AN757

Interfacing Microchip's MCP41XXX and MCP42XXX Digital Potentiometers to Motorola's 68HC12 Microcontroller

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OVERVIEW

The MCP41XXX and MCP42XXX family of digital potentiometers communicate using a standard 3-wire SPI™ compatible interface. This application note will cover communication between these devices and the Motorola 68HC12 family of microcontrollers. Specifically, the MC68HC912B32 evaluation board was used.

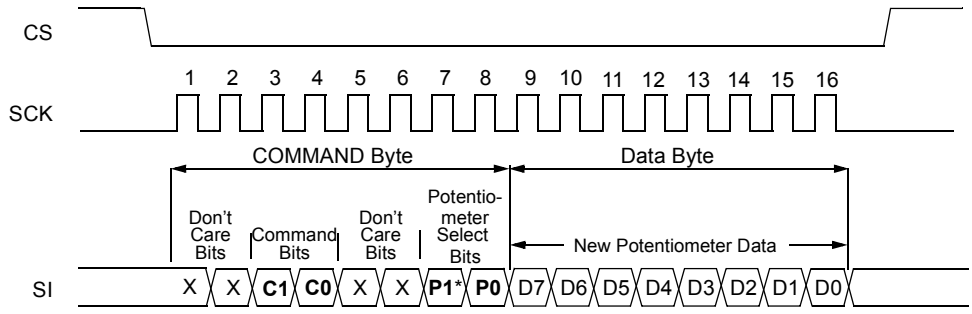
COMMUNICATION

Instructions for the MCP41XXX and MCP42XXX devices consist of two bytes. Figure 1 shows the format of these two bytes using a standard 3-wire SPI interface. The first byte is the command byte. The command byte contains which command to be issued and the instructions as to which potentiometer will execute the command (MCP42XXX devices contain two potentiometers). The second byte is the data byte. The MCP41XXX and MCP42XXX potentiometers are 8-bit or 256 tap potentiometers. All 8 bits in the data byte are wiper data bits.

There are four important bits in the command byte. Bits <4:5> determine which command is being issued and bits <0:1> determine which potentiometer will execute the command, see Figure 1. The MCP42XXX device contains two pots, P0 and P1. Bits <0:1> of the command byte allow the user to select either, both, or neither potentiometer. A '1' for either P1 or P0 will cause the data to be written to the respective data register and a '0' for P1 or P0 will cause no change. The MCP41XXX device contains only one potentiometer. For this device, P1 is a don't care.

Bits <4:5> determine which command is being issued. For the MCP41XXX and MCP42XXX devices, there are three possible commands:

1. Write new data to potentiometer(s).
2. Shutdown potentiometer(s).
3. NOP (No Operation).



C1	C0	Command	Command Summary
0	0	None	No Command will be executed
0	1	Write Data	Write the data contained in Data Byte to the potentiometer(s) determined by the potentiometer selection bits
1	0	Shutdown	Potentiometer(s) determined by potentiometer selection bits will enter Shutdown Mode. Data bits for this command are don't cares
1	1	None	No Command will be executed

P1*	P0	Potentiometer Selections
0	0	Dummy Code: Neither Potentiometer affected
0	1	Command executed on Potentiometer 0
1	0	Command executed on Potentiometer 1
1	1	Command executed on both Potentiometers
*PI is a don't care bit for the MCP41XXX		

FIGURE 1: INSTRUCTION SEQUENCE AND COMMAND BYTE SUMMARY FOR DIGITAL POTENTIOMETERS.

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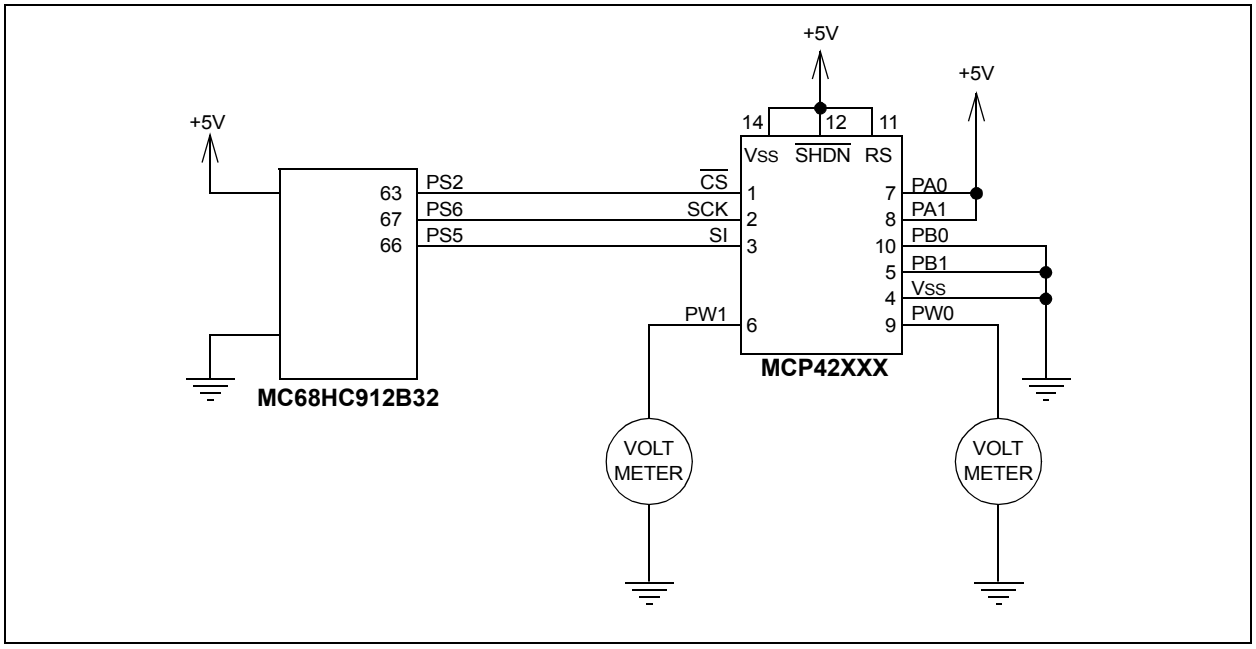


FIGURE 2: BLOCK DIAGRAM OF CIRCUIT USED TO DEVELOP APPLICATION NOTE

IMPLEMENTATION

Appendix A has assembly code for the 68HC12 family of microcontrollers using hardware SPI implementation. First, this code initializes the necessary registers to enable the hardware SPI. See `Set register values for SPI` in the source code in Appendix A. Once the registers are set to the proper configuration, chip select is cleared to enable the digital potentiometer. Accumulator A is then loaded with the command byte to be transmitted. The content of accumulator A is transferred to the SPI register, SP0DR. A branch to the `Transmit` subroutine transmits the command byte to the digital potentiometer through the SPI port. Once transmission is complete, the data byte is loaded into accumulator A followed by a transfer to the SPI register, SP0DR. Another branch to the `Transmit` subroutine sends the data to the digital potentiometer. Once data transmission is complete, driving the chip select line high sets the wiper position to the corresponding value. The software interrupt command, `SWI`, completes the digital potentiometer programing sequence.

Note:	The $\overline{SS}/\overline{CS}$ output can not be used as a chip select line for the MCP41XXX/MCP42XXX. This integrated feature of the SPI module is driven high after transmitting a byte which prematurely terminates the programming sequence. Therefore, an I/O line must be dedicated to drive chip select high at the end of the second transmitted byte.

Figure 2 shows the block diagram of the circuit used to develop this application note. The SPI port, PORTS, is directly connected to the MCP42XXX digital potentiometer. PS6, PS5, and PS2 of the 68HC12 are connected to the serial clock, serial data, and chip select inputs of the MCP42XXX, respectively. The evaluation board and the digital potentiometer are powered using a +5V power supply. P_A and P_B of the MCP42XXX are connected to +5V and ground, respectively. The wiper output voltage is measured using a voltmeter.

CONCLUSION

This application note shows how to interface Microchip's MCP41XXX/MCP42XXX Digital Potentiometers to the Motorola 68HC12 family of microcontrollers. The source code in Appendix A is compatible with the 68HC11 family of microcontrollers. The MC68HC912B2 evaluation board was used for this application.

REFERENCES

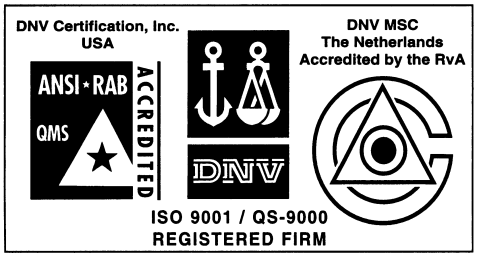
MCP41XXX/MCP42XXX Single/Dual Digital Potentiometer with SPI Interface, Microchip Technology, DS11195, 2000.

APPENDIX A: ASSEMBLY CODE USING HARDWARE SPI IMPLEMENTATION

```
*****************************************************************************************
*                                                                                       *
*        Interfacing Microchip's MCP42xxx digital potentiometer to                      *
*        Motorola's 68HC12 microcontroller using Serial Peripheral Interface (SPI)      *
*                                                                                       *
*****************************************************************************************
*                                                                                       *
*         Filename:      MOT_6812_2_MCP_Digipot.asm                                     *
*         Date:          01.09.2001                                                     *
*         File Version:  1.00                                                           *
*                                                                                       *
*         Controller:    MC68HC912B32                                                   *
*                                                                                       *
*         Assembler:     WIN IDE V1.13   P&E Microcomputer Systems, Inc.                *
*         Programmer:    Prog12Z programmer V1.09                                       *
*         Debugger:      ICD12Z debugger V1.24                                          *
*                                                                                       *
*         Author:        Ezana Haile                                                    *
*         Company:       Microchip Technology, Inc.                                     *
*                                                                                       *
*****************************************************************************************
*                                                                                       *
*                                                                                       *
*        Microchip's MCP42xxx Digital Potentiometer (POT) requires serial               *
*        communication to program the command and data bytes.  This program             *
*        demonstrates how Motorola's 68HC12 microcontroller is interfaced to the POT    *
*        using SPI.  The assembly code for the Motorola microcontrollers are fully      *
*        compatible, therefore, this code can be used in other controllers such as      *
*        68HC11.  However, register addresses must be modified accordingly.             *
*                                                                                       *
*        To change the command byte and the POT wiper position the user must change     *
*        COMMAND and DATA variables properly and reprogram the controller.              *
*                                                                                       *
*                                                                                       *
*****************************************************************************************
*-----------------------------------------------
*     Equate registers addresses
*-----------------------------------------------

copctl          equ     $0016           ;COP Control Register
mode            equ     $000b           ;mode register
reset           equ     $fffe           ;reset
sp0cr1          equ     $00d0           ;spi control register 1
sp0cr2          equ     $00d1           ;spi control register 2
sp0br           equ     $00d2           ;spi boud rate register
sp0sr           equ     $00d3           ;spi status register
sp0dr           equ     $00d5           ;spi data register
ports           equ     $00d6           ;port s data register
ddrs            equ     $00d7           ;data direction register for port s
purds           equ     $00db           ;pull-up and reduced drive for port s
cs              equ     $0004           ;chip select (ps2)
```

```
*-----------------------------------------------
*     Digital POT command and data bytes
*-----------------------------------------------

command         equ     $13             ;command byte for the digital pot
data            equ     $50             ;digital value to set the wiper position

*-----------------------------------------------
*     Set register values for SPI
*-----------------------------------------------

                org     $8000           ;program the Flash EEProm

start           ldaa    #$19            ;special single chip mode
                staa    mode
                ldaa    #$00            ;turn off watchdog
                staa    copctl
                ldaa    #$5e
                staa    sp0cr1          ;set control register 1
                clra
                staa    sp0cr2          ;set control register 2
                staa    sp0br           ;set boud rate
                staa    purds           ;set pull-up and reduced drive for ports
                ldaa    #$ff
                staa    ddrs            ; set data direction register for ports

*-----------------------------------------------
*     Program the POT
*-----------------------------------------------

                bclr    ports,cs        ;select digital pot
                ldaa    #command        ;load the command byte
                staa    sp0dr           ;store command byte to the SPI data register
                bsr     transmit        ;program the command byte

                ldaa    #data           ;load the data byte
                staa    sp0dr
                bsr     transmit        ;program the data byte
                bset    ports,cs        ;deselect digital pot

                swi                     ;software interrupt
*-----------------------------------------------
*    Transmit data thru SPI
*-----------------------------------------------

transmit        brset   sp0sr,$80,done  ;wait until the end of transmission
                bra     transmit
done            ldaa    sp0sr           ;clear SPIF  (SPI interrupt request)
                ldaa    sp0dr            ;
                rts                     ;return from subroutine

*-----------------------------------------------
*     Set reset vector
*-----------------------------------------------

                org     reset           ;set reset vector
                dw      start           ;upon reset goto 'start'

*===============================================
```

Trademarks



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