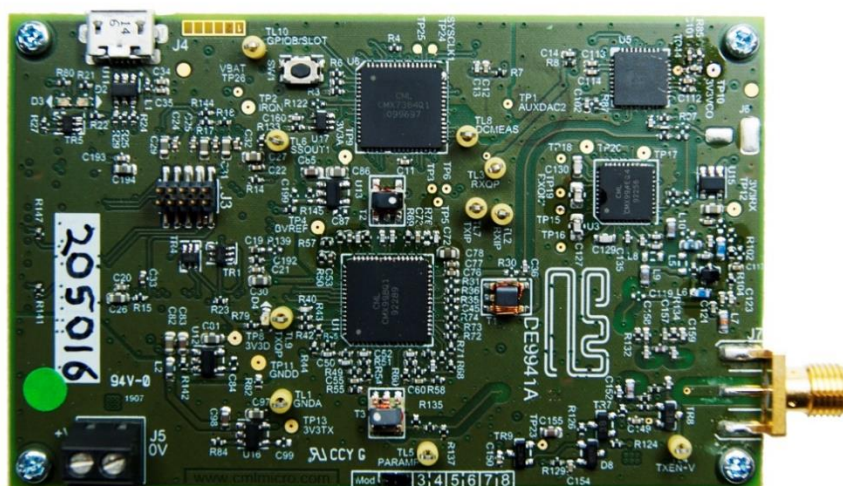


Features

- Demonstration platform for the CMX7364 FI-8 wireless data modem using RTCM-SC135 mode.
- Direct Conversion Receiver (CMX994E) and Cartesian Feedback Loop Transmitter (CMX998)
- 1 W Transmitter Operation
- Designed to meet EN 302 561 / EN 300 113
- On-board PLL and VCO for 350 to 400 MHz and 400 to 470 MHz Operation
- On-board STM32 ARM microcontroller with bootloader and USB interface
- Small size – 87mm x 55mm



1 Brief Description

The DE9941A is a small demonstration platform for the CMX994E Direct Conversion Receiver, the CMX998 Cartesian Loop Transmitter and the CMX7364 Multi-mode High Performance Wireless Data Modem. The platform's small form factor is made possible by the compact nature of CML's IC solutions. The DE9941A can be used to demonstrate Tx and Rx performance with multi-level QAM, FSK and GMSK type modulation as described in document UM9941A/2, but the functionality described in this document is specifically for use with Function Image™ 7364FI-8.x.x.x, which supports functions specific to the RTCM SC135 protocol.

The DE9941A provides a Fractional-N PLL and VCO to provide local oscillator signals for the CMX994E and CMX998. The on-board ARM microcontroller, together with the Windows GUI, programs the RF synthesiser to supported operating frequencies. The design also includes a 1 W power amplifier, harmonic filter, and Tx/Rx switch. The RF performance is designed to be compliant with EN 302 561 / EN 300 113 and all the circuits are provided with power-down capability to allow standby functionality. The design is aimed to be low cost, with a minimum number of component types/values.

Two variants of the DE9941A are available. The DE9941A-375 covers 350-400 MHz and the DE9941A-435 covers 400-470 MHz. Throughout this document "DE9941A" refers to both variants unless otherwise indicated.

A full hardware description and details of the DE9941A are provided in document UM9941A that should be referred to where appropriate. This document describes DE9941A operation only for CMX7364 FI-8 that supports RTCM SC135.

CONTENTS

<u>Section</u>		<u>Page</u>
1	Brief Description	1
2	Block Diagram	4
3	Preliminary Information	4
3.1	Laboratory Equipment.....	4
3.1.1	Power Supply.....	5
3.2	Handling Precautions	5
3.2.2	Contents - Unpacking	5
3.3	Approvals.....	5
4	Quick Start	5
4.1	Software Setup	5
4.2	Hardware Setup.....	5
4.3	ARM Firmware Programming	6
4.4	Operation	6
5	Signal Lists	7
6	Circuit Schematics and Board Layouts	8
7	Detailed Description	9
7.1	Hardware Description	9
7.1.1	Harmonic Filter	9
7.1.2	Tx/Rx Switch	9
7.1.3	Coupler	9
7.1.4	Power Amplifier.....	9
7.1.5	Transmitter.....	10
7.1.6	Receiver.....	10
7.1.7	Local Oscillator	10
7.1.8	Reference Oscillator	10
7.1.9	Power Supply.....	10
7.1.10	Inductors	10
7.1.11	Adjustments and Controls External/Internal LO.....	10
8	RTCM-SC135 Demonstrator GUI	10
8.1	Configuration.....	11
8.1.1	Demo Modes	11
8.1.2	OPH Records.....	12
8.1.3	Data	12
8.1.4	Frames.....	12
8.1.5	Frame Type.....	12
8.1.6	Baud	12
8.1.7	Freq.	13
8.1.8	Device.....	13
8.1.9	Scrambled.....	13
8.1.10	Browse.....	13
8.1.11	Load.....	13
8.1.12	Start.....	13
8.1.13	Stop	13
8.1.14	Save	13
8.1.15	Clear	13
8.2	Optional Setup.....	14
8.2.1	Pulse Shaping Filter	14
8.2.2	VCTCXO	14
8.2.3	Deviation	14
8.2.4	Data File.....	14
8.3	Reflash Device	15
8.3.1	ID	15
8.3.2	Version	15
8.3.3	CRC	15
8.3.4	RE-FLASH	16
8.3.5	Browse.....	16
8.3.6	Load.....	16

8.3.7 Save16

8.3.8 Clear16

9 Operating Frequencies..... 16

10 Typical Performance 17

10.1 RX performance.....17

10.1.1 RX sensitivity - PER17

10.1.2 Co-Channel Rejection19

10.1.3 Adjacent Channel Rejection20

10.2 TX Performance..... 21

11 PRBS-9 Data Sequence..... 24

Table Page

Table 1 Connector List7

Table 2 Test Points.....7

Table 3 DE9941A-375 Channel Table (350 to 400MHz Operation).....16

Table 4 DE9941A-435 Channel Table (400 to 470MHz Operation).....17

Figure Page

Figure 1 Block Diagram4

Figure 2 Typical Evaluation Connections for DE9941A6

Figure 3 PCB Layout: top.....8

Figure 4 PCB Layout: bottom8

Figure 5 RTCM-SC135 Demonstrator GUI Launch Screen.....11

Figure 6 Mode Drop-down Box11

Figure 7 Optional Setup Pane14

Figure 8 Reflash Device pane.....15

Figure 9 RE-FLASH Sequence16

Figure 10 RF Power vs Header PER Results Summary, Low and High Baud Rates18

Figure 11 RF Power vs Data PER Results Summary, Low and High Baud Rates18

Figure 12 Co-Channel Rejection - Header PER Summary, Low and High Baud Rates19

Figure 13 Co-Channel Rejection - Data PER Summary, Low and High Baud Rates20

Figure 14 Adjacent Channel Rejection - Header PER Summary, Low and High Baud Rates21

Figure 15 Adjacent Channel Rejection - Data PER Summary, Low and High Baud Rates.....21

Figure 16 Adjacent Channel Power - 4800 baud.....22

Figure 17 Modulation - 4800 baud22

Figure 18 Adjacent Channel Power - 9600 baud.....23

Figure 19 Modulation - 9600 baud23

It is always recommended that you check for the latest product datasheet version from the Products page of the CML website: [www.cmlmicro.com].

History

Version	Changes	Date
3	Editorial clarifications, additional BER/PER data	September 2023
2	Figure 5: updated GUI launch screen to reflect the new GUI	March 2022
1	First Issue	February 2022

2 Block Diagram

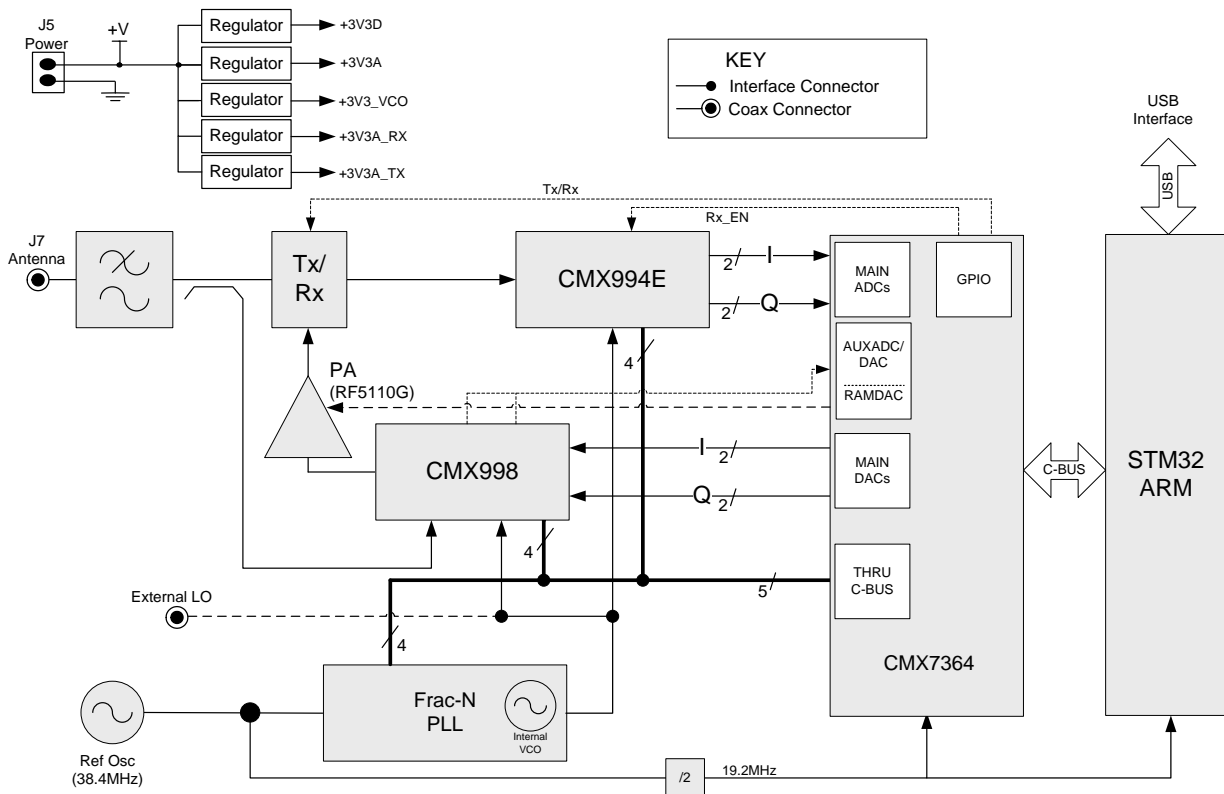


Figure 1 Block Diagram

3 Preliminary Information

The DE9941A provides an RF platform for demonstration and evaluation of the CMX7364 Multi-mode High Performance Wireless Data Modem, with the use of the CMX994E Direct Conversion Receiver and the CMX998 Cartesian Feedback Loop Transmitter. A 1 W power amplifier has been included plus Fractional-N PLL with integral VCO for stand-alone operation.

The DE9941A is designed to be used with the DE9941A-RTCM-SC135-GUI.exe software package running on a PC to provide convenient DE9941A control via a USB interface. This software demonstrates the RTCM SC135 standard as implemented in the CMX7364 FI-8. It also relies on the use of specific controller software running on the ARM (STM32) microcontroller (DE9941A-RTCM_F03.XX.XX.bin). The GUI will interrogate the DE9941A on start-up to check the ARM code and allow the correct variant to be loaded if required. DE9941A-375 hardware must be at mod state 4 and DE9941A-435 hardware at mod state 1; earlier hardware versions are not supported.

If users wish to run their own code or the CML script language in the DE9941A ARM microcontroller, then the standard UM9941A, ES9941A and EF9941A packages should be used and are available from the CML Technical Portal.

3.1 Laboratory Equipment

The following laboratory equipment is needed to use this demonstration/evaluation kit:

- Power Supply
- Spectrum Analyser
- RF Signal Generator
- Oscilloscope
- Personal Computer + USB interface

For more detailed design or investigation work, additional RF test equipment may be required.

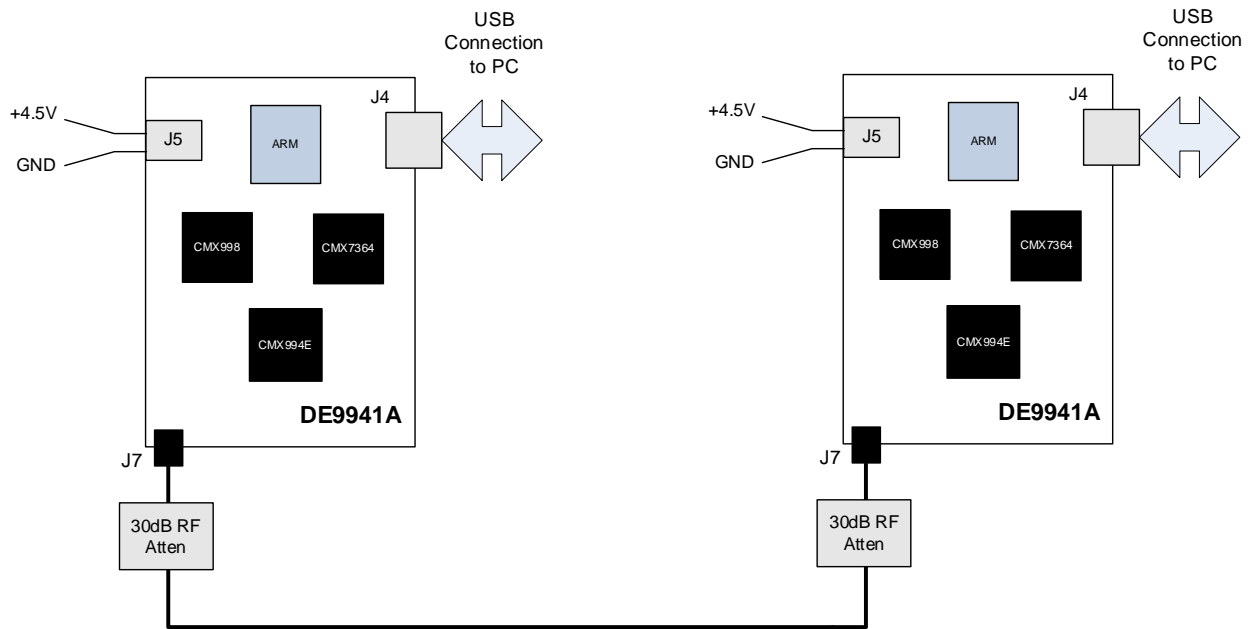


Figure 2 Typical Evaluation Connections for DE9941A

4.3 ARM Firmware Programming

- Run the GUI (DE9941A-RTCM-SC135-GUI.exe).
- Select the correct COM port from the 'Device' pull-down (use Windows Device Manager to find COM ports described as 'STMicroelectronics Virtual COM Port').
- Select the 'Reflash Device' Tab.
- Click 'RE-FLASH'. Check that the red LED on the DE9941A is flashing.
- Click 'Browse' and browse to the ARM firmware file (DE9941A-RTCM_F03.XX.XX.bin)
- Click 'Load'. Wait for the progress bar to complete. Check that the green LED on the DE9941A is flashing.
- Repeat this for each DE9941A that you will be using.

NOTE:

Early releases of the DE9941A (before mod state 2 for the -375 version and mod state 1 for the -435 version) will need to have their installed bootloader updated. The bootloader firmware (DE9941A-BOOTLOADER_F01.XX.XX.bin) can be reloaded at any time using the JTAG port and an application that supports loading the firmware into the internal flash memory of an STM32F411VE (Cortex M4) processor. The firmware should be loaded starting at address 0x00000000. The firmware is available to download from the CML website.

4.4 Operation

- Open two copies of the GUI (DE9941A-RTCM-SC135-GUI.exe).
- On each GUI:
 - Select an appropriate COM port.
 - Browse to and load the Function Image (7364FI-8.x.x.x.h). The product code and version should be displayed.
- Select TX RTCM mode on one GUI, and RX RTCM on the other.
- Press 'Start' on the Rx GUI, and wait until 'Searching for Frame Sync' is displayed.
- Press 'Start' on the Tx GUI.
- Ten RTCM frames should be transmitted and received.

5 Signal Lists

Table 1 Connector List

CONNECTOR PINOUT				
Connector Ref.	Connector Pin No.	Signal Name	Signal Type	Description
J7	N/A	ANTENNA	RF	Tx Output or Rx Input
J5	2	+V	DC	4.5 V Power supply input
J5	1	GNDA	DC	Power supply ground

Table 2 Test Points

TEST POINTS		
Test Point Ref.	Default Measurement	Description
TP1	-	AUXDAC2 – VCTCXO Control Voltage
TP2	-	IRQN on ARM
TP3	-	AUXADC1 – Tx Instability Detector Output
TP4	1.6 V DC	CMX998 BVRef (Buffered Vref)
TP5	-	AUXADC3 – CMX998 Q Feedback Path Output
TP6	-	AUXADC4 – CMX998 I Feedback Path Output
TP7	-	AUXADC2 – CMX998 DC Meas – used for DC Calibration
TP8	3.3 V DC	+3V3D - Digital Power Supply
TP9	3.3 V DC	+3V3A - Analogue Power Supply
TP10	3.3 V DC	+3V3_VCO - VCO and PLL Power Supply
TP11	0 V	DGND - Digital Ground
TP12	3.3 V DC	+3V3A_RX - Rx Analogue Power Supply
TP13	-	+3V3A_TX - Tx Analogue Power Supply
TP14	1.3 – 1.4 V DC	VCO Control Voltage
TP15	-	RXI+
TP16	-	RXI-
TP17	-	GPIOD/RXD
TP18	-	RXQ+
TP19	-	RXQ-
TP20	3.3 V DC	CMX994E Vddio Power Supply Voltage
TP21	-	TXEN+V Tx/Rx PIN switch supply
TP22	-	AUXDAC1 - PARAMP PA control ramp
TP23	-	VAPC – PA control pins
TP24	-	CMX7364 – SYSCLK1
TP25	-	CMX7364 – SYSCLK2
TP26	-	VBAT – Back up voltage supply 1

6 Circuit Schematics and Board Layouts

The DE9941A circuit schematic for each variant is available as separate high-resolution files that can be downloaded from the CML website. The layout on each side of the pcb is shown in Figure 3 and Figure 4.

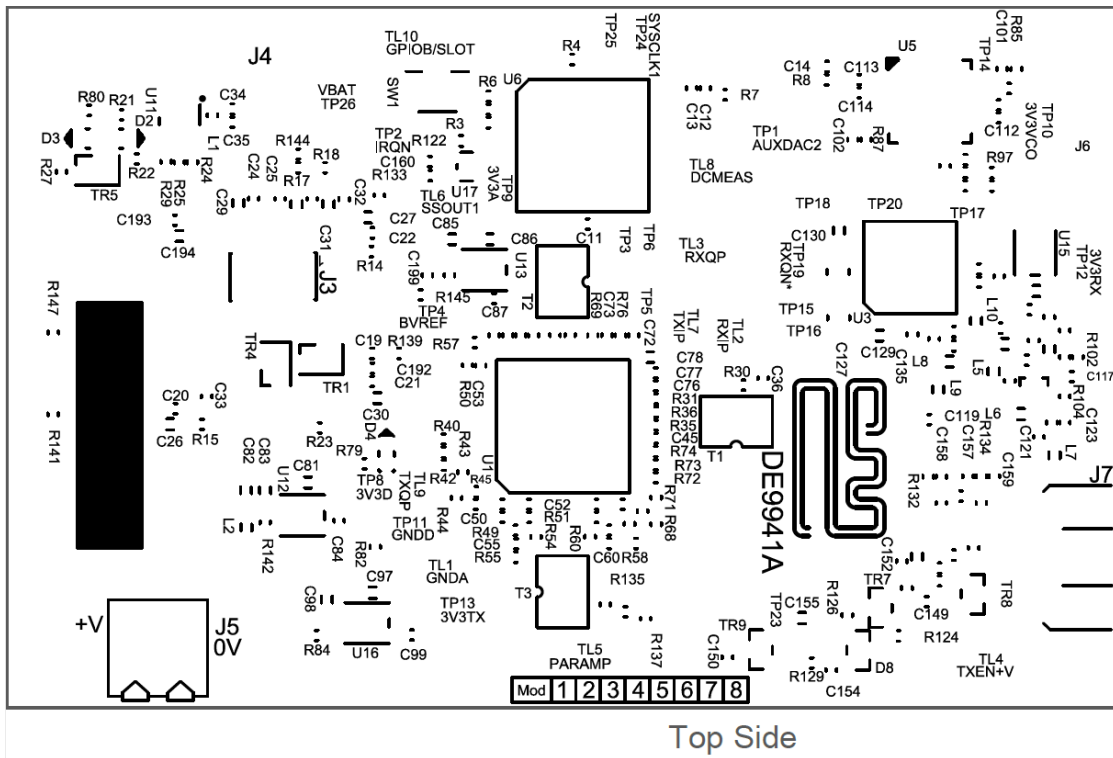


Figure 3 PCB Layout: top

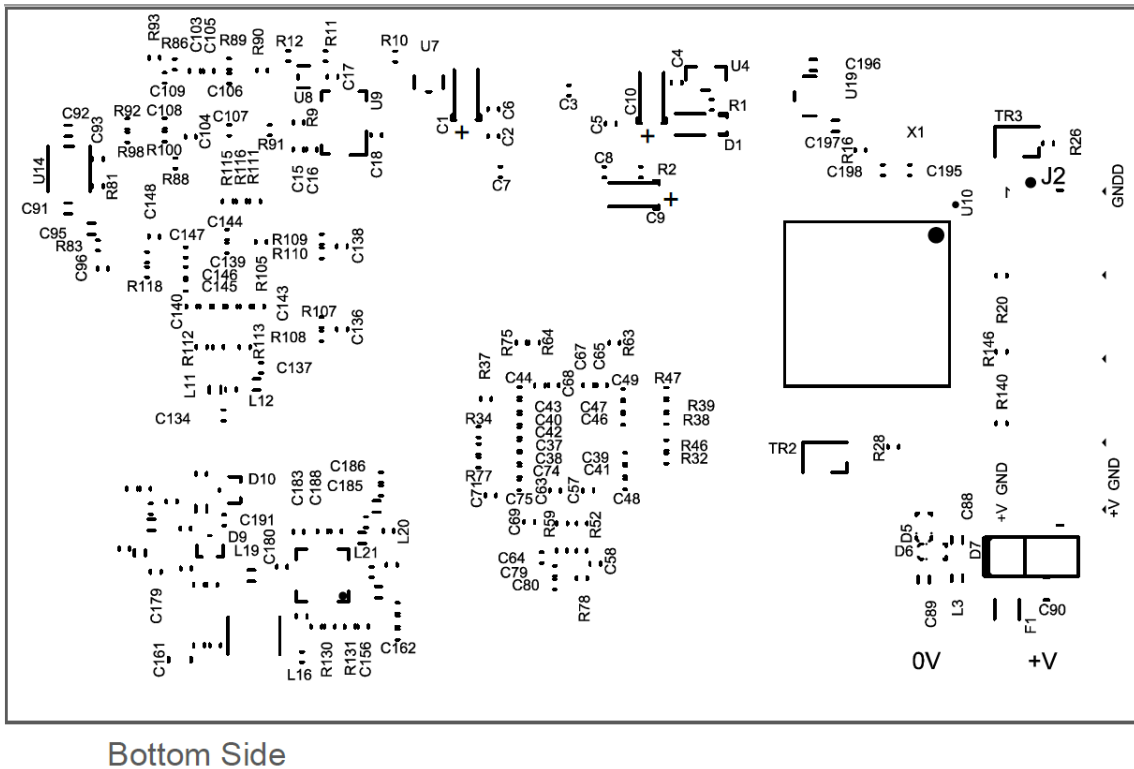


Figure 4 PCB Layout: bottom

7 Detailed Description

The DE9941A functionality includes:

- Nominal +4.5 V Supply
- Direct Conversion Receiver
- Cartesian Feedback Loop Transmitter
- 1 W Power Amplifier
- Fractional-N PLL with integrated VCO
- 38.4 MHz VCTCXO
- Operation from 350 to 400 MHz (DE9941A-375) or 400 to 470 MHz (DE9941A-435)
- USB Interface that allows the card to be connected to a host PC to control all device functions, to support initial test and customer evaluation.
- Capability to demonstrate the performance of the CMX7364 Multi-mode High Performance Wireless Data Modem with FI-8 loaded.

For full hardware description, please see the EKDS9941A document and the appropriate CMX7364, CMX994E and CMX998 datasheets, all available on the CML Technical Portal.

In summary, the DE9941A allows the user to experiment and investigate all aspects of the CMX7364 device using an RF platform based around the CMX994E Direct Conversion Receiver and the CMX998 Cartesian Feedback Loop Transmitter. The DE9941A is designed to allow user modification to support detailed investigation of the user's various applications. The evaluation platform also includes additional circuits that allow the user to use the DE9941A in standalone mode, e.g., by including a fractional-N PLL with integrated VCO (U5).

7.1 Hardware Description

7.1.1 Harmonic Filter

L17, L18 and associated components form a low-loss low pass filter with taps centred at the 2nd and 3rd Tx harmonics. This filter is common to the transmitter and receiver paths and is connected between the Tx/Rx switch and the antenna connector J7.

7.1.2 Tx/Rx Switch

The Tx/Rx switch is a classic series-shunt switch using PIN diodes (D9 and D10) after a lumped quarter wave section. The diodes are activated in transmit via the GPIOC/TXD signal from the CMX7364. An additional diode is provided (at D10), in anti-parallel, to protect the LNA from extremely strong signals (e.g., a nearby transceiver). This branch of the switch then goes to the receiver input.

7.1.3 Coupler

The coupler is a lumped coupler formed around one of the low pass sections of the harmonic filter (L17). The signal is coupled from this low pass section to another low pass section (L14) via very low value capacitors (C166 & C167). The coupling factor is ~ 31dB and the output of the coupler forms part of the feedback path to the CMX998 to create the Tx Cartesian Feedback Loop Transmitter.

7.1.4 Power Amplifier

The DE9941A includes a 1 W Power Amplifier U2 (RF5110G) configured for the relevant band of operation and is capable of producing ~+25dBm (mean) output power with 16-QAM modulation.

The CMX7364 RAMDAC (AUXDAC1) output is connected to the PA control line via a diode and transistor (D8 and TR9) to provide sufficient current to the PA control pins.

7.1.5 Transmitter

The transmitter is based on the CMX998 Cartesian Feedback Loop Transmitter (CFBL) IC plus the PA and coupler that complete the loop. The up-converter, down-converter and LO Input are matched with broadband baluns. The LO is at two times the final operating frequency (DE9941A-375 is 700 to 800 MHz and DE9941A-435 is 800 to 940 MHz). The CMX998 IQ differential inputs are provided straight from the CMX7364 main DACs. The error amplifier is configured with a loop filter optimised for operation with the on-board power amplifier, for modulation bandwidths up to ~40 kHz for up to 50 kHz channel spacings.

The DCMEAS pin is connected to an AUXADC (2) on the CMX7364 to allow automatic DC calibration and the ability to control the PA from the CMX7364.

The CMX998 is controlled via the CMX7364 SPI-Thru port using chip select 1 (SSOUT1).

7.1.6 Receiver

The receiver uses the CMX994E Direct Conversion Receiver that can support a range of digital radio systems of both constant envelope and linear modulation types. The CMX994E integrated LNA has been utilised with the output of the LNA matched directly to the IQ down conversion mixer. The mixer converts the received signal to IQ baseband format, where C129 and C130 combine with on-chip components to remove off-channel signals. The signal is then amplified before further filtering to remove adjacent channel signals (C127 and C128). The nominal maximum bandwidth of the adjacent channel filters is 16 kHz and this is scaled by a factor of 2 or 4 in the other CMX994E second stage filter bandwidth modes. A final amplifier stage completes the receiver line-up, providing differential IQ outputs directly to the CMX7364 Main ADCs.

The overall receiver gain and noise figure for the default configuration is ~63.5 dB and ~6 dB respectively. The Rx input third-order intercept point is ~ -2 to -3 dBm in normal mode and ~+1 to +2 dBm in enhanced mode.

The LO input is at two times the final operating frequency.

The CMX994E is controlled via the CMX7364 SPI-Thru port using chip select 1 (SSOUT1).

7.1.7 Local Oscillator

The LO (Local Oscillator) for Tx and the Rx is at two times the final operating frequency. The LMX2571 has been used to provide the LO; it integrates a Fractional N PLL, VCO, programmable dividers and output buffers. The LMX2571 also includes a partially integrated loop filter. The LMX2571 (U5) is controlled via the CMX7364 SPI Thru port and uses chip select 2 (SSOUT2).

If required, an external LO source (J6 PCB pad) can be used instead of the on-board VCO.

7.1.8 Reference Oscillator

A 1.5 ppm 38.4 MHz VCTCXO (Golledge MP09744) is used as the reference for the Frac-N PLL and is divided by 2 to generate 19.2 MHz CMX7364 (U6) and ARM (U10 - STM32) clock signals.

7.1.9 Power Supply

The input to the PCB is nominally 4.5V (3.5V to 4.8V is acceptable). On-board regulators are provided to generate voltage rails used on the DE9941A.

NOTE: Care should be exercised with the supplies as they are not protected for reverse polarity. The 4.5V supply directly feeds the power amplifier and it should not exceed 5.0V for nominal operating limits.

7.1.10 Inductors

All inductors used in the RF sections of the design are manufactured by Coilcraft (www.coilcraft.com). Performance of the circuits with inductors from other manufacturers may vary.

7.1.11 Adjustments and Controls External/Internal LO

An external LO may be applied at J6 but R96 should be moved to position R97 and the LMX2571 should be powered down.

8 RTCM-SC135 Demonstrator GUI

The DE9941A-RTCM-SC135-GUI is used to demonstrate transmitting and receiving RTCM SC135 frames and it includes several other modes designed to aid interoperability trials and debugging. In conjunction with the preloaded EF9941A-

RTCM-FI-8 ARM firmware, the GUI enables automatic configuration, set-up, and calibration of the CMX998, CMX994E and Frac-N-PLL.

The GUI has Configuration, Optional Setup and Reflash Device tabs that configure the demonstrator, as shown in Figure 5.

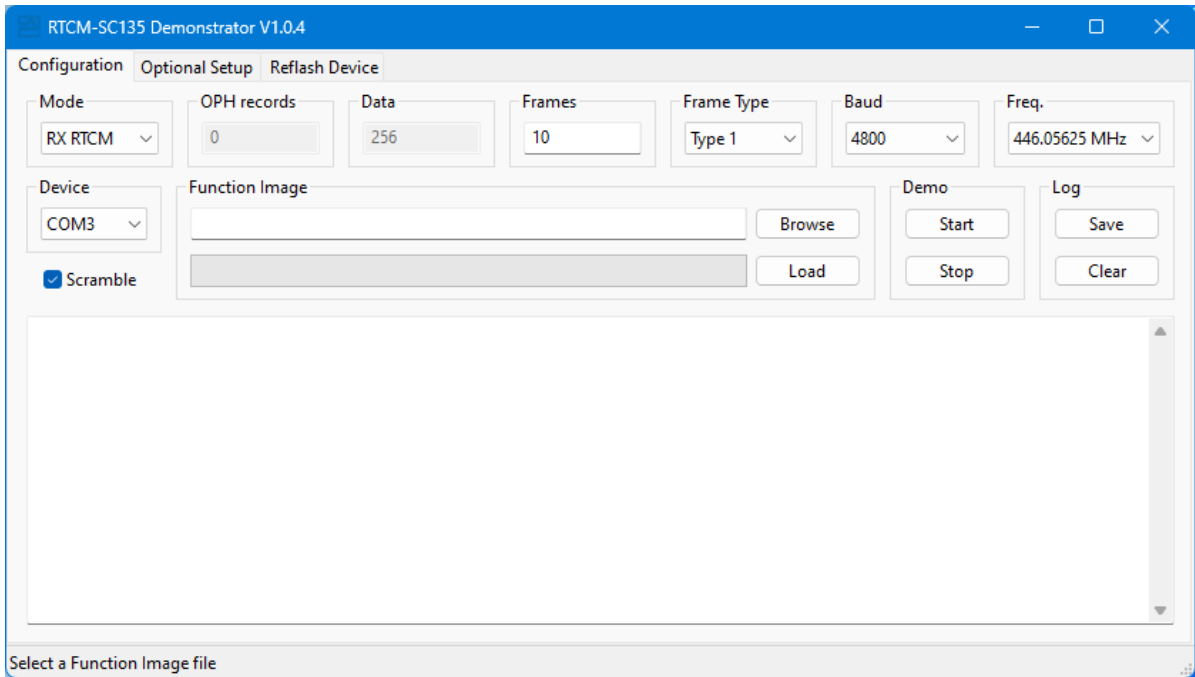


Figure 5 RTCM-SC135 Demonstrator GUI Launch Screen

8.1 Configuration

The Configuration tab is used to configure, load the CMX7364 FI-8 Function Image™, and start and stop demonstration runs based on text fields’ values and drop-down menu selections. Hover the mouse cursor over a given field to display its description.

8.1.1 Demo Modes

The Mode drop-down menu selects the demonstration modes shown in Figure 6.

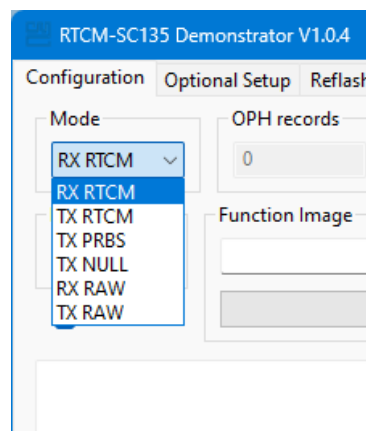


Figure 6 Mode Drop-down Box

RX RTCM

In a demonstration running this mode makes the DE9941A search for a frame sync pattern and, if one is detected, automatically Rx and decode RTCM SC135 frames. After each frame is received the GUI will display the frame’s error

magnitude, frequency offset, bit-error-rate, AGC step, and RSSI. The EF9941A-RTCM-FI-8 ARM firmware calculates bit error rate by comparing the received Optional Packet Header and the User Data to a PRBS-9 data sequence or a user-selected data sequence as described in section 8.2.4.

TX RTCM

In a demonstration run this mode makes the DE9941A transmit a burst. The EF9941A-RTCM-FI-8 ARM firmware automatically inserts the first 5 bytes of the frame's Packet Header and then, depending on the header and data lengths selected, inserts a PRBS-9 data sequence for the constructed frame's Optional Packet Header and the User Data. RTCM frame formatting and FEC will optionally be applied by the firmware according to selections made in remaining GUI fields. When a user-defined data sequence is selected as described in section 8.2.4, the header length will automatically be set to 5 bytes.

TX PRBS

In a demonstration run this mode makes the DE9941A continuously transmit the PRBS-9 data sequence listed in section 10.

TX NULL

In a demonstration run this mode makes the DE9941A continuously transmit a non-modulated carrier ("CW"), to enable CMX998 CFBL system DC calibration to be checked.

TX RAW

In a demonstration run this mode makes the DE9941A transmit a sequence of RTCM SC135 preamble, RTCM SC135 frame sync pattern and a PRBS-9 or user-defined data sequence, without applying FEC, CRC insertion or other RTCM SC135 frame protocol to the data field. For the PRBS-9 data sequence option, the number of data bytes sent is set by the Data field value. When a user-defined data sequence is selected per section 8.2.4, then the length of the user-defined sequence determines the number of data bytes sent.

RX RAW

In a demonstration run this mode makes the DE9941A search for an RTCM SC135 frame sync pattern and, if one is detected, automatically decode 4-FSK symbols until the number of data bytes received matches the number expected. The number expected depends on whether the user-defined sequence option described in section 8.2.4 has been selected; if not then the number expected is the value in the Data field otherwise it is the length of the user-defined data sequence. The GUI message window will display the received data bytes as they arrive. After each data burst been received the GUI will display the error magnitude, frequency offset, bit error rate, AGC step, and RSSI.

8.1.2 OPH Records

The OPH Records field is only available when TX RTCM mode is selected. It sets the number of optional packet header records transmitted, in addition to the standard, 5-byte header. Each OPH record consists of 1 'tag' byte and 20 bytes of payload. The firmware will insert data bytes taken from a PRBS-9 sequence for optional packet header payload.

8.1.3 Data

This field sets the length of the User Data payload. The maximum supported size is 8191 bytes.

8.1.4 Frames

This field sets the number of data frames transmitted or received by a demo.

8.1.5 Frame Type

This field sets the RTCM SC135 frame type. It is only available when TX RTCM is selected (frame type detection is automatic in Rx).

- 0 selects no error correction
- 1 selects RTCM-SC135 FEC mode

8.1.6 Baud

This field sets the demonstration symbol rate.

- 4800 (9600 bps) should be selected for 12.5 kHz channel operation.
- 9600 (19200 bps) should be selected for 25 kHz channel operation.

8.1.7 Freq.

This field sets demonstration operating frequency. This should be appropriate for the frequency range of the hardware in use and the user should be mindful of local regulations. Supported frequencies are shown in Table 3 and Table 4.

8.1.8 Device

This field selects the virtual COM port associated with the attached DE9941A device for the demonstration.

8.1.9 Scrambled

The Scrambled check box enables and disables data scrambling. It can only be selected when either TX RTCM or RX RTCM mode has been selected. By default, RTCM SC135 expects scrambling to be enabled, so Scramble disabled is provided as a diagnostic mode.

8.1.10 Browse

The Browse button selects the CMX7364 FI-8.x Function Image™ file on the host computer.

8.1.11 Load

The Load button loads the selected FI-8.x Function Image™ into the DE9941A's CMX7364 modem baseband processor device.

8.1.12 Start

The Start button starts a demonstration run.

8.1.13 Stop

The Stop button stops a running demonstration. All TX and RX modes will automatically stop when the configured number of frames have been transmitted or received except for TX NULL and TX PRBS modes, which will continue until the stop button is pressed. **It is important that TX NULL and TX PRBS modes not be left running too long as that could damage the DE9941A RF power amplifier.**

8.1.14 Save

The Save button saves log pane messages to a text file on the host computer.

8.1.15 Clear

The Clear button clears the log message pane.

8.2 Optional Setup

The Optional Setup pane, shown in Figure 7, can be used to change the pulse shaping filter, adjust the frequency offset, modulation frequency deviation, and select a user defined data sequence.

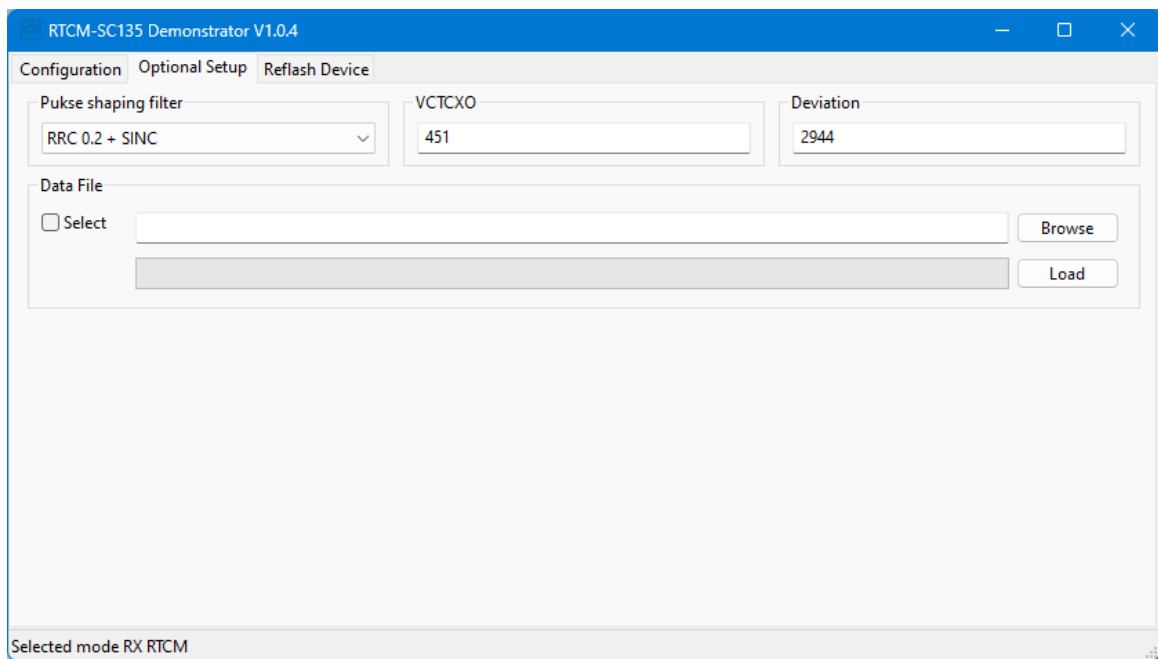


Figure 7 Optional Setup Pane

8.2.1 Pulse Shaping Filter

The RTCM SC135 Standard specifies a Tx/Rx pulse shaping modulation filter response that is a root raised cosine filter of roll-off factor 0.2 convolved with a square pulse (RRC 0.2 + SINC). The GUI also allows the user to select a non-standard Tx/Rx pulse shaping modulation filter response that is a root raised cosine filter with a roll-off factor of 0.2 (RRC 0.2). The selected pulse shaping filter is applied in all modes.

8.2.2 VCTCXO

This field sets the 10-bit code value of the CMX7364 AUXDAC2 that generates a DC output trim voltage applied to the reference VCTCXO device used in the DE9941A LO synthesizer section. Accordingly, changing the VCTCXO field value trims the VCTCXO frequency and the DE9941A synthesized LO frequency, which trims the absolute RF tuning frequency of the DE9941A. The VCTCXO field accepts values between 0 and 1023. The default value is 451.

8.2.3 Deviation

The Deviation field adjusts modulation frequency deviation. The default value of 2944 should meet the RTCM standard, but some fine adjustment may be necessary. The field will accept values between 0 and 4095. Using the pulse shaping filter defined in the RTCM SC135 standard (RRC + SINC), the deviation during the preamble sequence should be:

- ±3.056kHz in 12.5kHz channel / 4800 baud mode
- ±6.108kHz in 25kHz channel / 9600 baud mode

8.2.4 Data File

The Data file panel can be used to upload a user defined data sequence from a text file. The data sequence should be saved as comma separated 8-bit hexadecimal values, each value prefixed with 0x. Use the **Browse** and **Load** buttons to upload the text file. When the **Select** check box is selected, the firmware will use the data sequence instead of the internal PRBS-9 sequence in the following modes:

- RX RTCM
- TX RTCM
- RX RAW
- TX RAW

8.3 Reflash Device

The Reflash pane as shown in Figure 8 can be used to upload the EF9941A-RTCM-FI-8_F03.XX.XX.bin into the flash memory of the DE9941A.

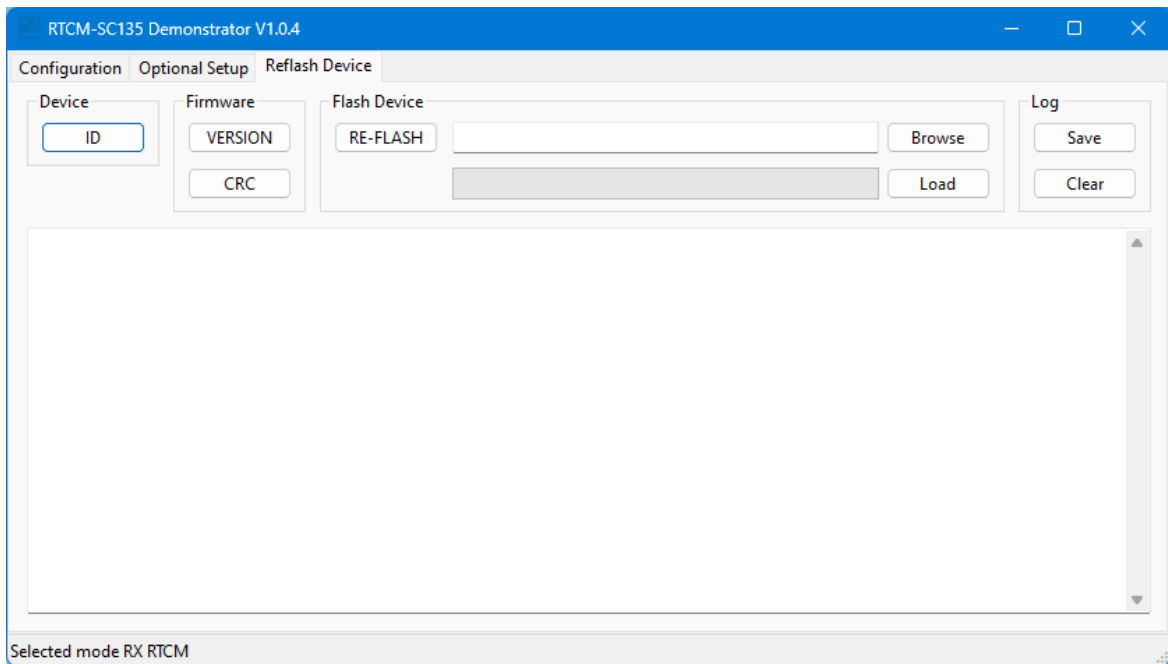


Figure 8 Reflash Device pane

8.3.1 ID

This button asks the attached device to identify itself. If a DE9941A is attached to the selected Device COM port, “Device is DE9941A” will appear in the message pane.

8.3.2 Version

Request the firmware version currently installed in flash memory. If a DE9941A is attached the response will be one of the following:

- DE9941A Bootloader: F01.XX.XX
- DE9941A Script Handler: F02.XX.XX
- DE9941A RTCM-SC135: F03.XX.XX
- Unknown Firmware: FAA.AA.AA

8.3.3 CRC

Request the CRC of firmware version currently installed in flash memory.

8.3.4 RE-FLASH

Pressing this button will cause the DE9941A to restart and enter bootloader mode. When in bootloader mode, a red led will blink on and off. A new firmware file can now be selected and uploaded into flash memory. NOTE: The RE-FLASH sequence must be (1) click the RE-FLASH button, (2) browse to select the .bin file to be flashed and finally (3) click the Load button, as shown in Figure 9. Other sequences will make the RE-FLASH operation fail.

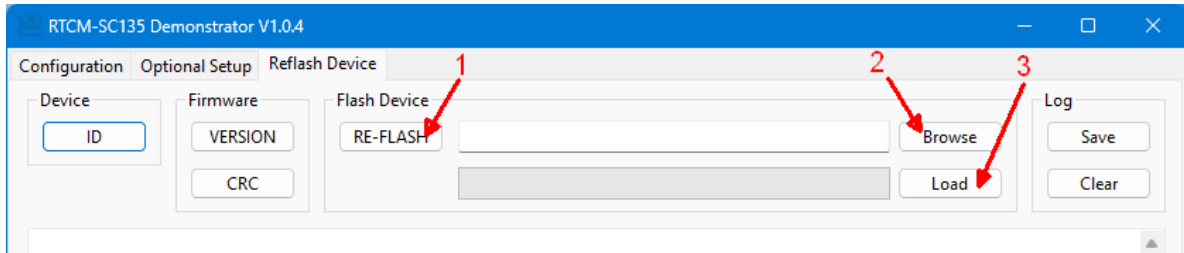


Figure 9 RE-FLASH Sequence

8.3.5 Browse

Select the firmware file.

8.3.6 Load

Load the firmware file into flash memory. When successful a green LED will blink.

8.3.7 Save

Save the messages in the log pane to a text file.

8.3.8 Clear

Clear the log message pane.

9 Operating Frequencies

Table 3 DE9941A-375 Channel Table (350 to 400MHz Operation)

Frequency (MHz)	Channel No
351.25	1
353.5	2
355.95	3
361.05	4
363.5	5
365.95	6
350.05	7
366.5	8
383.5	9
399.55	10

Table 4 DE9941A-435 Channel Table (400 to 470MHz Operation)

Frequency (MHz)	Channel No
400.0625	1
435.0125	2
469.975	3
446.0125	4
446.05625	5
462.125	6
462.375	7
462.4	8
464.5	9
464.55	10
464.725	11
464.75	12

10 Typical Performance

10.1 RX performance

The following performance plots were obtained using the DE9941A-435.

10.1.1 RX sensitivity - PER

The RF Power is set to below the sensitivity limit of -110 dBm, to ensure enough packet errors are captured for the test. Starting at -125 dBm, the Tx begins to transmit packets. The DE9941A receives the packets, checking the header CRC for any errors. The test continues until a total of 100 packet errors have been accumulated. The RF power is then increased by +1 dB, and the test run starts again to receive packets and counting the packet errors.

This process is repeated until the RF power is -110 dBm, at which point there are a very low number of packet errors (100 errors in ~25,000 – 30,000 packets received). The RF power may be increased further if required, until this error ratio is reached.

There test is in two sections: first is the packet Header CRC, and then the packet Data block which also has its own CRC. The Data PER is only checked if the Header CRC is received with no errors.

Both results for the Header PER and the Data PER are shown for Frame Types 1 and 0. PER is calculated by the following formula:

- **(Header) PER = Packet Errors / Total Packets Received**
- **Data PER = Data Packet Errors / Total Valid Data Packets**

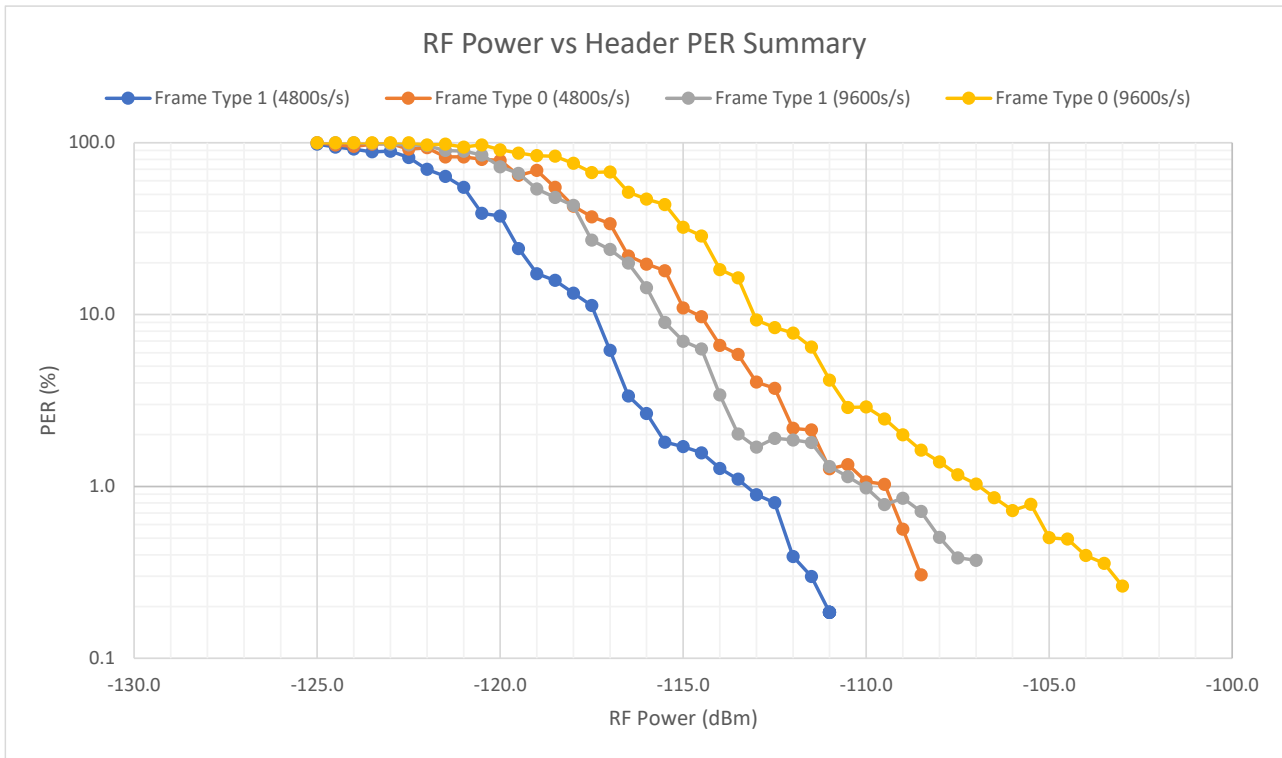


Figure 10 RF Power vs Header PER Results Summary, Low and High Baud Rates

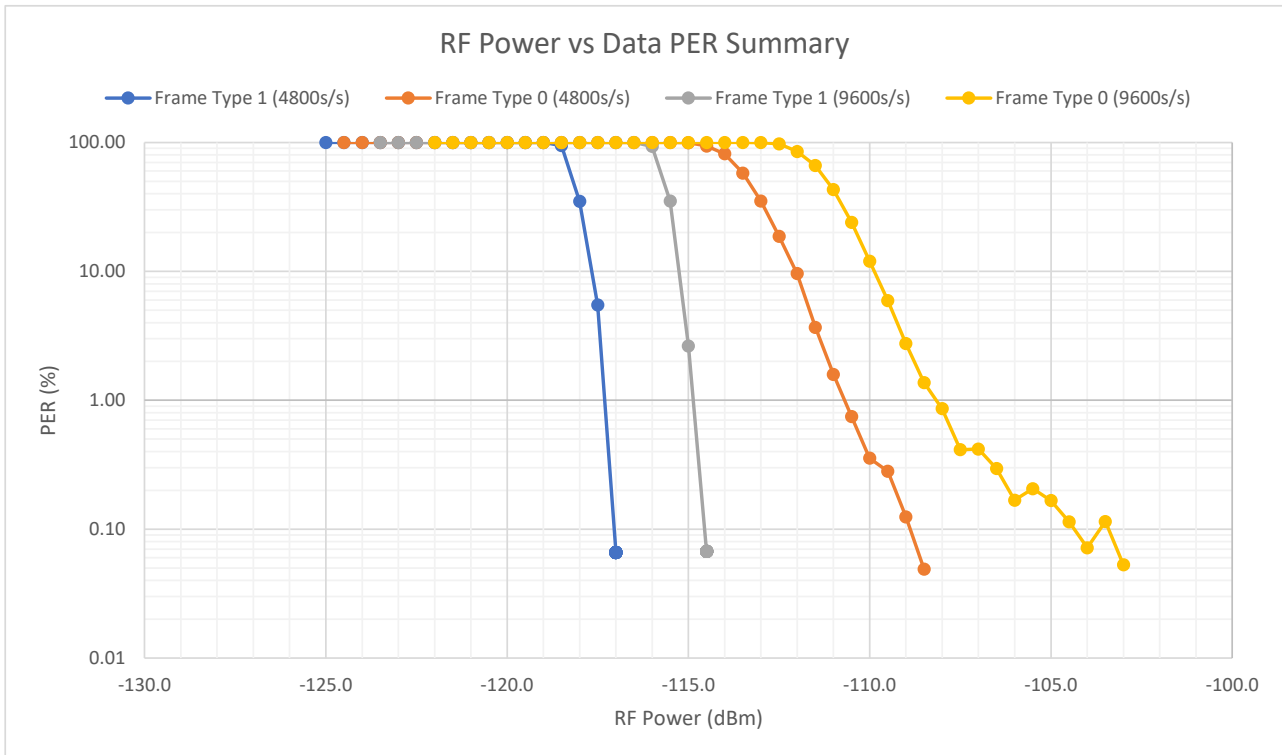


Figure 11 RF Power vs Data PER Results Summary, Low and High Baud Rates

10.1.2 Co-Channel Rejection

This test requires the use of a second RF signal generator for the ‘interfering’ or unwanted noise source. Both signal generator outputs are connected to the signal combiner, with the output feeding into the DE9941A receiver. The frequency of the unwanted signal used was the same as the nominal frequency (446.056250 MHz).

The testing procedure used is defined in ETSI EN 300 113 [3] section 8.5. With the wanted signal A fixed at -107 dBm (sensitivity limit + 3 dB), the level of the unwanted signal B was initially set to -110 dBm. This is to obtain a PER/BER of ~ 100%. Running the same transmission as in 10.1.1, the results were recorded. The unwanted signal B is then reduced in steps of 1 dB, then repeating the test sequence.

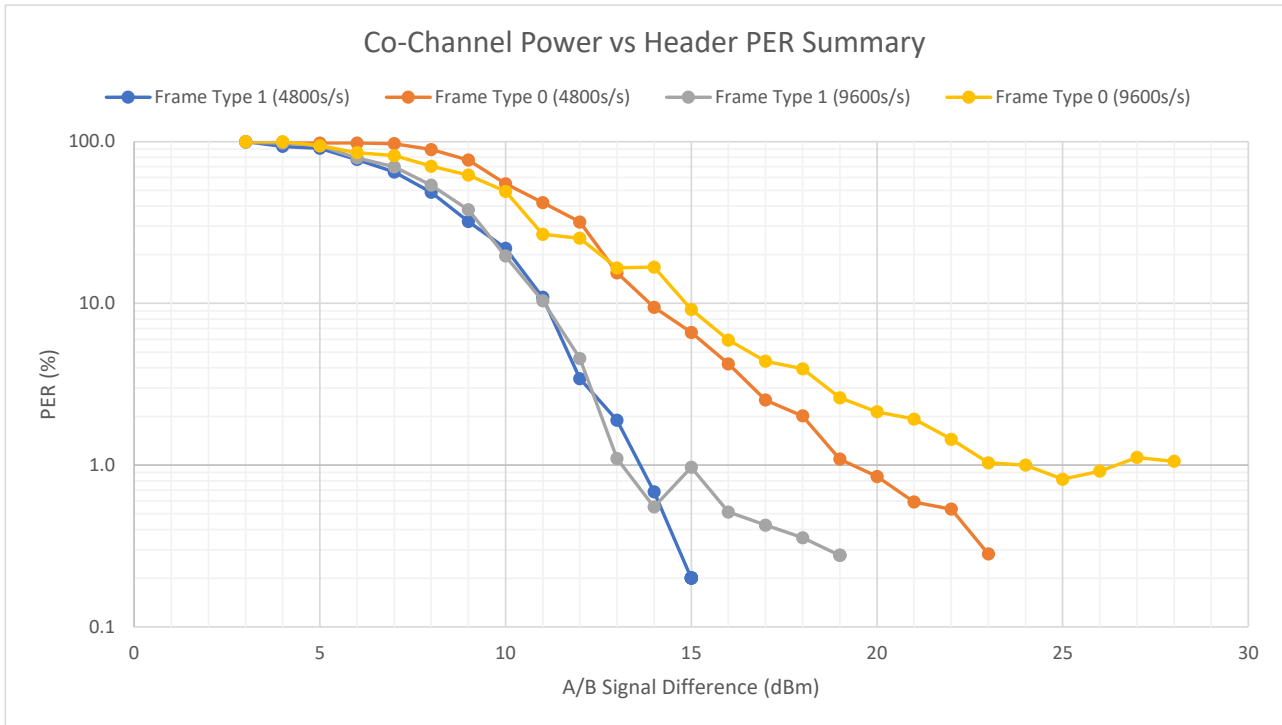


Figure 12 Co-Channel Rejection - Header PER Summary, Low and High Baud Rates

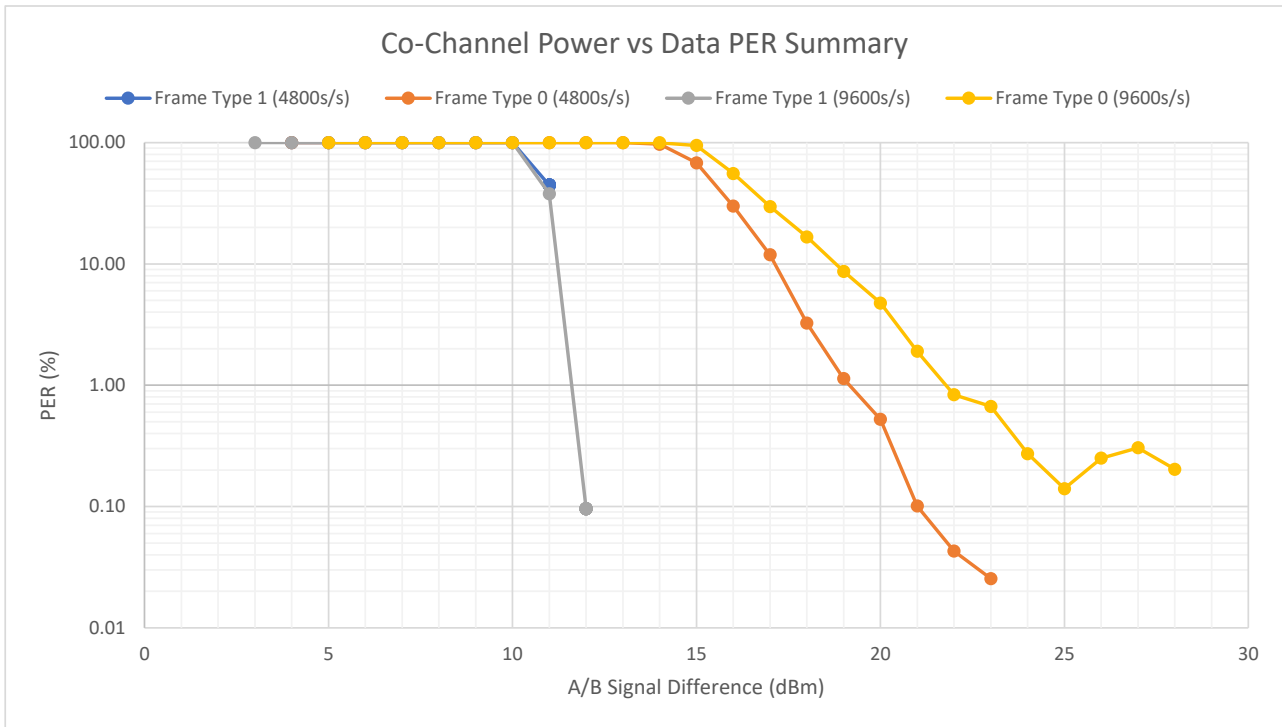


Figure 13 Co-Channel Rejection - Data PER Summary, Low and High Baud Rates

10.1.3 Adjacent Channel Rejection

This test requires the use of a second RF signal generator for the ‘interfering’ or unwanted noise source. Both signal generator outputs are connected to the signal combiner, with the output feeding into the DE9941A receiver. The frequency of the unwanted signal used was the nominal frequency (446.056250 MHz) + the channel bandwidth (12.5 kHz for 4800 baud, or 25 kHz for 9600 baud).

The testing procedure is defined in ETSI EN 300 113 [3] section 8.6. With the wanted signal A fixed at -107 dBm (sensitivity limit + 3 dB), the level of the unwanted signal B is initially set to -30 dBm. This is to obtain a PER/BER of ~ 100%. Running the same transmission as in 10.1.1, the results are recorded. The unwanted signal B is then reduced in steps of 1 dB, then repeating the test sequence.

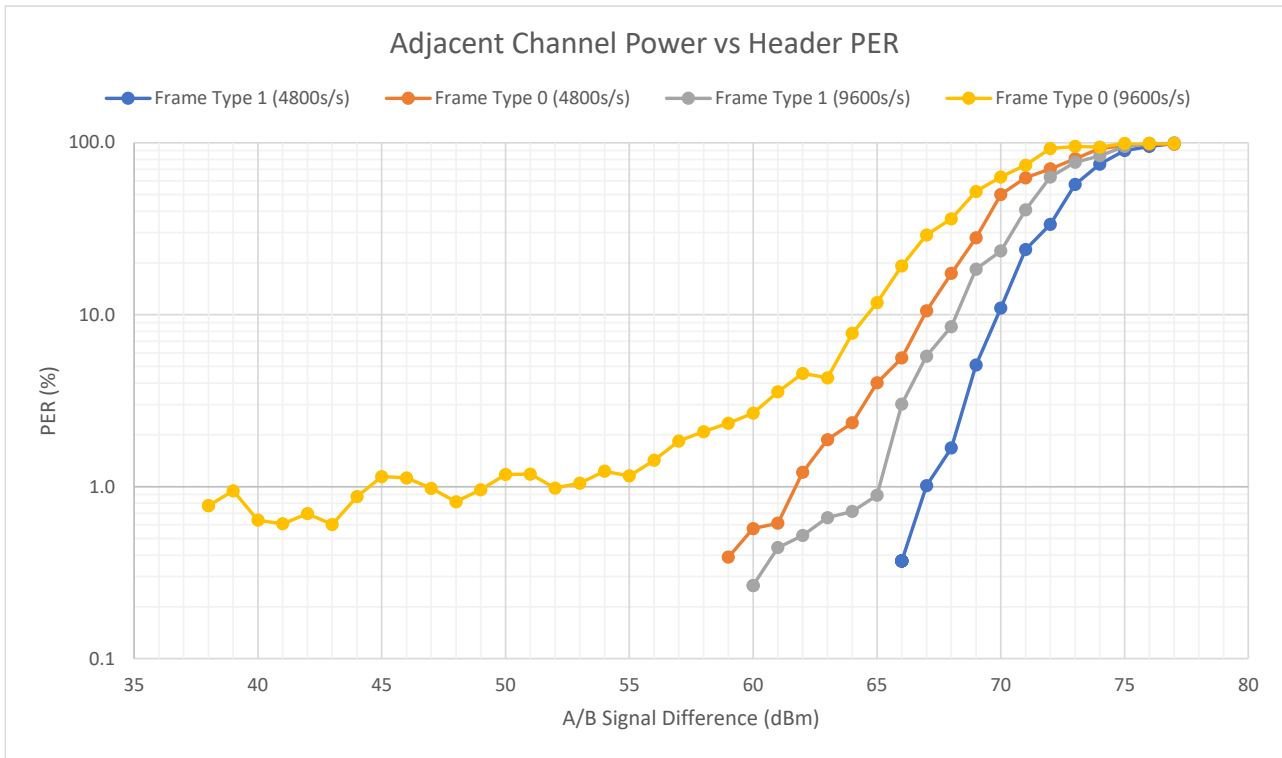


Figure 14 Adjacent Channel Rejection - Header PER Summary, Low and High Baud Rates

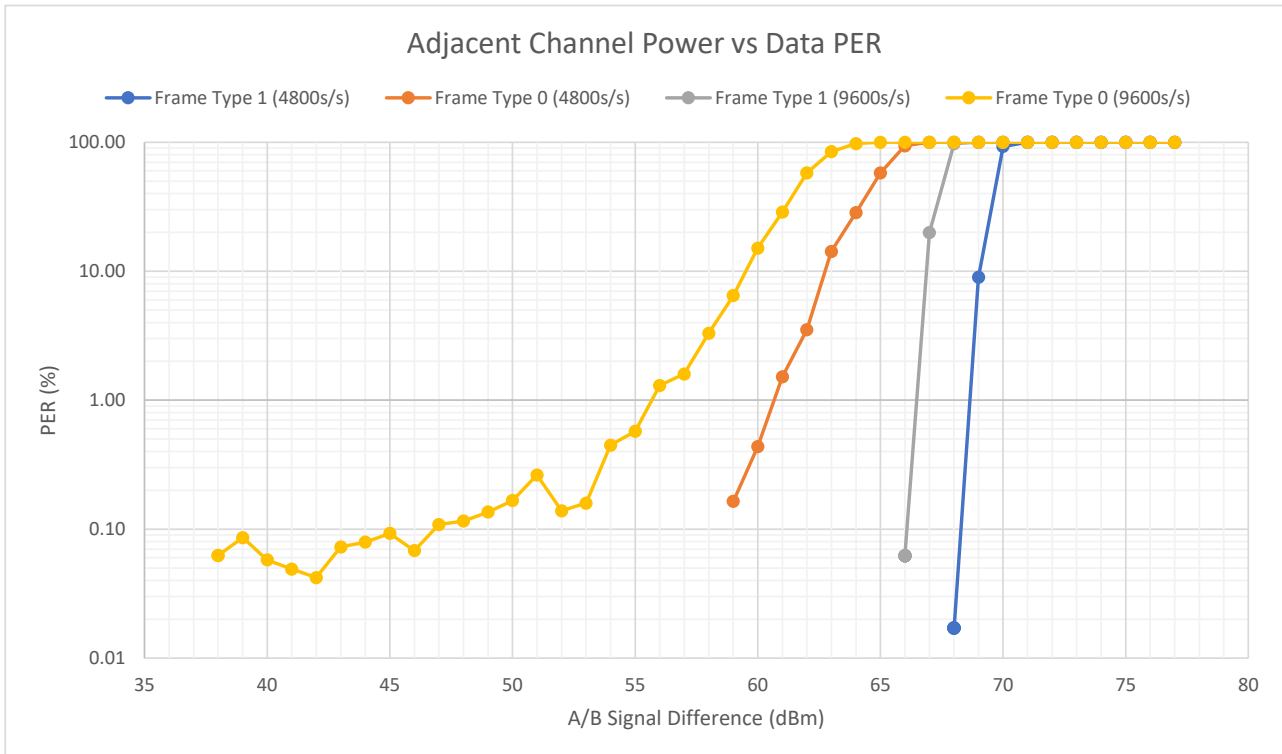


Figure 15 Adjacent Channel Rejection - Data PER Summary, Low and High Baud Rates

10.2 TX Performance

The following are plots showing the performance of the DE9941A as measured at CML.

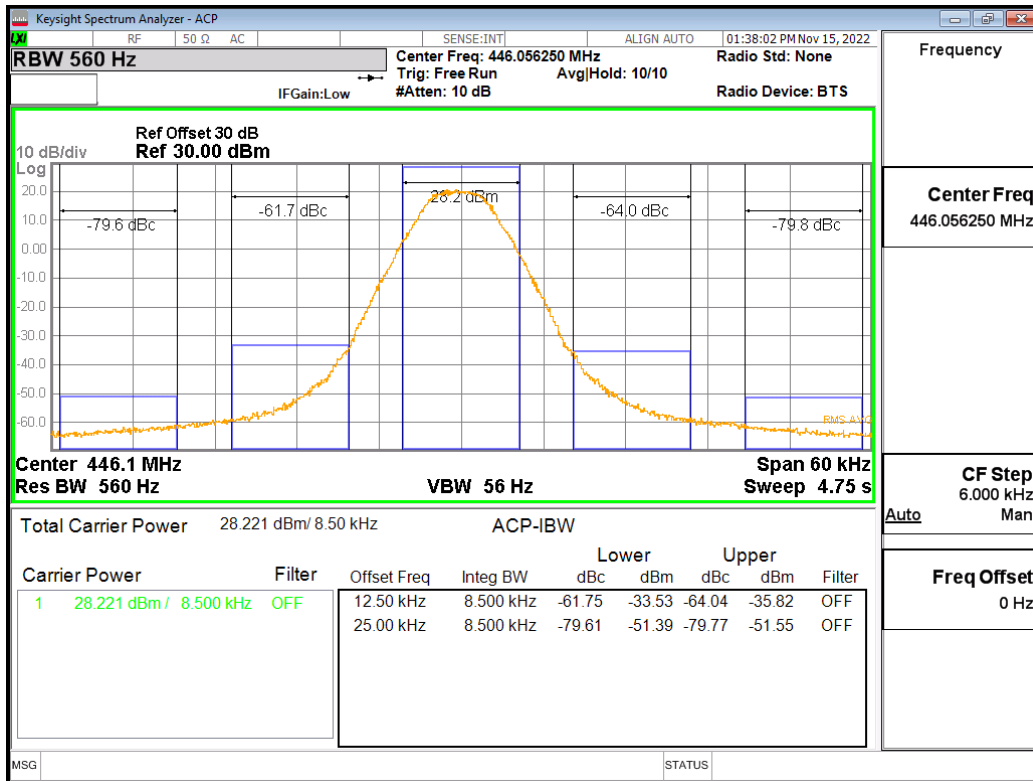


Figure 16 Adjacent Channel Power - 4800 baud

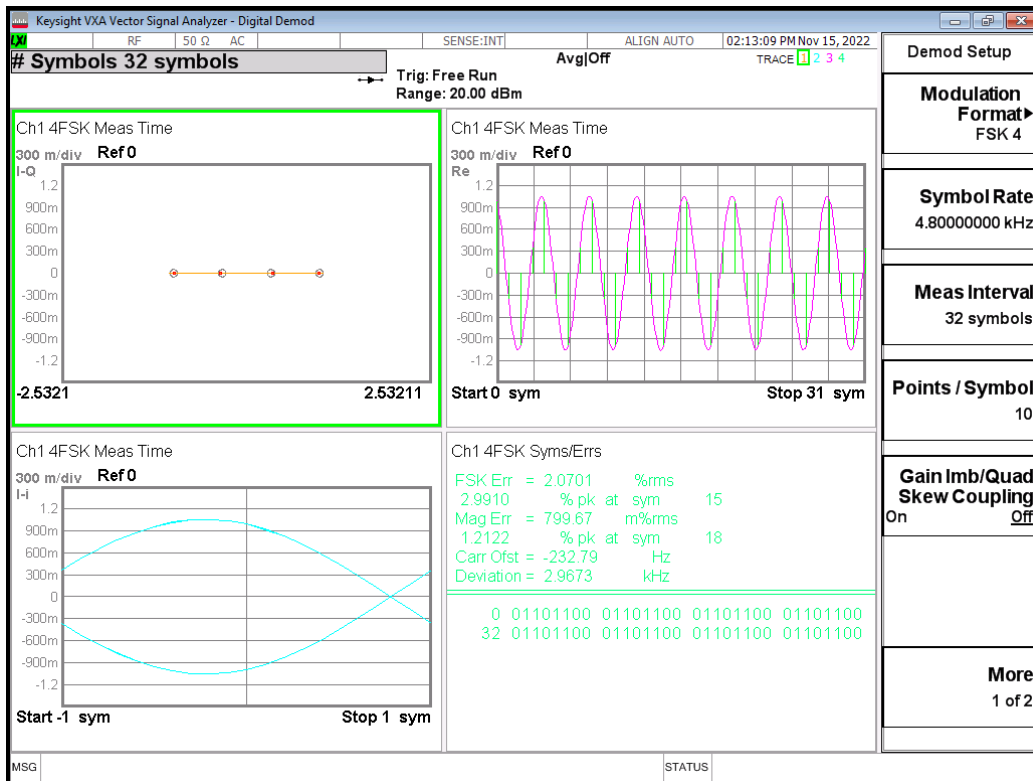


Figure 17 Modulation - 4800 baud

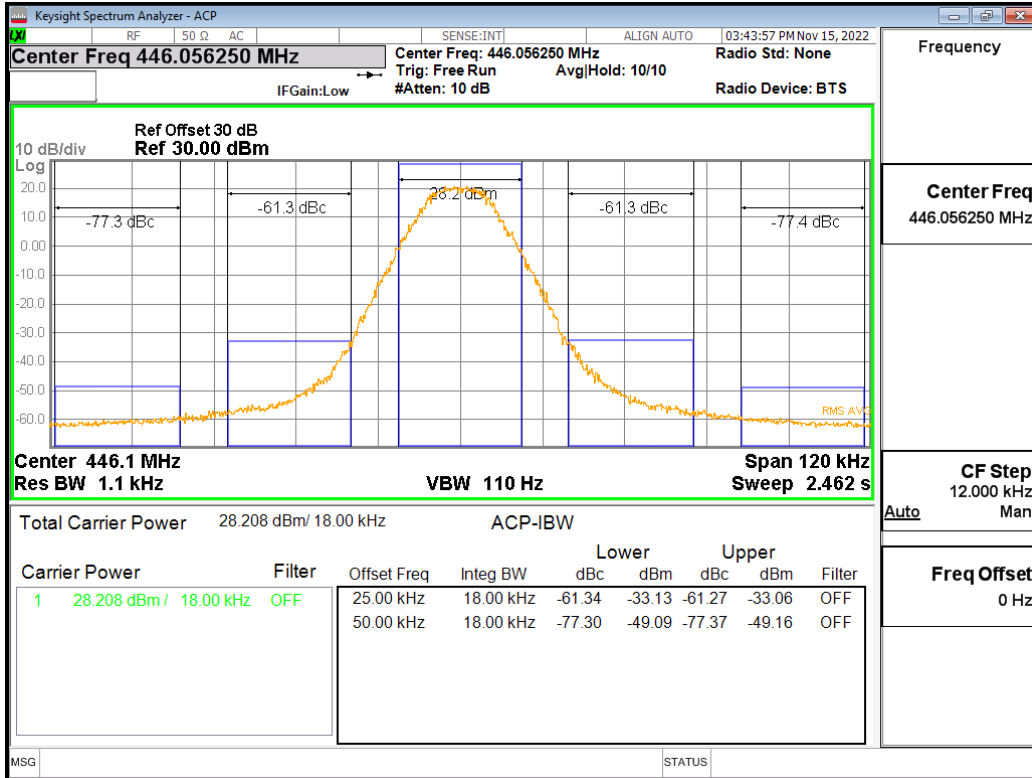


Figure 18 Adjacent Channel Power - 9600 baud

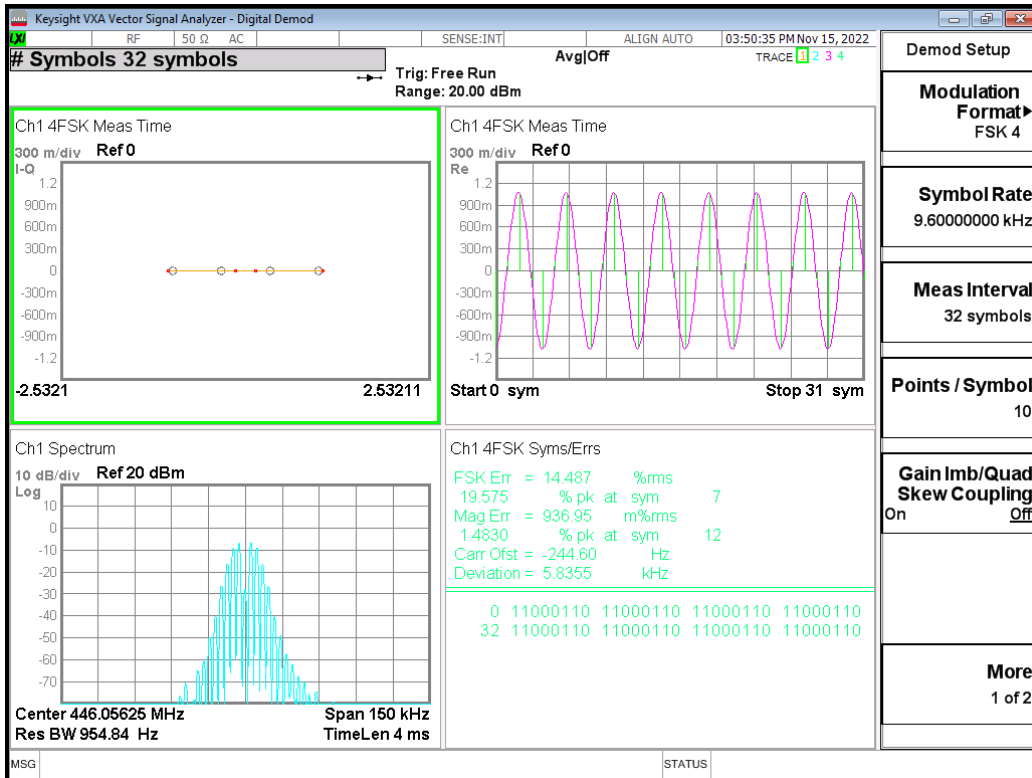


Figure 19 Modulation - 9600 baud

11 PRBS-9 Data Sequence


The PRBS-9 data sequence used by the GUI is:

```

0xFF, 0x83, 0xDF, 0x17, 0x32, 0x09, 0x4E, 0xD1, 0xE7, 0xCD, 0x8A, 0x91,
0xC6, 0xD5, 0xC4, 0xC4, 0x40, 0x21, 0x18, 0x4E, 0x55, 0x86, 0xF4, 0xDC,
0x8A, 0x15, 0xA7, 0xEC, 0x92, 0xDF, 0x93, 0x53, 0x30, 0x18, 0xCA, 0x34,
0xBF, 0xA2, 0xC7, 0x59, 0x67, 0x8F, 0xBA, 0x0D, 0x6D, 0xD8, 0x2D, 0x7D,
0x54, 0x0A, 0x57, 0x97, 0x70, 0x39, 0xD2, 0x7A, 0xEA, 0x24, 0x33, 0x85,
0xED, 0x9A, 0x1D, 0xE1, 0xFF, 0x07, 0xBE, 0x2E, 0x64, 0x12, 0x9D, 0xA3,
0xCF, 0x9B, 0x15, 0x23, 0x8D, 0xAB, 0x89, 0x88, 0x80, 0x42, 0x30, 0x9C,
0xAB, 0x0D, 0xE9, 0xB9, 0x14, 0x2B, 0x4F, 0xD9, 0x25, 0xBF, 0x26, 0xA6,
0x60, 0x31, 0x94, 0x69, 0x7F, 0x45, 0x8E, 0xB2, 0xCF, 0x1F, 0x74, 0x1A,
0xDB, 0xB0, 0x5A, 0xFA, 0xA8, 0x14, 0xAF, 0x2E, 0xE0, 0x73, 0xA4, 0xF5,
0xD4, 0x48, 0x67, 0x0B, 0xDB, 0x34, 0x3B, 0xC3, 0xFE, 0x0F, 0x7C, 0x5C,
0xC8, 0x25, 0x3B, 0x47, 0x9F, 0x36, 0x2A, 0x47, 0x1B, 0x57, 0x13, 0x11,
0x00, 0x84, 0x61, 0x39, 0x56, 0x1B, 0xD3, 0x72, 0x28, 0x56, 0x9F, 0xB2,
0x4B, 0x7E, 0x4D, 0x4C, 0xC0, 0x63, 0x28, 0xD2, 0xFE, 0x8B, 0x1D, 0x65,
0x9E, 0x3E, 0xE8, 0x35, 0xB7, 0x60, 0xB5, 0xF5, 0x50, 0x29, 0x5E, 0x5D,
0xC0, 0xE7, 0x49, 0xEB, 0xA8, 0x90, 0xCE, 0x17, 0xB6, 0x68, 0x77, 0x87,
0xFC, 0x1E, 0xF8, 0xB9, 0x90, 0x4A, 0x76, 0x8F, 0x3E, 0x6C, 0x54, 0x8E,
0x36, 0xAE, 0x26, 0x22, 0x01, 0x08, 0xC2, 0x72, 0xAC, 0x37, 0xA6, 0xE4,
0x50, 0xAD, 0x3F, 0x64, 0x96, 0xFC, 0x9A, 0x99, 0x80, 0xC6, 0x51, 0xA5,
0xFD, 0x16, 0x3A, 0xCB, 0x3C, 0x7D, 0xD0, 0x6B, 0x6E, 0xC1, 0x6B, 0xEA,
0xA0, 0x52, 0xBC, 0xBB, 0x81, 0xCE, 0x93, 0xD7, 0x51, 0x21, 0x9C, 0x2F,
0x6C, 0xD0, 0xEF, 0x0F, 0xF8, 0x3D, 0xF1, 0x73, 0x20, 0x94, 0xED, 0x1E,
0x7C, 0xD8, 0xA9, 0x1C, 0x6D, 0x5C, 0x4C, 0x44, 0x02, 0x11, 0x84, 0xE5,
0x58, 0x6F, 0x4D, 0xC8, 0xA1, 0x5A, 0x7E, 0xC9, 0x2D, 0xF9, 0x35, 0x33,
0x01, 0x8C, 0xA3, 0x4B, 0xFA, 0x2C, 0x75, 0x96, 0x78, 0xFB, 0xA0, 0xD6,
0xDD, 0x82, 0xD7, 0xD5, 0x40, 0xA5, 0x79, 0x77, 0x03, 0x9D, 0x27, 0xAE,
0xA2, 0x43, 0x38, 0x5E, 0xD9, 0xA1, 0xDE, 0x1F, 0xF0, 0x7B, 0xE2, 0xE6,
0x41, 0x29, 0xDA, 0x3C, 0xF9, 0xB1, 0x52, 0x38, 0xDA, 0xB8, 0x98, 0x88,
0x04, 0x23, 0x09, 0xCA, 0xB0, 0xDE, 0x9B, 0x91, 0x42, 0xB4, 0xFD, 0x92,
0x5B, 0xF2, 0x6A, 0x66, 0x03, 0x19, 0x46, 0x97, 0xF4, 0x58, 0xEB, 0x2C,
0xF1, 0xF7, 0x41, 0xAD, 0xBB, 0x05, 0xAF, 0xAA, 0x81, 0x4A, 0xF2, 0xEE,
0x07, 0x3A, 0x4F, 0x5D, 0x44, 0x86, 0x70, 0xBD, 0xB3, 0x43, 0xBC, 0x3F,
0xE0, 0xF7, 0xC5, 0xCC, 0x82, 0x53, 0xB4, 0x79, 0xF3, 0x62, 0xA4, 0x71,
0xB5, 0x71, 0x31, 0x10, 0x08, 0x46, 0x13, 0x95, 0x61, 0xBD, 0x37, 0x22,
0x85, 0x69, 0xFB, 0x24, 0xB7, 0xE4, 0xD4, 0xCC, 0x06, 0x32, 0x8D, 0x2F,
0xE8, 0xB1, 0xD6, 0x59, 0xE3, 0xEE, 0x83, 0x5B, 0x76, 0x0B, 0x5F, 0x55,
0x02, 0x95, 0xE5, 0xDC, 0x0E, 0x74, 0x9E, 0xBA, 0x89, 0x0C, 0xE1, 0x7B,
0x66, 0x87, 0x78, 0x7F, 0xC1, 0xEF, 0x8B, 0x99, 0x04, 0xA7, 0x68, 0xF3,
0xE6, 0xC5, 0x48, 0xE3, 0x6A, 0xE2, 0x62, 0x20, 0x10, 0x8C, 0x27, 0x2A,
0xC3, 0x7A, 0x6E, 0x45, 0x0A, 0xD3, 0xF6, 0x49, 0x6F, 0xC9, 0xA9, 0x98,
0x0C, 0x65, 0x1A, 0x5F, 0xD1, 0x63, 0xAC, 0xB3, 0xC7, 0xDD, 0x06, 0xB6,
0xEC, 0x16, 0xBE, 0xAA, 0x05, 0x2B, 0xCB, 0xB8, 0x1C, 0xE9, 0x3D, 0x75,
0x12, 0x19, 0xC2, 0xF6, 0xCD, 0x0E, 0xF0,

```


CML does not assume any responsibility for the use of any circuitry described. No IPR or circuit patent licences are implied. CML reserves the right at any time without notice to change the said circuitry and any part of this product specification. Evaluation kits and demonstration boards are supplied for the sole purpose of demonstrating the operation of CML products and are supplied without warranty. They are intended for use in a laboratory environment only and are not for re-sale, end-use or incorporation into other equipments. Operation of these kits and boards outside a laboratory environment is not permitted within the European Community. All software/firmware is supplied "as is" and is without warranty. It forms part of the product supplied and is licensed for use only with this product, for the purpose of demonstrating the operation of CML products. Whilst all reasonable efforts are made to ensure that software/firmware contained in this product is virus free, CML accepts no responsibility whatsoever for any contamination which results from using this product and the onus for checking that the software/firmware is virus free is placed on the purchaser of this evaluation kit or development board.

	United Kingdom	p: +44 (0) 1621 875500	e: sales@cmlmicro.com techsupport@cmlmicro.com
	Singapore	p: +65 62888129	e: sg.sales@cmlmicro.com sg.techsupport@cmlmicro.com
	United States	p: +1 336 744 5050	e: us.sales@cmlmicro.com us.techsupport@cmlmicro.com
www.cmlmicro.com			