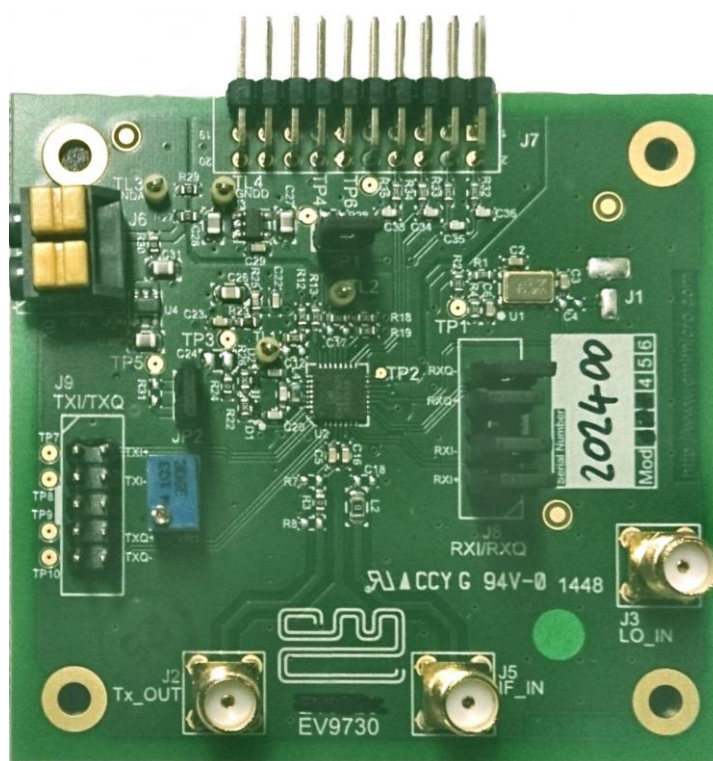


Features

- **CMX973 Quadrature Modulator and Demodulator Demonstrator**
- **C-BUS Interface to Host μ C**
- **Easy Interfacing to PE0601-xxx**
- **Demodulator 20-300MHz**
- **Modulator 20-1000MHz**
- **Options for on-chip PLL or External LO sources**



1 Brief Description

The EV9730 is an Evaluation Kit designed for evaluating and demonstrating the capabilities of the CMX973 integrated circuit. All the circuits necessary to demonstrate the facilities provided by the IC, such as matching circuits, power supply regulators, etc are provided on the EV9730 board.

A C-BUS interface connector is provided for control of the EV9730 by a host microcontroller or CML PE0002 interface card.

Click here for:

- Latest Datasheet
- Product Data Resource



CONTENTS

<u>Section</u>		<u>Page</u>
1	Brief Description	1
1.1	History	3
2	Block Diagram	4
3	Preliminary Information	5
3.1	Laboratory Equipment	5
3.1.1	Power Supply	5
3.1.2	Control Interface.....	5
3.2	Handling Precautions	5
3.2.1	Static Protection	5
3.2.2	Contents - Unpacking.....	5
3.3	Approvals	6
4	Quick Start	7
4.1	First – Initial Setup - EV9730 Quadrature Modulator	7
4.1.1	Make External Connections and Apply Power	7
4.1.2	Hardware/Software Installation (for PE0002).....	8
4.2	Second – Configure - EV9730 Quadrature Modulator	8
4.2.1	EV9730 Configuration	8
4.3	Third – Operate - EV9730 Quadrature Modulator.....	9
4.4	First – Initial Setup - EV9730 Quadrature IF Demodulator	10
4.4.1	Make External Connections and Apply Power	10
4.5	Second – Configure - EV9730 Quadrature IF Demodulator	11
4.5.1	EV9730 Configuration	11
4.6	Third – Operate - EV9730 Quadrature IF demodulator	12
5	Signal Lists	13
6	Circuit Schematics and Board Details	17
7	Detailed Description	19
7.1	Hardware Description.....	19
7.1.1	Quadrature Modulator	19
7.1.2	Quadrature IF Demodulator	19
7.1.3	Oscillator	19
7.1.4	Reference Oscillator.....	20
7.1.5	Power Supply	20
7.2	PC Control Software Description	20
7.2.1	The C-BUS Control Tab.....	22
7.2.2	The Registers 1 Tab	24
7.2.3	The Registers 2 Tab	24
7.2.4	The Script Handler Tab.....	25
7.3	Evaluation Tests.....	27
7.3.1	Quadrature Modulator	27
7.3.2	Quadrature IF Demodulator	28
7.4	Troubleshooting	31
7.4.1	General	31
7.4.2	Quadrature Modulator Operation	31
7.4.3	Quadrature IF Demodulator Operation	32
7.4.4	PLL/VCO Operation	32

8	Performance Specification	33
8.1	Electrical Performance	33
8.1.1	Absolute Maximum Ratings	33
8.1.2	Operating Limits	33
8.1.3	Operating Characteristics.....	34

<u>Table</u>	<u>Page</u>
Table 1 Signal List.....	13
Table 2 C-BUS Interface	14
Table 3 Quadrature Modulator I/Q Input Connector.....	15
Table 4 Quadrature Demodulator Output Connector	15
Table 5 Jumpers/Links	15
Table 6 Test Loops and Points	16
Table 7 Possible General Errors	31
Table 8 Possible Quadrature Modulator Errors.....	31
Table 9 Possible Quadrature IF Demodulator Errors.....	32
Table 10 Possible PLL/VCO Errors.....	32

<u>Figure</u>	<u>Page</u>
Figure 1 EV9730 Block Diagram	4
Figure 2 Typical Connections for EV9730 as a Quadrature Modulator.....	7
Figure 3 USB Driver Installation Message Box	8
Figure 4 Typical Connections for EV9730 as a Quadrature IF Demodulator.....	10
Figure 5a PCB Layout: top	17
Figure 6 Reset Dialog Box	21
Figure 7 Product Selection Dialog Box.....	22
Figure 8 The CBUS Control Tab	23
Figure 9 The Registers 1 Tab	24
Figure 10 The Registers 2 Tab	25
Figure 11 The Script Handler Tab.....	26
Figure 12 I/Q Modulator Output Spectrum with a Single Tone Input	27
Figure 13 I/Q Modulator Output Spectrum with a Two Tone Input.....	28
Figure 14 I/Q Output Signals.....	29
Figure 15 I/Q Signal to Noise Measurement	30

1.1 History

Version	Changes	Date
3	<ul style="list-style-type: none"> Top layer diagram (Figure 5) updated and photo on front page 	15/01/15
2	<ul style="list-style-type: none"> Receiver input specified to 300MHz 	13/8/12
1	<ul style="list-style-type: none"> First Issue 	30/5/12

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

2 Block Diagram

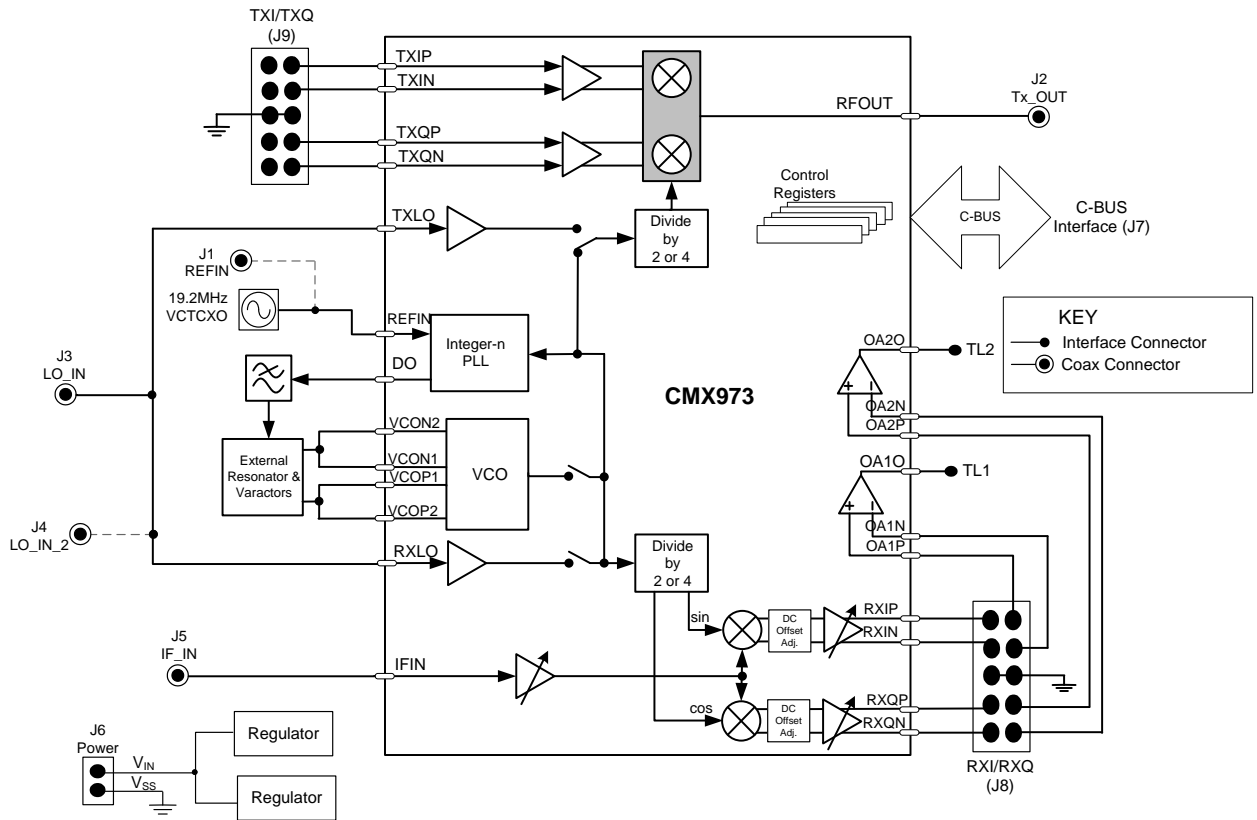


Figure 1 EV9730 Block Diagram

3 Preliminary Information

3.1 Laboratory Equipment

The following laboratory equipment is recommended for use with this Evaluation Kit:

- Power Supply
- Spectrum Analyser
- Signal Generator(s)
- Oscilloscope
- Digital Multi-meter

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

3.1.1 Power Supply

The supply input voltage to the PCB is nominally 7.2V (3.6V to 7.6V acceptable). On board regulators are provided to generate all voltage rails used on the PCB (3.3V). The 7.2V supply should be rated at 200mA.

NOTE: Care should be exercised with the supplies as they are not protected for reverse polarity. Operation at 12V will exceed the power dissipation ratings of the internal regulators.

3.1.2 Control Interface

To use the EV9730, the user will need a mechanism to send and receive data and commands via the C-BUS host microcontroller interface on the CMX973, which is brought out on connector J7. The CMX973 datasheet gives details of the registers and commands.

A PE0002 Interface Card (not supplied) can be used to control the EV9730. A user interface program developed specifically for the EV9730 is available from the CML website (see www.cmlmicro.com for details). Use of this GUI is described later in this document.

3.2 Handling Precautions

In common with other Evaluation Kits, this product is designed for use in office and laboratory environments. The following practices will help ensure its proper operation.

3.2.1 Static Protection

This product uses low power CMOS circuits that can be damaged by electrostatic discharge. Partially damaged circuits can function erroneously, leading to misleading results. Observe ESD precautions at all times when handling this product.

3.2.2 Contents - Unpacking

Please ensure that you have received all of the items detailed on the separate information sheet (EK9730) and notify CML within 7 working days if the delivery is incomplete.

3.3 Approvals

This product is not approved to any EMC or other regulatory standard. Users are advised to observe local statutory requirements, which may apply to this product and the radio frequency signals that may emanate from it.

4 Quick Start

This section provides instructions for users who wish to experiment immediately with the EV9730 Evaluation Kit. A more complete description of this kit and its use appears later in this document. The user should read the CMX973 datasheet before using this kit.

4.1 First – Initial Setup - EV9730 Quadrature Modulator

4.1.1 Make External Connections and Apply Power

An example of typical connections to the EV9730 is shown in Figure 2. Perform the following steps in sequence:

1. Connect test leads as shown in Figure 2, except the power to J6.
2. Connect a controller to C-BUS interface J7 (PE0002 can be used - see section 4.1.2. Note: J3 or J5 can be used on PE0002, but ensure the correct C-BUS port is selected when programming data).
3. Install PE0002 hardware/software and apply power to PE0002 - see section 4.1.2
4. Power should be applied to the main supply input J6 (7.2V nominal). The CMX973 device will be reset on power-up.

The board is now ready for operation.

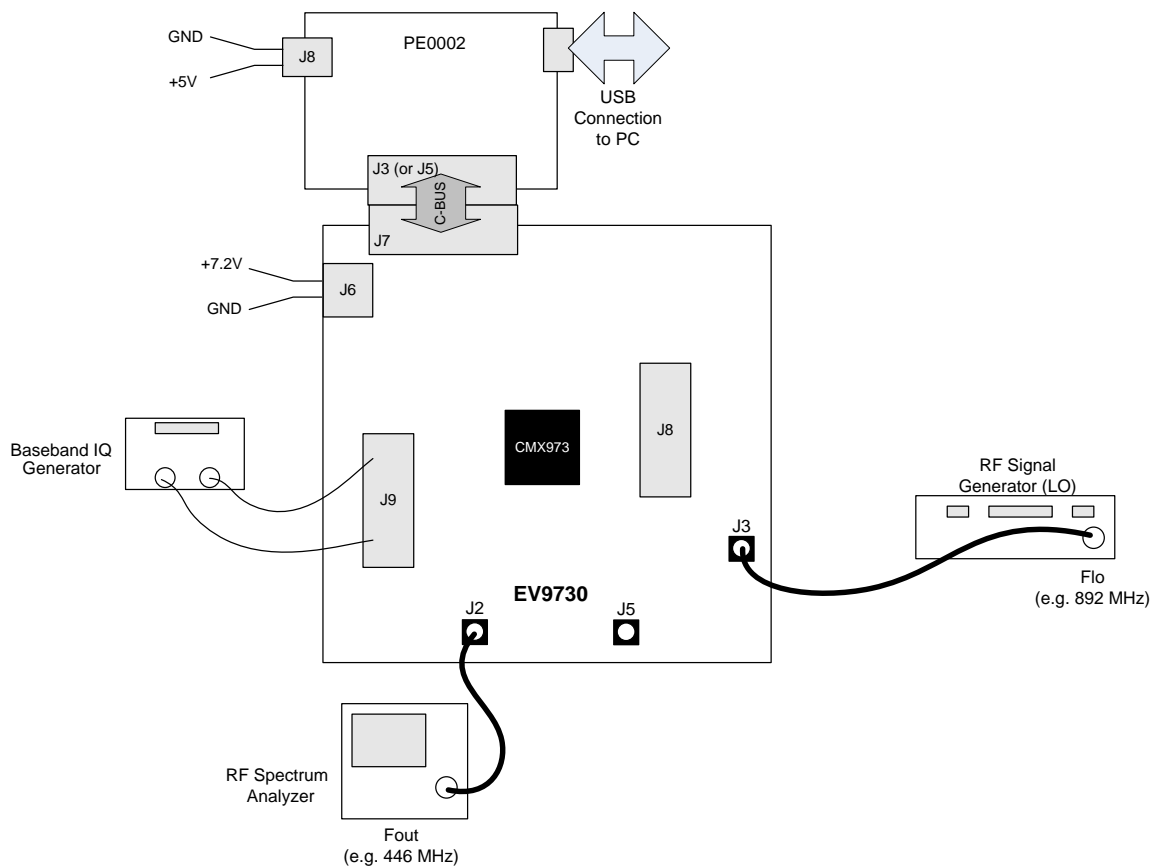


Figure 2 Typical Connections for EV9730 as a Quadrature Modulator

4.1.2 Hardware/Software Installation (for PE0002)

This section is valid whether the EV9730 is being setup as a quadrature modulator or demodulator.

- Copy the file '**ES9700xx.zip**', which is downloaded from the CML website following registration, to the hard drive of your host PC.
- Extract the files to the hard drive of your host PC.
 - Connect a 5V dc supply to the PE0002 Interface.
 - Connect a 7.2V dc supply to the EV9730.
 - Attach a USB cable from connector J2 of the PE0002 Interface Card to the PC USB port.
- Turn on the power supply to the PE0002. The PE0002 power-on indicator D6 will light
- Install the USB driver when requested. The driver is in the same folder where the '**ES9700xx.zip**' files were extracted to, in directory '\Driver'. Follow instructions on the screen to install the USB driver. Click the 'Continue Anyway' button when the Message Box in Figure 3 is shown.

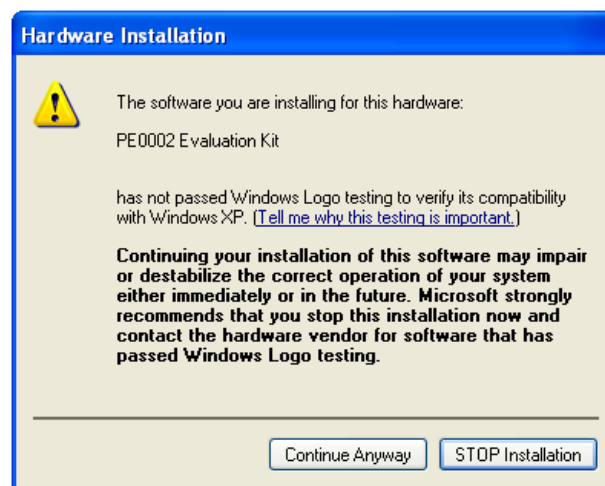


Figure 3 USB Driver Installation Message Box

4.2 Second – Configure - EV9730 Quadrature Modulator

In this second step the EV9730 Quadrature Modulator is configured for Tx operation at 446MHz output frequency.

4.2.1 EV9730 Configuration

The following steps should be undertaken to configure the EV9730 to transmit at 446MHz with an I/Q input. Set the applied signals and register values as shown in the following table.

Note: Setting the CMX973 registers requires the use of the PE00002 host connected as above. The CMX973 datasheet give details of the registers and commands.

Signal or Register	Setting	Note
LO_IN (J3)	892MHz @-10dBm	This frequency is twice the RF output frequency that will be developed.
TXI/TXQ (J9)	1.6V dc	These inputs must be connected to 1.6V dc; do not leave them unconnected or open circuit
General Reset register (\$1A)	To ensure the device and hardware are in known states issue the General Reset command	See lower right of GUI tab "C-BUS Control".
General Control register (\$1B)	The General Control register should be set to enable the following: <ul style="list-style-type: none"> • Bias generator • Tx Select Tx LO/2 mode.	Write \$51 to register \$1B.
Tx Control register (\$1E)	Select LO source from TxLO pin. Select optimum operating frequency for the Modulator.	Write \$00 to register \$1E.
Tx_OUT (J2)	446MHz Output	Typical an output at 446MHz of approximately -40dBm should be seen on the spectrum analyser. This represents the nulled carrier condition.

4.3 Third – Operate - EV9730 Quadrature Modulator

Following the configuration procedures given in sections 4.1 and 4.1.2, the EV9730 should be operating as a transmitter at 446MHz. Differential baseband I/Q signals (typically 1.0V p-p¹) can now be applied to develop a modulated RF output up to 0dBm PEP. Various evaluation tests can now be performed.

Notes:

- A single ended input of 1Vp-p can be applied to TXI+ and TXQ+ (TXI- and TXQ- must be at 1.6V dc, this can be achieved by fitting R36 and R38 as 0R links and adjusting VR1 to get the desired dc level) to achieve approximately the same output power as with the differential input drive.
- The peak to average power ratio of the user-provided modulation will determine the mean RF output power delivered by the EV9730.

¹ i.e. 500mVp-p on each pin TXIN/TXIP and TXQN/TXQP.

4.4 First – Initial Setup - EV9730 Quadrature IF Demodulator

4.4.1 Make External Connections and Apply Power

An example of typical connections to the EV9730 is shown in Figure 4. Perform the following steps in sequence:

1. Connect test leads as shown in Figure 4, except the power to J6.
2. Connect a controller to C-BUS interface J7 (PE0002 can be used - see section 4.1.2. Note: J3 or J5 can be used on PE0002, but ensure the correct C-BUS port is selected when programming data).
3. Install PE0002 hardware/software and apply power to PE0002 - see section 4.1.2.
4. Power should be applied to the main supply input J6 (7.2V nominal). The CMX973 device will be reset on power-up.

The board is now ready for operation.

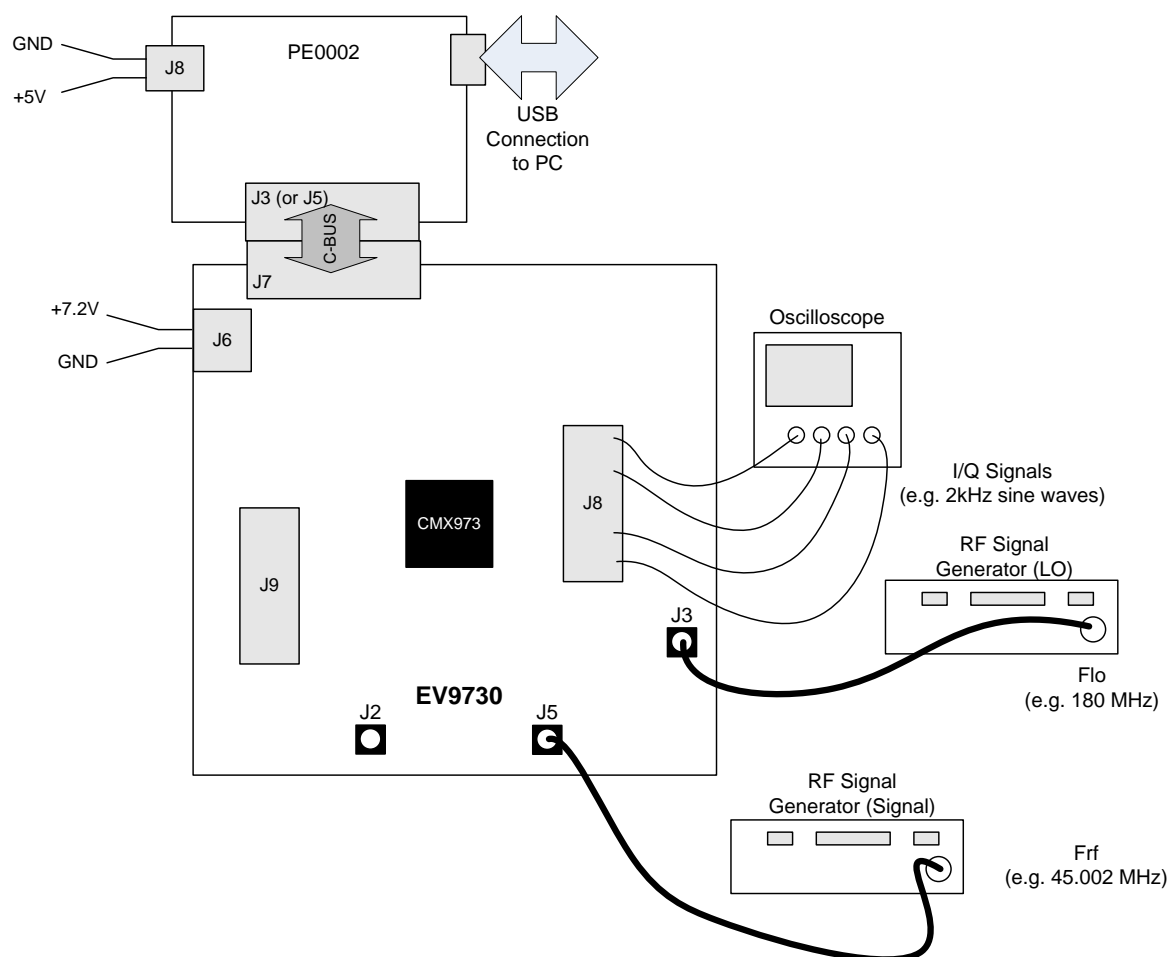


Figure 4 Typical Connections for EV9730 as a Quadrature IF Demodulator

4.5 Second – Configure - EV9730 Quadrature IF Demodulator

In this second step the EV9730 Quadrature Demodulator is configured for receive operation at 45MHz input frequency.

4.5.1 EV9730 Configuration

The following steps should be undertaken to configure the EV9730 to receive at 45MHz with an I/Q output. Set the applied signals and register values as shown in the following table.

Note: Setting the CMX973 registers requires the use of the PE00002 host connected as above. The CMX973 datasheet give details of the registers and commands.

Signal or Register	Setting	Note
LO_IN (J3)	180MHz @-10dBm	This frequency is four times the RF input frequency.
IF_IN (J5)	45.002MHz	The input level here may be user defined: for example an input signal of –60dBm at J5 the typical single ended output level would be 220mVp-p at J8 pin 2. The output should be 2kHz sine and cosine waves on I and Q when the configuration in this table is completed.
General Reset register (\$1A)	To ensure the device and hardware are in known states issue the General Reset command	See lower right of GUI tab “C-BUS Control”.
General Control register (\$1B)	The General Control register should be set to enable the following: <ul style="list-style-type: none"> • Bias generator • Rx Select Rx LO/4 mode.	Write \$12 to register \$1B.
Rx Control register (\$1C)	Set Rx Gain to maximum, output drive to low and phase correction circuit off.	Write \$00 to register \$1C, this enables maximum gain, with low output drive capability and no phase correction. This gives the lowest power consumption mode.
Rx Mode register (\$1D)	Enable I and Q outputs. The general purpose op-amps are enabled/disabled in this register.	Write \$00 to register \$1D, op-amps disabled. Write \$30 to register \$1D, op-amps enabled.
Rx Offset register (\$1F)	The value written to this register will vary between devices, the default value (\$00) is a good starting point.	Check the dc levels on J8 (I and Q) to ensure that the dc offsets are less than 25mV; adjust the value written to \$1F as required.
IMD Cntrl register (\$2F)	For initial testing the default value (\$00) can be used so there is no need to write to this register.	The value written to this register can be adjusted to give the optimal intermod (IMD) performance, see CMX970 datasheet for further details.
RXI/Q (TL1 and TL2)	Single ended Rx I/Q output.	The single ended I and Q signals can be taken from TL1 and TL2 if the jumper/links are fitted to J8. Ensure op-amps are enabled in register \$1D.
RXI/Q (J8)	Differential Rx I/Q output.	The differential I and Q signals can be taken from J8, remove jumpers when using the differential output.

4.6 Third – Operate - EV9730 Quadrature IF demodulator

Following the configuration procedures given in sections 4.4 and 4.5, the EV9730 should be operating as a receiver at 45MHz. Various evaluation tests can now be performed.

5 Signal Lists

The input power supply connection is via a 2-way snap socket J6. J2, J3 and J5 are RF signals and use SMA 50 Ohm sockets. J8 and J9 are 10-pin headers, J8 for differential RXI/RXQ modulation outputs from the demodulator, J9 for differential I/Q inputs to the modulator. These connectors can interface signals easily to the PE0601-xxx Evaluation Kit.

The PCB will be configured with jumper links fitted to J8 this converts the differential demodulator output signals to single ended outputs, available on test loops, using the on chip general purpose op-amps.

Signal	Signal Type	PCB Connector
Ground	DC	J6 Pin 1
+Vin (7.2V nominal)	DC	J6 Pin 2
Quadrature Modulator RF output	RF	J2
Quadrature Demodulator RF input	RF	J5
Local Oscillator RF input 1	RF	J3
Local Oscillator RF input 2 (optional)	RF	J4 (PCB pads)
Reference Clock input (optional). To use this input C4 needs to be fitted to the PCB and C3, R1 removed.	RF	J1 (PCB pads)
Differential Quadrature Modulator inputs	Baseband	J9
Differential Quadrature Demodulator outputs	Baseband	J8
Single ended Quadrature Demodulator outputs	Baseband	TL1 (RXI) TL2 (RXQ)
C-BUS interface (e.g. to PE0002)	Logic	J7

Table 1 Signal List

Connections to the host C-BUS interface J7 are as follows. All are 3.3V logic levels unless otherwise stated.

CONNECTOR PINOUT for J7			
Connector Pin No.	Signal Name	Signal Type	Description
1	-	-	Spare pin. Leave unconnected.
2	CSN	I/P	C-BUS Chip Select.
3	-	-	Spare pin. Leave unconnected.
4	CDATA	I/P	C-BUS Data Input.
5	-	-	Spare pin. Leave unconnected.
6	SCLK	I/P	C-BUS Clock.
7	-	-	Spare pin. Leave unconnected.
8	RDATA	O/P	C-BUS Data Output
9	-	-	Spare pin. Leave unconnected.
10	IRQN	I/P	Interrupt request - if required. Not used, so remains unconnected on EV9730.
11	GNDD	Power	Connection to Digital Ground.
12	GNDD	Power	Connection to Digital Ground.
13	-	-	Spare pin. Leave unconnected.
14	-	-	Spare pin. Leave unconnected.
15	-	-	Spare pin. Leave unconnected.
16	-	-	Spare pin. Leave unconnected.
17	-	-	Spare pin. Leave unconnected.
18	-	-	Spare pin. Leave unconnected.
19	-	-	Spare pin. Leave unconnected.
20	-	-	Spare pin. Leave unconnected.

Table 2 C-BUS Interface

Connections to the quadrature modulator I/Q input interface J9 are shown in Table 3. As well as an ac signal, a dc bias must also be applied. If resistors R36 and R38 (0R) are fitted, single-ended I/Q signals may be applied to pins 2 and 8. The dc bias to the other I/Q inputs can be adjusted using VR1.

CONNECTOR PINOUT for J9			
Connector Pin No	Signal Name	Signal Type	Description
2	TXI+	Baseband	Positive Tx I input
4	TXI-	Baseband	Negative Tx I input
8	TXQ+	Baseband	Positive Tx Q input
10	TXQ-	Baseband	Negative Tx Q input
1, 3, 7, 9	N/C	-	-
5,6	GNDA	-	Ground (Analogue)

Table 3 Quadrature Modulator I/Q Input Connector

The differential output I/Q signals from the demodulator (interface connector J8) are described in Table 4, along with the connections for single ended I/Q outputs, by using the general purpose op-amps, in Table 5.

CONNECTOR PINOUT for J8			
Connector Pin No	Signal Name	Signal Type	Description
2	RXI+	Baseband	Positive Rx I Output
4	RXI-	Baseband	Negative Rx I Output
8	RXQ+	Baseband	Positive Rx Q Output
10	RXQ-	Baseband	Negative Rx Q Output
1	OA1N	Baseband	Negative I/P to Differential Amplifier 1
3	OA1P	Baseband	Positive I/P to Differential Amplifier 1
7	OA2N	Baseband	Negative I/P to Differential Amplifier 2
9	OA2P	Baseband	Positive I/P to Differential Amplifier 2
5,6	GNDA	-	Ground (Analogue)

Table 4 Quadrature Demodulator Output Connector

JUMPERS/LINKS			
Test Point Ref.	Positions	Default	Description
JP1	1-2	1-2	+3V3D
JP2	1-2	1-2	+3V3A
RXI+, J8	1-2	1-2	Connect RXI+ to differential to signal ended amplifier
RXI-, J8	3-4	3-4	Connect RXI- to differential to signal ended amplifier
RXQ+, J8	7-8	7-8	Connect RXQ+ to differential to signal ended amplifier
RXQ-, J8	9-10	9-10	Connect RXQ- to differential to signal ended amplifier

Table 5 Jumpers/Links

TEST LOOPS/POINTS		
Test Point Ref.	Typical Value	Description
TL1	-	RXI Single ended output
TL2	-	RXQ Single ended output
TL3	0V	GNDA
TL4	0V	GNDD
TP1	1.6V	VCTCXO Control Voltage
TP2	3.3V	VDD – CMX973 Digital Supply Pin
TP3	-	Tuning voltage for the PLL
TP4	3.3V	+3V3 regulator output (+3V3D - digital supplies)
TP5	3.3V	+3V3 regulator output (+3V3A - analogue supplies)
TP6	-	C-BUS connector: IRQN
TP7, 8, 9, 10	-	Test points to spare pins on J9

Table 6 Test Loops and Points

Notes: I/P = Input BI = Bidirectional TP = Test Point
 O/P = Output TL = Test Loop

Note that the voltages are typical for their active state.

6 Circuit Schematics and Board Details

For clarity, circuit schematics are available as a separate high-resolution file available from the CML web site as part of the support files package. The layout on each side is shown in Figure 5 (a and b), below. The PCB is a 4-layer design fabricated with FR4 material and is 1.6mm thick. Full Gerber and Drill files are available on request.

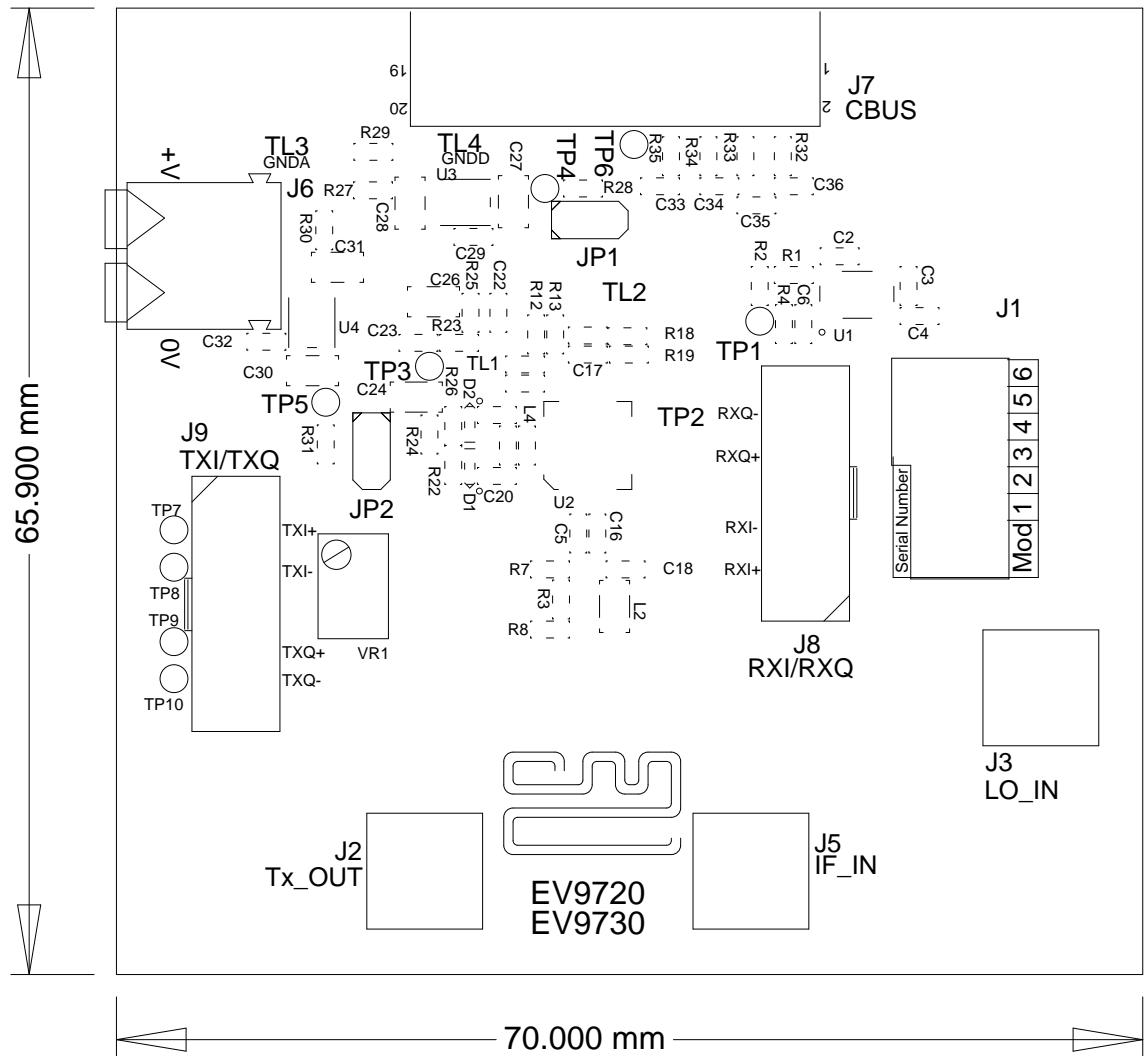


Figure 5a PCB Layout: top

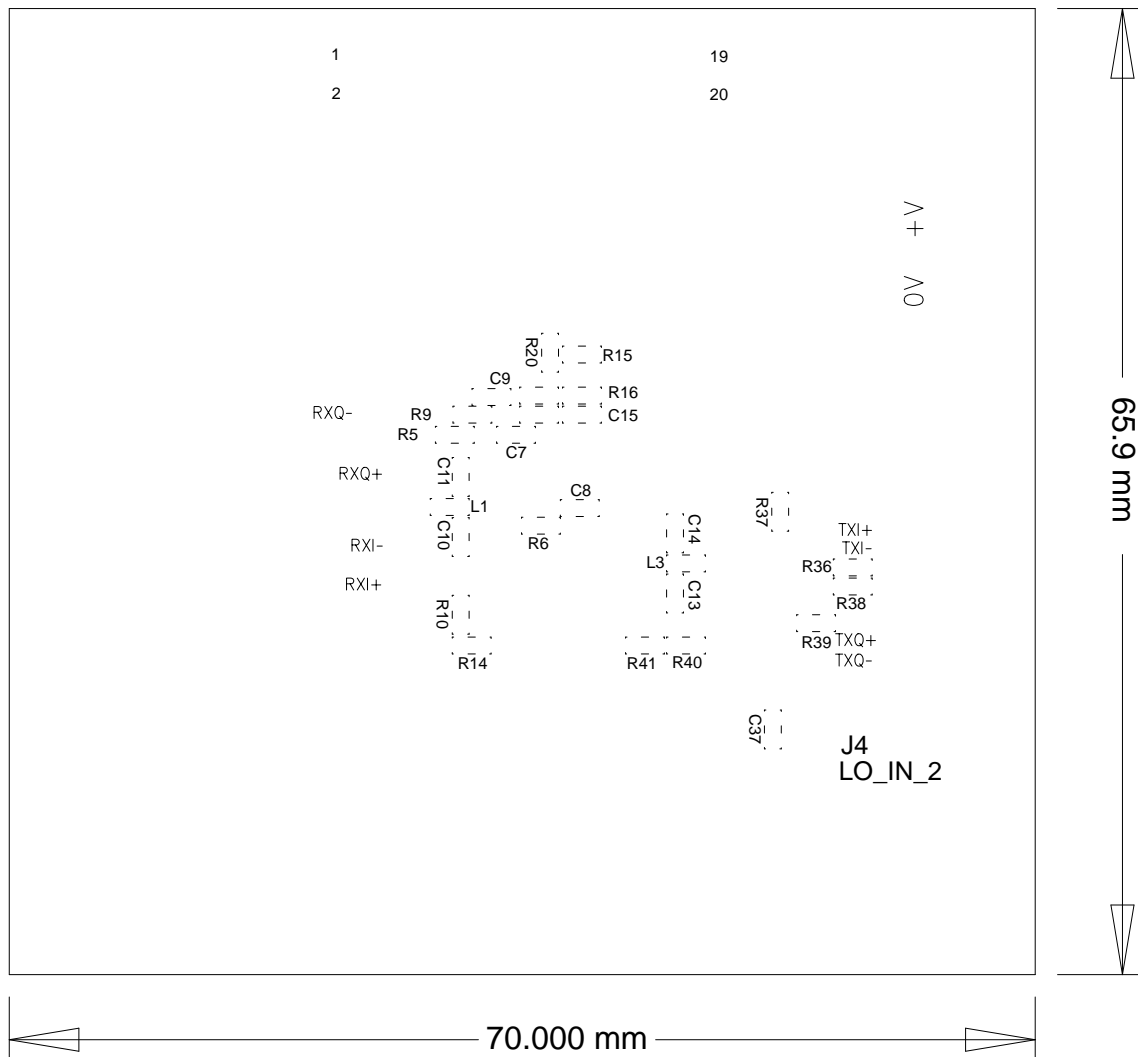


Figure 5b PCB Layout: bottom

7 Detailed Description

The CMX973 datasheet (available from www.cmlmicro.com) should be referred to for a detailed description of the CMX973 device.

The EV9730 functionality includes:

- Evaluation and demonstration of the CMX973 Quadrature modulator
- Evaluation and demonstration of the CMX973 Quadrature IF demodulator
- VCO, Integer-N PLL and divider
- 19.2MHz VCTCXO
- Interface to CMX7163 or CMX7164 evaluation boards (PE0601-7163/PE0601-7164, not included) to allow demonstration/test of QAM and 2-FSK/4-FSK demodulation.
- An interface that allows the card to be connected to a host μ Controller, to allow real-time control. A PC user interface can be provided using a PE0002 and ES9700 software.

If further design support is required, please contact your regional CML office or an approved CML distributor.

7.1 Hardware Description

7.1.1 Quadrature Modulator

This Evaluation Kit is configured to allow the CMX973 Quadrature Modulator to operate with single-ended or differential external inputs. The TXI/TXQ inputs can be accessed differentially for direct connection to a PE0601-xxxx kit, for example. For single-ended input operation it is necessary to bias the unused inputs (nominally +3V3A divided by 2), this can be done by fitting a 0R link at R36 and R38, then VR1 can be adjusted to achieve the desired dc level.

The modulator output is unmatched and can be operated from 20MHz to 1GHz.

The TxLO input circuit (L1, C10 and C11) can be used with an external source and there is no matching on this input, so a broad range of LO frequencies can be applied.

7.1.2 Quadrature IF Demodulator

The Evaluation Kit is configured to allow the CMX973 Quadrature Demodulator to operate over a broad range of input frequencies (20 to 300MHz) i.e. no matching has been applied at the IFIN input (L2, C16 and C18). Matching can be applied to the IFIN input; this will increase the gain, improve the noise figure and degrade the IIP3.

The RxLO input (L3, C13 and C14) can be used with an external source and there is no matching on this input so a broad range of LO frequencies can be applied.

The RXI/RXQ outputs can be accessed differentially for direct connection to a PE0601-xxx kit, for example, or the general purpose op-amps on the CMX973 can be used to convert the Rx outputs from differential to single ended. Jumpers need to be fitted to J8 when using the op-amps (see Table 5 for details of jumper positions).

7.1.3 Oscillator

The EV9730 provides components to use the VCO amplifier and PLL contained within the CMX973 device. As supplied, the resonator circuit (L4, C21, C20, C25, D1, D2) is configured for 180MHz operation with a tuning sensitivity of approximately 8MHz/V. The oscillator is usable up to about 1GHz, for further details consult the CMX973 datasheet.

The component values used for the PLL loop filter provide a bandwidth of approximately 500Hz for a comparison frequency of 25kHz. The loop filter is a passive 3rd order type. The user may change

the values dependent upon the comparison frequency spur suppression, lock time and operating frequency requirements.

The Quadrature Modulator or Demodulator can make use of the internal VCO by ensuring the correct LO path has been selected (see CMX973 datasheet).

7.1.4 Reference Oscillator

A 19.2MHz VCTCXO (U1) is provided on the PCB. This is specified as a 1.5ppm part over –20 to +70°C. If C3 and R1 is removed and C4 (1nF) fitted, an alternative clock source can be applied to J1.

7.1.5 Power Supply

Two 3.3V regulator supplies are generated on the PCB. U3 provides supply for digital circuits and U4 for analogue circuits. Current drawn from each supply rail may be measured by connecting an ammeter across JP1 (digital) or JP2 (analogue), after removing the corresponding jumper.

7.2 PC Control Software Description

The EV9730 itself does not require any embedded firmware, however, it does require C-BUS control from an external microcontroller. The CML product, PE0002, can be used with the EV9730 and PC software files ('**ES9700xx.zip**'). To use the software, connect the EV9730 as shown in Figure 2 or Figure 4. First ensure the drivers supplied for the PE0002 are installed correctly. The executable must be in the same folder on the PC as the '**EF0002xx.hex**' file. Run the **ES9700xx.exe** and the main application window will open with a request for the Reset button to be pressed on the PE0002 board, see Figure 6. The window then displays a progress bar for the initialisation process. This software is common to a number of Evaluation Kits, so the appropriate kit must then be selected in a new dialog box, see Figure 7. Once the initialisation and kit selection process is complete, one of three tabs can be selected, as shown in Figure 8 to Figure 11.

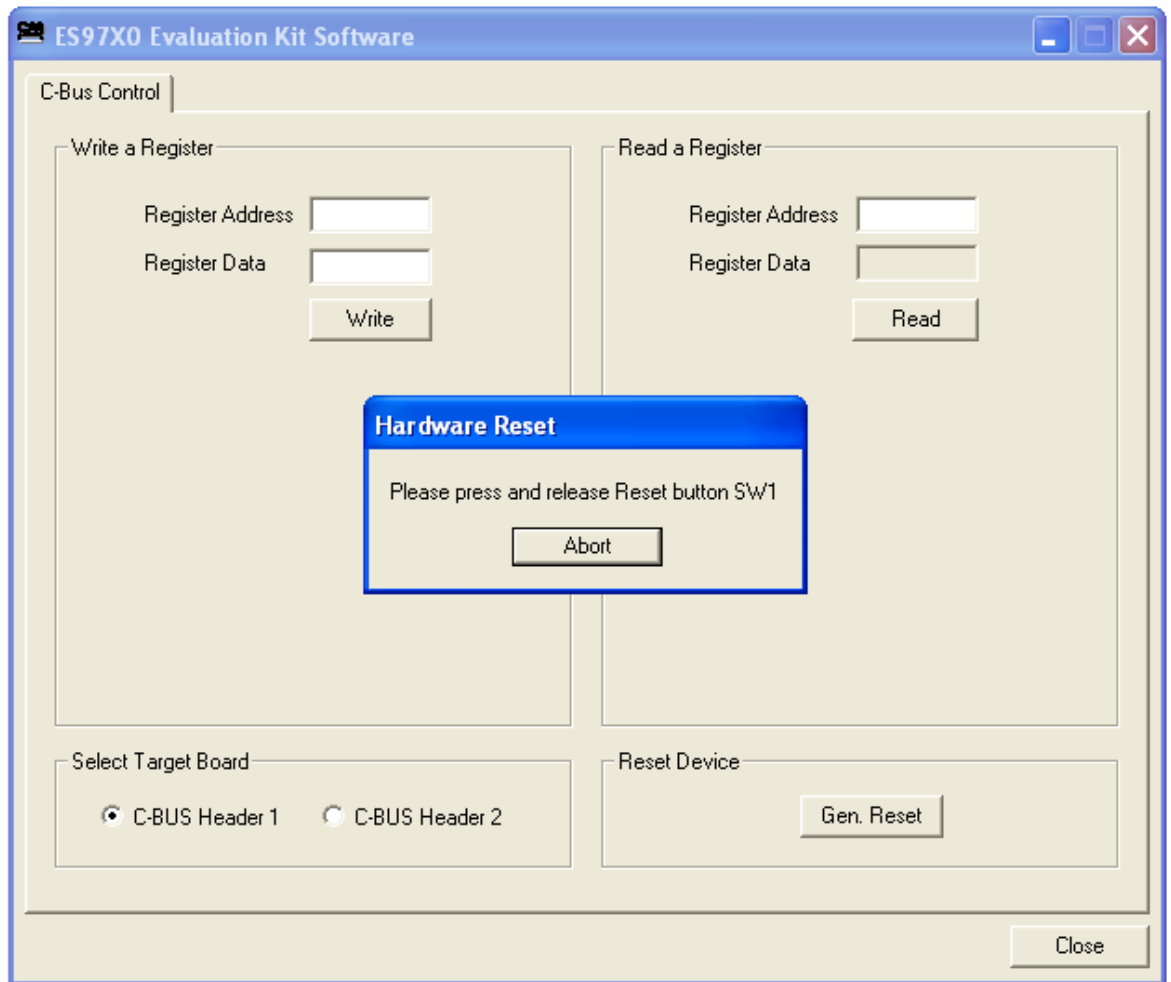


Figure 6 Reset Dialog Box

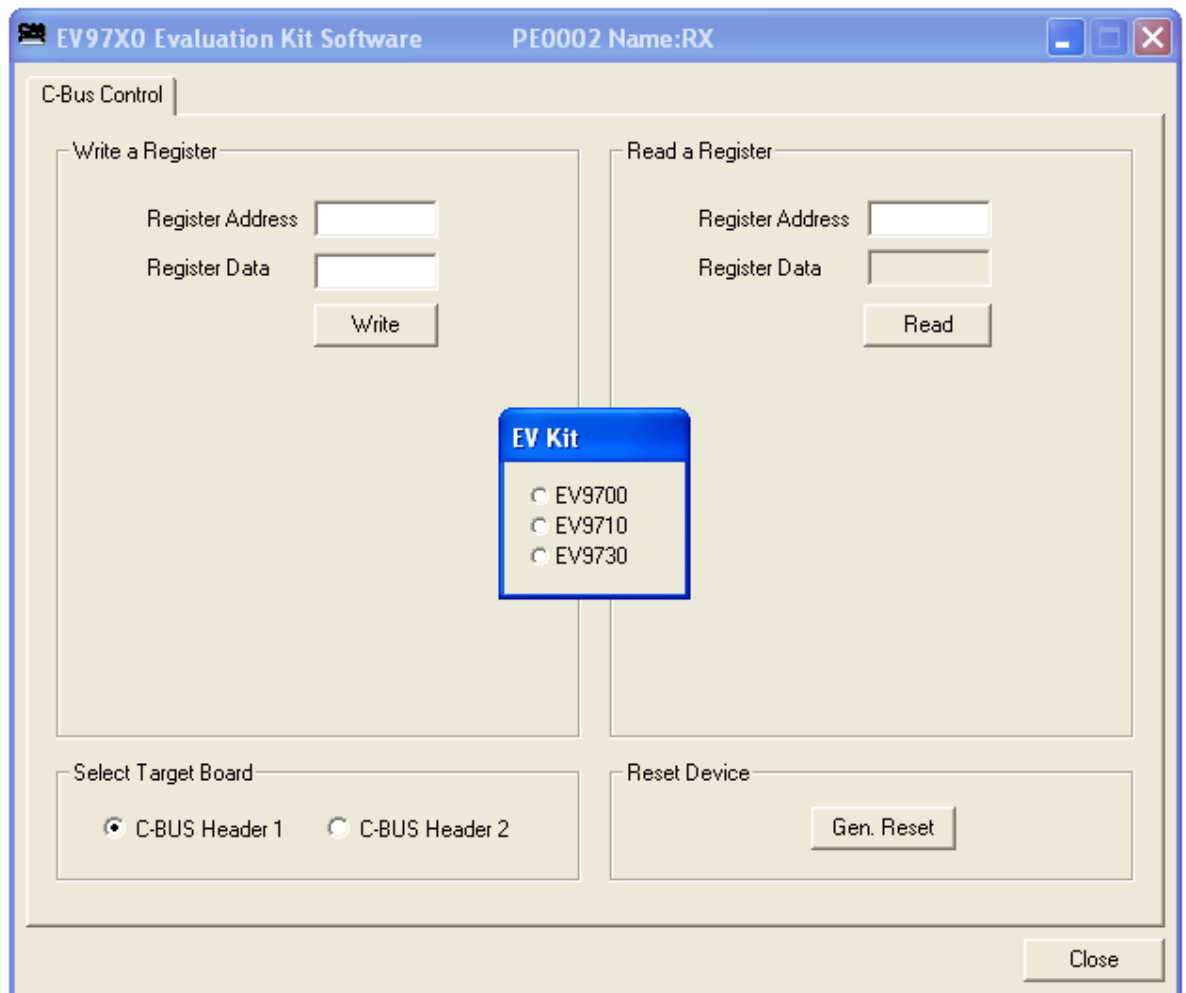


Figure 7 Product Selection Dialog Box

There are four tabs that represent a particular set of registers or a particular function of the CMX973. To select a tab simply click on the corresponding name in the row at the top of the program window. Setting or clearing the check box associated with a bit of a register will cause that bit to be set or cleared when the register is next written to. If the 'Auto Write' check box is set a register will be written whenever a check box or list box associated with it is modified. This removes the need to click the 'Write' button associated with that register. The program can be closed at any time by clicking the 'Close' button or by pressing 'Alt' and 'F4' keys simultaneously.

7.2.1 The C-BUS Control Tab

The C-BUS Control Tab allows the user to read from or write to any register or to issue a General Reset command, see Figure 8. The C-BUS header which is used can also be selected on this tab.

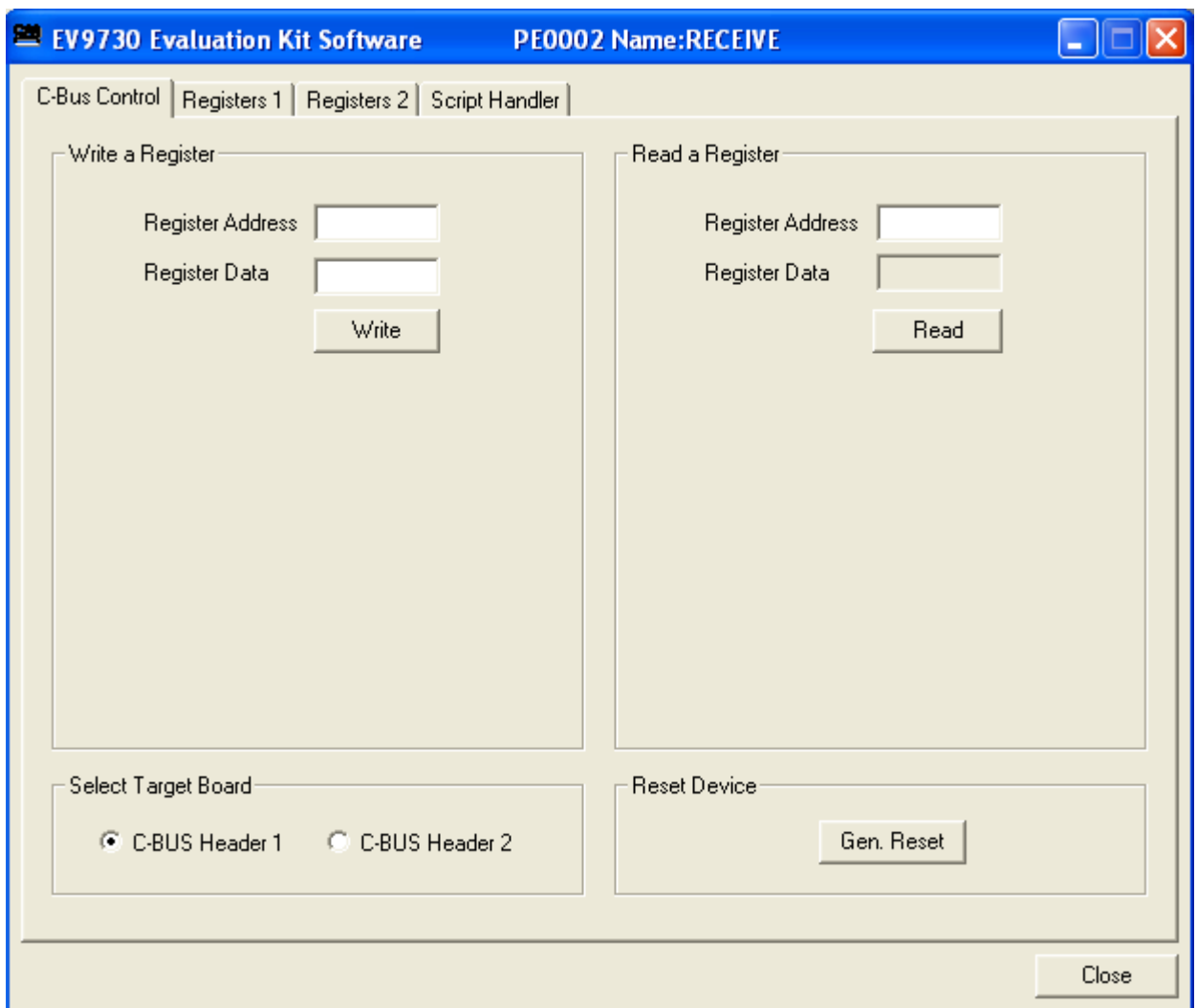


Figure 8 The CBUS Control Tab

To perform a General Reset on the CMX973, either the Gen. Reset button can be clicked or a single write can be made to register \$1A. The following script (see section 7.2.4), which may be used with the **ES9700xx** software, is recommended.

```

;General Reset.pes
;This script will send a C-BUS General reset.
;Reset C-BUS (assigns register RESET a zero length parameter to get a single 8-bit write)
;format: register <device (1 or 2)> <C-BUS address> <# parameter bytes (0 to 2)>

RESET const $1A
        register 1 RESET 0
        copy 0 *RESET

;If using C-BUS port 2 then use the following lines
;        register 2 RESET 0
;        device 2
;
;        copy 0 *RESET

```

7.2.2 The Registers 1 Tab

The Registers 1 tab gives the user access to the general control, Rx control, Rx mode and Tx Control registers, see Figure 9. Note that registers can be written to individually or as a whole mass register write (“Write All” in the bottom left hand corner of window). If Auto Write is checked, the register is changed as the user makes changes to the register window.

In the case of the TXLO Frequency a slide bar has been used to allow easy control during operation.

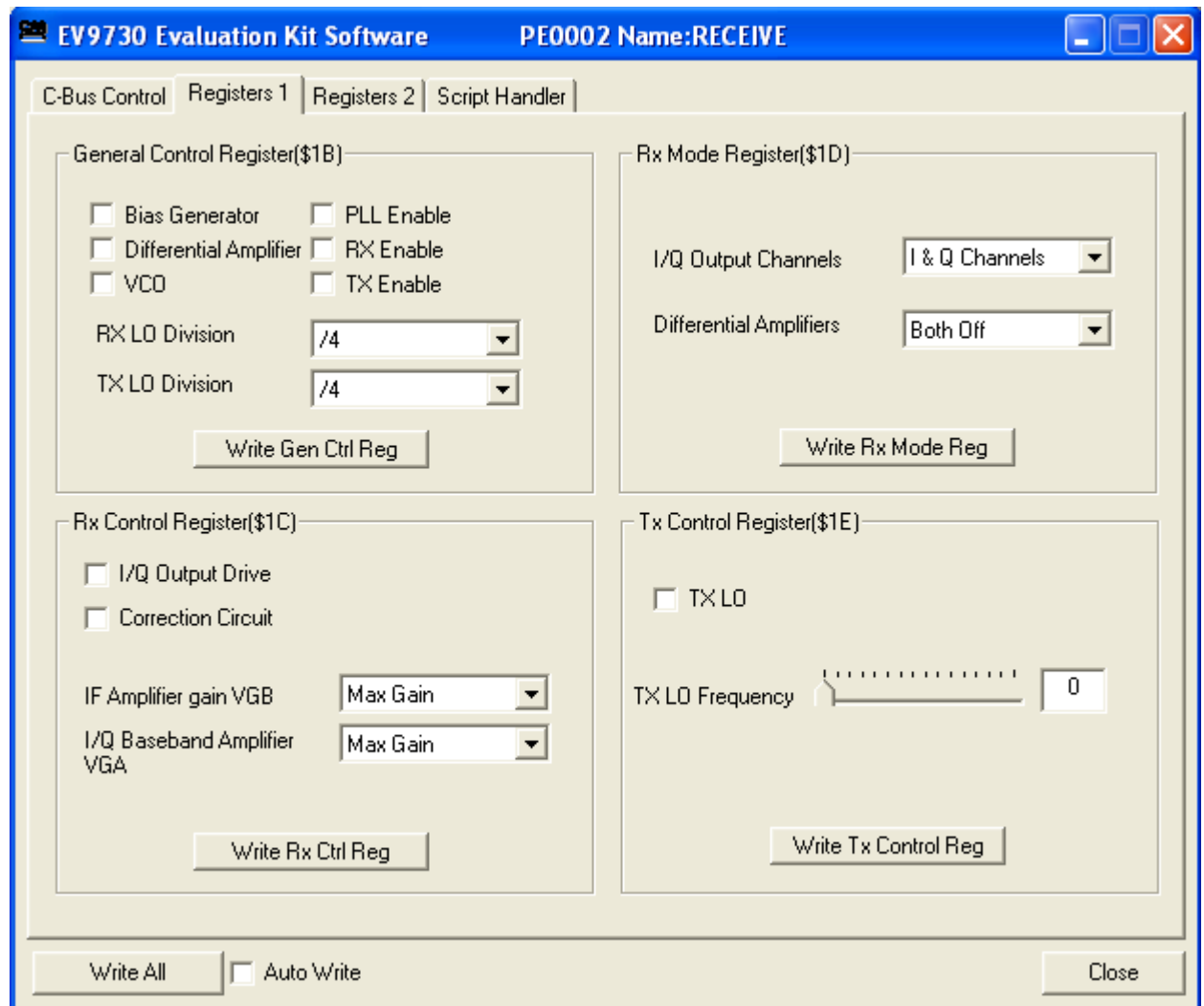


Figure 9 The Registers 1 Tab

7.2.3 The Registers 2 Tab

The Registers 2 tab gives the user access to the Rx Offset, VCO Control and PLL Divider Registers see Figure 10. Note that registers can be written to individually or as a whole mass register write (“Write All” in the bottom left hand corner of window). If Auto Write is checked, the register is changed as the user makes changes to the register window.

The PLL M/R Divider register window has a box which indicates the PLL lock detect states. The lock detect is read each time the PLL divider values are written and the status updated. The box will be blank to indicate PLL is out of lock and when the PLL is in lock the box will have an L in it.

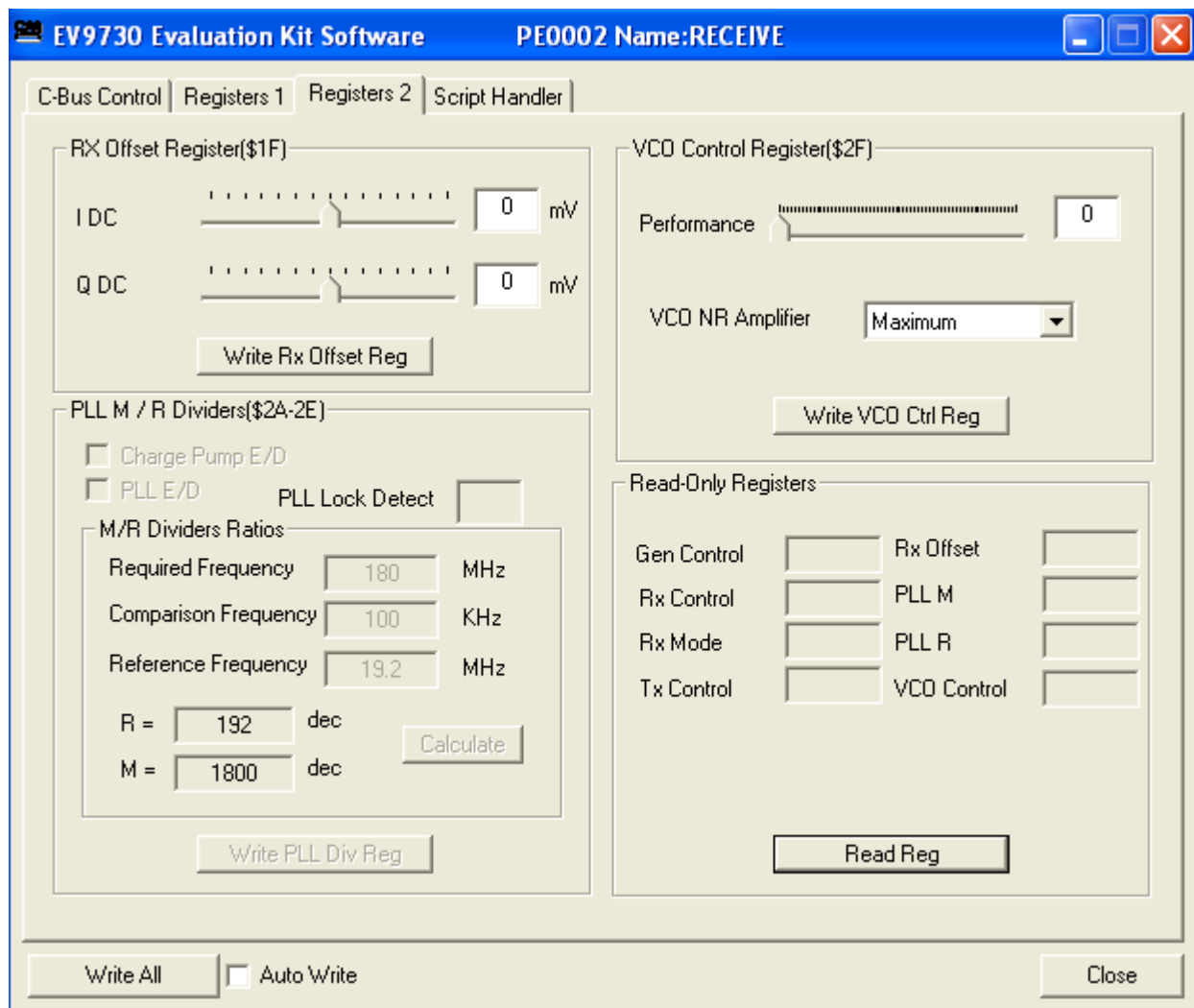


Figure 10 The Registers 2 Tab

7.2.4 The Script Handler Tab

The Script Handler Tab (shown in Figure 11) allows the execution of script files consisting of register write, read, and delay commands. These are plain text files on the PC, which are compiled via the GUI but executed by the E2 Microprocessor on the PE0002 board. The script language is documented separately in the “Script Language Reference” document, which can be downloaded with the PE0002 support package from the CML website. Control of the EV9730 does not require the use of script files.

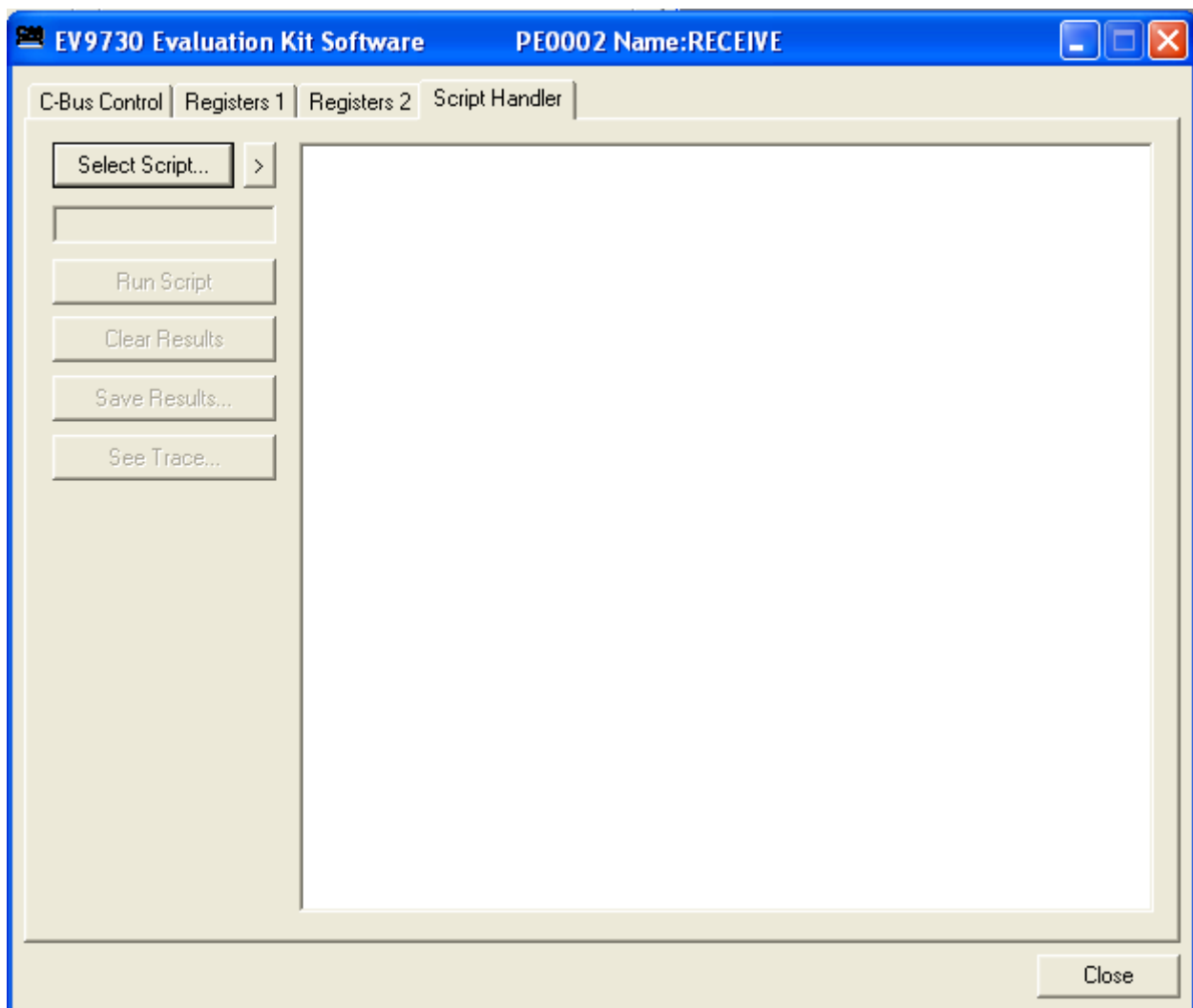


Figure 11 The Script Handler Tab

To select a script file, click on the 'Select Script' button. The Open File Dialog is displayed. Browse and select the script file. The folder that contains the script file will be the working folder of the script (i.e. all the files referenced in the script will be searched in this folder). Alternatively, select a script file from the recent files list. Click on the '>' button to display the list.

The results window displays the values returned by the script. These results can be saved to a text file or discarded by clicking on the 'Save Results' or 'Clear Results' buttons, respectively. When a script file is being executed the 'Run Script' button will change to be the 'Abort' button, the rest of the tab will be disabled and the other tabs cannot be selected.

After a script has finished running and when trace data is available, the 'See Trace...' button will be enabled. Up to 131072 C-BUS transactions can be logged in the PE0002 board. Click in the 'See Trace...' button to display the Trace dialog box. Note that the C-BUS transactions are only logged if the feature has been enabled in the script. See the "Script Language Reference" document for details.

7.3 Evaluation Tests

The EV9730 is intended to allow evaluation and demonstration of the CMX973 device. The following is a list of tests which can be performed, along with the typical EV9730 performance.

7.3.1 Quadrature Modulator

7.3.1.1 Single Tone Test

Apply a LO signal (J5) of 1GHz, -10dBm and a single tone I/Q input (J9) of 1Vp-p differential. Observing the results on a spectrum analyser the Tx output should look like the results in Figure 12. In Figure 12 the input signal on TXI/TXQ is a 7kHz tone in quadrature biased at 1.6Vdc.

From the plot it can be seen that at 500MHz the output level is ~ 0dBm, the image rejection is approximately 66dBc (delta marker 1) and the higher 3rd order product is ~ 46.4dBc (delta marker 2).

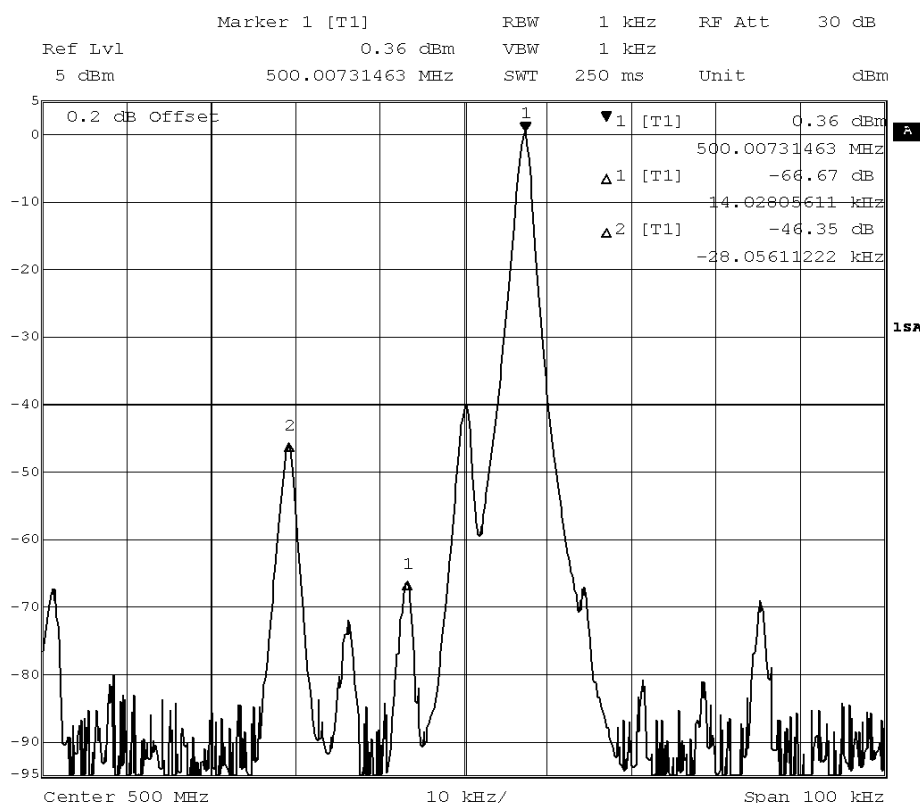


Figure 12 I/Q Modulator Output Spectrum with a Single Tone Input

7.3.1.2 Two Tone Test

Apply a LO signal (J5) of 1GHz, -10dBm and a two tone input to TXI and TXQ. The two tone test allows you to evaluate the linearity of the modulator. Figure 13 is a plot of the I/Q modulator output with a two tone input. The input signal comprises 7kHz and 9kHz tones of 1Vp-p differential in quadrature biased at 1.6Vdc.

From the plot it can be seen that at 500MHz the main output tone level is -6dBm, the highest IMD3 product ($2f_1 + f_2$) is 45.7dBc and the highest 3rd order product is ~ 57dBc.

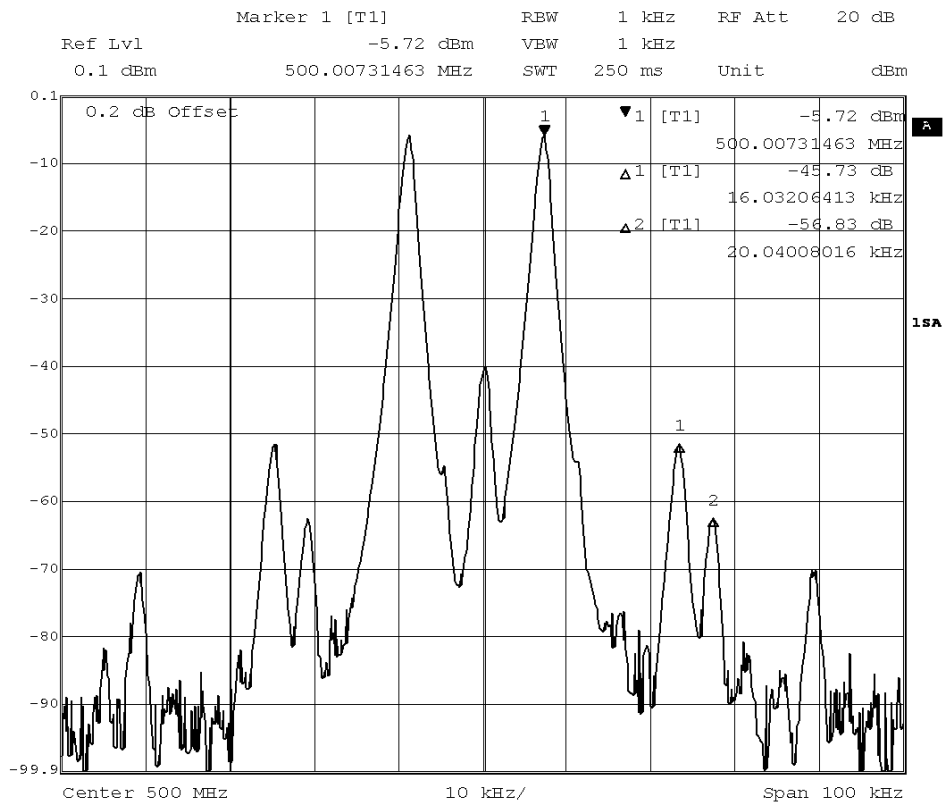


Figure 13 I/Q Modulator Output Spectrum with a Two Tone Input

7.3.2 Quadrature IF Demodulator

7.3.2.1 I/Q Signals

Apply a LO signal (J3) of 90MHz, -10dBm and a RF signal (J5) of 45.002MHz, -53dBm. Observing the results on an oscilloscope, the baseband I/Q outputs (J8) should look like the results shown in Figure 14. From this trace the peak to peak voltage of the RXQ- pin is 0.56V (RXQ = 1.12V differential) so the gain of the CMX973 can be calculated as 58dB.

From Figure 14, the 180 degree phase relationship between the RXn- and RXn+ signals can be observed and the 90 degree phase relationship between I and Q channels is also apparent.

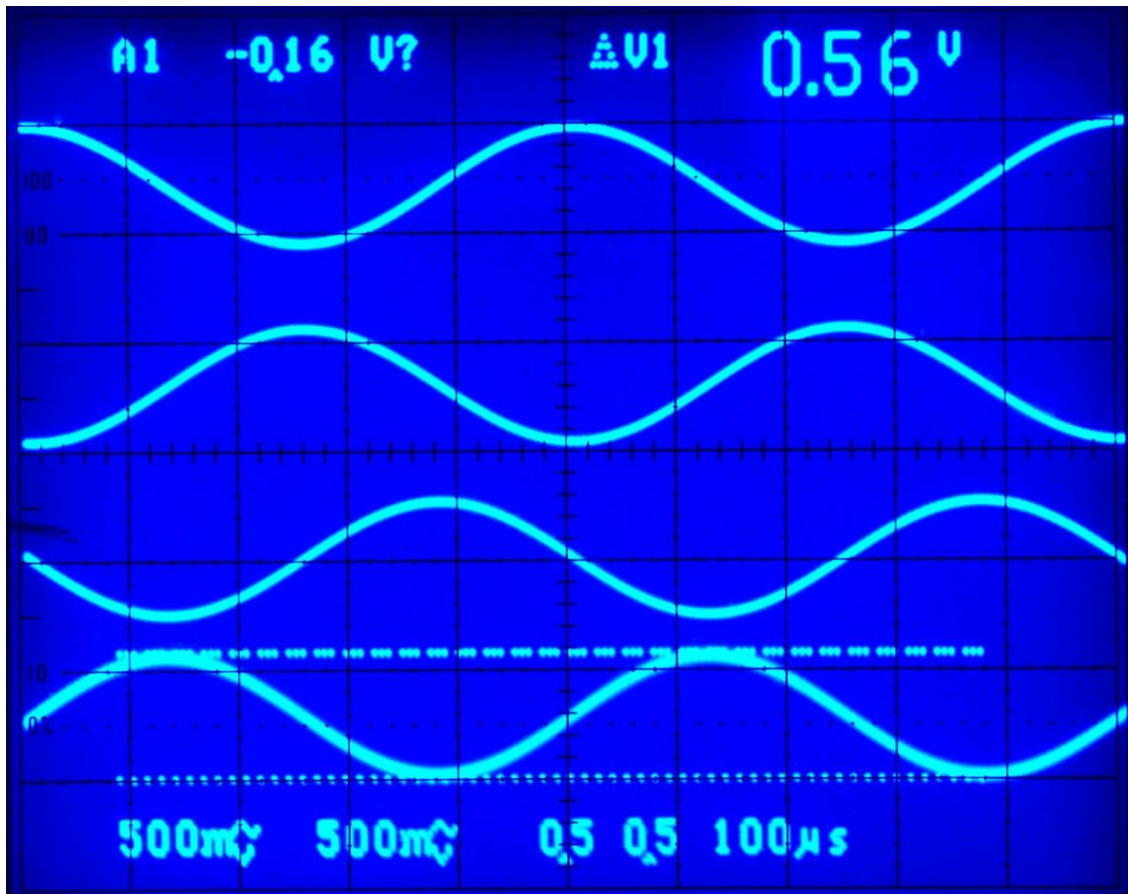


Figure 14 I/Q Output Signals

The signals, from bottom to top, are RXQ-, RXQ+, RXI-, RXI+

7.3.2.2 Noise Figure

By applying a -100dBm signal to the EV9730 receiver input (J5) it is easy to evaluate the system noise figure by measuring the signal to noise on either I/Q output.

For example, apply a LO signal (J3) of 90MHz, -10dBm and a RF signal (J5) of 45.002MHz, -100dBm. With these conditions the output I/Q signal is evaluated (Figure 15) and the noise figure can be calculated as follows (including an I/Q measurement correction factor of 3 dB):

$$\begin{aligned} \text{Noise figure} &= \text{SNR dB} - (-174 \text{ dBm/Hz} - (-100 \text{ dBm})) - 3\text{dB} \\ &= -60.5 + 74 - 3 \\ &= 10.5\text{dB} \end{aligned}$$

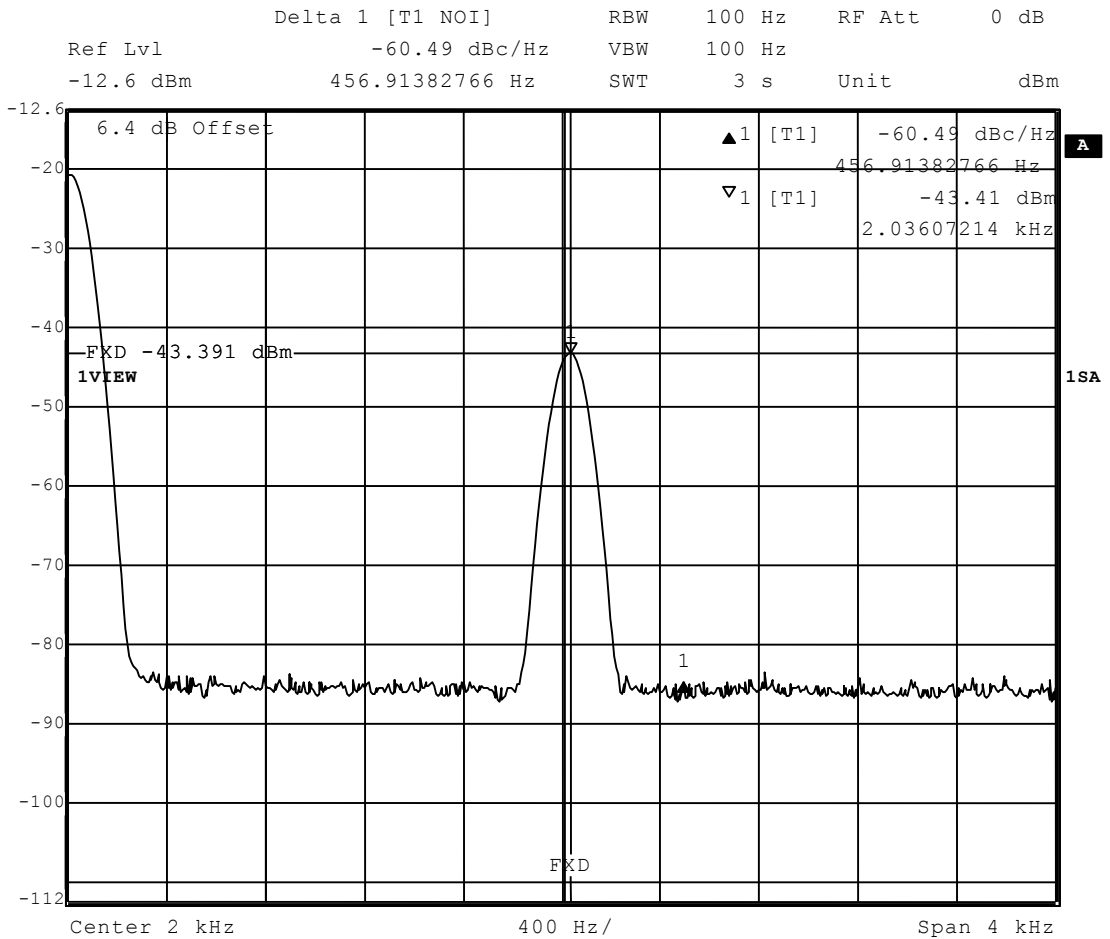


Figure 15 I/Q Signal to Noise Measurement

7.4 Troubleshooting

The CMX973 is a complex RF system. If incorrectly programmed or modified, results will be at variance from datasheet performance. Please study the CMX973 datasheet, this manual and the associated schematics and layout drawings carefully when troubleshooting.

This section provides suggestions to help users resolve application issues they might encounter.

7.4.1 General

Error Observed	Possible Cause	Remedy
'ES9700xx.exe' software fails to run correctly and reports an error during start up.	Faulty USB port or cable.	Check USB cable to your PC.
	PE0002 or EV9730 is not powered up during start up.	Power up PE0002 (5.0V) and EV9730 (7.2V).
	Incorrect software for PE0002.	Contact: techsupport@cmlmicro.com
Programming data to EV9730 does not appear to work.	The data is being programmed to the wrong C-BUS port on PE0002.	Check whether EV9730 is connected to PE0002 Port 1 (J5) or Port 2 (J3) and ensure the correct window is used for programming data. (See PE0002 user manual for further information).

Table 7 Possible General Errors

7.4.2 Quadrature Modulator Operation

Error Observed	Possible Cause	Remedy
No output from the modulator.	The transmitter and/or the bias has not been enabled. C-BUS Tx enable (\$1B, b0). C-BUS Bias enable (\$1B, b4).	Set C-BUS Tx enable (\$1B, b0='1') and set C-BUS Bias enable (\$1B, b4='1').
	No LO signal applied.	Check LO signal is present at sufficient drive level.
	The wrong Tx divider ratio has been selected (\$1B, b6)	Check CMX973 data sheet for details on register \$1B to ensure correct divider ratio is selected.
	The wrong LO path has been selected.	Check CMX973 data sheet for details on LO connections (Table 13) to ensure correct divider ratio is selected.
Carrier leakage high.	Each of the TXI/TXQ inputs are not at the same dc level (nominal is 1.6V dc).	Check the dc level on each of the four I/Q inputs is the same, nominally 1.6V dc.

Table 8 Possible Quadrature Modulator Errors

7.4.3 Quadrature IF Demodulator Operation

Error Observed	Possible Cause	Remedy
No output from the demodulator.	The demodulator and/or the bias has not been enabled. C-BUS Rx enable (\$1B, b1). C-BUS Bias enable (\$1B, b4).	Set C-BUS Rx enable (\$1B, b1='1') and set C-BUS Bias enable (\$1B, b4='1').
	No LO signal applied.	Check LO signal is present at sufficient drive level.
	The wrong Rx divider ratio has been selected (\$1B, b7)	Check CMX973 data sheet for details on register \$1B to ensure correct divider ratio is selected.
	The wrong LO path has been selected.	Check CMX973 data sheet for details on LO connections (Table 13) to ensure correct divider ratio is selected.

Table 9 Possible Quadrature IF Demodulator Errors

7.4.4 PLL/VCO Operation

Error Observed	Possible Cause	Remedy
PLL does not lock. (Lock detect bit = '0').	VCO or PLL is not enabled. M and R Divider setting are incorrect.	Check values of PLL registers \$2A to 2D. Check general control register \$1B.
	VCO has been programmed to a frequency outside its operating range.	Check VCO control voltage on CMX973 signal DO (pin 13 or TP3). If the voltage is at either supply rail, try a different frequency and observe the effect.

Table 10 Possible PLL/VCO Errors

8 Performance Specification

8.1 Electrical Performance

8.1.1 Absolute Maximum Ratings

Exceeding these maximum ratings can result in damage to the Evaluation Kit.

	Min.	Max.	Units
Supply Voltage ($V_{IN} - V_{SS}$)	0.0	8.4	V
Current into or out of V_{IN} and V_{SS} pins	0	+200	mA
Current into or out of any other connector pin	-20	+20	mA

8.1.2 Operating Limits

Correct operation of the EV9730 Evaluation Kit outside these limits is not implied.

	Notes	Min.	Max.	Units
Supply Voltage ($V_{IN} - V_{SS}$)		3.6	7.6	V

8.1.3 Operating Characteristics

For the following conditions unless otherwise specified: $V_{IN} - V_{SS} = 7.2V$, $T_{AMB} = +25^{\circ}C$.

	Notes	Min.	Typ.	Max.	Units
DC Parameters					
I_{DD} (CMX973 Powersaved)	1	–	1.5	–	mA
I_{DD} (CMX973 Modulator)	1	–	65	–	mA
I_{DD} (CMX973 Demodulator, PLL and VCO)	1	–	28	–	mA
AC Parameters					
Modulator					
Output					
Output Impedance		–	50	–	Ω
Frequency Range		20	–	1000	MHz
Output Power		–	–	0	dBm
I/Q Input Signal					
Differential Amplitude	2	–	–	1	Vp-p
DC Level		–	1.6	–	Vdc
Demodulator					
Input					
Frequency Range		20	–	300	MHz
I/Q Output Signal					
Differential Amplitude	3	–	440	–	mVp-p
DC Level		–	1.6	–	Vdc
45MHz Operation					
Gain	4	56	57	58	dB
Noise Figure		–	10	–	dB
Input Third Order Intercept Point		–	-15	–	dBm
LO Input					
Frequency Range	5	40	–	2000	MHz
Input Level		–	-10	–	dBm
Frequency Reference (U1)					
Frequency		–	19.2	–	MHz
Stability		–	1.5	–	ppm
C-BUS Interface					
See CMX973 data sheet					

- Notes:**
1. Total PCB current consumption, not current consumption of the CMX973 alone.
 2. Differential Input level required to achieve typical output level at 500MHz; 1Vp-p differential means 500mVp-p on each pin; if the modulator is driven single ended the input level should be 1Vp-p on TXIP and TXQP.
 3. 45MHz input at -60dBm at J5.
 4. Gain is measured from an unmatched IFIN to differential voltage measured at output of I or Q channels.
 5. Local oscillator input frequency twice or four times the required operating frequency.

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