CML Microcircuits

COMMUNICATION SEMICONDUCTORS

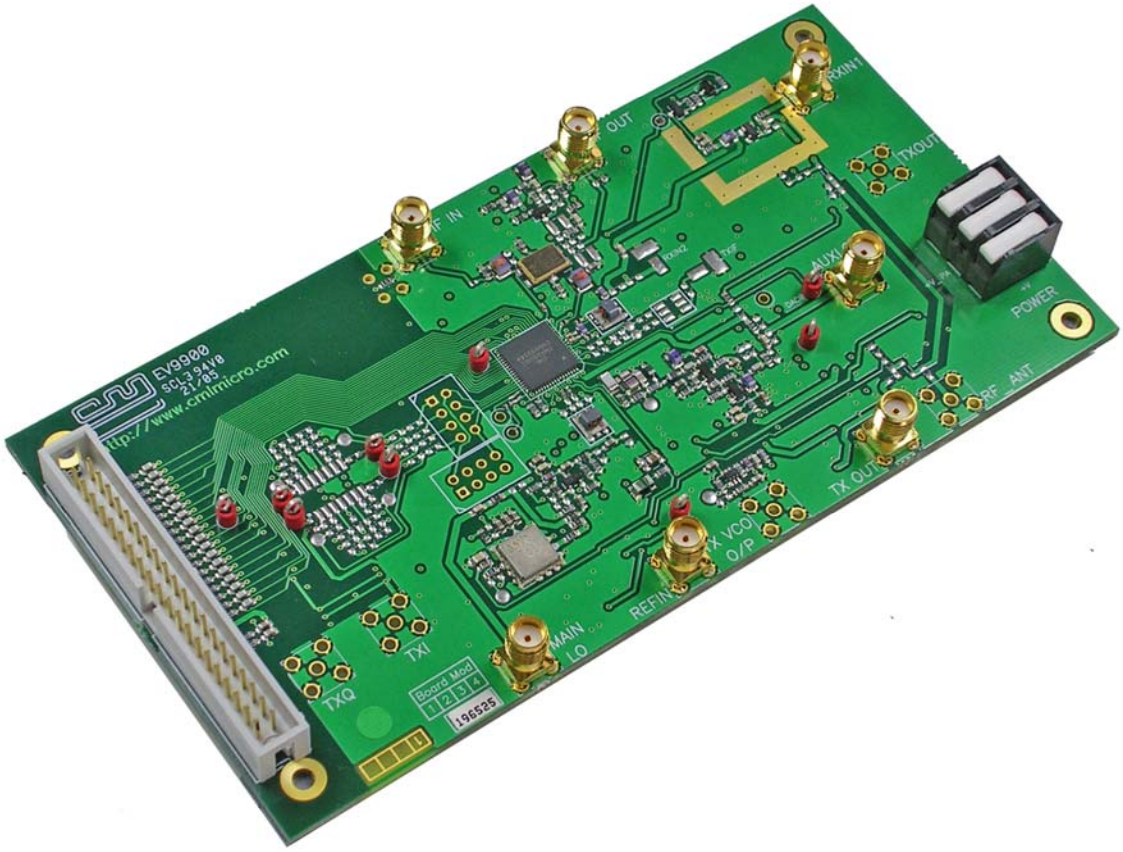
EV9900
Evaluation Kit User Manual

UM9900/1 September 2005

Advance Information

Features

- **Complete 800 / 900 MHz Transceiver (Initial Configuration for 819 - 825MHz Tx / 864 - 870MHz Rx)**
- **Configurable for 400 MHz (e.g. 425 – 463MHz Transceiver)**
- **Test Access for Important Signals**
- **Parallel Interface to a µC**



1 Brief Description

The EV9900 allows evaluation of the CMX990 Baseband and RF Modem IC. The design is a flexible platform to allow users to configure and evaluate the CMX990 for various applications and frequency bands. Initial configuration is for 864-870MHz receive and 819-825MHz transmit. Various RF circuits, such as a VCO, PA and LNA, are provided on the EV9900 to facilitate easy evaluation.

CONTENTS

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

Note: This product is in development: Changes and additions will be made to this specification. Items marked TBD or left blank will be included in later issues.

Information in this datasheet should not be relied upon for final product design.

The CMX990 device which is fitted on this Evaluation Kit is not a full production device and customers should ensure that they are aware of the limitations to the CMX990 performance by obtaining a copy of the bug list from the CML website. This kit has been released with existing silicon in order to facilitate the early evaluation of the CMX990. The limitations of this device will be corrected in a later silicon revision.

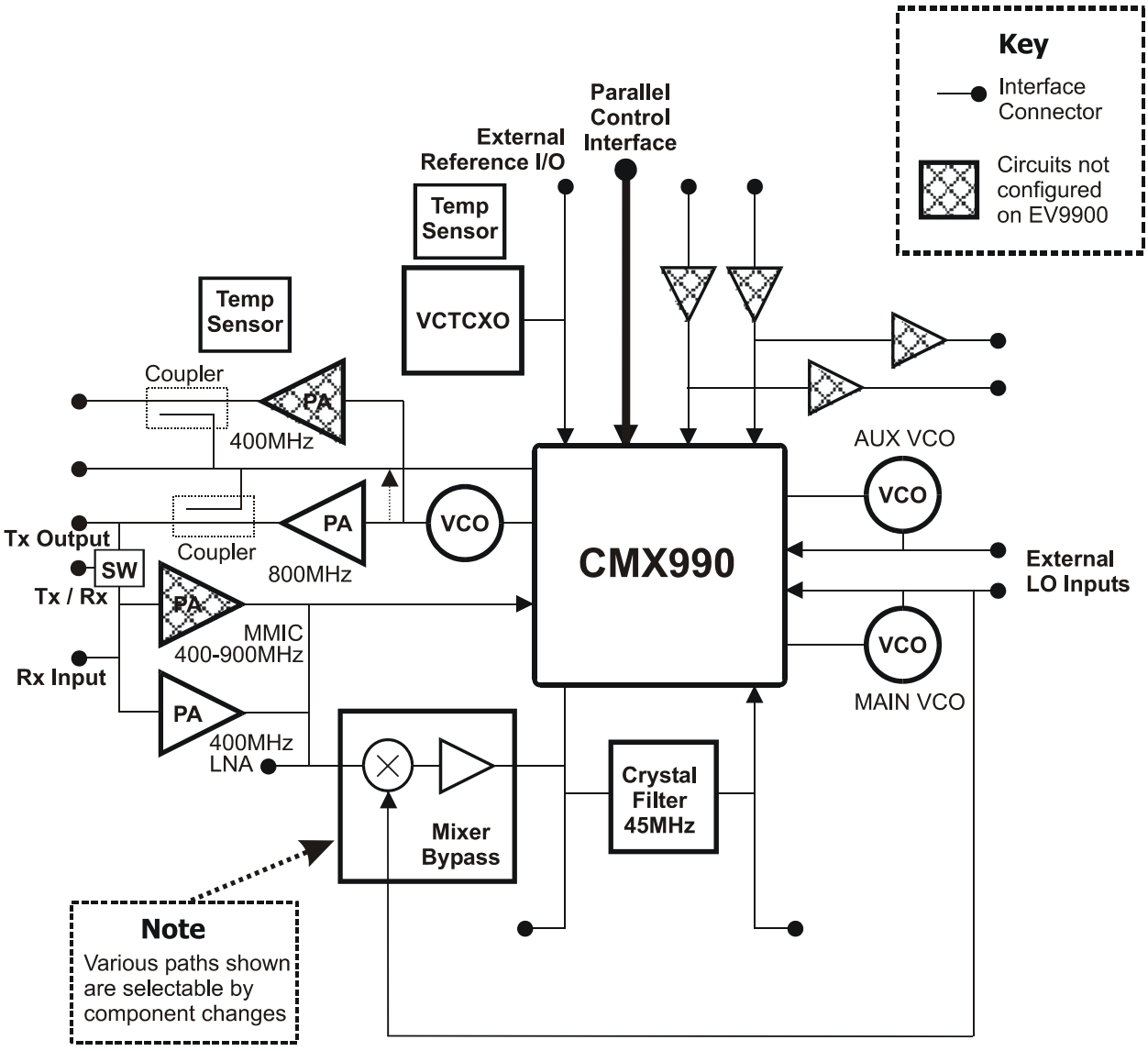


Figure 1 – Block Diagram

2. Preliminary Information

The EV9900 provides a platform for the evaluation of the CMX990. To use the EV9900, a separate micro-controller or PC, for example, is required to program the CMX990 via its parallel interface. This controlling device is not included on the EV9900 but two CML products are available to provide the controlling functionality: the DE9901 or the EV9902.

2.1 Laboratory Equipment

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

- Dual Power Supply
- Spectrum Analyzer
- RF Attenuator
- RF Signal Generator

For more detailed design or investigation work the customer may require other RF test equipment.

2.1.1 Power Supply

The supply input voltage to the PCB, for all circuits except the PA, is 7.2V (5.25V to 8V acceptable). On board regulators are provided to generate all voltage rails used on the PCB (3V and 5V rails are used).

The supply to the PA is directly connected to the PA: a voltage of 3.5V is recommended.

The 7.2V supply should be rated at 1A and the 3.5V supply rated at 2A.

NOTE: Care should be exercised with the supplies as they are not protected for reverse polarity. For optimum RF performance, the PA supply is connected directly to the RF2173 device so care is required to ensure the RF2173 manufacturer's ratings are not exceeded.

2.2 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.

2.2.1 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.

2.2.2 Contents - Unpacking

Please ensure that you have received all of the items on the separate information sheet (EK9900) and notify CML within 7 working days if the delivery is incomplete.

2.3 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.

3. Quick Start

This section provides instructions for users who wish to experiment immediately with the evaluation kit. A more complete description of the kit and its use appears later in this document. The EV9900 includes a CMX990 device that is described in its own, separate, datasheet. Accordingly, the user should read the CMX990 datasheet before using the EV9900.

3.1 Setting-Up

The following procedure is recommended:

1. Connect test leads as required, including the host µController to parallel interface J13.
2. The power amplifier output should be connected to a suitable 50Ω load.
   THE USE OF AN EXTERNAL 50Ω LOAD IS ESSENTIAL TO PREVENT POSSIBLE DAMAGE TO THE PA STAGE.
3. Power should be applied to the main supply (7.2V nominal).
4. The CMX990 device should be reset by issuing a RESET task to the host µController parallel interface (using the TASK bits (b3 - b0) of the Command register [address $01]).
5. Power should be applied to the power amplifier supply connector (3.5V).

The board is now ready for operation. An example of typical connections to the EV9900 is shown in *Figure 2*.

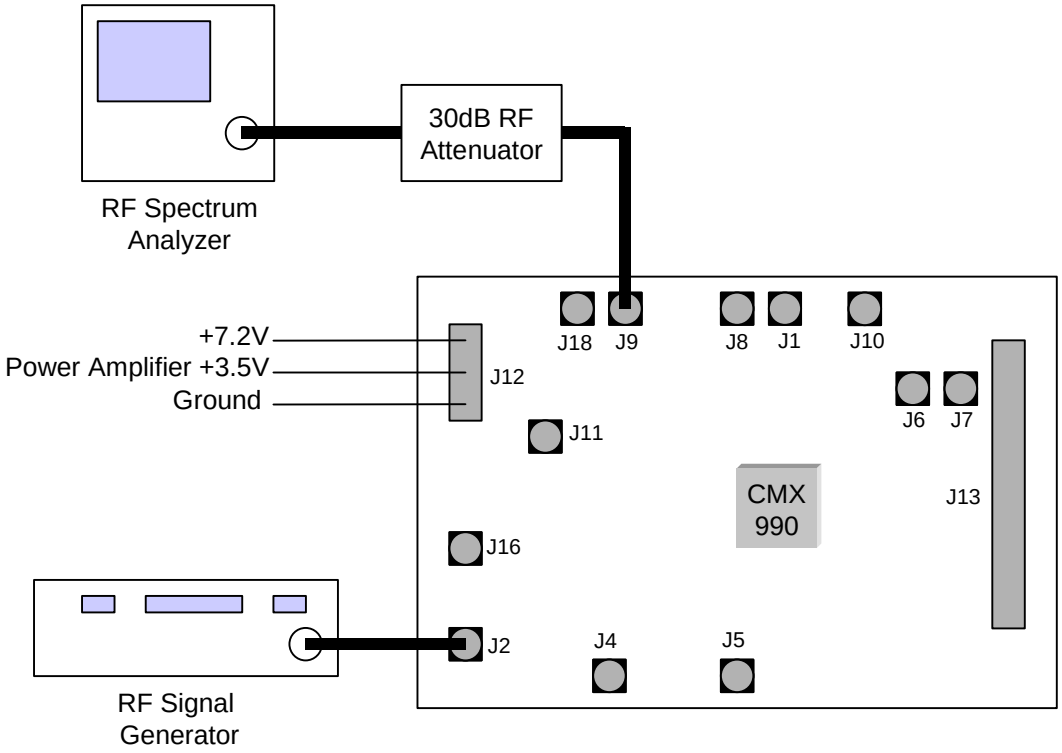


Figure 2 – Typical Connections for EV9900

3.2 Adjustments

None.

3.3 Operation

The CMX990 is a complex RF and Baseband Modem IC. It is recommended that the user familiarise themselves with the datasheet of this device prior to attempting to use the EV9900.

To use the EV9900 the user will need a mechanism to send and receive data and commands via the 8bit parallel host µController interface on the CMX990, which is brought out on connector J13 on the EV9900. The CMX990 datasheet gives details of the registers and commands. To operate the CMX990, some typical command sequences are given below:

Receive Mode

The following example C code shows a typical configuration for reception.

```
register_write(POWER_UP_2, 0x08);     //Reset
register_write(POWER_UP_2, 0x01);     //Vbias on
register_write(POWER_UP_1, 0xEE);     //Clock+BB+Vreg,+Rx:on & Opamps+Tx:off
register_write(POWER_UP_2, 0xF1);     //DACs on
register_write(AUX_DAC_1_MSB,169);  //AFC to mid rail (1.65V)

//Set up synths:

set_main_synth(0x8600,0x011C10);      //1818HMz, high side, Rx Freq=864MHz
                                      //(assuming ref 19.2MHz & comp 12.5kHz)

set_aux_synth(0x80C0,0x0708);                 //180HMz
                                      //(assuming ref 19.2MHz & comp100kHz)

register_write(CONTROL, 0xE9);        //AGC max gain & run, IQ offset fine,
                                      //AFC Slow, PLL Narrow

register_write(MODE, 0xD2);           //IRQ enabled, scrambler enabled,
                                      //INV bit enabled, Main ADC enabled, Rx mode

register_write(POWER_UP_2,0xF5);      //Turn LNA on.

register_write(COMMAND, 0x60);        //Acquire DC offset & AFC
                                      //DelayBy(90000);
                                      //Wait for Offset to complete
```

Following the above routines the user may initiate reception of data using the modem task commands in Command register ($01).

Transmit Mode

The following example 'C' code shows a configuration for the CMX990 transmitter.

```
register_write(POWER_UP_2, 0x08);    //Reset
register_write(POWER_UP_2, 0x01);    //Vbias on
register_write(POWER_UP_1, 0xE0);    //Clock, BB, Vreg:on & Opamps+Tx+Rx:off

register_write(COMMAND, RESET);      //give modem reset command

register_write(CONTROL, 0x00);       //
register_write(MODE, 0xB1);          //IRQ, Tx Mode, Scrambler & Main DAC enabled
```

The user should also ensure that the synthesisers are set to appropriate frequencies and enabled. The transmitter is now ready to start transmission but the offset loop is unlikely to lock without modulation being generated. To achieve lock, write task TSO (Transmit Scrambler Output), which will result in a continuous sequence of random data being generated by the baseband modem. The transmitter is enabled by setting the TxIFRF bit in POWER_UP_1 register.

```
register_write(COMMAND, TSO);        //Transmit Scrambler Output
register_write(POWER_UP_1,0xE1);     //Clock, BB, Vreg, Opamps off , Tx RFIF on
```

The above sequence just enables the transmitter. The power amplifier can now be enabled using the DAC0 Output. This DAC has an automatic ramping circuit to allow an accurate power ramping profile to be applied to the power amplifier.

```
register_write(AUX_DAC_0_MSB,0x39);          //Turn PA on at minimum power to all lock
```

For some operating frequencies the free-running frequency of the Tx VCO needs to be within certain limits of the desired Tx frequency (as described in the datasheet). On the EV9900 this can be achieved using the pre-charge facility as follows:

```
Register_write(0x24,0x11);           //Enable Tx VCO Charge
Delay(1000);                         //Wait while VCO tunes
Register_write(0x24,0x01);           //Disable Tx VCO Charge
```

The power amplifier may now be either ramped up or, for basic testing, enabled to the required power. An output power of >1W is generally achieved with a DAC0 value of 0x50.

```
register_write(AUX_DAC_0_MSB,0x50);          //PA output approx 1W
```

4. Signal Lists

CONNECTOR PINOUT				
Connector Ref.	**Connector Pin No.**	**Signal Name**	**Signal Type**	**Description**
J1	N/A	REFIN	RF / Clock	Clock input / output. By selecting coupling capacitors (C3 / C4) this port may be used to monitor the on-board 19.2MHz reference or the external reference input.
J2	N/A	RXIN1	RF	Input to receiver LNA.
J3	N/A	RXIN2	RF	By selecting components this port may be used as an LNA output or input to the receiver mixer. Coupling capacitor C168 can be fitted to use the off-chip 1st mixer (U15). In this mode T3 should be removed. *NB: This port is a test port designed to allow connection of a coax cable.*
J4	N/A	IFOUT	RF	1st Mixer Output or input to IF filter (F2).
J5	N/A	IF IN	RF	Output of IF filter (F2) or input to CMX990 receiver IF stages.
J6	N/A	TXI	BASEBAND	EV9900 is not configured to use this port.
J7	N/A	TXQ	BASEBAND	EV9900 is not configured to use this port.
J8	N/A	TX VCO O/P	RF	Monitor point for Tx VCO feedback signal.
J9	N/A	TXOUT	RF	900MHz transmitter output.
J10	N/A	MAIN LO	RF	Input or output / monitor for main local oscillator.
J11	N/A	AUX LO	RF	Input or output / monitor for auxiliary (180MHz) local oscillator (normally not connected).
J12	A (1)	+7.2V	DC	7.2V power supply input.
J12	B, C (2, 3)	+3.5V	DC	3.5V power supply for RF power amplifier.
J12	D, E (4, 5)	GND	DC	Power supply ground.
J13	1 – 40	HOST INTERFACE	LOGIC	8 bit parallel interface from CMX990 to host / controller or PC. See schematics and CMX990 datasheet for details.
J14	1 – 8	TX/RX/I/Q	BASEBAND	EV9900 is not configured to use this port.
J15	1,3,5,7	TX/RX/I/Q	BASEBAND	EV9900 is not configured to use these pins.
J15	2	DAC3	BASEBAND	DAC3 output.
J15	4	DAC2	BASEBAND	DAC2 output.
J15	6	ADC5	BASEBAND	ADC5 input.
J15	8	ADC4	BASEBAND	ADC4 input.
J16	N/A	TXOUT	RF	400MHz Transmitter Output (not used in default EV9900 configuration).
J17	N/A	N/A	N/A	EV9900 is not configured to use this connector.
J18	N/A	TXOUT	RF	TX / RX Switch Output (Default configuration of EV9900 does not use this connector).

Table 1 – Signal List

CONNECTOR PINOUT for J13			
Connector Pin No.	**Signal Name**	**Signal Type**	**Description**
1	GNDD	POWER	Connection to digital ground.
2	GNDD	POWER	Connection to digital ground.
3	ADDRESS5	I/P	CMX990 Address (A5).
4	ADDRESS4	I/P	CMX990 Address (A4).
5	ADDRESS3	I/P	CMX990 Address (A3).
6	ADDRESS2	I/P	CMX990 Address (A2).
7	ADDRESS1	I/P	CMX990 Address (A1).
8	ADDRESS0	I/P	CMX990 Address (A0).
9	GNDD	POWER	Connection to digital ground.
10	GNDD	POWER	Connection to digital ground.
11	READN	I/P	CMX990 read strobe.
12	WRITE	I/P	CMX990 write strobe.
13	CSN	I/P	CMX990 chip select input.
14	IRQN	O/P	CMX990 open-drain Interrupt output. Needs a pullup resistor (not fitted on pcb).
15	GNDD	POWER	Connection to digital ground.
16	GNDD	POWER	Connection to digital ground.
17	DATA7	BI	CMX990 Data (D7).
18	DATA6	BI	CMX990 Data (D6).
19	DATA5	BI	CMX990 Data (D5).
20	DATA4	BI	CMX990 Data (D4).
21	DATA3	BI	CMX990 Data (D3).
22	DATA2	BI	CMX990 Data (D2).
23	DATA1	BI	CMX990 Data (D1).
24	DATA0	BI	CMX990 Data (D0).
25	GNDD	POWER	Connection to digital ground.
26	GNDD	POWER	Connection to digital ground.
27	TX_ON	I/P	TX Enable (default configuration does not use this signal).
28	RX_ON	I/P	RX Enable (default configuration does not use this signal).
29, 30	~	~	Spare pin. Leave unconnected.
31, 32	~	~	Spare pin. Leave unconnected.
33, 34	~	~	Spare pin. Leave unconnected.
35, 36	~	~	Spare pin. Leave unconnected.
37, 38	~	~	Spare pin. Leave unconnected.
39, 40	~	~	Spare pin. Leave unconnected.

Table 2 – Host µController Interface

TEST LOOPS		
Test Loop Ref.	**Default Measurement**	**Description**
TL1		LNAON control line from CMX990
TL2		EV9900 is not configured to use this port
TL3		EV9900 is not configured to use this port
TL4		EV9900 is not configured to use this port
TL5		EV9900 is not configured to use this port
TL6		800/900MHz power amplifier control voltage
TL7		Control port chip select line (This pin is useful to trigger measurements on command inputs to the CMX990 registers)
TL8		DAC 0 (PA Ramping)
TL9		DAC 1 (AFC)
TL10		ADC 0 Input
TL11		ADC 1 Input
TL12		Test point for differential amplifier 1 inverting input
TL13		Test point for differential amplifier 1 output
TL14		Test point for differential amplifier 2 output
TL15		Test point for differential amplifier 2 inverting input
TL16	2.5V	+2.5V power supply
TL17		400MHz power amplifier control voltage (not used in default configuration)

Table 3 – Test Loops

TEST POINTS		
Test Point Ref.	**Default Measurement**	**Description**
TP1		EV9900 is not configured to use this signal
TP2		EV9900 is not configured to use this signal
TP3		EV9900 is not configured to use this signal
TP4		EV9900 is not configured to use this signal
TP5		EV9900 is not configured to use this signal
TP6		EV9900 is not configured to use this signal
TP7		EV9900 is not configured to use this signal
TP8		EV9900 is not configured to use this signal
TP9		Transmitter PLL VCO control line
TP10		EV9900 is not configured to use this signal
TP11		Main PLL VCO control line
TP12		Auxiliary PLL VCO control line
TP13	2.5V	2.5V regulator output
TP14	5.0V	5.0V regulator output for digital baseband
TP15	0V	Analogue ground
TP16	0V	Analogue ground
TP17	0V	Digital ground
TP18	0V	Digital ground
TP19	5.0V	5.0V regulator output for analogue baseband
TP20	3.3V	3.3V regulator output
TP21	3.3V	3.3V regulator output for VCO
TP22		EV9900 is not configured to use this signal
TP23		PA output power detector voltage
TP24		AFC Temperature sensor voltage
TP25		PA Temperature sensor voltage
TP26	5.0V	5.0V regulator output for VCO

Table 4 – Test Points

JUMPERS			
Link Ref.	**Positions**	**Default Position**	**Description**
J14		Open	EV9900 is not configured to use this port
J15		Open	EV9900 is not configured to use this port

Table 5 – Jumpers

Notes:

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

5. Circuit Schematics and Board Layouts

For clarity, circuit schematics are available as separate high-resolution files. The layout on each side is shown in *Figure 3*, below:

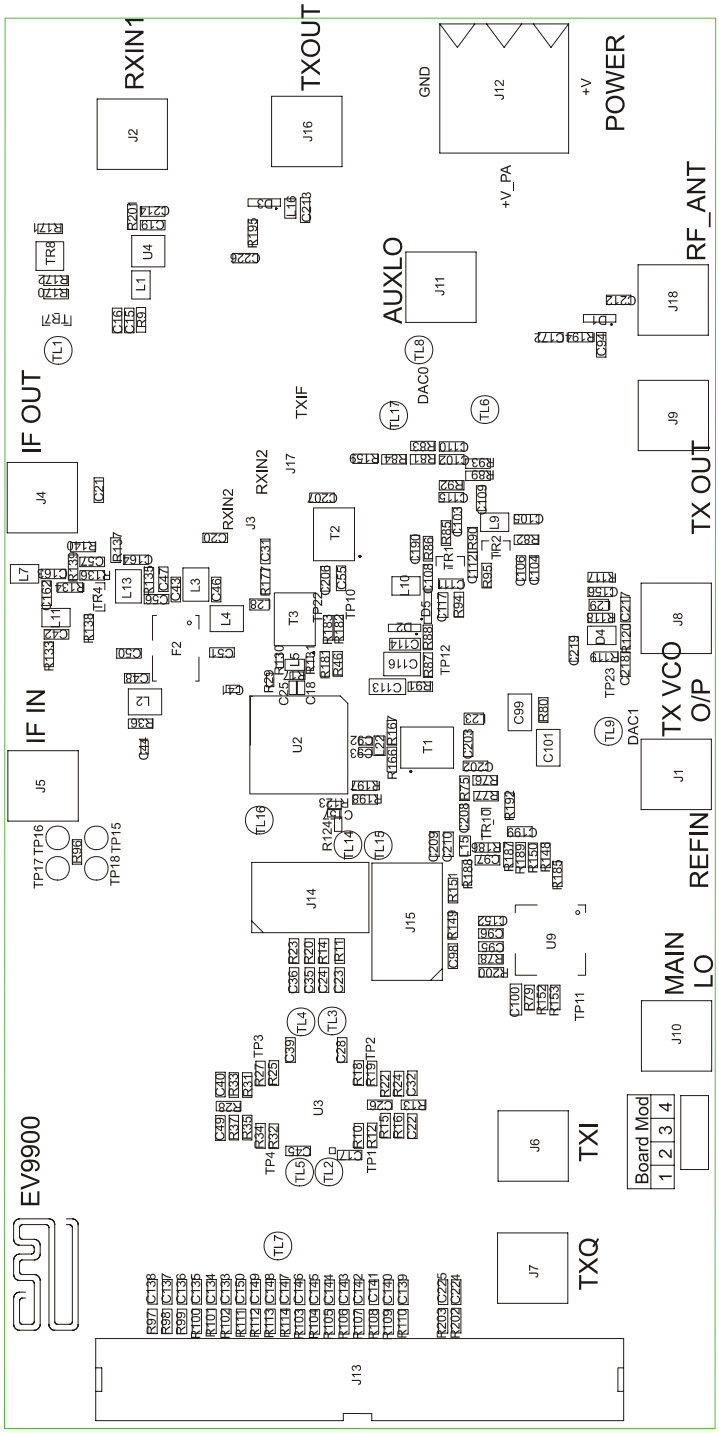


Figure 3a - PCB Layout: top

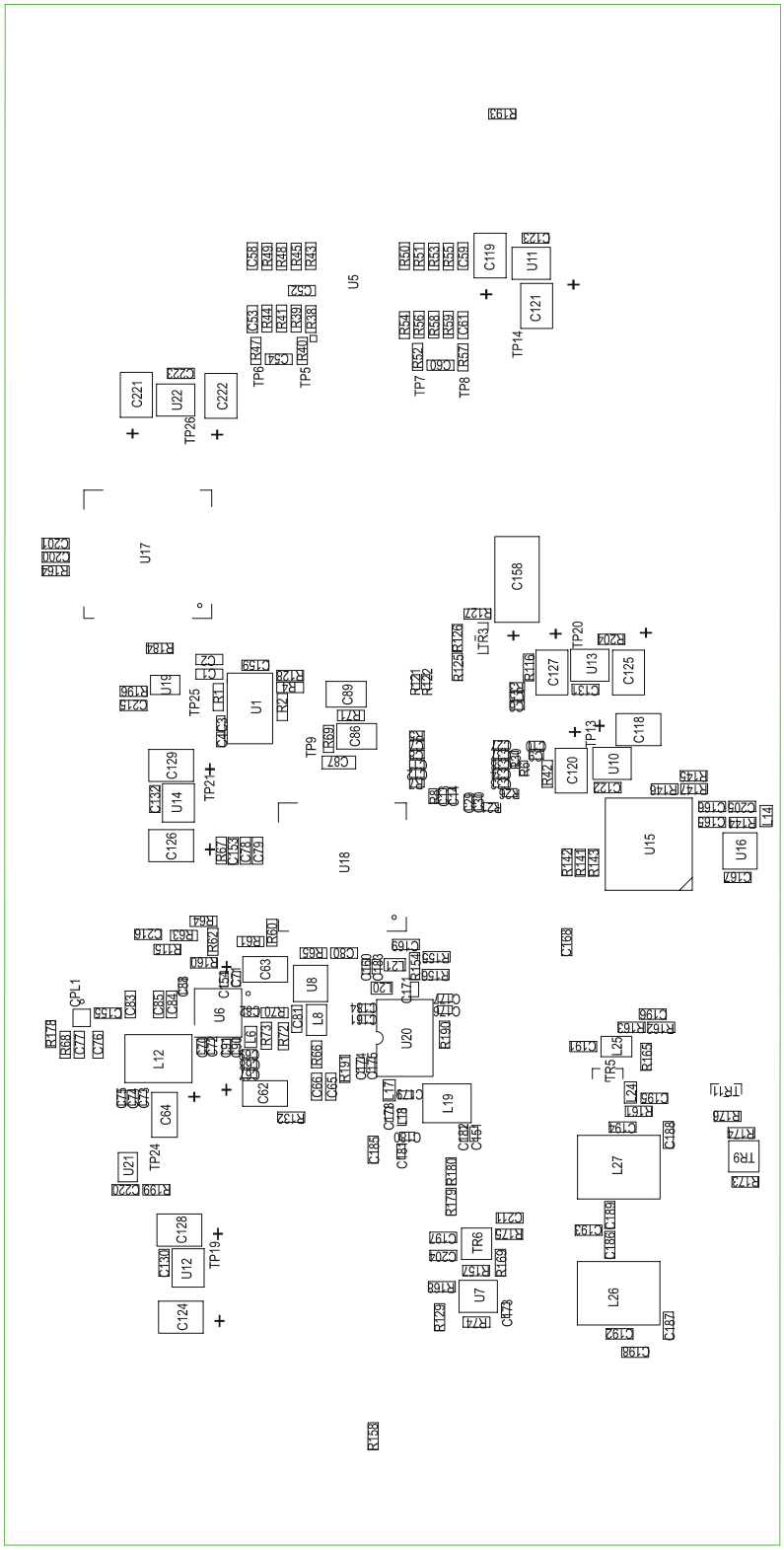


Figure 3b – PCB Layout: bottom

6. Detailed Description

The CMX990 datasheet (not included but available at www.cmlmicro.com) should be referred to for a detailed description of the CMX990 device.

The EV9900 functionality includes:

- Demonstration of the CMX990 RF functionality at ≈400MHz or ≈800MHz
- Implementation of the 1st receive mixer bypass mode
- Demonstration of EN 300 113 receive performance in mixer bypass mode
- Interfaces that allow the card to be connected to a host µController, to allow real-time control, or to a PC (a separate interface may be required)
- An interface allowing the connection of an external reference clock

In summary, the EV9900 allows the user to create experiments to investigate all aspects of the CMX990 device. The EV9900 is designed to allow user modification, to support detailed investigation of each user's specific and different applications.

6.1 Hardware Description

Front End LNA

The PCB includes a broad band MMIC LNA operating 400MHz to 1GHz, for evaluation at different operating frequencies. Also provided is an LNA using TR5, which is designed for 440-453MHz and to meet EN 300 113 requirements. The LNA includes the front end image reject filtering (L26, L27, C186, C187, C188, C189, C192, C193 and C194). This is not configured in the default version of the EV9900.

1st Rx Mixer

By fitting or not fitting certain capacitors the user is able to select the CMX990 image reject mixer or an external mixer (U15) compliant with EN 300 113 requirements. The external mixer is a diode ring type. U15 is followed by a buffer (TR4). This buffer has a flexible configuration to allow optimisation by the user if required. The outputs of the mixer sections may be connected to test equipment or to the IF filter section. (Note: if the user wishes to interface to test equipment they will need to match the ports to the impedance of the test equipment, typically 50Ω).

IF Filter

The IF filter (F2) is a 45MHz 4-pole crystal filter. The pass-band of the filter fitted to the EV9900 is +/-6kHz, however other filters are available in the same package outline, offering different bandwidths. Correct matching of the filter is necessary to achieving optimum performance.

Reference Oscillator

A 19.2MHz VCTCXO is provided on the PCB. If C4 is removed and C3 fitted an alternative clock source can be applied to J1.

Transmitter

The transmitter provides at least +30dBm in the default configuration (819-825MHz). Two power amplifier footprints are provided on the PCB, however only the 800MHz (U6) device is fitted to the EV9900. The other PA (U20) can be fitted for 400MHz operation. The 400MHz PA is tuneable (by component changes) over the range 380 to 512MHz. The transmit VCO (U18) also has very broad tuning range typically from below 800MHz to above 900MHz with a 3.3V charge pump.

The CMX990 RAM DAC output (DAC 0) is be connected to the PA control line with a buffer (U7) which is used to scale the gain and transistor (TR7) to provide sufficient current to the PA control pin. The buffer is required as the PA control lines can sink several mA of current, which is more than the CMX990 DAC output can provide.

Local Oscillators

VCO's are provided for the main and aux synthesizers. The aim is to cover the frequency bands of 864-870MHz (Rx) and 819-825MHz (Tx).

This requires the following local oscillator frequencies, based on the following frequency plan:

Rx Band / MHz	Tx Band / MHz	Tx IF / MHz	Rx IF / MHz	LO Range / MHz
864 – 870			45.0	1818 - 1830
	819-825MHz	90.0		1818 - 1830

Table 6 – Local Oscillator Frequencies

If the mixer bypass mode is to be used the main LO should be operated at the desired local oscillator frequency, rather than twice the LO frequency (as required by the CMX990 image reject mixer). The CMX990 has a control register bit to switch into this mode. The VCO for the main PLL now requires an operating band at around 800MHz.

The VCOs are packaged parts from Z-communications, who provide a range of VCO's in the same package outline, so that the user can evaluate other frequency bands if required. These VCOs have some performance limitations and so fail to meet EN 300 113 adjacent channel requirements for transmitter and receiver.

The aux VCO is a discrete design operating at 180MHz and covering the range 160-180MHz. This may be re-tuned by component changes if required by the user.

Differential Amplifiers

Simple circuits are provided to allow evaluation of the differential amps on the CMX990 (R117, R118, R119, R120, R121, R122, R123, R124, C156 and C157).

Temperature Sensors

Two temperature sensors are provided, one (U21) adjacent to the PAs and the other (U19) adjacent to the VCTCXO. These are connected to the CMX990 Aux ADC inputs 0 and 1 respectively.

Tx/Rx Switch

Although not configured in the default EV9900, circuits are provided to implement a Tx / Rx switch using PIN diodes. (See section 6.2.2)

Interface

The EV9900 provides access to the CMX990 parallel interface via connector J13.

The EV9900 has test pins to allow measurement of aux DAC outputs and test pins that allow the user to apply test signals to the aux ADC inputs.

All RF connectors are SMA type.

The power connector provides two separate power connections: one for the power amplifier and the other to supply all other circuits.

6.2 Adjustments and Controls

The user has the ability to configure the EV9900 for a number of different operational scenarios.

6.2.1 Mixer Bypass / 400MHz Operation

The CMX990 contains a mixer intended for the 1st mixer in a superhetrodyne receiver architecture. The mixer is an image reject type intended for a 45MHz IF output. The intermodulation performance of this mixer does not meet some performance standards, such as EN 300 113, so the user may wish to use an external mixer with the CMX990 if such performance is desired. The EV9900 has been supplied with a typical mixer bypass circuit, using a diode ring mixer, which may be used as an alternative to the CMX990 mixer. By default the EV9900 is configured to use the CMX990 mixer.

To use the external mixer the following changes should be made:

- C56 and C168 should be fitted with a 1nF capacitor.
- Remove C191 unless 400MHz LNA is to be used.
- R177 should be fitted with 0R resistor unless 400MHz LNA is to be used.
- R151 should be fitted with 18R resistor.
- L28 and T3 should be removed.
- The user will need to match the IF Filter (F2) to the output of the buffer. Components C46, L3 and C56 are likely to need optimisation.

In the mixer bypass mode the 400MHz main VCO should be used (U17).
The following changes should be made:

- Remove R152, R200, C97.
- Fit R164 with 120Ω.
- Fit R153 with 0Ω.
- Fit R184 with 0Ω.

For 400MHz operation of the transmitter the Tx VCO needs to be changed to a 400MHz part for example the V560MC03 from Z-Communications.

NOTE: Problems may be encountered with the transmitter in mixer bypass mode and with the main local oscillator on the EV9900, as no shielding is provided between the power amplifier and the local oscillator.

To achieve optimum performance from the diode ring mixer (U15) all ports should see a good 50Ω match. The IF port is particularly critical and a matching arrangement is provided into a buffer amplifier. Using negative feedback in such buffer amplifiers is often beneficial but in this case can be problematic, as it is essential to ensure that the buffer provides good isolation so as to prevent the crystal filter impedance from disturbing the match to the mixer. The buffer is configurable to allow the user to determine the best configuration for particular design requirements.

6.2.2 Tx/Rx Switch

The following modifications need to be implemented on the EV9900 (PCB546D) evaluation board for the RX/TX switch to work at 800/900MHz:

- D1 = BAR63_02W.
- Use a 0R to link out D3's usual placement. Then D3 should be placed as shown in *Figure 4* then is done by removing some PCB solder resist from the long track in the RX path near J16 (placed in line with leg of J16 as shown below) and also some resist from the nearby GND plane has to be removed. D3 = BAR63_02W. D3 connections are cathode to GND and anode to track (signal).

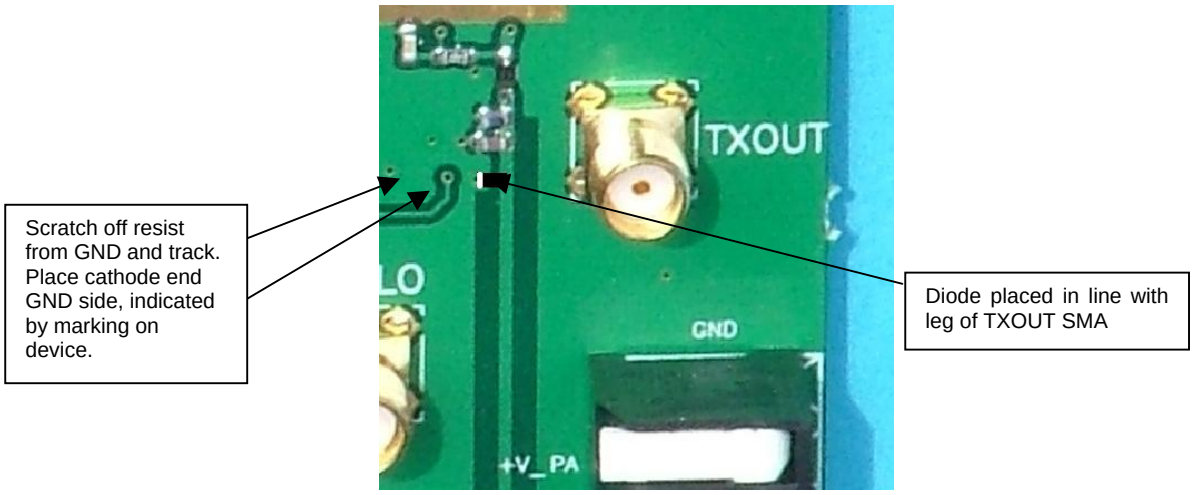


Figure 4 – Picture of relevant area for new placement of D3

- C214, C212 and C94 = 1nF
- R194 =150nH (0603CS)
- R202 = 2k2
- C172 = 470pF
- R178 and R201 = NF

The main consequence with this topology is that only one control line is required and the logic is as follows; TX_ON = 3V (HIGH) => TX mode, TX_ON = 0V (LOW) => RX mode.

6.2.3 External Local Oscillator

To evaluate the performance of the CMX990 it is recommended that a low noise external oscillator be used for the main LO. This is particularly important when performing blocking and adjacent channel tests. An external main LO can be supplied via J10. The following changes are recommended:

- Remove R78, R164 and R200.
- Ensure C98 (1nF) and R149 (18Ω) are fitted.

6.2.4 Intermediate Signal Connections

The EV9900 allows a user to connect signals at various points in the signal path of the IC. Details can be found on the schematic and in the list of connectors. Users can choose appropriate matching and configurations to suit their requirements. Note that just connecting test

equipment to the ports may not give the expected results – correct RF matching arrangements are required.

6.2.5 400MHz LNA

To use the 400MHz LNA provided on the PCB:

- Fit C198 (1nF).
- Fit either R177 (0R) for CMX990 mixer or C168 (1nF) for external mixer.

6.3 Firmware Description

The EV9900 has no embedded firmware.

6.4 Software Description

CML products DE9901 and EV9902 (not included) can be used with the EV9900 and include related software.

6.5 Application Information

6.5.1 TX Loop Operating Power Levels

The range of input powers to the feedback port (TxFB) of the offset loop is designed to allow operation over an 80dB range. This is to permit the loop to lock prior to commencing power ramping however initial CMX990 silicon has a slightly reduced operating range.

6.5.2 90MHz Operation

Operation of the Tx Loop with a 90MHz IF results in a small degradation of adjacent channel power. The loop can also have problem locking if the free-running VCO frequency is below the wanted Tx frequency.

Operation with a 45MHz IF is correct.

6.5.3 Transmitter Adjacent Channel Power

The following commands should be written to the CMX990 to improve the Tx Modulation spectrum.

Address	Value
0x1C	0x00
0x1B	0x3D
0x1E	0x20
0x1D	0x00
0x1A	0x0C
0x1C	0x00
0x1B	0x3E
0x1E	0x20
0x1D	0x00
0x1A	0x0C

6.6 Evaluation Tests

The EV9900 is intended to allow evaluation of CMX990 RF and baseband performance. The following is a list of typical test from radio modem standards. Some guidance notes on likely EV9900 performance are provided.

Frequency Error

Compliant, based on a selected 19.2MHz VCTCXO.

Adjacent Channel Power (ACP)

60dB adjacent channel power can be demonstrated for 12.5kHz channels with G(M)FSK, B_t = 0.3 and 8kbit/s. To achieve this an external LO is required and a TxIF of 45MHz selected.

Spurious Emissions

EV9900 is not designed to be compliant with spurious emissions limits as transmitter filtering is not included.

Transmitter Attack and Release Time, Transient Behaviour of the Transmitter

See section 6.5.

Maximum Usable Sensitivity

Typically –117dBm for 1% BER

Error rate at High Input Levels

See section 6.5.

Co-channel Rejection

With an interferer on the same frequency this is typically 8-10dB for 12.5kHz channel spacing operation (8kbit/s). See also section 6.7.1.

Adjacent Channel Rejection (ACR)

ACR performance is limited by local oscillator phase-noise. The performance of the EV9900 meets Mobitex MIS requirements but does not meet EN 300 113.

Spurious Response Rejection

A front-end SAW filtering is not provided on the EV9900 so spurious response rejection is not guaranteed.

Blocking or Desensitisation

Blocking performance is about 80dB. This will be improved in later silicon.

6.7 Troubleshooting

The CMX990 is a complex RF and Baseband system. If incorrectly programmed or modified, results will be at variance from datasheet performance. Please study the 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.

6.7.1 Receiver Operation

Error Observed	Possible Cause	Remedy
No packets are received, however synthesisers are locked and the receiver otherwise appears to be operating correctly.	'INV' bit incorrectly set.	Invert current setting of 'INV' bit.
Receiver sensitivity is 30dB less than anticipated.	'Sign' bit is incorrectly set.	Invert current setting on 'Sign' bit
Degraded receiver performance.	Incorrect DC offset correction.	Ensure DC offset correction sequence has been executed.
Degraded receiver sensitivity and/or imbalance in adjacent channel power in the transmitter (i.e. ACP high is much better than ACP low or vice versa)	There is a frequency offset between EV9900 reference oscillator and the test equipment. (Note: EV9900 requires an approximate AFC value to be programmed into the DAC1. A value of 0x95 in register 0x0B is a good starting point.)	To check if a frequency error exists measure the frequency of the main local oscillator either using the measuring equipment in question or compare results from EV9900 with those from the measurement equipment. To overcome a frequency error either: a) Use a external reference for the EV9900 b) Tune to control voltage on the AFC output (DAC1).
Poor sensitivity on some channels or BER results variable.	The main Tx VCO is not powered down and can drift into the Rx band.	In a normal modem design the Tx VCO (U18) would be powered down during Rx mode. This is not implemented on EV9900. To overcome the problem the Tx VCO should be disabled during Rx BER testing. This can be done by removing R67.
Poor co-channel rejection at negative frequency offsets	The SAW IF filter (F2) is slightly miss-aligned.	Change L4 to 1.8μH. Note: is necessary to ensure the centre frequency of the receiver matches that of the test signal generators precisely to get reliable results.

6.7.2 Transmitter Operation

Error Observed	Possible Cause	Remedy
Transmitter loop does not lock	No modulation is present.	Ensure the transmitter is outputting data. The TSO command can be used to continuously send data for testing. Note also the modem needs to be in transmit mode and main DAC enable (register $03)
Transmitter loop does not lock	The PA is not turned on.	The Tx loop in the engineering silicon of the CMX990 requires a reasonable level of feedback for the loop to lock. The PA ramping register (0x09) should be set to at least 0x39 to ensure lock.
Poor modulation spectrum in transmit.	An incorrect filter has been chosen for the selected Tx IF.	Select the correct filter using bits 5 and 6 of the Aux PLL M div MSB register ($26).

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})	0.0	8.0	V
Supply Voltage (V_{PA} - V_{SS})	0.0	4.0	V
Current into or out of V_{IN} V_{PA} 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
Supply Voltage (V_{PA} - V_{SS})		3.0	3.6	V
Xtal/External Clock Frequency			24	MHz

7.1.3 Operating Characteristics

Details in this section represent design target values and are not currently guaranteed.

For the following conditions unless otherwise specified:

Evaluation Device Xtal Frequency = 19.2MHz, Bit Rate = 8k bits/sec,
V_{IN} - V_{SS} = 7.2V, V_{PA} - V_{SS} = 3.5V, Tamb = +25°C.

	Notes	Min.	Typ.	Max.	Units
DC Parameters (Excluding PA Supply)					
I_{DD} (CMX990 powersaved)	1		135		mA
I_{DD} (Tx)	1		200		mA
I_{DD} (Rx CMX990 internal mixer; LNA enabled)	1		260		mA
AC Parameters					
Tx Output					
Tx output impedance			50		Ω
TX output power			30		dBm
Rx Input					
Rx input impedance			50		Ω
Rx Sensitivity	2		-117		dBm
Maximum Input Level without damage				0	dBm
Xtal/Clock Input					
Reference Clock Frequency			19.2		MHz
Reference Clock Level	3	1			Vp-p
µC Interface					
See CMX990 Datasheet					

Notes:
1. PCB current consumption, not current consumption of the CMX990.
2. 1% BER
3. Typically clipped sine wave

7.1.3 Operating Characteristics - Timing Diagrams

Please refer to CMX990 Datasheet for details.

www.cmlmicro.com

For FAQs see: www.cmlmicro.com/products/faqs/

For a full datasheet listing see: www.cmlmicro.com/products/datasheets/download.htm

For detailed application notes: www.cmlmicro.com/products/applications/

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