Digitally Controlled Potentiometer (DCP) Evaluation USB Kit

Introduction

The Digital Potentiometer Evaluation USB Kit provides application and design engineers with a tool for evaluating the operation of many kinds of different Digitally Controlled Potentiometers (DCPs). It includes a USB2DCP interface board also called a motherboard, DCP Evaluation Software and a DCP evaluation board also called a DCP Daughter Card. The DCP Evaluation Kit provides a platform for evaluating all functions and features of Digitally Controlled Potentiometers and supports I^2C, SPI, UP/DOWN and Push Button interfaces. The two-piece construction, utilizing a motherboard and a daughter card, enables remote control operation of a DCP from PC through USB port.

Installation of the DCP Evaluation Software and USB Drivers

The DCP Evaluation Software and USB drivers have to be installed on a PC running Windows NT/2000/XP/Vista Operating System before connecting the USB2DCP interface board to USB port.

- Insert CD in the CD/DVD drive of the PC. Do not plug in the USB2DCP board yet.
- Run the Setup.exe. If Setup will not start automatically go to Explorer/DVD drive and run Setup.exe manually.
- Click to agree in the license window, then click to install. The installation program will place the DCP Evaluation software in C:\Program Files\Intersil\Intersil_DCP_Comm directory.
- After software has been installed, plug the USB2DCP board into the USB port and let Windows set up a driver for the new hardware. Note, the USB driver for the USB2DCP board is located in C:\ProgramFiles\Intersil\Intersil_DCP_Comm directory.

Overview and Operation of the DCP Evaluation Platform

Hardware Overview

USB2DCP INTERFACE BOARD (MOTHERBOARD)

This board provides the interface between a PC and DCP Evaluation Board (Daughter Card), as shown in Figure 1. A USB cable, with type A and B connectors on each end, is required to plug the board into a PC (schematic of USB2DCP board in Appendix A). The USB2DCP board is powered from the USB port. It contains a microcontroller (U1) with USB interface (J1) for communicating with the PC, and I/O pin connector (J2) to supply power and communicate with the DCP daughter card.

The mother board also provides power to the daughter card either from the USB port or from an external power supply through the adjustable voltage regulator (U4). An external power supply can be connected to JP2 (+6V) and JP3 (GND) hookup pins. A JP5 jumper allows the selection between USB or external power. An on-board inverter (U6) generates negative voltage from U4 output. Both positive (VCC) and negative (V-) outputs are controlled through the Graphical User Interface (GUI) of DCP Evaluation Software.

The U2 MUX minimizes the number of J2 pins by mapping selected interface to the daughter card connectors J2 and JP6. The J2 and JP6 mapping is fully compatible with previous generation of DCP evaluation boards, e.g. XLABVIEW01 board. The voltage at VIN0, VIN1, VIN2 and VIN3 pins of JP8 can be measured through the onboard ADC. Usually these inputs are wiper outputs from the daughter card. Note, the ADC can measure only positive signals from 0V to 5.5V; negative inputs are blocked out by Schottky diodes D3~D6.

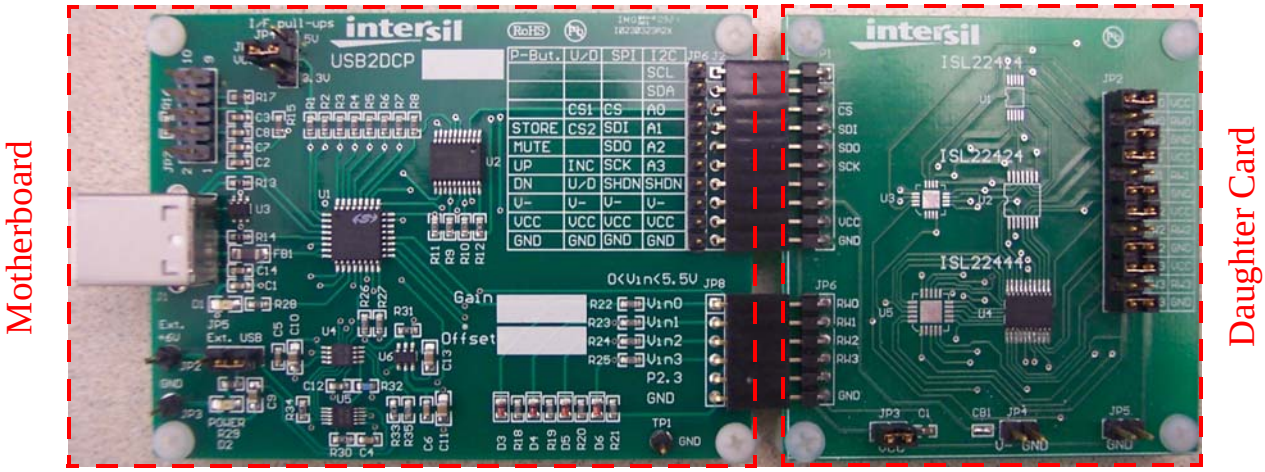


FIGURE 1. DCP EVALUATION PLATFORM

DCP Evaluation Board (Daughter Card)

Each DCP daughter card is different, but typically contains one DCP device, one or two connectors to attach to the mother board and a DCP terminal header allowing different terminal configurations, such as connection to VCC, GND, V- or to each other.

For example, the ISL223x3 daughter card, which is shown in Figure 2, has a JP1 male connector to match with the J2 female connector of the mother board to provide VCC, V-, GND and I^2C interface signals to the DCP. The JP6 male connector provides wiper outputs back to the mother board through the matching JP8 to be measured and displayed on the GUI, or measured from the terminal header JP2. The DCP terminals RHi, RWi and RLi can be left open, or connected to VCC, V-, each other or external circuitry by using jumpers. The VCC power is supplied through the JP3 jumper from the motherboard. The JP3 header also allows measuring power consumption of the DCP by connecting an ammeter between the JP3.1 and JP3.2 pins instead of jumper, or use an external power supply connected to JP3.2. An external negative power supply can be used by connecting to JP4 header. In this case, the CB1 shunt should be removed from the board.

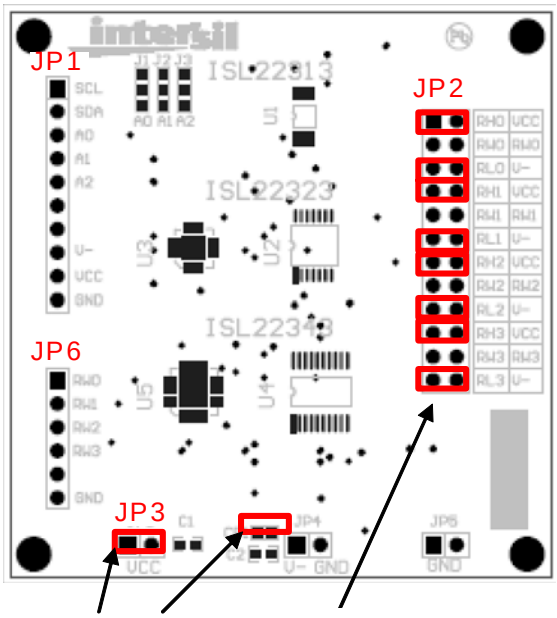


FIGURE 2. ISL223x3 DCP DAUGHTER CARD

DCP Evaluation Software

Software Overview

When the DCP Evaluation Software starts, the "Select DCP Type" window appears and the user can select the appropriate interface from a pull down menu as shown in Figure 3. Select either I^2C, SPI, Up/Down or Push Button interface.

The Product Demonstration GUI automatically appears when the interface is selected as shown in Figure 4. It starts up with the Manual Setup window, where the user can choose a number of taps, number of DCPs in package (i.e. single, dual or quad), slave address, address pin settings A0~A4, enable or disable VCC and V- outputs etc. There are convenient initial setups available from the Device Select pull-down menu, located in menu bar, -> Parameter file.

All executable functions are separated by individual frames that provide more visibility and "easy to use" convenience. All "white text boxes" have either a pull-down menu, selectable or type in capability. Type in capability means that the user can type in a new value, hit the Enter button on the keyboard, or Write/Read software button, and this data will be executed by the software. "Gray boxes" are read only.

The interface clock frequency for the I^2C and SPI interfaces is selectable from a pull-down menu as well.

VCC Control

In order to start communication with the DCP, the onboard voltage regulator has to be turned on. The regulator control, i.e. VCC Control, is located in the upper left corner of the GUI. There are several VCC options available in the pull-down menu from fixed to user-adjustable. By default VCC is set to 5V. The negative V- voltage tracks the VCC or can be turned off.

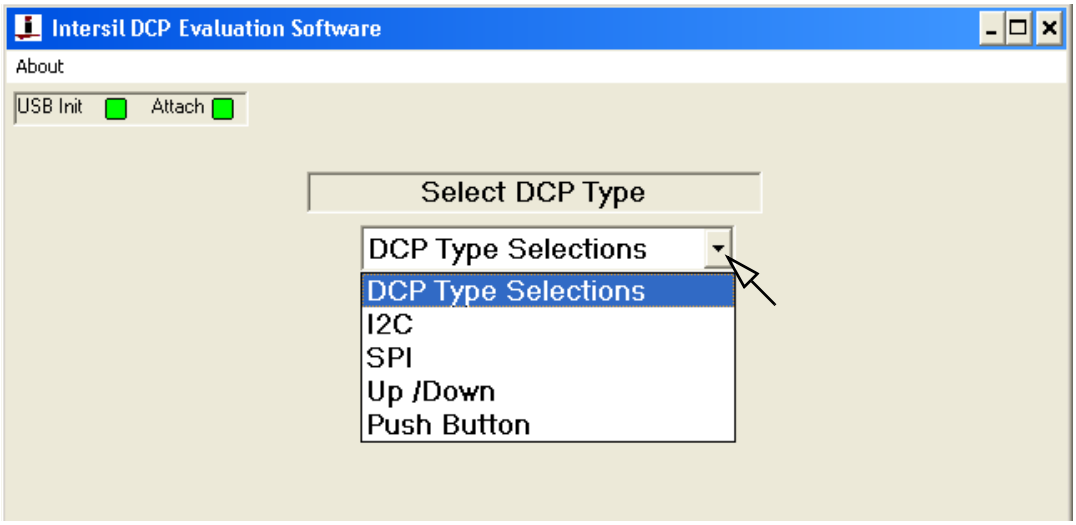
The VCC level is automatically sampled by an on-board analog-to-digital converter (ADC) every time the VCC is turned on or off, or can be manually sampled by pushing the Sample VCC button.

The ADC requires calibration in order to receive the correct VCC readings. The calibration procedure is shown in the following steps:

1. Set the VCC level to 5.0V. Use an external voltmeter to measure the actual VCC output and record its reading as Measure1. Write down the ADC reading as Read1.
2. Set the VCC level to 3.0V. Write down the voltmeter reading as Measure2 and the ADC reading as Read2.
3. Calculate the ADC Gain as

$$\text{Gain} = 2 \times \frac{\text{Measure1} - \text{Measure2}}{\text{Read1} - \text{Read2}} \quad \text{(EQ. 1)}$$

4. Type in the new Gain value and repeat the measurement starting at step 1.
5. The ADC Offset = Measure1 - Read1.The calibrated Gain and Offset values can be written down directly on the USB2DCP mother board and should be used for correct readings.



NOTE: Green lights indicate that USB2DCP board is attached and communication is established.

FIGURE 3. DCP TYPE SELECT WINDOW

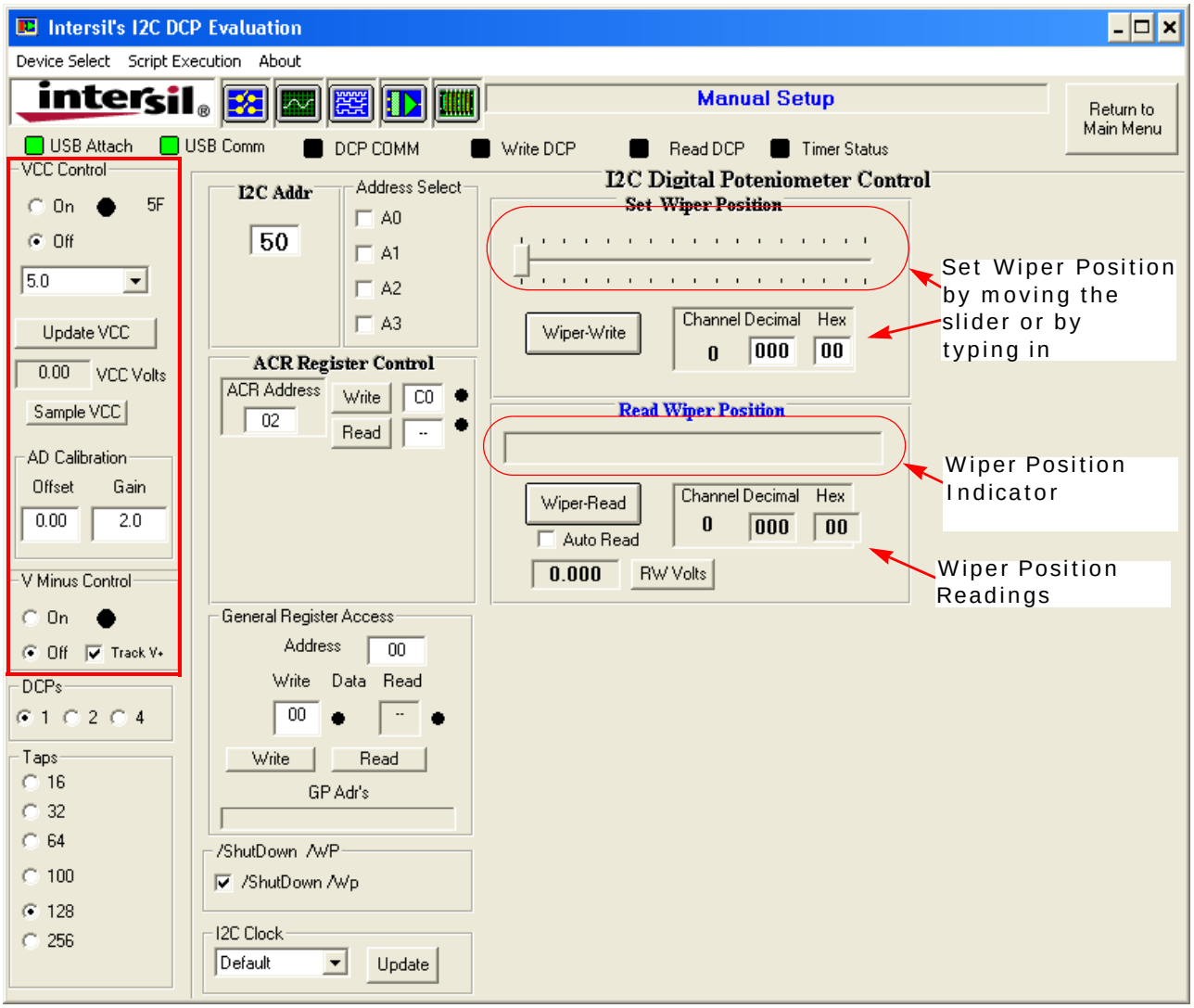


FIGURE 4. I²C INTERFACE PRODUCT EVALUATION WINDOW, MANUAL SETUP

Set Wiper Position in I²C and SPI interfaces

The wiper position can be set by moving the slider or by typing in a hex or decimal value in the corresponding text box, see Figure 4. Software will automatically read back the wiper register if Auto Read box is checked out. Each DCP channel has its own wiper control and read capability.

Set Wiper Position in Up/Down and Push-Button Interfaces

In order to move the wiper in Up or Down direction, type in the number of counts in corresponding text box as shown in Figure 5 and push the Up or Down button.

Script Execution

The DCP Evaluation software allows multiple commands to be executed, that had been written in sequence in a script file. A script file is a text file written in Notepad or other simple text editing programs. There are some examples of script files provided for your convenience, that can be opened by following Script Execution > File > Open Script File from the menu bar. Script files can be executed only in I²C and SPI interface product windows. Script execution is not supported for Up/Down and Push-button DCPs.

I²C Script File

The structure of the command line for the I²C interface is a Slave Address followed by a Register Address, Write Data, Read Data and Comments. The data in the command line is separated by a comma without spacing. All spaces will be ignored.

The Slave Address should be written once at the beginning of the command sequence, starting with an acute symbol and letter “A”, e.g. ‘AA0 for address A0 or ‘A50 for address 50. This slave address will be used for all

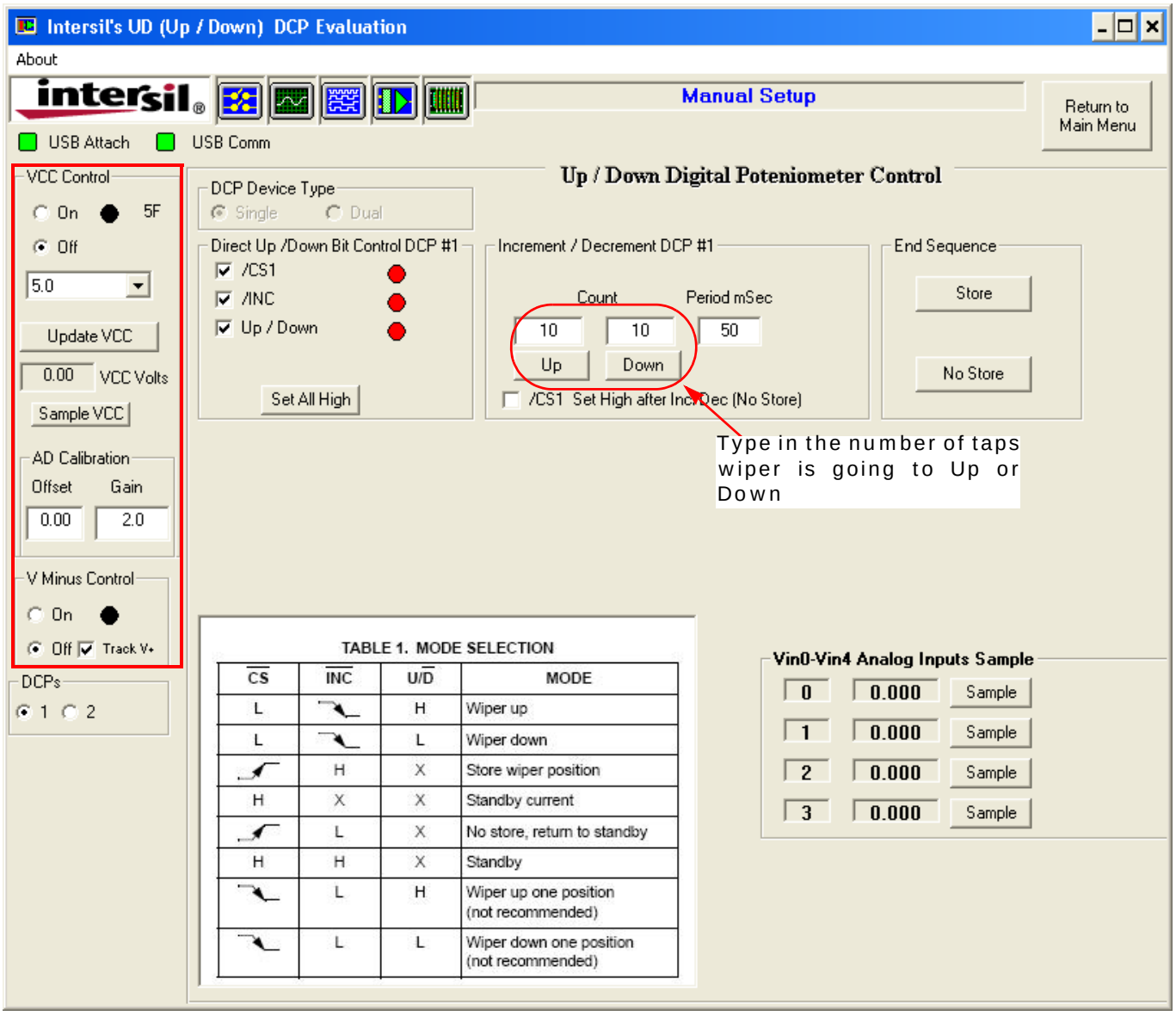


FIGURE 5. UP/DOWN INTERFACE PRODUCT EVALUATION WINDOW

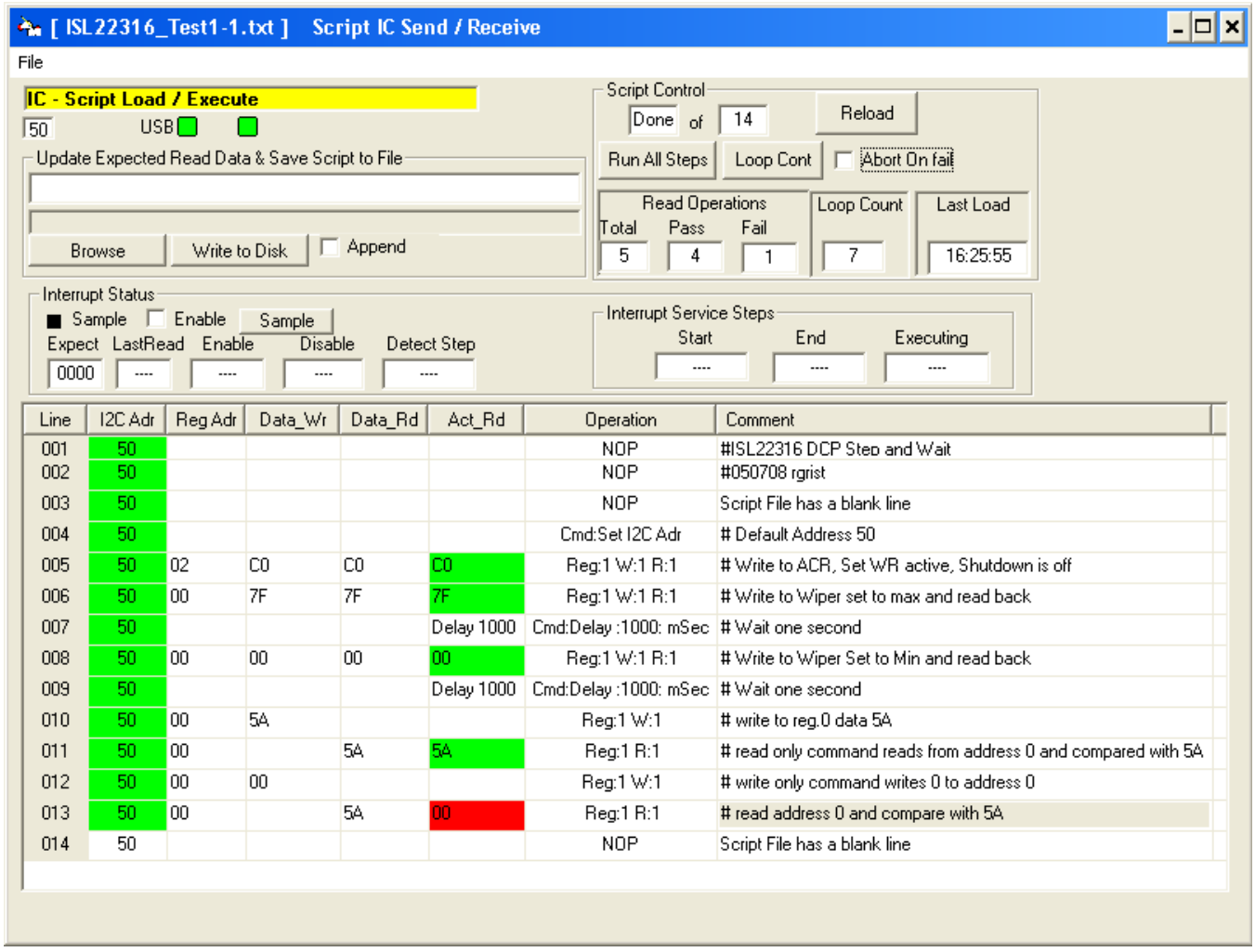
lines below in the sequence until the next address line, if a script file is written to communicate with several DCPs on the bus. Comments must start with the number sign "#" followed by any ASCII symbols.

The Write Data or Read Data can be omitted for Read only or Write only operation. For example:

- 00,55, #write 55 to address 0 without reading back
- 00,55,55 #write 55 to address 0, then read back from address 0. The read data will be compared with 55
- 00, ,55 #read from address 0 and compare result with 55

The wait command starts with the acute symbol followed by a letter "w" and a number that represents waiting time before execution of the next command in milliseconds. For example, 'w1000 #delay for 1000ms. The script execution window is shown in Figure 6.

Successfully executed commands are highlighted by a green color, while non successful command or unexpected returned values are highlighted by a red color. A script file can be executed at once, or put in a loop by pressing the "Run All Steps" or "Loop Count" buttons in the upper right corner of the Script Execution Window. The actual read data can be stored in an updated script file by specifying a path and press the "Write to Disk" button.



Line	I2C Adr	Reg Adr	Data_Wr	Data_Rd	Act_Rd	Operation	Comment
001	50					NOP	#ISL22316 DCP Step and Wait
002	50					NOP	#050708 rgrist
003	50					NOP	Script File has a blank line
004	50					Cmd:Set I2C Adr	# Default Address 50
005	50	02	C0	C0	C0	Reg:1 W:1 R:1	# Write to ACR, Set WR active, Shutdown is off
006	50	00	7F	7F	7F	Reg:1 W:1 R:1	# Write to Wiper set to max and read back
007	50				Delay 1000	Cmd:Delay :1000: mSec	# Wait one second
008	50	00	00	00	00	Reg:1 W:1 R:1	# Write to Wiper Set to Min and read back
009	50				Delay 1000	Cmd:Delay :1000: mSec	# Wait one second
010	50	00	5A			Reg:1 W:1	# write to reg.0 data 5A
011	50	00		5A	5A	Reg:1 R:1	# read only command reads from address 0 and compared with 5A
012	50	00	00			Reg:1 W:1	# write only command writes 0 to address 0
013	50	00		5A	00	Reg:1 R:1	# read address 0 and compare with 5A
014	50					NOP	Script File has a blank line

FIGURE 6. THE ISL22316 SCRIPT EXECUTION EXAMPLE

SPI Script File

The structure of the command line for SPI interface is slightly different than for I²C. The first executable command should be an acute symbol followed by letters “SPIO”, e.g. ‘SPIO. All the following commands start with the comma followed by data bytes. The total number of data bytes is limited to 32 for this application. Comments must start with the number sign “#” followed by any ASCII symbols. The acute symbol followed by the ENDM, e.g. ‘ENDM, indicates the end of the script.

Command examples for ISL224x4 family (2 byte Write, 4 byte Read operation), see Figure 7.

- ,60C0 #Write C0h into the ACR register to set volatile #operation
- ,C05A #Write 5Ah into reg. 0
- ,80000000, XXXXXX5A #Read from reg. 0 and compare #with the anticipated data of 5Ah.

where the “X” symbol represents ignored by test.

Command examples for ISL224x6 family (3 byte Write, 3 byte Read operation) are as follows:

- ,50C8C0 #Write C0h into the ACR register, reg. 8, to set #volatile operation
- ,50C07F # Write 7Fh into reg. 0
- ,50B000,XXXX7F #Read back from reg. 0 and compare with #the anticipated data of 7Fh

The script file can be used for programming DCPs in daisy chain configuration. The DCP Evaluation software supports up to 8 daisy chained devices. The example of daisy chain programming is shown in Figure 8.
Note, not all SPI DCPs have daisy chain capability.

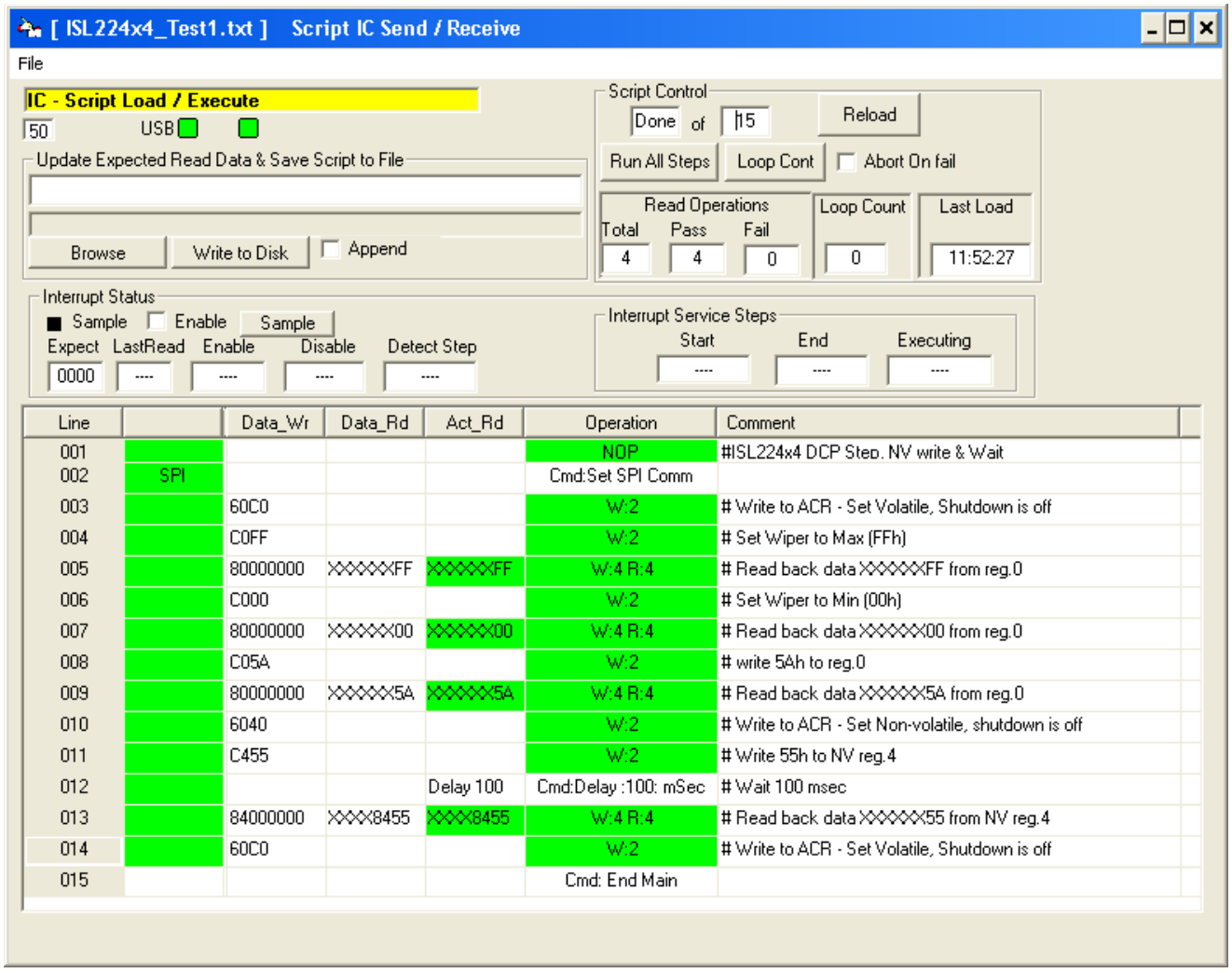


FIGURE 7. THE ISL224X4 SCRIPT EXECUTION EXAMPLE

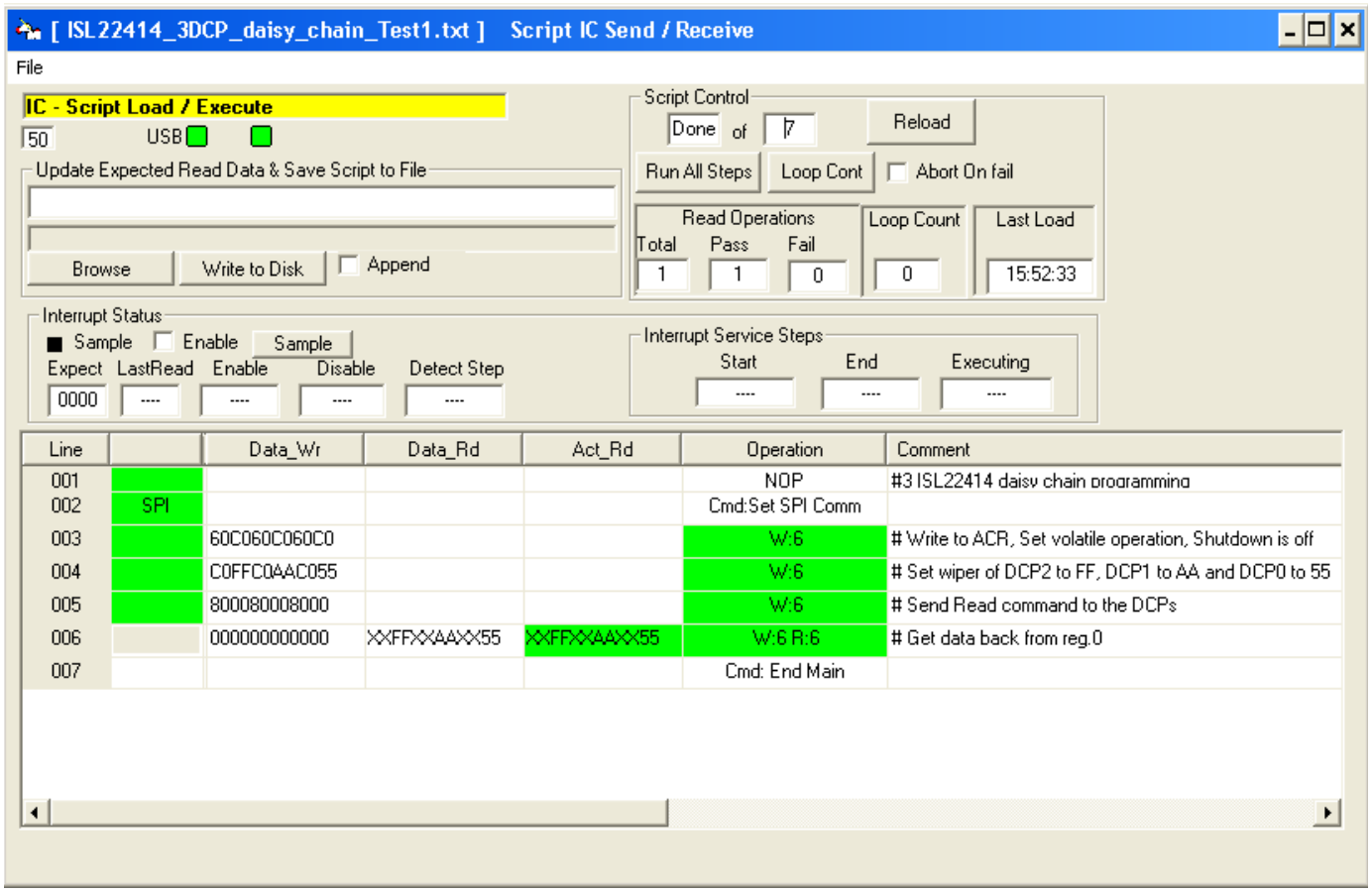


FIGURE 8. THE THREE DAISY CHAINED ISL22414 PROGRAMMING EXAMPLE

Appendix A

USB2DCP Board Schematic