technical Publications Department, issued for use with the CX300 ComXpert Communications Service Monitor. The PDF format of this manual is available on the VIAVI product website.

Go to: https://www.viavisolutions.com/en-us/resources/literature-library

- Type CX300 to find the manuals associated with the CX300 ComXpert Communications Service Monitor

Contact Information

Contact the Technical Assistance Center (TAC) for technical support or with any questions regarding this or other VIAVI products.

- Phone: 1-844-GO-VIAVI
- Email: Techsupport.Avcomm@viavisolutions.com

For the latest TAC information, go to:

https://www.viavisolutions.com/support/technical-product-support

Software Notifications

DFARS Statement

If software is for use in the performance of a U.S. Government prime contract or subcontract, software is delivered and licensed as “Commercial Computer Software” as defined in DFAR 252.227-7014 (Feb 2014), or as a “Commercial Item” as defined in FAR 2.101(a) or as “Restricted Computer Software” as defined in FAR 52.227-19 (Dec 2007) or any equivalent agency regulation or contract clause. Use, duplication or disclosure of Software is subject to VIAVI Solutions' standard commercial license terms, and non-DOD Departments and Agencies of the U.S. Government will receive no greater than Restricted Rights as defined in FAR 52.227-19(c)(1-2) (Dec 2007). U.S. Government users will receive no greater than Limited Rights as defined in FAR 52.227-14 (June 1987) or DFAR 252.227-7015 (b)(2) (November 1995), as applicable in any technical data.

Open Source Disclaimer - IMPORTANT READ CAREFULLY

The CX300 ComXpert Communications Service Monitor includes third party software licensed under the terms of separate open source software licenses. By using this software you agree to comply with the terms and conditions of the applicable open source software licenses. Software originated by VIAVI is not subject to third party licenses. Terms of the VIAVI Software License different from applicable third party licenses are offered by VIAVI alone.

This page intentionally left blank.

Preface

This preface explains how to use this manual. Topics discussed include the following:

About this Manual

Scope of Manual

This manual describes test and measurement functions associated with the *CX300 ComXpert* P25 Option. Refer to the *CX300 ComXpert Communication Service Monitor Operation Manual* for information about test set operation, system settings, and Analog test and measurement functions.

Intended Audience

This manual is intended for personnel who are familiar with P25 systems and operation of the *CX300 ComXpert Communication Service Monitor.*

This manual is intended for novice, intermediate, and experienced users who want to use the *CX300 ComXpert P25 Option* effectively and efficiently.

Related Information

This is the CX300 ComXpert P25 Option Guide *22146777.* This manual is to be used in conjunction with the following publications:

- *CX300 ComXpert Quick Start Guide, 22130635*, which provides basic operating and safety information
- *CX300 ComXpert DMR Option Guide, 22163052,* which provides information about the test and measurement functions found in the CX300 DMR options
- *CX300 ComXpert VNA Option Guide, 22163053,* which provides information about the test and measurement functions found in the CX300 VNA options
- *CX300 ComXpert Operation Manual, 22130634*, which provides instructions to install, configure, and operate the CX300 ComXpert's standard test and measurement functions
- *CX300 Remote Programming Manual, 22146776,* which defines the Standard-Commands-for-Programmable-Instrument (SCPI) Consortium's SCPI standard and provides instructions for using this manual for various test and measurements
- *CX300 Maintenance Manual, 22130636,* provides basic instructions for assembling the instrument components, setting up the CX300 Test Set, instrument specifications, and instructions for removal, installation and calibration procedures. The CX300 Maintenance Manual is available on CD ROM 22165108

Typographical Conventions

This manual uses the following typographical conventions:

Table 1-1 Text formatting and other typographical conventions

Item(s)	Example(s)
References to terms used to identify key areas of the UI such as screens, panes, menus, or toolbars.	Navigate to the **Date and Time screen**. Open the **RF Receiver settings menu**. Some controls are also accessed from the **Quick Access Toolbar.**
Hardware buttons, keys, or switches that you press or flip.	Press the **On button**. Flip the **Power** switch to the on position.
Software components such as buttons, menus, tabs, or fields on a PC-based or Web-based user interface	Click **Start**. Click **File > Properties**. Type the name of the probe in the **Probe Name** field.
Directory names, file names, and code and output messages that appear in a command line interface or in some graphical user interfaces (GUIs).	`$NANGT_DATA_DIR/results` (directory) – `test_products/users/defaultUser.xml` (file name) – `All results okay.` (output message)
Text you must type exactly as shown into a command line interface, text file, or a GUI text field.	– Restart the applications on the server using the following command: **`$BASEDIR/startup/npiu_init restart`** Type: **`a:\set.exe`** in the dialog box.
References to guides, books, and other publications appear in *this typeface*.	Refer to *Newton's Telecom Dictionary.*
Required arguments (text variables in code).	`<password>`

Contact Information

Contact the Technical Assistance Center (TAC) for technical support or with any questions regarding this or another VIAVI products.

- Phone: 1-844-GO-VIAVI
- email: Techsupport.avcomm@viavisolutions.com

For the latest TAC information, go to:

https://www.viavisolutions.com/en-us/services-and-support/support/technical-assistance.

Conventions

Symbols and Markings

The following conventions are found on the instrument and in product documentation:

Table 1-2 Symbols and Markings

	**NOTE** This symbol indicates a note that includes important supplemental information or tips related to the main text.
	**Attention Symbol** This symbol represents a general hazard. It may be associated with either a DANGER, WARNING, CAUTION, or ALERT message. See Table 1-3 for more information.

Safety Definitions

This manual uses the following terms to indicate conditions or activities which are potential safety hazards:

Table 1-3 Safety Definitions

Term	Definition
CAUTION	Identifies conditions or activities that, if ignored, can result in equipment or property damage, e.g., Fire.
Mise en Garde	Identifiez les conditions ou les activités qui, si ignorées, peuvent entraîner des dommages à l’équipement ou aux biens, p. ex. un incendie.

Table of Contents

List of Figures

This page intentionally left blank.

List of Tables

This page intentionally left blank.

1

Introduction to the CX300

This chapter provides a general description of the CX300 P25 options. Topics discussed in this chapter include the following:

1.1 CX300 Overview

The CX300 ComXpert is a compact, bench-top communications test set for use in the Land Mobile Radio or Two-Way Communications Industry. The CX300 is ideal for performing preventative maintenance on two-way radios and their applicable support infrastructure.

Refer to the CX300 product brochure for a succinct overview of the unit, and to the CX300 Operation Manual for additional details.

The CX300 P25 software option provides various features for testing P25 radio systems.

1.2 CX300 P25 Option Features and Capabilities

This section highlights key features and capabilities of CX300 P25 software options.

1.2.1 P25 Conventional

P25 Standard: P25, or Project 25, is **a suite of standards developed to provide digital voice and data communication systems suited to public safety and first responders**. Project 25 was initiated by the Association of Public Safety Communications OfficialsP25 Conventional, option CX300-DP25, provides the following test features:

- Software identified as **P25 Phase 1**
- Ability to transmit P25 C4FM modulation waveforms
- Ability to receive, demodulate, and analyze P25 C4FM signals
- A variety of P25 and Analog meters for evaluating DUT transmit and receive performance
- Constellation, Distribution, and Eye Diagram plots for P25 modulation analysis

1.2.2 P25 CX300-DP25P2 option Phase 2

The CX300 P25 Phase 2 protocol is CX300-DP25P2. It adds th ability to configure HCPM and HDQPSK Phase 2 Modulation types. It requires prior option CX300-DP25.

1.3 Verifying P25 Option Installation

The CX300 provides several test and measurement functions which allow the user to evaluate the transmit and receive performance of an analog communications system.

1.3.1 Factory Installed Option

When a P25 software option(s) is purchased as a factory installed option, the P25 software is ready to use when the test set is received from the factory.

1.3.2 Post Production Option

When a P25 software option is purchased post production, the option software and option license files must be installed on the test set by the end user. See the following steps for selecting and installing Options.

Refer to the CX300 ComXpert Communication Service Monitor Operation Manual for more information on option selection.

CX300 software is a field-upgradeable software which can be updated using StrataSync™ or a USB device.

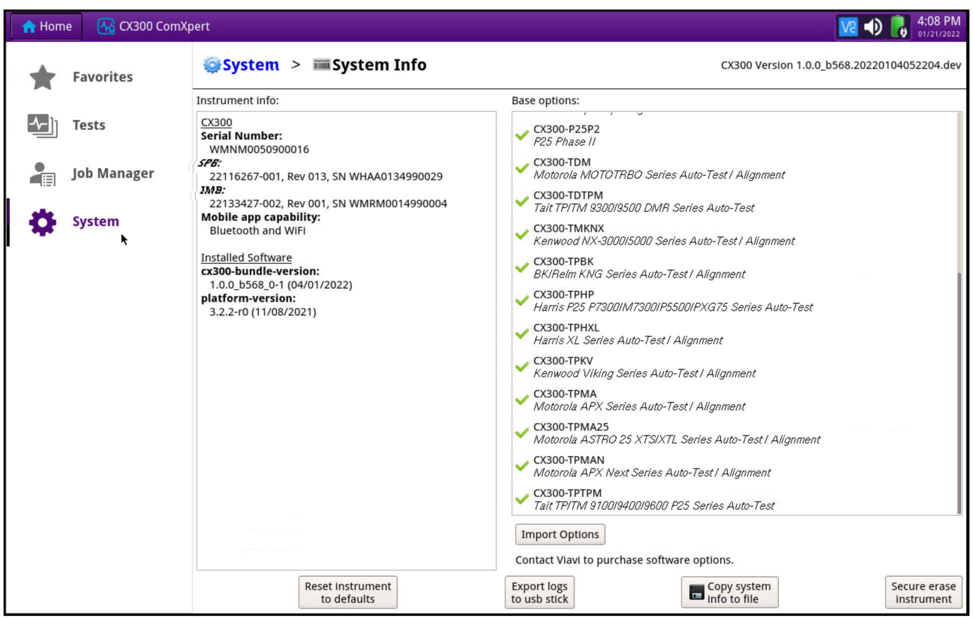


Figure 1-1 System Info Screen

To Install CX300 Options:

1. If using a USB device, install the USB device.
2. Navigate to the System Info Screen. See Figure 1-1.

3. Select the **Import Options** button. See Figure 1-1 and Figure 1-2.

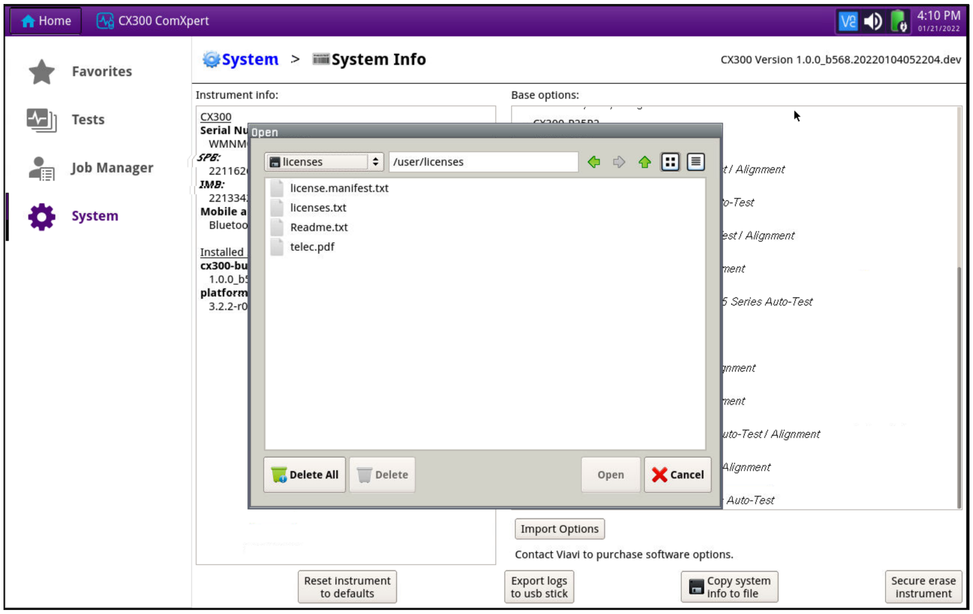


Figure 1-2 Import Options Selected

4. Select the Option to install, or use the Select All button. See Figure 1-2.
5. Select Open.
6. Select OK. The Option selected is automatically installed to the system.

1.4 P25 Test Modes

P25 provides several test modes for the purpose of evaluating the transmit and receive performance of a P25 system. Each test mode contains controls and settings that are required to use the functions in the selected mode. The CX300 contains the following test modes:

- Radio Test Mode
- Auto Test Mode

1.4.1 Radio Test Mode

Radio Test mode supports full duplex, Transmit, and Receive capabilities, providing simultaneous access to RF Generator and RF Receiver functions. Radio test mode is typically used for manual testing of subscriber or infrastructure equipment.

1.4.2 AutoTest Mode

AutoTest Mode used to automatically test a large library of OEM radios to OEM specifications. This feature provides test reports to document the results and automated alignment to keep radio operation optimal.

1.5 Accessing P25 Option

The following procedure describes how to select a test mode of operation.

To Select Test Mode of Operation

1. Navigate to the T**est Home Screen**.
2. Select Communications Test from the Mode Pane.
3. Select **P25** from the **Measure Pane**.
4. Perform one of the following to load P25:
   - Press the **P25** button again.
   - Select the **Done Button**.

1.6 P25 User Interface Layout

The P25 User Interface (UI) uses the same layout, methods of navigation, and control used in the CX300 **Analog Duplex** test and measurement mode of operation. Refer to the *CX300 ComXpert Operation Manual* for a detailed description about the UI layout, accessing system and test screens, and configuring controls and settings.

1.7 Channel Analyzer

The **Channel Analyzer plot** is supported in Transmit Test and Duplex Test modes.

The Channel Analyzer is an asynchronous, Fast Fourier Transform (FFT) based analyzer that displays the spectrum of the RF signal received by the test set up to a 100 MHz bandwidth, centered on the receive frequency. The source of the signal for the Channel Analyzer is the receiver chain of the test set, therefore the Channel Analyzer is dependent on the receiver for connector selection, global attenuation and center frequency.

The **Channel Analyzer plot** can be viewed in default size, or as an expanded window. When the **Channel Analyzer plot** is expanded, frequently used analyzer controls and settings are available on the measurement window; other controls and settings are accessed from the **Channel Analyzer settings menu**.

The CX300 contains several methods of displaying the modulation fidelity results.

This page intentionally left blank.

2

P25 Test and Measurement Functions

This chapter describes the test and measurement functions that are supported in P25. Topics discussed in this chapter include the following:

2.1 P25 Generate and Receive Functions

The CX300 provides the user with an RF Generator that provides a signal source of known parameters and control settings menu.

> **NOTE**
> The availability of generate and receive functions is based on the selected test mode of operation. See "P25 Test Modes", section 1.4, on page 1 - 4.

2.1.1 RF Generator

The **RF Generator** provides users with a signal source of known parameters which can be used to evaluate the receive performance of the Device Under Test (DUT). When configuring **RF Generator** settings, configure the characteristics of the outgoing signal according to the capabilities of the receiver, the test requirements, and the hardware configuration of the test.

RF Generator controls and settings are configured from the **RF Generator** settings menu. Some controls are also accessed from the Quick Access Toolbar or Function Toolbar. Refer to the *CX300 ComXpert Operation Manual* for detailed descriptions of **RF Generator** controls and settings.

Mod Type: This setting selects the type of modulation applied to the outgoing signal. Selections vary according to the P25 options available on the test set.

2.1.2 P25 Modulation Controls and Settings

P25 modulation controls and settings are configured from the **P25 Mod** settings menu. Some controls are also accessed from the **Quick Access Toolbar** or **Function Toolbar.** The following P25 modulation controls and settings are used to configure the characteristics of the modulated P25 signal:

Table 2-1 P25 Modulation Controls and Settings

Control/Setting	Description
Pattern	This setting selects the data or voice pattern to be generated by the test set. P25 patterns are derived from *TIA-102.CAAA Specification.* Pattern types include standard and non-standard P25 patterns. Available pattern types are depend on the type of **Protocol** selected and the options installed in the test set.
NAC	The Network Access Code (NAC) field applies to Group Calls. The **NAC** field defines the Network Access Code used by the test set to simulate calls.

Table 2-1 P25 Modulation Controls and Settings (Continued)

Control/Setting	Description
TGID/Dest ID	**TGID** defines the Subscribers Mobile Talk Group Identifier (TGID) as a six hex digit value when the value is entered in hex format. **Dest ID** defines the Destination ID of the target device in Unit to Unit calls when the value is entered in decimal format.
Source ID	A 24-bit unit identity portion of the unique subscriber unit identity. This field uniquely addresses a subscriber unit. This can also be called the Unit ID.
Priority	This setting defines the relative importance attributed to the signal.
Emergency	This is the status indicator which determines if this service is to be specially processed as an emergency service. • **0** = Non-emergency - indicates the normal processing status. • **1** = Emergency - indicates special processing required
Service Option	Service requests and service grants allow for special service extensions called the Service Options field. This feature provides extended flexibility to tailor the requested service to the needs of the requesting unit. Figure 2-1 shows the Service Option field definition.

	E	P	D	M		Priority level		
Bit	7	6	5	4	3	2	1	0

Figure 2-1 Service Option Field Definition

2.1.3 RF Receiver

The **RF Receiver** controls and settings are used to determine how the instrument processes an incoming signal. In order to obtain accurate test and measurement results, **RF Receiver** parameters must be set according to the known characteristics of the incoming signal.

The **RF Receiver Port**, **Frequency**, **Reference Level**, and **External Attenuator** parameters apply to all types of incoming signals. There are additional parameters that must be configured depending on the type of modulation that has been applied to the incoming signal.

RF Receiver controls and settings are configured from the **RF Receiver settings menu**. Some controls are also accessed from the Quick Access Toolbar or Function Toolbar. Refer to *CX300 ComXpert Communication Service Monitor Operation Manual* for detailed descriptions of **RF Receiver** controls and settings.

CAUTION
Do not overload input connectors. Refer to product labeling or product specifications for maximum input ratings.

2.2 P25 Meters

CX300 P25 meters provide users with the test functions necessary to evaluate the operational capabilities of P25 systems. This section describes the meters supported in P25 test mode.

2.2.1 Meter Controls and Settings

P25 supports a variety of analog and P25 meters. The controls and settings described in this section are found throughout various analog and P25 meters.

2.2.1.1 Meter Limits

Meter limits are used to define pass/fail criteria for measurements. CX300 meters support upper and lower limits as appropriate for each measurement. When limits are enabled for a meter, visual indicators are provided that indicate enabled limits, limit settings, and reading pass/fail status. Refer to the *CX300 ComXpert Communications Service Monitor Operation Manual* for a complete description of limit features and indicators.

- The **Lower Limit** field sets a minimum acceptable reading for a specific measurement. When a measurement falls below the enabled lower limit value, the meter scale turns blue. When readings are above a defined lower limit, or within enabled upper and lower limits, the meter scale turns green.

- The **Upper Limit** field sets a maximum acceptable reading for a specific measurement. When a measurement exceeds the enabled upper limit value, the meter scale turns red. When readings are under a defined upper limit, or within enabled upper and lower limits, the meter scale turns green.

2.2.2 Meter Scale Settings

The upper and lower settings of a meter’s scale are defined using the **Meter Scale button** which is located on each meter setting menu. The following methods are supported to define a meter’s scale settings:

Pre-Defined

Select from a pre-defined list of values which are appropriate for the measurement. The selected value defines the upper scale value; the lower value defaults to a value appropriate for the measurement.

Custom

Define the upper and lower scale settings. When Custom is selected, the upper and lower scale fields update to editable data fields. Selecting the upper and lower scale field displays the Numeric Keypad which allows you to enter an arbitrary value.

Auto

System adjusts the scale to settings best suited to the characteristics of the received signal.

2.2.2.1 Average Measurements

When appropriate for the measurement type, CX300 measurement meters support average measurements. When supported, the **Avg Samples** field is used to define the number of samples that are used to calculate average measurements.

2.2.2.2 Refresh Meters

Meter readings are refreshed using the **Refresh** button ( ).

2.2.3 P25 Demod Controls and Settings

P25 demodulation controls and settings are used to configure the device's RF Receiver to demodulate P25 modulated signals. The resulting P25 measurements can be used to evaluate modulation performance characteristics such as modulation accuracy and to identify any distortion present on the signal.

P25 demodulation controls and settings are configured from the **P25 Demod** function menu. Some controls are also accessed from the Quick Access Toolbar or Function Toolbar.

See section 2.2.1, "Meter Controls and Settings", on page 2-4 for a description of the controls and settings that are available for P25 Demod Meters. P25 Demod Meters also contain the following demodulation controls and setting:

Table 2-2 Screen Name Controls and Settings

Control/Setting	Description
Demod Type	This setting selects the type of modulation to the incoming signal. Selections vary according to the P25 options available on the test set. **NOTE**: • The P25 test pattern defines the reference used for the TX BIT Error Rate measurement. • Bit Error Rate (BER) is a measure of the number of bit errors that occur in a given number of bit transmissions.
Pattern	This setting selects the P25 test pattern of the receive signal.

2.2.4 RF Error Meter

The **RF Error Meter** indicates the difference (frequency error) between the received RF signal and the defined receive frequency. **RF Error Meter** controls and settings are configured from the **RF Error settings menu**. Some controls are also accessed from the Quick Access Toolbar or Function Toolbar. See section 2.2.1, "Meter Controls and Settings", on page 2-4 for a description of the controls and settings supported for the **RF Error Meter**.

2.2.5 Signal Power Meter

The **Signal Power Meter** is a tuned power meter that indicates the amount of RF energy that is contained within the CX300's selected receiver bandwidth (i.e. 12.5 kHz). The **Signal Power Meter** is tuned to a specific frequency, giving the ability to selectively measure the power of one channel when other channels are present.

Signal Power Meter controls and settings are configured from the **Signal Power settings menu**. Some controls are also accessed from the Quick Access Toolbar or Function Toolbar. The **Signal Power Meter** support the meter controls and settings described in See section 2.2.1, "Meter Controls and Settings", on page 2-4.

2.2.6 Modulation Fidelity Meter

P25 standard (TIA/EIA-102) contains a measurement called modulation fidelity. Modulation fidelity is "the degree of closeness to which the modulation follows the desired ideal theoretical modulation". The **Modulation Fidelity Meter** measures P25 waveform modulation fidelity as indicated in the *TIA-102.CAAA Specification*. Desired measurement is equal to or less than 5% per *TIA-102.CAAB Specification*. Modulation fidelity is an indication of the quality of the signal being transmitted by the radio. Readings > 5% indicate the radio may require alignment or repair.

Modulation Fidelity Meter controls and settings are configured from the **Mod Fidelity settings menu**. Some controls are also accessed from the Quick Access Toolbar or Function Toolbar. See section 2.2.1, "Meter Controls and Settings", on page 2-4 for a description of the controls and settings supported for the **Modulation Fidelity Meter**.

2.2.7 Symbol Deviation Meter

The **Symbol Deviation Meter** measures the symbol deviation accuracy of a P25 signal per *TIA-102.CAAA* and *TIA-CAAB Specifications*. Symbol deviation measurements should be ± 1620 and ± 1980 for Phase 1 P25 signals.

Symbol deviation measurement controls and settings are configured from the **Sym Dev settings menu**. Some controls are also accessed from the Quick Access Toolbar or Function Toolbar. See section 2.2.1, "Meter Controls and Settings", on page 2-4 for a description of the controls and settings supported for the **Symbol Deviation Meter**.

2.2.8 Symbol Clock Error Meter

The **Symbol Clock Error Meter** measures the 4800 baud symbol clock of the incoming P25 signal. Symbol clock error measurements should not exceed ± 48 mHz per *TIA-102.CAAA Specification*.

Symbol Clock Error Meter controls and settings are configured from the **Symbol Clock Error settings menu**. Some controls are also accessed from the Quick Access Toolbar or Function Toolbar. See section 2.2.1, "Meter Controls and Settings", on page 2-4 for a description of the controls and settings supported for the **Symbol Clock Error Meter**.

2.2.9 Bit Error Rate Meter

Bit Error Rate (BER) is a measure of the number of bit errors that occur in a given number of bit transmissions. BER measurements are essential to diagnosing P25 system coverage problems and avoiding critical loss of communications.

The P25 BER Meter evaluates a radio's transmit BER performance by comparing incoming P25 symbol data to a standard pattern in order to determine errors in signal processing. Supported patterns are defined in accordance with the *TIA-CAAA Specification*.

See section 2.2.1, "Meter Controls and Settings", on page 2-4 for a description of the controls and settings supported for the Bit Error Rate Meter.

NOTE

BER is calculated over the entire data packet, not just the voice data. Use Standard P25 Patterns for accurate BER measurements.

2.3 P25 Plots and Graphs

The CX300 contains several methods of displaying the modulation fidelity results.

2.3.1 Constellation Plot

The **Constellation Plot** shows a graph of the measured deviation for each of the symbols. The plot contains four circles that indicate the ideal location for each of the measured deviations. These circles identify the location (from left to right) for deviation:

- -1800 Hz
- -600 Hz
- +600 Hz
- +1800 Hz

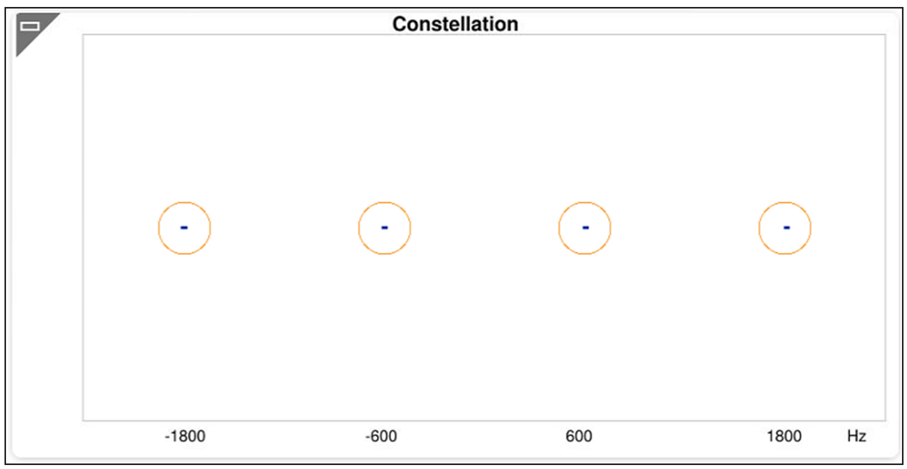


Figure 2-2 Example of Constellation Plot

A perfect signal would display a single dot in the center of each of the circles. In reality, there is usually a line in each of the circles that shows the spread of deviation for each symbol. A wider line translates into a larger mod fidelity reading. The line may extend outside of the circle, which indicates very poor modulation fidelity, or that the symbol deviation is too large or too small. The circle should be interpreted as the not a pass fail indication of the modulation fidelity.

2.3.2 Distribution Plot

The **Distribution Plot** shows not only the deviation of each of the symbols, but also the relative number of occurrences of each of the deviations. The **Distribution Plot** shows a wide range of parameters associated with modulation fidelity. The horizontal axis is the frequency deviation of the signal at symbol time and the vertical axis shows the number of times the deviation occurred. The vertical dotted lines indicate the ideal deviation points (from left to right) of:

- -1800
- -600
- +600
- +1800

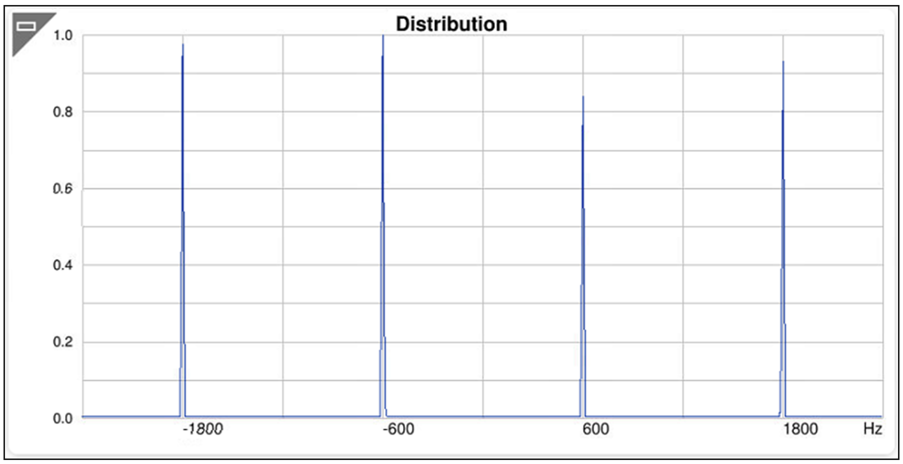


Figure 2-3 Example Distribution Plot

A perfect signal would be represented by a single line superimposed on top of each of the dashed lines. If the distribution plot is shifted wider than the location of the dashed lines, the plot indicates a symbol deviation greater than 1800 Hz. Conversely, a plot that is narrower than the dashed lines would indicate a symbol deviation less than 1800 Hz.

2.3.3 Eye Diagram

The **Eye Diagram** shows a graph of the demodulated signal at all points. The symbol deviation versus time. The horizontal scale represents time, the vertical scale indicates the deviation. The four horizontal dashed lines represent the deviations at the symbol points and are deviations of (from bottom to top):

- -1800 Hz
- -600 Hz
- +600 Hz
- +1800 Hz

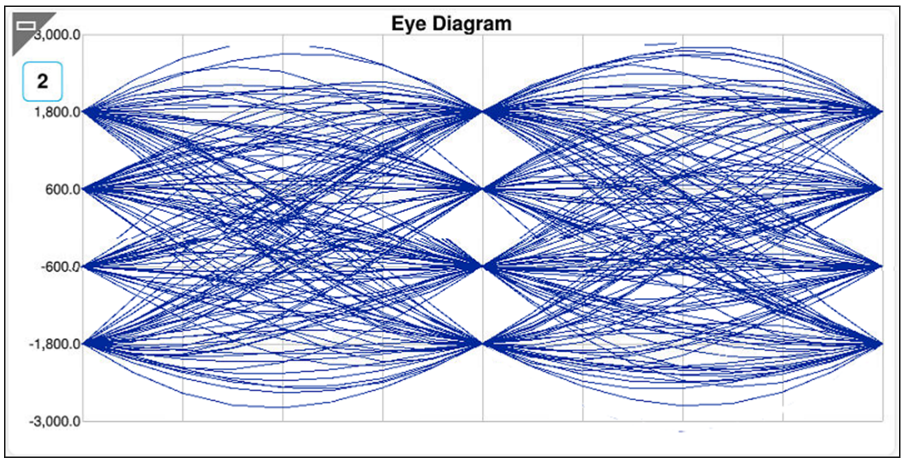


Figure 2-4 Example Eye Diagram

The center vertical dashed line and the start and stop of the graph are the locations at which the graph intersects a symbol point. An ideal P25 signal presents as the lines crossing through the point at which the vertical and horizontal dashed lines intersect. As modulation fidelity becomes larger, or symbol deviation becomes wider or narrower, the plot of the symbol deviation passes below and/or above the dashed lines.

Table 2-3 Eye Diagram Controls and Settings

Control/Setting	Description
Symbol Count Button	2 The Symbol Count button selects the number of symbols

2.4 Audio Controls and Signal Routing

The audio signal routing, volume, and squelch settings of the CX300 are configured on the **Audio Controls window**. The **Audio Controls window** is used to configure settings such as speaker routing, the signal source for performing noise measurements and the Oscilloscope input signal.

The **Audio Controls window** is displayed by selecting the **Audio Controls button** from the **Quick Access Toolbar**.

Refer to the *CX300 ComXpert Communication Service Monitor Operation Manual* for detailed information about the audio controls and signal routing settings.

2.5 Frequency List Controls and Settings

The Frequency List tool allows users to define frequency list tables which can easily be loaded and applied via the CX300 UI.

Refer to the *CX300 ComXpert Communication Service Monitor Operation Manual* for additional information about this function.

2.6 Normalize

The **Normalize function** performs a series of internal measurements and corrections to reduce measurement inaccuracies which may occur due to environmental conditions such as temperature change. Normalize optimizes various performance parameters, including carrier leakage, IQ gain and balance, Third Order Intercept (IP3), and level correction.

Refer to the *CX300 ComXpert Operation Manual* for additional information about this function.

3

P25 Measurements

This chapter provides task-based instructions for using the CX300 ComXpert to establish P25 calls and to perform key P25 tests and measurements. This chapter describes how to use the CX300 in the following test scenarios.

3.1 Testing P25 Phase 1 Transceiver

3.1.1 P25 Transceiver Test Description

The following instructions guide the user through an objective P25 Transmitter Test and a subjective P25 Receiver Test. It is not necessary to control the DUT through the DUT OEM tuner or programming software for this test.

3.1.2 Equipment Needed

The following equipment is required to perform the test procedures defined in this section:

- CX300 ComXpert Test Set
- RF Coaxial Cable and adapters

3.1.3 Hardware Setup Diagram

Connect the CX300 and DUT as shown in Figure 3-1, and then proceed to the next section.

Figure 3-1 P25 Transceiver Test Setup Diagram

3.1.4 Configuring the CX300 Test Set

1. Select the CX300 ComXpert Tab.
2. Select Communications Test on the **Mode Pane**.
3. Select P25 on the Measure Pane.
4. Click the **Done** button.
5. Select the RF Generator menu.
    a. Set the RF Generator port to **RF Duplex.**
    b. Set the RF Generator Frequency state to Off.
    c. Set the RF Generator Frequency to match the DUT Receiver Frequency.
    d. Set the Modulation to C4FM.
    e. Set the RF Generator Level to -80 dBm.
6. Set the **P25 Mod menu**.
    a. Set the Pattern to 1011.
    b. Set the NAC to match the DUT Receive NAC.
    c. Set the TGID to match the TGID or the DUT Receiver.
7. Set the **P25 Demod menu**.
    a. Set the RF Receiver Port to **RF Duplex**.
    b. Set the RF Receiver Frequency to match the DUT transmit frequency.
    c. Set the RF Receiver Demodulation Type to C4FM. to C4FM.
    d. Set the AGC Mode to **AUTO**.
8. Set the **P25 Demod menu**.
    a. Set the P25 Demond BER Pattern to Framesync.
9. Select the Signal Power meter on the **Meter tile.**
10. Select P25 Measurements on the **Meter/Data tile.**

3.1.5 Testing P25 Transmitter

1. Key the DUT Transmitter.
2. Record and compare the P25 Measurements to Table 3-1.
3. Un-key the DUT Transmitter.
4. If no further testing required, proceed to next step. If not proceed to Testing the P25 Transmitter.
5. Disconnect and power **OFF** the DUT.

Table 3-1 Testing P25 Phase 1 Transceiver

Measurement	Lower Limit	Target	Upper Limit
RF Frequency Error (ppm)		0	1
Symbol Clock Error (ppm)		0	10
Modulation Fidelity (%)		0	5
Symbol Deviation (Hz)	1620	1800	1980
(Signal Power		(Radio Specific)	
BER (%)		0	5

3.1.6 Testing P25 Receiver

1. Select the RF Generator menu.
   a. Set the Generator state to On.
2. Verify an audible tone is present at the DUT Receiver speaker.
3. Lower the RF Generator output level until the audio begins to sound unstable. This is a subjective receiver sensitivity of the P25 Receiver. A more formal test is described in the next section, See section 3.2, “P25 Receiver Sensitivity Test”, on page 3-5.
4. If no further testing is to be conducted, disconnect and power **OFF** the DUT.

3.2 P25 Receiver Sensitivity Test

3.2.1 P25 Receiver Sensitivity Description

Receiver sensitivity is a determination of the level of the signal that produces the standard bit error rate (BER) in the receiver. The TIA standard specifies the standard bit error rate to be 5%. This measurement is performed by generating the standard test pattern and then reducing the level of the RF signal until the number of bit errors in the receiver, as a percentage of the total number of bits transmitted, is 5%.

3.2.2 Equipment Needed

The following equipment is required to perform the test procedures defined in this section:

- CX300 ComXpert Test Set
- RF Coaxial Cable and adapters
- DUT OEM tuner or programming software (if required - see note below)

NOTE

BER may be measured in different manners depending on the radio manufacturer. Most radios have a built-in BER measurement that takes the detected bit stream from the received signal and compares it with the standard test pattern. This measurement may be displayed on the radio or in the DUT OEM tuner or programming software. Other radios have a bit detector output and an external BER detector measures the bit error rate.

If necessary, switch the receiver under test to test mode to perform a bit error rate test.

3.2.3 Test Setup

1. Connect the CX300 and DUT as shown in Figure 3-2, and then proceed to the next section.

Figure 3-2 P25 Receiver Sensitivity Test Setup Diagram

3.2.4 Configuring the CX300 Test Set

1. Configure the CX300 as described in section 3.1.4, on page 3-3.
2. Select the **P25 Mod menu.**
   a. Set the pattern to the standard test pattern prescribed by the DUT OEM for testing P25 Receiver Sensitivity / RX BER.

3.2.5 Performing the P25 Receiver Sensitivity Test

1. Select the **RF Generator menu**.
   a. Set the DUT OEM for testing P25 Receiver Sensitivity / RX BER.
2. Adjust the RF Generator output level until the DUT control software Rx BER meter displays 5%, or in test scenarios where the radio calculates and report its own Rx BER, until the DUT reports a BER of 5%.
3. Record the RF Generator output level.
4. If no further testing is to be conducted, disconnect and power Off the DUT.

4

P25 AES/DES Encryption

This chapter provides task-based instructions for using the P25 AES/DES Encryption Option. The AES/DES Encryption Option supports encoding and decoding of Advanced Encryption Standard data exchanged between P25 radios.

4.1 P25 AES/DES Encryption Option Guide

4.1.1 Configuring Encryption Keys

The Encryption Keys Configuration allows the user to configure encryption parameters. The Test Set is configured with AES and DES Default encryption keys for industry standard testing. DES Encryption is included in the CX300 P25 Base Option. P25 AES Encryption is an *option enabled feature. Encryption Keys must be configured before they can be selected. At the display screen select Encryption Keys tab as seen in Figure 4-1 to access Encryption Keys Configuration menu as seen in Figure 4-2.

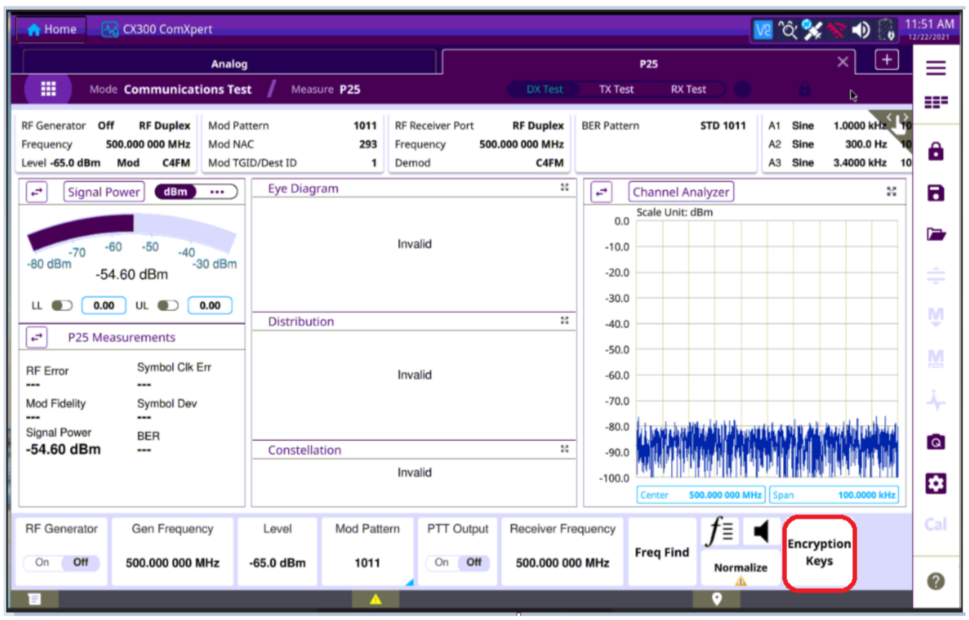


Figure 4-1 Selecting Encryption Keys

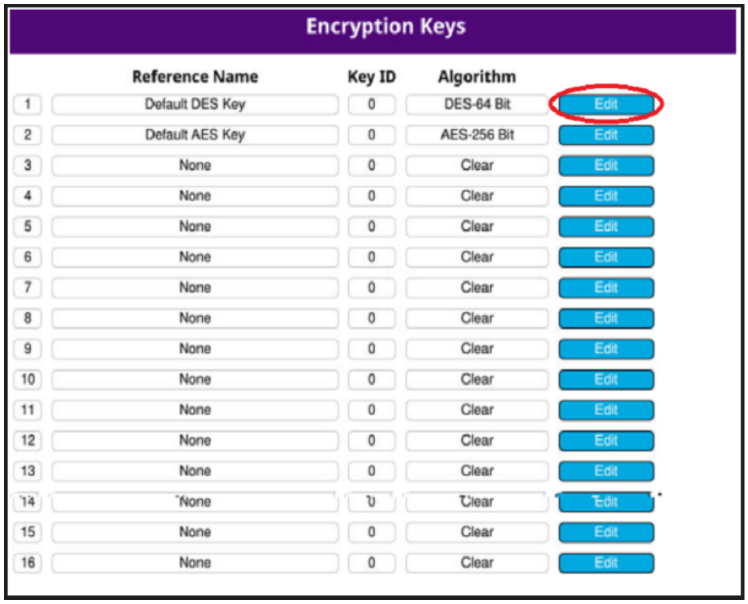


Figure 4-2 Configuring Encryption Keys

4.1.2 AES/DES Encryption Keys

Encryption keys are defined on the Encryption Keys Configuration. Refer to the section titled Configuring Encryption Keys on page 4-2 for information on configuring encryption keys.

4.1.3 Selecting AES/DES Encryption

Encryption format is selected from the ALG drop-down menu on the Simulator as shown in Figure 4-3.

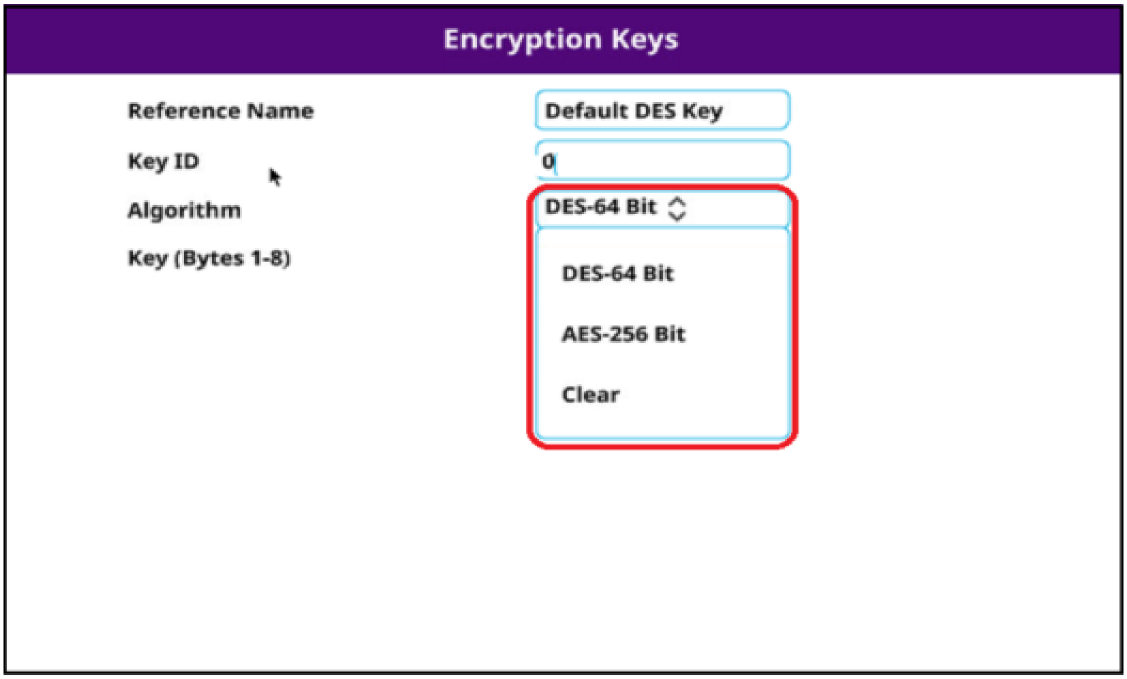


Figure 4-3 Selecting Encryption Type

4.1.4 Valid AES/DES Pattern Types

Standard patterns are not encrypted.Only non-standard and Voice can be encrypted. If a standard pattern is selected, encryption is disabled and not changeable.

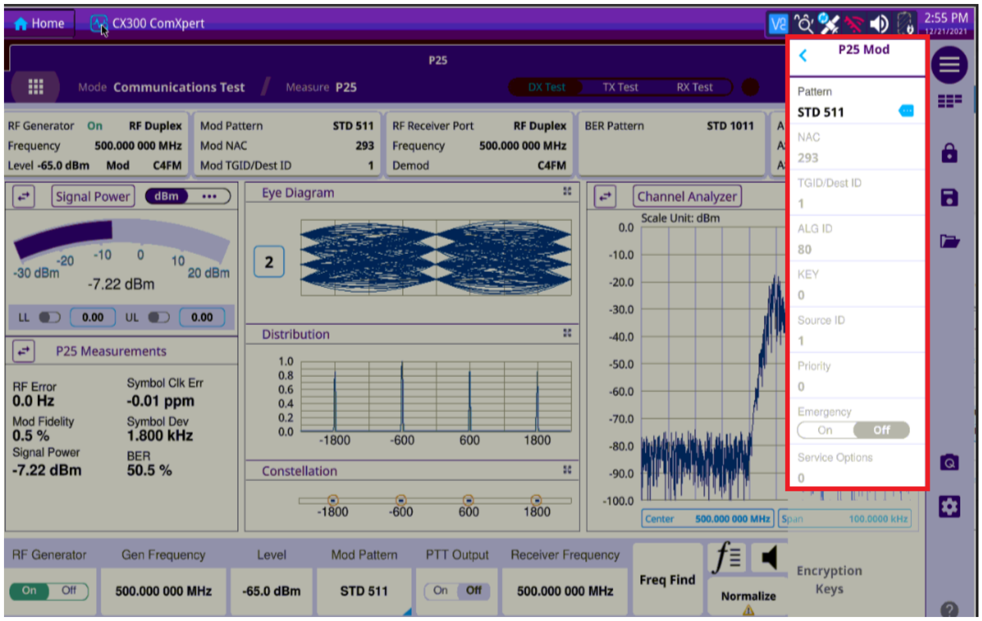


Figure 4-4 Standard Pattern Selected

This page intentionally left blank.

5

P25 Keyloader

This chapter provides task-based instructions for using the KVL Keyloader Option. The Keyloader adds the ability to enter encryption keys into the CX300 for AES and DES. Encryption keys may be loaded manually using either the front panel, external keypad, or the P25 Key Fill Device (KFD) interface protocol.

5.1 KVL LOADER OPTION

5.1.1 Automatic Loading

The KVL Keyloader option includes a cable P/N 22181533 for connecting the CX300™. The KVL-3000 Plus, KVL-4000 and KVL-5000 may be set to load keys as is done for a radio, Up to 16 keys of either AES or DES can be loaded from the keyloader.

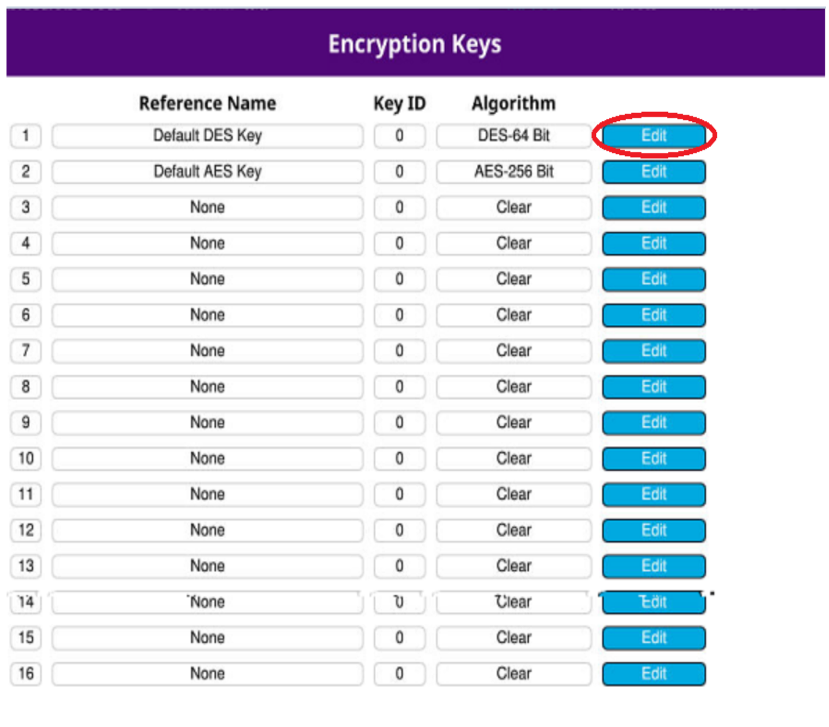
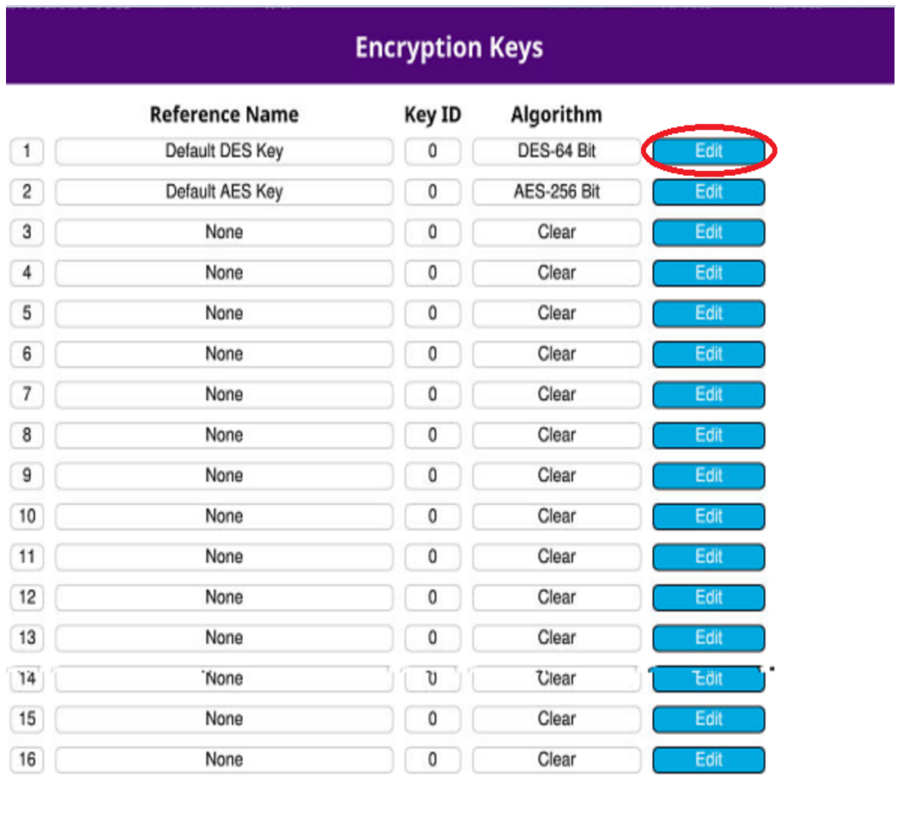


Figure 5-1 Configuring Encryption Keys Automatic Loading

5.1.2 Manual Loading

Manual Key loading is configured using the Encryption Keys Configuration section as seen in Figure 5-2 Configuring Encryption Keys Manual Loading.



Encryption Keys

	Reference Name	Key ID	Algorithm	
1	Default DES Key	0	DES-64 Bit	Edit
2	Default AES Key	0	AES-256 Bit	Edit
3	None	0	Clear	Edit
4	None	0	Clear	Edit
5	None	0	Clear	Edit
6	None	0	Clear	Edit
7	None	0	Clear	Edit
8	None	0	Clear	Edit
9	None	0	Clear	Edit
10	None	0	Clear	Edit
11	None	0	Clear	Edit
12	None	0	Clear	Edit
13	None	0	Clear	Edit
14	None	0	Clear	Edit
15	None	0	Clear	Edit
16	None	0	Clear	Edit

Figure 5-2 Configuring Encryption Keys Manual Loading

This page intentionally left blank.

6

P25 Vocoder

This chapter provides task-based instructions for using the P25 Vocoder. This chapter describes how to use the CX300 P25 Vocoder in the following test scenarios.

6.1 P25 Vocoder

The vocoder enables the user to perform, transmit and receive audio testing. Included in this option is the capability to:

- Measure C4FM modulation fidelity and symbol deviation
- Measure power, frequency error and TX BER
- Measure symbol clock error y Measure RX BER
- Display eye diagram of C4FM demodulation
- Display constellation plot of C4FM symbols
- Display C4FM symbol deviation distribution plot
- Transmit full TIA/EIA-102 test patterns (STD1011, CAL, SILENCE, STD511, etc) as specified by TIA/EIA102.CAAA-C
- Transmit and receive live audio using the vocoder
- Decode voice channel header and link control messages

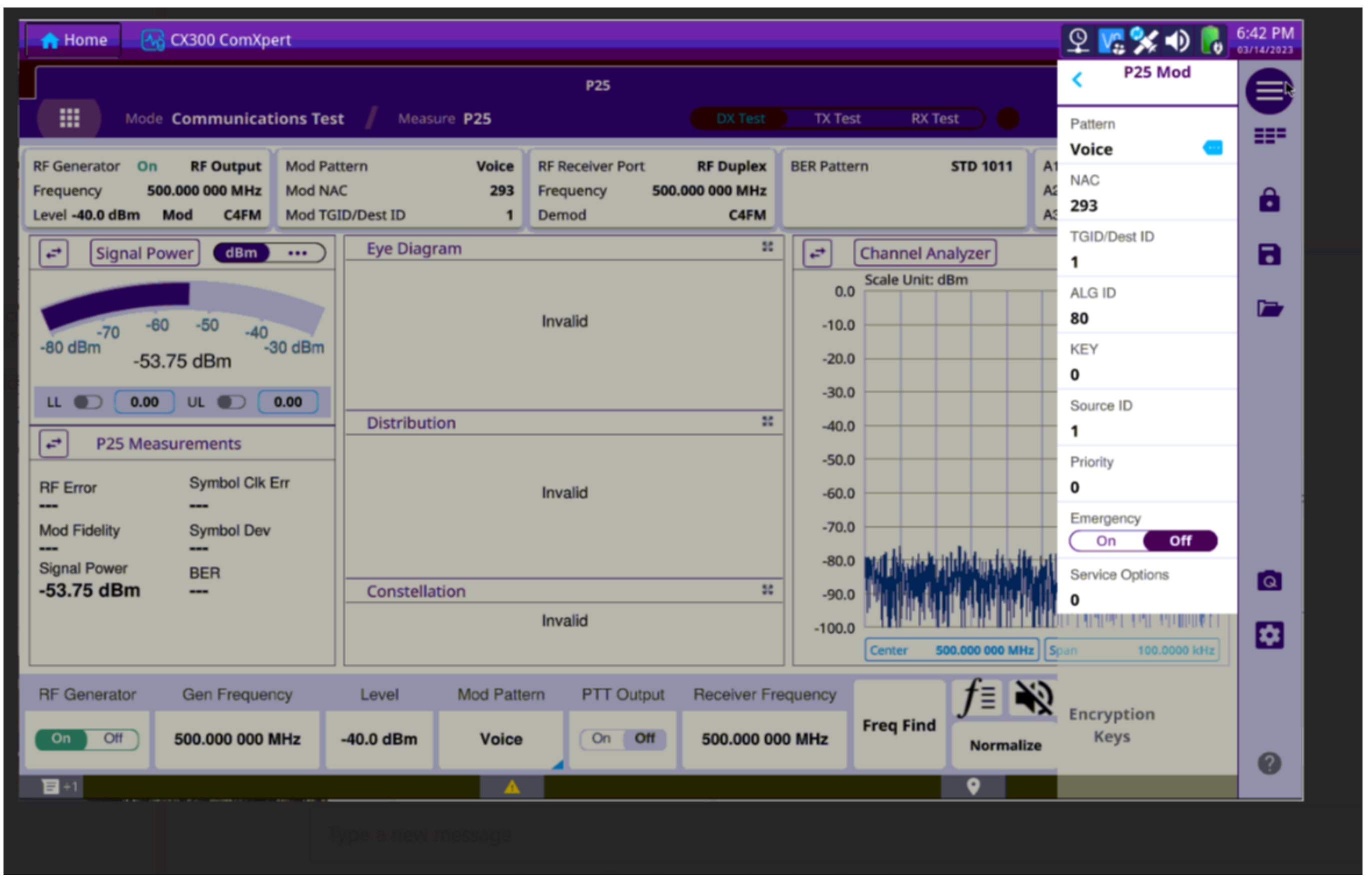


Figure 6-1 Vocoder Voice Pattern

6.1.1 AMBE Vocoder runs in Full Rate

1. **FULL RATE mode:** This is the P25 Phase one IMBE compatible mode in which the vocoder encode generated 144 bits of vocoded data for each voice frame and vocoder decode consumes those 144 bits to regenerate the voice frame.

This page intentionally left blank.

A

Terms and Acronyms

A - B

ACC — accessory

AES — Advanced Encryption Standard

AF — Audio Frequency

AGC — Automatic Gain Control

Avg — average

BER — Bit Error Rate

C - D

C4FM — P25 uses a type of modulation called C4FM, which is an acronym for “compatible 4 level frequency modulation.

dBm — decibel milliwatts

DES — Data Encryption Standard

DEST ID — Destination Identifier

DUT — Device Under Test

F - L

FM — Frequency Modulation

GUI — Graphic User Interface

HP — High Pass in relation to High Pass filter

kHz — kilohertz

LP — Low Pass in relation to Low Pass Filter

M - N

mHz — millihertz

MHz — megahertz

MIC — microphone

Mod — Modulation

NAC — Network Access Code

P - S

P25 — Project 25 (P25) is a suite of digital radio communication standards that were created to develop an interoperability between the U.S. military and civilian public safety agencies (e.g., police and fire).

RF — Radio Frequency

SCCB — Secondary Control Channel Broadcast

Sym Dev — Symbol Deviation

U - Z

TGID — Talk Group Identifier

WACN — Wide Area Communications Network

This page intentionally left blank.

CX300 ComXpert

P25 Option Guide

22146777 Rev. 002
April, 2024
English

VIAVI Solutions

North America:	**1.844.GO VIAVI / 1.844.468.4284**
Latin America	**+52 55 5543 6644**
EMEA	**+49 7121 862273**
APAC	**+1 512 201 6534**
All Other Regions:	**viavisolutions.com/contacts**