7850 East Gelding Drive • Scottsdale, AZ 85260-3420

IS-Dev Kit-7 & 7D User's Manual

Revision B

Firmware Version 2.6

IS-Dev Kit-7
(ISC15ANP4)

IS-Dev Kit-7D
(ISC01P)

NKK SWITCHES
7850 E. Gelding Drive
Scottsdale, AZ 85260

Toll Free 1-877-2BUYNKK (877-228-9655)
Phone 480-991-0942
Fax 480-998-1435
e-mail <engineering@nkkswitches.com>

NKK Switches makes no warranty for the use of these products and assumes no responsibility for any errors, which may appear in this document, nor does it make a commitment to update the information contained herein. Smart Switch is trademark of NKK Switches.

7850 East Gelding Drive • Scottsdale, AZ 85260-3420

TABLE OF CONTENTS

Toll Free 1.877.2BUYNKK (877.228.9655) • **Phone** 480.991.0942 • **Fax** 480.998.1435
www.nkkswitches.com • **Email** engineering@nkkswitches.com

7850 East Gelding Drive • Scottsdale, AZ 85260-3420

1. General Features

The IS-Dev Kit-7 is a two OLED SmartSwitches (ISC15ANP4) Development kit. The IS-Dev Kit-7D Version is a two OLED SmartDisplays (ISC01P) Development kit. The IS-Dev kit-7D additionally has a JB switch below each OLED SmartDisplay.
The CL04 controller is used in these development Kits as well as IS-DEV KIT-8. For complete features of the CL04 controller refer to IS-CL04R user manual.
In this document we refer to both OLED Smart Switch and OLED Smart Display as OLED Switch.

Below are current features:

- IS-Dev Kit-7 controls two OLED (64x48) SmartSwitches (ISC15ANP4).
- Pushbutton functionality on each SmartSwitch.
    - RGB color OLED display with a resolution of 64x48 pixels.

- IS-Dev Kit-7D controls two OLED (52x36) SmartDisplays (ISC01P).
    - JB switches below SmartDisplays for control.
    - RGB color OLED display with a resolution of 52x36 pixels.

- Power from 9V battery or AC power supply. (9V battery not included).
- On board microSD Flash that can hold up to 65,536 images.
- Adjustable audio feedback when a switch is pressed.
- Software control for 16 levels of brightness setting to extend OLED life.
- User programmable for images, attributes and set-ups.
- Real-time control by host.
    - Commands to direct the controller to display any of 65535 images
    - Command to send characters so controller create images for the displays
    - Commands to check various statuses of the controller
    - Report switch activities to host
    - Report the address of any new image displayed to host
- Stand-alone operation
    - Set up the controller to function based on switch presses.
    - Set up to the controller to function based on timer expire.
    - Report switch activities to host
    - Report the address of any new image displayed to host

- Serial communication via RS232 (57.6K, 1 start bit, 8 bit, 1 stop bit).
- Set the type of activity reports from the controller to host.
- Power requirement: 5V to 12V at 100 mA Max
- Controller board firmware can be customized based on customer requirements.

Toll Free 1.877.2BUYNKK (877.228.9655) • **Phone** 480.991.0942 • **Fax** 480.998.1435
www.nkkswitches.com • **Email** engineering@nkkswitches.com

7850 East Gelding Drive • Scottsdale, AZ 85260-3420

2. Thank you for purchasing NKK Switches' Development kit

By purchasing this kit a new horizon of design is expanding before your eyes. The OLED SmartSwitch and OLED SmartDisplay can be the distinguishing feature within your application that sets your product apart from the competition. This kit contains all the necessary components to get you started using, testing and ultimately incorporating NKK Switches' OLED SmartSwitch and OLED SmartDisplay into your designs.

The development kits come preprogrammed for demonstration. They can be reprogrammed by user for demonstration or real time application. NKK provides a free PC software (Universal Communicator) for programming the development kits. It can be downloaded from the web page below. Included in the download are the default demonstration images and attributes.
http://www.nkkswitches.com/SmartSwitch-Download-Software.aspx

There are many documents such as "How to" in the web page below that can be useful.
http://www.nkkswitches.com/SmartSwitch-Engineering-Documentation.aspx

The part numbers that come with each kit are listed below. A handling instruction also included in each kit.

IS-DEV KIT-7

	Part Number	QTY	Description
1	IS-CL04-F-E-F-E	1	Controller
2	IS-L02L1-C	1	Logic Board
3	ISC15ANP4	2	OLED Switch (64x48)
4	IS-418-TR1509-12	1	Power Supply
5	IS-SERIAL-CABLE	1	RS232 cable RJ11 to DB9

IS-DEV KIT-7D

	Part Number	QTY	Description
1	IS-CL04-F-E-F-E	1	Controller
2	IS-L02P1-C	1	Logic Board
3	ISC01P	2	OLED Switch (64x48)
4	IS-418-TR1509-12	1	Power Supply
5	IS-SERIAL-CABLE	1	RS232 cable RJ11 to DB9

7850 East Gelding Drive • Scottsdale, AZ 85260-3420

3. Preface

The IS-Dev Kit-7/7D are development kits designed to demonstrate the features of the OLED SmartSwitch/Display as well as facilitate the incorporation of the pushbutton or display into new application designs. The OLED SmartSwitch is best used for displaying video or images that change frequently.

This user manual will go through general features and rudimentary commands, like how to download images and attributes, and then go into the more technical details of how the Dev Kit-7 operates. The controller used in these development kits is CL04. It can handle an OLED rocker as well. For a complete list of the controller features you can check the user manual for IS-CL04R.

Section 4 and 5 briefly describe the basic Dev Kit operations and provide a starter guide for programming the Dev Kit with the most popular commands using the Universal Communicator program. These sections were designed for those who wish to simply start using the Dev Kit without getting into the technical details.

Section 6, 7, 8 and 9 covers communication and commands between the host computer and the Dev Kit controller. Section 10 is the hardware and the schematic and section 11 and 12 are definitions and firmware issues. There is also an appendix for understanding hexadecimal.

Universal Communicator

Universal Communicator version 1.7.1 is a free program provided by NKK Switches to help download images and attributes to the Dev Kit controllers. The program is designed to work with the family of SmartSwitch Dev Kits. It can import bitmaps, convert them to the proper switch format, and then download them to the controller. It also allows input and download of attributes.
It can handle single or batch downloads and has the most common commands as easy button interfaces. The Universal communicator can be downloaded from the web page below:
http://www.nkkswitches.com/SmartSwitch-Download-Software.aspx

On the NKK website documents can be found for how to creating images as well as the manual for Universal Communicator that shows how to download images and attributes. They can be found at:
http://www.nkkswitches.com/SmartSwitch-Engineering-Documentation.aspx

The dev kits can communicate with any communication software that can perform the communication protocol. Universal Communicator is provided as demonstration software.

Toll Free 1.877.2BUYNKK (877.228.9655) • **Phone** 480.991.0942 • **Fax** 480.998.1435
www.nkkswitches.com • **Email** engineering@nkkswitches.com

7850 East Gelding Drive • Scottsdale, AZ 85260-3420

4. Operational Overview

Power-up Sequence:
Upon power up, the controller checks the position of the Mode Select Switch. The controller initializes the OLED display or switch based on this selection. The proper selection of switch/display mode must be set before power up.
The OLED switch will show the full image while the "Display" position will display only the middle 52 pixels of the top 36 lines of the image and the to 36 rows.

OLED Brightness Adjustment Mode:
The controller will then allow the brightness of the two OLED modules to be adjusted. The left OLED displays the brightness level "F" and the word DIM. The right OLED displays the brightness "F" and the word BRIGHT. The left button can be pressed to make both displays dimmer and the right button makes both displays brighter.

There are 16 level of brightness 0,1,2,3,4,5,6,7,8,9,A,B,C,D,E and F where F is the maximum brightness. The level of brightness is displayed in the middle of image. After power up, the display is at the maximum brightness level (F). The OLED rated life of 15,000 hours is based on the maximum brightness. The dimmer the level is set the longer the life of the OLED. Any switch activity will keep the unit in this mode.
The brightness changes stay in effect for duration of the session.
After 2.6 seconds of user inactivity the controller will move into the main operations mode.

Main Operational Mode:
There are 65535 addresses (0x0001 to 0xFFFF) to store images and attributes. Upon power up as default, switch one display image of address 0x0001 and switch two display image of address 0x001F. These addresses are user defined and can be changed.
The IS-DEV KIT-7 is programmed with factory default images. The user can change the images and programming through the use of attributes. The images are pictures to be displayed. The attributes are user defined information on what image to display based on the switch activity and when the timer expires. After a few seconds of user inactivity the controller will move into the main operations mode where the switch on the left displays the image at the user's first preset address. The right hand switch will display the image at the user's second preset address. There is room for 65,535 images and attributes (address 1 to 65535) in memory.

The controller associates one address to each image and the display shows the image at the associated address. Each address has a group of five attributes which together is called an Attribute Block. The function of the Attribute Block is to tell the controller what image to display next either when the switch associated with that particular address is pressed or when the timer expires. These are called actions.

Toll Free 1.877.2BUYNKK (877.228.9655) • **Phone** 480.991.0942 • **Fax** 480.998.1435
www.nkkswitches.com • **Email** engineering@nkkswitches.com

7850 East Gelding Drive • Scottsdale, AZ 85260-3420

Attribute Block:

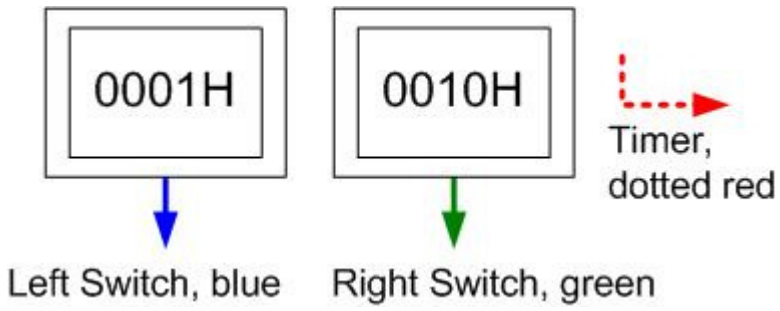
Addresses:

The controller associates the first address with the left switch and the second address with the right switch. Each switch will display the image at their associated addresses. The addresses are in hexadecimal. The controller handles the addresses as a group of addresses with associated images and attributes within user defined loops. Each loop has a starter address and an ending address. The function of the attributes for each address is to tell the controller where to point to next either when the switch associated with that particular address is pressed or when a timer expires. There are three types of attributes:

- Attributes SW1 and SW2 are the Action Addresses. In the starting address the Action Addresses tell the controller what addresses to point to when the switch associated with that particular address is pressed. In the ending address the Action Addresses tell the controller what addresses to point to when the loop has ended.
- The end address, EP1, sets the ending address for the loop.
- T1 and T2 are timers that are multiplied together to set the length of time to stay at one address before moving to the next address within the loop.
-

For visual illustration, through out the document blue is used to show a left switch action, green is a right switch action, a dotted red line is the timer action associated with that address. The timer action could be of either of the two timers.

Illustration 1, Switch and timer actions as described by the attributes. The Hex number shown is the address of an image that is displayed.



Toll Free 1.877.2BUYNKK (877.228.9655) • **Phone** 480.991.0942 • **Fax** 480.998.1435
www.nkkswitches.com • **Email** engineering@nkkswitches.com

The only addresses that need attributes within the loop are the first and last addresses.
Illustration 2 shows the starting and ending addresses for "Switch A" which is associated with address 0001H. Switch A could be the left or right switch.

Illustration 2, Start and Ending Addresses for Switch A

		Actions Addresses				
	Address	SW1	SW2	EP1	T1	T2
…	…	…	…	…	…	…
Start Image	0001	Left switch's future address when switch A is pressed.	Right switch's future address when switch A is pressed.	Ending Address (0003)	milli-seconds	milli-seconds
…	…	…	…	…	…	…
Ending Image	0003	Left switch's future address when end of loop	Right switch's future address when end of loop	Don't care	Don't care	Don't care
…	…	…	…	…	…	…

Illustration 3 shows a simple loop where images at addresses 0041H through 0057H are shown in sequence for two seconds each and will loop continuously until the switch associated with that particular address is pressed or the loop ends. When that switch is pressed the controller will set the left hand switch to address 0001H and the right hand switch to address 006AH. If the loop ends before the switch is pressed the left switch will go to address 0059H and the right switch will go to address 005AH.

Illustration 3, Simple Image Loop

		Actions Addresses				
	Address	SW1	SW2	EP1	T1	T2
…	…	…	…	…	…	…
Start Image	0041	0001	006A	0057	7D	14
Next Image	0042	0000	0000	0000	00	00
…	…	…	…	…	…	…
Next Image	0056	0000	0000	0000	00	00
Ending Image	0057	0059	005A	0000	00	00
…	…	…	…	…	…	…

If SW1 and/or SW2 for the ending addresses are 0000H the loop will start again. Loops can overlap where, for instance, the left switch starts at address 0001H and ends at 0005H while the right switch starts at 0002H and ends at 0006H. The two loops will not interfere with each other.

Toll Free 1.877.2BUYNKK (877.228.9655) • **Phone** 480.991.0942 • **Fax** 480.998.1435
www.nkkswitches.com • **Email** engineering@nkkswitches.com

Timers Operation:

Each switch has an independent timer; timer1 and timer2. Each timer value is the product of the two user defined variables T1 and T2 of the attributes. The formula for the timer value in millisecond is:

The timer value in ms= (T1)x(T2)

Each of these variables can have a value between 01H to FFH (1 to 255). The timer for a given switch will be disabled if the T1 value is set to zero. For T2 the zero value is defined as 256. Pressing either switch will reset the timers for both switches. Holding down either switch will prevent both timers from running. The controller takes 35ms to send an image to each OLED for a maximum of 28 images per second on one OLED.

Attribute Block:

An attribute is handled as a block of 8 bytes.

Byte	Description
1	High byte of action address for OLEDModule #1.
2	Low byte of action address for OLEDModule #1.
3	High byte of action address for OLEDModule #2.
4	Low byte of action address for OLEDModule #2.
5	High byte of end address.
6	Low byte of end address.
7	Timer B
8	Timer A

Toll Free 1.877.2BUYNKK (877.228.9655) • **Phone** 480.991.0942 • **Fax** 480.998.1435
www.nkkswitches.com • **Email** engineering@nkkswitches.com

Image Block:

An image is handled as a block of 6144 bytes. Each pixel requires two bytes in the 565 format as shown below.

B4	B3	B2	B1	B0	G5	G4	G3	G2	G1	G0	R4	R3	R2	R1	R0
B15	B14	B13	B12	B11	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1	B0

The current version of the controller can only handle 64x48 format images. The OLED switches show the full image while the OLED displays will only show the middle 52 pixels of the top 36 lines of the image. The image is handled from top left to bottom right as shown below. Byte 1 and byte 2 are for color of top left pixel. Byte 6143 and byte 6144 are for color of bottom right pixel.

Byte	Description
1-128	First line of image
129-256	Second line of image
•	
•	
•	
5889-6016	47th line of image
6017-6144	48th line of image

Toll Free 1.877.2BUYNKK (877.228.9655) • **Phone** 480.991.0942 • **Fax** 480.998.1435
www.nkkswitches.com • **Email** engineering@nkkswitches.com

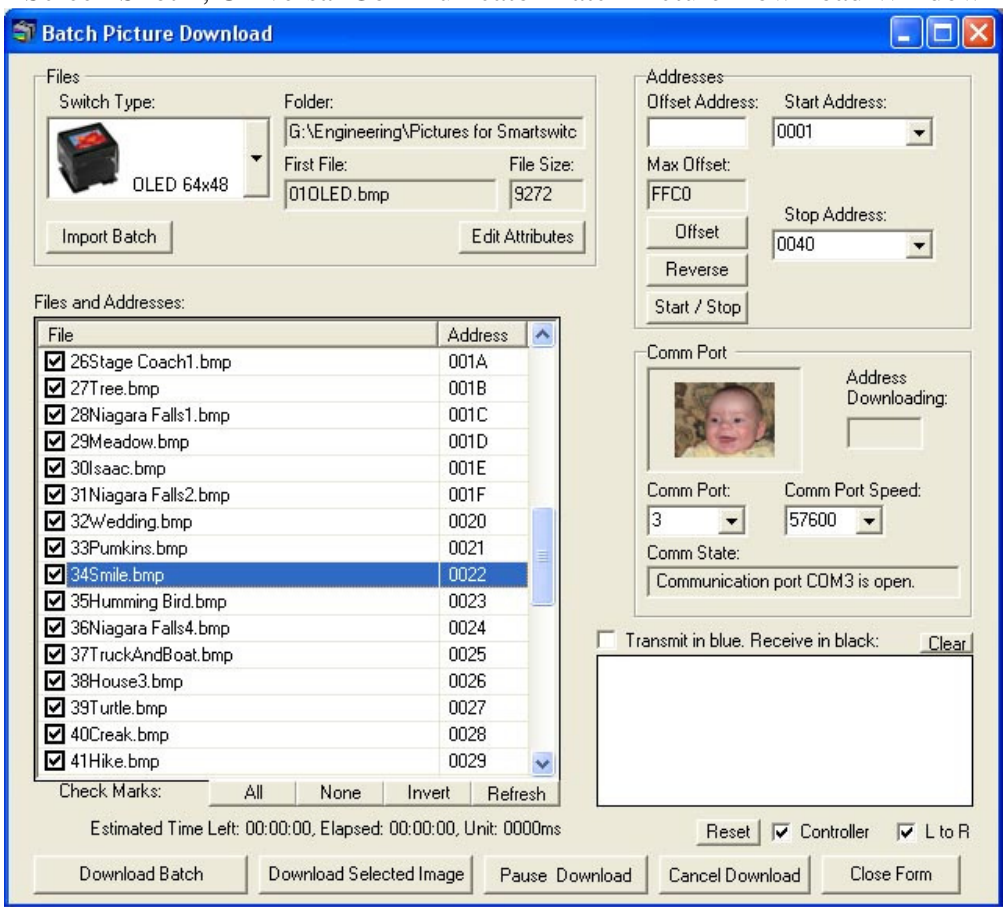
7850 East Gelding Drive • Scottsdale, AZ 85260-3420

5. Programming the IS-Dev Kit-7

The IS-Dev Kit-7 communicates via RS232 with any communication software. The commands and protocol will be explained in the sections 6 and 7.
This section covers programming the Dev Kit using the Universal Communicator.
The Universal Communicator handles all the communication protocol. Once the images are created, they can be imported to the Universal Communicator. The Universal Communicator allows attributes information to be inputted. Once the images and attribute information are created, they can be downloaded to the Dev Kit. The Dev Kit will function as programmed after the next power up or reset.
For how to use the software please refer to Universal Communicator documentation.

Creating OLED Images for Universal Communicator
The OLED SmartSwitch has a RGB color OLED display with a resolution of 64x48 pixels. The OLED SmartDisplay has a RGB color OLED display with a resolution of 52x36 pixels. Images can be created graphically or by cropping from a picture using graphic software such as Paint, Photoshop, etc. The images must be saved as 64x48 24-bit color bitmap files. The image files should be saved in a single folder. Universal Communicator imports the files from the folder in alphanumeric order according to the file names. The file names should be selected so the order of images will be as desired.
The Universal Communicator displays the image file names and assigned addresses for the controller. (Screen Shot 1) These files can be downloaded to the controller.

Screen Shot 1, Universal Communicator Batch Picture Download Window



Input/programming the

Toll Free 1.877.2BUYNKK (877.228.9655) • **Phone** 480.991.0942 • **Fax** 480.998.1435
www.nkkswitches.com • **Email** engineering@nkkswitches.com

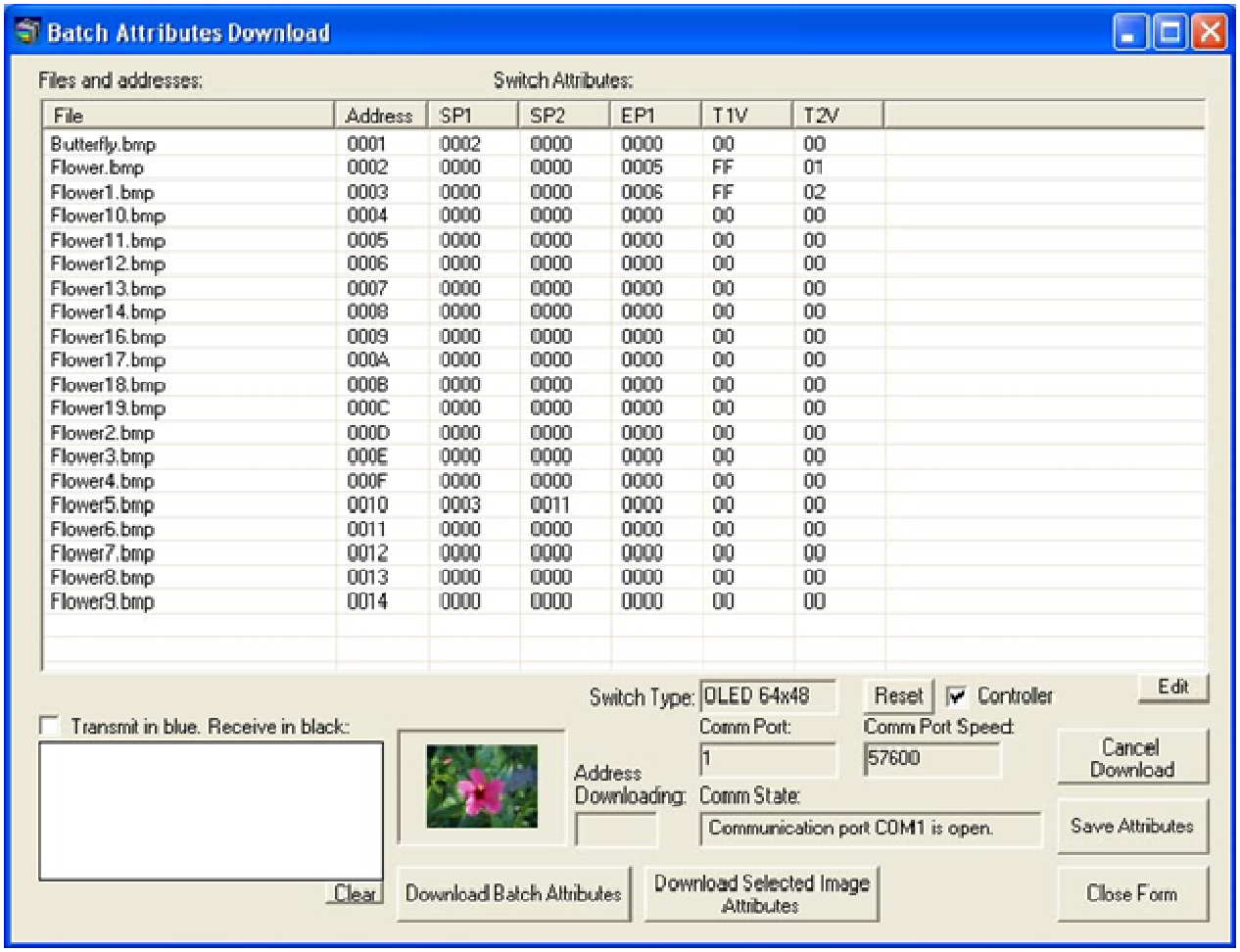
7850 East Gelding Drive • Scottsdale, AZ 85260-3420

Attribute information

After importing the images into the Universal Communicator (Screen shot 1), Make sure the order of the images are as desired so all the loops for sequential changes based on timer are sequential.
You can select "Edit Attributes" from Batch Picture Download screen (Screen shot 1).Universal Communicator display "Batch Attributes Download screen and allows input of the attributes information. (Screen shot 1)

All the numeric inputs only allow HEX format. The addresses are four digit long HEX values from 0001H to FFFFH (1 to 65,535 decimal). The Universal Communicator lists the addresses in HEX format. These addresses can be used for attribute information without knowing HEX numbering. For HEX numbering and conversion between HEX and decimal please refer to the appendix.
The image name and the address as well as attribute information are displayed. The attribute information can be modified by the user.

Screen Shot 2, Universal Communicator Batch Attribute Download Window



Toll Free 1.877.2BUYNKK (877.228.9655) • **Phone** 480.991.0942 • **Fax** 480.998.1435
www.nkkswitches.com • **Email** engineering@nkkswitches.com

7850 East Gelding Drive • Scottsdale, AZ 85260-3420

An Example of How Attributes Work

The following demonstrate the way attributes of Screen Shot 2 (above) works. The Illustration 3 (below) visually demonstrates the way these attributes work.

The blue is the left switch action, the green is the right switch action, the dashed red line is the timer action.

Illustration 3, Examples of various loops

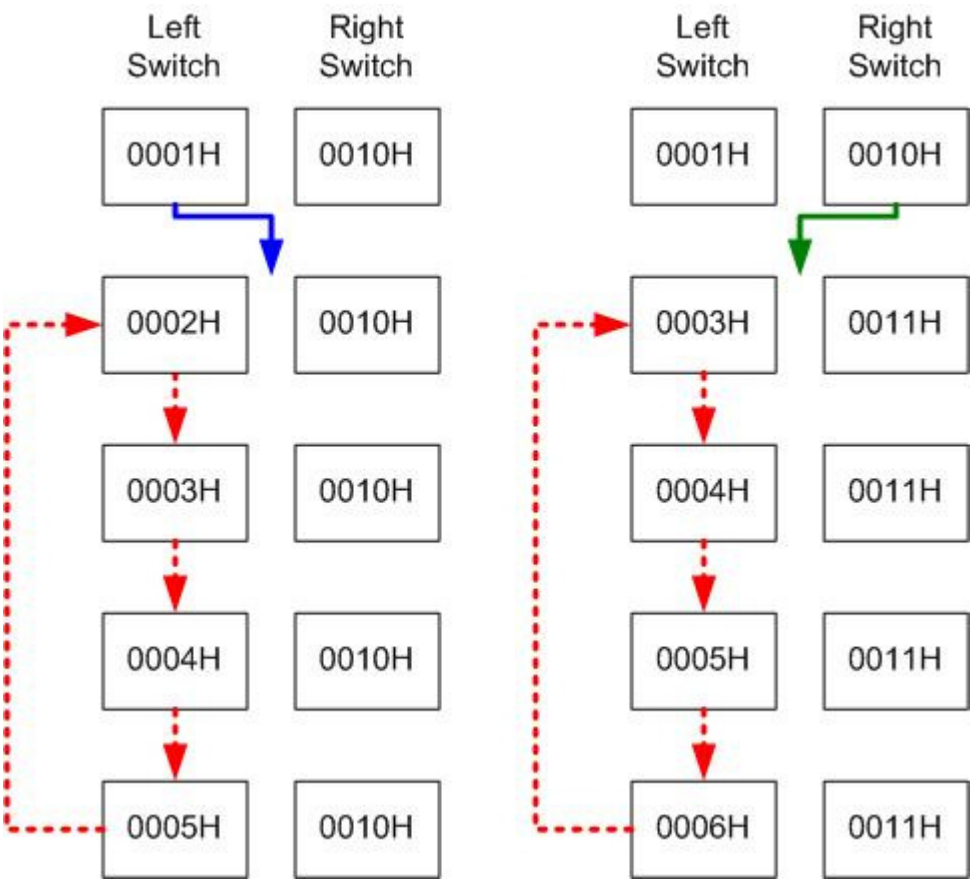


Illustration only shows switch and timer actions that result in an image change on the display. All other attributes are ignored by the controller and are not shown.

When the Dev Kit enters the Main Operational Mode the images at the address 0001H and 0010H are displayed. The Attribute Block at address 0001H and 0010H become active.

Attribute Block at address 0001H

Current Address	Left Switch Address	Right Switch Address	End Address	Timer1	Timer2
0001H	0002H	0000H	0000H	00H	00H

Toll Free 1.877.2BUYNKK (877.228.9655) • **Phone** 480.991.0942 • **Fax** 480.998.1435
www.nkkswitches.com • **Email** engineering@nkkswitches.com

Since the Timer1 is zero the timer does not run so there will be no changes based on the timer.
The image at the address 0001H is displayed until a switch is pressed:

Pressing the Left Switch

Attribute Block at address 0001H

Current Address	Left Switch Address	Right Switch Address	End Address	Timer1	Timer2
0001H	0002H	0000H	0000H	00H	00H

If the left switch is pressed, the image at address 0002H is displayed on the left switch and the Attribute Block of address 0002H becomes active. The display on the right switch does not change as it is set to zero.

Attribute Block at address 0002H

Current Address	Left Switch Address	Right Switch Address	End Address	Timer1	Timer2
0002H	0000H	0000H	0005H	FFH	01H

Since the switch addresses are zero there will be no changes if a switch gets pressed. The timer is 255ms. If there is no switch activity for 255ms the timer expires causing the next image, 0003H, to be displayed. This continues until images 0004H and 0005H are also displayed. When the timer expires at address 0005H the address is equal to the End Address. The Left Switch Address from the Attribute Block of 0005H is then checked. Please note the attribute information of addresses 0003H and 0004H are not used.

Attribute Block at address 0005H

Current Address	Left Switch Address	Right Switch Address	End Address	Timer1	Timer2
0005H	0000H	0000H	0000H	00H	00H

The image at address 0001H is displayed and the Attribute Block of address 0001H becomes active. Notice that the other attributes within the Attribute Block of address 0005H are ignored.

Pressing the Right Switch

Attribute Block at address 0010H

Current Address	Left Switch Address	Right Switch Address	End Address	Timer1	Timer2
0010H	0003H	0011H	0000H	00H	00H

Toll Free 1.877.2BUYNKK (877.228.9655) • **Phone** 480.991.0942 • **Fax** 480.998.1435
www.nkkswitches.com • **Email** engineering@nkkswitches.com

If the right switch is pressed, the image at address 0003H is displayed on the left switch and the image at address 0011H is displayed on the right switch. The Attribute Blocks of the address 0003H and 0011 become active.

Attribute Block at address 0003H

Current Address	Left Switch Address	Right Switch Address	End Address	Timer1	Timer2
0003H	0000H	0000H	0006H	FFH	02H

The timer is 510ms. If there is no switch activity for 510ms the timer expires causing the next image, 0004H, to be displayed. This continues until images 0005H and 0006H are also displayed. When the timer expires at address 0006H the address is equal to the End Address. The Left Switch Address from the Attribute Block of 0006H is then checked.

Attribute Block at address 0006H

Current Address	Left Switch Address	Right Switch Address	End Address	Timer1	Timer2
0006H	0000H	0000H	0000H	00H	00H

Since the Left Switch Address is zero then the image at address 0003H is displayed and the Attribute Block of address 0003H becomes active. The display on the right switch does not change as it is set to zero.

Please note when a timer causes a new image to be displayed the Attribute Block of the beginning image stays active. All other Attribute Blocks within the loop are ignored except the Left Switch Address when the End Address is active.

Toll Free 1.877.2BUYNKK (877.228.9655) • **Phone** 480.991.0942 • **Fax** 480.998.1435
www.nkkswitches.com • **Email** engineering@nkkswitches.com

7850 East Gelding Drive • Scottsdale, AZ 85260-3420

6. Operational Details

Power-Up Sequence (Steps 1,2,3)
Upon power-up or reset, controller performs the following steps:

Step 1: Check the status of Mode Select Switch for mode of operation. Initialize according to selected mode.

Step 2: Display dim and bright on the two switches and allow for adjustments of the brightness. There are 16 brightness levels (0 to F). When the internal timer is expired, the controller proceeds to Step 3. Every time a switch is pressed, the timer gets reset. If a switch is held depressed the timer does not run. Switch activity are not reported to host.

Step 3: Transmit 11H to host via RS232. Check the microSD for set up value. If set up values are programmed, get the start address for switch 1, start address for switch 2 and the flag byte. If the set up values are not programmed use the default values: start address for switch 1 = current address for switch 1 = 0001H, start address for switch 2 = current address for switch 2 = 0010H and flag byte = 80H.

Step 4:

A. If attributes for start address of switch 1 are programmed, get the attribute for switch 1.
B. If attributes for start address of switch 1 are not programmed, use the default: Switch 1 Action address for switch 1 = 0000H, switch 1 action address for switch 2 = 0000H, end address for switch 1 = 0010H Timer2 for switch 1=00H timer1 for switch 1= 0AH.
C. If attributes for start address of switch 2 are programmed, get the attribute for switch 2.
D. If attributes for start address of switch 2 are not programmed, use the default: Switch 2 action address for switch 1 = 0000H, switch 2 action address for switch 2 = 0000H, end address for switch 2 = 0020H Timer2 for switch 2=00H timer1 for switch 2= 0DH,

Step 5: Send the pictures from microSD to OLED module according to start addresses.

Main Operational Mode

Step 6:

A. If the switch 1 is pressed, process it. (see details below)
B. If the switch 2 is pressed, process it. (see details below)
C. If the timer for switch 1 is expired, process it. (see details below)
D. If the timer for switch 2 is expired, process it. (see details below)
E. If the switch 1 is released: Transmit B1H to host if flag is enabled.
F. If the switch 2 is released: Transmit B2H to host if flag is enabled.
G. If there is update flag for switch 1 is set, process it.
H. If there is update flag for switch 2 is set, process it.
I. Checks the host communication buffer for data. If there is data, process them. (For detail see **Communication Protocol**)
J. Go to step 6 A.

Toll Free 1.877.2BUYNKK (877.228.9655) • **Phone** 480.991.0942 • **Fax** 480.998.1435
www.nkkswitches.com • **Email** engineering@nkkswitches.com

Detailed Explanation of Operation Step 6

Step 6A: If switch 1 is pressed then:

1. Transmit 81H to host if flag is enabled.

2. If switch 1 action address for switch 1 is not equal zero and the attribute for the location is programmed then:
   a. Start address for switch 1 = switch 1 action address for switch 1.
   b. Current address for switch 1 = switch 1 action address for switch 1.
   c. Get the attributes and put the values for switch 1 action address for switch 1, switch 1 action address for switch 2, end address for switch 1 and timers for switch 1.
   d. Set update flag for switch 1.

3. If switch 1 action address for switch 1 is equal zero or the attribute for the location is not programmed then take no action.

4. If switch 1 action address for switch 2 is not equal zero and the attribute for the location is programmed then:
   a. Start address for switch 2 = switch 1 action address for switch 2.
   b. Current address for switch 2 = switch 1 action address for switch 2.
   c. Get the attributes and put the values for switch 2 action address for switch 1, switch 2 action address for switch 2, end address for switch 2 and timers for switch 2.
   d. Set update flag for switch 2.

5. If switch 1 action address for switch 2 is equal zero or the attribute for the location is not programmed then take no action.

Step 6B: If switch 2 is pressed then:

1. Transmit 82H to host if flag is enabled.

2. If switch 2 action address for switch 1 is not equal zero and the attribute for the location is programmed then:
   a. Start address for switch 1 = switch 2 action address for switch 1.
   b. Current address for switch 1 = switch 2 action address for switch 1.
   c. Get the attributes and put the values for switch 1 action address for switch 1, switch 1 action address for switch 2, end address for switch 1 and timers for switch 1.
   d. Set update flag for switch 1.

3. If switch 2 action address for switch 1 is equal zero or the attribute for the location is not programmed then take no action.

4. If switch 2 action address for switch 2 is not equal zero and the attribute for the location is programmed then:
   e. Start address for switch 2 = switch 2 action address for switch 2.

f. Current address for switch 2 = switch 2 action address for switch 2.
g. Get the attributes and put the values for switch 2 action address for switch 1, switch 2 action address for switch 2, end address for switch 2 and timers for switch 2.
h. Set update flag for switch 2.

5. If switch 2 action address for switch 2 is equal zero or the attribute for the location is not programmed then take no action.

Step 6C: If timer for switch 1 expires then:

1. Transmit 83H to host if flag is enabled.

2. Increment current address for switch 1.

3. If current address for switch 1 is not equal ((end address for switch 1) +1) then:
   i. Transmit FDH and current address for switch 1 to host if flag is enabled.
   j. Set update flag for switch 1.

4. If current address for switch 1 is equal ((end address for switch 1) +1) then:
   k. Read the Attributes for end address location.
      i. If end location action address for switch 1 is equal zero then put current address = start address and set update flag for switch 1.
      ii. If end location action address for switch 1 is not equal zero then:
         1. Start address for switch 1 = end address action address for switch 1.
         2. Current address for switch 1 = end address action address for switch 1.
         3. Get the attributes and put the values for switch 1 action address for switch 1, switch 1 action address for switch 2, end address for switch 1 and timers for switch 1.
         4. Set update flag for switch 1.
      iii. If end location action address for switch 2 is equal zero then take no action.
      iv. If end location action address for switch 2 is not equal zero then:
         1. Start address for switch 2 = end address action address for switch 2.
         2. Current address for switch 2 = end address action address for switch 2.
         3. Get the attributes and put the values for switch 2 action address for switch1, switch 2 action address for switch 2, end address for switch 2 and timers for switch 2.
         4. Set update flag for switch 2.

Step 6D: If timer for switch 2 is expired then:

1. Transmit 84H to host if flag is enabled.

2. Increment current address for switch 2.

3. If current address for switch 2 is not equal ((end address for switch 2) +1) then:
   l. Transmit FEH and current address for switch 2 to host if flag is enabled.
   m. Set update flag for switch 2.

4. If current address for switch 2 is equal ((end address for switch 2) +1) then:
   n. Read the attributes for end address location for switch 2.
   o. If end location action address for switch 2 is equal zero then put current address for switch 2 = start address for switch 2 and set update flag for switch 2.
   p. If end location action address for switch 2 is not equal zero then:
      i. Start address for switch 2 = end address action address for switch 2.
      ii. Current address for switch 2 = end address action address for switch 2.
      iii. Get the attributes and put the values for switch 2 action address for switch 1, switch 2 action address for switch 2, end address for switch 2 and timers for switch 2.
      iv. Set update flag for switch 2.
   q. If end location action address for switch 1 is equal zero then take no action.
   r. If end location action address for switch 1 is not equal zero then:
      i. Start address for switch 1 = end location action address for switch 1.
      ii. Current address for switch 1 = end location action address for switch 1.
      iii. Get the attributes and put the values for switch 1 action address for switch 1, switch 1 action address for switch 2, end address for switch 1 and timers for switch 1.
      iv. Set update flag for switch 1.

Step 6E: If the switch 1 is released: Transmit B1H to host if flag is enabled.

Step 6F: If the switch 2 is released: Transmit B2H to host if flag is enabled.

Step 6G: If update flag for switch 1 is set then:
1. Clear the switch 1 update flag.
2. Transmit FDH and current address for switch 1 to host if flag is enabled.
3. Send the picture from microSD to OLED module 1 according to current address for switch 1.

Step 6H: If update flag for switch 2 is set then:
1. Clear the switch 2 update flag.
2. Transmit FEH and current address for switch 2 to host if flag is enabled.

Send the picture from microSD to OLED module 2 according to current address for switch 2.

Step 6I: Checks the host communication buffer for data. If there is data, process them. (For detail see **Communication Protocol**)

Step 6J: Go to step **6A**.

7850 East Gelding Drive • Scottsdale, AZ 85260-3420

7. Communication Protocol

Communication initiated by Host
The controller communicates with the host via RS232 serial communication (57.6K, 1 start bit, 8 bit, 1 stop bit). The controller receives the data via an interrupt routine that places the data on the circular receive buffer. When the controller detects data in the circular receive buffer, the controller reads one byte and executes the following:

A. If the byte is a command, the controller transmits a 61H and executes the subroutine for the command and upon completion of command the controller transmits 79H.
B. If the byte is not a command, it is ignored.

When the controller executes a subroutine and expects additional information:

A. A timer is set. If the expected data byte is not received in 64ms, the controller transmits 6CH 6EH and terminates the routine.
B. If the byte value is not acceptable (invalid range, option, etc.), the controller transmits 6EH and terminates the routine.

Commands are one byte in the range of 20H to 2FH and 01H and are transmitted in hex format. The proper format for all command options and data is specified for each command. See Section 7.

Communication initiated by the IS-Dev Kit-7
The Dev Kit transmits codes to host via RS232 based on activities stated below. Many of these reporting can be enable/disabled by the flag setup.

A. Left switch press is reported as 81H
B. Left switch release is reported as B1H
C. Right switch press is reported as 82H
D. Right switch release is reported as B2H
E. Left Timer expire is reported as 83H
F. Right Timer expire is reported as 84H
G. Upon changing the image on left switch, the image address is reported as FDH followed by the address in HEX so total of 3 bytes transmitted for each image change.
H. Upon changing the image on right switch, the image address is reported as FEH followed by the address in HEX so total of 3 bytes transmitted for each image change.
I. If there is a communication problem between microcontroller and the microSD flash, the controller will transmit 6FH to host for each communication failure.

Toll Free 1.877.2BUYNKK (877.228.9655) • **Phone** 480.991.0942 • **Fax** 480.998.1435
www.nkkswitches.com • **Email** engineering@nkkswitches.com

7850 East Gelding Drive • Scottsdale, AZ 85260-3420

8. Commands

Commands to the controller

Command to reboot the controller

The command reboots the controller to power-up state.

command format:	**24H**
transmit format:	(xxH)

Command to check communication

The command is used to check if the controller is on-line.

command format:	**01H**
transmit format:	(xxH)

The controller transmits back 61H to the host.

Command to query controller for mode, controller, and firmware version

This command queries the controller for the mode as set by the Mode Select Switch, the controller name, and the firmware version installed.

command format:	**26H**	52H	58H
transmit format:	(xxH)	(xxH)	(xxH)

Example: The command is sent. The controller responds with the following:

61	34	43 4C 30 31	12	79
61H	[mode]	[Controller name]	[version]	79H

[mode] one byte. 33H indicating OLED module mode or 34H indicating OLED display mode.
[Controller name] 4 bytes. 43H 4CH 30H 31H (CL01)
[version] one byte. 11H (version 1.1)

Command to query controller for firmware version

This command queries the controller for the firmware version installed.

command format:	**26H**	15H
transmit format:	(xxH)	(xxH)

Example: The command is sent. The controller responds with the following:

61	11
61H	[version]

[version] one byte. 11H (version 1.1)

Toll Free 1.877.2BUYNKK (877.228.9655) • **Phone** 480.991.0942 • **Fax** 480.998.1435
www.nkkswitches.com • **Email** engineering@nkkswitches.com

Command for temporarily setting the timers

This command sets both the left and right switch timers.

command format:	**26H**	51H	55H	[left timer]	[right timer]
transmit format:	(xxH)	(xxH)	(xxH)	(xxH)	(xxH)

[left timer] timer for left switch. Two bytes send in HEX format.
[right timer] timer for right switch. Two bytes send in HEX format.
The command sets the timers with the given values and activates them. If either switch is pressed or the timers expire the values are lost. These values are over written by the values stored on the microSD flash in the current address.
This command is useful for determining the best values for animations or movies.

Command to disable the timers and switch execution

This command disables the timers and switch execution.

command format:	**26H**	51H	5AH
transmit format:	(xxH)	(xxH)	(xxH)

The controller disables the timers and switch execution upon receiving this command. However, the switches are still scanned and reported. They are enabled upon reboot/power up or by command from host.

Command to enable the timers and switch execution

This command enables the timers and switch execution.

command format:	**26H**	51H	65H
transmit format:	(xxH)	(xxH)	(xxH)

The controller enables the timers and switch execution upon receiving this command.

Command to turn the switch display off

This command turns off the OLED module display.

command format:	**26H**	51H	69H
transmit format:	(xxH)	(xxH)	(xxH)

Command to turn the switch display on

This command turns on the OLED module display.

command format:	**26H**	51H	66H
transmit format:	(xxH)	(xxH)	(xxH)

Toll Free 1.877.2BUYNKK (877.228.9655) • **Phone** 480.991.0942 • **Fax** 480.998.1435
www.nkkswitches.com • **Email** engineering@nkkswitches.com

Command to dim switch display

This command dims the OLED module display.

command format:	**26H**	51H	71H
transmit format:	(xxH)	(xxH)	(xxH)

Command to turn the OLED voltage off

This command turns off the 16V supply to the OLED module.

command format:	**26H**	51H	74H
transmit format:	(xxH)	(xxH)	(xxH)

Command to turn the OLED voltage on

This command turns on the 16V supply to the OLED module.

command format:	**26H**	51H	75H
transmit format:	(xxH)	(xxH)	(xxH)

Note: This command should only be used when the OLED displays are in the off mode.

Toll Free 1.877.2BUYNKK (877.228.9655) • **Phone** 480.991.0942 • **Fax** 480.998.1435
www.nkkswitches.com • **Email** engineering@nkkswitches.com

7850 East Gelding Drive • Scottsdale, AZ 85260-3420

Commands that disable switch and timer execution

Upon transmitting any of the following commands, the timers stop running and attributes for the switches activity do not execute. The switches are still scanned and reported. The attributes execution is enabled upon reboot/power up or by command from host.
The reason for disabling attribute execution is for faster download of images and attribute as well as command to check the image at any address.

Command to download setup data

This command downloads the set-up data. These set up are saved on microSD

command format:	**2AH**	[00H]	[00H]	[55H]	[flag]	[address1]	[address2]	[reserved]
transmit format:	(xxH)	(xxAH)	(xxAH)	(xxAH)	(xxAH)	(xxAH)	(xxAH)	(xxAH)

[flag] is one byte sent in ASCII HEX format. (Detail below)
[address 1] is two bytes with value of 0001H to FFFFH sent in ASCII HEX format. This is the address for the image that switch 1 displays upon power up/reboot.
[address 2] is two bytes with value of 0001H to FFFFH sent in ASCII HEX format. This is the address for the image that switch 2 displays upon power up/reboot.
[reserved] is two bytes sent in ASCII HEX format. This is for future use. Customer could use the last byte for storing the data version.

This set up data can be read using the attribute upload command.

The controller disables the timers and switch execution upon receiving this command. However, the switches are still scanned and reported. They are enabled upon reboot/power up or by command from host.

Flag Byte Default value=80H

Bit	Enable Value	Flag	Controller action when flag is set
B0	0	Buzzer	Beeper sound for switch press
B1	0	61H flag	61H is transmitted in response to command.
B2	0	79H flag	79H is transmitted upon completion of command.
B3	0	Switch release report flag	Switch release are reported
B4	0	6EH flag	6CH/6EH is transmitted if there is any error during communication to host.
B5	0	Timers expire report flag	Timers expiration are reported
B6	0	Switch press report flag	Switch presses are reported
B7	0	Address change report flag	Newest address is reported for each switch

Example: **2A30303030 3535 3830 30303031 30303146 30303030** sets all the flags on, points left switch to address 0001H and right switch to address 001FH. The flag takes affect when the controller is reset.

Toll Free 1.877.2BUYNKK (877.228.9655) • **Phone** 480.991.0942 • **Fax** 480.998.1435
www.nkkswitches.com • **Email** engineering@nkkswitches.com

Command to download an image

This command downloads an image from the host to the EEPROM location.

command format:	**28H**	[address]	[image]
transmit format:	(xxH)	(xxAH)	(xxAH)

[address] is two bytes with value of 0001H to FFFFH sent as ASCII HEX format.
[image] is 6144 bytes transmit in ASCII HEX format.

Command to upload an image

This command uploads an image from the microSD location to the host.

command format:	**29H**	[address]
transmit format:	(xxH)	(xxAH)

[address] is two bytes with value of 0001H to FFFFH sent as ASCII HEX format.

The controller transmits back the image (6144 bytes) in HEX format.

Command to download attribute block

This command downloads an attribute block from the host to the EEPROM location.

command format:	**2AH**	[address]	[attribute block]
transmit format:	(xxH)	(xxAH)	(xxAH)

[address] is two bytes with value of 0001H to FFFFH sent as ASCII HEX format.
[attribute block] is eight bytes transmit in ASCII HEX format.

The address and attribute block are saved at this address. When the controller reads the attribute block it compares the requested address to the saved address and if they do not match controller knows that the attribute block is not programmed and ignores it.

Command to upload an attribute block

This command uploads an attribute block from the EEPROM location to the host.

command format:	**2BH**	[address]
transmit format:	(xxH)	(xxAH)

[address] is two bytes with value of 0001H to FFFFH sent as ASCII HEX format.

The controller transmits back the saved address and [Attribute block] in hex format.

Toll Free 1.877.2BUYNKK (877.228.9655) • **Phone** 480.991.0942 • **Fax** 480.998.1435
www.nkkswitches.com • **Email** engineering@nkkswitches.com

Command to display image on left switch at the requested address

This command displays an image on left switch at the requested address.

command format:	**2EH**	31H	[address]
transmit format:	(xxH)	(xxH)	(xxAH)

[address] is two bytes with value of 0001H to FFFFH sent as ASCII HEX format.

Example: 2E 31 30303445 displays the image stored at address 004EH.

Command to display image on right switch at the requested address

This command displays an image on right switch at the requested address.

command format:	**2EH**	32H	[address]
transmit format:	(xxH)	(xxH)	(xxAH)

[address] is two bytes with value of 0001H to FFFFH sent as ASCII HEX format.

Example: 2E 32 30313034 displays the image stored at address 0104H.

Command to increment address on left switch

This command displays an image on left switch at the address+1.

command format:	**2EH**	33H
transmit format:	(xxH)	(xxH)

Example: Start at address 00A1H. Send 2E 33 and the left switch displays the image stored at address 00A2H. Send 2E 33 again and the left switch displays the image stored at address 00A3H.

Command to increment address on right switch

This command displays an image on right switch at the address+1.

command format:	**2EH**	34H
transmit format:	(xxH)	(xxH)

Example: Start at address 0F09H. Send 2E 34 and the right switch displays the image stored at address 0F0AH. Send 2E 34 again and the right switch displays the image stored at address 0F0BH.

Command to decrement address on left switch

This command displays an image on left switch at the address-1.

command format:	**2EH**	35H
transmit format:	(xxH)	(xxH)

Toll Free 1.877.2BUYNKK (877.228.9655) • **Phone** 480.991.0942 • **Fax** 480.998.1435
www.nkkswitches.com • **Email** engineering@nkkswitches.com

Example: Start at address 1004H. Send 2E 35 and the left switch displays the image stored at address 1003H. Send 2E 35 again and the left switch displays the image stored at address 1002H.

Command to decrement address on right switch

This command displays an image on right switch at the address-1.

command format:	**2EH**	36H
transmit format:	(xxH)	(xxH)

Example: Start at address 2345H. Send 2E 36 and the right switch displays the image stored at address 2344H. Send 2E 36 again and the right switch displays the image stored at address 2343H.

Commands to download information directly to OLED switches/displays

Note: Care must be taken using these commands. The OLED switches/displays could get damaged if they are initialized with a value exceeding the specifications. Please check the OLED switches/displays data sheet and application notes before using these commands.

Command to download data directly to OLED switches/displays

This command downloads data directly from the host to the OLE**D switches/displays.**

command format:	**2FH**	53H	[number]	[data]
transmit format:	(xxH)	(xxH)	(xxAH)	(xxAH)

[number] is one byte sent in ASCII HEX format (01H to 80H). This is the number of data bytes (1 to 128 bytes).
[data] is 1 to 128 bytes sent in ASCII HEX format.

The controller sends the [data] to both OLED modules as data.

Command to download a command directly to OLED switches/displays

This command downloads a command from the host to the OLED switches/displays.

command format:	**2FH**	47H	[number]	[data]
transmit format:	(xxH)	(xxH)	(xxAH)	(xxAH)

[number] is one byte sent in ASCII HEX format (01H to 80H). This is the number of data bytes (1 to 128 bytes).
[data] is 1 to 128 bytes sent in ASCII HEX format.

The controller sends the [data] to both OLED modules as a command.

Toll Free 1.877.2BUYNKK (877.228.9655) • **Phone** 480.991.0942 • **Fax** 480.998.1435
www.nkkswitches.com • **Email** engineering@nkkswitches.com

7850 East Gelding Drive • Scottsdale, AZ 85260-3420

Command to download a command directly to OLED switches/displays (special)

This command turns off the OLED module, downloads a command from the host to the OLED switches/displays, and turns it back on.

command format:	**2FH**	49H	[number]	[data]
transmit format:	(xxH)	(xxH)	(xxAH)	(xxAH)

[number] is one byte sent in ASCII HEX format (01H to 80H). This is the number of data bytes (1 to 128 bytes).
[data] is 1 to 128 bytes sent in ASCII HEX format.

The controller turns off the OLED display switches, sends the [data] to both switches as a command and then turns on the OLED display switches.

Toll Free 1.877.2BUYNKK (877.228.9655) • **Phone** 480.991.0942 • **Fax** 480.998.1435
www.nkkswitches.com • **Email** engineering@nkkswitches.com

7850 East Gelding Drive • Scottsdale, AZ 85260-3420

9. Version 2.6 New Character Commands for OLED switches/Displays

The following commands allow changing of the images being displayed. Host can download ASCII characters to a specified location and the controller creates the graphic image using a 7x10 font look up tables based on ON/OFF pixel colors. Host can download the ON pixels and OFF pixels colors. These colors stay in effect unless they are changed by host.
Host can command the controller to change the status of one or more row of pixels to line color. Host can download the line color. These colors stay in effect unless they are changed by host.
Host can specify the OLED's brightness.
None of these commands affect the storage memory.

Command to specify the OLED brightness (OLED Color & OLED Rocker)

This command specifies the brightness for both OLED color and OLED Rocker.

command format:	**27H**	4EH	[BRIGHTNESS OLED COLOR]	[BRIGHTNESS OLED ROCKER]
transmit format:	**(xxH)**	(xxH)	(xxAH)	(xxAH)

[BRIGHTNESS OLED COLOR] is one byte send as ASCII HEX format. The acceptable values are from 00H to 0FH where 0FH is the brightest. Default (0FH).

[BRIGHTNESS OLED ROCKER] is one byte send as ASCII HEX format. The acceptable values are from 00H to 0FH where 0FH is the brightest. Default (0FH).

The specified brightness levels go to effect immediately and remain in effect for duration of the session.

Command to specify the color for line command (OLED Color)

This command specify the color used in line command.

command format:	**27H**	47H	[Color]
transmit format:	(xxH)	(xxH)	(xxAH)

[Color] is two bytes send as ASCII HEX format. It specifies any of over 65000 available colors. Default (0000H).

The specified color remains in effect only for duration of the session.

Command to specify the OFF/ON colors for Character generator commands (OLED Color)

This command specify the colors used in the character generator command.

command format:	**27H**	49H	[OFF color]	[ON color]
transmit format:	(xxH)	(xxH)	(xxAH)	(xxAH)

[OFF Color] is two bytes send as ASCII HEX format. It specifies any of over 65000 available colors. Default (0000H). This is for background color.

[ON Color] is two bytes send as ASCII HEX format. It specifies any of over 65000 available colors. Default (FFFFH). This is for character color.

The specified colors remain in effect only for duration of the session.

Command to generator characters for OLED color #1

Toll Free 1.877.2BUYNKK (877.228.9655) • **Phone** 480.991.0942 • **Fax** 480.998.1435
www.nkkswitches.com • **Email** engineering@nkkswitches.com

7850 East Gelding Drive • Scottsdale, AZ 85260-3420

This command generate 1 to 12 characters in font 8x10(include the space between the character) from the specified coordinate in the OLED memory. Please note the characters can be generated on the memory outside the viewing area. The controller uses the specified ON/OFF colors.

command format:	**27H**	51H	[# of characters]	[Row]	[column]	[Characters]
transmit format:	(xxH)	(xxH)	(xxAH)	(xxAH)	(xxAH)	[xxH]

[# of characters] is one byte send as ASCII HEX format. The acceptable values are from 01H to 0CH.
[Row] is one byte send as ASCII HEX format. It specifies the starting pixel row of the memory. The acceptable values are from 00H to 36H.
[Column] is one byte send as ASCII HEX format. It specifies the starting pixel column in the memory. The acceptable values are from 00H to 58H.
[Characters] 1 to 12 bytes of ASCII code for characters. The acceptable values for characters are from 20H to 7FH.

Picture 1 OLED on-board memory map

Command to generator characters for OLED color #2

This command generate 1 to 12 characters in font 8x10(include the space between the character) from the specified coordinate in the OLED memory. Please note the characters can be generated on the memory outside the viewing area. It uses the ON/OFF colors.

command format:	**27H**	52H	[# of characters]	[Row]	[column]	[Characters]
transmit format:	(xxH)	(xxH)	(xxAH)	(xxAH)	(xxAH)	[xxH]

[# of characters] is one byte send as ASCII HEX format. The acceptable values are from 01H to 0CH.
[Row] is one byte send as ASCII HEX format. It specifies the starting pixel row of the memory. The acceptable values are from 00H to 36H.

Toll Free 1.877.2BUYNKK (877.228.9655) • **Phone** 480.991.0942 • **Fax** 480.998.1435
www.nkkswitches.com • **Email** engineering@nkkswitches.com

[Column] is one byte send as ASCII HEX format. It specifies the starting pixel column in the memory. The acceptable values are from 00H to 58H.
[Characters] 1 to 12 bytes of ASCII code for characters. The acceptable values for characters are from 20H to 7FH.

Command to change a line color (pixel row) for OLED color #1

This command changes the color of 1 to 64 rows of pixels from the specified row in the OLED memory. . Please note the entire row of the memory change including the outside the viewing area. The controller uses the specified line command color.

command format: **27H** 59H [# of rows] [Row]
transmit format: (xxH) (xxH) (xxAH) (xxAH)

[# of Rows] is one byte send as ASCII HEX format. The acceptable values are from 01H to 40H.
[Row] is one byte send as ASCII HEX format. It specifies the starting pixel row of the memory. The acceptable values are from 00H to 3FH.

Command to change a line color (pixel row) for OLED color #2

This command changes the color of 1 to 64 rows of pixels from the specified row in the OLED memory. . Please note the entire row of the memory change including the outside the viewing area. The controller uses the specified line command color.

command format: **27H** 5AH [# of rows] [Row]
transmit format: (xxH) (xxH) (xxAH) (xxAH)

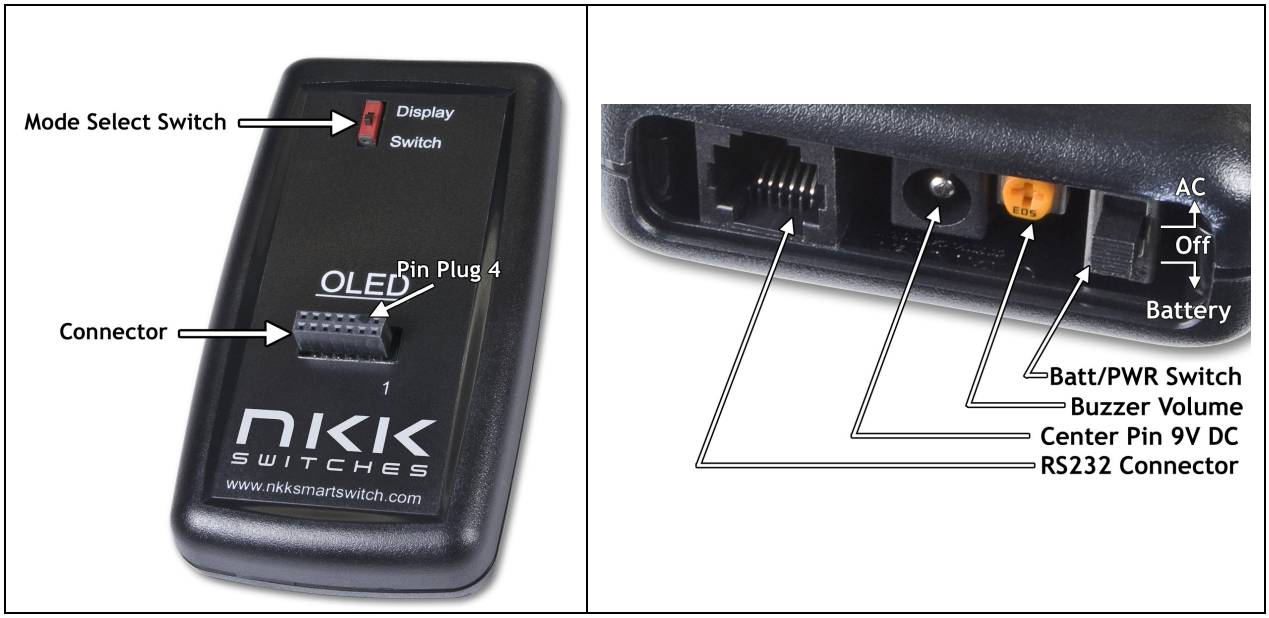
[# of Rows] is one byte send as ASCII HEX format. The acceptable values are from 01H to 40H.
[Row] is one byte send as ASCII HEX format. It specifies the starting pixel row of the memory. The acceptable values are from 00H to 3FH.

Toll Free 1.877.2BUYNKK (877.228.9655) • **Phone** 480.991.0942 • **Fax** 480.998.1435
www.nkkswitches.com • **Email** engineering@nkkswitches.com

7850 East Gelding Drive • Scottsdale, AZ 85260-3420

10. Hardware

Controls Overview



The **Mode Select Switch** has two settings; "Switch" is for the OLED (64x48) switches and "Display" is for the OLED (52x36) displays.
The **Connector** is for the installation of the Logic Boards onto the controller. One pin is keyed to reduce miss mates.

Note: Improper installation of the Logic Boards could damage either/both the Logic Board and controller.

The **Batt/PWR switch** has three positions: battery, off, line power.
Buzzer Volume adjusts the volume of the buzzer that activates when a button is pushed.
The **9V DC Power** jack mates with a 2.5mm cylinder power connector with a center positive.
Power Requirement: 5V to 12V at 100mA Max
The **RS232 Connector** links the controller to the host.

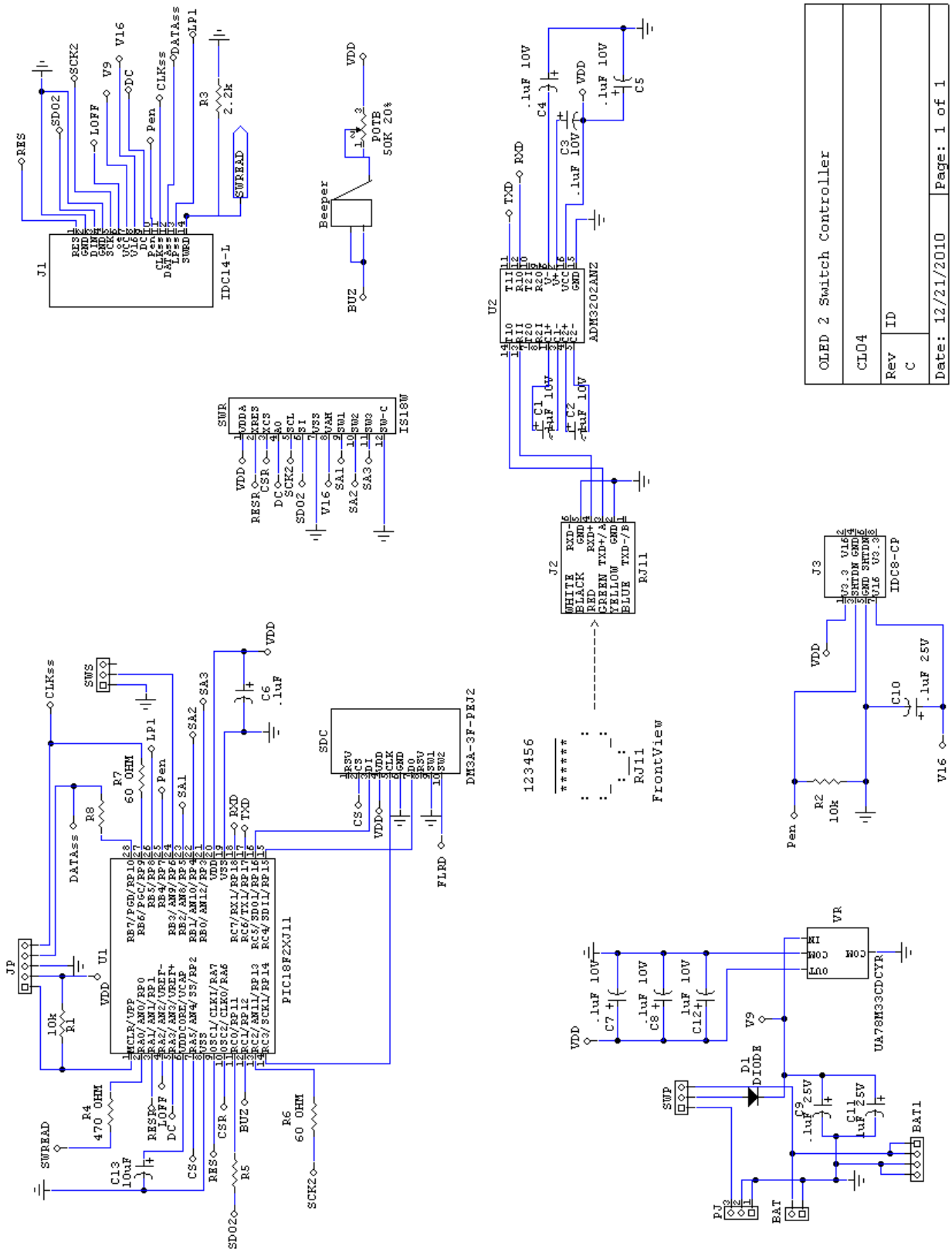
	1	2	3	4	5	6
RS232		GND	TX	RX	GND	

Note: To turn off the controller, press both switches at the same time until the switches are off then turn off the Batt/PWR switch. This step must be followed to comply with OLED power off requirement.

Toll Free 1.877.2BUYNKK (877.228.9655) • **Phone** 480.991.0942 • **Fax** 480.998.1435
www.nkkswitches.com • **Email** engineering@nkkswitches.com

7850 East Gelding Drive • Scottsdale, AZ 85260-3420

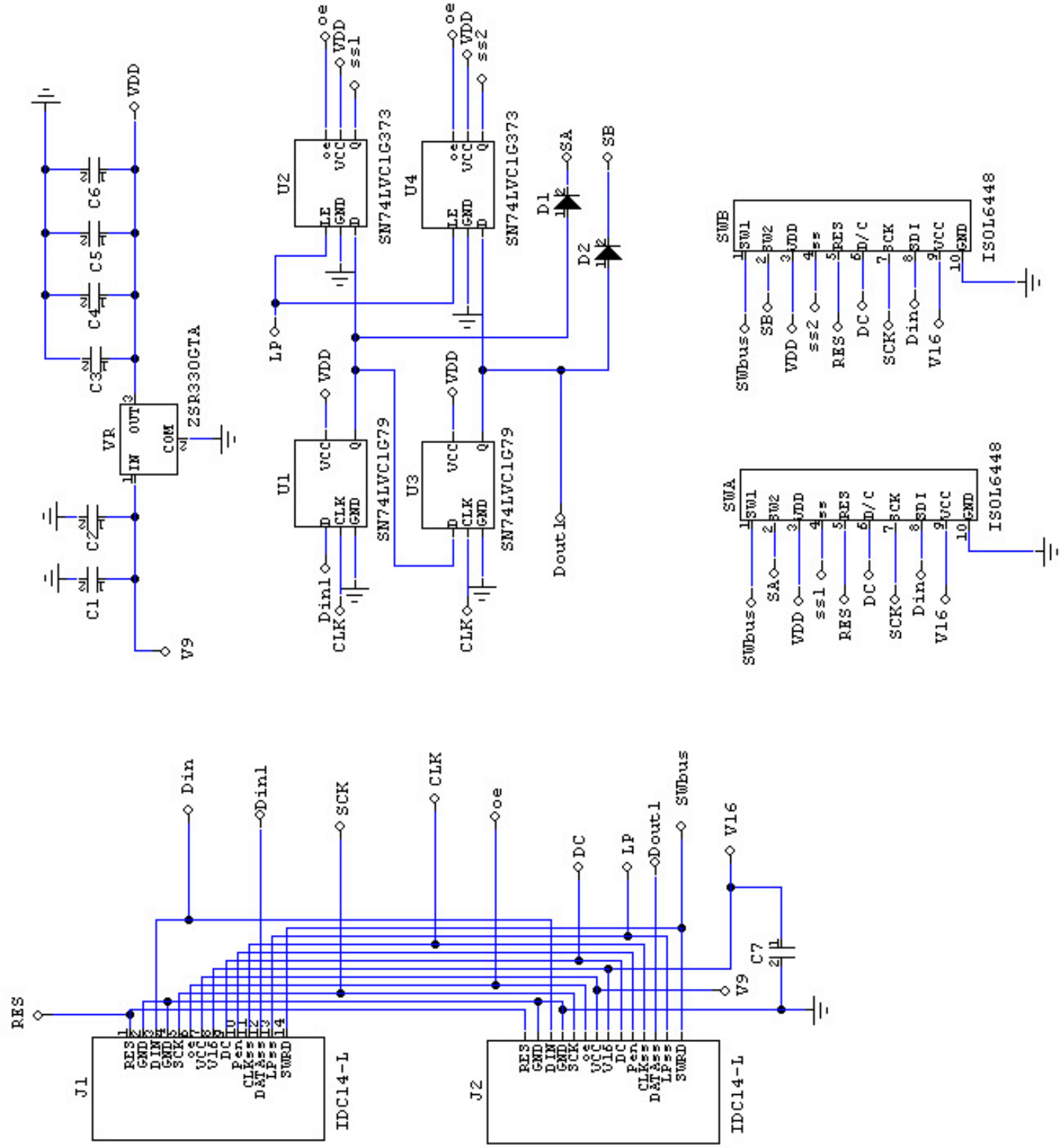
Controller Schematic



Toll Free 1.877.2BUYNKK (877.228.9655) • **Phone** 480.991.0942 • **Fax** 480.998.1435
www.nkkswitches.com • **Email** engineering@nkkswitches.com

7850 East Gelding Drive • Scottsdale, AZ 85260-3420

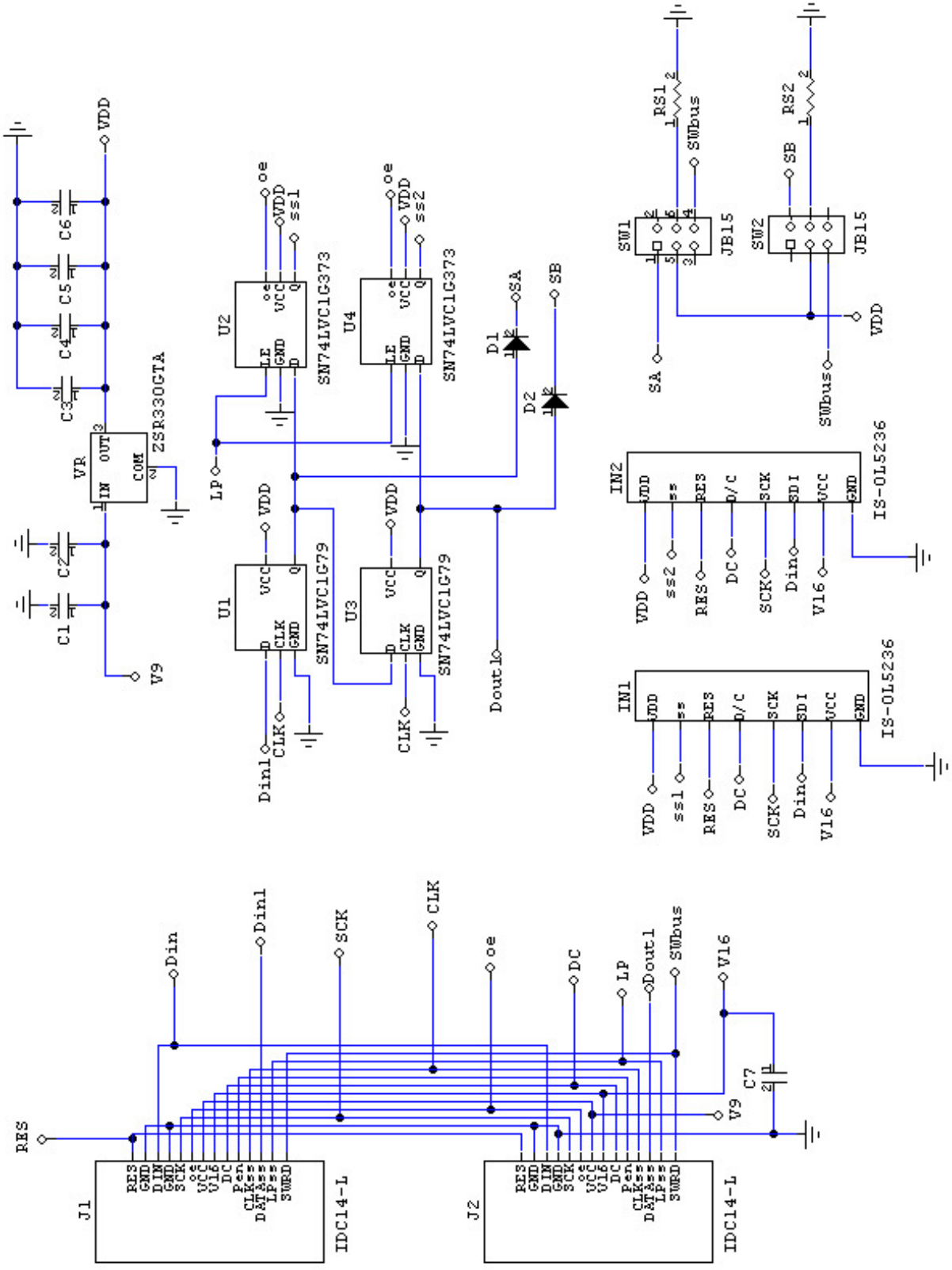
Logic board, IS-L02L1, Two OLED SmartSwitches



Toll Free 1.877.2BUYNKK (877.228.9655) • **Phone** 480.991.0942 • **Fax** 480.998.1435
www.nkkswitches.com • **Email** engineering@nkkswitches.com

7850 East Gelding Drive • Scottsdale, AZ 85260-3420

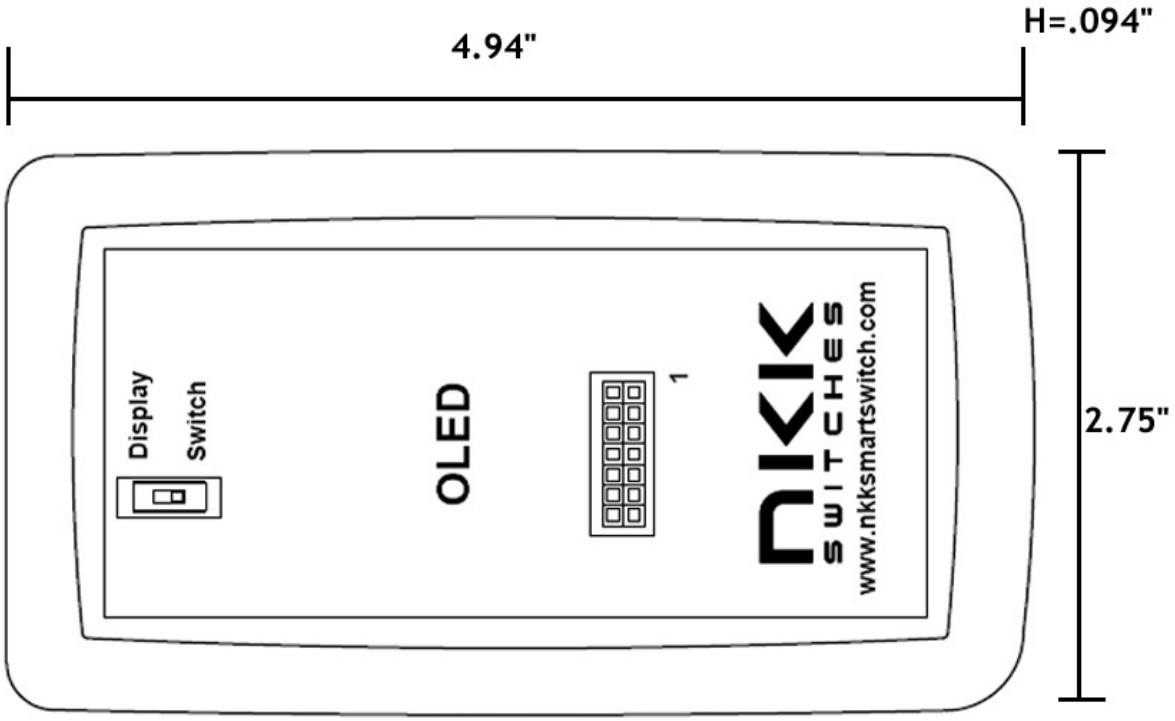
Logic board, IS-L02P1, Two OLED SmartDisplays



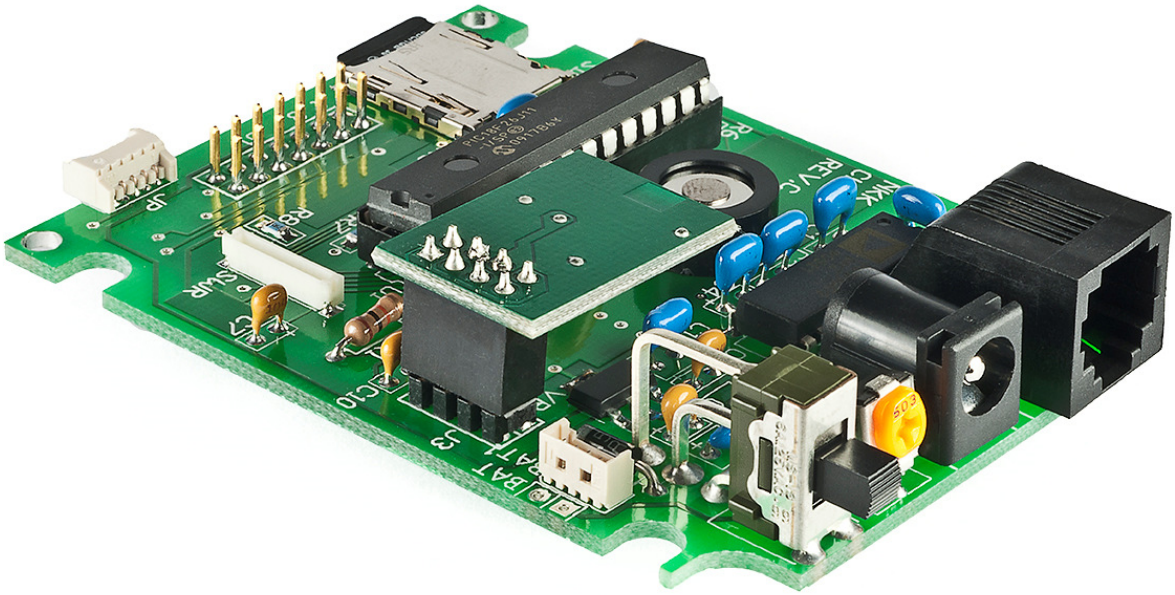
Toll Free 1.877.2BUYNKK (877.228.9655) • **Phone** 480.991.0942 • **Fax** 480.998.1435
www.nkkswitches.com • **Email** engineering@nkkswitches.com

7850 East Gelding Drive • Scottsdale, AZ 85260-3420

Container size



Board photo



Toll Free 1.877.2BUYNKK (877.228.9655) • **Phone** 480.991.0942 • **Fax** 480.998.1435
www.nkkswitches.com • **Email** engineering@nkkswitches.com

7850 East Gelding Drive • Scottsdale, AZ 85260-3420

11. Key Terms & Definitions

OLED module — NKK Switches' OLED SmartSwitches and SmartDisplays.

Host — Any computer, terminal, or other device that can communicate over the RS232 line.

Controller — A PCB assembly that controls one or more logic boards and the switches associated with them. It communicates with a host over the RS232 line.

Logic Board — A PCB assembly with "glue logic" for mounting switches. It is controlled by a controller.

Byte — An eight bit hex value ranging from 00H to FFH (Decimal 0 to 255). The bit format of a byte is: (B7 B6 B5 B4 B3 B2 B1 B0) where B7 is most significant and bit B0 is least significant bit.

Nibble/Hex digit — A four bit value ranging from 0H to FH. A byte consists of two nibbles.

ASCII — A byte value representing a symbol.

Communication Format — There are two formats to transmit a byte:

1. **Hex format** - A hex byte is transmitted without any change to it. [**xxH**] will be used to denote this.

   All commands and some data are sent by using this format.

2. **ASCII HEX format** - Each nibble of the byte is converted to ASCII code and sent as a byte. [**xxAH**] will be used to denote this.

   For example, the hex byte 5AH is transmitted in two bytes, **35H** and **41H**. The ASCII value for **5** is **35H** and the ASCII value for **A** is **41H**.

   All addresses and most data are sent using this format.

Address — A two byte value ranging from 0001H to FFFFH representing the 65536 memory locations for pictures and attributes on microSD flash.

Toll Free 1.877.2BUYNKK (877.228.9655) • **Phone** 480.991.0942 • **Fax** 480.998.1435
www.nkkswitches.com • **Email** engineering@nkkswitches.com

7850 East Gelding Drive • Scottsdale, AZ 85260-3420

12. Firmware issues

The problems found in the most current version are listed below and get resolved in the following version.

Version V2.6

Xon/Xoff was implemented for receive communication. Controller transmits 0x11after power up indicating it is ready for communication. The controller transmits 0x13 when the buffer is ¾ full and transit 0x11 when the buffer is ¼ full.
Character generation commands have been added.

Version V2.4

During batch downloads, due to the different response times of the MicroSD, sometimes the communication buffer gets filled/overwrite so some images would be corrupted.

Toll Free 1.877.2BUYNKK (877.228.9655) • **Phone** 480.991.0942 • **Fax** 480.998.1435
www.nkkswitches.com • **Email** engineering@nkkswitches.com

7850 East Gelding Drive • Scottsdale, AZ 85260-3420

Appendix

Understanding Decimal, Hexadecimal and Binary Numbers

Decimal is the numbering system we use. It is called base-10. Every digit can be between 0 to 9.
The value of each digit is equal to the digit with ((Digit order) -1) zero in front.

Table 1, Base-10								
Value in base-10 Digit x				10000	1000	100	10	1
Multiplication for converting to decimal	$10^{(N-1)}$	…	…	10^4	10^3	10^2	10^1	10^0
Digit order	Nth digit	….	….	Fifth digit	Fourth digit	Third digit	Second digit	First digit

Example: The value of each digit of the Base-10 number 7605 is as follow:

Fourth digit:	7 with (4-1) zero =	7000
Third digit:	6 with (3-1) zero =	600
Second digit:	0 with (2-1) zero =	0
First digit:	5 with (1-1) zero =	5

Numbering system
A numbering system can be based on any number (base-N). However it has to follow the rules:
1. Each digit has to be between 0 to (Base minus one). For example:
   ---Each digit for Base-2 numbering system can be 0 or 1
   ---Each digit for Base-5 numbering system can be 0 to 4
   ---Each digit for base-8 numbering system can be 0 to 7

2. The value of each digit is equal to the digit with ((Digit order) -1) zeros in front.
All the operations that we use on base 10 numbering system such as addition, subtraction, multiplication, division… works the same for all the numbering systems. The difference is the carry over will be based on the base-number of the numbering system instead of 10.

Why do we need other base numbering systems?
Computers logic is based on two states:
Yes or No
False or True
High voltage or low voltage

Toll Free 1.877.2BUYNKK (877.228.9655) • **Phone** 480.991.0942 • **Fax** 480.998.1435
www.nkkswitches.com • **Email** engineering@nkkswitches.com

7850 East Gelding Drive • Scottsdale, AZ 85260-3420

Base-2 numbering system (binary)

The numbering system to accommodate the computer logic is called binary or base 2. Each digit of binary can be 0 or 1.

Table 2, Base-2								
Value in base-2 Digit x				10000	1000	100	10	1
Multiplication for converting to decimal	$2^{(N-1)}$	…	…	2^4 =16	2^3 =8	2^2 =4	2^1 =2	2^0 =1
Digit order	Nth digit	….	….	Fifth digit	Fourth digit	Third digit	Second digit	First digit

Example: The value of each digit of the Base-2 number 1010 is as follow:

Fourth digit:	1 with (4-1) zero =	1000
Third digit:	0 with (3-1) zero =	0
Second digit:	1 with (2-1) zero =	10
First digit:	0 with (1-1) zero =	0

To convert a base-2 number to decimal, multiply each digit by multiplier and add them together:

Example: converting base-2 number 1010 to decimal is as follow:
(1 x 8) + (0 x 4) + (1 x 2) + (0 x 1) = 10

To convert a decimal number to base-2 number
---divide the decimal number by 2, the remainder is the first digit of the base-2 number
--- continue dividing quotient by 2 and put the remainder as the next digit until the quotient is equal 0.

Example: Convert the decimal number 21 to base-2

21 divide by 2 = 10 with 1 remainder	First digit = 1
10 divide by 2 = 5 with 0 remainder	Second digit = 0
5 divide by 2 = 2 with 1 remainder	Third digit = 1
2 divide by 2 = 1 with 0 remainder	Fourth digit = 0
1 divide by 2 = 0 with 1 remainder	Fifth digit = 1

21 decimal = 101001 base-2 or binary
The base-2 number 101001 reads as one zero one zero zero one.

Toll Free 1.877.2BUYNKK (877.228.9655) • **Phone** 480.991.0942 • **Fax** 480.998.1435
www.nkkswitches.com • **Email** engineering@nkkswitches.com

7850 East Gelding Drive • Scottsdale, AZ 85260-3420

Base-16 numbering system

Communicating base-2 numbers is difficult for human because of all zero's and one's. To make it easier to present computer data, hexadecimal or base-16 numbering system is used. Four digit of base-2 numbering system convert to one digit of base-16 numbering system. Since we did not have digits for 10, 11, 12, 13, 14 and 15, they were assigned letters A, B, C, D, E and F respectively.

Table 3, Number base conversion

Hexadecimal base-16	Decimal base-10	Binary base-2
0	0	0
1	1	1
2	2	10
3	3	11
4	4	100
5	5	101
6	6	110
7	7	111
8	8	1000
9	9	1001
A	10	1010
B	11	1011
C	12	1100
D	13	1101
E	14	1110
F	15	1111
10	16	10000
11	17	10001
etc	etc	etc

Table 4, Base-16

Value in base-16 Digit x				10000	1000	100	10	1
Multiplication for converting to decimal	$16^{(N-1)}$	…	…	16^4 =65536	16^3 =4096	16^2 =256	16^1 =16	16^0 =1
Digit order	Nth digit	….	….	Fifth digit	Fourth digit	Third digit	Second digit	First digit

Toll Free 1.877.2BUYNKK (877.228.9655) • **Phone** 480.991.0942 • **Fax** 480.998.1435
www.nkkswitches.com • **Email** engineering@nkkswitches.com

Example: Convert 2A7 hex to decimal

Digit 3: 2 x 256 = 512
Digit 2: (10) x 16 = 160
Digit 1: 7x1 = 7

679
2A7 hex = 679 decimal

Example: Convert 925 decimal to hex

925 divide by 16 = 57 with 13 remainder First digit =D
57 divide by 16 = 3 with 9 remainder Second digit = 9
3 divide by 16 = 0 with 3 remainder Third digit = 3

925 decimal = 39D hex

Converting between hex and binary is as easy as replacing each digit of hex with equivalent 4 digit of binary.

Example: convert A5B hex to binary

A = 1010
5 = 0101
B = 1011

A5B hex = 1010 0101 1011 binary
Converting binary to hex is as easy as replacing each 4 digit of binary to equivalent digit of hex. If the binary digits are not multiple of 4 for grouping, add enough zero to the left to make them multiple of 4.

Example: Convert 0111 1010 1111 binary to hex

1111 = F
1010= A
0111 = 7
0111 1010 1111 binary = 7AF hex

Common terms:

Bit = binary digit
Nibble = 4 binary digits
Byte = 8 binary digits = 2 nibbles = 2 HEX digits

Toll Free 1.877.2BUYNKK (877.228.9655) • **Phone** 480.991.0942 • **Fax** 480.998.1435
www.nkkswitches.com • **Email** engineering@nkkswitches.com