

# MC1319x RF Test Modes

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## 1 Introduction

The Freescale MC1319x 802.15.4 transceiver can be used in proprietary, IEEE 802.15.4, or full ZigBee compatible networks. During development, evaluation, manufacturing test, or standards certification, it is useful to be able to support certain RF test modes. It is the intent of this application note to overview the programming interface details and procedures needed to implement the RF test modes. These modes in turn can be used to facilitate broader RF test procedures.

## 2 SPI Register Assignments Necessary to Support RF Test

The user should be familiar with the register model and programming procedures for the MC1319x transceiver, especially using Packet Mode. If additional information is needed please refer to the appropriate reference manual (MC13192RM or MC13191RM). This section details additional register field assignments that help facilitate RF test.

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**Table 1. MC1319x SPI Register Fields Useful for RF Test**

Field	Register	Bit(s)	Default	Description
<b>pa_en</b>	0x08	15	0b1	Power amp (PA) enable - when pa_en = 1, the TX PA is enabled. When pa_en = 0, the transmitter puts out no power.
<b>ber_en</b>	0x30	15	0b0	Bit error rate test enable - when ber_en = 1, the transceiver is put in continuous receive or transmit mode. Continuous TX mode is useful for current measurements or for looking at the TX spectrum. Continuous RX mode is useful for current measurements.
<b>psm_tm[2:0]</b>	0x31	5-3	0b000	Phase shift modulator test mode - only two modes are used for this field. When psm_tm[2:0] = 0b000, this is normal operation (normal modulation). When psm_tm[2:0] = 0b001, the modulator is disabled and the transmitter puts out an unmodulated signal.

**NOTE**

For reference, the reset default values for the above registers are shown below:

Register 0x08 (default) = 0xFFE5

Register 0x30 (default) = 0x0004

Register 0x31 (default) = 0xA000

### 3 Programming the Transceiver for Test Modes

The MC13192 and MC13193 transceivers are capable of two data transfer modes: (Packet Mode and Streaming Mode). The MC13191 transceiver supports only Packet Mode. The Packet Mode should be used to implement the RF test modes. The RF modes are activated by setting appropriate control bits and then invoking RX or TX packet data mode.

### 4 Transmitter Test Modes

There are several transmitter modes that are useful for testing RF output spectrum. The Packet Transmit Mode can be reviewed in Section 4.3.3.3 of the MC13192/MC13193 Reference Manual (MC13192RM) or in Section 4.3.3.3 of the MC13191 Reference Manual (MC13191RM) as background for understanding the information in the following sections.

## 4.1 Continuously Transmit Unmodulated Carrier

It is possible to transmit a continuous, unmodulated signal. This mode is useful for observing transmitter characteristics and measuring TX current for the transceiver. The steps to implement this mode include first sending a dummy packet to setup the TX analog circuitry, next disabling the modulator, and then turning on continuous transmit mode:

- Setup TX analog circuitry by sending a dummy packet
  - Disable the PA (write `pa_en`, Register 0x08, Bit 15 = 0).
  - Set the message field length to a short number (frame length of 4 is a good example).
  - Transmit dummy message (PA is off) to setup TX analog circuitry (use packet mode and no data needs to be loaded because dummy data is sufficient).
  - Wait for transmission completion (this can be interrupt driven by waiting for `tx_done` IRQ).
- Enable the PA (write `pa_en`, Register 0x08, Bit 15 = 1).
- Enable the continuous TX mode (write `ber_en`, Register 0x30, Bit 15 = 1).
- Disable the phase shift modulator (write `psm_tm[2:0]`, Register 0x31, Bits 5-3 = 0b001).
- Enable the transmitter with a TX operation which will be continuous and without modulation (RXTXEN must be high and set `xcvr_seq[1:0]` to TX mode).

The TX operation will continue until aborted.

## 4.2 Continuously Transmit Modulated Carrier

It is possible to transmit a continuous, modulated signal. The data pattern sent is a repeating sequence of the two (2) symbols stored in `tx_pkt_ram[15:0]`, Register 0x02. The steps to implement this mode include first sending a dummy packet to setup the TX analog circuitry and then turning on continuous transmit mode:

- Setup TX analog circuitry by sending a dummy packet
  - Disable the PA (write `pa_en`, Register 0x08, Bit 15 = 0).
  - Set the message field length to a short number (frame length of 4 is a good example).
  - Transmit dummy message (PA is off) to setup TX analog circuitry (use packet mode and no data needs to be loaded because dummy data is sufficient).
  - Wait for transmission completion (this can be interrupt driven by waiting for `tx_done` IRQ).
- Load desired 2 TX symbols into `tx_pkt_ram[15:0]` (these 2 symbols will get continuously repeated).
- Enable the PA (write `pa_en`, Register 0x08, Bit 15 = 1).
- Enable the continuous TX mode (write `ber_en`, Register 0x30, Bit 15 = 1).
- Enable the transmitter with a TX operation which will be continuous and with modulation as determined by the data word (RXTXEN must be high and set `xcvr_seq[1:0]` to TX mode).

The TX operation will continue until aborted.

### 4.3 Transmit PRBS9 Data Packet Data

It is useful to repeatedly transmit a known data packet for observing transmitter characteristics as part of radio certification. The packet uses pseudo-random binary sequence (PRBS) data generated via a maximal length 9th order binary polynomial (PRBS9). The packet length is set to the maximum length of 127 bytes (including the two CRC data bytes). The following steps assume default operation of the transceiver (PA enabled, ber\_en off, and modulator enabled) and include:

- Generate 125-byte data buffer based on a PRBS9 algorithm (such as  $x^9 + x^5 + 1$  polynomial).
- Load data buffer into tx\_packet\_ram[15:0].
- Set message field length to 127 (maximum length).
- Enable the transmitter with a TX operation which will be normal with modulation (RXTXEN must be high and set xcvr\_seq[1:0] to TX mode).
- Wait for transmission completion (this can be interrupt driven by waiting for tx\_done IRQ).
- To repeat the transmission, again enable the transmitter with a TX operation.

## 5 Receiver Test Mode

Other than normal operation, there is one additional receive test mode that is useful for a MC1319x device. A continuous receive mode can be enabled that turns on the analog receive circuitry and leaves it on. This is useful for measuring current in RF receive mode. With normal operation, packet error rate (PER) can be tested, but a true bit error rate is not possible for the receiver because no direct access to the decoded bit stream is given. The steps include enabling a receive with the ber\_en bit set:

- Enable the continuous RX mode (write ber\_en, Register 0x30, Bit 15 = 1).
- Enable the receiver with a RX operation which will be continuous (RXTXEN must be high and set xcvr\_seq[1:0] to RX mode).

## 6 Conclusion

The purpose of this application note is to outline the means to put the MC1319x transceiver in a mode for RF testing. These modes are useful for characterizing RF performance in the lab, in production or in government certification. Freescale provides these modes in its SMAC, reference the *SMAC Users Guide*, (SMACRM) and 802.15.4 MAC software. In other circumstances, it becomes the user's task to provide these modes in different software.

## NOTES

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