Programming the AT89S8252 using SPI

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Abstract

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1 Introduction

The 8051 and 8052 microprocessors are very common processors. Quite some manufacturers (among them are Intel, Atmel and Analog Devices) produce 8051 processors. Personally, I have experience with the Atmel and the Analog Devices processors.

Atmel's 8051 processors can be programmed with two different protocols: a parallel protocol that I will not discuss here, and the SPI protocol.

2 Reasons for writing my own programmer

There are several SPI programmers available for the Atmel 8051 series, however only few of them are available for Linux, and none that I could find used a serial port or had a GUI.

Available programmers (and reasons not to use them):

- ponyprog — has a GUI and is written in C++
- 89prog — uses the parallel port
- sp89 — uses the parallel port
- atmel-isp — only for windows, no source code available

And of course, figuring out the protocol with the help of a logic analyser and some datasheets is a lot of fun...

3 The way other manufacturers do it

Previously, for my work, I have written a programmer for Analog Devices 8051. Their protocol is quite a bit better since it uses the standard RS232 protocol. Something that also helps is the fact that their microcontroller acknowledges or (refuses) commands it gets, while with the AT89 processors, you just have to guess that the processor understood what you wanted.

Next to that, Analog Devices provided an example program that could be used to program the microcontroller of the serial port.

4 Other data lines used by the Atmel

Next to the lines necessary for SPI, there is another used for putting the processor in programmable mode:

RST Reset. Used to put microprocessor in programmable state. Also used to restart running program (by toggling). (Connected to DTR on my board)

My own circuit board has uses an additional port that is used to confirm that CHK has been set.

When the RST port on the 8051 has been set, the processor listens for SPI input and handles incoming data.

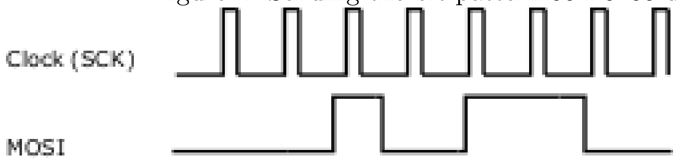
5 The SPI protocol

So, what is SPI? SPI is a very simple serial data protocol. This means that bytes are send serially instead of parallel. SPI is a standard protocol that is used mainly in embedded devices. It falls in the same family as $I2C$ or $RS232$.

As can be read in Atmel's datasheets (document 0401 to be precise), the SPI protocol uses 3 lines:

MOSI *(Master Out, Slave In)* Data line, in my case sitting on the TxD of my serial port

Figure 1: Sending the bit pattern 00110100 using SPI



MISO *(Master In, Slave Out)* Data line, controlled by client. (In my case on CTS)

SCK The Clock (in my case on RTS of the serial port)

5.1 How does SPI work?

The SPI works with two parties: the slave and the master. The master controls the line. In my case the personal computer is the master and the 8051 is the slave. There is another data line (*Slave Select*) that is used to select who the slave is, but I didn't need to use that bit.

The master sets a bit on the *MOSI* and then generates a clock pulse, after which the next bit is set and another clock pulse is generated, etc.

A clock pulse is generated by simply setting the *SCK* bit high and then low again after a few microseconds.

Here is my *SPI_Out* function:

```
void SPI_Out(int b)
{
        int i;
        for(i = 7; i >= 0; i--) {
                if(b & (1 << i)) SetMOSI();
                else ClearMOSI();
                waitmicrosec(2);
                SetSCK();
                waitmicrosec(3);
                ClearSCK();
                waitmicrosec(2);
        }
}
```

Reading data from the slave is done in a similar way. The server requests data from the slave, after which it generates clock pulses on which the slave sets the MISO line.

My *SPI_In* function:

```
int SPI_In()
{
        int i, b = 0;
        for(i = 7; i >= 0; i--) {
                SetSCK();
                waitmicrosec(2);
                if(GetMISO()) b |= 1 << i;
```

```
                waitmicrosec(3);
                ClearSCK();
                waitmicrosec(2);
        }
        return b;
}
```

That's basically all that SPI does. It's that simple!

6 AT89* commands

This section describes the various commands that can be sent to the 8051 over SPI when it's *RST* bit is set.

6.1 Enabling program modus

Before the 8051 accepts any commands, it needs to be put into command mode. That's what this command is for. Always run this command before you run any other command.

```
void programming()
{
        /* Send enable serial instruction to MOSI */
        SPI_Out(0xAC); /* 1010 1100 */
        SPI_Out(0x53); /* 0101 0011 */
        SPI_Out(0x00); /* xxxx xxxx (don't care) */
        waitmillisec(9);
}
```

6.2 Erasing code and data memory

```
void erase()
{
        SPI_Out(0xAC); /* 1010 1100 */
        SPI_Out(0x04); /* xxxx x100 (x = don't care) */
        SPI_Out(0x00); /* xxxx xxxx (don't care) */
        waitmillisec(9);
}
```

6.3 Writing data to code memory

```
void writecode(int addr, char b)
{
    /* hhhh h010 */
        SPI_Out(0x02 | ((addr >> 5) & 0xF8) | ((addr >> 11) & 0x04));
        SPI_Out(addr & 0xFF); /* llll llll */
        SPI_Out(b);
        waitmillisec(6);
}
```

6.4 Reading from code memory

```
int readcode(int addr)
{
    /* hhhh h001 */
        SPI_Out(0x01 | ((addr >> 5) & 0xF8) | ((addr >> 11) & 0x04));
        SPI_Out(addr & 0xFF); /* llll llll */
        return SPI_In();
}
```

6.5 Writing to data memory

```
void writedata(int addr, char b)
{
        SPI_Out(0x06 | ((addr >> 5) & 0xF8));
        SPI_Out(addr & 0xFF); /* llll llll */
        SPI_Out(b);
}
```

6.6 Reading from data memory

```
int readdata(int addr)
{

        SPI_Out(0x05 | ((addr >> 5) & 0xF8));
        SPI_Out(addr & 0xFF); /* llll llll */
        return SPI_In();
}
```

6.7 Locking memory

```
void lock(int byte)
{
        int mask = 0xff & ~byte;

        SPI_Out(0xAC);          /* 1010 1100 */
        SPI_Out(mask | 0x07);   /* pqrx x111 */
        SPI_Out(0);             /* xxxx xxxx */
        waitmillisec(9);
}
```

7 Tips

These are some random tips that might be useful when you are interested in implementing the SPI protocol or the 8051 programming that is running over it.

- Make sure you clear and set the RST line in the beginning of your program
- Make sure you wait long enough between clock pulses and that clock pulses are long enough
- A logic analyser is very useful when debugging timing problems

References

[1] Atmel: AT89S8252 Datasheet, *http://www.atmel.com/dyn/resources/prod_documents/doc0401.pdf*

[2] Rob Melby: Atmel 89 programmer, *http://www.cc.gatech.edu/gvu/ccg/people/rob/software/89prog.tar.gz*