TRANSMITTER:

When master MCUPIC16C57 finished the measurement of distance. It will send out a serial of bit stream from it's output pin to the transmitter for communication with the slave display unit.

The transmitter functions as a plus switch provided the TXD is at the high stage, the SAW device and internal oscillator become an 915MHz puls generater. The 15p cap is a coupler for leads the 915 MHz signal to the antenna, if a low stage is apply to, it will cause the oscillator to cease, the inductor L1, L2 prevent the signal leaking from oscillator circuit.

High quality of the SAW device kept the side band emission (against to the centerial frequence 915HMz) is enough lower, and with 3V power supple caused the emission effect only at a small area.

The control MCU is a low power type. (less $2 \mu A$) then the clock (4 MHz) signal is limited within the printed circuit board.

TX4915 Low Power ASK Transmitter IC

Description

The TX4915 is a low power ASK transmitter IC intended for applications in the North American and European VHF/UHF bands. The integrated voltage-controlled oscillator (VCO), phase/frequency detector, prescaler, and reference oscillator require only the addition of an external crystal to provide a complete phase-locked loop (PLL). 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.
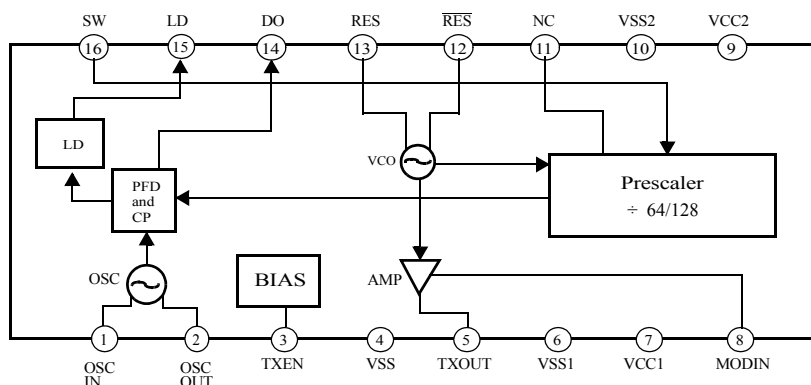
Features

◆ Output frequency range: 100 – 960 MHz

◆ Supply voltage range: 2.2 – 3.6 V

◆ Low current consumption with power down capability

◆ On-chip VCO with integrated PLL ($\div$ 64/128) dual modulus prescaler

◆ Out-of-lock inhibit circuit

◆ SSOP-16 package (0.64 mm pitch)

Applications
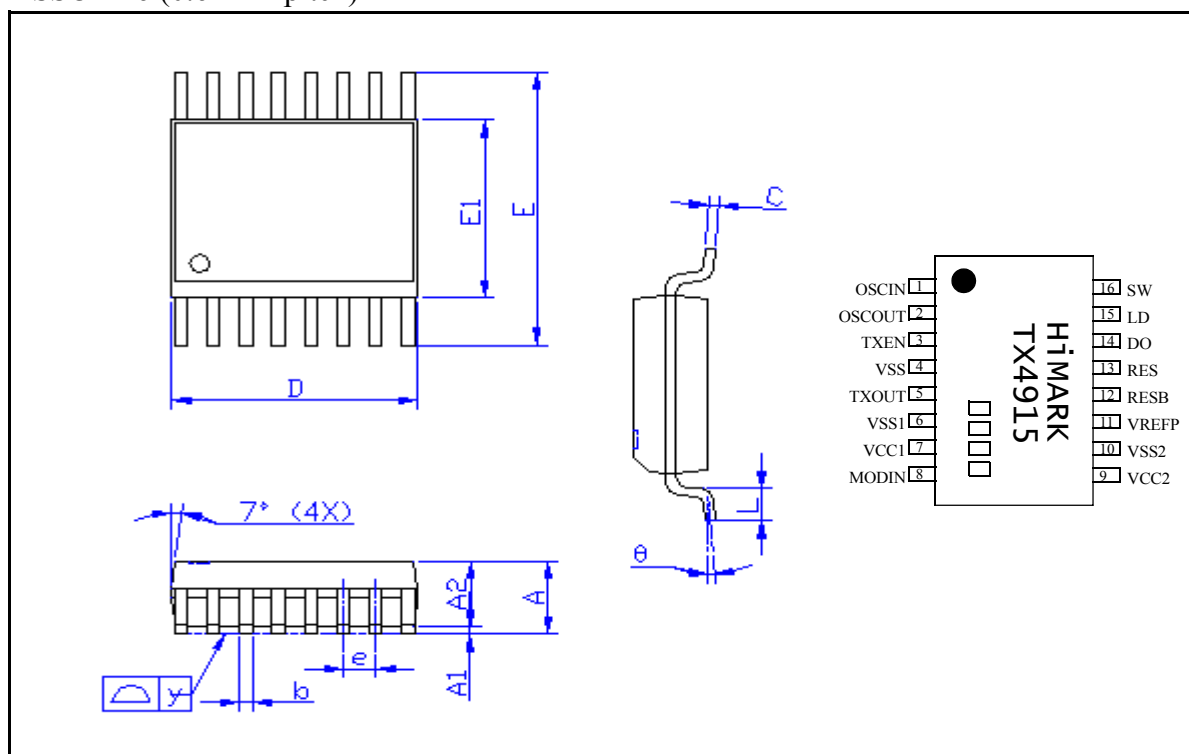
◆ Wireless mouse

◆ Car alarm and home security systems

◆ Remote control systems

Block Diagram

Package and Pin Assignment

SSOP-16 (0.64mm pitch)

Symbol	Dimensions in mm			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°

Pin Descriptions

Number	Name	Description
1	OSCIN	This pin is connected directly to the base of the reference oscillator transistor. The reference oscillator uses a modified Colpitts configuration.
2	OSCOUT	This pin is connected directly to the emitter of the reference oscillator transistor.
3	TXEN	Transmitter enable control (TXEN = low = power down mode; TXEN = high = normal operation mode).
4	VSS	Ground connection for the transmit output amplifier.
5	TXOUT	Transmitter output. This pin is an open collector output and requires a pull-up inductor for bias/matching and a tapped capacitor network for matching.
6	VSS1	Ground connection for the transmit driver amplifier.
7	VCC1	Nominal supply voltage for the transmit driver amplifier.
8	MODIN	ASK modulation input. An external resistor, R_{MODIN}, connected from the MODIN pin to supply voltage is used to bias the transmit amplifier chain.
9	VCC2	Nominal supply voltage for the VCO and PLL circuitry.
10	VSS2	Ground connection for the PLL circuitry.
11	NC	No connection.
12	$\overline{\text{RES}}$	Differential open collector VCO outputs.
13	RES	
14	DO	Output of the charge pump. An R-C network from this pin to ground is used to establish the PLL bandwidth.
15	LD	Lock detector output. This pin is used to set the threshold of the lock detect circuitry which enables or disables the transmit amplifier. A shunt capacitor should be used to set an R-C time constant with the on-chip series 1 KΩ resistor. The time constant should be set to approximately 15 times the reference period.
16	SW	Prescaler modulus control input (SW = high = ÷ 64; SW = low = ÷ 128).

Absolute Maximum Ratings

V_{SS}, V_{SS1}, V_{SS2} = 0V

Parameter	Rating	Unit
Supply voltage range	–0.3 to +3.6	V
Power-down voltage	–0.3 to V_{CC}	V
MODIN voltage	–0.3 to +1.1	V
Operating ambient temperature	–40 to +85	°C
Storage temperature	–40 to +150	°C

Recommended Operating Conditions

V_{SS}, V_{SS1}, V_{SS2} = 0V

Parameter	Symbol	Value			Unit
		min.	typ.	max.	
Supply voltage range	V_{CC}	2.2	3.0	3.6	V
Operating temperature	T_A	–10	+25	+60	ºC

Electrical Characteristics

(V_{CC} = 3 V, V_{SS}, V_{SS1}, V_{SS2} = 0 V, TXEN = high, T_A = 25 °C, and f_{RF} = 433.92 MHz unless otherwise noted)

Parameter	Symbol	Condition	Value			Unit
			min.	typ.	max.	
Power supply						
Supply voltage	V_{CC}		2.2	3.0	3.6	V
Total dc current (normal operation)	I_{CC}	50% duty cycle, 10 KHz data applied to the MODIN pin (R_{MODIN} = 10 KΩ)		10.5		mA
Total dc current (power-down mode)	$I_{standby}$	TXEN = low			1	μA
Overall						
RF input frequency range	f_{RF}		100		960	MHz
Modulation				ASK		
Modulation frequency	f_{MOD}				100	KHz
Output power	P_{OUT}	50Ω load	1	8		dBm
ON/OFF ratio				70		dB
PLL						
Prescaler divide ratio		SW = high = ÷ 64 SW = low = ÷ 128	64		128	
VCO gain	K_{VCO}	Frequency and board layout dependent		20		MHz/V
Phase noise		10 KHz offset, 50 KHz loop BW		−80		dBc/Hz
		100 KHz offset, 50 KHz loop BW		−89		dBc/Hz
2nd harmonic				−30		dBc
3rd harmonic				−40		dBc
Reference frequency				7		MHz
Crystal frequency spurs		50 KHz PLL loop BW		−50		dBc
Charge pump current	I_{CP}		-100		100	μA
Stand-by mode control						
Transmitter enable/disable voltage		TXEN = high = normal operation	Vcc − 0.3 V			V
		TXEN = low = power-down mode			0.3	V
Turn-on time				1	2	ms
Turn-off time				1	2	ms

Functional Description

The TX4915 is a low-power ASK transmitter IC designed for applications operating within the frequency range of 100 to 960 MHz. In particular, it is intended for transmitter applications in 315/433 MHz band remote keyless entry and 868/915 MHz ISM-band systems. In addition, the TX4915 possesses a PLL-only mode which allows it to be simply used as a local oscillator source. The integrated voltage-controlled oscillator (VCO), phase/frequency detector, prescaler, and reference oscillator require only the addition of an external crystal to provide a complete phase-locked loop. In addition to the normal operation mode, the chip also includes an automatic lock-detect feature that disables the transmitter output when the PLL is out-of-lock.

Reference crystal oscillator

The OSCIN and OSCOUT inputs (pins 1 and 2) provide connections to an on-chip transistor which may be used to implement a Colpitts crystal oscillator. The Colpitts oscillator configuration is a low parts count topology which achieves reasonable phase noise performance. Optionally, an external signal may be ac-coupled into the OSCIN pin to provide a reference source. The OSCIN input drive level should be near 500 mV_{pk-pk} to prevent overdriving the on-chip transistor in order to keep the phase noise and reference spurs to a minimum.

Voltage controlled oscillator

The VCO uses a tuned differential amplifier topology with the bases and collectors cross-coupled to provide positive feedback and the necessary 360° phase shift. A tuned circuit is connected to the open collector outputs and is comprised of both on-chip varactors and user-selectable off-chip inductors. The choice of inductor values determines the frequency band of operation.

Dual-modulus prescaler

A series of flip-flops divides the VCO frequency by either 64 or 128, depending upon the logic level of the SW input (pin 16). SW = high will select the ÷ 64 mode and SW = low will select the ÷ 128 mode. The divided-down signal is then applied to the phase/frequency detector where its phase/frequency is compared with the phase/frequency of the crystal reference.

Phase/frequency detector and charge pump

The phase/frequency detector (PFD) is implemented using the "tri-state comparator" topology while the charge pump (CP) consists of a current source and sink for charging and discharging the off-chip loop filter. When the VCO and reference inputs to the PFD are both phase- and frequency-locked, the CP output enters a high impedance state. Otherwise, the CP will either charge or discharge the loop filter.

Out-of-lock inhibit circuitry

The out-of-lock inhibit circuitry is used to disable the transmitter output when the VCO is not locked to the reference oscillator and comply with regulatory limits during the unlocked condition. An off-chip shunt capacitor connected to the LD output (pin 15) is used to set an R-C time constant (together with an on-chip series 1 KΩ resistor.) This time constant should be set to be approximately 15 times the reference period.

Transmit amplifier chain

A transmit amplifier chain consists of a driver amplifier followed by an open collector output stage. The open collector TXOUT output (pin 5) requires an external pull-up inductor for bias. This inductor may be used as part of an L-C matching circuit for transforming the amplifier output impedance to that of an external loop antenna. To achieve optimum power-added efficiency, the peak-to-peak RF voltage swing at the TXOUT pin should be twice the supply voltage. Also, the output amplifier has its own ground pin (VSS) in order to improve isolation.

The transmitter chain is designed for amplitude-shift-keying/on-off keying (ASK/OOK), with the modulation data provided at the MODIN input (pin 8). When $V_{MODIN} > 0.7$ V, an output signal is transmitted, and when $V_{MODIN} \leq 0.7$ V, no output signal is transmitted.
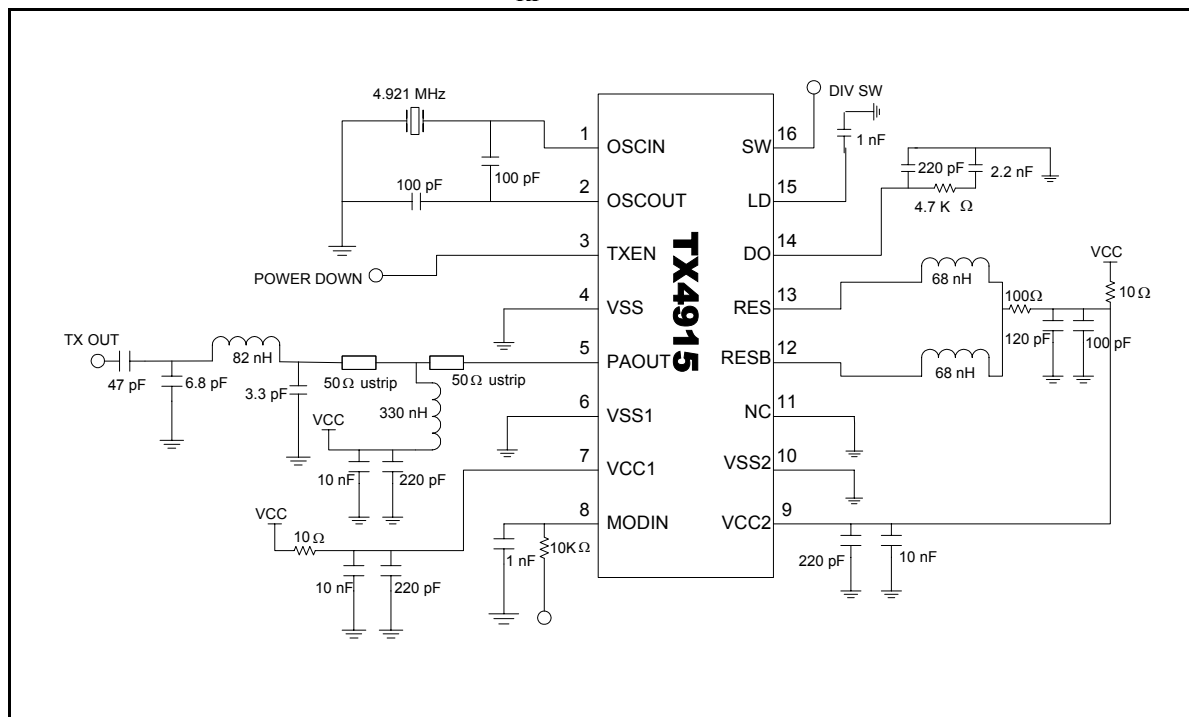
Operation modes

The table below summarizes the TX4915's three operating modes — power-down, PLL-only and transmit, which are controlled by the TXEN and MODIN inputs.

TXEN	MODIN	Operation Mode
L	L	Power-down
H	L	PLL-only
H	> 0.7 V	Transmit

Application Circuits

f_{RF} = 315 MHz
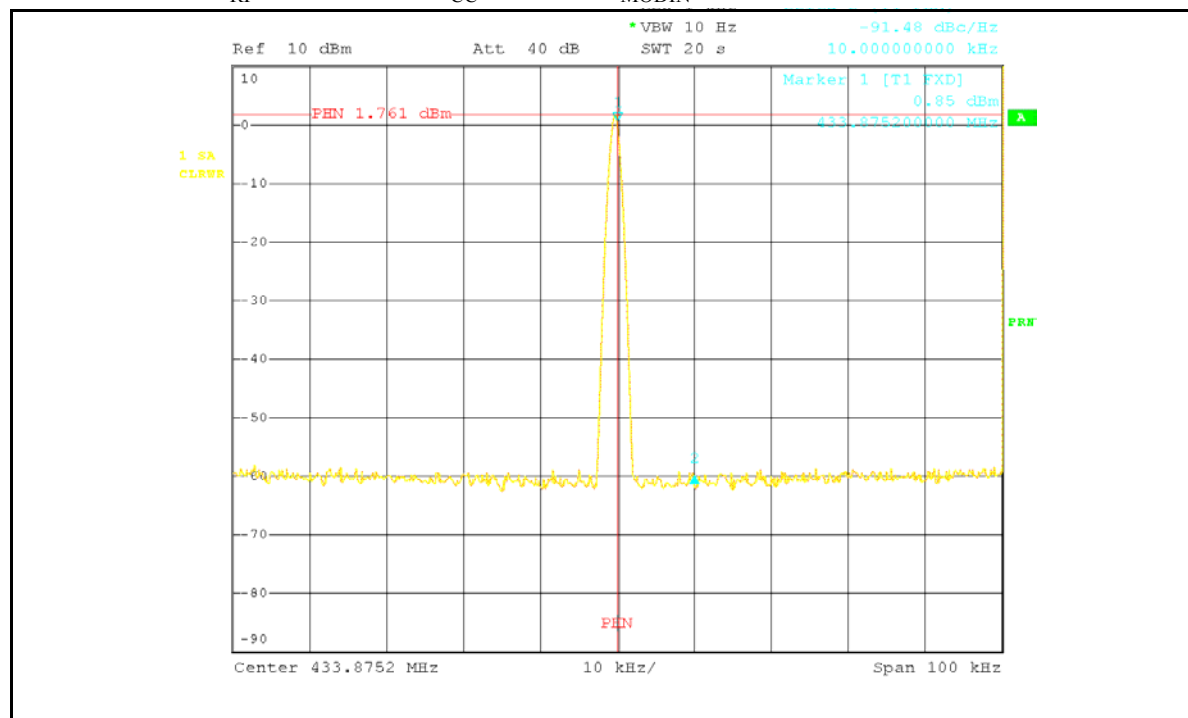

f_{RF} = 434 MHz

HiMARK
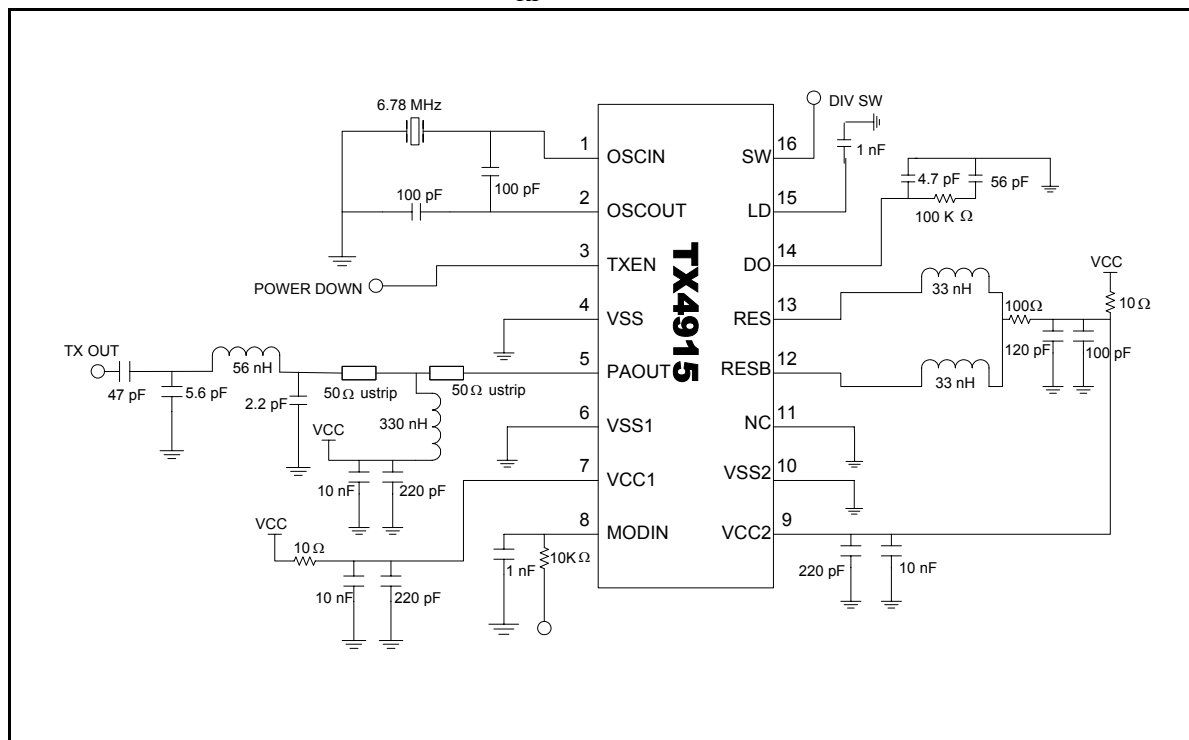
f$_{RF}$ = 868 MHz
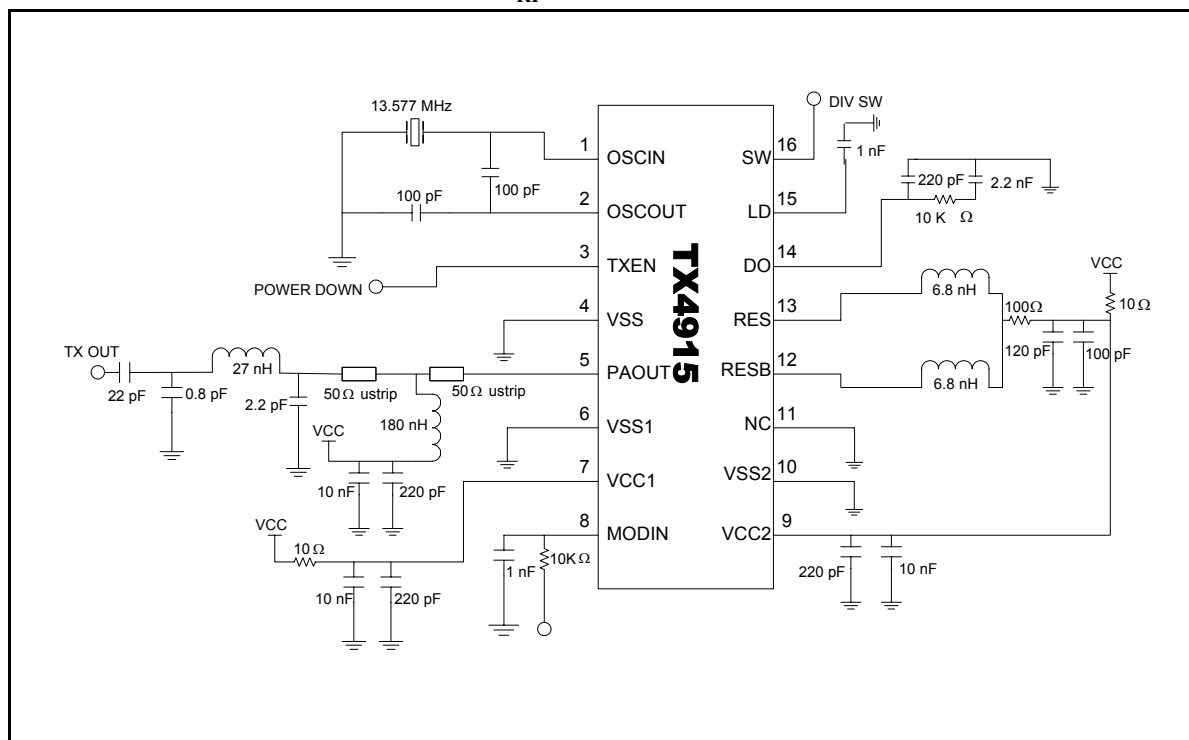
Typical Performance Characteristics

Output Power vs. R_{MODIN} (f_{RF} = 433 MHz)

R_{MODIN} (Ω)	V_{CC} = 2.0 V		V_{CC} = 2.4 V		V_{CC} = 2.8 V		V_{CC} = 3.2 V		V_{CC} = 3.6 V	
	I_{CC} (mA)	P_{OUT} (dBm)	I_{CC} (mA)	P_{OUT} (dBm)	I_{CC} (mA)	P_{OUT} (dBm)	I_{CC} (mA)	P_{OUT} (dBm)	I_{CC} (mA)	P_{OUT} (dBm)
1 K	18.4	4.4	22.2	6.1	25.8	7.2	30.0	8.1	36.5	8.6
3 K	16.7	4.6	19.6	6.0	21.3	7.1	24.0	8.1	26.7	9.0
5 K	15.8	4.2	18.5	5.5	20.4	6.4	22.1	7.1	24.3	7.8
7 K	15.1	3.6	17.7	4.9	19.6	5.7	20.7	6.4	22.3	7.1
9 K	14.4	2.8	16.8	4.0	18.3	4.8	19.2	5.4	20.6	6.1
11 K	13.5	1.7	15.7	3.0	17.2	3.9	18.5	4.6	19.9	5.3
13 K	13.1	1.2	15.1	2.4	16.3	3.1	17.5	3.7	18.5	4.2
15 K	12.6	0.4	14.4	1.8	15.7	2.7	16.9	3.4	18.1	4.1
17 K	12.3	0.1	14.1	1.4	15.1	2.2	16.2	2.8	17.3	3.3
19 K	11.9	−0.6	13.5	0.9	14.7	1.8	15.8	2.5	16.9	3.1
21 K	11.5	−1.1	11.5	0.4	14.2	1.2	15.1	1.8	16.2	2.4

Phase Noise

f_{RF} = 433 MHz, V_{CC} = 3.0 V, R_{MODIN} = 3 KΩ, 10 KHz offset

$f_{RF} = 433$ MHz, $V_{CC} = 3.0$ V, $R_{MODIN} = 3$ KΩ, 100 KHz offset

Output Impedance

Input Reflection Coefficient

VCC=3.0V..S(1,1)
VCC=2.0V..S(1,1)
VCC=3.3V..S(1,1)

freq (300.0MHz to 1.000GHz)
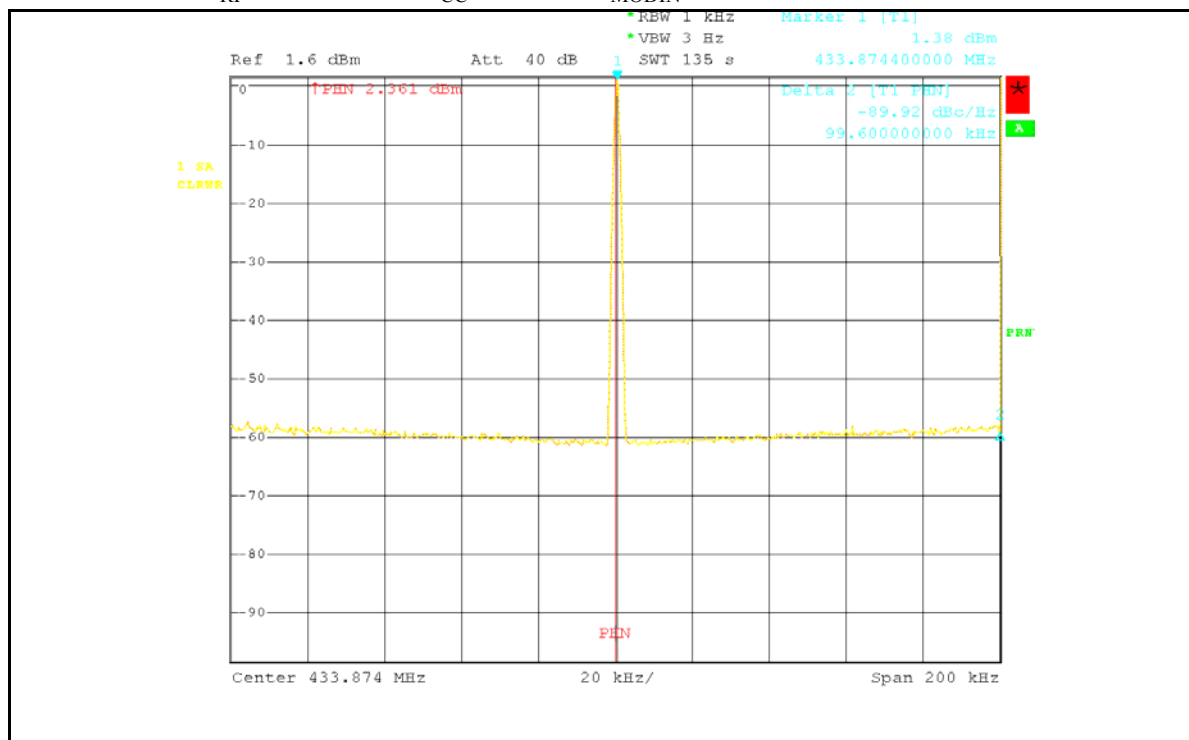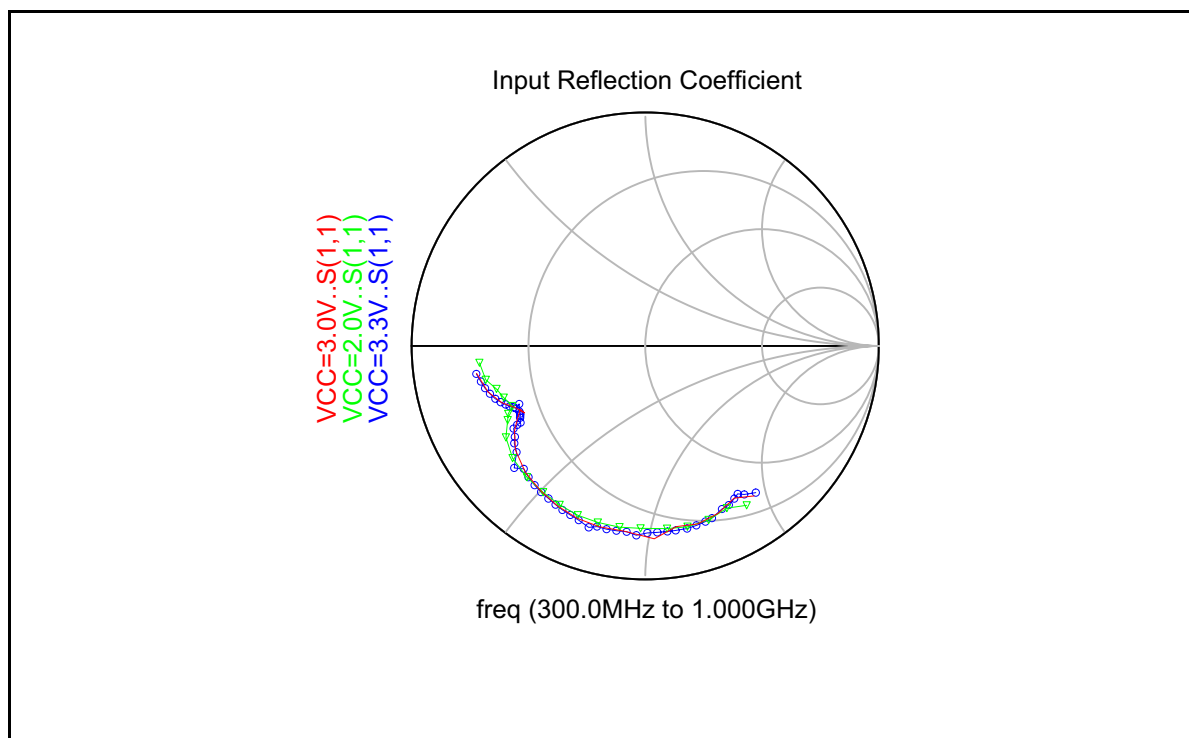
Revision History

Date	Version Number	Author	Comments
7/17/2003	NC	Bruce Jen	Most up-to-date document
7/18/2003	B1	E. Lin	Several style corrections. Corrected R_{MODIN} condition from 33 KΩ to 10 KΩ in "Total dc current" specification of Electrical Characteristics section.
8/13/2003	B2	Bruce Jen E. Lin	Update some spec. and added measurement data.

PIC16C5X

EPROM/ROM-Based 8-bit CMOS Microcontroller Series

Devices Included in this Data Sheet:

- PIC16C54
- PIC16CR54
- PIC16C55
- PIC16C56
- PIC16CR56
- PIC16C57
- PIC16CR57
- PIC16C58
- PIC16CR58

> **Note:** PIC16C5X refers to all revisions of the part (i.e., PIC16C54 refers to PIC16C54, PIC16C54A, and PIC16C54C), unless specifically called out otherwise.

High-Performance RISC CPU:

- Only 33 single word instructions to learn
- All instructions are single cycle except for program branches which are two-cycle
- Operating speed: DC - 40 MHz clock input
  DC - 100 ns instruction cycle

Device	Pins	I/O	EPROM/ROM	RAM
PIC16C54	18	12	512	25
PIC16C54A	18	12	512	25
PIC16C54C	18	12	512	25
PIC16CR54A	18	12	512	25
PIC16CR54C	18	12	512	25
PIC16C55	28	20	512	24
PIC16C55A	28	20	512	24
PIC16C56	18	12	1K	25
PIC16C56A	18	12	1K	25
PIC16CR56A	18	12	1K	25
PIC16C57	28	20	2K	72
PIC16C57C	28	20	2K	72
PIC16CR57C	28	20	2K	72
PIC16C58B	18	12	2K	73
PIC16CR58B	18	12	2K	73

- 12-bit wide instructions
- 8-bit wide data path
- Seven or eight special function hardware registers
- Two-level deep hardware stack
- Direct, indirect and relative addressing modes for data and instructions

Peripheral Features:

- 8-bit real time clock/counter (TMR0) with 8-bit programmable prescaler
- Power-on Reset (POR)
- Device Reset Timer (DRT)
- Watchdog Timer (WDT) with its own on-chip RC oscillator for reliable operation
- Programmable Code Protection
- Power saving SLEEP mode
- Selectable oscillator options:
  - RC: Low cost RC oscillator
  - XT: Standard crystal/resonator
  - HS: High speed crystal/resonator
  - LP: Power saving, low frequency crystal

CMOS Technology:

- Low power, high speed CMOS EPROM/ROM technology
- Fully static design
- Wide operating voltage and temperature range:
  - EPROM Commercial/Industrial 2.0V to 6.25V
  - ROM Commercial/Industrial 2.0V to 6.25V
  - EPROM Extended 2.5V to 6.0V
  - ROM Extended 2.5V to 6.0V
- Low power consumption
  - < 2 mA typical @ 5V, 4 MHz
  - 15 µA typical @ 3V, 32 kHz
  - < 0.6 µA typical standby current
    (with WDT disabled) @ 3V, 0°C to 70°C

> **Note:** In this document, figure and table titles refer to all varieties of the part number indicated, (i.e., The title "Figure 15-1: Load Conditions For Device Timing Specifications - PIC16C54A", also refers to PIC16LC54A and PIC16LV54A parts), unless specifically called out otherwise.