HiMARK
the wireless IC company

TX4915 VHF/UHF TRANSMITTER

Description

The TX4915 is a monolithic integrated circuit intended for use as a low-cost AM/ASK transmitter. The chip can be used in applications in the north American and European VHF/UHF bands. The integrated VCO, phase detector, prescaler, and reference oscillator transistor require only the addition of an external crystal to provide a complete phase-locked loop. In addition to the standard power-down mode, the chip also includes an automatic lock-detect feature that disables the transmitter output when the PLL is out-of-lock.

Features

◆ Fully Integrated Frequency Synthesizer

◆ 2.2V to 5.5V Voltage Supply Range

◆ Low Current and Power Down Capability

◆ Integrated VCO and Reference Oscillator

◆ integeated 64/128 Dual Modulus Prescaler

◆ 100MHz to 960MHz frequency Range

◆ Out-of-Lock inhibit Circuit

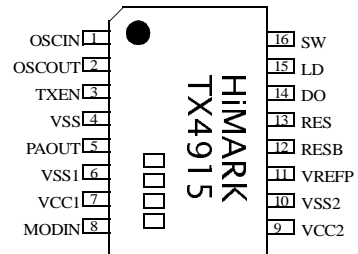## Package and Pin Assignment

16 pin, plastic SSOP (dimensions in mm)
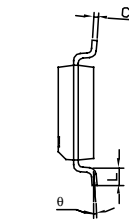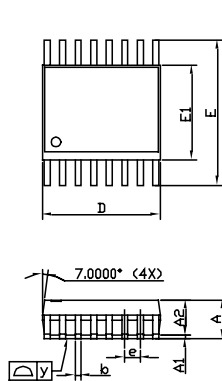
SYMBOLS	DIMENSIONS IN MILLIMETERS			DIMENSIONS IN INCHES		
	MIN	NOM	MAX	MIN	NOM	MAX
A	1.35	1.60	1.75	0.053	0.064	0.069
A1	0.10	——	0.25	0.004	——	0.010
A2	——	1.45	——	——	0.057	——
b	0.20	0.25	0.30	0.008	0.010	0.012
C	0.19	——	0.25	0.007	——	0.010
D	4.80	——	5.00	0.189	——	0.197
E	5.80	——	6.20	0.228	——	0.244
E1	3.80	——	4.00	0.150	——	0.157
e	——	0.64	——	——	0.025	——
L	0.40	——	1.27	0.016	——	0.050
y	——	——	0.10	——	——	0.004
θ	0°	——	8°	0°	——	8°

NOTE
1. PACKAGE BODY SIZES EXCLUDE MOLD FLASH AND GATE BURRS
2. DIMENSION L IS MEASURED IN GAGE PLANE
3. TOLERANCE 0.10 mm UNLESS OTHERWISE SPECIFIED
4. CONTROLLING DIMENSION IS MILLIMETER. CONVERTED INCH DIMENSIONS ARE NOT NECESSARILY EXACT.
5. FOLLOWED FORM JEDEC MO-137

Pin assignment (HiMARK TX4915):

Pin	Name	Pin	Name
1	OSCIN	16	SW
2	OSCOUT	15	LD
3	TXEN	14	DO
4	VSS	13	RES
5	PAOUT	12	RESB
6	VSS1	11	VREFP
7	VCC1	10	VSS2
8	MODIN	9	VCC2

Pin Descriptions

Number	Name	Description
1	OSCIN	This pin is connected directly to the base of reference oscillator transistor. The intended reference oscillator configuration is a modifiled Colpitts.
2	OSCOUT	This pin is connected directly to the emitter of reference oscillator transistor.
3	TXEN	Enable control for all circuitry. When this pin is a logic "low" all circuiits are turn off. When this pin is logic "high", all circuits are operating normally.
4	VSS	Ground connection for the PAOUT amp.
5	PAOUT	Transmitter output. This pin is an open collector and require a pull-up inductor for bias/matching and a tapped capacitor for matching.
6	VSS1	Ground connection for the PAOUT buffer amplifier.
7	VCC1	This pin is used to supply bias to the PA buffer amplifier.
8	MODIN	AM analog or ASK digital modulation can be imparted to the carrieer by an input to this pin. An external resistor is used to bias the output amplifiers through this pin.
9	VCC2	This pin is used to supply DC bias to the VCO, crystal oscillator, prescaler, PFD, and charge pump.
10	VSS2	Digital PLL ground connection.
11	VREFP	Bias voltage reference pin for bypassing the prescaler.
12	RESB	The RES pins are used to supply DC voltage to the VCO, as well as to tune the center frequency of the VCO.
13	RES	see pin 12
14	DO	Output of the charge pump. An RC network from this pin to ground is used to establish the PLL bandwidth.
15	LD	This pin is used to set the threshold of the lock detect circuit. A shunt capacitor should be used to set an RC time constant with the on-chip series $1k\Omega$ resistor.This signal is used to clamp (enable or disable) the MODIN circuitry. The time constant should be approximately 15 times the reference period.
16	SW	Logic "High" input selects divide-by-64 prescaler. Logic "Low" input selects divide-by-128 prescsaler.

Block Diagram
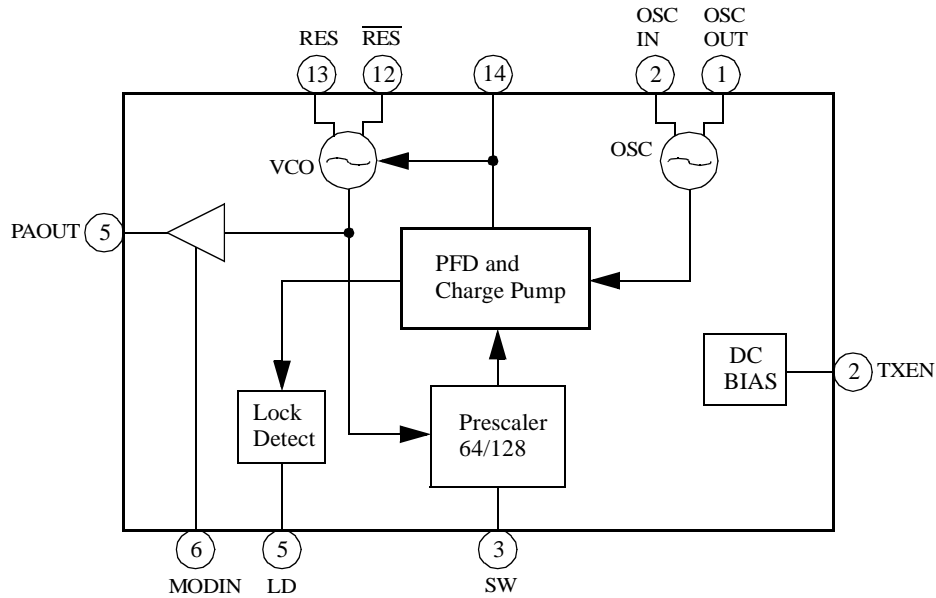
Absolute Maximum Ratings

$V_{SS} = 0$ V

Parameter	Rating	Unit
Supply voltage	– 0.3 to + 7.0	V_{DC}
Control Voltage	– 0.3 to + 7.0	V_{DC}
Input RF Level	+10	dBm
Output Load VSWR	–40 to +85	°C
Operating Ambient Temperature	-40 to +85	°C
Storage Temperature	-40 to +150	°C

Recommended Operating Conditions

$V_{SS} = 0$ V

Parameter	Symbol	Value			Unit
		min.	typ.	max.	
Supply voltage range	V_{CC}	2.2	3.0	5.5	V
Operating temperature	T_A	–40	+25	+85	ºC

Electrical Characteristics

($V_{DD1, DD2}$ = 2.2 to 5 V, $V_{SS, SS1, SS2}$ = 0 V, T_A = –40 to +85 °C unless otherwise noted)

Parameter	Symbol	Condition	TX4915 Capability(Simulated) Value			Unit
			min.	typ.	max.	
Power supply						
Supply Voltage	V_{CC1}, V_{CC2}		2.2	3	5	V
Total dc Current (normal operation)	I_{DC}	TXEN=high , 50% Duty Cycle 10kHz data applied to the MODIN input.R_{MODIN}(R3)=3kΩ				mA
Total dc Current (stand-by mode)	$I_{standby}$	TXEN = low			1	μA
Overall						
Frequency Range			100		960	MHz
Modulation				AM/ASK		
Modulation frequency						MHz
Incidental FM						kHz $_{P-P}$
Output Power		50Ω load				dBm
ON/OFF Ratio						dB
PLL and Prescaler						
Prescaler Divie Ratio				64/128		
VCO gain, K_{VCO}		Frequency and board layout dependent		20		MHz/V
PLL Phase Noise		10KHz Offset, 50kHz loop bandwidth				dBc/Hz
		100KHz Offset, 50kHz loop bandwidth				dBc/Hz
Harmonics		with output tuning				dBc
Reference Frequency					17	MHz
crystal Frequency Spurs		50KHz PLL loop bandwidth				MHz
Max crystal Rs		For a typ. 1ms turn-on time				Ω
Max crystal Motional Inductance		For a typ. 1ms turn-on time				mH
Charge pump current	I_{CP}	K_{PD}=100uA/2Π		100		μA
Power Down Control						
Power "ON"	V_{TXEN}		Vcc-0.3V			V
Power "OFF"	V_{TXEN}				0.3	V
Turn On Time				1	2	ms
Turn Off Time				1	2	ms

March 2000

Functional Description

The TX4915 is a low-cost AM/ASK VHF/UHF transmitter designed for applications operating within the frequency range of 100MHz to 960MHz. In particular, it is intended for 315/433MHz band systems remote keyless entry systems, and 868/915MHz ISM Application. It can also be used as a local oscillator signal source. The integrated VCO, phase detector, prescaler, and reference oscillator require only the addition of an external crystal to provide a complete phase-locked loop. In addition to the standard power-on mode, the chip also includes an autonatic lock-detect feature that disables the transmitter output when the PLL is out-of-lock.

The TX4915 Functional Blocks

A PLL consists of a reference oscillator, a phase detector, a loop filter, a voltage control oscilator (VCO), and a programmable divider in the feedback path. The TX4915 includes all of these internally, except for the loop filter and the reference oscillator's crystal and two feedback capacitors.

Reference crystal oscillator

Pins 1 (OSCIN) and 2 (OSCOUT) provide connections to a transistor that is used as a Colpitts type oscillator. The Colpitts configuration is a low parts count topology with realiable performance and reasonable phase noise. Alternatively, an external signal could be injected into the Pins 1 (OSCIN). The drive level should, in either case, be around 500mVpp. This level prevents overdriving the device and keeps the phase noise and reference spurs to a minimum.

Voltage Controlled Oscillator

VCO is a tuned differential amplifier with the bases and collectors cross-coupled to provide positive feedback and a 360° phase shift. The tuned circuit is located in the collectors, and is comprised of internal varactors and external inductors. The designer selects the inductors for the desired frequency of operation. These inductor also provide DC bias for the VCO.

Prescaler

Using a series of flip-flops divide the VCO frequency by either 64 or 128, depending upon the logic level present at the SW pin. A high logic level will select the 64 divider. A low logic level will select the 128 dividor. This divided signal is then fed into the phase detector where it is compared with the reference frequency.

Phase dector and Charge pump

Phase dector is implemented using flip-flops in "digital tri-state comparator" topology. It compares the phase of the reference oscillator to the phase of the VCO. The charge pump consists of two transistors, one for charging the loop filter and the other for discharging the loop filter. When both inputs of the flip-flops are identical, the signals are both frequency and phase locked. If they are different, they will provide signals to the charge pump which will either charge or discharge the loop filter, or enter into a high impedance state.

Lock-detect Protection

The Lock-detect circuitry connect to the output of the phase dector ciruits and is used to disable the transmitter when the VCO is not phase-locked to the reference oscillator. This is necessary to avoid unwanted out-of-band transmission and to provide compliance with regulatory limits during an unlocked condition. Pin 15 (LD) is used to set the threshold of the lock-detect circuit. A shunt capacitor is used to set an RC time constant with an on-chip series $1K\Omega$ resistor. The time constant should be approximately 15 times the reference period.

Fig. 1 – PFD input/output waveforms
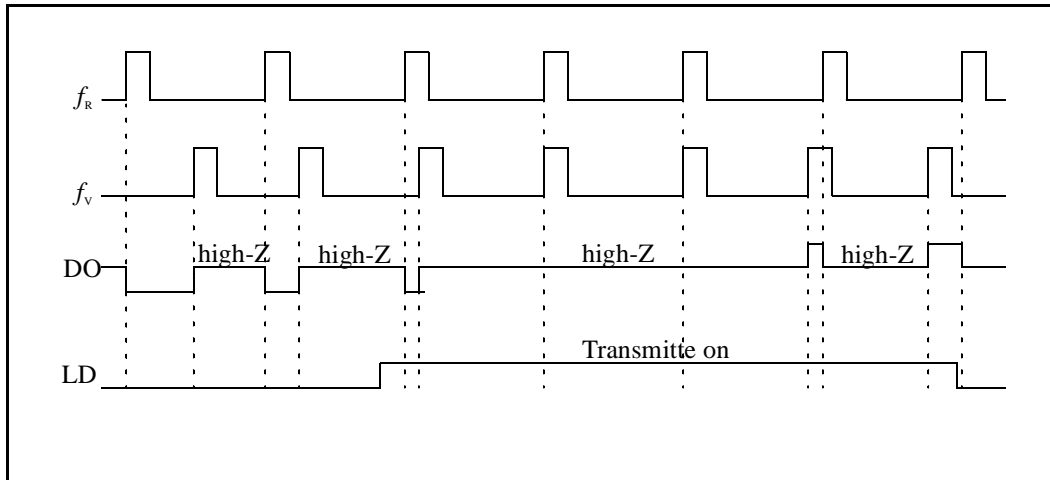
Power Amplifier

A two-stage amplifier consisting of a driver and an open collector final stage. The PAOUT open collector output requires an external pull up coil to provide bias. The coil is part of the tuning and matching LC circuit to get best performance with the external loop antenna. To achieve the best power amplifier efficiency the high frequency voltage swing at the PAOUT pin should be two times the supply voltage. The power amplifier has its own ground pin (VSS,VSS1) in order to reduce the aount of coupling to the other circuits.

The device is an ASK/OOK transmitted, with the data provided at the MODIN pin. When the MODIN is a high logic level, the carrier is transmitted. When MODIN is a low logic level, then the carrier is not transmitted.

Power Mode

The IC provides three power modes, the POWER DOWN MODE, the PLL ENABLE MODE and the TRANSMIT MODE. How to get in this modes is described in the table below.

TXEN	MODIN	
L	X	POWER DOWN MODE
H	L	PLL ENABLE MODE
H	H	TRANSMIT MODE

Application Circuit
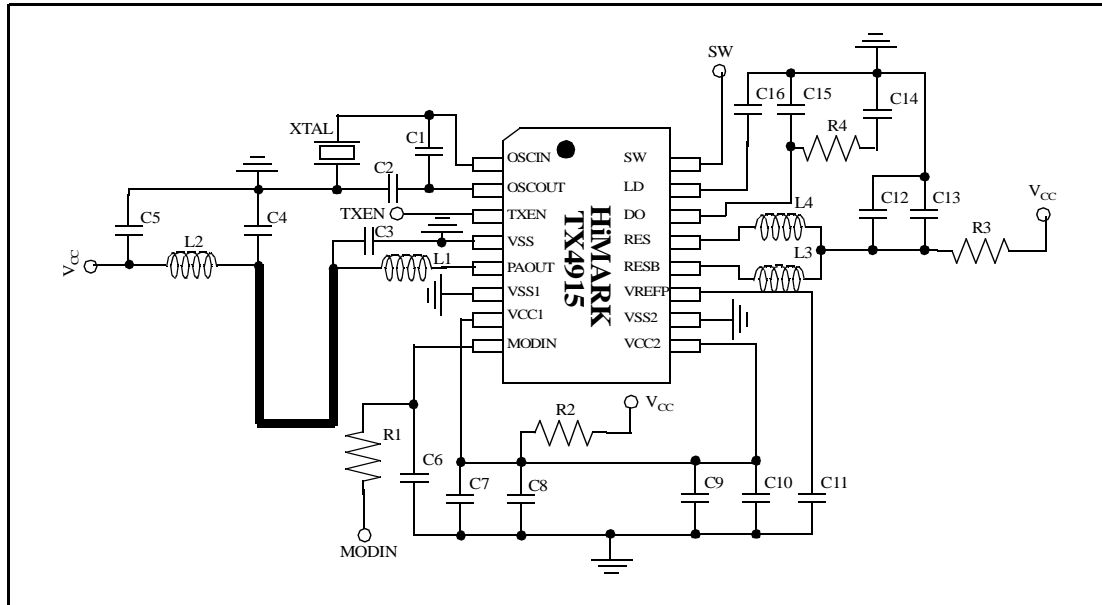
Bill of Materials

Component	Frequency Band (MHz)				Unit	Specification
	315	434	868	916.5		
XTAL	4.92188	6.78125	6.78125	7.16016	MHz	
C1[1]	68	68	68	68	pF	0603, +/-5 %
C2[1]	33	33	33	33	pF	0603, +/-5 %
C3[2]				4.7	pF	0603, +/-5 %
C4[2]				4.7	pF	0603, +/-5 %
C5				3.3	pF	0603, +/-5 %
C6	100	100	100	100	pF	0603, +/-5 %
C7	68	68	22	22	pF	0603, +/-5 %
C8	10	10	10	10	nF	0603, +/-5 %
C9	68	68	22	22	pF	0603, +/-5 %
C10	10	10	10	10	nF	0603, +/-5 %
C11	10	10	10	10	nF	0603, +/-5 %
C12	68	68	22	22	pF	0603, +/-5 %
C13	10	10	10	10	nF	0603, +/-5 %
C14	1000	1000	470	470	pF	0603, +/-5 %
C15	100	100	47	47	pF	0603, +/-5 %
C16	18	18	18	18	nF	0603, +/-5 %
R2	10	10	10	10	Ω	0603, +/-5 %
R3	10	10	10	10	Ω	0603, +/-5 %
R4	11	11	22	22	kΩ	0603, +/-5 %
L1[2]					nH	DELTA, 0805CS

Component	Frequency Band (MHz)				Unit	Specification
	315	434	868	916.5		
L2[2]					nH	DELTA, 0805CS
L3	18	18	8	8	nH	DELTA, 0805CS
L4	18	18	8	8	nH	DELTA, 0805CS

1 Dependent on the crystal.

2 Dependent on the antenna and the PCB layout.

Test Circuit
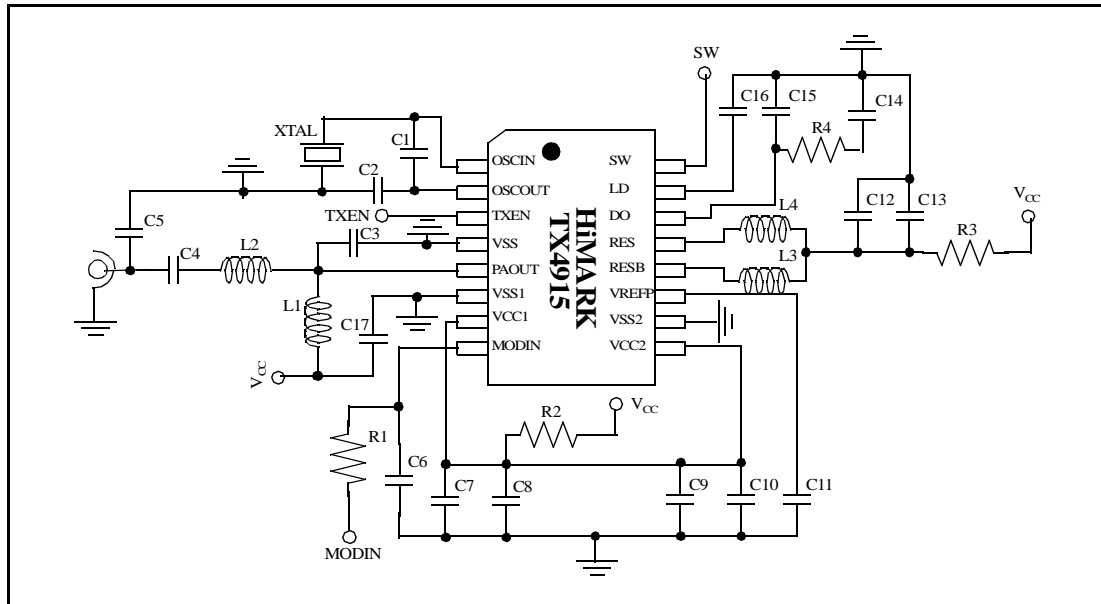
Transmitter power

(1)315MHz

V_{CC}	Mod IN Res. Value (R1)	I_{CC} (mA)	PAOUT (dBm)
	1K		
	3K		
	5.1K		
	6.8K		
	9.1K		
2.4V	11K		
	13K		
	15K		
	18K		
	22K		

V_{CC}	Mod IN Res. Value(R1)	I_{CC} (mA)	PAOUT (dBm)
	1K		
	3K		
	5.1K		
	6.8K		
	9.1K		
3V	11K		
	13K		
	15K		
	18K		
	22K		

V_{CC}	Mod IN Res. Value(R1)	I_{CC} (mA)	PAOUT (dBm)
	1K		
	3K		
	5.1K		
	6.8K		
	9.1K		
3.6V	11K		
	13K		
	15K		
	18K		
	22K		

(2)434MHz

V_{CC}	Mod IN Res. Value (R1)	I_{CC} (mA)	PAOUT (dBm)
2.4V	1K		
	3K		
	5.1K		
	6.8K		
	9.1K		
	11K		
	13K		
	15K		
	18K		
	22K		

V_{CC}	Mod IN Res. Value(R1)	I_{CC} (mA)	PAOUT (dBm)
3V	1K		
	3K		
	5.1K		
	6.8K		
	9.1K		
	11K		
	13K		
	15K		
	18K		
	22K		

V_{CC}	Mod IN Res. Value(R1)	I_{CC} (mA)	PAOUT (dBm)
3.6V	1K		
	3K		
	5.1K		
	6.8K		
	9.1K		
	11K		
	13K		
	15K		
	18K		
	22K		

(3)868MHz

V_{CC}	Mod IN Res. Value (R1)	I_{CC} (mA)	PAOUT (dBm)
2.4V	1K		
	3K		
	5.1K		
	6.8K		
	9.1K		
	11K		
	13K		
	15K		
	18K		
	22K		

V_{CC}	Mod IN Res. Value(R1)	I_{CC} (mA)	PAOUT (dBm)
3V	1K		
	3K		
	5.1K		
	6.8K		
	9.1K		
	11K		
	13K		
	15K		
	18K		
	22K		

V_{CC}	Mod IN Res. Value(R1)	I_{CC} (mA)	PAOUT (dBm)
3.6V	1K		
	3K		
	5.1K		
	6.8K		
	9.1K		
	11K		
	13K		
	15K		
	18K		
	22K		

(4)916.5MHz

V_{CC}	Mod IN Res. Value (R1)	I_{CC} (mA)	PAOUT (dBm)
2.4V	1K		
	3K		
	5.1K		
	6.8K		
	9.1K		
	11K		
	13K		
	15K		
	18K		
	22K		

V_{CC}	Mod IN Res. Value(R1)	I_{CC} (mA)	PAOUT (dBm)
3V	1K		
	3K		
	5.1K		
	6.8K		
	9.1K		
	11K		
	13K		
	15K		
	18K		
	22K		

V_{CC}	Mod IN Res. Value(R1)	I_{CC} (mA)	PAOUT (dBm)
3.6V	1K		
	3K		
	5.1K		
	6.8K		
	9.1K		
	11K		
	13K		
	15K		
	18K		
	22K		