AN1006

Interfacing SPI™ Serial EEPROMs to PIC18 Devices

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INTRODUCTION

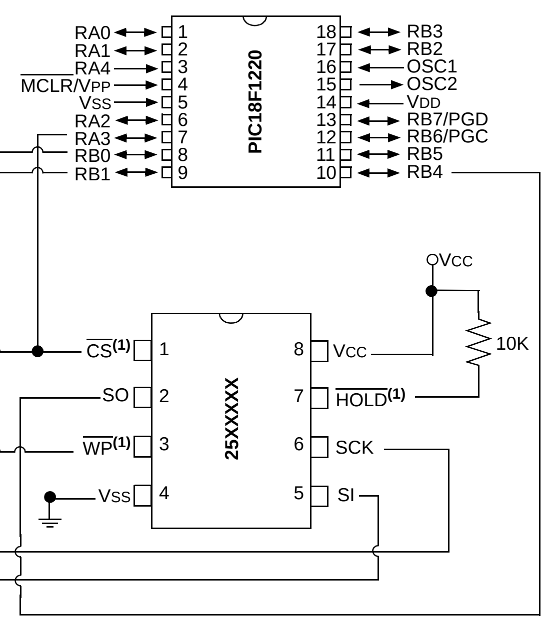
There are many different microcontrollers on the market today that are being used in embedded control applications. Many of these embedded control systems need nonvolatile memory. Because of their small footprint, byte level flexibility, low I/O pin requirement, low power consumption and low cost, serial EEPROMs are a popular choice for nonvolatile storage.

Microchip Technology has addressed these needs by offering a full line of serial EEPROMs covering industry standard serial communication protocols for two-wire (I^2C™), three-wire (Microwire), and SPI™ communication. Serial EEPROM devices are available in a variety of densities, operational voltage ranges, and packaging options.

This application note provides assistance and source code to ease the design process of interfacing a Microchip PIC18F1220 PICmicro® microcontroller to a Microchip SPI serial EEPROM, without the use of a hardware serial port.

Figure 1 depicts the hardware schematic for the interface between Microchip's SPI series devices and the PIC18F1220 PICmicro microcontroller. The schematic shows the connections necessary between the microcontroller and the serial EEPROM as tested, and the software was written assuming these connections. The $\overline{WP}$ pin is tied to VCC through a resistor because the STATUS register write-protect feature is not used in the examples provided.

FIGURE 1: CIRCUIT FOR PIC18F1220 AND 25 SERIES (SPI) DEVICE



Note 1: $\overline{CS}$, $\overline{WP}$, and $\overline{HOLD}$ pins should all have pull-up resistors (~10K ohms).

FIRMWARE DESCRIPTION

The purpose of the program is to show individual features of the SPI protocol and give code samples of the opcodes so that the basic building blocks of a program can be shown. The firmware performs five basic operations.

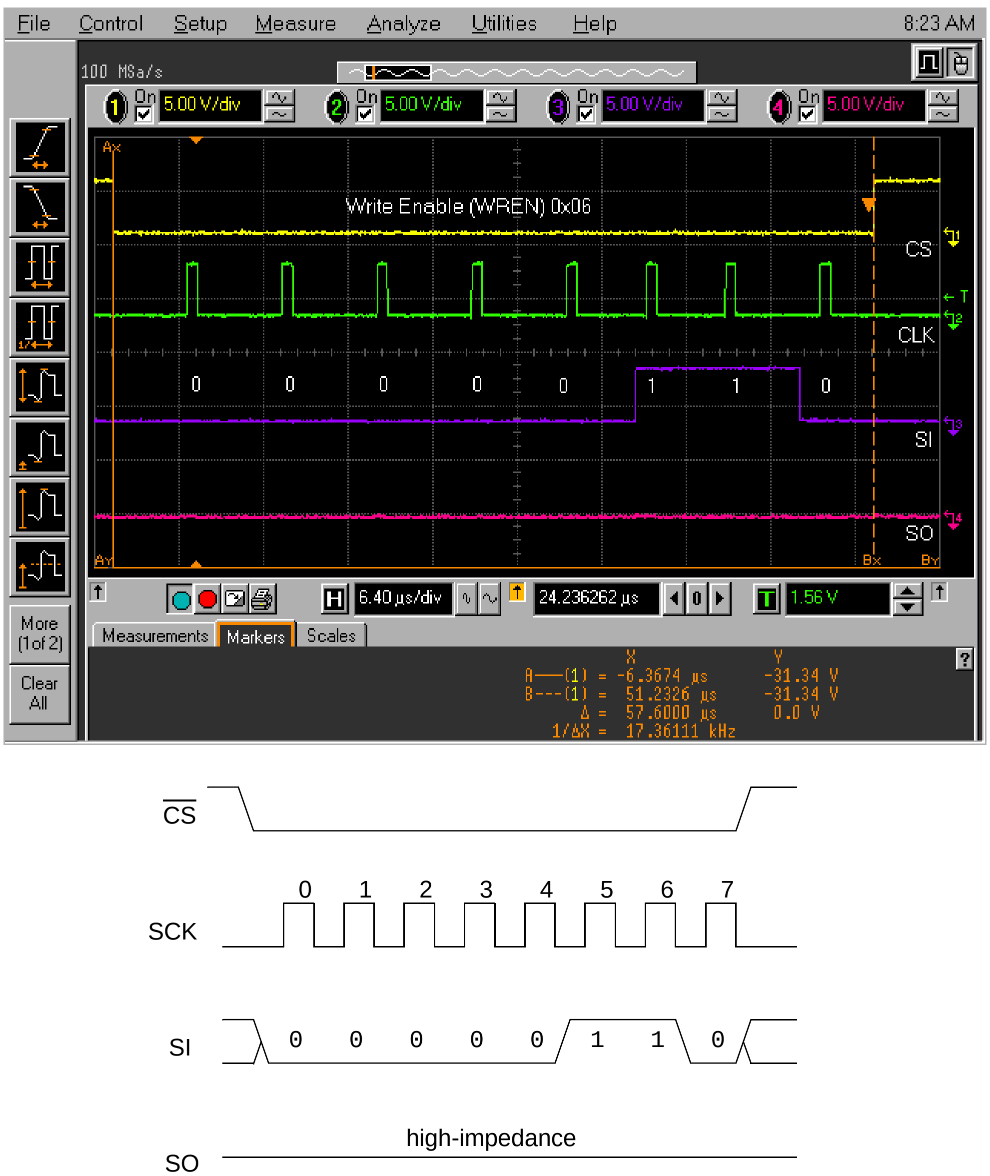
- Write Enable command (WREN)
- Write command (WRITE)
- Write In Progress polling (WIP)
- Read command (READ)
- Write Disable command (WRDI)

The code was tested using a 25LC160B serial EEPROM. A 10 MHz crystal oscillator is used to clock the PIC18F1220. If a faster clock is used, the code must be modified to ensure all timing specs are met. The waveforms provided are shown from $\overline{CS}$ enable to $\overline{CS}$ disable for ease in reading. For ease in interpretation of serial data, the data sheet version of the waveform is below the actual oscilloscope picture. All values represented in this application note are decimal values unless otherwise noted.

WRITE ENABLE

Figure 2 shows an example of the Write Enable command. Chip Select is brought low (active) and the opcode is sent. The Write Enable command must be given before a write is attempted to either the array or the STATUS register. The WEL bit can be cleared by issuing a Write Disable command (WRDI) or it is automatically reset if the device is powered down or a write cycle is completed.

FIGURE 2: WRITE ENABLE (WREN)

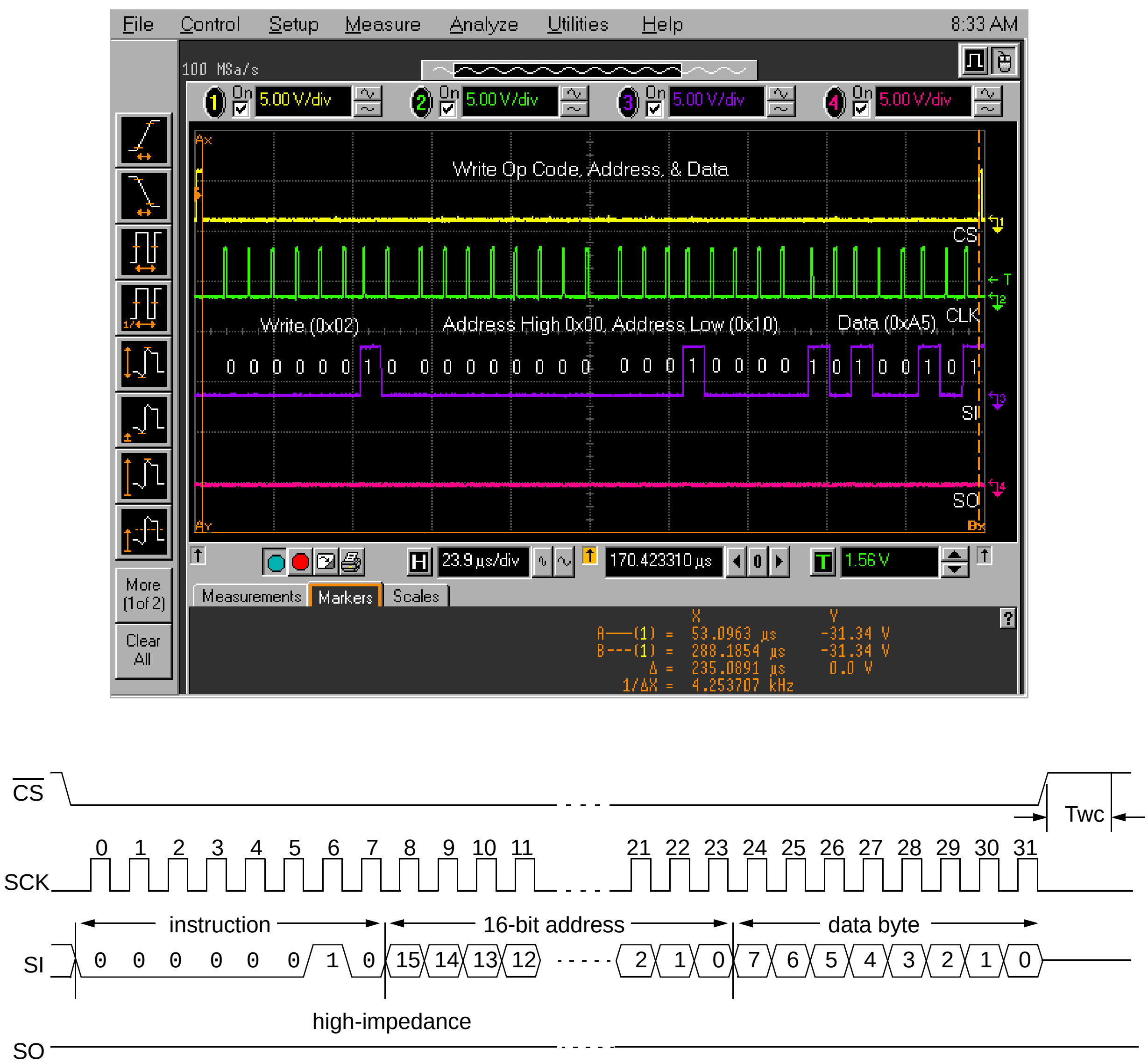


BYTE WRITE COMMAND (OPCODE, ADDRESS AND DATA)

Figure 3 shows an example of the Write command. For this the device is selected and the opcode 0x02 is sent. The High Address byte is given 0x00 followed by the Low Address byte, 0x10. Finally, the data is clocked in last, in this case, 0xA5. Once the Chip Select is toggled at the end of this command, the internal write cycle is initiated. Once the internal write cycle has begun, the WIP bit in the STATUS register can now be polled to check when the write finishes, or a delay needs to be added (~5ms) if the WIP bit is not being polled. This code uses WIP polling.

A page write can be accomplished by continuing to give data bytes to the device without toggling CS. Up to 32 bytes can be written to the 25LC160B before a write cycle is needed. Once CS is brought high after the data bytes have been transmitted, then the write cycle timer will begin and normal polling can be initiated.

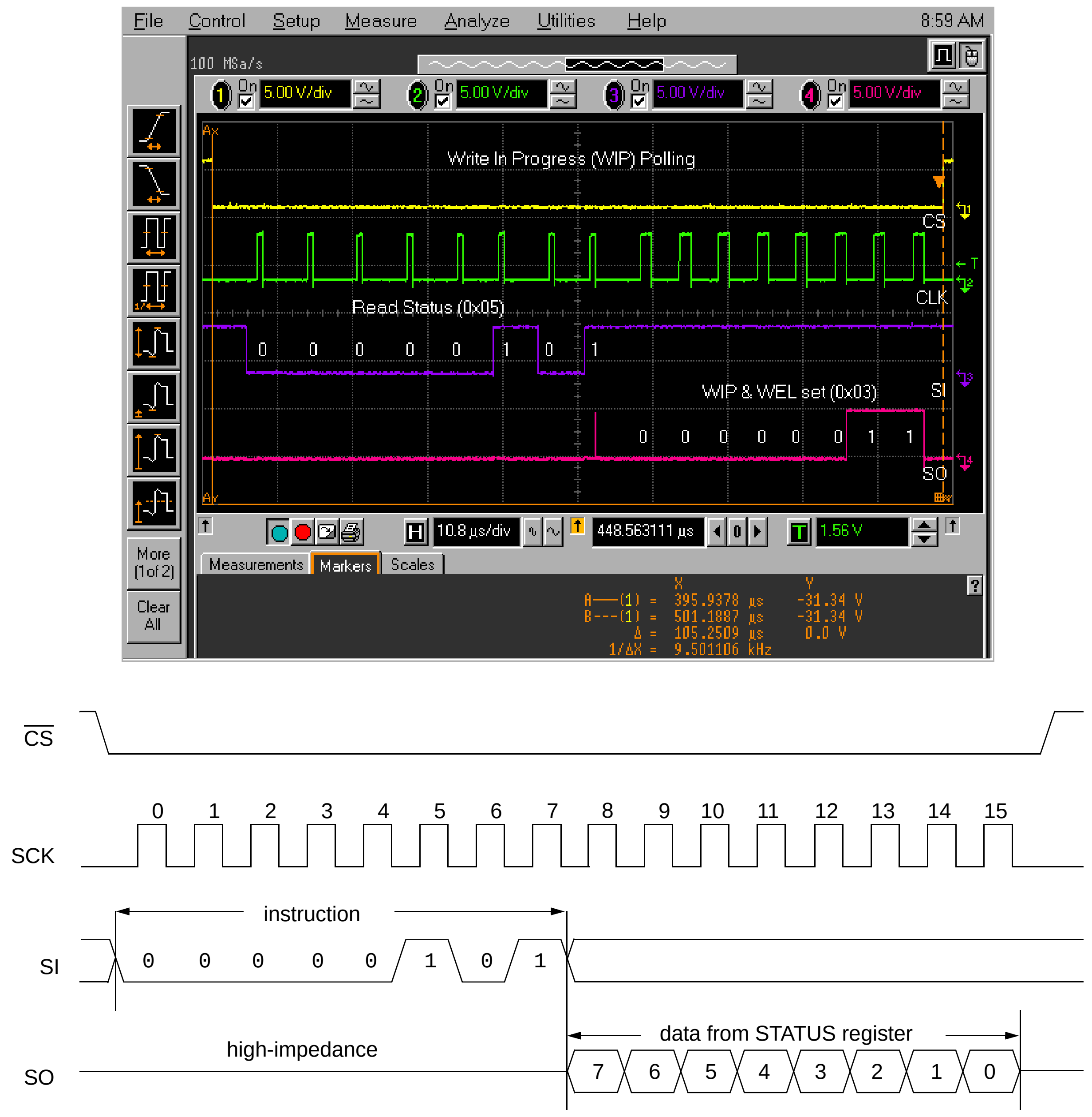
FIGURE 3: BYTE WRITE COMMAND, ADDRESS AND DATA



DATA POLLING (RDSR – CHECK FOR WIP SET)

After a valid write command is given, the STATUS register can be read to check if the internal write cycle has been initiated and it can continuously be monitored to look for the end of the write cycle. In this case, the device is selected and the opcode, 0x05, is sent. The STATUS register is then shifted out on the Data Out pin, resulting in a value of 0x03. Figure 4 shows that both the WEL bit (bit 1) and the WIP bit (bit 0) are set, meaning the write cycle is in progress.

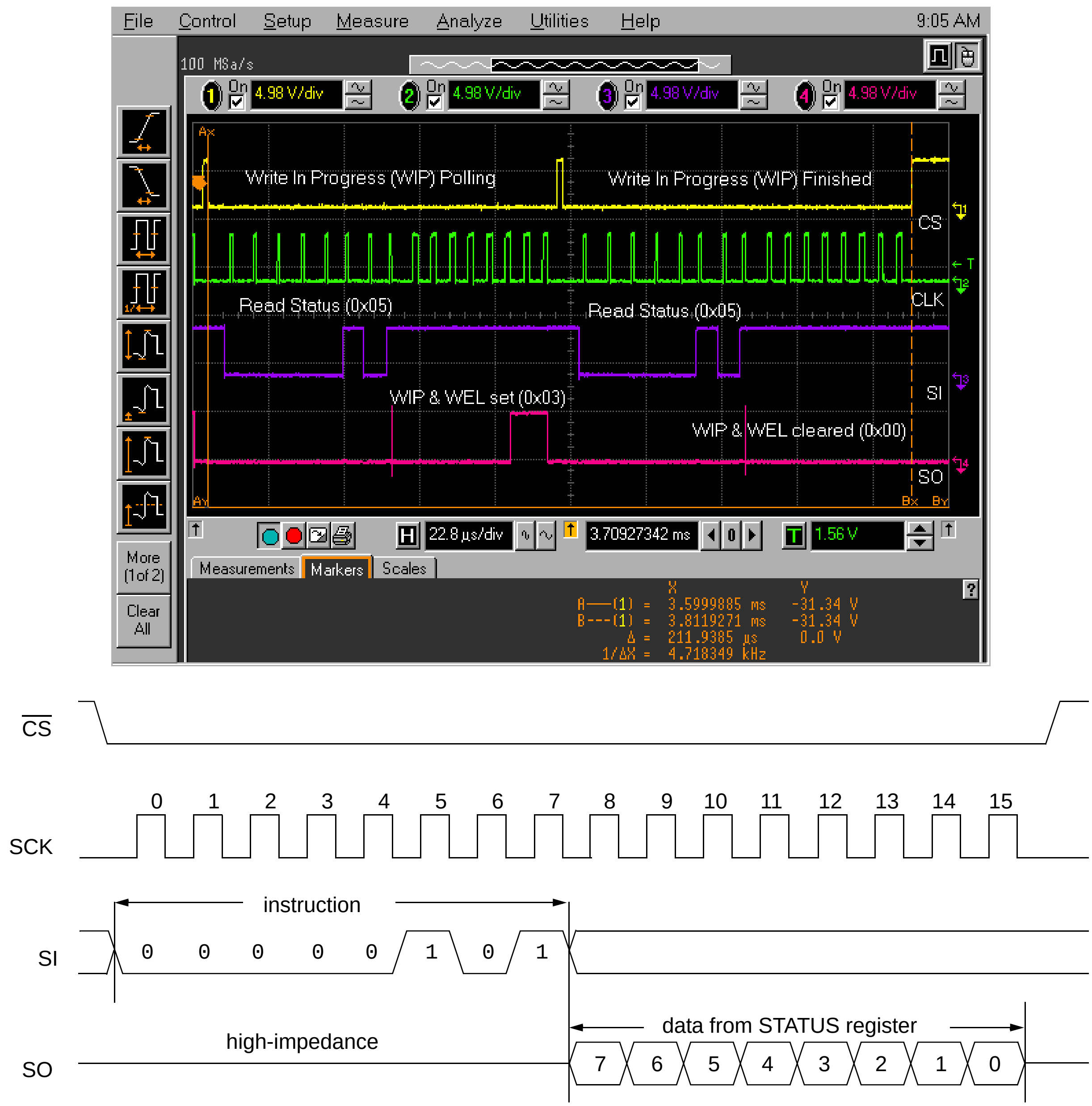
FIGURE 4: DATA POLLING (READ STATUS REGISTER TO CHECK WIP BIT)



DATA POLLING FINISHED (RDSR – WIP BIT CLEARED)

The firmware remains in a continuous loop and the WIP status is evaluated until the bit is cleared. Figure 5 shows the Status Register Read command followed by a value of 0x00 being shifted out on the Data Out pin. This indicates that the Write Cycle has finished and the device is now ready for additional commands. The WEL bit is also cleared at the end of a write cycle, which serves as additional protection against unwanted writes.

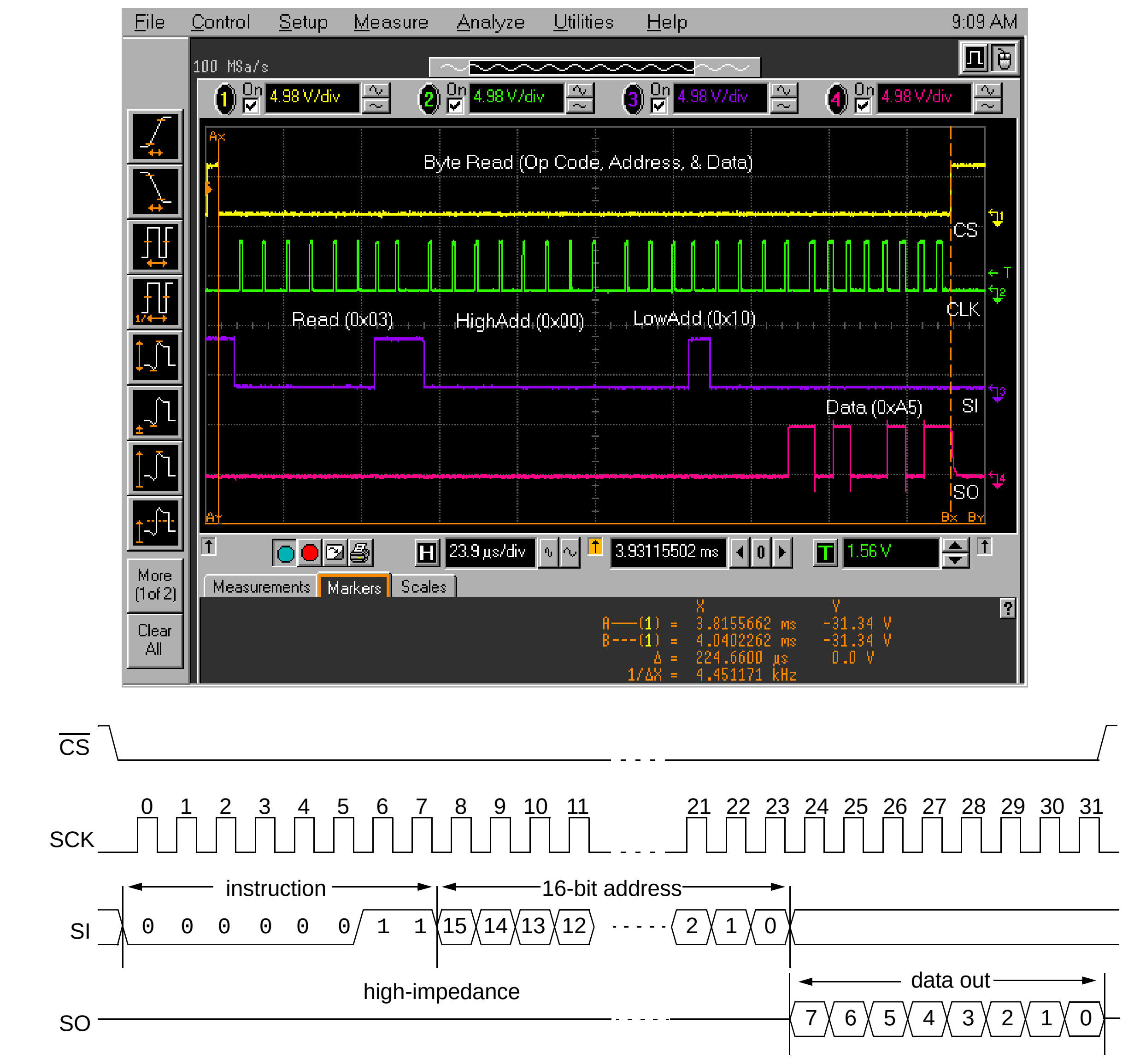
FIGURE 5: DATA POLLING FINISHED (RDSR – WIP AND WEL BITS CLEARED)



READ COMMAND (OPCODE, ADDRESS AND DATA)

Figure 6 shows an example of the Read command. For this the device is selected and the opcode, 0x03, is sent. The High Address byte is given 0x00 followed by the Low Address byte, 0x10. Finally, the data is clocked out on the Serial Out pin, in this case, 0xA5. In order to do a sequential read, more clocks need to be generated. It is possible to read the entire chip by continuing to provide clocks to the device. Once the end of the array is reached the data will wrap to the beginning of the array (Address 0x0000) and keep reading out until $\overline{CS}$ is deselected or clocks stop being provided.

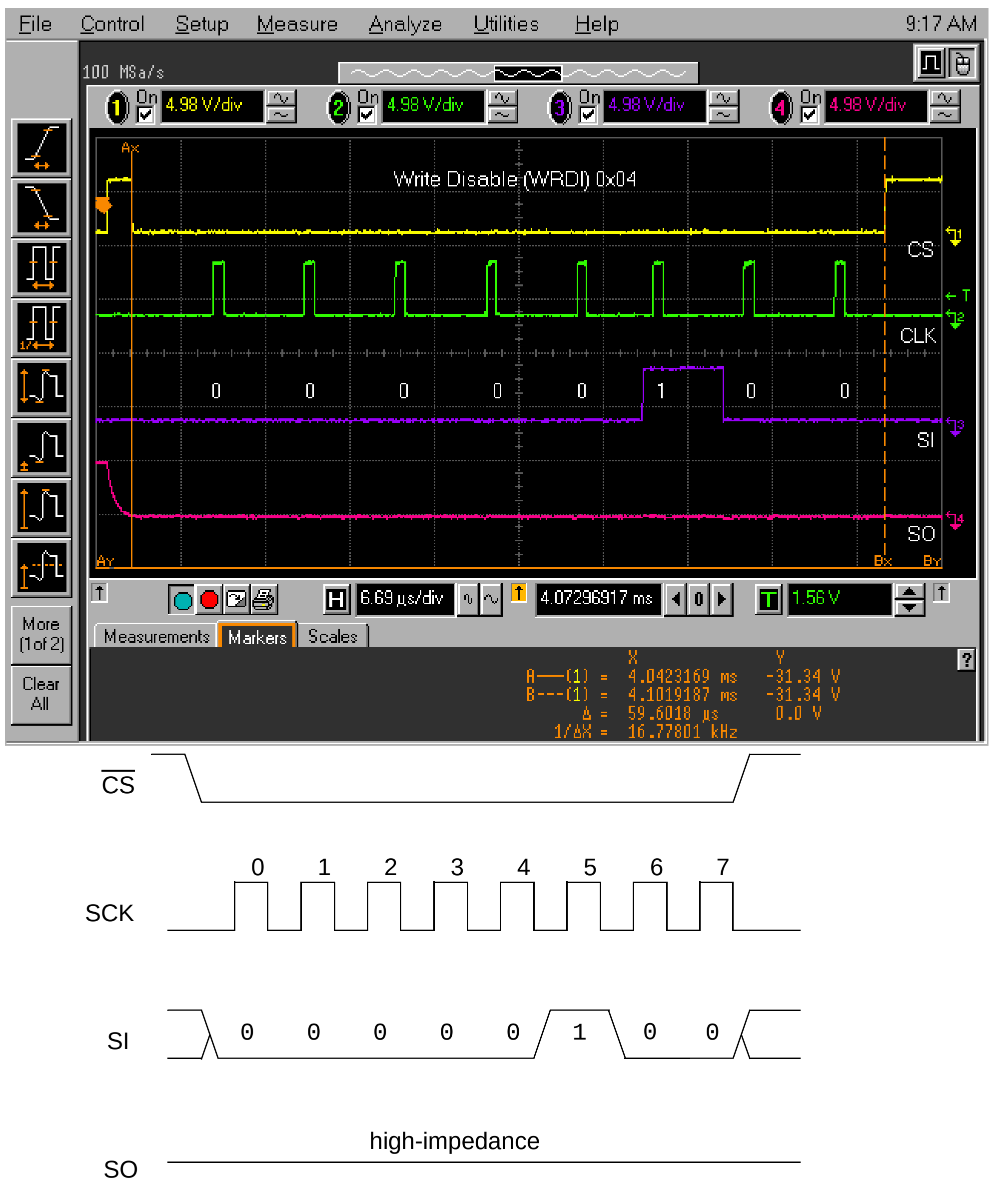
FIGURE 6: READ COMMAND, ADDRESS AND DATA



WRITE DISABLE

Figure 2 shows an example of the Write Disable command. Chip Select is brought low (active) and the opcode is sent. The Write Disable command should be given any time writing to the device or the STATUS register is unwanted. The WEL bit is also cleared automatically if the device is powered down or a write cycle is completed.

FIGURE 7: WRITE ENABLE (WREN)



CONCLUSION

These are some of the basic features of SPI communications on one of Microchip's PIC18 devices without the use of a hardware serial port. The code is highly portable and can be used on many PICmicro microcontrollers with very minor modifications. Using the code provided, designers can begin to build their own SPI libraries to be as simple or as complex as needed.

NOTES:

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