Consumer Microcircuits Limited

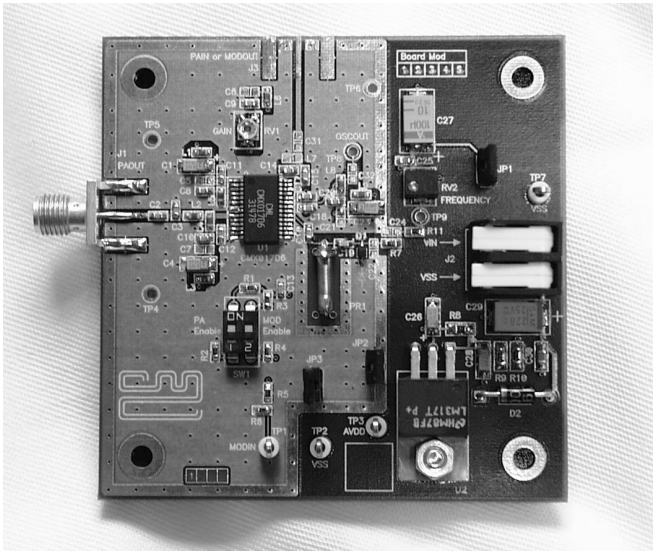
M-I-X-E-D S-I-G-N-A-L S-O-L-U-T-I-O-N-S

EV0171
Evaluation Kit
User Manual

UM0171/2 May 1999 Advance Information

1.0 Features

- **CMX017 Product Demonstration**
- **860 - 935 MHz Operation**
- **Direct FM/FSK Modulation**
- **Adjustable Output Power up to +20dBm**
- **Simple and Easy to Use Controls**
- **Single 6 - 12 V Power Supply**
- **Powersave and Zero-Power Modes**
- **Optional access to PAIN and MODOUT**



1.1 Brief Description

The EV0171 Evaluation Kit comprises a single board containing the CMX017 UHF FM/FSK transmitter, frequency and gain potentiometers, VCO tank circuitry and miniature control switches.

A multi-turn potentiometer allows the user to select an RF operating frequency between 860 - 935 MHz. The operating bandwidth and centre frequency can be optimised by modifying the VCO tank components.

The board is powered from a single 6 - 12 V dc power supply. Regulation circuitry sets the analog (AV_{DD}) supply for 3V operation. CMX017 supply currents may be measured by removing appropriate jumpers.

A low profile 2-way DIL switch controls the device enable lines, to obtain CMX017 powersave and zero-power modes.

Links, test points and an SMA connector provide access to various points in the circuit.

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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 data sheet should not be relied upon for final product design.

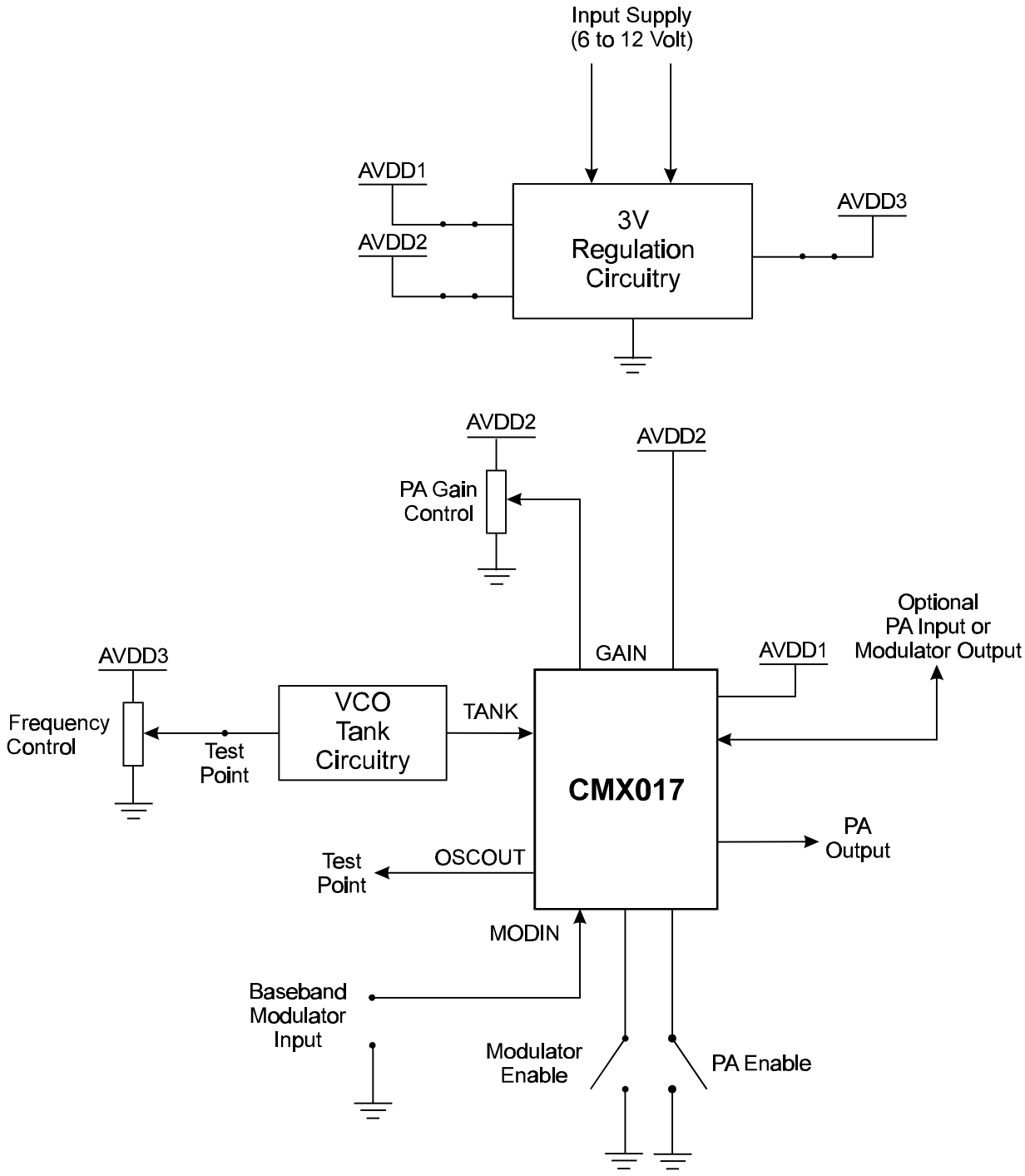


Figure 1 Block Diagram

1.2 Preliminary Information

1.2.1 Laboratory Equipment

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

1.2.1.1 6 - 12 V dc Power Supply

1.2.1.2 Radio Communications Test Set or similar

1.2.1.3 Modulation source

1.2.2 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.

1.2.2.1 Static Protection

This product uses low power CMOS circuits which 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.

1.2.2.2 Contents - Unpacking

Please ensure that you have received all of the items on the separate information sheet (EK0171) and notify CML within 7 working days if the delivery is incomplete.

1.2.3 Approvals

This Evaluation Kit is capable of producing radio frequency emissions. Users are advised to observe local statutory requirements which may apply to this product.

1.3 Quick Start

This section provides instructions for users who wish to experiment immediately with the evaluation kit. A fuller description of the kit and its use appears later in this document.

1.3.1 Setting-Up

The EV0171 comes pre-configured for an RF operating frequency of 860MHz. The output power at PAOUT, J1, is set to approximately 100mW when terminated with 50Ω.

Using suitable coaxial cable and adapters, connect PAOUT, J1, to the 50Ω input of a Radio Communications test set, or similar. Ensure this input can accept power levels > +20dBm without damage. Use an appropriate 50Ω inline attenuator if necessary.

Connect MODIN, TP1, to the output of a modulation (FM or FSK) source. Ensure the signal level does not exceed the maximum level specified in device datasheet.

Select the required RF operating frequency (860 - 935 MHz) by setting the frequency potentiometer, RV2.

Apply power to the input supply connector, J2, from a suitable 6 - 12 V dc power supply.

Operate switches SW1:1 and SW1:2 to enable the PA stage and modulator respectively.

To minimise the regulator (U2) power dissipation whilst operating for long periods with maximum gain, it is recommended that the input voltage, VIN, is kept below 9V.

1.3.2 Adjustments

To adjust the gain of the CMX017 PA driver slowly turn the trimmer potentiometer, RV1. Using RV1, the power level at PAOUT can be adjusted by typically 20dB.

A new RF operating frequency can be obtained by adjusting the trimmer potentiometer, RV2.

1.4 Signal Lists

CONNECTOR PINOUT				
Connector Ref.	**Connector Pin No.**	**Signal Name**	**Signal Type**	**Description**
J1	1	PAOUT	O/P	CMX017 PA Output
J2	1	V_{IN}	Power	+ve power from external power supply
	2	V_{SS}	Power	0V power from external power supply
J3	1	PAIN or MODOUT	BI	CMX017 PA Input or Modulator Output

TEST POINTS		
Test Point Ref.	**Default Measurement**	**Description**
TP1	-	CMX017 Modulator Input
TP2	0V	V_{SS} connection
TP3	3V	AV_{DD} connection
TP4	0V	V_{SS} connection
TP5	0V	V_{SS} connection
TP6	0V	V_{SS} connection
TP7	0V	V_{SS} connection
TP8	-	CMX017 Buffered Oscillator Output
TP9	-	Frequency Control Voltage

JUMPERS			
Link Ref.	**Positions**	**Default Position**	**Description**
JP1	1-2	S/C	Disconnect to measure AV_{DD3} current
JP2	1-2	S/C	Disconnect to measure AV_{DD2} current
JP3	1-2	S/C	Disconnect to measure AV_{DD1} current

ADJUSTMENTS			
Adjustment Ref.	**Adjustment**	**Adjustment Range**	**Description**
RV1	Gain	0 - 3V	CMX017 PA Driver Gain
RV2	Frequency	0 - 3V	RF Operating Frequency Control

SWITCHES			
Switch Ref.	**Positions**	**Default Position**	**Description**
SW1:1	on/off	on	CMX017 PA Enable
SW1:2	on/off	on	CMX017 Modulator Enable

Notes: I/P = Input
O/P = Output
BI = Bidirectional

1.5 Circuit Schematics and Board Layouts

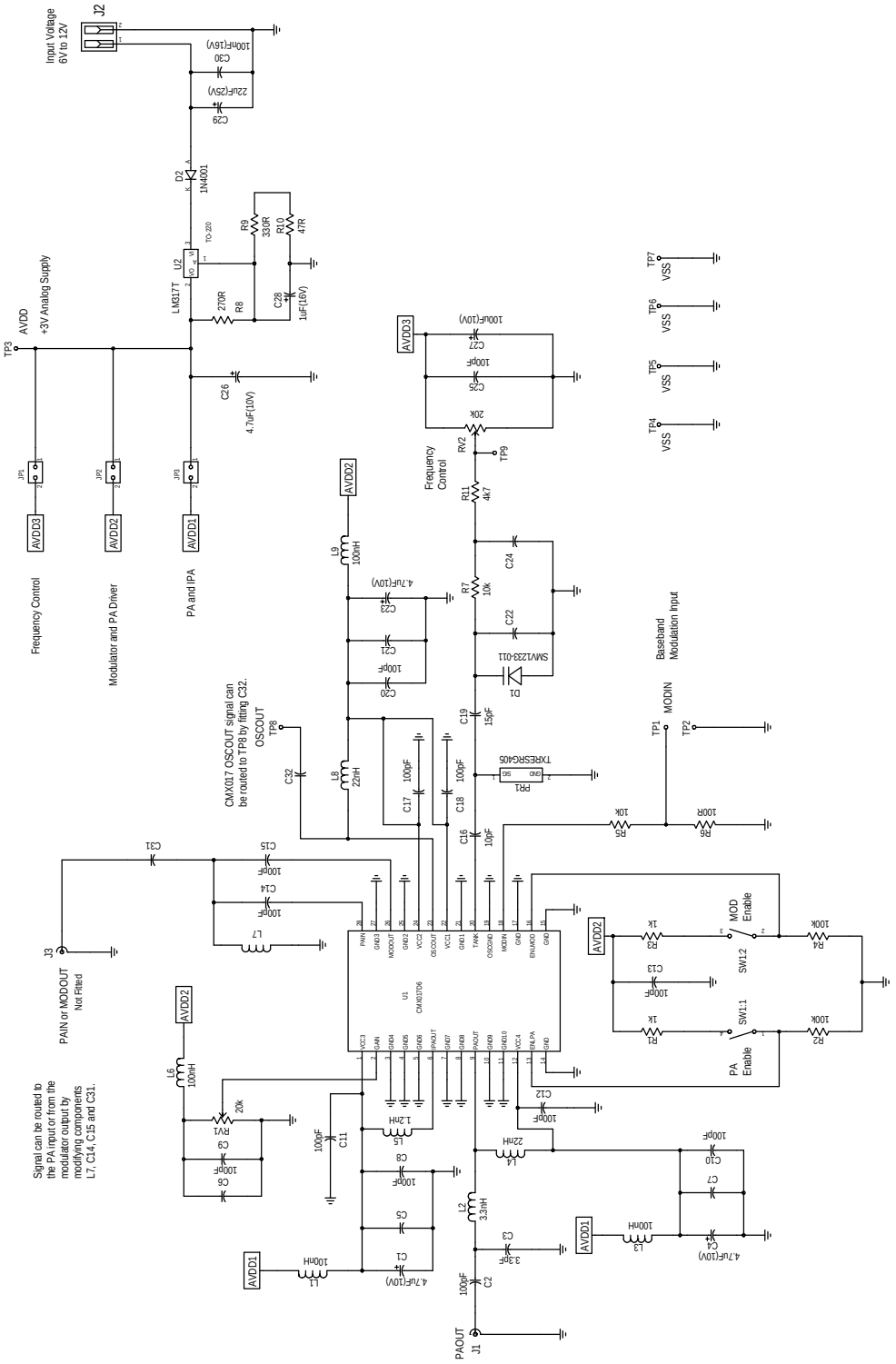
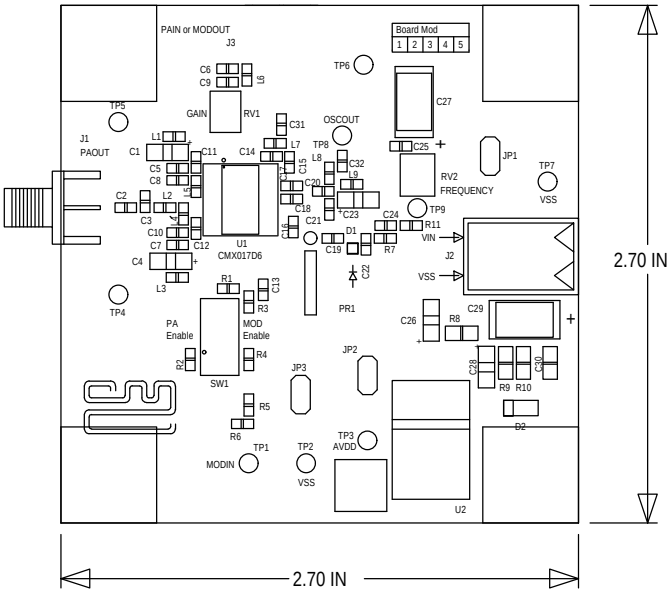


Figure 2 Evaluation Board - Circuit Schematic



Note: Board material is FR4

Figure 3 Evaluation Board Layout - Assembly

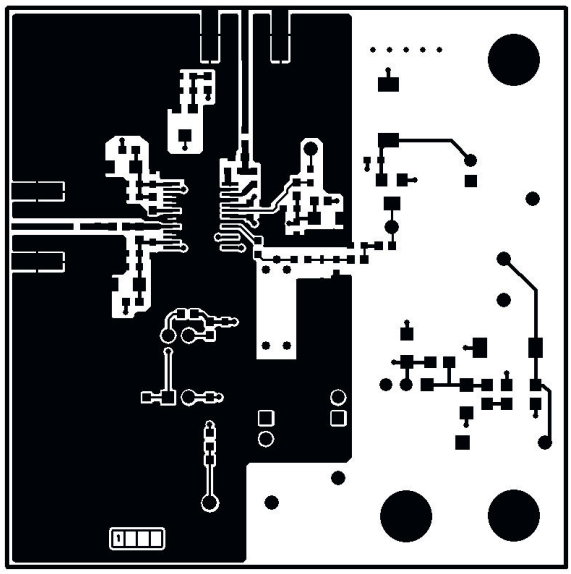


Figure 4 Evaluation Board Layout - Top Copper

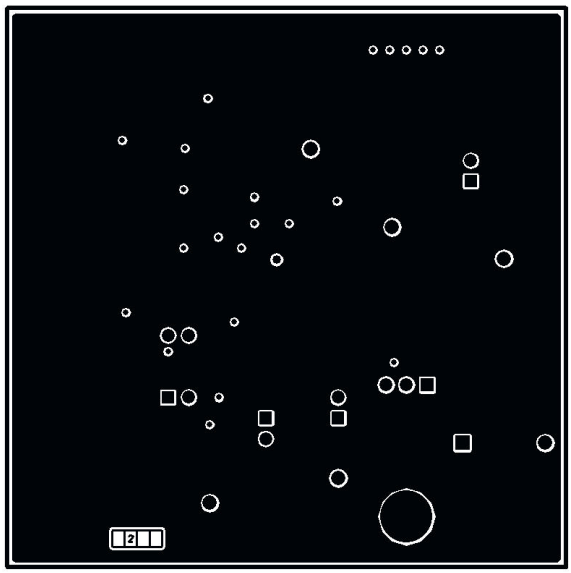


Figure 5 Evaluation Board Layout - Layer Two Copper

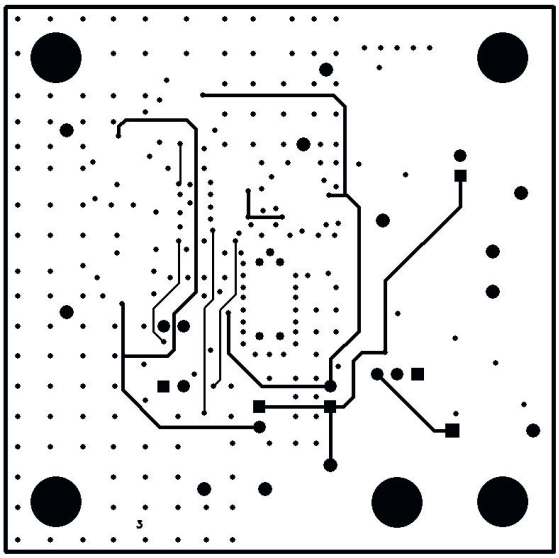


Figure 6 Evaluation Board Layout - Layer Three Copper

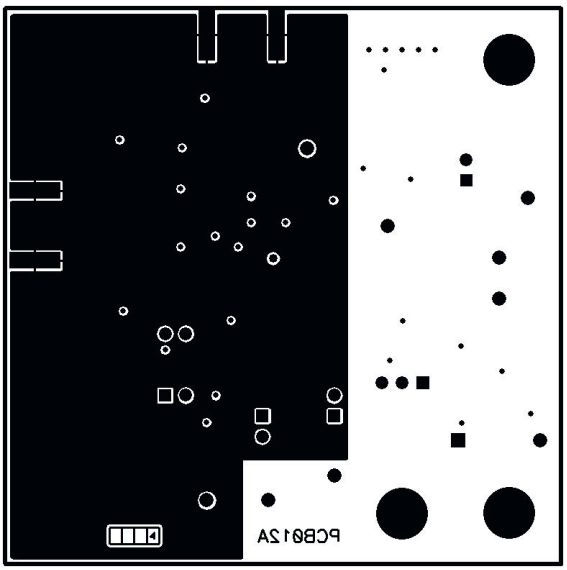


Figure 7 Evaluation Board Layout - Bottom Copper

1.6 Detailed Description

The EV0171 Evaluation Kit comprises a single board containing the CMX017 UHF FM/FSK transmitter, frequency and gain potentiometers, VCO tank circuitry and miniature control switches.

A multi turn potentiometer allows the user to select an RF operating frequency between 860-935MHz. The operating bandwidth and centre frequency can be adjusted by simply modifying the VCO tank components.

The board is powered from a single 6 - 12 V dc power supply. Regulation circuitry sets the analog(AV_{DD}) supply for 3V operation. CMX017 supply currents may be measured by removing appropriate jumpers.

A low profile 2-way DIL switch controls the device enable lines, to obtain CMX017 powersave and zero-power modes.

Links, test points and SMA connector provide access to various points in the circuit.

This open-loop configuration is not recommended for the majority of customer applications. A closed-loop PLL design is required to improve controllability and overcome stability and drift problems.

External PLL circuitry could be connected to test points TP8 (OSCOUT) and TP9 after removal of RV2.

1.6.1 Hardware Description

1.6.1.1 Operating Voltage

The supply regulation circuitry contains a single regulator and associated components to provide the analog supply (AV_{DD}). The operating voltage is set to 3.0V.

The supply feed is split three ways to reduce interference and to enable the user to separately measure various device/circuitry currents.

The supply regulation can be bypassed and external supplies applied, via jumpers JP1-JP3.

Note, due to the inductors dc resistance which is approximately 0.5Ω (100nH), small voltage drops will occur across inductors L3 and L1.

1.6.1.2 Current Measurement

Supply currents for the evaluation device and other board circuitry can be measured by removing the appropriate jumper and replacing it with a multimeter.

1.6.1.3 VCO Tank Circuitry

The tank resonator circuit is formed by two capacitors, C16 and C19, RG405 coaxial resonator, PR1, and varacter diode, D1, which is driven by the frequency control potentiometer, RV2.

The dc control voltage derived from the frequency control potentiometer, RV2, can be measured at TP9. Alternatively the potentiometer can be removed and control voltage applied to the VCO tank circuitry via the test point TP9.

1.6.1.4 FM/FSK Modulator

The modulation input, MODIN, TP1, is designed to be directly driven by a dc-coupled baseband input signal, to generate a frequency modulated (FM or FSK) RF signal.

Please refer to the CMX017 device datasheet for specifications on maximum modulation frequency/voltage at the device input (MODIN, pin 18).

The resistors R6 and R5 can be modified depending on the modulation source and required frequency deviation.

The output impedance at the CMX017 MODOUT pin is typically 50Ω. Using microstrip techniques the MODOUT track on the 4-layer PCB has been designed to provide a line impedance of 50Ω.

The CMX017 Modulator output signal can be routed to an SMA connector (not fitted), J3, by modifying components C14, C15, C31 and L7.

1.6.1.5 Power Amplifier

The input/output impedances at the CMX017 PAIN/PAOUT pins are typically 50Ω. Using microstrip techniques their tracks on the 4-layer PCB have been designed to provide line impedances of 50Ω.

Additional power gain improvement is achieved by employing the simple output matching network, C2, C3 and L2.

Both amplifier output stages, IPAOUT and PAOUT, must have a dc connection to the supply rail through RF chokes, L4 and L5.

The evaluation device can be used as a standalone UHF Power Amplifier by modifying components C14, C15, C31 and L7. The RF signal should be input via an SMA connector (not fitted), J3.

1.6.2 Adjustments and Controls

1.6.2.1 Frequency Control

The trimmer potentiometer, RV2, controls the RF operating frequency. The control voltage derived (0-3V) from this potentiometer allows the RF operating frequency to be set between 860 - 935MHz. The frequency control potentiometer draws a typical current of 150µA from the AV_{DD3} supply.

1.6.2.2 Gain Control

The trimmer potentiometer, RV1, controls the gain of the CMX017 PA driver. The output power, at the MODOUT pin, is variable over a 20dB range. The output power is maximum when the CMX017 GAIN pin is connected to 3V and is reduced by typically 20dB when this pin is connected to 0V.

The gain potentiometer draws a typical current of 150µA from the AV_{DD2} supply.

1.6.2.3 Powersave and Zero-Power Modes

The evaluation device enable lines are controlled by switch SW1. This switch allows the user to configure the CMX017 transmitter for powersave or zero-power.

The Modulator and Buffered Oscillator stages of the evaluation device can be powered down independently of the PA Driver and Power Amplifier stages.

In **SLEEP** mode (SW1:1 and SW1:2 are Off) all sections of the device are powered down and the device current consumption is reduced to typically 10μA. This is the zero-power mode.

In **TRANSMIT-STANDBY** mode (SW1:1 is Off and SW1:2 is On) only the PA Driver and Power Amplifier stages are powered down, whilst the Modulator and Buffered Oscillator remain active.

In **TRANSMIT** mode (SW1:1 and SW1:2 are On) both the Modulator and Power Amplifier sections of the device are fully operational.

1.6.2.4 VCO Tank Circuitry

The coaxial resonator, PR1, consists of a length of RG405 semi-rigid cable. The outer is cut to approximately 0.370" (9.4mm). One end of the inner is soldered to the outer whilst the other is soldered to the tank PCB Pad. The resonator is laid down and outer soldered to PCB ground points using tinned wire. The overall length of the resonator is approximately 0.430" (11mm).

Reducing the length of the coaxial resonator will increase the resonant frequency and vice versa. Increasing C16 and C19 will reduce resonant frequency.

The capacitance ratio of C19 to varactor diode, D1, will determine the achievable operating band for the 0-3V control voltage. Therefore to reduce the bandwidth, reduce C19 and/or insert a small picofarad capacitor, C22. The introduction of C22 will also reduce resonant frequency.

1.6.3 PCB Design

The EV0171 PCB is a 4-layer design, with an overall thickness of 0.062", including top and bottom layer copper. The top layer comprises the regulation circuitry connections, RF signal tracks and CMX017 ground plane. The second layer is purely a ground plane for the supply. Layer three contains the analog power supply tracks, AV_{DD} which feed all the board's sub-circuits. The bottom layer contains another ground plane for screening purposes.

CMX017 ground pins are connected directly to the top layer ground plane as close to the package as possible. The power supply pins are bypassed to ground directly at the package using decoupling capacitors with direct returns to ground.

Using microstrip techniques the PAOUT and PAIN/MODOUT tracks on the 4-layer PCB have been designed to provide line impedances of 50Ω. This design technique is based on the track width and separation distance between track and ground plane for a given dielectric constant of the PCB material. The layout assumes the board material is FR4 with a ground plane on the second layer, separated from the top layer by 0.016". Therefore, for a dielectric constant between 4-5 and track widths of 0.032", approximately 50Ω line impedances are obtained.

Refer to an RF/Microwave designer's guide to obtain more information on microstrip line impedance design.

1.7 Performance Specification

1.7.1 Electrical Performance

1.7.1.1 Absolute Maximum Ratings

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

	Notes	Min.	Max.	Units
Supply (V_{IN} - V_{SS})		-0.3	40.0	V
Current into or out of V_{IN} and V_{SS} pins		0	+1.5	A
Storage Temperature		-10	+70	°C
Operating Temperature		+10	+35	°C
Input Power to PAIN, J3 (not fitted)	1		+7	dBm

1.7.1.2 Operating Limits

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

	Notes	Min.	Max.	Units
Supply (V_{IN} - V_{SS})		6V	12V	V
Supply (AV_{DD} - V_{SS})		2.7V	3.3V	V
Operating Temperature		+10	+35	°C

1.7.1.3 Operating Characteristics

For the following conditions unless otherwise specified:
AV_{DD} = 3.0V, Tamb = +25°C
RF = 860MHz, 50Ω load impedance.

	Notes	Min.	Typ.	Max.	Units
DC Parameters					
I_{DD} (evaluation board - output power = + 20dBm)	2		135mA		
I_{DD} (evaluation board - PA and MOD disabled)	3		5mA		

Notes: 1. With optional SMA connector fitted.
2. SW1:1 and SW1:2 are on
3. SW1:1 and SW1:2 are off.

Refer to current CML CMX017 data sheet for further information.

Consumer Microcircuits Limited

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