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TX6004

914.00 MHz Hybrid Transmitter

- ***Designed for Short-Range Wireless Data Communications***
- ***Supports RF Data Transmission Rates Up to 115.2 kbps***
- ***3 V, Low Current Operation plus Sleep Mode***
- ***Stable, Easy to Use, Low External Parts Count***
- ***Complies with Directive 2002/95/EC (RoHS)***

SM-20H Case

The TX6004 hybrid transmitter is ideal for short-range wireless data applications where robust operation, small size, low power consumption and low cost are required. All critical RF functions are contained in the hybrid, simplifying and speeding design- in. The TX6004 includes provisions for both on-off keyed (OOK) and amplitude-shift keyed (ASK) modulation. The TX6004 employs SAW filtering to suppress output harmonics, facilitating compliance with FCC 15.249 and similar regulations.

Absolute Maximum Ratings

Rating	Value	Units
Power Supply and All Input/Output Pins	-0.3 to +4.0	V
Non-Operating Case Temperature	-50 to +100	°C
Soldering Temperature (10 seconds / 5 cycles max.)	260	°C

Electrical Characteristics

Characteristic	Sym	Notes	Minimum	Typical	Maximum	Units
Operating Frequency	f_o		913.80		914.20	MHz
Modulation Types				OOK & ASK		
OOK Data Rate					20	kbps
ASK Data Rate					115.2	kbps
Transmitter Performance						
Peak RF Output Power, 250 µA TXMOD Current	P_O			1.5		dBm
Peak Current, 250 µA TXMOD Current	I_{TP}			12		mA
OOK Turn On/Turn Off Times	t_{ON}/t_{OFF}				15/10	µs
ASK Output Rise/Fall Times	t_{TR}/t_{TF}				1.1/1.1	µs
2nd - 4th Harmonic Outputs					-50	dBm
5th - 10th Harmonic Outputs					-55	dBm
Non-harmonic Spurious Outputs					-50	dBm
Sleep Mode Current	I_S			0.7		µA
Sleep to Transmit Switch Time	t_{TOR}				16	µs
Transmit to Sleep Switch Time	t_{RTO}				10	µs
Control Input Logic Low Level					200	mV
Control Input Logic High Level		1	Vcc - 300			mV
Power Supply Voltage Range	V_{CC}		2.2		3.7	Vdc
Operating Ambient Temperature	T_A		-40		+85	°C

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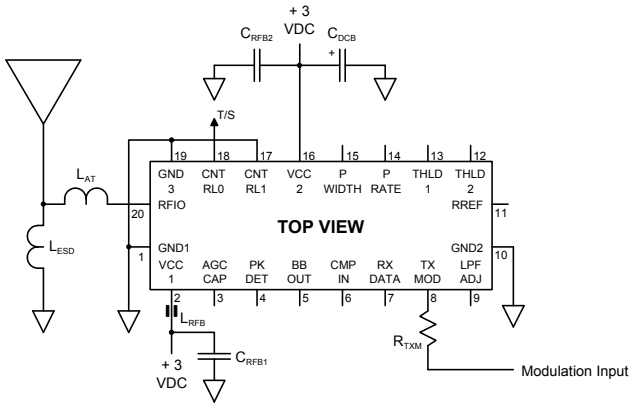
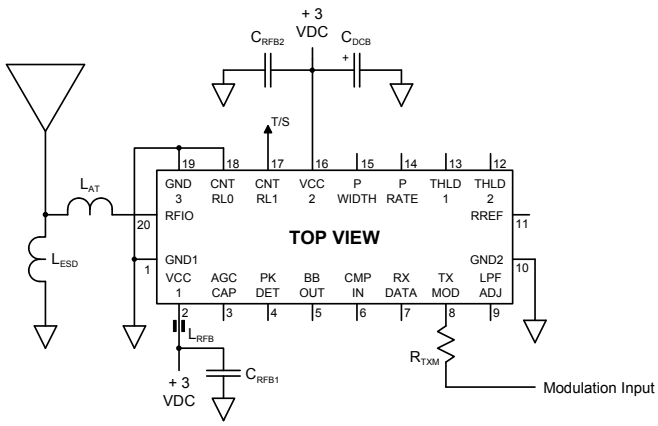
Transmitter OOK Configuration



Transmitter ASK Configuration



Transmitter Set-Up, 3.0 Vdc, -40 to +85 °C

Item	Symbol	OOK	ASK	ASK	Units	Notes
Nominal NRZ Data Rate	DR_{NOM}	2.4	19.2	115.2	kbps	see page 1
Minimum Signal Pulse	SP_{MIN}	416.67	52.08	8.68	µs	single bit
Maximum Signal Pulse	SP_{MAX}	1666.68	208.32	34.72	µs	4 bits of same value
TXMOD Resistor	R_{TXM}	4.7	4.7	4.7	K	±5%, for 0 dBm output
DC Bypass Capacitor	C_{DCB}	4.7	4.7	4.7	µF	tantalum
RF Bypass Capacitor 1	C_{RFB1}	27	27	27	pF	±5% NPO
RF Bypass Capacitor 2	C_{RFB2}	100	100	100	pF	±5% NPO
RF Bypass Bead	L_{RFB}	Fair-Rite	Fair-Rite	Fair-Rite	vendor	2506033017YO or equivalent
Series Tuning Inductor	L_{AT}	10	10	10	nH	50 ohm antenna
Shunt Tuning/ESD Inductor	L_{ESD}	100	100	100	nH	50 ohm antenna

CAUTION: Electrostatic Sensitive Device. Observe precautions for handling.

NOTES:

1. Do not allow the voltage applied to a control input pin to exceed Vcc + 200 mV.
2. The companion receiver to the TX6004 is the RX6004. Please see Murata's web site at www.murataamericas.com for details.

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Transmitter Theory of Operation

Introduction

Murata's TX-series hybrid transmitters are specifically designed for short-range wireless data communication applications. These transmitters provide robust operation, very small size, low power consumption and low implementation cost. All critical RF functions are contained in the hybrid, simplifying and speeding design-in. The transmitters can be readily configured to support a wide range of data rates and protocol requirements. TX-series transmitters feature excellent suppression of output harmonics and virtually no other RF emissions, making them easy to certify to short- range (unlicensed) radio regulations.

Transmitter Block Diagram

Figure 1 is the general block diagram of the transmitter. Please refer to Figure 1 for the following discussions.

Antenna Port

The only external RF components needed for the transmitter are the antenna and its matching components. Antennas presenting an impedance in the range of 35 to 72 ohms resistive can be satisfactorily matched to the RFIO pin with a series matching coil and a shunt matching/ESD protection coil. Other antenna impedances can be matched using two or three components. For some impedances, two inductors and a capacitor will be required. A DC path from RFIO to ground is required for ESD protection.

Transmitter Chain

The transmitter chain consists of a SAW coupled-resonator oscillator followed by a modulated buffer amplifier. The SAW coupled resonator output filter suppresses transmitter harmonics to the antenna.

Transmitter operation supports two modulation formats, on-off keyed (OOK) modulation, and amplitude-shift keyed (ASK) modulation. When OOK modulation is chosen, the transmitter output turns completely off between "1" data pulses. When ASK modulation is chosen, a "1" pulse is represented by a higher transmitted power level, and a "0" is represented by a lower transmitted power level. OOK modulation provides compatibility with first-generation ASH technology, and provides for power conservation. ASK modulation must be used for high data rates (data pulses less than 200 µs). ASK modulation also reduces the effects of some types of interference and allows the transmitted pulses to be shaped to control modulation bandwidth.

The modulation format is chosen by the state of the CNTRL0 and the CNTRL1 mode control pins, as discussed below. In the OOK mode, the oscillator amplifier TXA1 and buffer amplifier TXA2 are turned off when the voltage to the TXMOD input falls below 220 mV. In the OOK mode, the data rate is limited by the 20/15 µs turn-on and turn-off time of the oscillator. In the ASK mode TXA1 is biased ON continuously, and the output of TXA2 is modulated by the TXMOD input current. Minimum output power occurs in the ASK mode when the modulation driver sinks about 10 µA of current from the TXMOD pin.

Transmitter Block Diagram

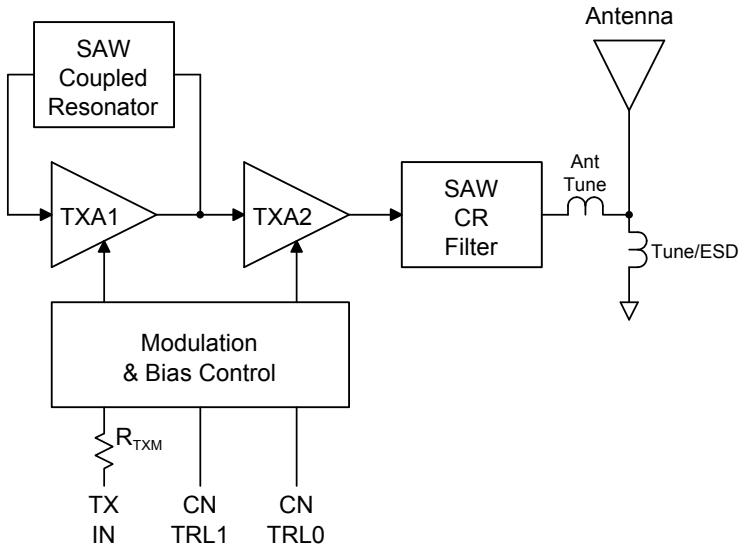

Figure 1

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The transmitter RF output power is proportional to the input current to the TXMOD pin. A series resistor is used to adjust the peak transmitter output power. 1.5 dBm of output power requires about 450 µA of input current.

Transmitter Mode Control

The three transmitter operating modes – transmit ASK, transmit OOK, and power-down (sleep), are controlled by the Modulation & Bias Control function, and are selected with the CNTRL1 and CNTRL0 control pins. Setting CNTRL1 high and CNTRL0 low place the unit in the ASK transmit mode. Setting CNTRL1 low and CNTRL0 high place the unit in the OOK transmit mode. Setting CNTRL1 and CNTRL0 both low place the unit in the power-down mode. (Note that the resistor driving TXMOD must also be low in the power-down mode to minimize power-down current.) CNTRL1 and CNTRL0 are CMOS compatible inputs. These inputs must be held at a logic level; they cannot be left unconnected.

Turn-On Timing

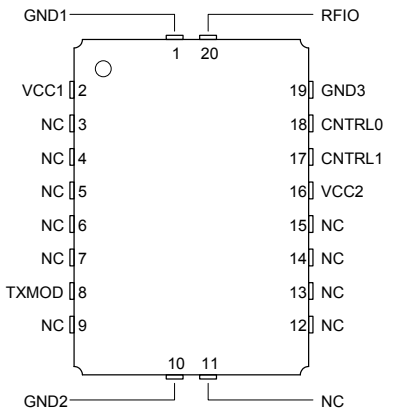
The maximum time required for either the OOK or ASK transmitter mode to become operational is 5 ms after the supply voltage reaches 2.2 Vdc. The total turn-on time to stable transmitter operation for a 10 ms power supply rise time is 15 ms.

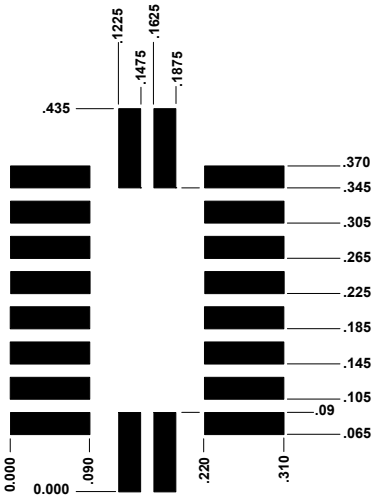
Sleep and Wake-Up Timing

The maximum transition time from either transmit mode to the sleep mode (t_{TOS} and t_{TAS}) is 10 µs after CNTRL1 and CNTRL0 are both low (1 µs fall time).

The maximum time required to switch from the sleep mode to either transmit mode (t_{STO} and t_{STA}) is 16 µs. Most of this time is due to the start-up of the transmitter oscillator.

Transmitter Pin Out

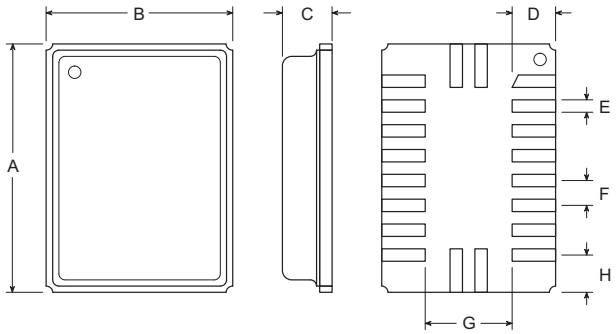




Dimensions in inches.

SM-20H PCB Pad Layout

SM-20H Package Drawing



Dimension	mm			Inches		
	Min	Nom	Max	Min	Nom	Max
A	9.800	10.033	10.135	.388	.395	.400
B	6.650	6.858	6.985	.261	.270	.275
C	1.735	1.930	2.032	.068	.076	.080
D	1.645	1.778	1.905	.064	.070	.075
E	0.381	0.508	0.635	.015	.020	.025
F	0.889	1.016	1.143	.035	.040	.045
G	3.175	3.302	3.429	.125	.130	.135
H	1.360	1.524	1.651	.055	.060	.065

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Pin	Name	Description
1	GND1	GND1 is the RF ground pin. GND2 and GND3 should be connected to GND1 by short, low-inductance traces.
2	VCC1	VCC1 is the positive supply voltage pin for the transmitter output amplifier and the transmitter base-band circuitry. VCC1 is usually connected to the positive supply through a ferrite RF decoupling bead which is bypassed by an RF capacitor on the *supply side*. See the description of VCC2 (Pin 16) for additional information.
3	NC	No connection. Printed circuit board pad may be grounded or floating.
4	NC	No connection. Printed circuit board pad may be grounded or floating.
5	NC	No connection. Printed circuit board pad may be grounded or floating.
6	NC	No connection. Printed circuit board pad may be grounded or floating.
7	NC	No connection. Printed circuit board pad may be grounded or floating.
8	TXMOD	The transmitter RF output voltage is proportional to the input current to this pin. A series resistor is used to adjust the peak transmitter output voltage. 1.5 dBm of output power requires 450 µA of input current. In the ASK mode, minimum output power occurs when the modulation driver sinks about 10 µA of current from this pin. In the OOK mode, input signals less than 220 mV completely turn the transmitter oscillator off. Internally, this pin appears to be a diode in series with a small resistor. Peak transmitter output power P_O for a 3 Vdc supply voltage is approximately: $P_O = 7*(I_{TXM})^2$, where P_O is in mW, and the peak modulation current I_{TXM} is in mA A ±5% resistor value is recommended. In the OOK mode, this pin is usually driven with a logic-level data input (unshaped data pulses). OOK modulation is practical for data pulses of 200 µs or longer. In the ASK mode, this pin accepts analog modulation (shaped or unshaped data pulses). ASK modulation is practical for data pulses 8.7 µs or longer. This pin must be low in the power-down (sleep) mode. Please refer to the *ASH Transceiver Designer's Guide* for additional information on modulation techniques.
9	NC	No connection. Printed circuit board pad may be grounded or floating.
10	GND2	GND2 is an IC ground pin. It should be connected to GND1 by a short, low inductance trace.
11	NC	No connection. Printed circuit board pad may be grounded or floating.
12	NC	No connection. Printed circuit board pad may be grounded or floating.
13	NC	No connection. Printed circuit board pad may be grounded or floating.
14	NC	No connection. Printed circuit board pad may be grounded or floating.
15	NC	No connection. Printed circuit board pad may be grounded or floating.
16	VCC2	VCC2 is the positive supply voltage pin for the transmitter oscillator. Pin 16 must be bypassed with an RF capacitor, and must also be bypassed with a 1 to 10 µF tantalum or electrolytic capacitor. Power supply voltage ripple should be limited to 10 mV peak-to-peak. See the *ASH Transceiver Designer's Guide* for additional information.
17	CNTRL1	CNTRL1 and CNTRL0 select the transmit modes. CNTRL1 high and CNTRL0 low place the unit in the ASK transmit mode. CNTRL1 low and CNTRL0 high place the unit in the OOK transmit mode. CNTRL1 and CNTRL0 both low place the unit in the power-down (sleep) mode. CNTRL1 is a high-impedance input (CMOS compatible). An input voltage of 0 to 300 mV is interpreted as a logic low. An input voltage of Vcc - 300 mV or greater is interpreted as a logic high. An input voltage greater than Vcc + 200 mV should not be applied to this pin. A logic high requires a maximum source current of 40 µA. A logic low requires a maximum sink current of 25 µA (1 µA in sleep mode). This pin must be held at a logic level; it cannot be left unconnected.
18	CNTRL0	CNTRL0 is used with CNTRL1 to control the operating modes of the transmitter. See the description of CNTRL1 for more information.
19	GND3	GND3 is an IC ground pin. It should be connected to GND1 by a short, low inductance trace.
20	RFIO	RFIO is the transmitter RF output pin. This pin is connected directly to the SAW filter transducer. Antennas presenting an impedance in the range of 35 to 72 ohms resistive can be satisfactorily matched to this pin with a series matching coil and a shunt matching/ESD protection coil. Other antenna impedances can be matched using two or three components. For some impedances, two inductors and a capacitor will be required. A DC path from RFIO to ground is required for ESD protection.

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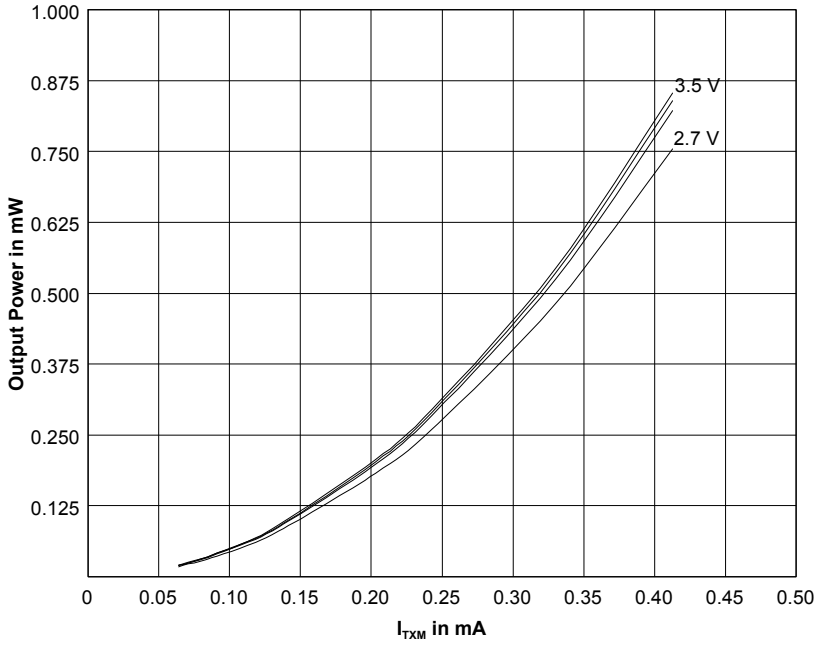
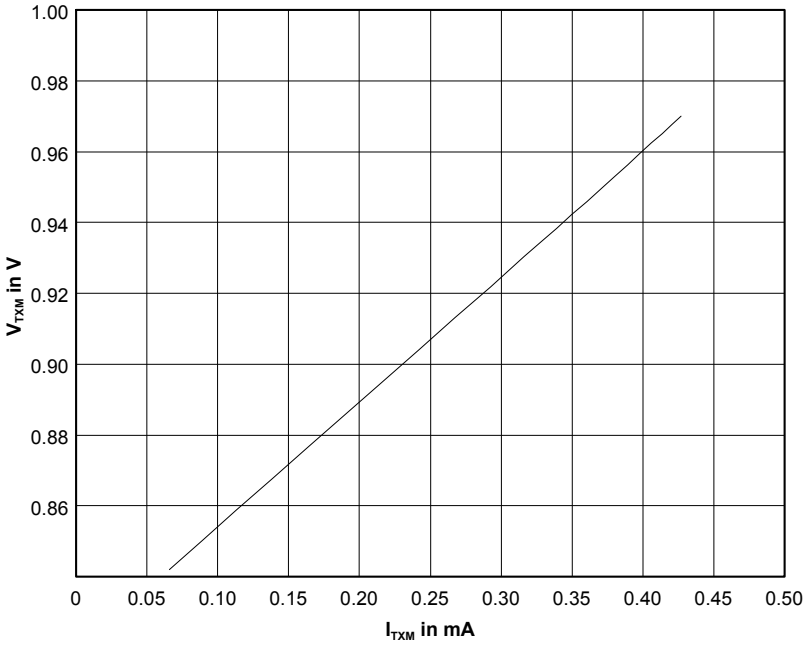
RF Output Power vs I_{TXM}



V_{TXM} vs I_{TXM}



Note: Specifications subject to change without notice.

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