

## 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  $\mu$ 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  $\mu$ 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  $\mu$ A of current from the TXMOD pin.

## Transmitter Block Diagram

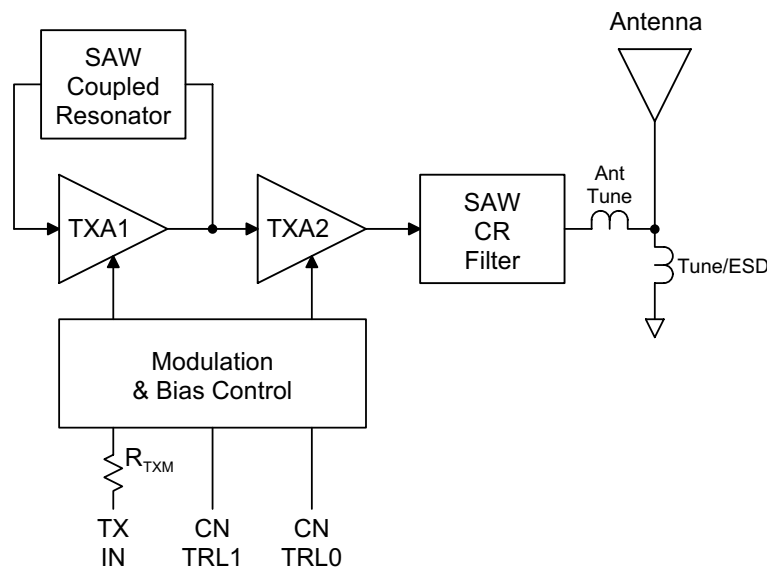


Figure 1

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  $\mu$ 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  $\mu$ s after CNTRL1 and CNTRL0 are both low (1  $\mu$ s fall time).

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

