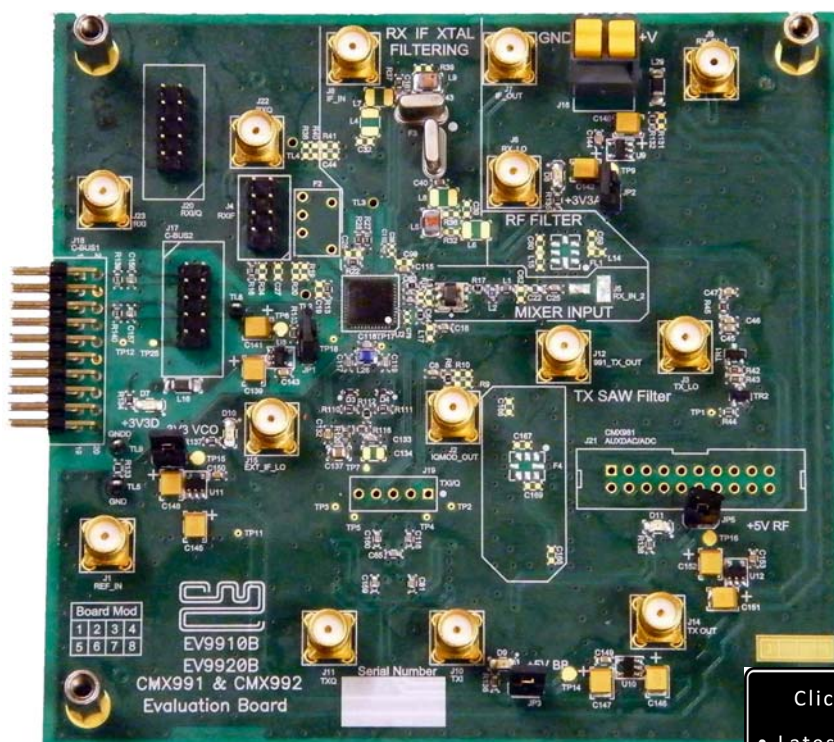


### Features

- **CMX991 and CMX992 Evaluation**
- **Receiver:**
  - LNA
  - I/Q or IF Output
  - Selectable IF Filters
  - Test Access
- **450-470 MHz default operation**
- **100MHz to 1GHz evaluation**
- **Transmitter (CMX991 Only)**
  - IF and RF Outputs
  - I/Q Input Interface
  - Gain Control
  - Optional o/p Filter and Buffer
- **PC control interface available**
- **Interface to EV9810 or EV9100**



Click here for:

- Latest Datasheet
- Product Data Resource

## 1. Brief Description

The EV9910B allows the evaluation of the CMX991 RF Quadrature Transceiver and the EV9920B allows the evaluation of the CMX992 Quadrature / Low IF Receiver. Both Evaluation Kits use the same printed circuit board, but with different components fitted. This User Manual is also common to both kits. The CMX991 is an RF Transceiver IC providing I/Q modulator and up-conversion, superheterodyne receiver and IF local oscillator. The CMX992 includes only the receiver and IF LO sections of the CMX991 and is ideal for applications that do not require the CMX991 transmitter, for example when a linearised transmitter is required, in which case the CMX998 Cartesian Loop Transmitter IC could be used for Tx and the CMX992 for Rx.

Access is provided to all CMX991 (CMX992) RF, baseband and control signals by either connector or test points. Test access points are available to accept common test equipments, such as RF and baseband signal generators and spectrum analysers. All signal paths are matched by suitable components. The EV9910B also provides an optional lumped bandpass filter plus buffer amplifier at 460MHz (default) to aid evaluation. The overall evaluation frequency range of this Evaluation Kit is for RF frequencies between 100MHz and 1GHz, with default operation over 450MHz to 470MHz. In the form of a populated PCB, this flexible Evaluation Kit enables users to configure and evaluate the CMX991 (CMX992) devices for various applications and frequency bands.

The on-board CMX991 (CMX992) is controlled via its C-BUS serial interface. The PE0002 Interface Card is available separately to support PC-based control of the EV9910B/EV9920B. The PE0002 uses ES9910xx.exe PC software, part of the ES9910xx.zip file, which is available from the CML website. This software enables the PE0002 to control either an EV9910B or an EV9920B Evaluation Kit.

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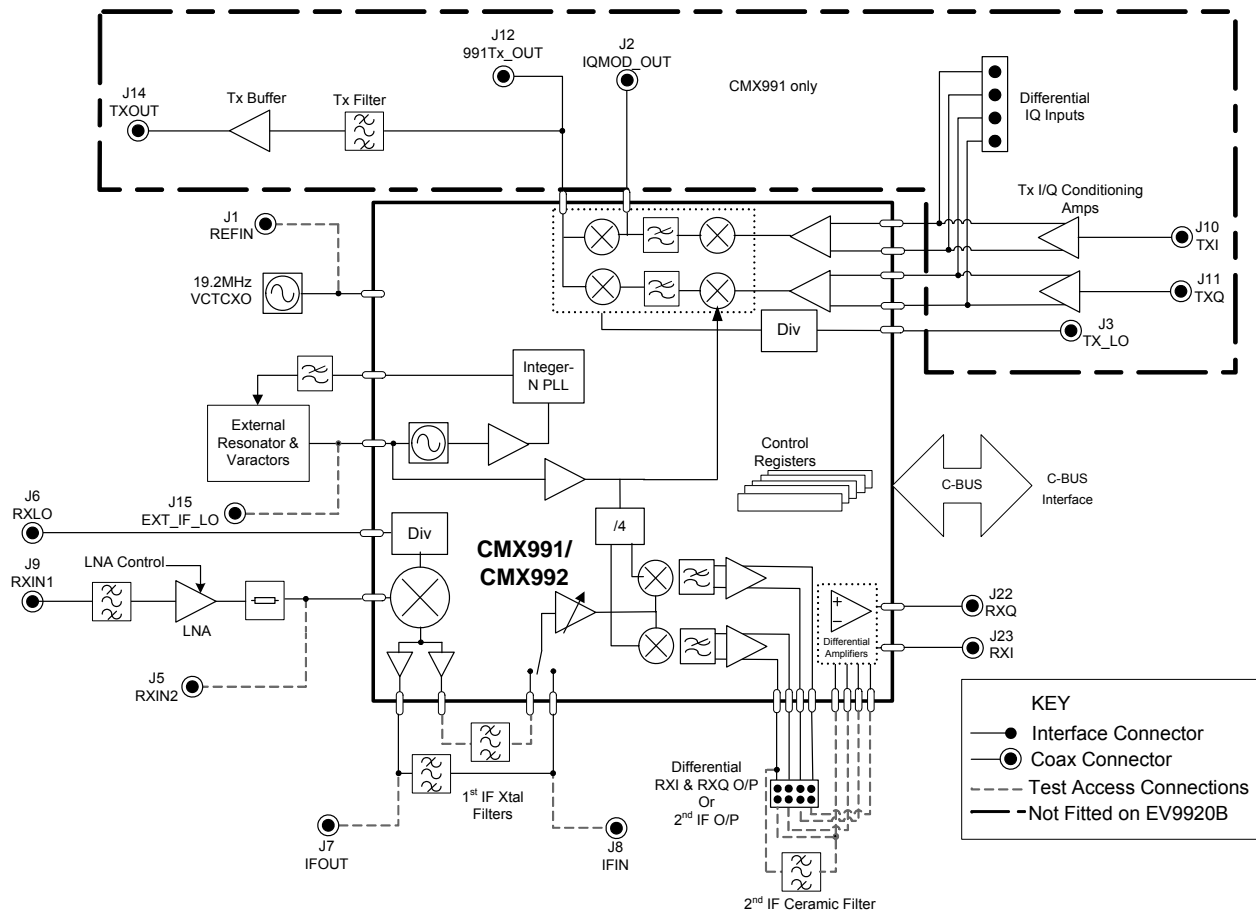
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It is always recommended that you check for the latest product datasheet version from the Datasheets page of the CML website: [www.cmlmicro.com].

This is Advance Information; changes and additions may be made to this specification. Parameters marked TBD or left blank will be included in later issues. Items that are highlighted or greyed out should be ignored. These will be clarified in later issues of this document. Information in this advance document should not be relied upon for final product design.



## 2. Preliminary Information

The EV9910B/EV9920B provides a platform for evaluation of either the CMX991 or the CMX992. The PCB is fitted with either a CMX991 (EV9910B) or a CMX992 (EV9920B).

To use the EV9910B/EV9920B, a separate PC or micro-controller is required to control the CMX991 (CMX992) via its C-BUS interface. This controller is not part of the EV9910B/EV9920B kit. A separate CML product (PE0002) is available which provides the controller functionality and interfaces to a standard PC by means of a USB cable.

Part Numbers:

- EV9910B – PCB fitted with CMX991 and fully populated.
- EV9920B – PCB fitted with CMX992 and with only LO and Receiver sections populated.
- PE0002 – Universal Controller Card which can be used for EV9910B/EV9920B.

**Note:** This kit is referenced generically as EV9910B/EV9920B throughout this document and this covers both build states: EV9910B and EV9920B. Where features are specific to EV9910B or EV9920B, this is noted, for example 'CMX991 only' implies the feature is only available on an EV9910B kit and not on kits supplied as EV9920B.

### 2.1. Laboratory Equipment

The following laboratory equipment is recommended for use with this evaluation kit:

- Power Supply (Dual Power Supply if using PE0002).
- Spectrum Analyser (100MHz to 1GHz)
- RF Signal Generator(s) (100MHz to 2GHz)
- I/Q Signal Source
- Oscilloscope
- Personal Computer + PE0002 or other C-BUS micro-controller

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

### 2.2. Power Supply

The supply input voltage to the PCB is 7.2V (5.25V to 8V acceptable). On board regulators are provided to generate all voltage rails used on the PCB (3.3V and 5V rails are used).

The 7.2V supply should be rated at 1A.

**NOTE:** Care should be exercised with the supplies, as they are not protected from reverse polarity.

**NOTE:** When using the EV9910B/EV9920B kit with a PE0002 kit, power is not supplied to the PE0002 via the C-BUS connector (J18). The PE0002 must be connected directly to a separate +5V regulated power supply.

#### Glossary

ADC	Analogue to Digital Converter
B/B	Baseband
BER	Bit Error Rate
C-BUS	4-Wire control interface, see CMX991 (CMX992) Datasheet
CW	Continuous Wave
DAC	Digital to Analogue Converter
DC	Direct Current
EMC	Electro-Magnetic Compatibility
ESD	Electro-Static Discharge
GUI	Graphical User Interface
IF	Intermediate Frequency
LNA	Low Noise Amplifier
LO	Local Oscillator
NF	Not Fitted
PA	Power Amplifier
PC	Personal Computer
PCB	Printed Circuit Board
PER	Packet Error Rate
PLL	Phase Locked Loop
RF	Radio Frequency
Rx	Receiver
SLI	Signal Level Indicator
TBD	To Be Decided
Tx	Transmitter
VCO	Voltage Controlled Oscillator
VGA	Variable Gain Amplifier

## **2.3. Handling Precautions**

Like most evaluation kits, this product is designed for use in office and laboratory environments. The following practices will help ensure its proper operation.

### **2.3.1. Static Protection**

This product uses 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.

### **2.3.2. Contents - Unpacking**

Please ensure that you have received all of the items on the separate information sheet (EK9910) and notify CML within 7 working days if the delivery is incomplete.

## **2.4. 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.**

### 3. Quick Start

This section provides instructions, in three steps, for users who wish to experiment immediately with the evaluation kit at 460MHz. This is the default frequency of the kit's hardware configuration. A more complete description of the kit and its use appears later in this document. The EV9910B includes a CMX991 and the EV9920B includes a CMX992 integrated circuit.

**Accordingly, before using the EV9910B/EV9920B, the user should read the current CMX991 or CMX992 datasheet.**

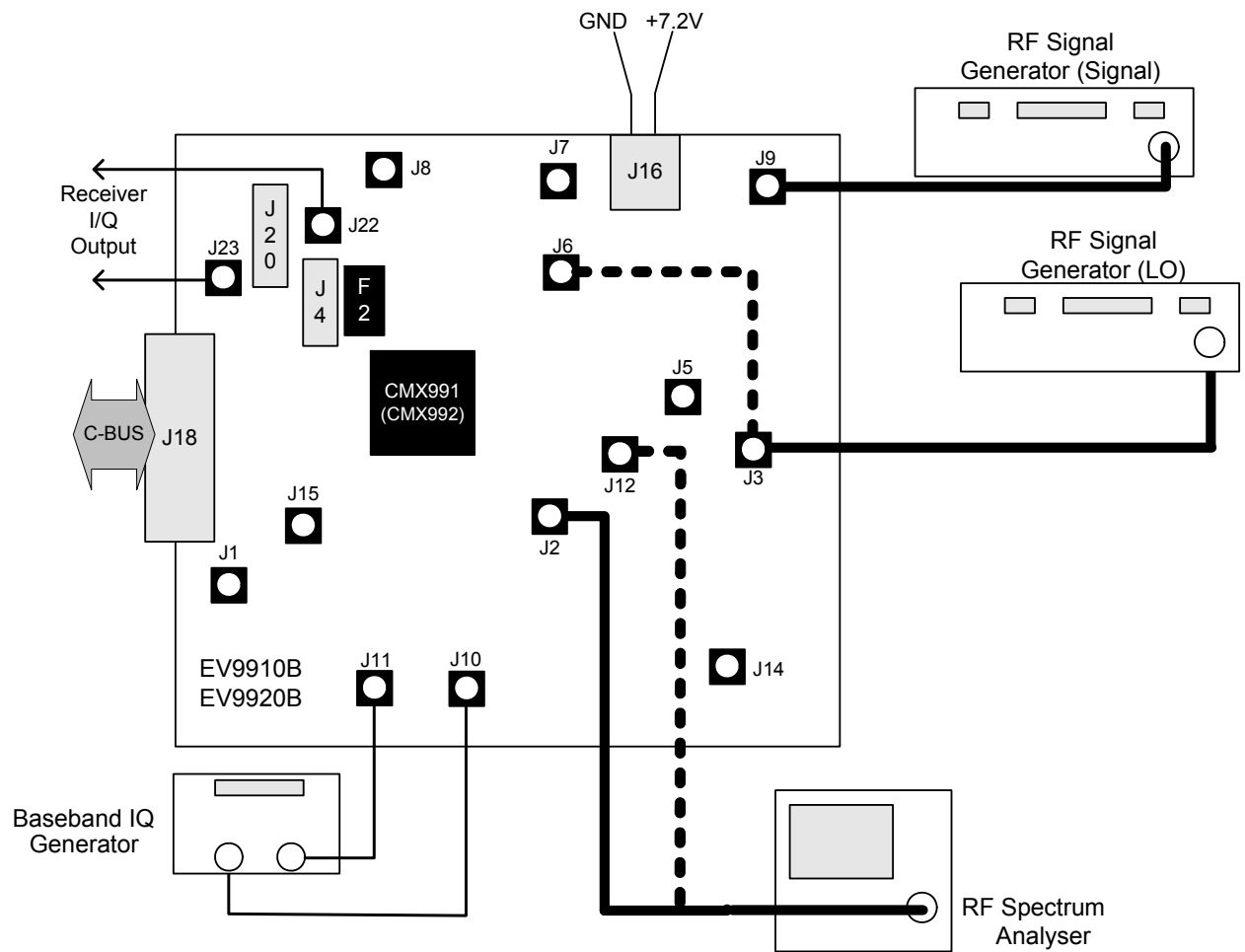
#### 3.1. First – Initial Setup

##### 3.1.1. Make External Connections and Apply Power

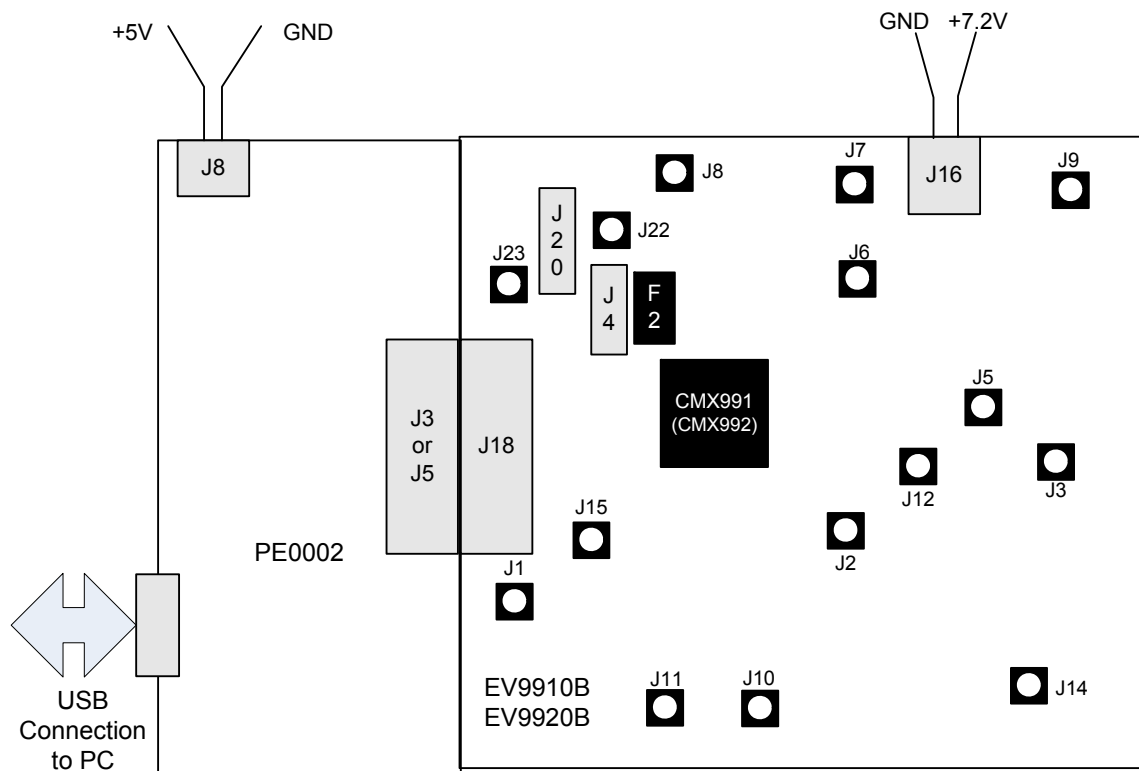
Perform the following steps in sequence:

1. Connect test leads as shown below in Figure 2.
2. Connect a Controller to C-BUS interface J17 or J18 (PE0002 can be used – see Figure 3).
3. Install PE0002 hardware/software and apply power to PE0002 – see section 3.1.2.
4. Power should be applied to the main supply (7.2V nominal).





**Figure 2 – Typical Evaluation Connections for EV9910B/EV9920B**



**Figure 3 – EV9910B/EV9920B Connection to PC Using PE0002**

### 3.1.2. Hardware/Software Installation (for PE0002)

- Copy the file 'ES9910xx.zip', which is downloaded from the CML website following registration, to the hard drive of your host PC. This is a customised version of the 'ES0002xx.zip' software.
- Extract the files to the hard drive of your host PC.
- Connect the PE0002 Interface Card to the EV9910B/EV9920B via the right angle connector, either J5 or J3. C-BUS port 1 (connector J5) is recommended, for full software functionality.
- Connect a dc supply to the PE0002 Interface Card and set to the voltage level to 5V.
- Connect a dc supply to the EV9910B/EV9920B and set voltage level to 7.2V.
- 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 power on indicator D6 will light.
- Install the USB driver when requested. The driver is in the same folder where the 'ES9910xx.zip' files were extracted to, in '..\Driver'. Follow instructions on the screen to install the USB driver. Click the 'Continue Anyway' button when the Message Box in Figure 4 is shown.

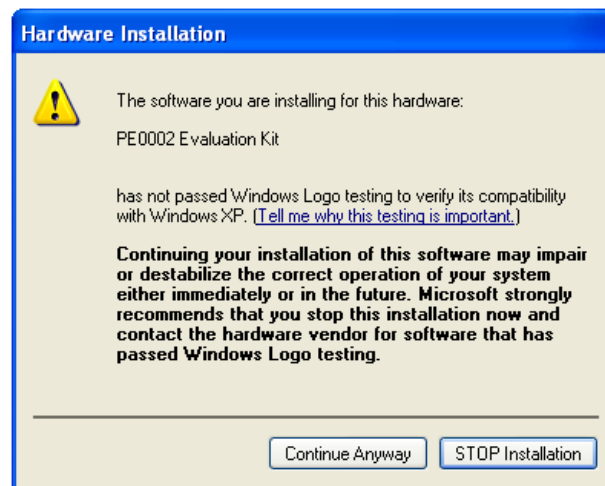


Figure 4 – USB Driver Installation Message Box

### 3.2. Second – Configure

In this second step the EV9910B/EV9920B is configured for either Rx (CMX991 and CMX992) or Tx (CMX991 only) operation.

#### 3.2.1. Rx Configuration

The following steps should be undertaken to configure the CMX991 or CMX992 to receive at 460MHz with an I/Q output. The EV9910B/EV9920B default IF frequency of the receiver is 45MHz and the channel filtering is typical for a 25kHz channel spaced system. Set the applied signals and register values as per the following table.

**Note:**

Setting the CMX991 (CMX992) registers requires the use of the host connected as per section 3.1 step 3, above. The CMX991 (CMX992) datasheets give details of the registers and commands.

Signal or Register	Setting	Connector	Note
RX_LO input	1010MHz at -10dBm	J6	This frequency is twice the LO frequency that will be used in the CMX991/2
RXIN1	460.005MHz	J9	The input level here is user defined: for an input signal of -60dBm at J9 the typical single ended output level would be ~450mVp-p at J4 pin 1. The output should be 5kHz sine and cosine waves on I and Q when the configuration in this table is completed
RXI/RXQ	Rx I/Q output (see register setting later in table to select I/Q output)	J22, J23 J4, J20	The J22/23 outputs use the on-chip baseband differential amplifiers to convert I and Q differential signals to single ended. These are only active if the J4 links 1-2, 3-4, 5-6, and 7-8 are fitted. The differential I and Q signals can be taken from J4 or J20

Signal or Register	Setting	Connector	Note
General Reset CMX991/992 register (\$10)	To ensure the device and hardware are in known states issue the general reset command.		The 'General Reset' button can be used, as this writes to register \$10
CMX991/2 General Control register (\$11)	The CMX991/2 general control register should be set as follows: <ul style="list-style-type: none"> <li>• IF&lt;75MHz [b6]</li> <li>• NR Minimum [b3-b2]</li> <li>• I/Q Mode [b5 – b4]</li> </ul> Also enable the: <ul style="list-style-type: none"> <li>• Bias generator</li> <li>• VCO Buffer</li> <li>• VCO NR Amp</li> </ul>		
Rx Control register (\$12)	Select the LO/2 mode and enable the following: <ul style="list-style-type: none"> <li>• Rx 1<sup>st</sup> Mixer</li> <li>• IF Amp/VGA, I/Q Mixers and B/B filters</li> <li>• B/B Differential Amps</li> <li>• LNA Control Signal</li> </ul>		If the Rx Signal Level Indication (SLI) output is required this is enabled in this register
Rx Mode register (\$13)	For maximum Rx gain the VGA attenuation should be set at 0dB. Select the following: <ul style="list-style-type: none"> <li>• I/Q Filter BW = 100kHz</li> <li>• MIXOUT1 and IFIN1</li> </ul>		Default EV9910B/EV9920B build uses MIXOUT1 from the 1 <sup>st</sup> Mixer and the IFIN1 to the IF stages
PLL M and N Dividers register (\$20-23)	Enable the following: <ul style="list-style-type: none"> <li>• Charge pump</li> <li>• PLL</li> </ul> The default settings for the IF LO are as follows: <ul style="list-style-type: none"> <li>• Required frequency = 180MHz</li> <li>• Comp frequency = 100kHz</li> <li>• Ref frequency = 19.2MHz</li> </ul>		<p>The default values would be M = 192 and N = 1800</p> <p>Note: If an external LO is to be used (see 6.2.3) the PLL circuitry (b7 in register \$21) and the NR amplifier (b0 in register \$11) should be disabled. The VCO Buffer (b1 in register \$11) should be enabled</p>

### 3.2.2. Tx Configuration (CMX991 Only)

In order to configure the CMX991 to transmit at 460MHz with an I/Q input, an IF frequency of 90MHz and a typical output power of –8dBm on J12, set the applied signals and register values as per the following table. (Setting CMX991 registers requires the use of the host connected per section 3.1 step 3, above. The CMX991 datasheet gives details of the registers and commands).

Signal or Register	Setting	Connector	Note
TX_LO input	740MHz at -10dBm	J3	
I and Q baseband inputs	10kHz sine wave on I and 10kHz cosine wave on Q. 1V pk-pk, 0V DC. The I/Q input tones should be in quadrature (Note: See also section 6.5.3 regarding I/Q connections)	J10, J11	These inputs must be connected to 0VDC; do not leave them unconnected or open circuit
Tx Output	50Ω output at 460MHz	J12	An optional filter and amplifier can be linked into circuit to reduce spurious. In this case, Tx Out is available at J14. As default, J14 is not configured for use
General Reset CMX991 register (\$10)	To ensure the device and hardware are in known states issue the general reset command		The 'General Reset' button can be used, as this writes to register \$10
CMX991 General Control register (\$11)	The CMX991 general control register should be set as follows: <ul style="list-style-type: none"> <li>• IF &gt; 75MHz [b6]</li> <li>• NR Minimum [b3-b2]</li> <li>• I/Q Mode [b5 – b4]</li> </ul> Also enable the: <ul style="list-style-type: none"> <li>• Bias generator</li> <li>• VCO Buffer</li> <li>• VCO NR Amp</li> </ul>		
Tx Control Register (\$14)	Set the LO operating mode to >600MHz, the I/Q modulator should be connected to the image reject mixer and enable the following; <ul style="list-style-type: none"> <li>• Image Reject Mixer</li> <li>• I/Q Modulator, filters and input circuits</li> </ul>		
Tx Mode Control Register (\$15)	Select the following; <ul style="list-style-type: none"> <li>• TxIF Filter BW = 120MHz</li> <li>• <math>F_{rf} = F_{lo} + F_{if}</math></li> <li>• RFLO /2 mode</li> <li>• IFLO /2 mode</li> </ul>		Both the RF and the IF LO dividers need to be in /2 mode and this results in a low side mix with an IF of 90MHz
Tx Gain Register (\$16)	The I/Q input gain should be set to 0dB gain		The 0dB gain setting should be used with a differential input level of 2Vp-p.
PLL M and N Dividers register (\$20-23)	Enable the following: <ul style="list-style-type: none"> <li>• Charge pump</li> <li>• PLL</li> </ul>		The default values would be M = 192 and N = 1800

	<p>The default settings for the IF LO are as follows:</p> <ul style="list-style-type: none"> <li>• Required frequency = 180MHz</li> <li>• Comp frequency = 100kHz</li> <li>• Ref frequency = 19.2MHz</li> </ul>		<p>Note: If an external LO is to be used (see 6.2.3) the PLL circuitry (b7 in register \$21) and the NR amplifier (b0 in register \$11) should be disabled. The VCO Buffer (b1 in register \$11) should be enabled</p>
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### 3.3. Third – Operate

Following the configuration procedures given in sections 3.1 and 3.2, the EV9910B/EV9920B should be operating as a receiver or a transmitter, as appropriate. Various evaluation tests can now be undertaken.

For the receiver, the typical single ended output level is 400-450mVp-p on each of the I and Q channels (e.g. J4 pin 1) with a –60dBm input signal level. For the suggested 460.005MHz CW input signal the output should be 5kHz sine and cosine waves on I and Q.

(Note: See also section 6.5.3 regarding I/Q connections)

#### 4. Signal Lists

CONNECTOR PINOUT				
Connector Ref.	Connector Pin No.	Signal Name	Signal Type	Description
J1	N/A	REFIN	RF	Input for external reference source for PLL. To use this input C3 needs to be fitted to the PCB and C4 removed.
J2 <sup>1</sup>	N/A	IQMOD_OUT	RF	Tx I/Q Modulator Output (50Ω), this output has to be selected in the Tx Control Register (\$14 – b0)
J3 <sup>1</sup>	N/A	TX_LO	RF	Transmitter main LO input
J4	1,3	RXI+, RXI-	Baseband	Receiver I differential output
J4	8, 5	RXQ+, RXQ-	Baseband	Receiver Q differential output
J4	2	IAMPN	Baseband	I channel amplifier negative input (R14 in series)
J4	4	IAMPP	Baseband	I channel amplifier positive input (R16 in series)
J4	6	QAMPP	Baseband	Q channel amplifier positive input (R27 in series)
J4	7	QAMPN	Baseband	Q channel amplifier negative input (R28 in series)
J5	N/A	RXIN2	RF	Input to Rx 1 <sup>st</sup> Mixer or access to LNA output. To use this connector fit C25 and remove R49.
J6	N/A	RX_LO	RF	Receiver main LO Input
J7	N/A	IF OUT	RF	Receiver IF output from 1 <sup>st</sup> mixer (Note this connector provides test access and must specifically be configured for a particular measurement; default state is not connected.)
J8	N/A	IF IN	RF	Receiver 1 <sup>st</sup> IF input (Note this connector provides test access and must specifically be configured for a particular measurement; default state is not connected.)
J9	N/A	RXIN1	RF	Receiver LNA input
J10 <sup>1</sup>	N/A	TXI	Baseband	Transmitter I Channel Input
J11 <sup>1</sup>	N/A	TXQ	Baseband	Transmitter Q Channel Input (See also section 6.5.3 regarding I/Q connections)
J12 <sup>1</sup>	N/A	991_TX_OUT	RF	Transmitter Image Reject Mixer Output
J13	N/A	N/A	N/A	not fitted
J14 <sup>1</sup>	N/A	TX OUT	RF	Tx Buffer Output (default state is not configured)

<sup>1</sup> EV9910B only

CONNECTOR PINOUT				
Connector Ref.	Connector Pin No.	Signal Name	Signal Type	Description
J15	N/A	EXT_IF_LO	RF	External IF LO input (See section 6.2.3 concerning use of this input)
J16	2	+7.2V	DC	7.2V power supply input
J16	1	GND	DC	Power supply ground
J17	1 – 10	Alternative C-BUS Interface	Logic	Alternative header for C-BUS interface (Default C-BUS connection is J18)
J18	1 – 20	C-BUS Interface	Logic	C-BUS interface from PE0002 or host controller. See schematics, CMX991 (CMX992) datasheet and Table 2 for details.
J19 <sup>1</sup>	1, 2, 4, 5	TXQ+, TXQ- TXI-, TXI+	Baseband	Differential I/Q input, e.g. from a CMX981 evaluation board (EV9810) (See also section 6.5.3 regarding I/Q connections)
J19 <sup>1</sup>	3	GND	DC	Connection to Analogue Ground
J20	2, 4, 8, 10	RXI+, RXI- RXQ-, RXQ+	Baseband	Differential I/Q output
J20	5	GND	DC	Connection to Analogue Ground
J20	1,3,7,9	NC	-	No connection
J21	1 – 20	ADC/DAC Interface	Baseband	Auxiliary ADC/DAC connector – <i>not fitted</i> (e.g. for connection to EV9810, see Table 3)
J22	N/A	RXQ	Baseband	Receiver Q channel output from QAMPO
J23	N/A	RXI	Baseband	Receiver I channel output from IAMPO

Table 1 – Signal List

**Notes:**

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

<sup>1</sup> EV9910B only



CONNECTOR PINOUT for J18			
Connector Pin No.	Signal Name	Signal Type	Description
1	RESET	I/P	General RESET (RESET active low)
2	CSN	I/P	C-BUS Enable
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.
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 1 Interface

<b>CONNECTOR PINOUT for J21 – connector not fitted</b>			
<b>Connector Pin No.</b>	<b>Signal Name</b>	<b>Signal Type</b>	<b>Description</b>
1	AUXADC2	O/P	TP30
3	AUXADC1	O/P	Receiver Signal Level Indicator (SLI)
5	AUXADC3	O/P	TP26
7	AUXADC4	O/P	TP27
9	AUXADC5	O/P	TP28
11	AUXADC6	O/P	TP29
13	AUXDAC2	I/P	TL8
15	AUXDAC1	I/P	suitable for an external PA Control signal
17	AUXDAC3	I/P	AFC
19	AUXDAC4	I/P	TP19
2, 4, 6, 8, 10, 12, 14, 16, 18, 20	GNDD	Power	Connection to digital ground

**Notes:**

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

Table 3 – EV9810 Auxiliary ADC/DAC Interface

<b>TEST LOOPS</b>		
<b>Test Loop Ref.</b>	<b>Default Measurement</b>	<b>Description</b>
TL1	-	This TL is not present on EV9910B/EV9920B
TL2	0V	RXI (IAMPO) – default state is not fitted
TL3	1.9V	Receiver Signal Level Indicator (SLI) – default state is not fitted
TL4	0V	RXQ (QAMPO)
TL5	0V	Analogue ground
TL6	0V	C-BUS RDATA
TL7	-	This TL is not present on EV9910B/EV9920B
TL8	-	This TL is not present on EV9910B/EV9920B
TL9	0V	Digital ground

Table 4 – Test Loops

TEST POINTS		
Test Point Ref.	Default Measurement	Description
TP1	3.25V	LNA ON
TP2	1.6V	TXI+
TP3	1.6V	TXQ+ (See also section 6.5.3 regarding I/Q connections)
TP4	1.6V	TXI-
TP5	1.6V	TXQ- (See also section 6.5.3 regarding I/Q connections)
TP6	-	J21 Pin 15 (AuxDAC1 on separate EV9810 board if connected to EV9910B/EV9920B)
TP7	1.0V – 2.5V	CMX991/CMX992 IF VCO tuning voltage (1.7V typical)
TP8	3.3V	3.3V regulator output for digital circuits
TP9	3.3V	3.3V regulator output for analogue circuits
TP10	-	J21 Pin 13 (AuxDAC2 on separate EV9810 board if connected to EV9910B/EV9920B)
TP11	1.65V	AFC (VCTCXO Control Voltage)
TP12	-	C-BUS IRQN not used in EV9910B / EV9920B
TP13		This TP is not present on EV9910B/EV9920B
TP14	5.0V	5.0V regulator output for baseband circuits
TP15	3.3V	3.3V regulator output for VCO/PLL circuits
TP16	5.0V	5.0V regulator output for RF circuits
TP17	1.6V	VBIAS
TP18	3.3V	VDDIO
TP19	-	J21 Pin 19 (AuxDAC4 on separate EV9810 board if connected to EV9910B/EV9920B)
TP20	0V	GNDA (NOT MARKED ON SILK SCREEN)
TP21	-	Spare CS1 (J17)
TP22	-	Spare CS2 (J17)
TP23	-	Spare CS3 (J17)
TP24	-	Spare CS4 (J17)
TP25	-	IRQN (J17 not used in EV9910B / EV9920B)
TP26	-	J21 Pin 5 (AuxADC3 on separate EV9810 board if connected)
TP27	-	J21 Pin 7 (AuxADC4 on separate EV9810 board if connected)
TP28	-	J21 Pin 9 (AuxADC5 on separate EV9810 board if connected)
TP29	-	J21 Pin 11 (AuxADC6 on separate EV9810 board if connected)
TP30	-	J21 Pin 1 (AuxADC2 on separate EV9810 board if connected)

Table 5 – Test Points

Jumper Links		
Ref.	Default Setting	Description
JP1	Connected	+3.3V digital power supply rail
JP2	Connected	+3.3V analogue power supply rail
JP3	Connected	+5.0V baseband power supply rail (EV9910B only)
JP4	Connected	+3.3V VCO/PLL power supply rail
JP5	Connected	+5.0V RF power supply rail
J4	Open	Note: Jumpers can be used on J4 (see Table 1) to configure receiver outputs for I/Q output or connection to 455kHz filter.

Table 6 – Jumper Links

## 5. Circuit Schematics and Board Layouts

For clarity, circuit schematics are available as separate high-resolution files. These can be obtained via the CML website.

The layout on each side of the PCB is shown in Figure 5 and Figure 6, below.

(Note: See also section 6.5.3 regarding I/Q connections)

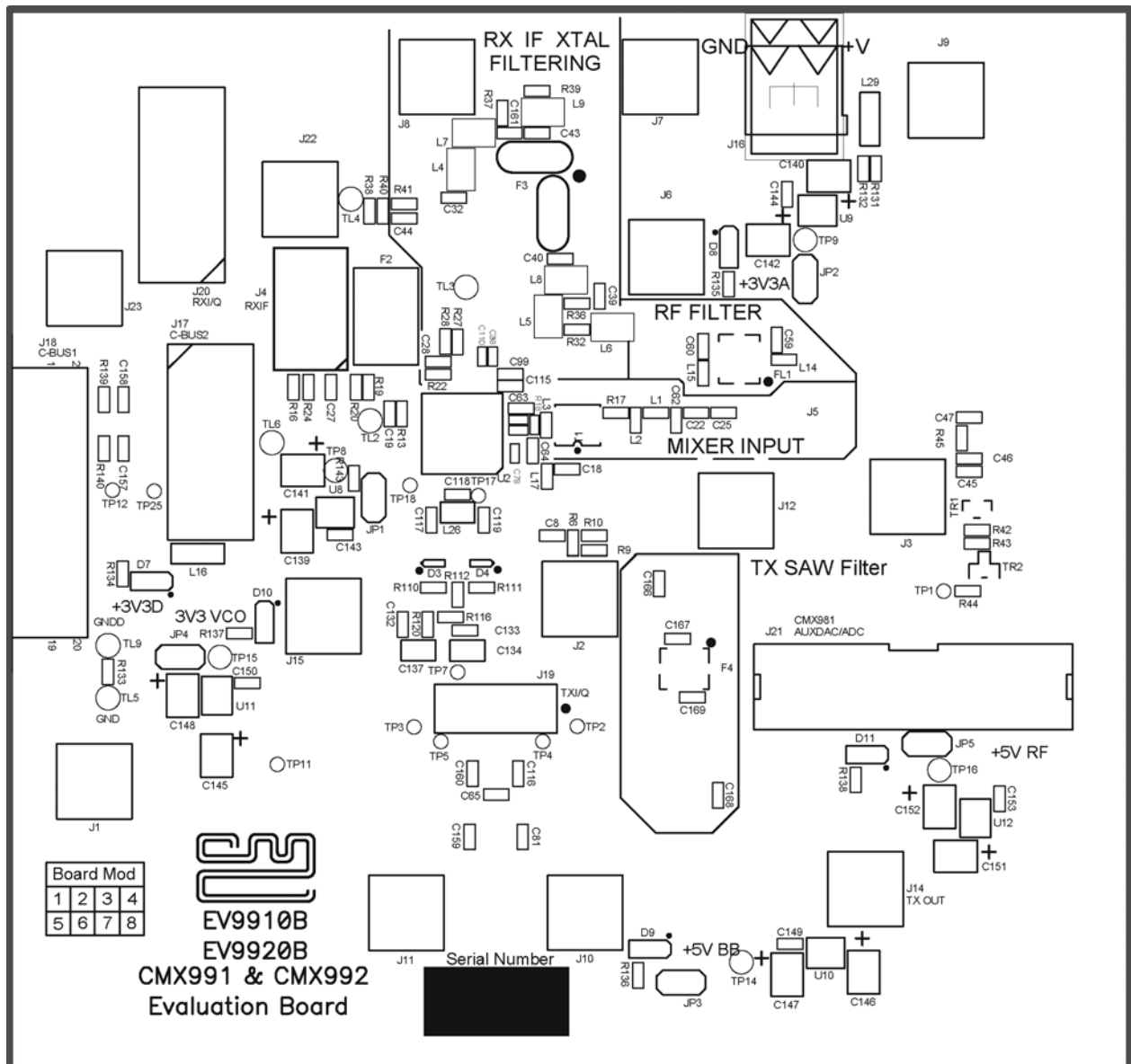


Figure 5 – PCB Layout: top

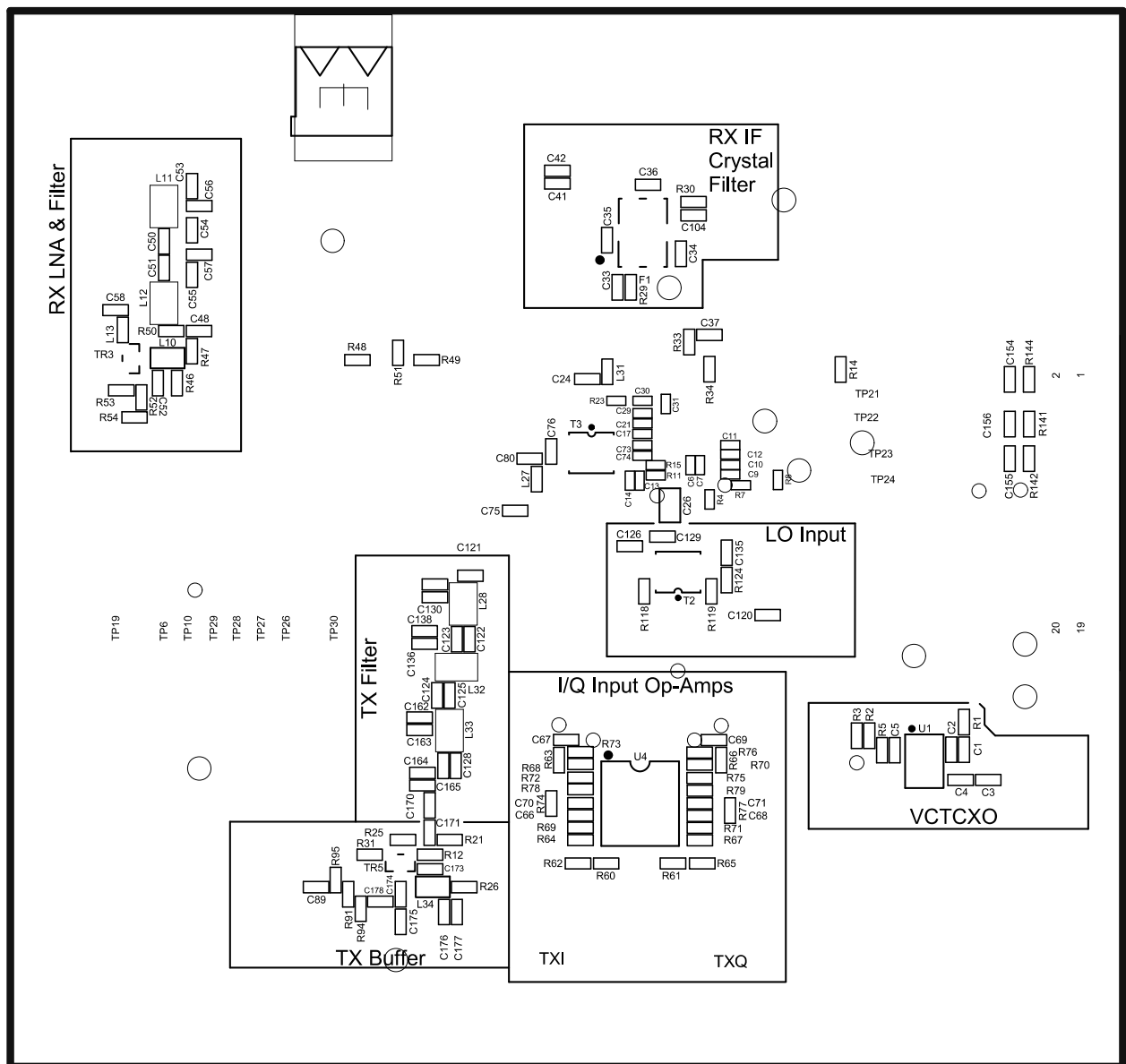


Figure 6 – PCB Layout: bottom

## 6. Detailed Description

Refer to the CMX991 (CMX992) datasheets (not included, but available at [www.cmlmicro.com](http://www.cmlmicro.com)) for a detailed description of the devices.

### The EV9910B/EV9920B functionality includes:

- Demonstration of linear receiver (CMX991 and CMX992) from RF input to output in either I/Q or low IF format including:
  - LNA
  - 1<sup>st</sup> mixer
  - IF filters
  - IF amplifiers
  - I/Q Mixers with selectable output bandwidth
  - Baseband amplifiers
  - IF VCO and PLL
  - Provision for Ceramic 455kHz IF filter
- Operation 100MHz to 1000MHz.
- Evaluation of Transmitter functions including (CMX991 only):
  - I/Q Input Conditioning Amplifiers
  - I/Q Modulator
  - Image Reject Mixer
  - Tx Filter and Buffer (supplied fitted but not enabled)
- IF VCO and PLL
- 19.2MHz VCTCXO
- On-board linear regulators for all necessary power rails
- C-BUS Interface that allows the card to be connected to a host  $\mu$ Controller. A PC Interface board is separately available and allows control of all devices functions to support initial test and customer evaluation.
- Interface to CMX910 evaluation card (EV9100, not included) to allow demonstration/test with GMSK modulation.
- Interface directly to CMX981 evaluation card (EV9810, not included) allows demonstration of:
  - Linear receiver
  - Burst and continuous transmission

In summary, the EV9910B/EV9920B allows the user to create experiments to investigate all aspects of the CMX991 (CMX992) device. The EV9910B/EV9920B is designed to allow user modification, to support detailed investigation of the user's specific and different applications. As the EV9920B is a sub-set of the EV9910B, i.e. no transmit functionality, many components are not fitted. The evaluation platform also includes additional functionality (e.g. a position to fit a second 1<sup>st</sup> IF crystal filter: this footprint has been left available for users to fit a part which is relevant to their application, later in this section particular solutions have been suggested).

### 6.1. Hardware Description

#### 6.1.1. Receiver (CMX991 and CMX992)

The EV9910B/EV9920B is a flexible multi-standard receiver designed to support multiple digital and analogue radio systems of both constant envelope and linear modulation types. The applied input signal, typically applied at J9, will be amplified by the LNA. Attenuators are provided to adjust the pre-gain before the CMX991 (CMX992) 1<sup>st</sup> mixer. A balun (T1) is used to produce a differential signal to the first mixer on the chip.

The receiver architecture is a superhetrodyne type with a 1<sup>st</sup> IF allowed in the range 10MHz to 150MHz, some typical 1<sup>st</sup> IFs being 10.7MHz, 21.4MHz, 45MHz, 70MHz and 150MHz. The EV9910B/EV9920B has a default crystal filter fitted for a 45MHz 1<sup>st</sup> IF (15kHz passband for 25kHz channel spacing).

At the 1<sup>st</sup> IF the CMX991 (CMX992) provide a variable gain amplifier (VGA) followed by mixers that may be used to mix to zero-IF I/Q format outputs or low 2<sup>nd</sup> IFs e.g. 450kHz, 455kHz, etc. The VGA output bandwidth is selectable as 100kHz or 1MHz.

Uncommitted differential amplifiers are provided for flexible interfacing. The EV9910B/EV9920B may be configured for I/Q output or to use the on-board 455kHz filter (F2 – not fitted).

The overall receiver noise figure measured at 460MHz (1010MHz Rx main local oscillator) is about 8dB.

#### 6.1.1.1. LNA

The LNA is a classic BJT design using TR3. Control switching uses TR1/TR2. The LNA input circuits include a lowpass filter designed to reject the image band if operating in the range 450-470MHz. (Note: in all applications the user must determine the need for and design of any external image reject filtering, only limited filtering is provided on the EV9910B/EV9920B). A digital control signal (TP1) is provided by the CMX991 (CMX992), which is used to enable/disable the LNA.

The LNA output is matched to 50 ohms and a 'T' attenuator can be used to adjust the level to the CMX991 (CMX992) 1<sup>st</sup> mixer. Alternatively a footprint is provided for a post LNA SAW filter<sup>1</sup> (FL1). As these filters are band-specific, a suitable filter for a particular application may be fitted.

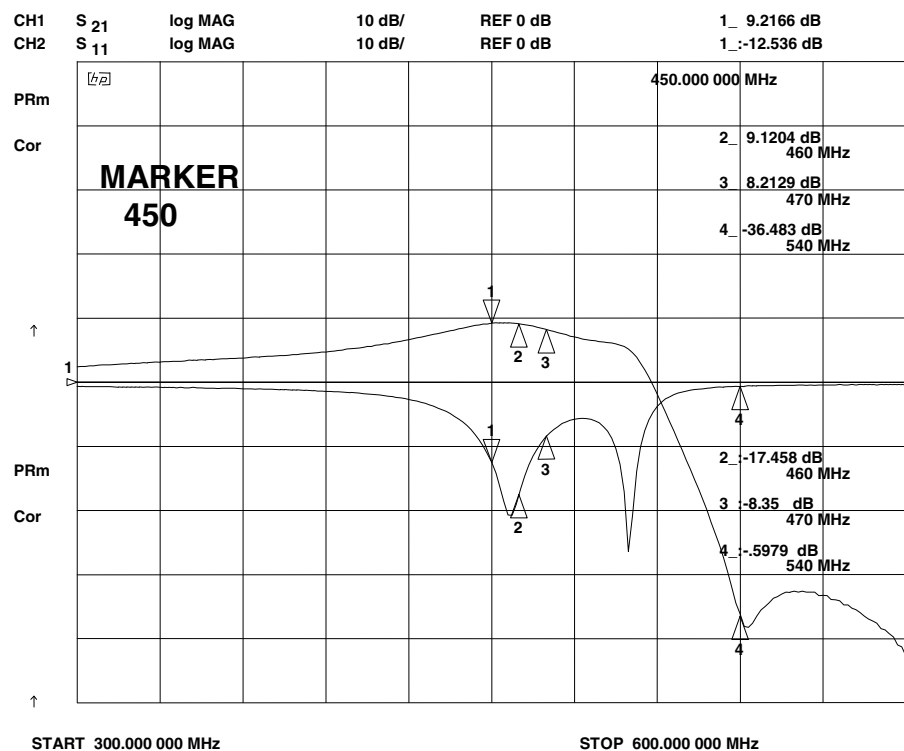


Figure 7 – Typical LNA S<sub>21</sub> and S<sub>11</sub> response

<sup>1</sup> e.g. Tai-Saw TA0311A (420MHz) or TA0420A (460MHz) ) available via Golledge Electronics Ltd.



#### 6.1.1.2. Rx 1<sup>st</sup> Mixer and IF Filtering

The Rx 1<sup>st</sup> Mixer has a differential input with a nominal input frequency range of 100MHz to 1GHz. As supplied, the mixer input is converted to single ended operation using balun transformer T1 and matched using L1 and L2 for 450-470 MHz operation. The 1<sup>st</sup> mixer has selectable LO input dividers: these are /1, /2 and /4 to allow common LO structures with the various Tx architectures, such as when using the combination of CMX992 and CMX998. The mixer RF LO input is differential but the normal configuration is single ended with the other input ac coupled to ground.

The mixer has two selectable outputs to allow the connection of two different 1<sup>st</sup> IF filters, which may be separately enabled. The EV9910B/EV9920B is fitted with a default leaded 4-pole crystal filter with a bandwidth of 15kHz. The PCB also provides a footprint for typical SMT crystal filter packages (F1)<sup>1</sup>. Test access is provided by J7 and J8.

#### 6.1.1.3. IF Variable Gain Amplifier and I/Q Down-converter Mixer

There are two selectable inputs to the IF VGA, which is low noise and controlled via the C-BUS serial interface. The Signal Level Indicator (SLI) output is provided on TL3.

Following the IF amplifier is a pair of mixers that perform the final down-conversion either to an I/Q or low IF output. The I/Q demodulator has an I/Q output bandwidth of 1MHz which allows a low IF output of up to 1MHz, typically 450kHz, 455kHz, 460kHz or 465kHz.

#### 6.1.1.4. I/Q or 2<sup>nd</sup> IF Filters

The I/Q outputs include two filters that provide continuous time rejection e.g. to serve as anti-alias filters for sigma-delta ADCs. The default filter will give an I/Q bandwidth of 1MHz. A narrower filter of 100kHz bandwidth is selectable via C-BUS.

If a 2<sup>nd</sup> IF is to be used, the EV9910B/EV9920B provides a footprint for an external ceramic filter (F2) which may be at 450kHz, 455kHz, etc. Following the filter, one of the uncommitted differential amplifiers may be used to buffer the output signal.

#### 6.1.1.5. IF VCO and PLL

The EV9910B/EV9920B provides components to use the VCO amplifier and PLL contained within the IC. As supplied, the resonator circuit (L26, C118, D3, D4 etc) is configured for 180MHz operation with a tuning sensitivity of approximately 4MHz/V. The component values used for the PLL loop filter provide a bandwidth of approximately 1kHz. Within the IC, the oscillator output is then divided by 4 and used for the Rx 2<sup>nd</sup> LO (For the CMX991, this LO is also provides the Tx IF source).

#### 6.1.1.6. DC Offset Correction

The EV9910B/EV9920B does not provide direct compensation of DC offsets in the I/Q outputs from the receiver, however it does provide a mode that allows the I/Q signals to be measured externally to support easy compensation. See the CMX991 (CMX992) datasheets for further details.

### 6.1.2. Transmitter (CMX991 only)

#### 6.1.2.1. I/Q Input Buffers

The EV9910B includes I/Q input conditioning op-amps (U4), which take a single ended, 0VDC biased input and produce a differential output biased at 1.6VDC. The op-amps have unity gain, so therefore a 1Vp-p single ended input will result in a 2Vp-p differential output. Differential I/Q inputs can alternatively be provided to J19. In this case the outputs of the conditioning amplifiers

<sup>1</sup> e.g. Golledge GSF-75 series available from [www.golledge.com](http://www.golledge.com)

will need to be disconnected by lifting R63, R73 etc. (Note: See also section 6.5.3 regarding I/Q connections).

#### 6.1.2.2. Tx Filter and Buffer

A 3<sup>rd</sup> order lumped element bandpass filter, centered at 460MHz, has been provided on the EV9910B. There is also provision for a RF SAW filter<sup>1</sup> which can be fitted (FL2). The Tx Buffer provided is a classic BJT design using TR5 and will provide approximately -3dBm output when driven from the matched CMX991 output.

As supplied, the lumped element filter and buffer are not configured for use, although the amplifier is biased. Capacitors C121 and C170 should be fitted as 1nF or 0Ω for the output of the combined filter and amplifier to appear at J14.

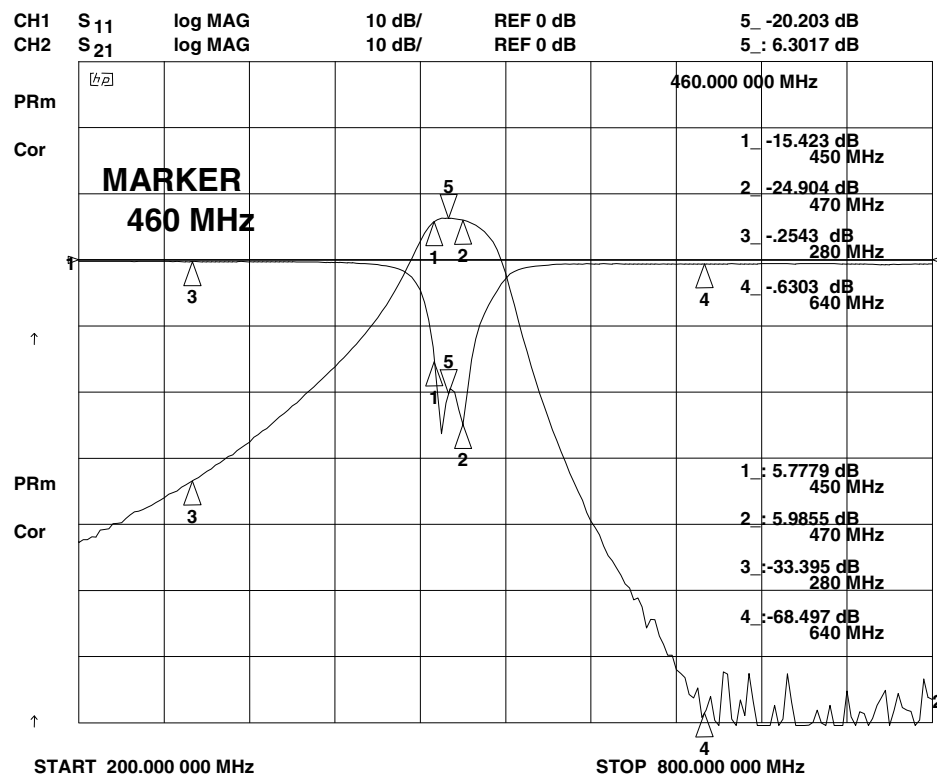


Figure 8 – Typical response of optional Tx filter + buffer.

#### 6.1.3. Local Oscillator (LO)

The main local oscillator has not been provided on the EV9910B/EV9920B. Separate connectors are provided to allow an external oscillator source to be injected for transmitter (CMX991 only) and receiver operation (CMX991 and CMX992).

#### 6.1.4. Power Supply

<sup>1</sup> e.g. Tai-Saw TA0311A (420MHz) or TA0420A (460MHz) available via Golledge Electronics Ltd.

The input to the PCB for CMX991 (CMX992) and interface circuits is nominally 7.2V (5.25V to 8V is acceptable). On board regulators are provided to generate voltage rails used on the EV9910B/EV9920B.

## 6.2. Adjustments and Controls

The user has the ability to configure the EV9910B/EV9920B for a number of different operational scenarios.

### 6.2.1. Operation on other frequency bands

The default operating frequency is 450 to 470MHz. The following components need to be changed to enable the EV9910B/EV9920B receiver to work at 850MHz:

- LNA and Filter Values

Ref. Designator	Values for 850MHz
L13	3.3nH (0603)
L10	12nH (0805)
L11 and L12	10nH (1008)
C54 and C55	1pF
C50 and C51	4.7pF
C56, C57 and C58	3.9pF

- Rx 1<sup>st</sup> Mixer Input Match

Ref. Designator	Values for 850MHz
L1	0R
L2	4.7nH (0603)
R17	6.8pF

The following components need to be changed on the EV9910B for optimum Tx Output match at J12.

Ref. Designator	Values for 100MHz	Values for 1GHz
C78	NF	NF
C76	0R	2.7pF
C80	8.2pF	3.3pF
L27	18pF	0R
C75	1nF	1nF

### 6.2.2. 2<sup>nd</sup> IF Operation

The default operation of the EV9910B/EV9920B receiver is for I/Q output. To configure the PCB for a 2<sup>nd</sup> IF output the following values should be fitted:

Ref. Designator	Values for 455kHz 2 <sup>nd</sup> IF
F2	CFWLB455KEFA
R33, R34 and R38	1.5kΩ
C37	100nF
R27 and R28	NF
R22	4.7kΩ
C28	33pF
C44	47nF

The Low IF output should be taken from J22 and VBIAS should be enabled in Rx Control register (\$12) to bias the op-amp correctly. The Low IF output will be biased at 1.6V with the values stated above. It should be noted that the value of the series resistors (R33 and R34) at the input and output of the ceramic filter provided the necessary resistive match, so this should be taken into consideration if a different filter is to be used. The suggested filter for F2 in the above table is suitable for most 25kHz channel spacing solutions.

### 6.2.3. External IF LO

The CMX991 (CMX992) contains an internal VCO and PLL that can be used for the 2<sup>nd</sup> LO for most applications. To use an external 2<sup>nd</sup> LO the following modifications are required (the default configuration is for a single ended solution):

Ref. Designator	Values for Single ended LO drive
D3 and D4	NF
L26	NF
C118	NF
C117 and C119	0R
R110 and R111	NF
C126 and C135	1nF
C120	0R

The PLL circuitry (b7 in register \$21) and the NR amplifier (b0 in register \$11) should be disabled. The VCO Buffer (b1 in register \$11) should be enabled.

### 6.2.4. Input to CMX991 (CMX992) 1<sup>st</sup> Mixer

Use RXIN2 (J5). The default matching values are for 450 to 470MHz operation; see section 6.2.1 for 850MHz values.

## 6.3. Software Description

The EV9910B/EV9920B itself does not require any embedded firmware, however, it does require C-BUS control from an external micro-controller. The CML product PE0002 can be used with the EV9910B/EV9920B and the related PC software files (ES9910xx.zip). To use the software, connect the EV9910B/EV9920B as shown in Figure 3. First ensure the drivers supplied for the PE0002 are installed correctly. The executable must be in the same folder on the PC as the EF9910xx.hex file. Run the ES9910xx.exe and the main application window will open with a progress bar for the initialisation process. Once the initialisation process is complete, one of six tabs can be selected.

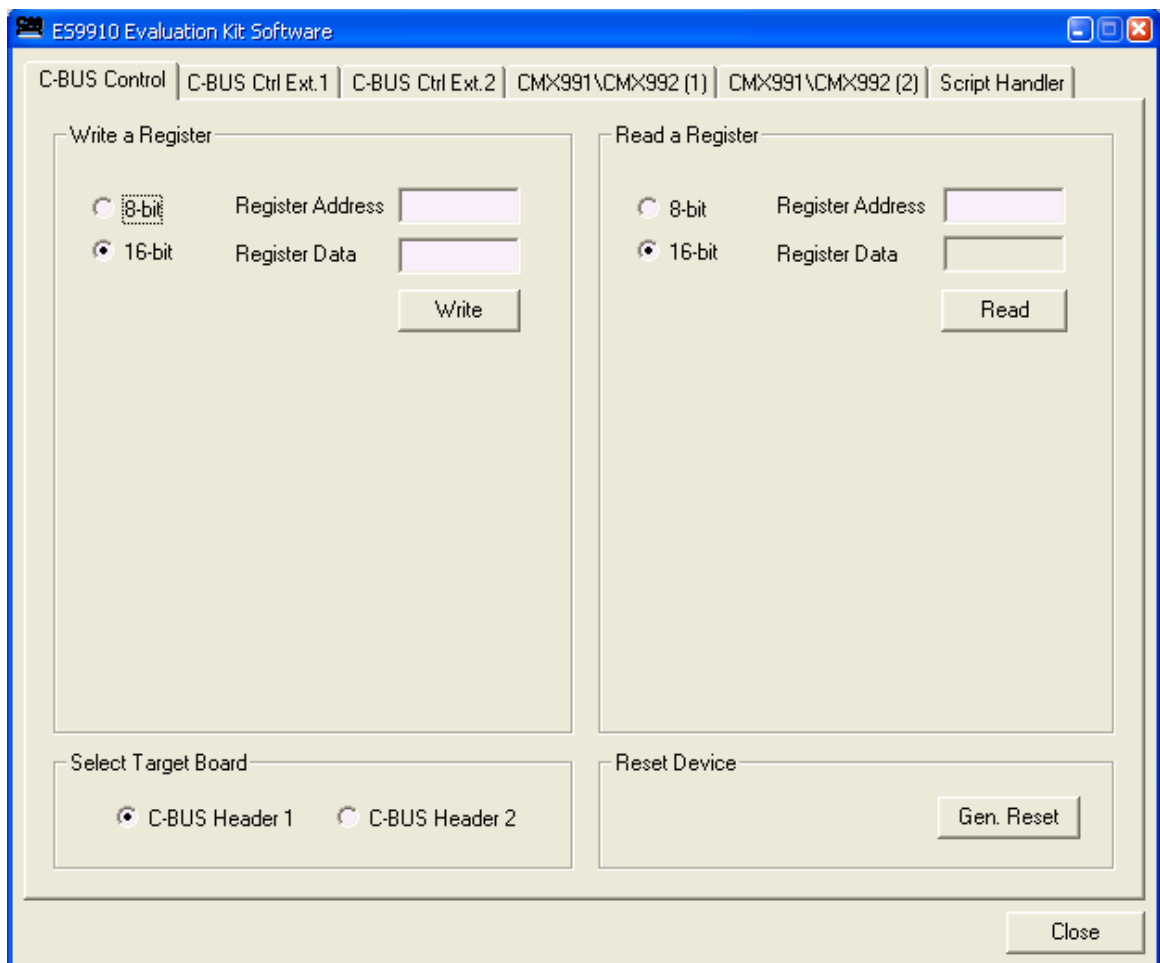
This PE0002 application software (ES9910xx.zip) is more specific than the normal ES0002xx.zip software. It allows the user to interact with the EV9910B/EV9920B via an easy to use GUI and consists of six tabs: three of the tabs are generic C-BUS control functions, with the other three representing a particular set of registers or a particular function of the CMX991 (CMX992).

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.

Users should ignore results from CMX991 (Tx only) registers if using a CMX992 (EV9920B). Likewise, users should also not program the Tx only registers when using a CMX992 (EV9920B).

### The 'C-BUS Control' Tab

This tab provides basic C-BUS read, write and general reset functions. Each character entered into the Address and Data edit boxes is checked to ensure that it is a valid hexadecimal value. The radio buttons select an 8-bit or 16-bit read/write operation. The lengths of the entered values are limited to 2 characters (1 byte) for read or write register addresses and 2 or 4 characters (1 or 2 bytes) for the register write data. The General Reset button writes 01<sub>H</sub> to the target device (this will not affect the CMX991 or CMX992 devices, which use 10<sub>H</sub> for their General Reset). The radio buttons select read/write operation to a CMX991 (CMX992) device using CSN1 on connector J5 or read/write operations to another C-BUS device using CSN2 on connector J3.



**Figure 9 – The 'C-BUS Control' Tab**

#### 6.3.1. The 'C-BUS Control Extended' Tabs (C-BUS Ctrl Ext. 1 and 2)

These tabs provide multiple C-BUS read and write functions. Each row in the table represents a single C-BUS register. Select the C-BUS register type from the drop down list. The Update button and the Data edit box will be configured according to the selection. Each character entered into the Address and Data edit boxes is checked to ensure that it is a valid hexadecimal value. The lengths of the entered values are limited to 2 characters (1 byte) for register addresses and 2 or 4 characters (1 or 2 bytes) for the register data. Click the Update button to read or write a single C-BUS register. For multiple C-BUS read or write operations, select the C-BUS registers using the Select check boxes and click on the 'Wr all', 'Rd all' or 'Wr\Rd all' buttons. Click on the 'Wr all'

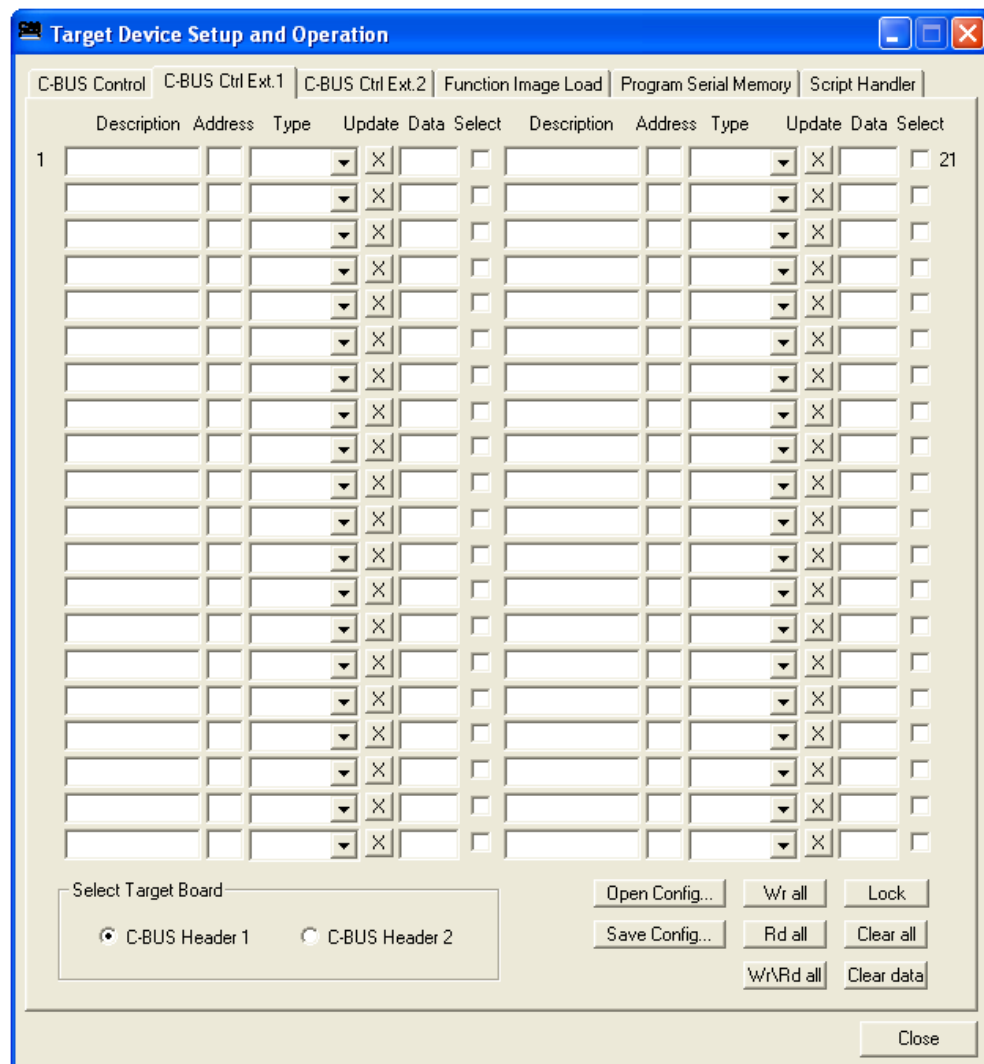
button to write all the selected write type C-BUS registers. Click on the 'Rd all' button to read all the selected read type C-BUS registers. Click on the 'Wr\Rd all' button to read or write all the selected C-BUS registers.

Click on the 'Clear all' button to reset the table. Click on the 'Clear data' button to reset the Data edit boxes.

When the 'Lock' button is selected the Description, Address and Type controls are disabled, preventing accidental changes.

Use the 'Save Config...' button to save the current table. The Description, Address, Type, Data and Select columns are saved in the specified file. Use the 'Open Config...' button to load a previously saved table.

The radio buttons select read/write operation to a CMX991 (CMX992) device using CSN1 on connector J5 or read/write operations to another C-BUS device using CSN2 on connector J3.



### Figure 10 – The ‘C-BUS Control Extended’ Tab

### 6.3.2. The 'CMX991\CMX992 (1)' Tab

The CMX991\CMX992 (1) tab provides access (via J5 only) to the general control (\$11) and PLL control (\$20 - \$23) registers, a general purpose read/write facility for any register address and access to all of the CMX991 (CMX992) read-back registers, see Figure 11. Note that the general control register is written to as (\$11), but read back as (\$E1): likewise for other registers.

The 'H/W Reset' button performs a hardware reset, whereas the 'Write Gen Reset Cmd' button writes a software reset to register \$10 on C-BUS 1 Port (J5) only. On the CMX991 (CMX992) this command is required, as a General Reset is performed by issuing command \$10, NOT \$01. This is to allow two C-BUS devices with non-overlapping addresses to share the same physical bus whilst retaining their independent control. Examples of compatible devices are the CMX993 and the CMX998. For other C-BUS devices, a separate physical bus is required. On the PE0002 Interface Card, two C-BUS interfaces are provided and connector J3 can be used to control another C-BUS device. To issue a General Reset command to another C-BUS device, use the 'Gen. Reset' button on the 'C-BUS Control' Tab to write the command \$01.

Explanation of the various bit functions may be found in the CMX991 (CMX992) datasheets.

The PLL function automatically calculates the desired divider ratios for a given frequency requirement. The selected frequency must take into account the dividers in the LO chain. The required comparison and reference frequencies should be entered in the appropriate windows. Then the user should click 'Calculate M and N' button and the appropriate values will appear in the boxes below the entry window. Click on 'Write PLL M and N Div Reg' and the values will be programmed into the CMX991 (CMX992). The PLL default conditions are shown in Figure 11.

ES9910 Evaluation Kit Software

C-BUS Control | C-BUS Ctrl Ext.1 | C-BUS Ctrl Ext.2 | **CMX991\CMX992 (1)** | CMX991\CMX992 (2) | Script Handler

**Reset functions**

**Write Regs**

Reg Address 0x  Reg Value 0x

**Read Regs (\$E1-\$E6, \$D0-\$D3)**

General Ctrl Reg (\$E1) 0x00 <input type="button" value="Read \$E1"/>	Tx Gain Reg (\$E6) 0x00 <input type="button" value="Read \$E6"/>
Rx Control Reg (\$E2) 0x00 <input type="button" value="Read \$E2"/>	PLL M Div (\$D0) 0x00 <input type="button" value="Read \$D0"/>
Rx Mode Reg (\$E3) 0x00 <input type="button" value="Read \$E3"/>	PLL M Div (\$D1) 0x00 <input type="button" value="Read \$D1"/>
Tx Control Reg (\$E4) 0x00 <input type="button" value="Read \$E4"/>	PLL N Div (\$D2) 0x00 <input type="button" value="Read \$D2"/>
Tx Mode Reg (\$E5) 0x00 <input type="button" value="Read \$E5"/>	PLL N Div (\$D3) 0x00 <input type="button" value="Read \$D3"/>

**General Ctrl Reg (\$11)**

☐ Bias Generator ☐ VCO Buffer ☐ VCO NR Amp

IF Control:

NR Magnitude:

Rx Output Mode Ctrl:

**PLL M and N Dividers (\$20-\$23)**

☐ Charge Pump ☐ PLL

**M and N Divider Ratios**

Required Frequency:  MHz

Comparison Frequency:  KHz

Reference Frequency:  MHz

M=  N=

N PLL Lock Status:

☐ Auto Write

Figure 11 – The 'CMX991\CMX992 (1)' Tab

### 6.3.3. The 'CMX991\CMX992 (2)' Tab

The 'CMX991\CMX992 (2)' tab provides access (via J5 only) to the Rx Control register (\$12), Rx Mode register (\$13), Tx Control register (\$14, CMX991 only), Tx Mode (\$15, CMX991 only) and Tx Gain Register (\$16, CMX991 only) see Figure 12.

Explanation of the various bit functions may be found in the CMX991 (CMX992) datasheets.

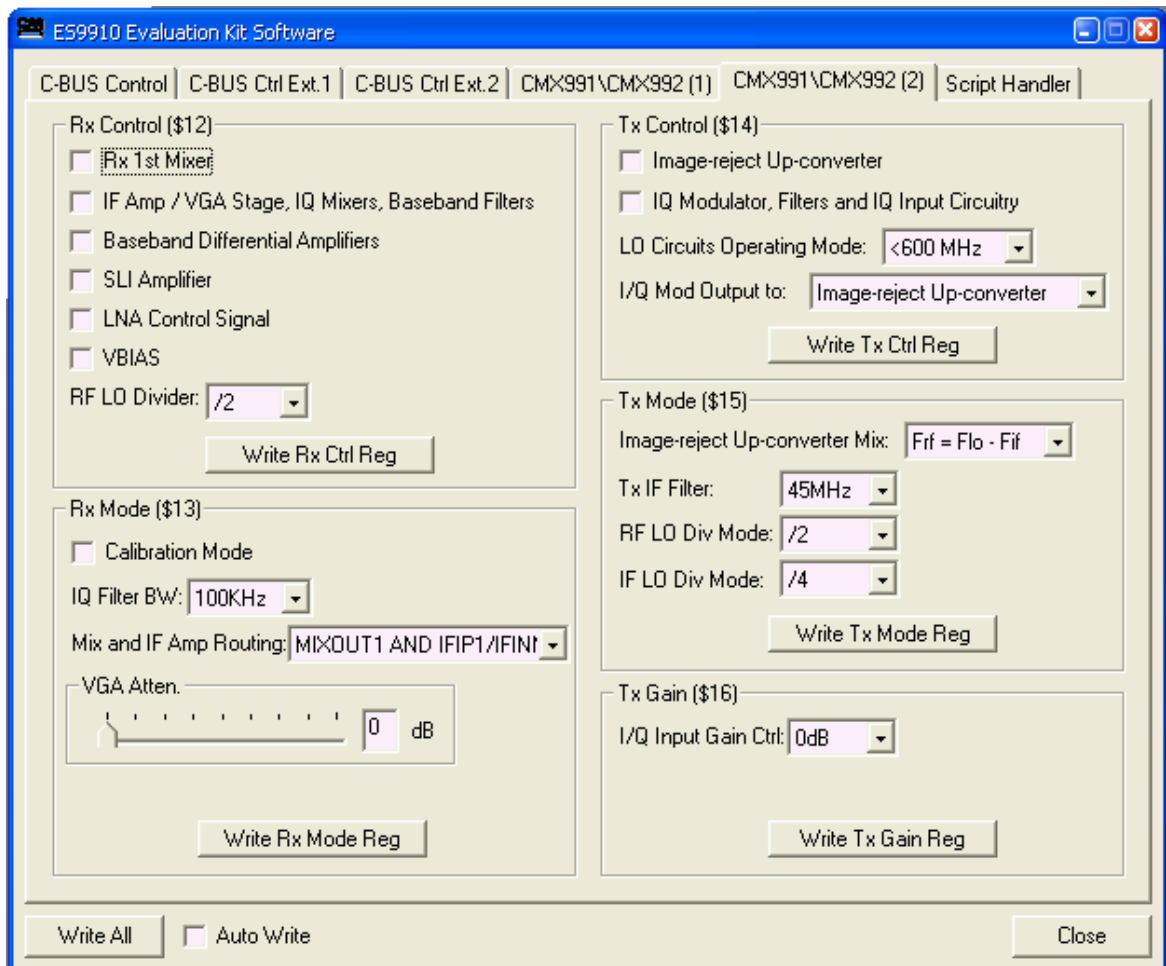
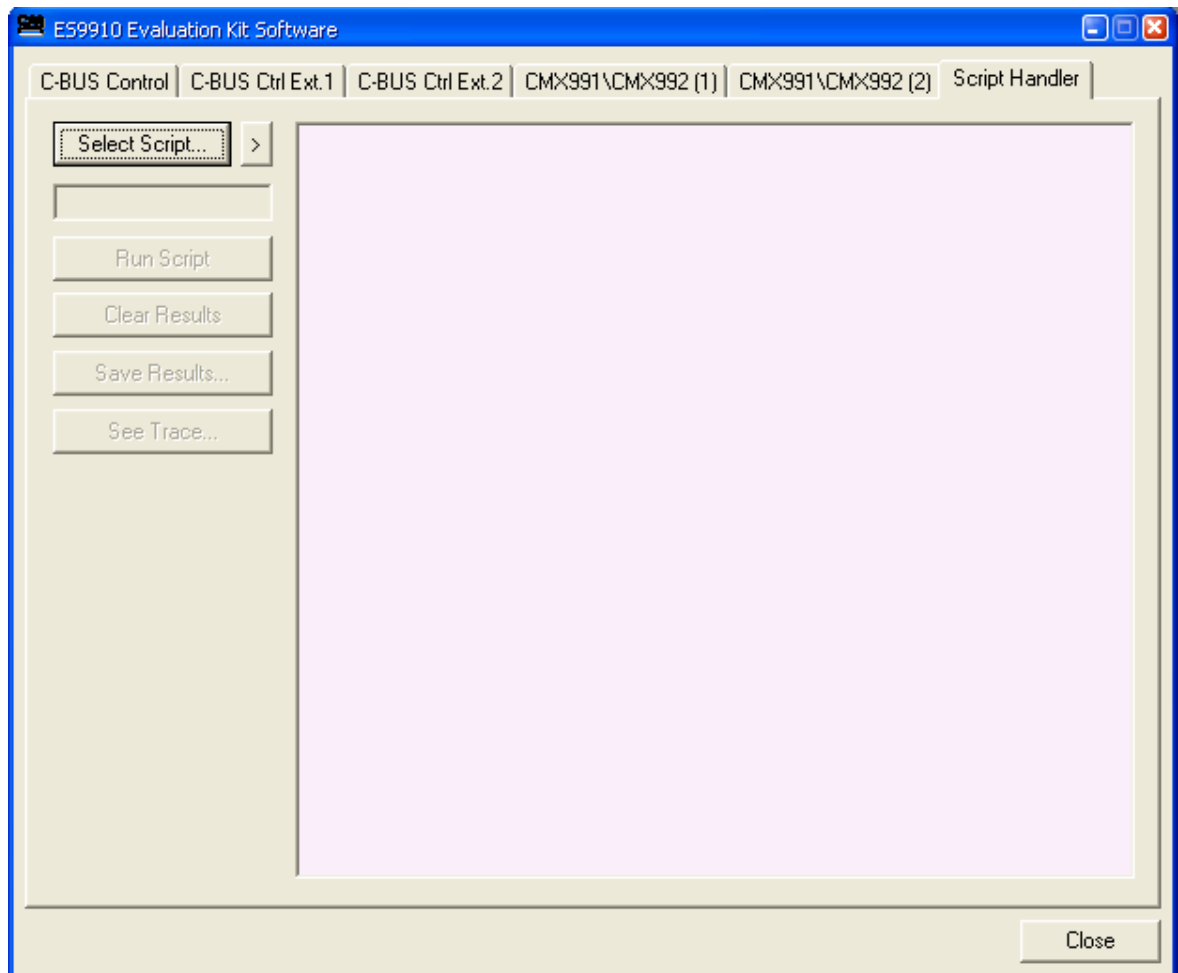


Figure 12 – The 'CMX991\CMX992 (2)' Tab



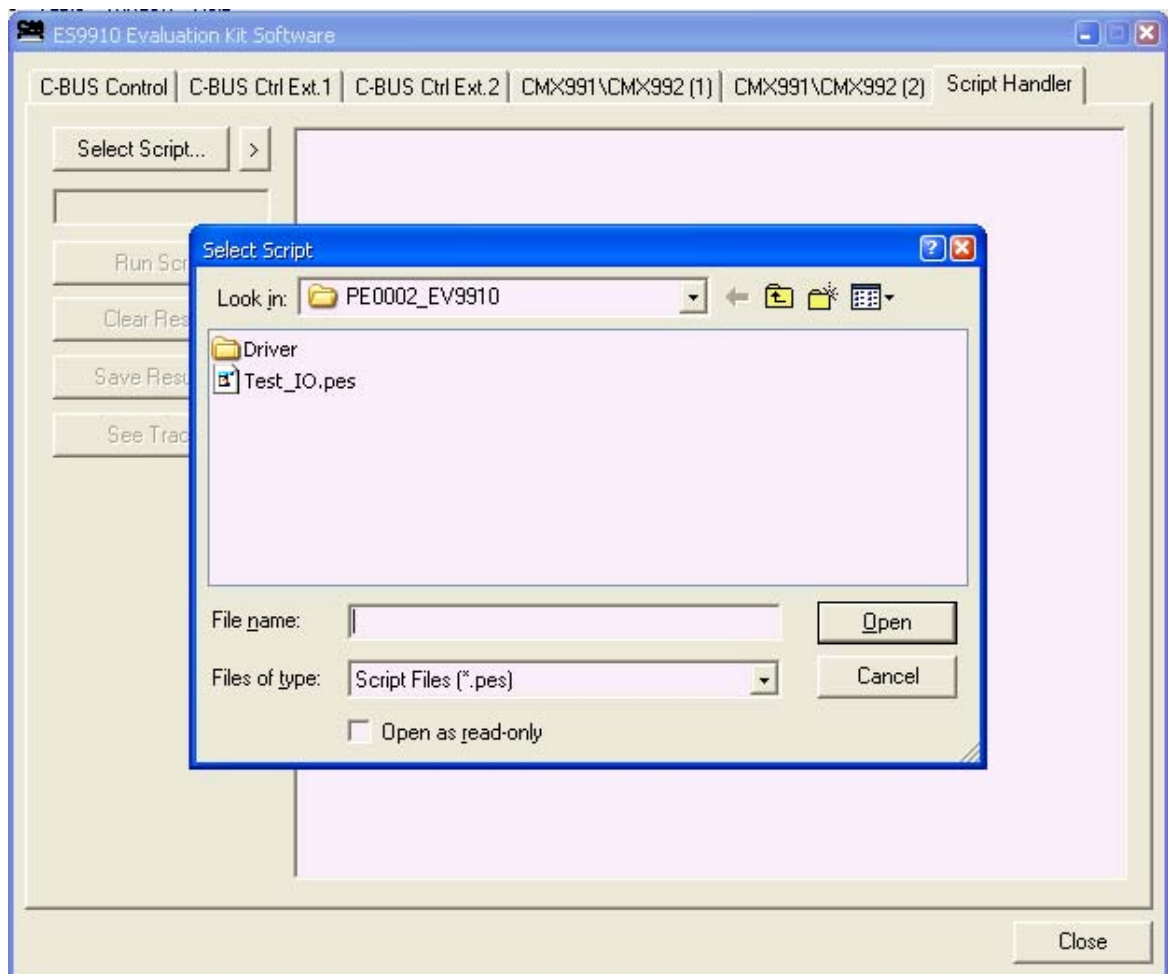
#### 6.3.4. The Script Handler Tab

The Script Handler tab 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 EV9910B/EV9920B does not require the use of script files.



**Figure 13 – The ‘Script Handler’ Tab**

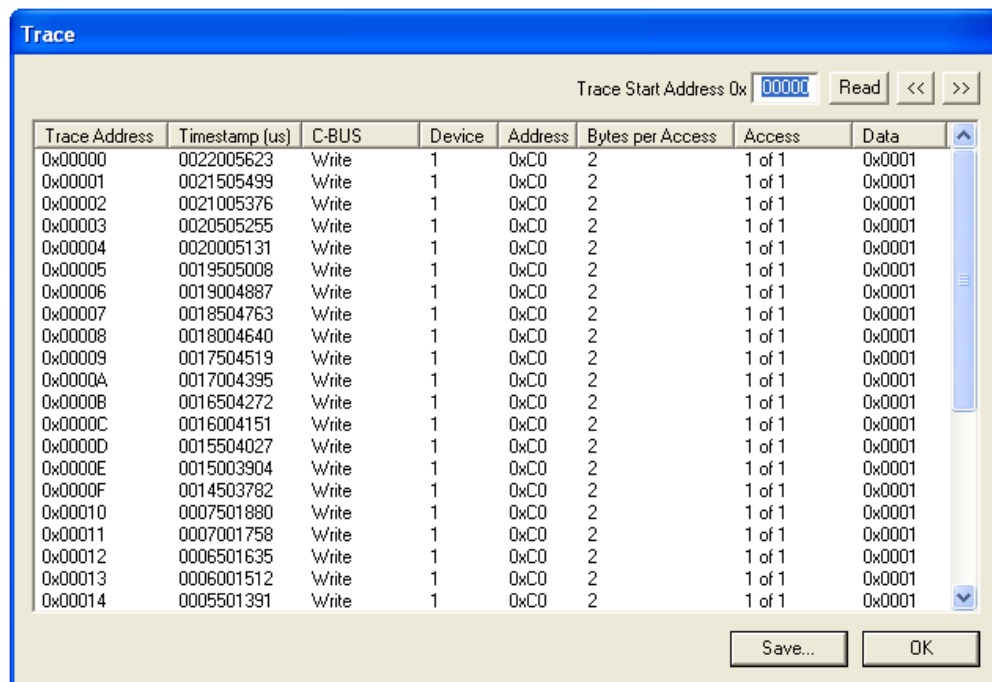
To select a script file, click on the ‘Select Script’ button, see Figure 14. The Open File Dialog is displayed. Browse and select the script file. The folder that contains the script file will be the working folder of the script (i.e. all the files referenced in the script will be searched in this folder). Alternatively, select a script file from the recent files list. Click on ‘>’ button to display the list.



**Figure 14 – Loading a Script File**

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, see Figure 15. 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.



**Figure 15 – The ‘Trace Dialog’ Box**

Click on the ‘>>’ or ‘<<’ buttons to upload and display the next or previous C-BUS transaction data block. Click on the ‘Read’ button to upload and display the C-BUS transaction data block starting at the address displayed in the Trace Start Address edit box. Use the ‘Save...’ button to save the trace data to a file.

The ES9910xx.zip application software will update the displayed register values, when they are read, to reflect those of any register read or write commands contained in an executed script file. When a script file is being executed the other tabs cannot be selected. A script file can be executed once, repeatedly until the ‘Stop’ button is pressed, or a specified number of times. The execution of a script file can be stopped or paused at any time by clicking the appropriate button.

## 6.4. Application Information

### 6.4.1. Rx Testing the CMX991 (CMX992) with the CMX910

The EV9910B/EV9920B has an I/Q interface which may be connected to an EV9100 through the use of a custom wired cable. The connections should be made as shown in Table 7. This allows evaluation of the CMX991 (CMX992) receiver with GMSK modulation.

Signal	EV9910B/EV9920B	EV9100
RXI-	J20 pin 4	J18:2
RXI+	J20 pin 2	J18:4
RXQ+	J20 pin 10	J18:8
RXQ-	J20 pin 8	J18:6
GND	J20 pin 6	J18:10

**Table 7 – EV9910B/EV9920B and EV9100 interconnection details**

Using this setup, the typical sensitivity (for a BER =  $1 \times 10^{-3}$ ) is around -113dBm.

Signal Level (dBm)	PER%
-111	2.37
-112	3.86
-112.5	5.85
-113	12.78
-113.5	16.03
-114	21.53
-115	46.2

**Table 8 – Typical sensitivity performance**

The adjacent channel rejection was evaluated using the marine AIS (IEC 61993-2) procedure<sup>2</sup>.

Adjacent Channel Interferer/dB	PER <sup>3</sup>
70	0%
77	1%
78	2%
79	4%
80	12%
81	20%

**Table 9 – Typical Adjacent Channel Rejection performance**

**(with Interferer +/-25kHz, Interferer = 400Hz modulation, 3kHz deviation,)  
(wanted signal level is -104dBm)**

**Note:** In a practical system implementation, the adjacent channel performance is likely to be limited by the phase noise of the 1<sup>st</sup> local oscillator. The above shows the performance that can be achieved using a CMX991/992 and CMX910 combination.

<sup>2</sup> The measurement method is typical of many similar standards including ETSI EN 300 113 although the PER equates to a more stringent BER requirement than the 1% used in EN 300 113.

<sup>3</sup> A Packet Error Rate (PER) of 20% is equivalent to a BER =  $1 \times 10^{-3}$ .

The IMD rejection is typically better than 66dB for <20% PER, with a wanted signal at -107dBm and interfering signals spaced at 50/100kHz.

## 6.5. Troubleshooting

The CMX991 (CMX992) is a complex RF system. If incorrectly programmed or modified, results will be at variance from datasheet performance. Please study the IC datasheet, this manual and the associated schematics and layout drawings carefully when troubleshooting.

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

### 6.5.1. General (CMX991 and CMX992)

Error Observed	Possible Cause	Remedy
ES9910xx.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 EV9910B/EV9920B is not powered up during start up.	Power up PE0002 (5.0V) and EV9910B/EV9920B (7.2V).
	Incorrect software for PE0002	Contact: techsupport@cmlmicro.com

**Table 10 – Possible general errors**

### 6.5.2. Receiver Operation (CMX991 and CMX992)

Error Observed	Possible Cause	Remedy
No output from the receiver	Mixer outputs and IF inputs incorrectly configured	Check PCB configuration and Rx mode register settings in \$13 correspond.
Output only on Rx I channel	IF Q channel mode has been selected	Set general control register (\$11) b5 and b4 as appropriate for the application.
Output only on Rx Q channel	IF I channel mode has been selected	Set general control register (\$11) b5 and b4 as appropriate for the application.
IF PLL does not lock. (Lock detect bit = '0')	Charge pump is not enabled. VCO is not enabled. LO Amplifier is not enabled. M and N Divider setting are incorrect.	Check values of PLL registers \$20, \$21, \$22 and \$23
	VCO has been programmed to a frequency outside its operating range	Check VCO control voltage on CMX991 (CMX992) signal DOIF (pin 40). If the voltage is at either supply rail, try a different frequency and observe the effect.
The receiver has poor sensitivity and low gain	The LNA has not been enabled	Set b3 = '1' in Rx Control register (\$12)

**Table 11 – Possible receiver errors**

**6.5.3. Transmitter Operation (CMX991 only)**

<b>Error Observed</b>	<b>Possible Cause</b>	<b>Remedy</b>
No RF Output	Relevant circuitry not enabled or I/Q signals not applied	Try re-enabling circuitry in CMX991 or measure I/Q signal at TL2, TL3, TL4 or TL5.
The RF output spectrum is frequency inverted.	The CMX991 had an inadvertent inversion of the transmitter I and Q signals; this is corrected in CMX991 data sheet version 13. Connection of the TXQN and TXQP pins on EV9910B follows the earlier (incorrect) datasheet connections so the spectrum at the output of the transmitter is inverted (i.e. frequencies that should be above the carrier are below and visa-versa).	Swap I and Q input connections.  Note: To avoid confusion connections details to external sources have not been changed in this document.
No output at J2 – I/Q Modulator Output	I/Q Modulator has not been selected in relevant control register.	Set b0 = '1' in Tx Control register (\$14)
High carrier leakage	DC offsets between I and Q inputs.	Check the carrier leakage with J10 & J11 grounded.  The offsets are generated by errors within the op-amp circuit of U4. These errors may be compensated through adding small dc offsets (a few mV) to the J10/J11 input signals. Note that maximum carrier suppression may be achieved with different offsets applied to each input.

**Table 12 – Transmitter possible errors**

## 7. Performance Specification

### 7.1. Electrical Performance

#### 7.1.1. 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	8.0	V
Current into or out of $V_{IN}$ and $V_{SS}$ pins	0	+2.0	A
Current into or out of any other connector pin	-20	+20	mA

#### 7.1.2. Operating Limits

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

	Notes	Min.	Max.	Units
Supply Voltage ( $V_{IN} - V_{SS}$ )		5.25	8.0	V

### 7.1.3. 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
<b>DC Parameters</b>					
$I_{DD}$ (CMX991 Powersaved)	2	–	28	–	mA
$I_{DD}$ (CMX992 Powersaved)	2	–	8	–	mA
$I_{DD}$ (CMX991– VCO and PLL only)	2	–	42	–	mA
$I_{DD}$ (CMX992 – VCO and PLL only)	2	–	22	–	mA
$I_{DD}$ (All CMX992 Circuitry Enabled)	2	–	68	–	mA
$I_{DD}$ (All CMX992 Circuitry Enabled and LNA)	2	–	89	–	mA
$I_{DD}$ (CMX991 Tx Circuitry Enabled)	2	–	115	–	mA
<b>AC Parameters</b>					
<b>Tx Output (CMX991 only)</b>					
Tx IF Output Power		–	-10	–	dBm
Tx Image Reject Mixer Output Power		–	-8	–	dBm
<b>Receiver Input</b>					
Input Impedance		–	50	–	$\Omega$
Input Level		–	–	0	dBm
Frequency Range (Default Components)		450	–	470	MHz
1 <sup>st</sup> IF Frequency		–	45	–	MHz
1 <sup>st</sup> IF Filter Bandwidth	3	–	16	–	kHz
<b>I/Q Output Signal (RXI, J23/RXQ, J22)</b>					
Amplitude		$AV_{SS}+0.1$	–	$AV_{DD}-0.1$	Vp-p
DC Level		–	1.6	–	VDC
<b>Rx Gain</b>	7	61	63	–	dB
<b>I/Q Input Signal (CMX991 only)</b>					
Amplitude		–	1	1.4	Vp-p
DC Level		–	0	–	VDC
<b>LO Inputs</b>					
<i>Receiver</i>					
Input Impedance		–	50	–	$\Omega$
Frequency Range		50	–	1500	MHz
Input Level		-10	–	0	dBm
<i>Transmitter (CMX991 only)</i>					
Input Impedance		–	50	–	$\Omega$
Frequency Range		50	–	2000	MHz
Input Level		-10	–	0	dBm
<b>Frequency Reference (U1)</b>					
Frequency		–	19.2	–	MHz
Stability		–	1.5	–	ppm
<b>400MHz Rx Operation</b>					
Input Third Order Intercept Point		0	+1	–	dBm
Sensitivity	6	-113	–	–	dBm



**400MHz Tx Operation (CMX991 only)**

Input Impedance		–	50	–	$\Omega$
Frequency Range (Default Components)		450	–	470	MHz
Output Level		–	-8	–	dBm
Carrier Leakage	8	–	-29	-26	dBc
Adjacent Channel Power	4	67	-70	–	dBc
Adjacent Channel Power	5	70	–	–	dBc

**800MHz Tx Operation (CMX991 only)**

Input Impedance		–	50	–	$\Omega$
Output Level		–	-10	–	dBm
Adjacent Channel Power	4	67	70	–	dBc
Adjacent Channel Power	5	70	–	–	dBc

**C-BUS Interface**

See CMX991 (CM992) Datasheet

**Notes:**

2. PCB current consumption, not current consumption of the CMX991 (CMX992).
3. Bandwidth selected is typical for 25kHz channel spacing.
4. Measured as specified in ANSI/TIA/EIA-102.CAAB and ANSI/TIA/EIA 102.CAAA (6kHz bandwidth, 100Hz resolution bandwidth, average).
5. Measured to EN 300 113, 25kHz Channel Spacing, GMSK modulation with a Bt = 0.3 and 9600bps.
6. GMSK with Bt = 0.4, 9600bps, PER =< 20% based on Marine AIS system data packets (see CMX910 for details).
7. Gain relates to the single ended output level on each of the I and Q channels (e.g. J4 pin 1) for a –60dBm input signal @ 460.002MHz to J9 (includes LNA circuit).
8. With inputs to J10 & J11 grounded. The carrier leakage is degraded from that typical of the CMX991 due to dc offset errors in the input op-amp U4,

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The Product Data Amendment series of documents is produced to provide basic details of changes to CML data publications.

## 1.0 Introduction

- 1.1 This document describes the changes made to the EV9910B and EV9920 EvKit user manual, Publication No: UM9910/5 May 2010 to produce the updated version: UM9910/6 September 2010.

## 2.0 Reference Document(s)

- 2.1 Product user manual: UM9910/6 September 2010.

## 3.0 Products Affected

- 3.1 EvKit EV9910B.

## 4.0 Additions and Alterations

- General:  
CMX991 TXQP and TXQN annotations are swapped on the CMX991/CMX992 datasheet, resolving a typographical error in the previous version.  
A consequence of this update is that the I and Q input connections should be swapped.  
See Section 6.5.3 (Table 12 Transmitter Possible Errors).  
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