

Evaluation Kit for MM04 Printhead Driver Module



APPLICABLE PARTS (SOLD SEPARATELY)

- MM04

INTRODUCTION

This breakout-board evaluation kit provides a plug-and-play platform for testing the capabilities of MM04. The EK48 plugs onto the input edge-card connector of MM04 to connect power and signals to the MM04 module. Its on-board USB-to-serial bridge connects the user's PC to MM04's on-board UART. Used in tandem with the MM04 Manager GUI, the user can get started with MM04 within minutes.

The MM04 Manager is a complete Graphical User Interface (GUI) designed for the evaluation of MM04's various functions without the need for a print data server. The GUI makes it easy to replicate most of the functions outlined in the MM04 Communication Protocol, including the definition of output waveforms and the triggering of fire pulses.

Figure 1: Block Diagram

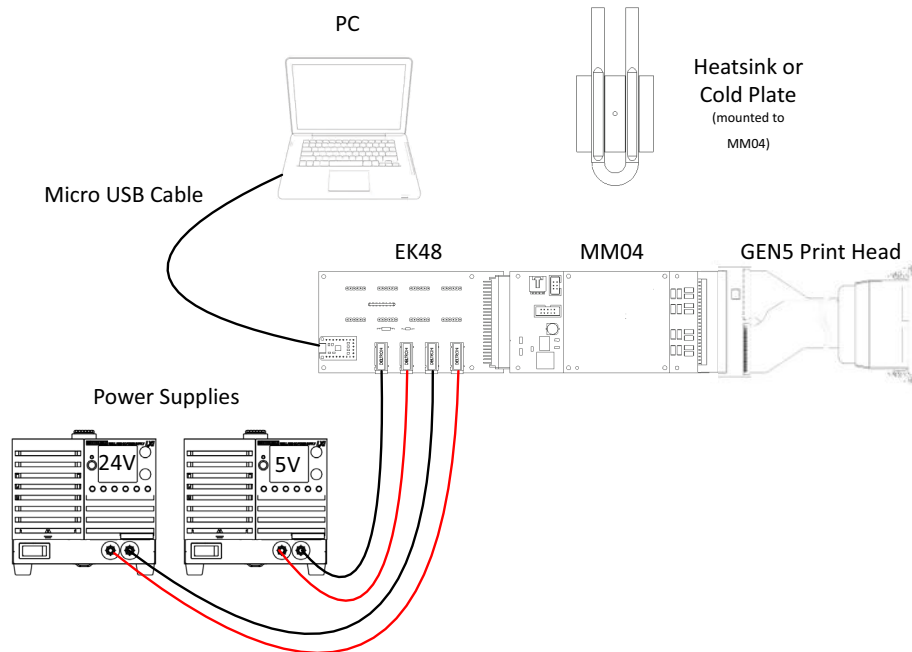
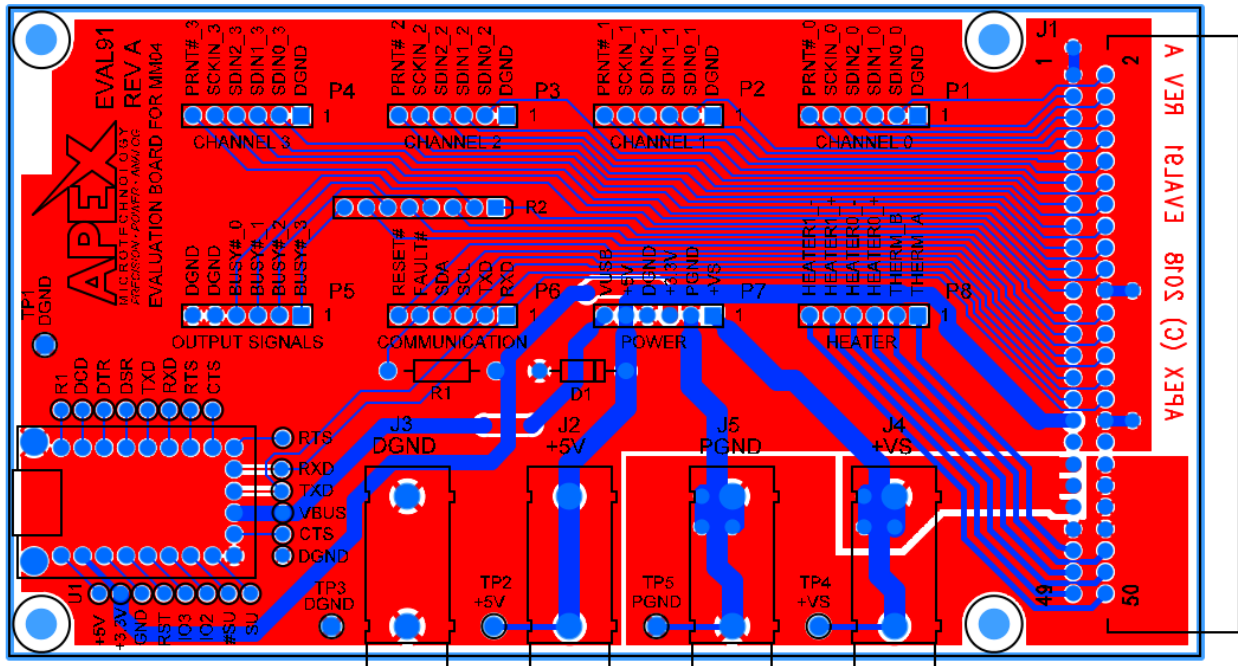
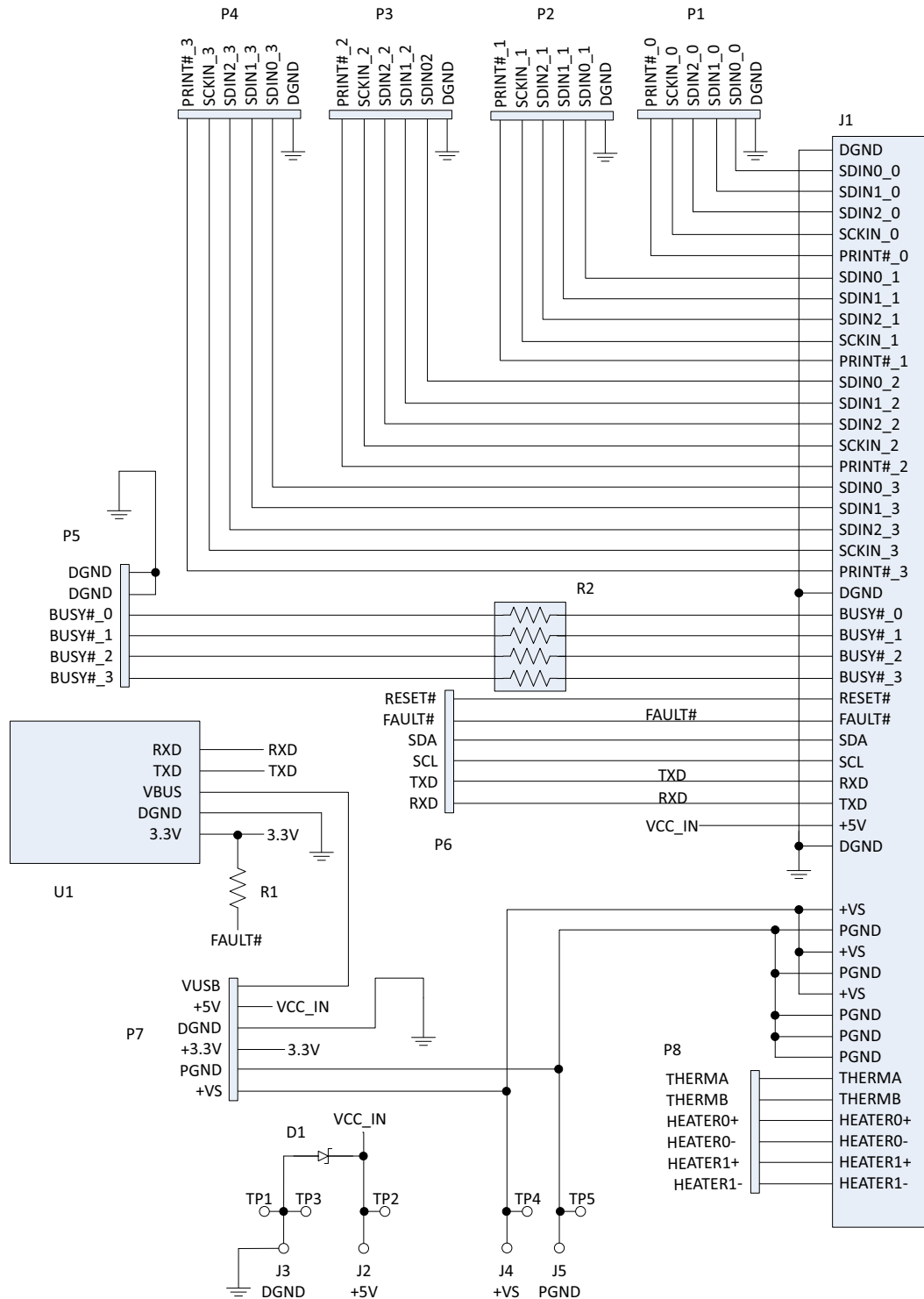


Figure 2: PCB



TOP SILKSCREEN
 TOP SOLDER MASK
 TOP SIDE
 BOTTOM SIDE
 BOARD OUTLINE

Figure 3: Schematic



Note: RXD and TXD on EK48 correspond to the serial bridge device (U1), not the MM04's UART device. For example, to monitor the signal at MM04's RXD pin, attach a probe on the breakout pin labeled "TXD" on the EK48.

PARTS LIST

Reference	Manufacturer Part #	Description/Vendor	QTY
EVAL91	EVAL91	Printed Circuit Board	1
J1	5532600-2	Card Edge Socket	1
J2-J5	571-0100	Horizontal Banana Jacks	4
P1-P8	PREC006SAAN-RC	6 position header	8
R1	CMF5510K000FKEA	10k Resistor	1
R2	4608X-102-510LF	51 Ω Resistor Network	1
D1	1N5232BTR	5.6V Zener	1
U1	3309	USB to UART Bridge	1

BEFORE YOU GET STARTED

- All Apex Microtechnology amplifiers should be handled using proper ESD precautions.
- Do not change the connections while the circuit is powered.
- Check for oscillations.
- Please refer to Application Note AN01 for general operating considerations.

ASSEMBLY

During assembly, please refer to the circuit schematics, assembly drawings, and the MM04 datasheet.

1. Note that all components are inserted from the component side and soldered from the opposite side. The component side has the reference designators printed on that side
2. First install the smaller components on the board. This includes R1, R2, and D2. This is done because it becomes difficult to install a smaller part on the board once all the larger components are installed. R1 and R2 may be installed in either direction, but D2 must match the direction shown in silk screen.
3. Install the 3309 USB to UART bridge. To do this, first break apart the included pin headers into properly-sized pieces. Not all pin headers must be used to mount the 3309. The critical electrical connections are highlighted in figure 4. Other connections may be used for mechanical stability. First "sandwich" all desired pin header connections between the EVAL91 and the 3309. Then, solder the connections from the bottom of EVAL91 and the top of 3309. The USB connector MUST be at the top of the entire assembly.
4. Mount and solder the edge card socket in J1.
5. (OPTIONAL). Solder P1 through P8. These are breakout pins for the MM04's edge card connector and are not necessary if MM04 will be operated entirely through the GUI using a UART connection. If desired, solder one pin of each header from the EVAL91 backside. Realign the pins if necessary and continue to solder the remaining 5 pins of each header.
6. Mount and solder Banana Jacks into J2 through J5.
7. The EK48 is now assembled. Read the directions in "First Time Start" to safely create the system as shown in Figure 1.

Figure 4: Critical 3309 Connections

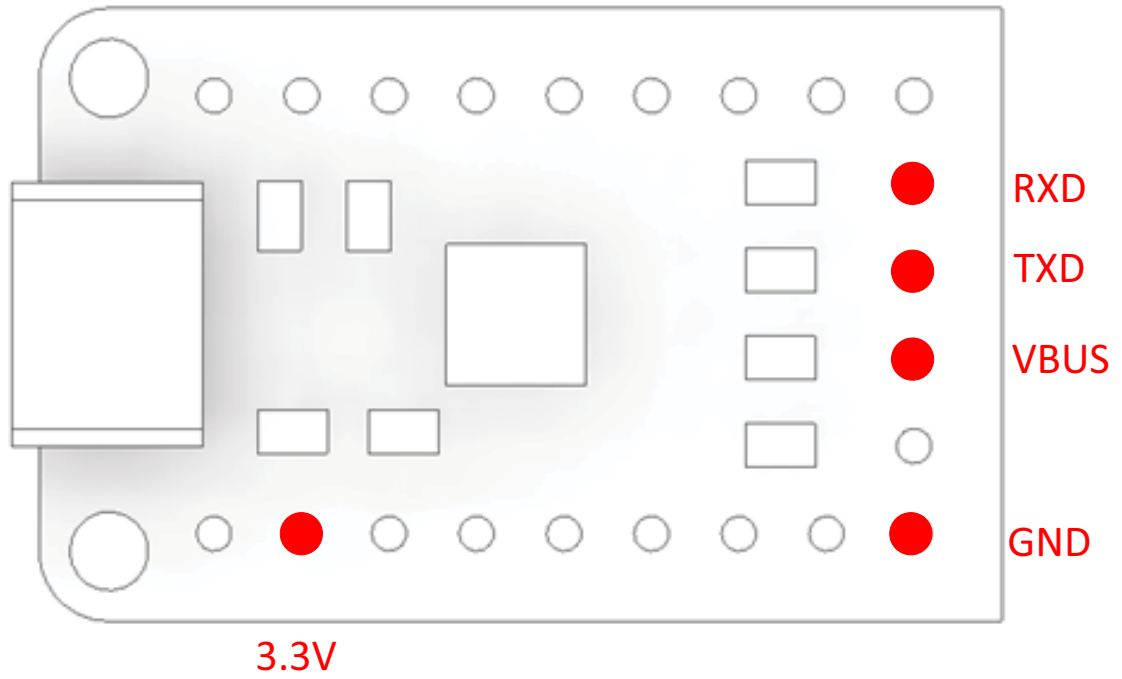
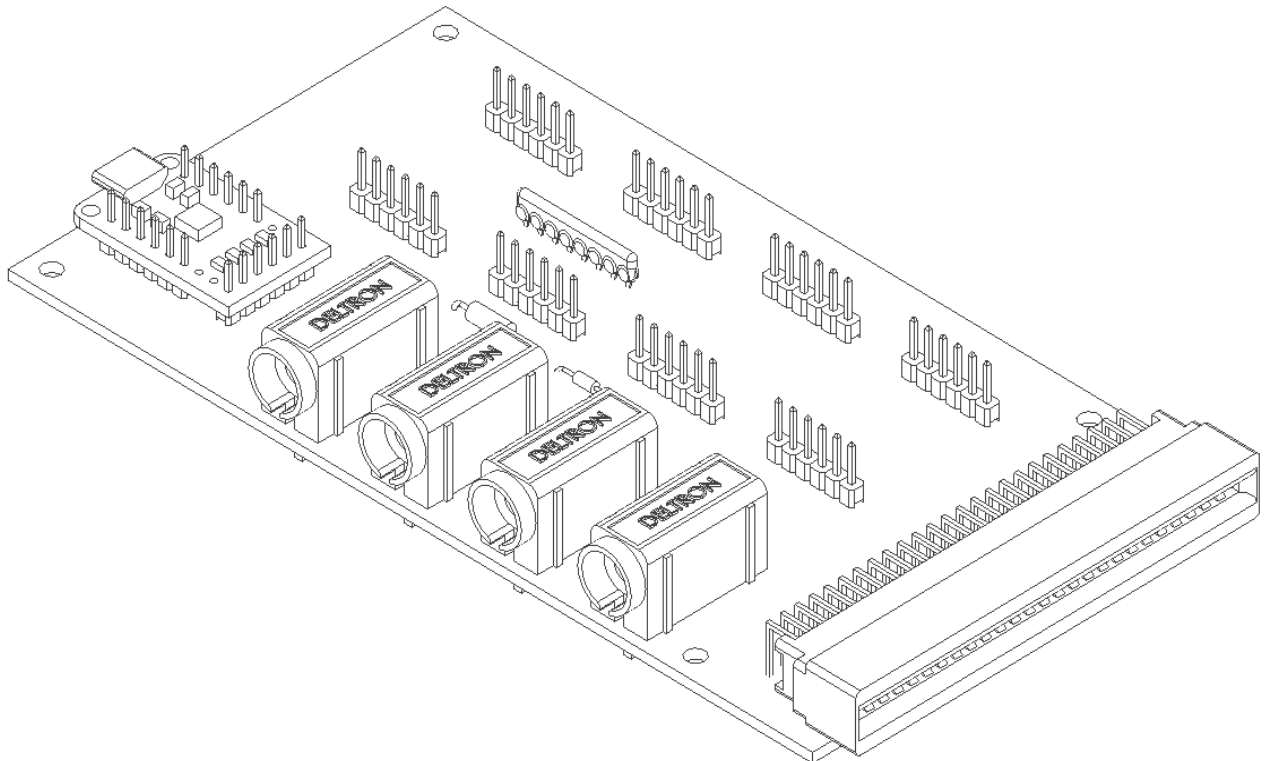


Figure 5: Assembly Diagram



INSTALLING THE MM04 MANAGER

The current MM04 Manager can be downloaded from Apex Microtechnology's website. If you use prototype versions of MM04 please contact Apex Microtechnology before you download and install the software to ensure that your prototype is compatible with the software provided on the website. The current installer only works on Windows™ operating systems. The software is provided with a self installer which will guide you through the installation steps. By installing the software on your computer, you agree to the terms and conditions provided in the licensing agreement that is shown to you at the beginning of the installation process. In particular, you agree that the software is provided to you “as is” without any warranties or conditions of any kind.

FIRST TIME START

When first using EK48 with the MM04 GUI, it is highly recommended to test without +VS or the printhead connected. This is to ensure the COM port is recognized and everything is connected properly. The initial setup should include **only** the following components:

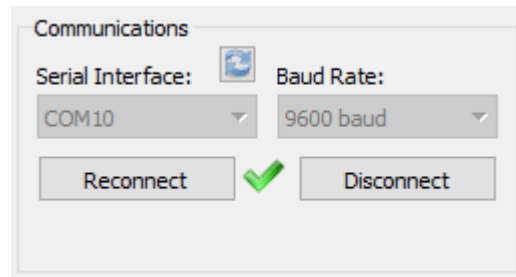
- PC
- USB micro cable
- Assembled EK48
- 5V supply
- MM04 (With MP204 analog portion attached - this is the aluminum backplate plugged into MM04)
- Heatsink and/or cold plate (optional - see MM04 datasheet for mounting instructions).

Assemble all components listed above as shown in Figure 1. The external unpowered 5V supply should be connected between the banana jacks designated “+5V” and “DGND”. This 5V supply must source up to 200mA.

Turn on the 5V supply. Check that the LEDs on MM04 for “VCC_IN”, “VCC”, and “-VB” are all illuminated. The other LEDs should remain dark.

Next, launch the MM04 Manager application. To test communication, select the correct COM port in the “Serial Interface” drop-down menu, select 9600 baud in the “Baud Rate” drop down menu, and press “connect.” If the connection is successful, the window will become full with figures and options, and the manager will read waveform data from the MM04, displaying the waveforms in the window. If no waveform data has been uploaded to MM04, the four graphs in the middle of the window will remain blank. The GUI will display an error indicating that no +VS supply is present; ignore this error for now.

Figure 6: Communications Section after Successful Connection



At this point, the communication has been confirmed functional. You may proceed to edit and upload new waveforms to the module, monitor A/D values, etc. Note that without the +VS supply, none of these options will have any effect on the VCOM outputs. Additionally, the module will not go online due to the +VS voltage being out of range (below 10V).

TESTING WITH +VS

Once the initial test has been completed, the module is ready to be powered with a high-voltage supply. To reduce risk to the module, press "disconnect" from the GUI and power down the 5V supply. Attach the unpowered +VS supply (30V max, 24V typical), leaving all other connections the same. Do not connect a printhead or load to the MM04 output.

Turn on the +5V and +VS supplies according to the Power Supply Sequence section below. This time, the "+VS" and "+VB" LEDs should illuminate in addition to the "VCC_IN", "VCC", and "-VB" LEDs. Connect as before. This time, the GUI should indicate no error codes, and turning the module online will be possible.

It is highly recommended to test all functions of the GUI at this point, before the printhead is connected. Without the printhead, there is very little risk to the analog portion while testing and prototyping. To view the output waveforms, use an oscilloscope to probe on the corresponding test points from the backside of MM04 (see Appendix for a list of relevant test points).

When the correct waveforms have been uploaded and evaluated, and the correct settings are selected, the module is ready to be connected to a printhead. Turn the module offline, turn off "VCOM Levels," press "Disconnect" from the GUI, and follow the power-OFF sequence. Attach a properly-sized heatsink to the analog portion of MM04 (see MM04 datasheet for instructions). Connect the printhead, follow the power-ON sequence, and connect to the module through the MM04 Manager GUI. The module is now ready for a full print evaluation.

POWER SUPPLY SEQUENCE

The power supplies to EK48 should be turned ON in the following order:

1. +5V supply
2. +VS supply

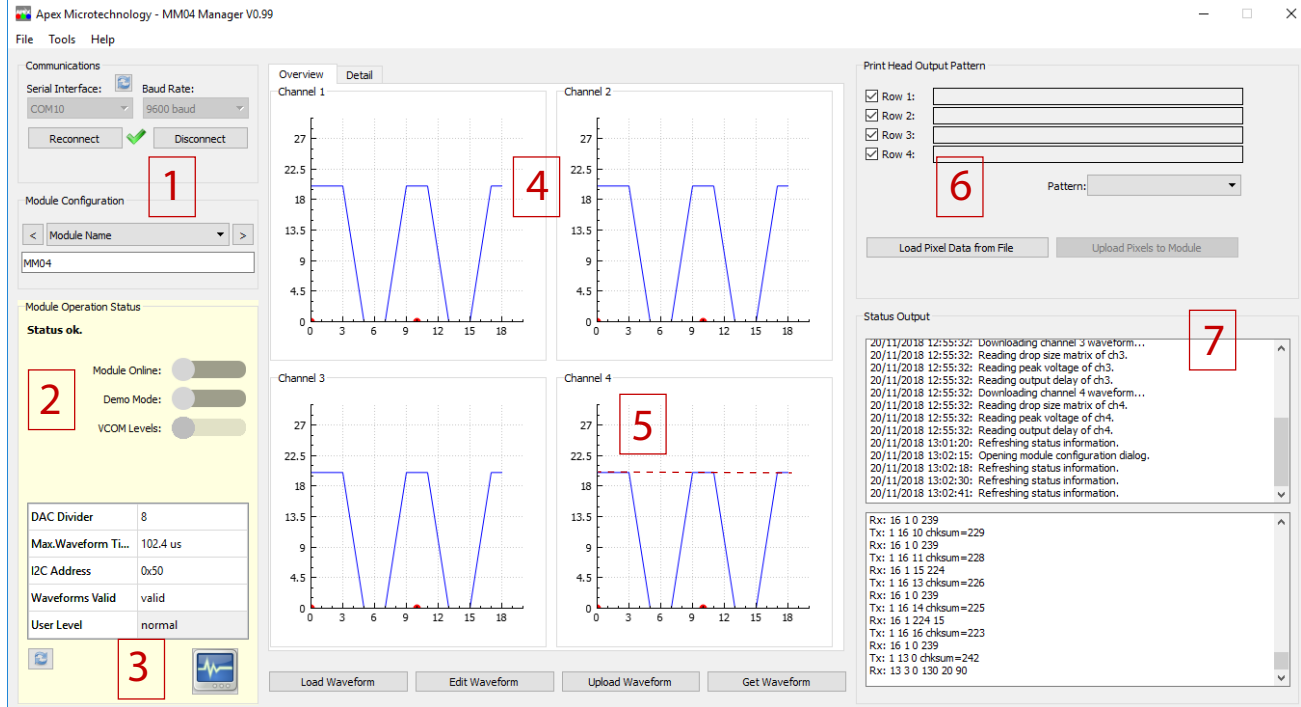
The power supplies to EK48 should be turned OFF in the following order:

1. +VS supply
2. +5V supply

THE MAIN SCREEN

Successful communication will result in the MM04 Manager's main screen shown below:

Figure 7: Main Window



1. Module Configuration - contains information about the MM04 collected when the module was first connected.
2. Module Operation Status - determines the mode of the MM04 and additional user-defined information. Also includes Error indications (see "Troubleshooting" section).
3. A/D Serial Monitor - Selecting this button will display a dialog window of various values monitored on the MM04. Values displayed in the dialog are: +VB, +VS, Ch A, Ch B, Ch C, Ch D outputs, Ch A/B Temperature, Ch C/D temperature and 5V supplies. It should be noticed that there are 2 columns of values, one column containing the raw hexadecimal 12-bit A/D digital word and the other column containing the appropriate converted decimal value.
4. Waveform Display - these four plots display the fire-pulse waveform that the MM04 Manager GUI is ready to upload to the MM04 module. Upon connection, these plots are updated with the waveforms currently downloaded onto the MM04 hardware. Red triangles on the X-axis signify the start of a new pulse.
5. Base Voltage Level - The "idle" output voltage level that is output when VCOM levels (within Module Operation Status) is set high, but no fire pulse is present.
6. Print Head Output Pattern - a visual representation of the Pixel data that will be output to the matrix inputs of the print head. Several pattern options are provided for various grayscales and demonstrations. Note that uploading Pixel Data to the module is only available during "Demo Mode"
7. Status Output - readout of commands sent to MM04. The upper text box contains descriptions of commands, while the lower text box contains the decimal "words" sent to / received from the MM04.

MODULE OPERATION STATUS

This section contains status information that controls the mode of operation for MM04. By changing the slider settings, MM04 can be controlled in various ways.

1. Module Online - Enables pass-through signals through the edge card connector, such as print data and fire pulses. If MM04 is not online (offline), input signals will be ignored. MM04 cannot go online if an error code is present. The “Print” button will only appear when Online Mode is turned on. All channels will be commanded to print simultaneously when the “Print” button is clicked.
2. Demo Mode - Enables print data and file pulses to be sent through the GUI, disabling the pass-throughs from the edge card connector.
3. VCOM - Sets outputs of all channels to their programmed Base Voltage Level.

For desired functions, set the operation modes as follows

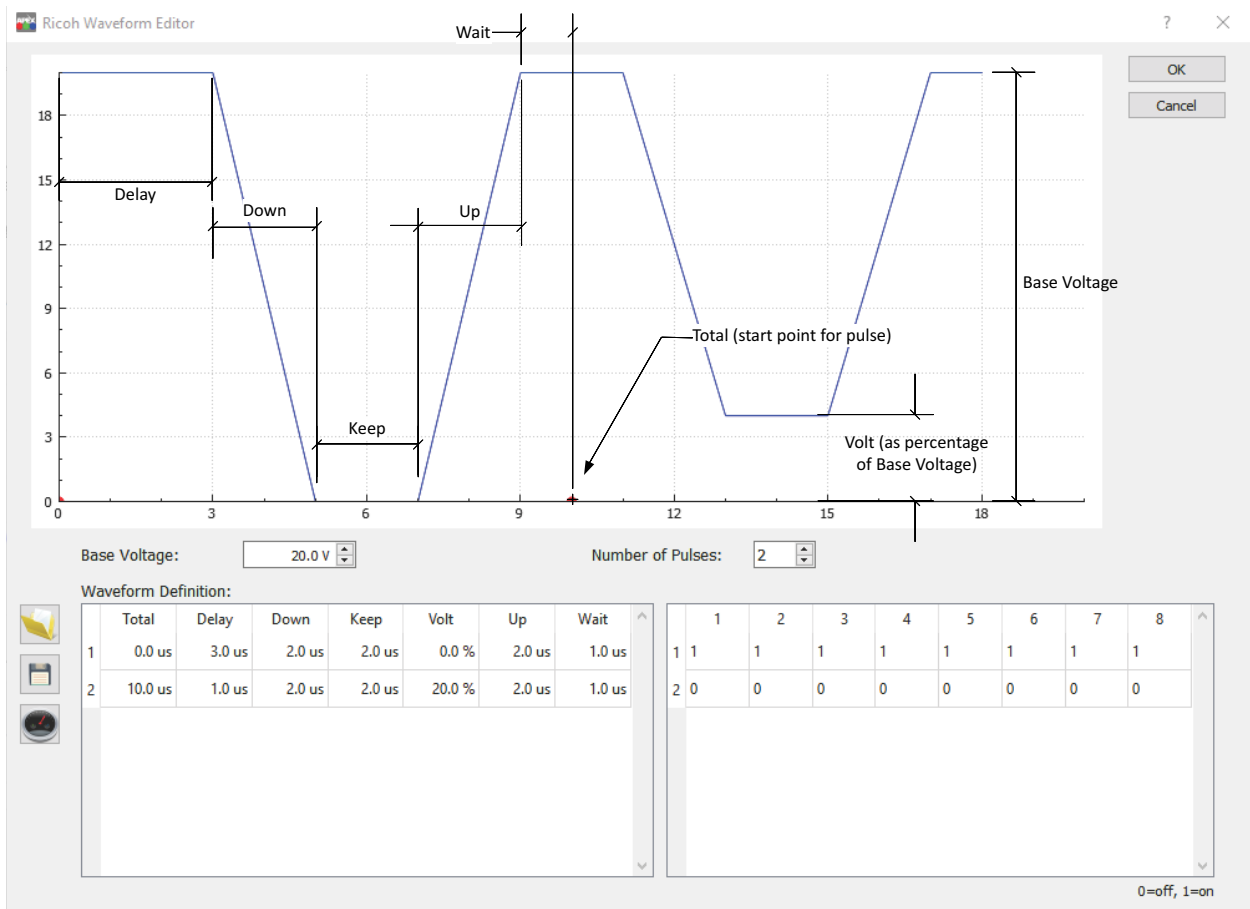
Function	Module Online	Demo Mode	VCOM
Test Analog functionality (output base voltage)	-	-	ON
Print from GUI	ON	ON	ON
Print from Edge Card Connections	ON	OFF	ON
Upload Waveforms	OFF	-	-
Upload Pixel Data	-	ON	-

WAVEFORM EDITING

Uploading waveforms to MM04 can be done one of two ways:

1. Press the **“Load Waveform”** button to locate a CSV or Excel format document which contains the waveform information. For an example of proper document formatting, use the **“Save”** functionality from within the **“Edit Waveform”** dialog.
2. Press the **“Edit Waveform”** button to open a dialog with options for adding/removing pulses, changing timings, voltage values, associated drop size matrix data, etc. See figure 8 for a visual representation of the settings.

Figure 8: Waveform Editor



CHANGING USER PRIVILEGES

Four user states exist: Normal, Elevated, Supervisor, and Factory. The specific differences between Normal, Elevated, and Supervisor levels are detailed in the MM04 Communication Protocol. The major differences are as follows:

User Status	Description
Normal	Allows typical print and demonstration capabilities
Elevated	Additionally enables "Configure the Module" in Tools menu and independent control of VCOM from Online mode.
Supervisor	Additionally enables "Clear Waveforms in Module" in Tools menu.
Factory	Reserved for use by Apex support team.

User level can be changed by double-clicking the current user level and selecting the desired user level from the drop-down menu. For Elevated and Supervisor status, a new dialog will request a password. The default passwords for Elevated and Supervisor levels are blank (simply click OK) and should be changed as soon as possible. See MM04 Communication Protocol for directions on changing user level passwords.

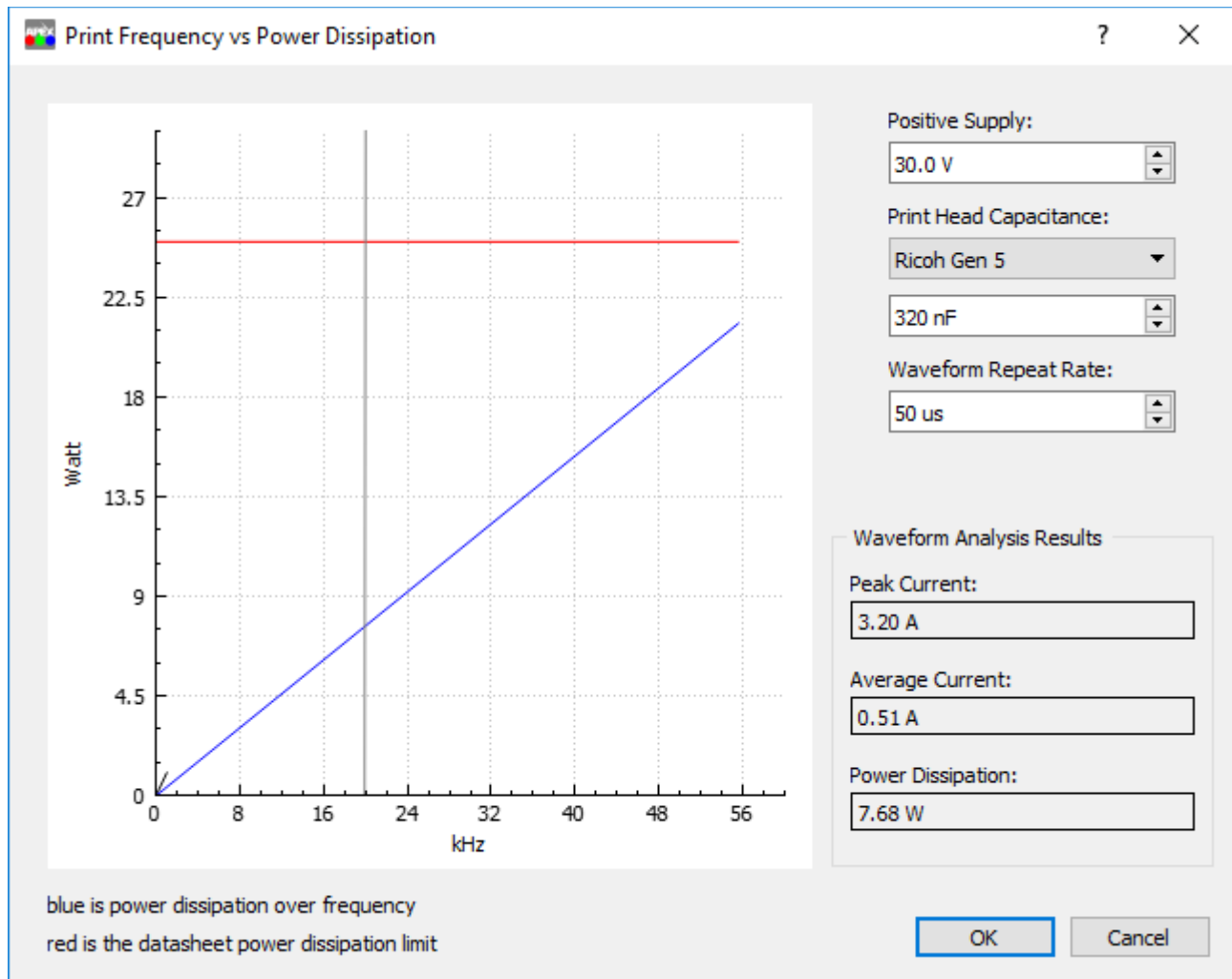
ANALYZE POWER DISSIPATION

From the Tools menu, select "Analyze Power Dissipation." The user can select a channel, and the MM04 manager will do an idealized power calculation based on the waveform for that channel. Note that the power dissipation calculation will change when any of the following are altered:

- +VS Voltage
- Waveform characteristics (rise times, voltage levels, keep times, etc.)
- Print frequency
- Number of active nozzles (interpreted as Print Head Capacitance). When a new print head is selected from the drop-down menu, the Print Head Capacitance is automatically populated with the maximum capacitance for that printhead (all nozzles active).

The plot will display power dissipation as a function of frequency. For the selected Waveform Repeat Rate (inverse of frequency), the specific power dissipation is presented in Watts. This must not exceed the datasheet absolute maximum per-channel power dissipation (displayed as a red horizontal line). Note that absolute maximum power dissipation assumes an infinitely-sized heatsink. The maximum power dissipation for MM04 with no heatsink is 6.8W per channel.

Figure 9: Analyze Power Dissipation Window



TROUBLESHOOTING

Failed Connection

If the connection to the MM04 does not occur after pressing the connect button within the GUI, please check the following:

- Is the device recognized within the Windows Device Manager? (it should find a Silicon Labs CP210x device)
- Does the computer have current USB to UART Bridge drivers? Go to <https://www.silabs.com/> for the most up-to-date drivers for CP210X.
- Does the computer have the most up-to-date MM04 Manager application installed? Go to <https://apex-analog.com/> for the most current software.
- Has the correct serial (COM) port been chosen before trying to connect? (check the Device Manager)
- Is the Micro USB cable connected correctly between the computer and EK48 board?
- Is +5V and its Ground connected on the EK48 board?
- Is the +5V supply turned on?

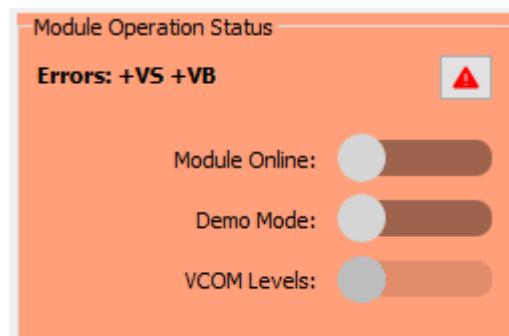
Errors

Errors are indicated in the Module Operation Status section of the GUI. Please interpret the error messages as follows. Settings for error thresholds and hysteresis are given in the MM04 Communication Protocol Manual

- +VS: the high-voltage supply is out of range
- +VB: the boosted supply is out of range (this is generated by the MM04 using the +VS supply and is not independently adjustable of +VS. See MM04 datasheet for +VS/+VB relationship.)
- VCC: the 5V logic supply is out of range
- TAB: the temperature of channel A or B of the analog driver portion is out of range. This can also occur when the analog portion is unpowered (+VS = 0)
- TCD: the temperature of channel C or D of the analog driver portion is out of range. This can also occur when the analog portion is unpowered (+VS = 0)

Note: Error flags must be cleared manually by default. To do this, press the red alert button next to the Error readout after the error has been resolved.

Figure 10: Error Clearing



APPENDIX

Test Point List

MM04 back-side Test Points of interest are listed below:

Description	Designator
UART RXD	TP88
UART TXD	TP99
I2C SCL	TP75
I2C SDA	TP76
+VS	TP100
VCC_IN (5V)	TP96
VCC (3.3V)	TP97
-VB (-5V)	TP115
DAC Reference (2.6V)	TP117
+VB	TP71
Signal GND	TP98
Power GND	TP70
DAC output channel 1	TP56
DAC output channel 2	TP57
DAC output channel 3	TP58
DAC output channel 4	TP59
Fire pulse waveform output channel 1	TP66
Fire pulse waveform output channel 2	TP65
Fire pulse waveform output channel 3	TP64
Fire pulse waveform output channel 4	TP67

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