Application Report
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# Management of the TRF7960, -60A Startup Sequence

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**ABSTRACT**

System developers concerned about minimizing the current draw of TRF7960, -60A (and their variants) systems at startup time need guidance about handling the Regulator Control register (0x0B) value. Guidance is necessary due to the conditions under which the TRF796x/-6xA starts up with the automatic (default) setting of this register, after the EN line (pin 28) is asserted from the controlling MCU in the system. Valid application use case for utilizing this guidance would be battery-powered RFID application where controlling the entire system current draw over time is of the utmost concern. The scope of this application report is limited to providing direction to the embedded developer for the specific handling of the condition at startup.

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# 1 Automatic Regulator Register (0x0B) Setting

***Register 0x0B = 0x87 (automatic, default)***

When the Register 0x0B is left at default setting at the time the EN line is asserted (pin 28), the output of the transmitter can be observed turning on for a period of time before the crystal oscillator starts up.

This observed activity is the automatic regulator adjustment module performing its task after power-up as its function is to switch on all the current consumption modules inside the TRF79xx (including the TX output) and perform a regulator adjustment for best noise performance.

Once the adjustment is complete, all the current consuming modules (including the transmitter) are switched off. For an actual example of this burst of TX activity while the automatic adjustment is being performed, see Figure 1.

Yellow trace is EN line, blue trace is 13.56 MHz clock, pink trace is TX.

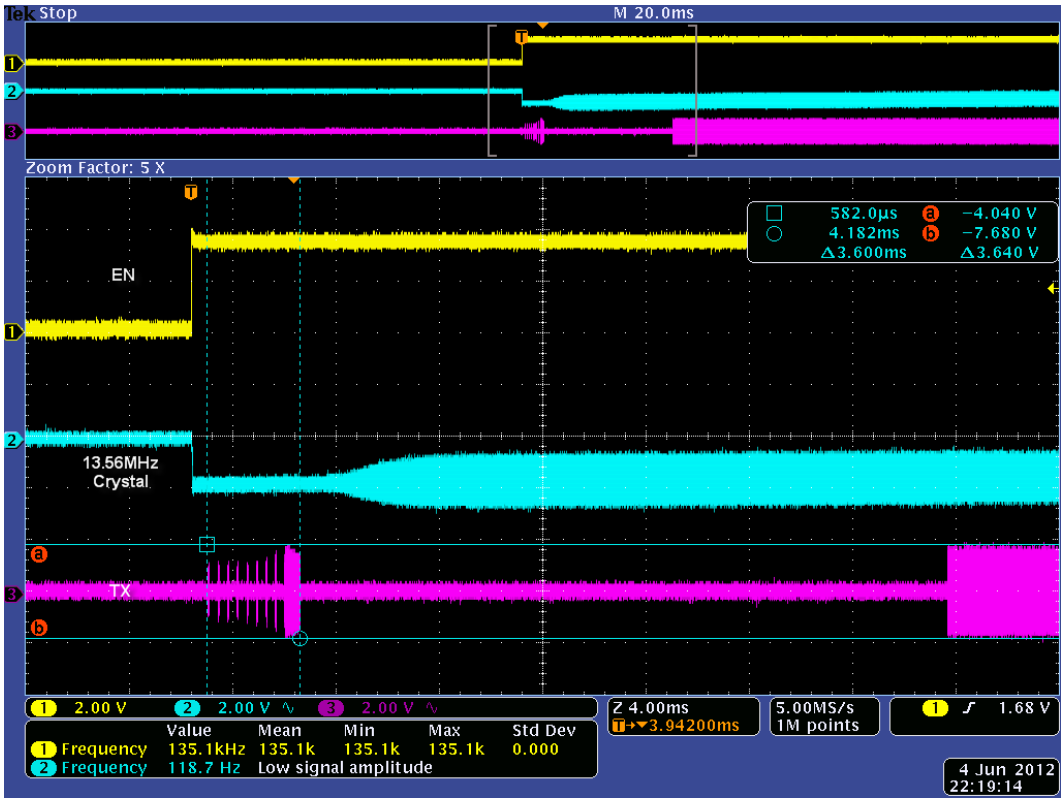


**Figure 1. TX Out Behavior When EN is Line Raised (Register 0x0B left at default)**

## 2 Manual Regulator Register (0x0B) Setting

***Register 0x0B = 0x0x (manual setting)***

For system designers and developers who do not want this TX activity to occur directly after raising the EN line, the behavior of the TX out can be changed if the Regulator Register (0x0B) is written to with a value other than B7=1 in the time between the power-up and the time the crystal oscillator is stable. This is a simple code change, which is described in Section 4.

For an example of this behavior, with the change (described above) made to the MCU firmware, see Figure 2.

Yellow trace is EN line, blue trace is 13.56 MHz clock, pink trace is TX out.


**Figure 2. TX Out Behavior When EN is Line Raised (Register 0x0B set to 0x07)**

Note that the burst of TX activity is removed. The TX on after that is normal as Register 0x00 has been written to with a value of 0x21 (for example, to turn the transmitter on) prior to starting RFID operations.

## 3 TRF79xx Startup Sequence Flow

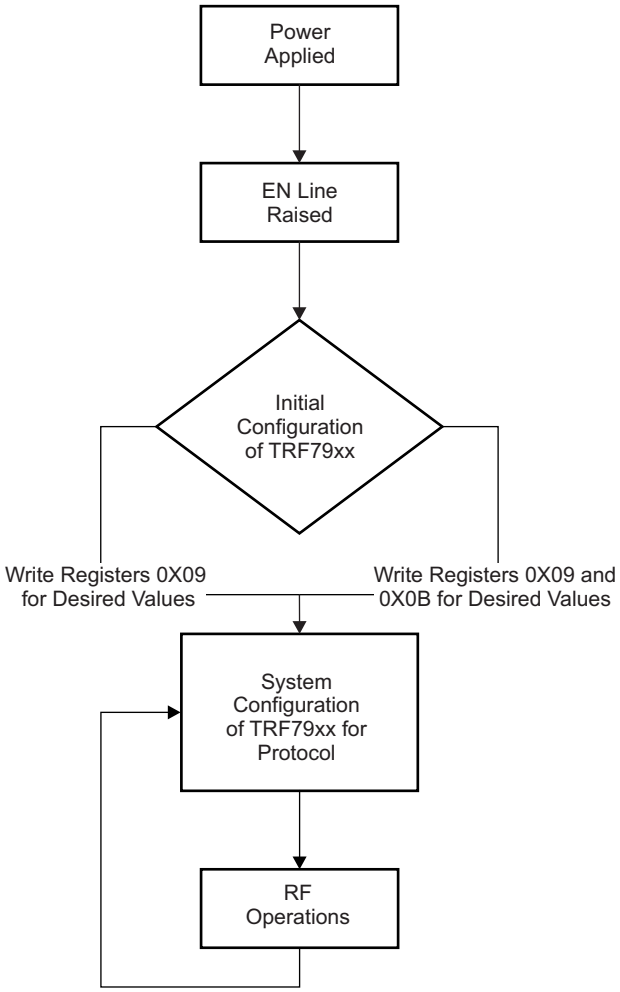


**Figure 3. Startup Sequence Flow**

## 4 C Code Change Example

The following code examples show where the InitialSettings function call resides in the firmware and how to implement the write to Register 0x0B in that function.

```
void main(void) //code snippet from top of main.c function
{

    // initialize peripherals
    WDTCTL = WDTPW + WDTHOLD;             // Stop WDT

    UARTset();

//sets MCU Port Pin for TRF79xx EN line (pin 28 on TRF) direction to OUT (#define in hardware.h)
    EnableSet;
    TRFDisable;   //sets MCU Port Pin for EN (pin 28 on TRF) to low (#define in hardware.h)
    delay_ms(1);
    TRFEnable;    //sets MCU Port Pin for EN (pin 28 on TRF) to high (#define in hardware.h)

    //Add logic for SPI/parallel selection.
    if (SPIMODE)
    { //Set Port Functions for Serial Mode
                    EnableSet;
                    irqPINset;
                    irqEDGEset;                              /* rising edge interrupt */

                    LEDallOFF;
                    LEDportSET;
                    TRFDirOUT;
    }
    else
      PARset();     //Set Port Functions for Parallel Mode

    /* Use the DCO to program the SPI first*/
     if (SPIMODE)
    {
      #ifndef SPI_BITBANG
            USARTset();         //Set the USART */
      #else
            SlaveSelectPortSet  // P3.0 - Slave Select
            SlaveSelectHIGH     // Slave Select - inactive ( high)
            SIMOSet
            clkPOUTset;
     #endif
    }

    InitialSettings();                 // Write Register 0x09 and 0x0B(if desired)
```

Where InitialSettings example function is:

```
void InitialSettings(void)
{
           /*~~~~~~~~~~~~~~~~~~~~~~~~*/
           unsigned char   command[2];
           /*~~~~~~~~~~~~~~~~~~~~~~~~*/

           command[0] = ModulatorControl; //Register 0x09
           command[1] = 0x21;   //6.78 MHz SYS_CLK OUT
           WriteSingle(command, 2);

           command[0] = RegulatorControl; //Register 0x0B
           command[1] = 0x07;   //manual setting example, to eliminate TX spike at startup
           WriteSingle(command, 2);
}
```

## 5 References


- *TRF7960, TRF7961 Multi-Standard Fully Integrated 13.56 MHZ RFID Analog Front End and Data-Framing Reader System Data Manual* (SLOU186)
- *TRF7960 Firmware Source Code* (SLOC136)
- *TRF7960A Multi-Protocol Fully Integrated 13.56 MHz RFID Reader/Writer IC Data Manual* (SLOS732)
- *TRF7960A C Code Samples* (SLOC251)

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