

Transmitter Module

Request for New Part Numbers

07/18/00

Requesting Party: Don Davis
Department:

Product Name: 916.5 MHz Transmitter

Manufacturer's Name: RFM

Manufacturer's Part # (if available): TX6000

Description of Part: 916.5 MHz Hybrid Transmitter

Manufactured by Us

Purchased

Cost: \$6.50

Item Type: IC

Application (where will this part be used): WOPI

New Part #: 214005-000

AI Description: TRANSMITTER, 916.5 MHz, HYBRID, SM-20P

Approved by: *DJC*

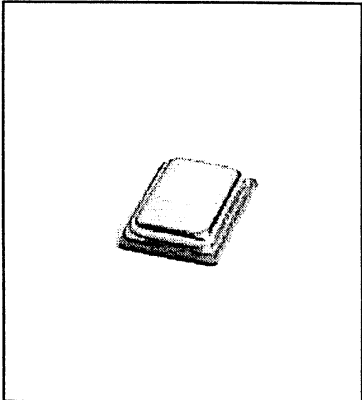
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Preliminary



TX6000

**916.50 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*

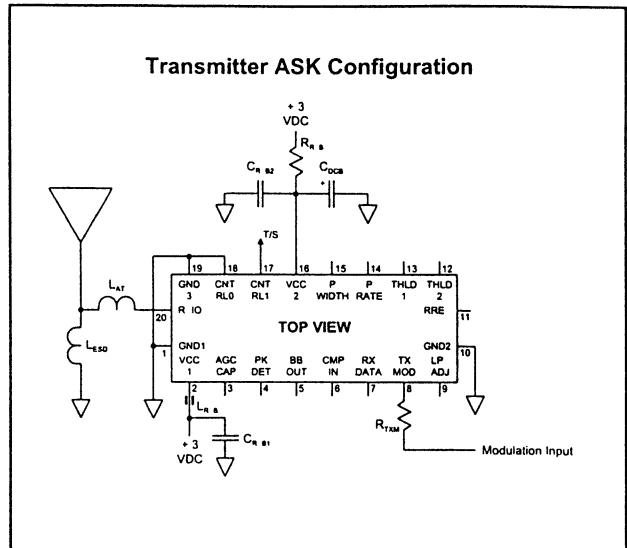
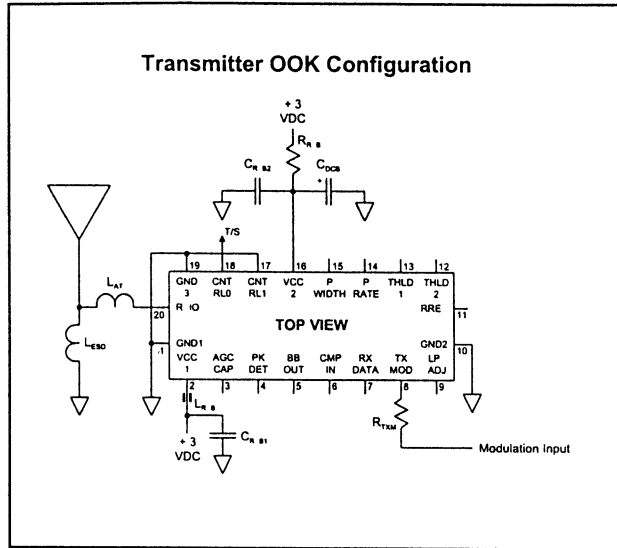
The TX6000 hybrid transmitter is ideal for short-range wireless data applications where robust operation, small size, low power consumption and low cost are required. All critical RF functions are contained in the hybrid, simplifying and speeding design-in. The TX6000 includes provisions for both on-off keyed (OOK) and amplitude-shift keyed (ASK) modulation. The TX6000 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) | 230 | °C |

Electrical Characteristics

| Characteristic | Sym | Notes | Minimum | Typical | Maximum | Units |
|----------------------------------|-----------------------------------|-------|-----------------------|---------|---------|-------|
| Operating Frequency | f _o | | 916.30 | | 916.70 | MHz |
| Modulation Types | | | OOK & ASK | | | |
| Data Rate | | | | | 115.2 | kbps |
| Transmitter Performance | | | | | | |
| Peak Input Current, 3 Vdc Supply | I _{TP} | | | | 12 | mA |
| Peak Output Power | P _O | | | 0.75 | | mW |
| Turn On/Turn Off Time, OOK | t _{ON} /t _{OFF} | | | | 40 | µs |
| Turn On/Turn Off Time, ASK | t _{ON} /t _{OFF} | | | | 1 | µs |
| 2nd Harmonic Emission | | | | | -36 | dBm |
| 3rd - 10th Harmonic Emissions | | | | | -42 | dBm |
| Non-harmonic Spurious Emissions | | | | | -50 | dBm |
| Sleep Mode Current | I _S | | | | 5 | µA |
| Sleep to Transmit Switch Time | t _{TOR} | | | | 46 | µs |
| Transmit to Sleep Switch Time | t _{TRT} | | | | 40 | µs |
| Control Input Logic Low Level | | | | | 200 | mV |
| Control Input Logic High Level | | 1 | V _{CC} - 200 | | | mV |
| Power Supply Voltage Range | V _{CC} | | 2.7 | | 3.5 | Vdc |
| Operating Ambient Temperature | T _A | | -40 | | +85 | °C |



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

| Item | Symbol | OOK | OOK | 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} | 8.2 | 8.2 | 8.2 | K | ±5%, for 0.25 mW output |
| RF Bypass Resistor | R _{RFB} | 100 | 100 | 100 | ohm | ±5% |
| DC Bypass Capacitor | C _{DCB} | 10 | 10 | 10 | 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 when 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 TX6000 is the RX6000. Please see RFM's web site at www.rfm.com for details.

Transmitter Theory of Operation

Introduction

RFM's TX-series hybrid transmitters are specifically designed for short-range wireless data communication applications. The 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 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 μ s). 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 40 μ s 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 μ A of current from the TXMOD pin.

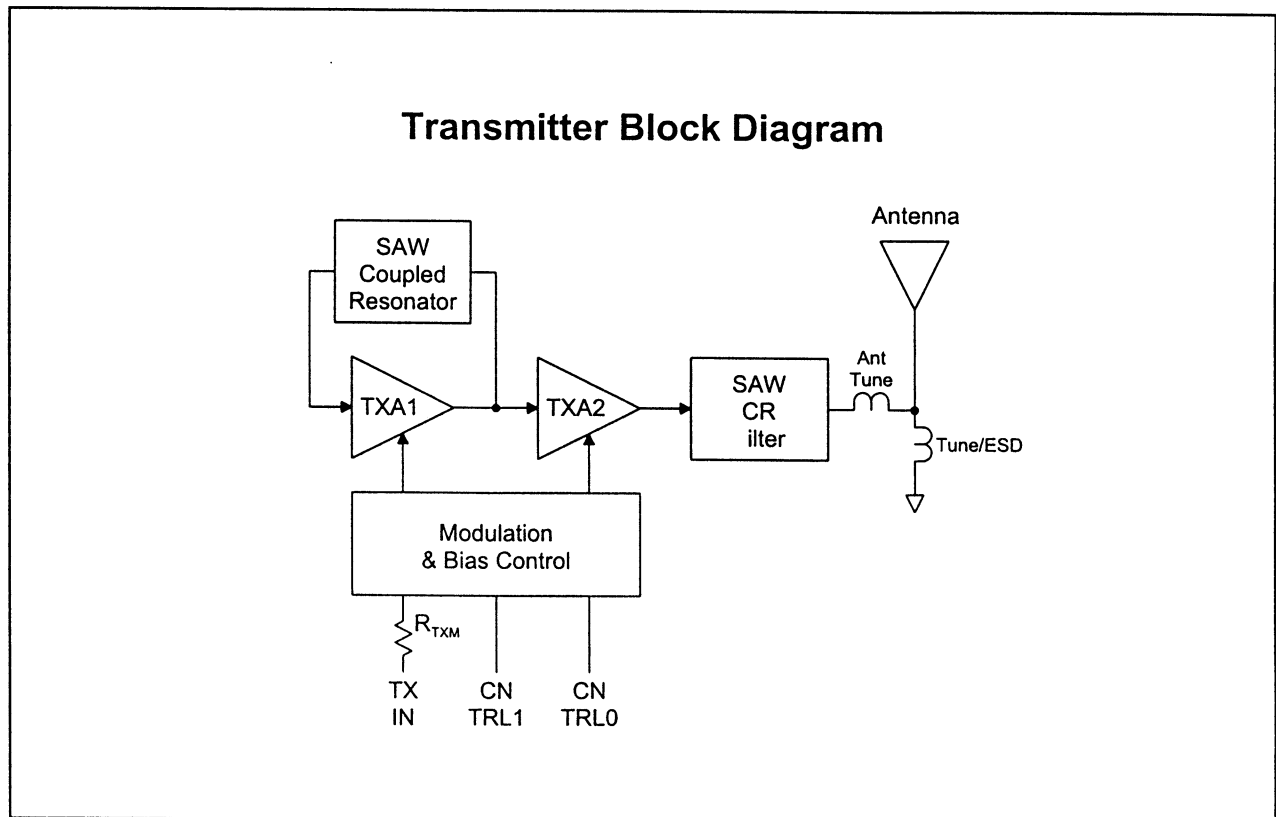


Figure 1

214005-000
 TRANSMITTER,916.5 MHZ,HYBRID,SM-20P

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. Maximum saturated output power requires 450 μ A 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.

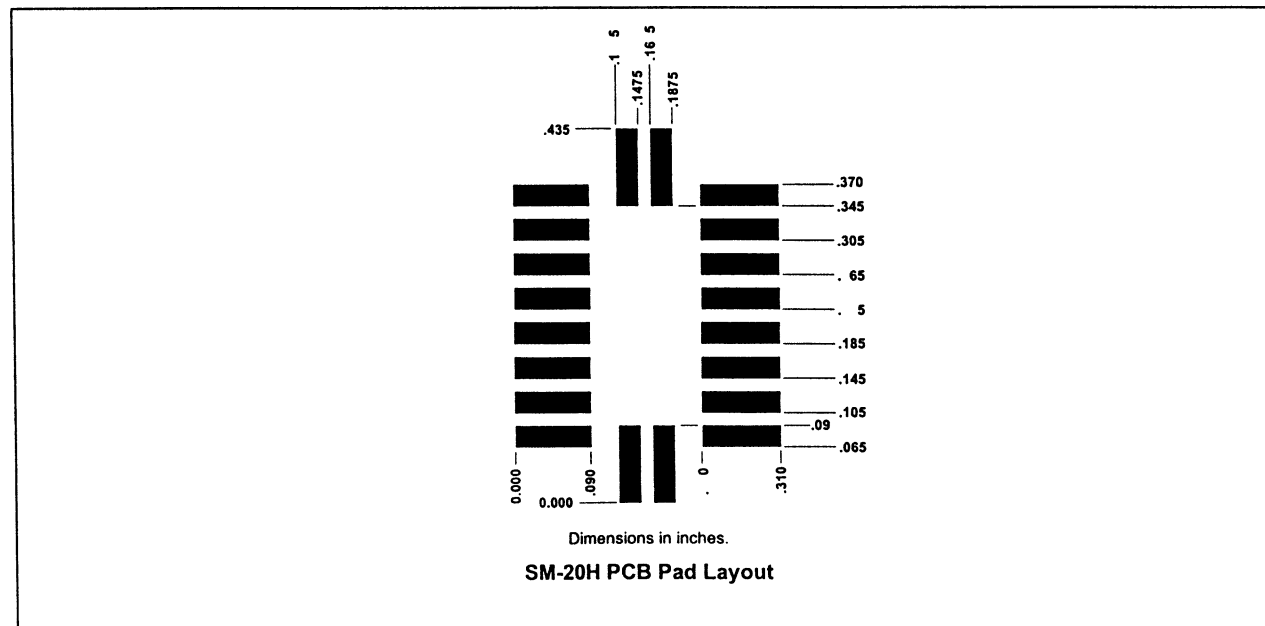
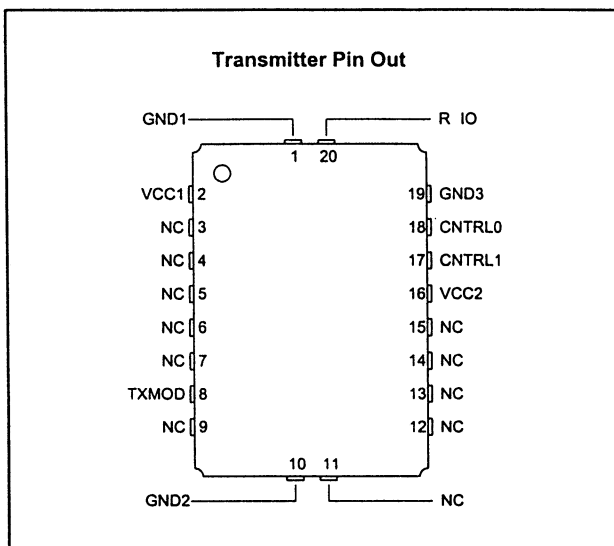
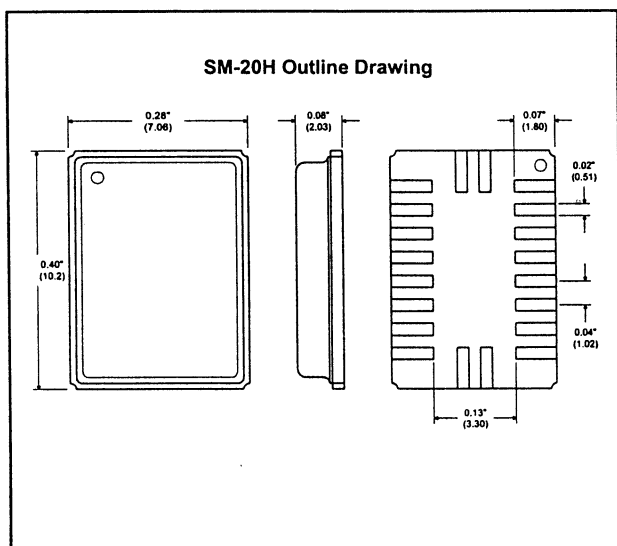
Turn-On Timing

The maximum time required for either the OOK or ASK transmitter mode to become operational is 5 ms after the supply voltage reaches 2.7 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 40 μ s after CNTRL1 and CNTRL0 are both low (1 μ s fall time).

The maximum time required to switch from the sleep mode to either transmit mode (t_{STO} and t_{STA}) is 46 μ s. Most of this time is due to the start-up of the transmitter oscillator.



Pin Descriptions

| Pin | Name | Description |
|-----|--------|---|
| 1 | GND1 | GND1 is a transmitter RF ground pin. This pin should be connected to GND3 by a direct, low-inductance trace. |
| 2 | VCC1 | VCC1 is the positive supply voltage pin for the transmitter output amplifier and the transmitter base-band circuitry. VCC1 must be connected to the positive supply through a ferrite RF decoupling bead which is bypassed by an RF capacitor on the <i>supply side</i> . 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 | <p>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. Maximum saturated 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> $P_O = 4.8 \cdot (I_{TXM})^2$ <p>where P_O is in mW, and the peak modulation current I_{TXM} is in mA</p> <p>A $\pm 5\%$ resistor is recommended. A starting point resistor value for FCC Part 15.249 applications is 8.2 K. 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 <i>ASH Transceiver Designer's Guide</i> for additional information on modulation techniques.</p> |
| 9 | NC | No connection. Printed circuit board pad may be grounded or floating. |
| 10 | GND2 | GND2 is the ground return pin for the receiver base-band circuitry. It should be returned to GND1 or GND3 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 isolated from the positive supply by a 100 ohm resistor. VCC2 must also be bypassed with a 10 μ F tantalum capacitor. See the description of VCC1 (Pin 2) 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 200 mV is interpreted as a logic low. An input voltage of $V_{CC} - 200$ mV or greater is interpreted as a logic high. An input voltage greater than $V_{CC} + 200$ mV should not be applied to this pin. 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 a transmitter RF ground pin. This pin should be connected to GND1 by a direct, 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 capacitor will be required. A DC path from RFIO to ground is required for ESD protection. |

