7850 East Gelding Drive • Scottsdale, AZ 85260-3420

IS-Dev Kit-8 User's Manual

Revision D

Version 2.6

IS18WWC1W Development Kit.



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1. General Features

The IS-Dev Kit-8 Version 2.6 controls one monochromatic OLED Rocker with a resolution of 96x64 pixels. The CL04 controller is used in IS-DEV KIT-8 as well as IS-DEV KIT-7/7D. For complete features of the CL04 controller refer to IS-CL04R user manual.

Below are current features:

- Controls one OLED Rocker (IS18WWC1W).
    1. Three button rocker; top, middle, and bottom.
    2. White monochrome OLED display with a resolution of 96x64 pixels.
    3. IP64 dust protected & splashproof.
    4. Snap-in mount.

- 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 65536 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 activities.
    - 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 120 mA Max
- Controller board firmware can be customized based on customer requirements.

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2. Thank you for purchasing NKK Switches' IS-Dev Kit-8

By purchasing this kit a new horizon of design is expanding before your eyes. The OLED Rocker 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 Rocker 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

This kit includes:

- Display unit with OLED Rocker (IS18WWC1W) and control board.
- Handling instructions.
- Serial port to RS232 adapter cable.
- Power supply.

IS-Dev Kit-8



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3. Preface

The IS-Dev Kit-8 is a development kit designed to demonstrate the features of the SmartSwitch OLED rocker as well as facilitate the incorporation of the rocker into new application designs. The OLED Rocker is best used for displaying and navigating through a menu so operator can select an action and/or displaying statuses for operator to monitor.

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-8 operates.

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, and 8 covers communication and commands between the host computer and the Dev Kit controller. Section 9 is list of newly added commands. 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.

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4. Operational Overview

Power-up and Brightness Adjustment:
When the power is turned on, the OLED displays the image below and allows for brightness adjustment. The brightness level is displayed in the middle.



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). Pressing the bottom switch will make the display dimmer. Pressing the top switch will make the display brighter. The OLED rated life of 52,000 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

The IS-DEV KIT-8 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 the brightness adjustment mode the OLED Rocker displays the image at address 1 and uses the attribute information of address 1. 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 seven 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.

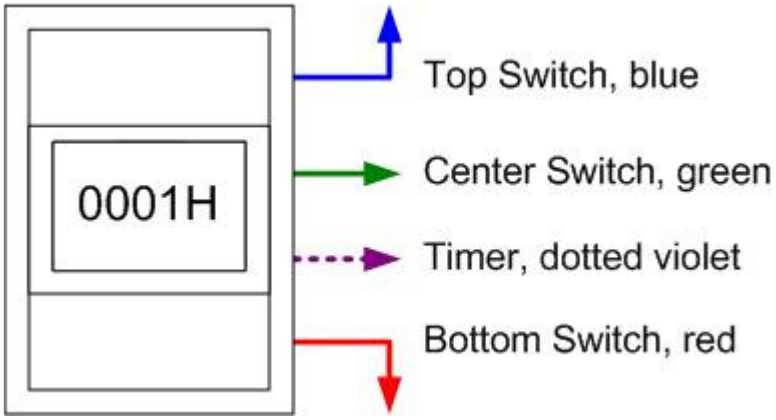
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For visual illustration, through out the document blue is used to show a top switch action, green is a middle switch action, a red is the bottom switch action, and a dotted violet line is the timer action.

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



Attribute Information (Attribute Block)
There are seven attributes per image.

1. Top Switch Address. The address of the image to be displayed if the top switch is pressed. When the top switch is pressed:
   A. If the address is set to 0x0000 there will be no change.
   B. If the address is set to 0x0001 to 0xFFFF the image at the address is displayed and the attributes at the address become active.

2. Middle Switch Address. The address of the image to be displayed if the middle switch is pressed. When the middle switch is pressed:
   A. If the address is set to 0x0000 there will be no change.
   B. If the address is set to 0x0001 to 0xFFFF the image at the address is displayed and the attributes at the address become active.

3. Bottom Switch Address. The address of the image to be displayed if the bottom switch is pressed. When the bottom switch is pressed:
   A. If the address is set to 0x0000 there will be no change.
   B. If the address is set to 0x0001 to 0xFFFF the image at the address is displayed and the attributes at the address become active.

4. End Address. The address of the last image to be displayed in an image sequence starting at the current address and ending at the end address where the speed of the sequence is based on the timer value.
   A. If the timer is set to zero this is attribute is ignored.

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5. Timer. The timer controls how fast to cycle through displaying the images sequentially. The timer can be up to 65 seconds. The images change sequentially from the beginning address (the active attribute address) to the end address (4)
    A. If the timer is set to zero there will be no changes based on the timer.
    B. If the timer is set to a positive number the timer starts running. If any of the switches are pressed, the timer gets reset. If a switch press causes a new image to be displayed the attributes associated with the new image become active.

When the timer expires:

For each timer expire:

- If the address of the image displayed is not equal to the End address (4):
    i. Then the next image is displayed. (The Attribute Block of the new image is ignored.)
    ii. And the timer is reset and starts running again.
- If the address of the image being displayed is equal to the End address (4) then the Middle address (2) of the End address (4) attribute block is checked.
    i. If the Middle address (2) is zero the image from the beginning address is displayed. This will create a loop of the images from beginning address to end address to be displayed until the a switch press causes a change
    ii. If the Middle address (2) is a positive number the image at the address is displayed and the attributes at the address become active.

6 & 7 Reserved for future use and must be set to zero.

5. Programming the IS-Dev Kit-8

The IS-Dev Kit-8 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.

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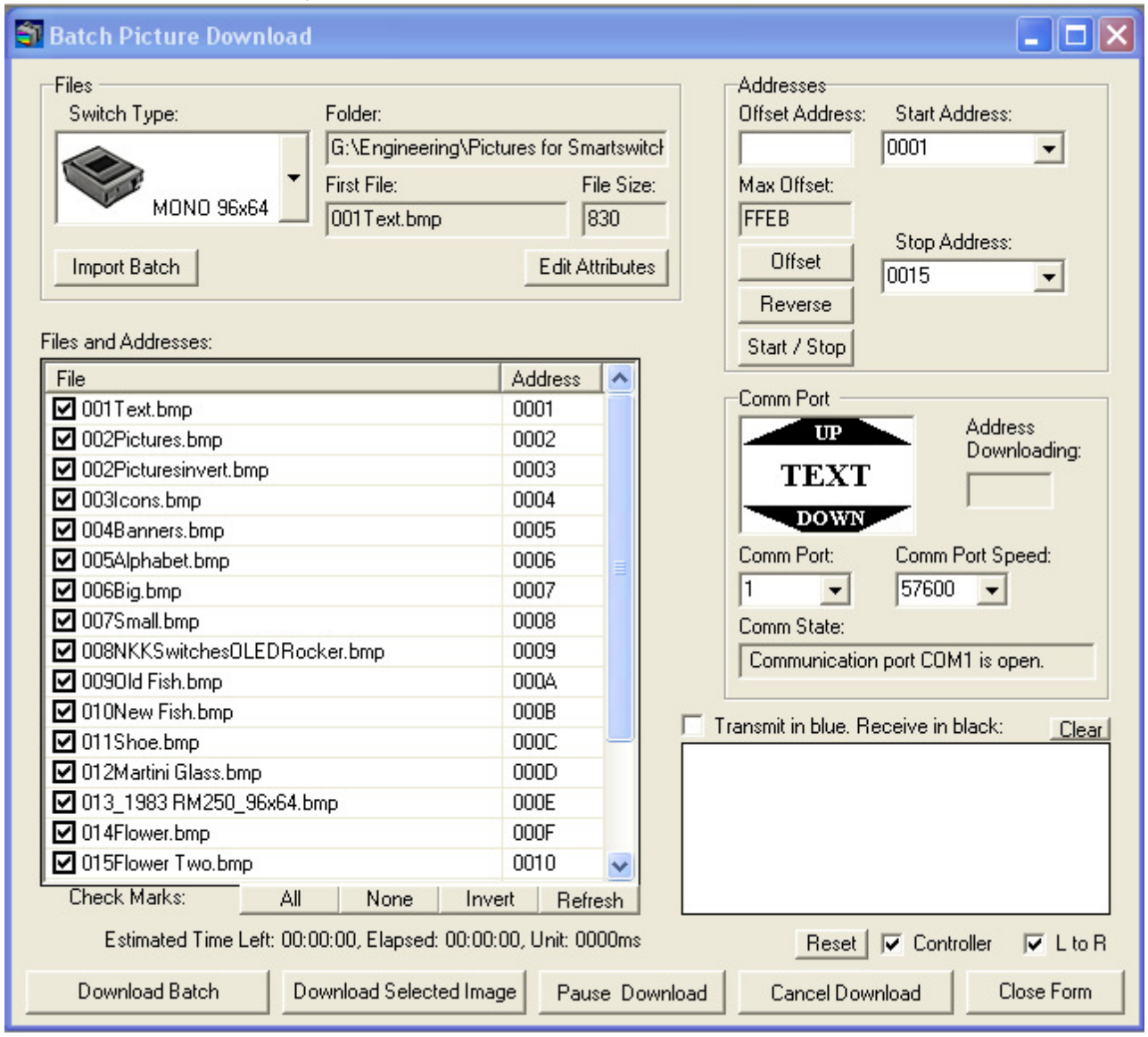
Creating OLED Rocker Images for Universal Communicator

The OLED Rocker display is 96x64 pixel monochrome. 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 96x64 monochromatic 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



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Input/programming the Attribute information

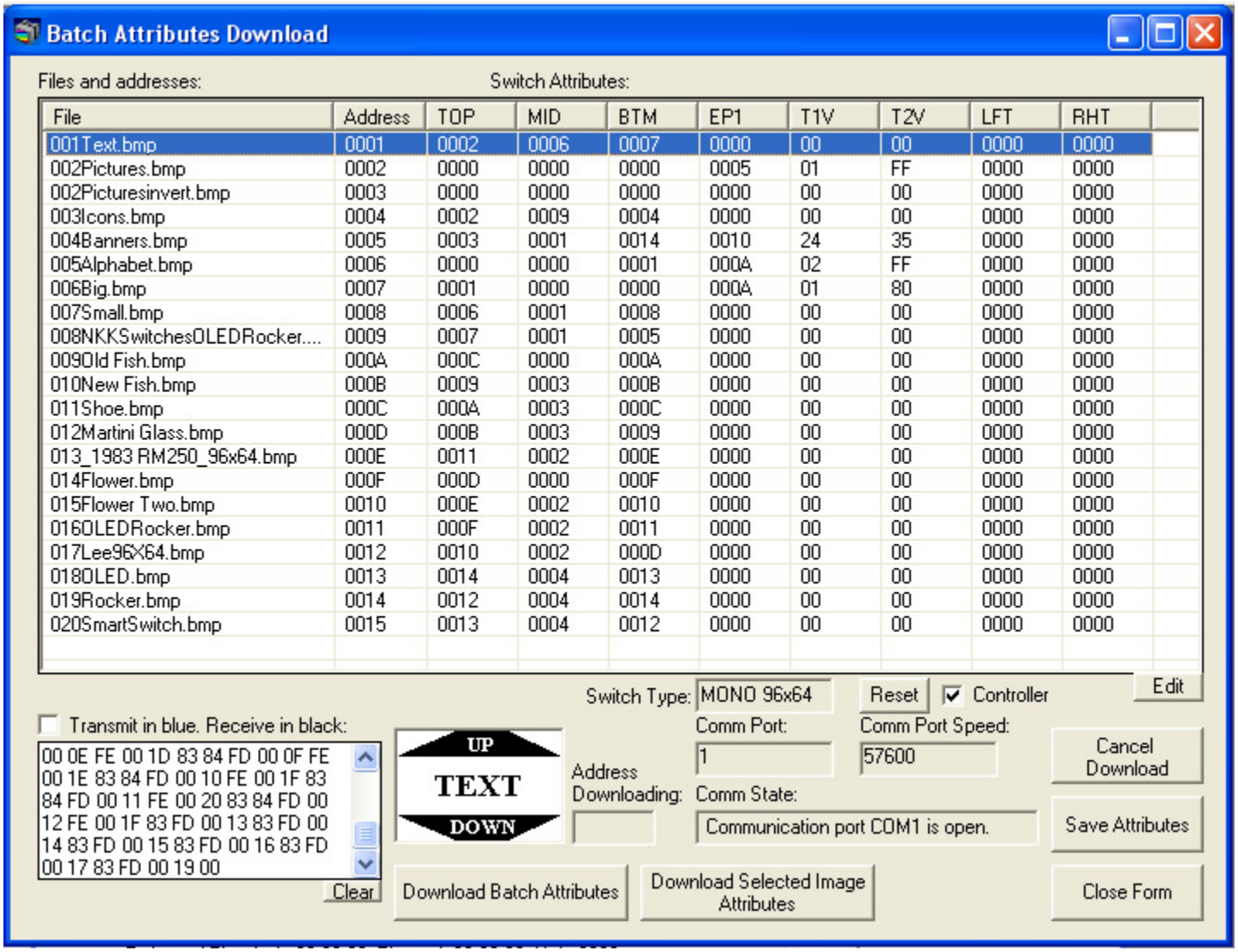
After importing the images into the Universal Communicator (Screen shot 1), Make sure the order of the images are as desired so all the loops for sequential changes based on timer are sequential.

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. There are two additional information inputs which are reserved and should be 0000. The attribute information can be modified by the user.

Screen Shot 2, Universal Communicator Batch Attribute Download Window



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Timer

The timer controls the number of milliseconds to display an image before switching to the next in the sequence. The timer consists of two numbers called Timer2 and Timer1. Each timer is a two digit hex number between 00H and FFH (0 to 255 decimal). If Timer1 is set to zero the timer does not run. If Timer2 is set to 0 it will count as 256.

The amount of time in millisecond = (Timer2) x (Timer1)

The maximum timer is when the Timer1 = FFH and Timer2 = 00H:

The maximum timer value = 255x256= 65280 ms = 65.28 Seconds. The time should not be set for less than 13 ms.

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The timer for 25 frame/s video is 40 ms so some possible Timer1 and Timer2 values can be as followed:
Timer1 = 01H and Timer2= 28H or Timer1=05H and Timer2=08H.
For HEX numbering and conversion between HEX and decimal please refer to the appendix.

An Example of How Attributes Work
The following demonstrate the way attributes of Screen shot 2 (above) works. The Illustration 2 (below) visually demonstrates the way these attributes work.
The blue is the top switch action, the green is the middle switch action, the red is the bottom switch action, and the dotted violet line is the timer action.

Illustration 2, Examples of various loops

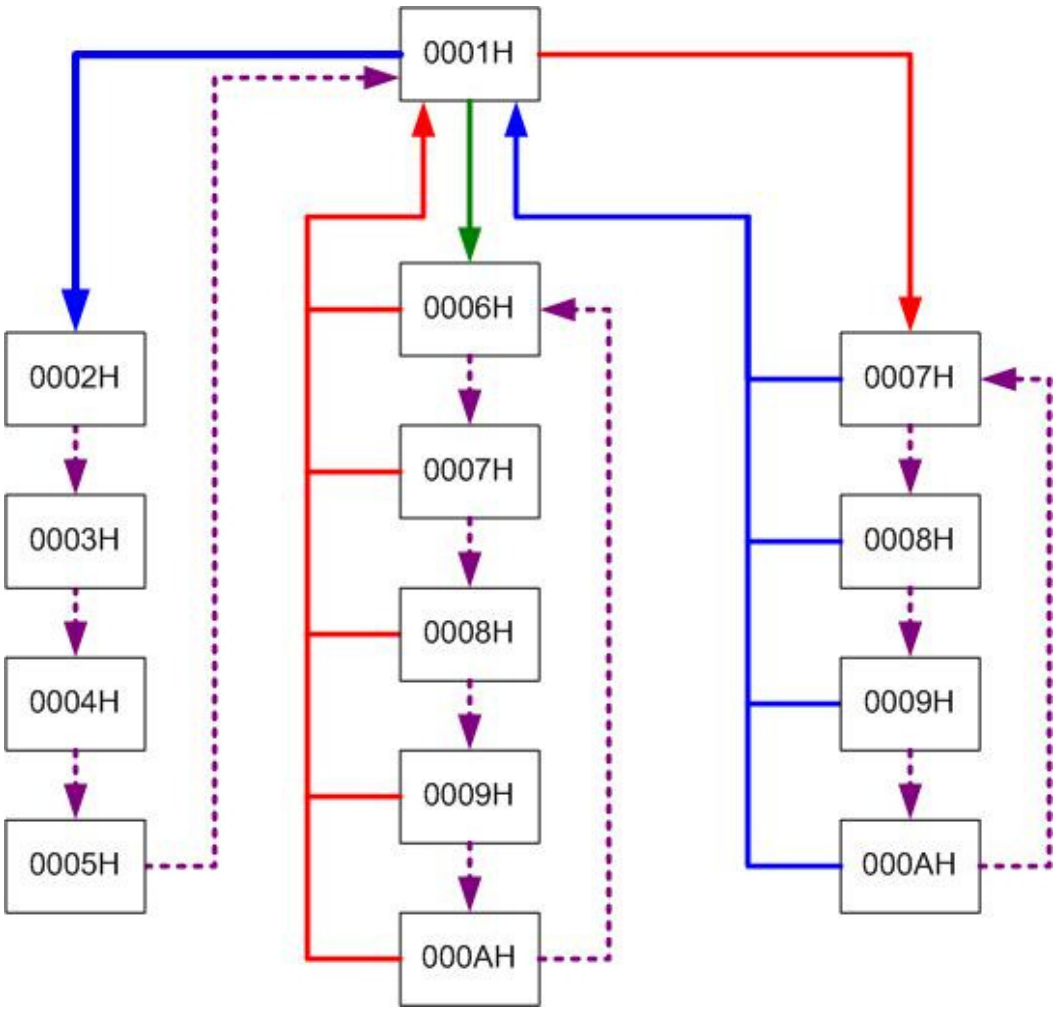


Illustration only shows switch and timer actions that result in an image change on the display. All other attributes are ignored by the controller and are not shown.

When the Dev Kit enters the Main Operational Mode the image at the address 0001H is displayed. The Attribute Block at address 0001H becomes active.

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Attribute Block at address 0001H

Current Address	Top Switch Address	Middle Switch Address	Bottom Switch Address	End Address	Timer2	Timer1
0001H	0002H	0006H	0007H	0000H	00H	00H

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 any of the switches are pressed:

Pressing the Top Switch

Attribute Block at address 0001H

Current Address	Top Switch Address	Middle Switch Address	Bottom Switch Address	End Address	Timer2	Timer1
0001H	0002H	0006H	0007H	0000H	00H	00H

If the top switch is pressed, the image at address 0002H is displayed and the Attribute Block of address 0002H becomes active.

Attribute Block at address 0002H

Current Address	Top Switch Address	Middle Switch Address	Bottom Switch Address	End Address	Timer2	Timer1
0002H	0000H	0000H	0000H	0005H	FFH	01H

Since all 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 Middle 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	Top Switch Address	Middle Switch Address	Bottom Switch Address	End Address	Timer2	Timer1
0005H	0002H	0001H	0014H	0010H	24H	35H

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.

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Pressing the Middle Switch

Attribute Block at address 0001H

Current Address	Top Switch Address	Middle Switch Address	Bottom Switch Address	End Address	Timer2	Timer1
0001H	0002H	0006H	0007H	0000H	00H	00H

If the middle switch, the image at the address 0006H is displayed and the Attribute Block of the address 0006H becomes active.

Attribute Block at address 0006H

Current Address	Top Switch Address	Middle Switch Address	Bottom Switch Address	End Address	Timer2	Timer1
0006H	0000H	0000H	0001H	000AH	FFH	02H

The timer is 510ms. If there is no switch activity for 510ms the timer expires causing the next image, 0007H, to be displayed. This continues until images 0008H, 0009H, and 000AH are also displayed. When the timer expires at address 000AH the address is equal to the End Address. The Middle Switch Address from the Attribute Block of 000AH is then checked.

Attribute Block at address 000AH

Current Address	Top Switch Address	Middle Switch Address	Bottom Switch Address	End Address	Timer2	Timer1
000AH	000CH	0000H	000AH	0000H	00H	00H

Since the Middle Switch Address is zero then the image at address 0006H is displayed and the Attribute Block of address 0006H stay active.

If the bottom switch is pressed in any address from 0006H to 000AH then the image at address 0001H is displayed and the Attribute Block of address 0001H become active.

Pressing the Bottom Switch

Attribute Block at address 0001H

Current Address	Top Switch Address	Middle Switch Address	Bottom Switch Address	End Address	Timer2	Timer1
0001H	0002H	0006H	0007H	0000H	00H	00H

If the bottom switch is pressed, the image at the address 0007H is displayed and the Attribute Block of the address 0007H becomes active.

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Attribute Block at address 0007H

Current Address	Top Switch Address	Middle Switch Address	Bottom Switch Address	End Address	Timer2	Timer1
0007H	0001H	0000H	0000H	000AH	80H	01H

The timer is 128ms. If there is no switch activity for 128ms the timer expires causing the next image, 0008H, to be displayed. This continues until images 0009H and 000AH are also displayed. When the timer expires at address 000AH the address is equal to the End Address. The Middle Switch Address from the Attribute Block of 000AH is then checked.

Attribute Block at address 000AH

Current Address	Top Switch Address	Middle Switch Address	Bottom Switch Address	End Address	Timer2	Timer1
000AH	000CH	0000H	000AH	0000H	00H	00H

Since the Middle Switch Address is zero then the image at address 0007H is displayed and the Attribute Block of address 0007H becomes active.

If the top switch is pressed in any address from 0007H to 000AH then the image at address 0001H is displayed and the Attribute Block of address 0001H become active. Notice that the other attributes within the Attribute Block are ignored. Notice that the loop starting at address 0007H overlaps the loop starting at address 0006H and both end at the same End Address without interfering with each other.

Please note when the 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 Middle Switch Address of the End Address.

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6. 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-8
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. Top switch press is reported as 91H
B. Top switch Release is reported as C1H
C. Middle switch press is reported as 92H
D. Middle switch Release is reported as C2H
E. Bottom switch press is reported as 93H
F. Bottom switch Release is reported as C3H
G. Timer Expire is reported as 94H
H. Upon changing the image, the image address is reported as FCH 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.

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7. Commands

Command to reboot the controller
The command reboots the controller to power-up state.

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

The controller resets itself and transmits 11H when it is ready for operation. Please note there may be other bytes transmitted before 11H, depending on the state of the controller at the reset time.

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. This command does not affect the controller operation.

Command to display image at the requested address
This command displays an image at the requested address on the OLED display. The timer and operations are stopped.

command format:	**2DH**	55H	[address]
transmit format:	(xxH)	(xxH)	(xxAH)

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

Example: 2D 51 30303445 displays the image stored at address 004EH. The attribute block of the address 004EH will be used.

Command to update the display
This command resends the picture from current address to the OLED Rocker. The controller transmits back 61H to the host.

command format: **2CH**
transmit format: (xxH)

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)

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

61H	[mode]	[controller name]	[version]	79H
61	33	43 4C 30 31	12	79

[mode] one byte. 33H indicating OLED switch mode or 34H indicating OLED display mode.
[controller name] 4 bytes. 43H 4CH 30H 31H (CL04)
[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:

61H	[version]	79H
61	11	79

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

Command to disable the timer and switch execution
This command disables the timer and switch execution.

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

The controller disables the timer 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 timer and switch execution
This command enables the timer and switch execution.

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

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

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Command to turn the switch display off
This command turns off the OLED display.

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

Command to turn the switch display on
This command turns on the OLED display.

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

Command to turn the OLED voltage off
This command turns off the 16V supply to the OLED display.

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 display.

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.

Commands that disable switch and timer execution

Upon transmitting any of the following commands, the timer stops 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
The command downloads the flags and other setup values. This information are stored on the MicroSD flash.

command format:	**2AH**	[00H]	[00H]	[55H]	[flag]	[0001H]	[0001H]	[reserved]
transmit format:	(xxH)	(xxAH)	(xxAH)	(xxAH)	(xxAH)	(xxAH)	(xxAH)	(xxAH)

[flag] is one byte sent in ASCII HEX format. (Detail below)
[reserved] is two bytes sent in ASCII HEX format. These bytes should be 00H. This is for future use. Customer could use the last byte for storing the data version.
All other byte must be transmitted with the stated values.

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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	Timer expire report flag	Timer expiration is reported
B6	0	Switch press report flag	Switch presses are reported
B7	0	Address change report flag	Whenever a new image is displayed, the two bytes address, preceding by FCH, are transmitted via RS232.

Example: **2A30303030 3535 3030 30303031 30303031 30303130** sets all the flags ON and set the data version to 10.The flag takes affect when the controller is reset.

Command to upload the setup data
This command uploads the flags and other setup values to the host.

command format: **2BH** 0000H
transmit format: (xxH) (xxAH)

The controller transmits 10 bytes in HEX. The first two bytes are always 00H.

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

61H [address] [setup data] 79H
61 0000 55 00 00 01 00 01 00 10 79

[address] is two bytes with value of 0001H to FFFFH sent as ASCII HEX format.
[setup data] is ten bytes in HEX**.**

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

command format: **28H** 55H [address] [image data]
transmit format: (xxH) (xxH) (xxAH) (xxAH)

[address] is two bytes with value of 0001H to FFFFH sent as ASCII HEX format.
[image] is 768 bytes transmitted in ASCII HEX format.

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An image is handled as a block of 768 bytes. Each pixel requires one bit with eight pixels to a byte.

Byte	Description
1-12	First line of image
13-24	Second line of image
•	
•	
•	
745-756	63th line of image
757-768	64th line of image

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

command format: **29H** 55H [address]
transmit format: (xxH) (xxH) (xxAH)

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

The controller transmits back the image (768 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** 55H [address] [attribute block]
transmit format: (xxH) (xxH) (xxAH) (xxAH)

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

Image and Attribute block

Attribute Block:
An attribute is handled as a block of 14 bytes. Table below show the transmit order of the data.

Byte	Description
1	High byte of action address for Top Switch.
2	Low byte of action address for Top Switch.
3	High byte of action address for Middle Switch.
4	Low byte of action address for Middle Switch.

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5	High byte of action address for Bottom Switch.
6	Low byte of action address for Bottom Switch.
7	High byte of end address.
8	Low byte of end address.
9	Timer 1
10	Timer 2
11	High byte of action address for Left Switch. Reserved. Must be (00)
12	Low byte of action address for Left Switch. Reserved. Must be (00)
13	High byte of action address for Right Switch. Reserved. Must be (00)
14	Low byte of action address for Right Switch. Reserved. Must be (00)

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

command format: **2BH** 55H [address]
transmit format: (xxH) (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 (16 bytes).

Command to display image at the requested address
This command displays an image at the requested address on the OLED display. Stops timer and operation.

command format: **2EH** 51H [address]
transmit format: (xxH) (xxH) (xxAH)

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

Example: 2E 51 30303445 displays the image stored at address 004EH.

Command to increment address and display it
This command increments the pointer to the next address and displays the image. Stops timer and operation.

command format: **2EH** 53H
transmit format: (xxH) (xxH)

Example: Start at address 00A1H. Send 2E 53 and the OLED display displays the image stored at address 00A2H. Send 2E 53 again and the OLED display displays the image stored at address 00A3H.

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Command to decrement address and display it
This command decrements the pointer to the next address and displays the image. Stops timer and operation.

command format:	**2EH**	52H
transmit format:	(xxH)	(xxH)

Example: Start at address 1004H. Send 2E 52 and the OLED display displays the image stored at address 1003H. Send 2E 52 again and the OLED display displays the image stored at address 1002H.

Commands to download information directly to OLED Rocker

Note: Care must be taken using these commands. The OLED Rocker could get damaged if it is initialized with a value exceeding the specifications. Please check the OLED Rocker data sheet and application notes before using this command.

Command to download data directly to OLED Rocker
This command downloads data directly from the host to the OLED Rocker.

command format:	**2FH**	55H	[number]	[data]
transmit format:	(xxH)	(xxH)	(xxAH)	(xxAH)

[number] is one byte sent in ASCII HEX format (02H to 80H). This is the number of data bytes (2 to 128 bytes).
[data] is 2 to 128 bytes sent in ASCII HEX format. The controller sends the first byte as command and the rest as data to OLED Rocker.
This command is provided for checking all the features of the OLED Rocker. It is possible to change the set up, exceed specifications and cause damage to the OLED Rocker. Please follow the specification when using this command.

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8. Version 2.6 New Character Commands for OLED Rocker

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 in normal or inverse, using a 7x10 font look up tables.
Host can command the controller to turn ON/OFF one or more row of pixels.
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 generate characters for OLED Rocker positive mode

This command generates 1 to 16 characters in font 8x10 (include the space between the character) from the specified coordinate in the OLED Rocker memory. Please note the characters can be generated on the memory outside the viewing area. The character pixels are white.

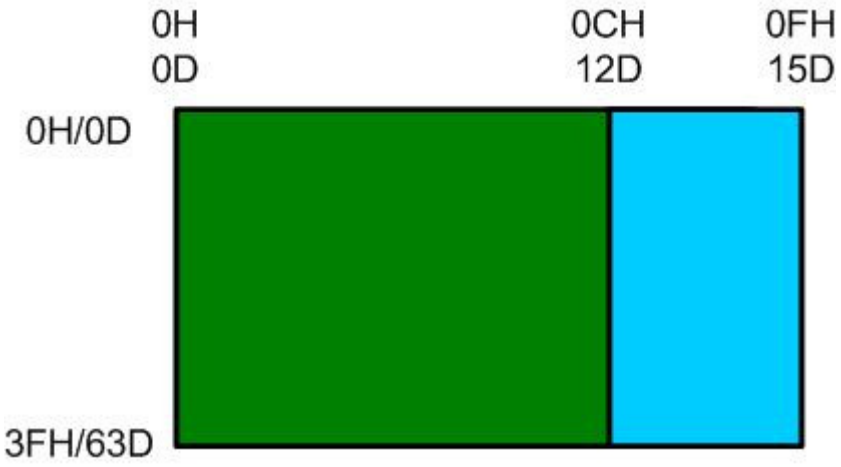
command format:	**27H**	54H	[# of characters]	[Row]	[column]	[Characters]
transmit format:	(xxH)	(xxH)	(xxAH)	(xxAH)	(xxAH)	[xxH]

[# of characters] is one byte send as ASCII HEX format. The acceptable values are from 01H to 10H.
[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 byte column in the memory. The acceptable values are from 00H to 0FH.
[Characters] 1 to 16 bytes of ASCII code for characters. The acceptable values for characters are from 20H to 7FH.

Illustration 2, OLED Rocker on-board memory map

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Command to generator characters for OLED Rocker Negative mode

This command generate 1 to 16 characters in font 8x10(include the space between the character) from the specified coordinate in the OLED Rocker memory. Please note the characters can be generated on the memory outside the viewing area. The character pixels are black.

command format: **27H** 57H [# 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 10H.
[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 byte column in the memory. The acceptable values are from 00H to 0FH.
[Characters] 1 to 16 bytes of ASCII code for characters. The acceptable values for characters are from 20H to 7FH.

Command to set pixel row data to OFF for OLED Rocker

This command set all row pixel data to zero for 1 to 64 rows from the specified row in the OLED Rocker memory. . Please note the entire row of the memory change including the outside the viewing area.

command format: **27H** 5CH [# 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 set pixel row data to ON for OLED Rocker

This command set all row pixel data to one for 1 to 64 rows from the specified row in the OLED Rocker memory. . Please note the entire row of the memory change including the outside the viewing area.

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

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[# 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.

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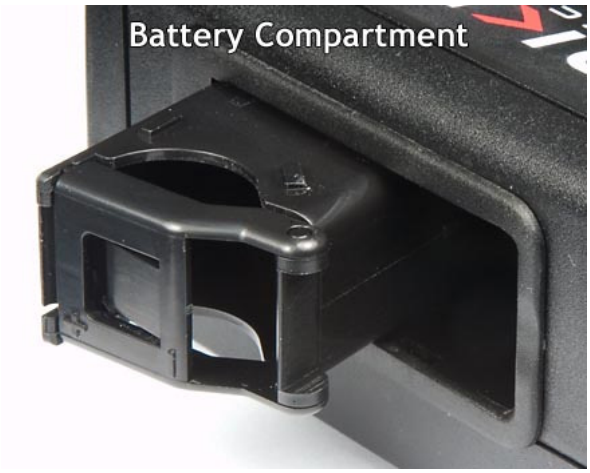
9. Hardware

Controls Overview

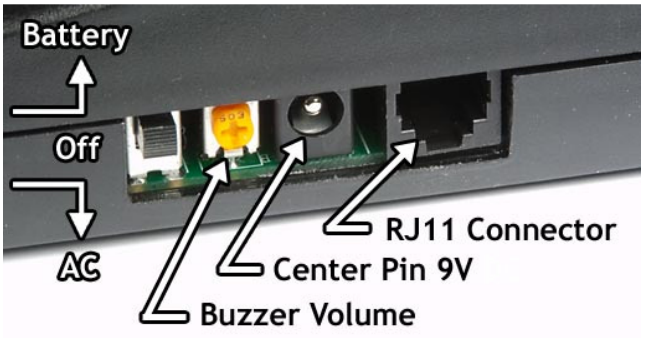
IS-Dev Kit-8



Battery Compartment



Operation Controls:



The **OLED Rocker** has a monochromatic 96x64 OLED display and top, middle, and bottom buttons.
The **Battery Compartment** is for an optional 9V battery.
The **Operation Controls** are as follows:
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.
The **RS232 Connector** links the controller to the host.

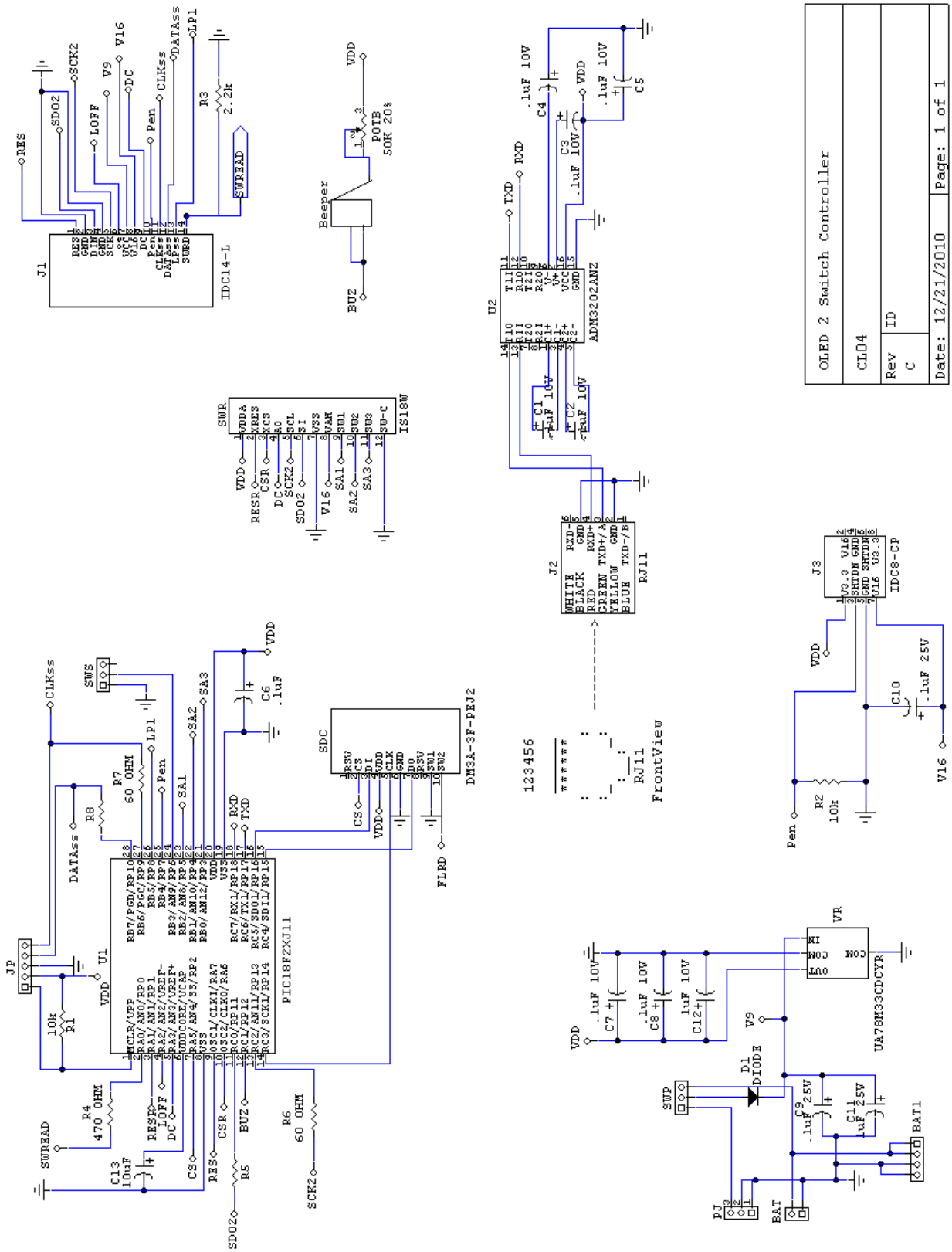
	1	2	3	4	5	6
RS232		GND	TX	RX	GND	

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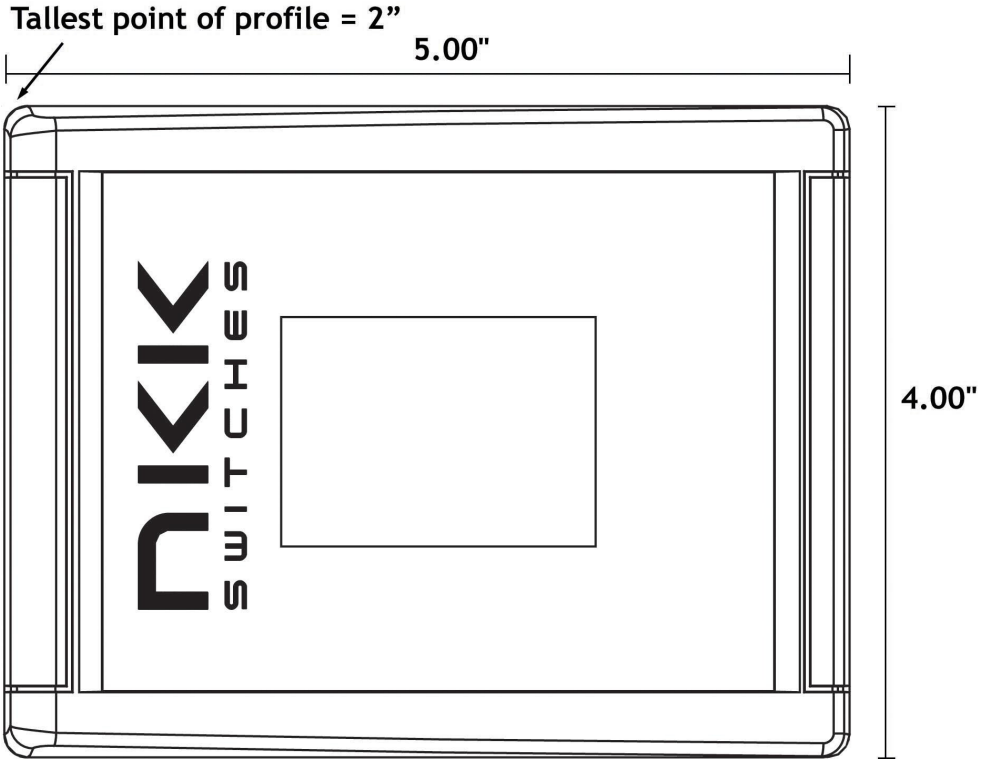
Controller Schematic



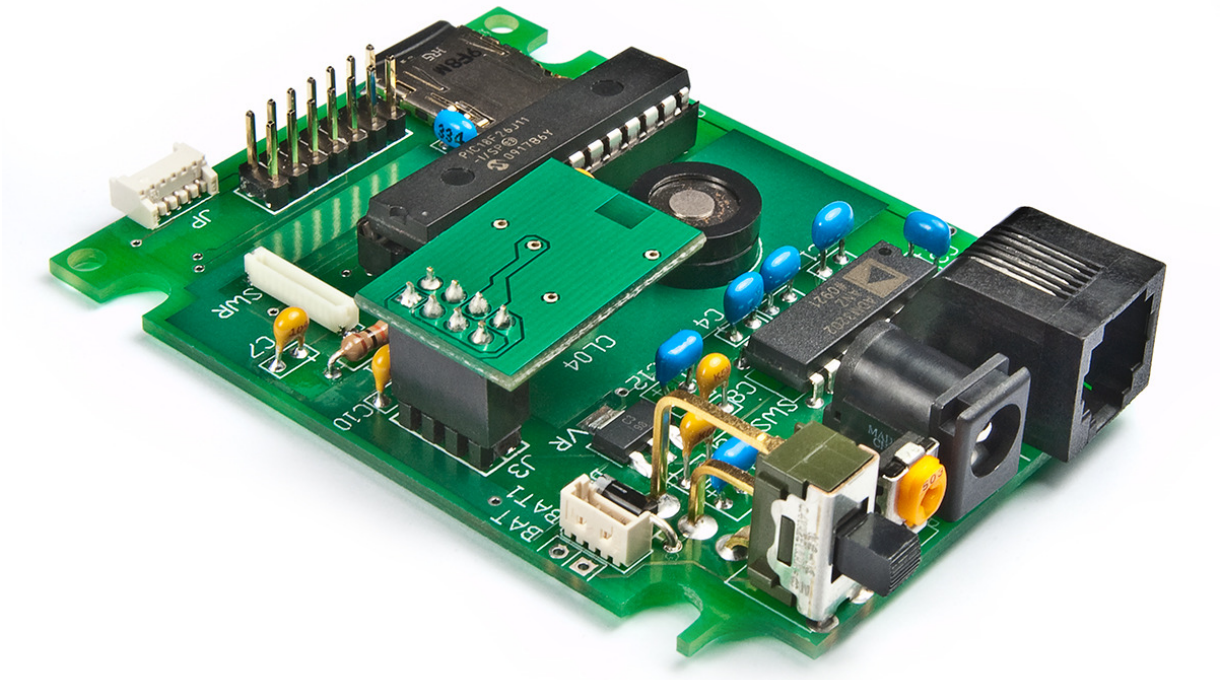
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Container size



CL04 Board photo



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10. 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.

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11. 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.

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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

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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 = 10101 base-2 or binary
The base-2 number 10101 reads as one zero one zero one.

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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

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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

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