WirelessUSB LS™ Firmware Tips and Tricks

Startup

Power the Radio

The first thing that must be done in order to communicate with the WirelessUSB LS™ Radio is to pull nPD and nRESET high. After the radio has been powered on and brought out of Reset, the firmware may communicate with the radio via its SPI interface (see the WirelessUSB LS Radio System on a Chip data sheet for more details).

Register Initialization

In order to initialize the radio the values of the following registers may need to modified, as the default values may not be appropriate for the given application:

- REG_DATA_RATE (0x04) – The default data rate is 16 kbps. In order to use 32- or 64-kbps data rates the value of this register must be changed.
- REG_SERDES_CTL (0x06) – By default the radio is in bit-serial mode. In order to use SERDES mode (which is used by all WirelessUSB LS kits) this register must be written.
- REG_TX_VALID (0x10) – By default the transmit valid bits are set to 0x00, which means that no data will be transmitted when in SERDES mode. If all transmissions use byte boundaries this register should be set to 0xFF.
- REG_THOLD_L (0x19) and REG_THOLD_H (0x1A) – the default threshold values are set to allow eight correlation errors when using 64 chip PN codes. If 32 chip PN codes are used the threshold values should be adjusted. The WirelessUSB LS kits use threshold values allow 1–2 correlation errors when using 32 chip PN codes.
- REG_ANALOG_CTL (0x20) – By default the PA Control Output is disabled, which causes the PA Control Output pin to float, which consumes power. In order to conserve power PA Control Output should be enabled.
- REG_PA (0x23) – The default PA setting is 0, which is the minimum value. Most applications will require a PA setting between 5 and 7.
- REG_XTAL_ADJ (0x24) – By default the 13-MHz clock is driven externally. This should be disabled when not in use in order to conserve power.
- REG_VCO_CAL (0x26) – By default VCO adjustment is disabled. It is recommended that the VCO Slope Enable bits are set to -5/+5 adjustment.

Basic RX

In order to receive data the RX Enable bit (0x07) of the REG_CONTROL (0x03) register must be set. If SERDES mode is used, the receive interrupts must also be enabled. It is recommended that that the Full A and EOF A interrupts are enabled; the FULL A interrupt signals that a byte of data has been received and the EOF A interrupt signals the end of a packet.

Note. The WirelessUSB LS radio cannot simultaneously transmit and receive; therefore the RX Enable (0x07) and TX Enable (0x06) bits of the REG_CONTROL (0x03) register must not be set at the same time.

Basic TX

In order to transmit data the TX Enable bit (0x06) of the REG_CONTROL (0x03) register must be set. If SERDES mode is used, the transmit interrupts must also be enabled. It is recommended that the Empty and Done interrupts are enabled; the Empty interrupt signals the radio is ready for another data byte to be loaded and the Done interrupt signals the end of a packet.

Note. The WirelessUSB LS radio cannot simultaneously transmit and receive; therefore the RX Enable (0x07) and TX Enable (0x06) bits of the REG_CONTROL (0x03) register must not be set at the same time.

Conserving Power

Radio Suspend

If the crystal is calibrated to a non-zero value when the radio comes out of standby the crystal can take up to 14 ms to settle. If the crystal is not calibrated it typically takes 3 ms or less to settle. Therefore, if crystal calibration is being used, the crystal should be calibrated to 0x00 before powering down the radio in order to reduce the amount of time required for the crystal to settle when the radio comes out of standby. The crystal may be recalibrated to a non-zero value after the crystal has settled; this typically requires another 2 ms.

Floating MISO Pin During Radio Standby

The radio does not drive the MISO pin during standby. If the radio is the only SPI slave connected to the microprocessor, the MISO pin on the microprocessor may float, which could consume 20–80 uA. The microprocessor can conserve this power by driving the MISO pin itself while the radio is in standby. It does not matter if the pin is driven high or low.

Optimizing the Receive ISR

Burst Mode

The Receive ISR typically requires reading the Receive Interrupt Status, Receive Data and Receive Valid registers. These registers are consecutive allowing burst reads (using the auto-increment bit in the SPI address). Using the burst read method reduces the SPI transaction from six bytes to four (writing the address of the Receive Interrupt Status Register followed by reading the Receive Interrupt Status, Receive Data and Receive Valid).

Note: Before using Burst Mode please read the data sheet concerning the SPI duty cycle of the radio; Burst Mode will not work if the SPI duty cycle is higher than the allowed duty cycle in the radio.

Using Data Valid Bit

If the Valid Data bit is set in the Receive Interrupt Status Register all eight bits in the Receive Data are valid; therefore it is unnecessary to read the Receive Valid Register, which further reduces the number of SPI transactions required in the Receive ISR.

Turning the Radio Off Before EOF

Typically the radio must stay in receive mode until the EOF interrupt occurs signaling the end of a packet. If the length of the packet is known the radio may be turned off immediately after receiving the last byte. This reduces the amount of time the radio is in an active state, which will conserve power.

Miscellaneous

RSSI

RSSI is the strength of the received signal and is used for the following tasks:

- Determining connection quality
- Determining the value of the noise floor
- Checking for a quiet channel before transmitting.

The RSSI state machine was designed specifically to determine connection quality. The state machine stops calculating the signal strength after the RSSI register is read. Therefore in order to periodically check RSSI receive mode must be toggled off and back on.

When the radio enters receive mode it recalibrates the RSSI value. If the noise floor is extremely high the RSSI state machine may not calibrate correctly and may return an invalid RSSI value or return 0. Therefore if an invalid or 0 RSSI value is read it may not be accurate. In order to get a valid RSSI value the Carrier Detect must be forced high. 50 us after the Carrier Detect is forced high the radio will calculate a valid RSSI value. (Bit 5 of the REG_RSSI register indicates whether the RSSI reading is valid or not.)

IRQ Polarity

It is recommended that the radio be set to use an active high IRQ, not the active low IRQ. The active low IRQ has extra transitions when turning RX and TX on/off that could be interpreted as interrupts.

13-MHz Harmonics

By default the 13-MHz clock output pin is enabled. This pin is useful for adjusting the 13-MHz clock, but it interferes with every 13th channel beginning with 2.405 GHz channel. Therefore it is recommended that the 13-MHz clock output pin be disabled when not in use.

Locking SPI Resource

The SPI bus from the microprocessor to the radio is a shared resource (between the main logic and the radio interrupts) and should be protected by locks in order to ensure that interrupts do not occur during SPI transactions or that SPI transactions in the interrupt will not preempt SPI transactions in the main logic.

PA Adjustment (Range vs. Colocation)

The PA may be adjusted by using the REG_PA (0x23) register. Increasing the PA will increase the range while lowering the PA will increase the number of colocated systems possible. The PA should be adjusted to balance the range and colocation requirements of each specific application. The default PA in most WirelessUSB kits is 0x07 (the maximum allowed value).

Using the Data Field in NULL Packets

NULL packets contain a two-bit field for application data. If the application sends certain messages frequently, (such as key-up events in keyboards) these messages can be assigned a two-bit value and sent in a NULL packet, which reduces these packets from a minimum of three bytes to only one byte.

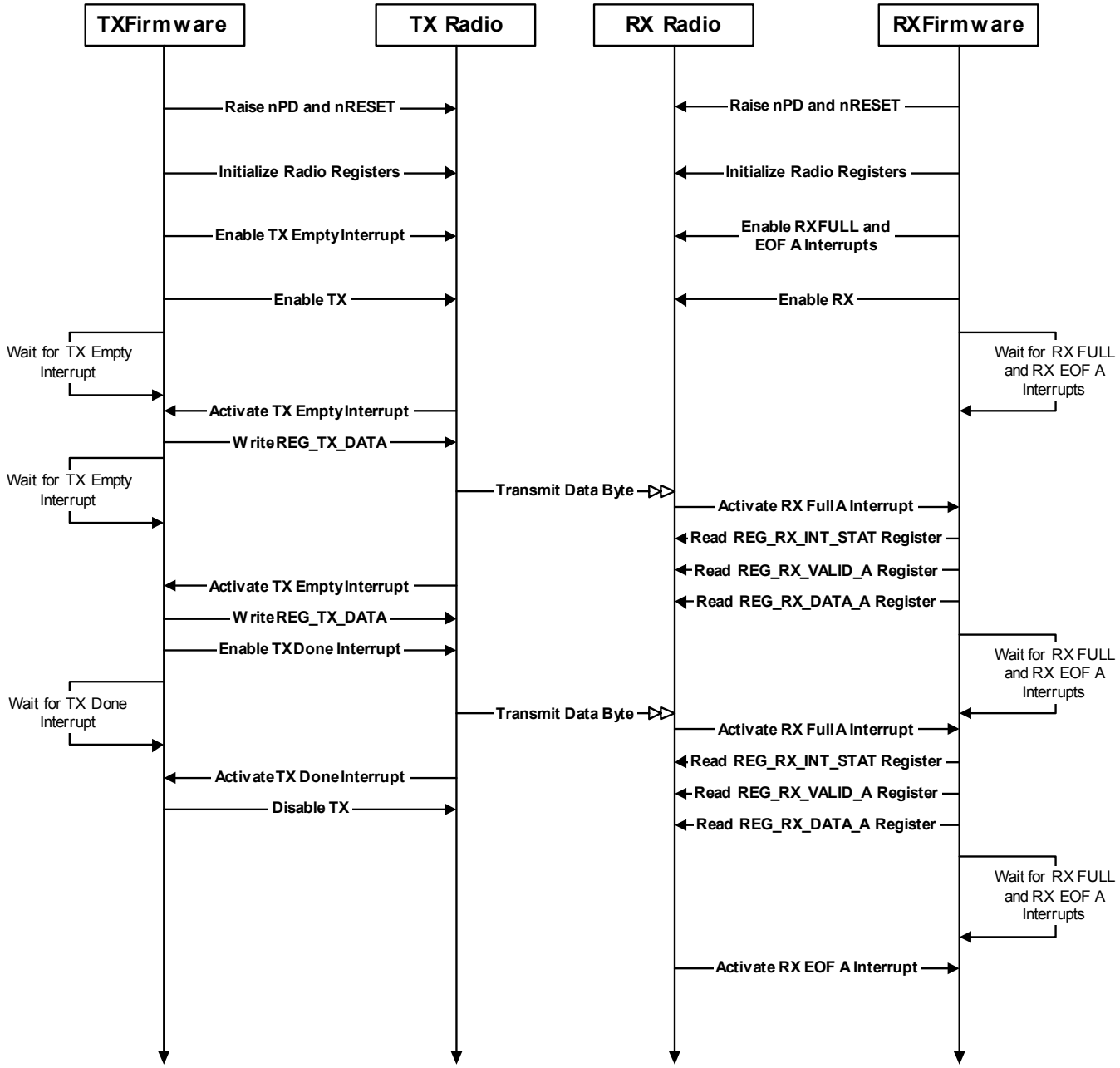
Reading the Manufacturing ID

Every WirelessUSB LS radio contains a 4-byte Manufacturing ID, which is useful radio identification and generating pseudo-random seeds. The WirelessUSB LS HID Bridge uses the Manufacturing ID to generate the channel subset and PN code. The Manufacturing ID is laser-trimmed into each radio during the manufacturing process and is stored in registers 0x3C – 0x3F. Because the values are stored by laser-trimming the part, enabling the registers uses a small amount of current. For this reason the Manufacturing ID registers are disabled by default. The MID Read Enable bit (0x05) of the REG_ANALOG_CTL (0x20) register must be enabled in order to read the Manufacturing ID. This bit should be disabled after reading Manufacturing ID in order to conserve power.

Resetting the Radio Interrupts

The WirelessUSB LS radio does not reset the TX and RX interrupts when switching into and out of receive and transmit modes. Therefore the receive interrupt registers (REG_RX_INT_STAT and REG_RX_DATA_A) should be read when entering receive mode in order to clear stale interrupts. The transmit interrupt register (REG_TX_INT_STAT) should be read when entering transmit mode as well.

Appendix
Quick Start Sequence Diagram



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