Application Note

AN_374

FT9xx UART to SPI Bridge

Version 1.1

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This note describes the implementation and usage of the FT9xx UART to SPI Master bridge.

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1 Introduction

This Application Note describes and explains the FT9xx UART to SPI Bridge. The FT9xx UART to SPI Bridge allows the SPI Master device on the FT9xx chip to be controlled via commands issued over a UART.

1.1 Overview

This document describes the design and implementation of the FT9xx UART to SPI Bridge. The FT9xx UART to SPI Bridge allows a user to transmit and receive bytes over the SPI Master.

This document is intended to demonstrate the bridging capabilities of the FT9xx family of microcontrollers.
2 Protocol

The FT9xx UART to SPI Bridge protocol is broken up into two parts: the length and the payload. The length is sent first as a single byte, this indicates the number of payload bytes which will follow this. An example of a packet is shown in Figure 1 - UART to SPI Packet Format.

![Figure 1 - UART to SPI Packet Format](image)

Upon receiving the Length byte, the SPI Master will assert the relevant SS (Slave Select) line low. With every Data byte, this byte will be sent out on SPI and the received byte will be sent back over the UART (as shown in Figure 2 - Timing Diagram for a SPI Transfer).

![Figure 2 - Timing Diagram for a SPI Transfer](image)

This format was chosen in order to facilitate multi-byte transfers required by modern SPI devices.
3 Implementation

All the source files for the FT9xx firmware are located in the src directory.

3.1 Setup

The setup_uart function, location in main.c, will set up UART0 and apply a given divider as well as set the UART for 8 data bits, no parity, and 1 stop bit.

```c
void setup_uart(uint16_t divider)
{
    sys_enable(sys_device_uart0);
    gpio_function(48, pad_uart0_txd); /* UART0 TXD */
    gpio_function(49, pad_uart0_rxd); /* UART0 RXD */
    uart_open(UART0, /* Device */
        1, /* Prescaler = 1 */
        divider,
        uart_data_bits_8, /* No. Data Bits */
        uart_parity_none, /* Parity */
        uart_stop_bits_1); /* No. Stop Bits */
}
```

Table 1 - Code Listing for setup_uart()

The setup_spi function, located in main.c, sets up the SPI Master device for a given channel, mode and divider.

```c
void setup_spi(uint8_t channel, spi_clock_mode_t mode, uint16_t divider)
{
    /* Enable the SPI Device */
    sys_enable(sys_device_spi_master);
    gpio_function(27, pad_spim_sck);
    gpio_function(28, pad_spim_ss0);
    gpio_function(29, pad_spim_mosi);
    gpio_function(30, pad_spim_miso);
    gpio_function(31, pad_spim_io2);
    gpio_function(32, pad_spim_io3);
    gpio_function(33, pad_spim_ss1);
    gpio_function(34, pad_spim_ss2);
    gpio_function(35, pad_spim_ss3);
    spi_channel = channel;

    if (-1 == spi_init(SPIM, spi_dir_master, mode, divider))
        uart_puts(UART0, "spi_init ERROR\n");
}
```

Table 2 - Code Listing for setup_spi()

The function setup(), location in main.c, will call setup_uart() and setup_spi() in order to set up the UART for 19200 baud, and set up the SPI Master for channel SPI_SSx (defined at the top of main.c), SPI Mode 0 and a divider of 16 (fclk = 100MHz / 16 = 6.667 MHz).
```c
void setup()
{
    /* Enable the UART Device... */
    setup_uart(UART_DIVIDER_19200_BAUD);

    /* Enable the SPI Device */
    setup_spi(SPI_SSx, spi_mode_0, 16);
}
```

Table 3 - Code Listing for setup()

### 3.2 Transfer Logic

The function `loop`, located in `main.c`, is the main logic for transferring SPI data.

```c
void loop()
{
    static uint8_t bytes = 0;
    static uint8_t c;

    uart_read(UART0, &c);

    if (bytes == 0)
    {
        bytes = c;
        spi_open(SPIM, spi_channel);
    }
    else
    {
        spi_write(SPIM, c);
        spi_read(SPIM, &c);

        bytes--;
        if (bytes == 0)
            spi_close(SPIM, spi_channel);

        uart_write(UART0, c);
    }
}
```

Table 4 - Code Listing for loop()

This will implement the behavior shown in Figure 2 - Timing Diagram for a SPI Transfer.
4 Using the GUI

A Java-based GUI application is provided with this Application Note as an example of how the UART to SPI Bridge can be used.

This application is located within ui/exe with the accompanying source located at ui/src.

In order to launch the application, double-click on the app.jar file located within ui/exe.

4.1 Selecting a Serial Port

When opening the GUI application, the first window that appears will ask you to choose which serial port to use.

![Serial Port Selection Window Example](image)

Figure 3 - Serial Port Selection Window Example

shows an example of a Serial Port Selection Window. Within it are these main controls:

1. **The Serial Port combo box.** Use this to select which serial port to use.

2. **The Refresh button.** If the serial port you wish to use is not shown, then it is currently in use by another application. After freeing up the serial port you wish to use, click this button to cause the GUI application to rescan for available serial ports.

3. **The OK button.** Click this to confirm your selection and progress to the next screen.

4. **Links.** Some links to the FT9xx product page and a link to the application note corresponding to this application.

4.2 Transferring Data

After selecting a serial port, the GUI will show the SPI Transfer Window (shown in Figure 4 - SPI Transfer Window Example).

Within this window are these main controls:

1. **Transmit Format.** This control selects which format the input in the Transmit Text Box (2) should be parsed as.
2. **Transmit Text Box.** This is the data to be transmitted. Each line represents a separate transfer.

3. **Transmit Button.** Clicking this button will start the transfer.

4. **Clear Button.** Clicking this button will clear the Transmit Text Box (2).

5. **Load Button.** Clicking this button will allow the user to load in a text file into the Transmit Text Box (2).

6. **Received Format.** This control selects which format the input in the Received Text Box (7) should be displayed as. Changing this option will automatically update the Text Box without having to start another transfer.

7. **Received Text Box.** This is the data received over SPI. Each line represents a separate transfer.

8. **Status Bar.** This will display any errors or a copyright notice if no errors have occurred in this transfer.

![Figure 4 - SPI Transfer Window Example](image)

### 4.3 Troubleshooting

**Q:** I get Error: Unknown Number. For input string: "..." at the bottom of the window when trying to transmit.

**A:** You have either entered a number in the wrong format, or it is too large. Decimal and Hexadecimal numbers need to be separated by spaces and only numbers from 0 to 255 (FFh) are usable.
5 Contact Information

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Appendix A– References

Document References

FT900/901/902/903 Datasheet
FT905/906/907/908 Datasheet
FT930/931/933 Datasheet
AN_324 FT900 User Manual
AN_374 FT9xx UART to SPI Bridge Source Code V1.0

Acronyms and Abbreviations

<table>
<thead>
<tr>
<th>Terms</th>
<th>Description</th>
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<tbody>
<tr>
<td>GUI</td>
<td>Graphical User Interface</td>
</tr>
<tr>
<td>MISO</td>
<td>Master In Slave Out</td>
</tr>
<tr>
<td>MOSI</td>
<td>Master Out Slave In</td>
</tr>
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<td>RXD</td>
<td>Received Data (UART)</td>
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<tr>
<td>SCK</td>
<td>Serial Clock</td>
</tr>
<tr>
<td>SPI</td>
<td>Serial Peripheral Interface</td>
</tr>
<tr>
<td>SS</td>
<td>Slave Select</td>
</tr>
<tr>
<td>TXD</td>
<td>Transmitted Data (UART)</td>
</tr>
<tr>
<td>UART</td>
<td>Universal Asynchronous Receiver Transmitter</td>
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Appendix C - Revision History

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<table>
<thead>
<tr>
<th>Revision</th>
<th>Changes</th>
<th>Date</th>
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<tr>
<td>1.0</td>
<td>Initial version</td>
<td>2015-10-06</td>
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<tr>
<td>1.1</td>
<td>Document migrated from FTDI to Bridgetek - Added Bridgetek logo, Replaced the contact info, copyright, disclaimer</td>
<td>2017-03-23</td>
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