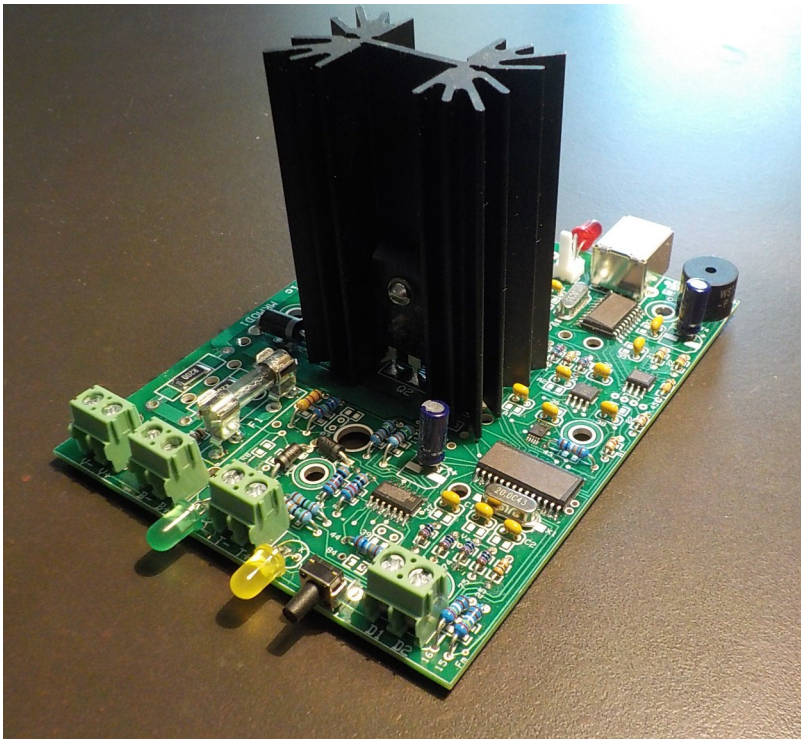
MK201 Programmable Battery Test Module



Introduction

The MK battery test module by Battery Metric™ is a battery analyzer and battery management device that can be used to test batteries, measure capacity, cycle batteries, perform load tests and a variety of other functions. It can charge, discharge and measure battery Internal Resistance (IR).

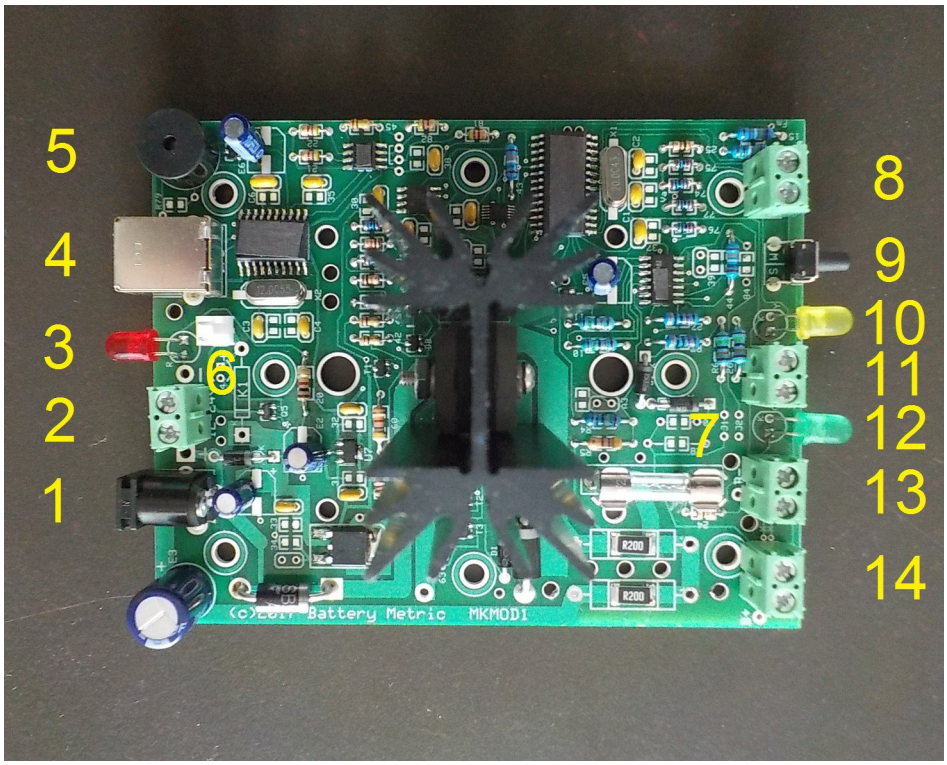
This open board format allows users to create their own battery management solution in whatever format required. It's a cost effective way to create battery solutions for testing, production, research, laboratory, maintenance, recycling, refurbishment or application specific requirements. There are a wide array of charge and discharge termination options that allows the device to execute any number of unique battery management tasks.

Battery Metric software is used to control the module. This provides a flexible and feature rich interface to operate, program, collect data and manage the battery under control. The ***BA500WIN*** software application is a full featured laboratory style GUI interface with many features. The ***Battery Console*** software takes programming of the device to the next level with sophisticated looping, IF statements, conditional routing & messaging for a high level of control. Routines developed with the ***Battery Console*** software can be downloaded to the module in order to execute routines and programs in stand alone mode. The MK module can be used by OEM producers to create new products for application specific customer requirements.

Features

- Use Battery Metric Windows™ software to program and control the device as well as collect battery performance data
- Fully isolated USB type B computer interface
- Charge and Discharge up to 1A for batteries up to 20V
- Measure battery performance & perform special battery management functions
- Integrated fan control circuit
- Can be configured for high input resistance for batteries up to 10V
- Programmable LED output indicators T1¾ – one each of red, green, yellow
- Single tone 2.3kHz audio indicator
- Integrated board mounted 20W finned heat sink
- Short circuit, reverse polarity, overload and fuse protection
- Factory calibrated

Board Overview



1. DC input power jack. Use this to connect power supply to the board. This DC power jack accepts 2.1mm DC barrel plug type adapters with center positive output.

2. DC input terminals. This is an alternative input method that can be use to connect DC power supply wires. Observe proper polarity as marked.

3. Power LED. This will illuminate when the power supply is connected. There is no switch so whenever the power supply is energized this LED will be ON. If a switch is required in the final application it should be on the power supply input wires.

4. USB Jack. This is USB type B receptacle. Use this to connect to the PC. The USB circuitry is fully isolated from the rest of the MK board.

5. Audio Indicator. This can be programmed to beep in various ways depending on the situation.

6. Fan control section. Fan connection and configuration area.

7. High Input Resistance configuration area. Used to configure device for high input resistance.

8. Data I/O lines. D1 & D2 digital *I / O* provided for future optional data control functionality.

9. Vector Switch. This momentary tactile switch is programmable using ***Battery Console*** for redirecting the operating program to an alternate step.

10. Yellow LED. Programmable indicator.

11. Thermistor Input terminals. Connect optional thermistor cable for battery temperature measurement.

12. Green LED. Programmable indicator.

13. Battery connection terminals. + and – connection points for battery connection. Observe the correct polarity for proper operation of the device.

14. Remote voltage sense terminals. Voltage sense input when using 4 wire battery connection option.

Specifications

Parameter	Value	Units
Maximum battery voltage	20	V
No of voltage measurement ranges	16	
Voltage measurement resolution	1	mV
Voltage regulation resolution	5	mV
Maximum charge current	1	A
Maximum discharge current	1	A
No of current ranges	1	
Current measurement resolution	1	mA
Current regulation resolution	1	mA
Charge & Discharge regulation type	Linear	
Regulator max power (open air no fan)	20	W @25°C
Input resistance	150	kΩ
A/D & D/A	12	bits
Accuracy (V,I – Full Scale)	0.25	%
Size (L, W, H)	11.4x8.9x6.9	cm
Weight	140	g

Other voltage and current configurations available by special order.
Specifications subject to change without notice

Power Supply

Select a power supply that is between 12 and 24V DC. The power supply needs to be able to supply all of the charge current as well as power the board electronics. The board itself will consume about 100mA. In order to utilize the full charge current range, a power supply that can supply at least 1.1A will be needed. Additionally, if the fan option is used, then the power supply will also need additional current capacity to power the fan. If the application does not call for use of the full 1A charge capability then a lower power power supply can be used. For a discharge only application a considerably lower power supply could be used such as 12V / 0.5A / 6W.

The power supply voltage needs to be at least 12V. Since the power supply is also used to provide the charge current an additional 5V of headroom is required above the maximum battery voltage anticipated. See Thermal Management section in this guide for more information regarding power supply selection. Do not use a Class II type transformer. It will have poor regulation and may introduce noise into the charge circuit. Choose a switch mode style power supply. A 36W, 1.5A, 24V DC switch mode power supply would be a good choice for general use. For example: CUI:SWM30-24-NV-P5 (North America) Digikey-102-4277 or CUI:SWM30-24-EV-P5 (Europe) Digikey-102-4280

Software

Software to operate the MK module can be found on the Battery Metric website. Download the software and manuals at: http://www.batterymetric.com/downloads/

Be sure to use the most recent software version. Note the MK modules require BA500WIN version 1.39 or greater. Earlier versions do not support the MK modules.

Firmware

There may be firmware updates from time to time to add new features, capabilities and fixes. The firmware hex file as well as the ***fwmanger*** program is available from the Battery Metric website at: http://www.batterymetric.com/downloads/

The software program ***fwmanger*** is used to connect and load the firmware into the device. To update the firmware, simply download the latest firmware file from the website. eg. mkfw8_8.hex. Then start ***fwmanager*** and use it to open the firmware hex file and load it into the device. When the ***fwmanger*** program connects to the module it will automatically put the module into update mode. In update mode the green and yellow LED's will alternate. When running ***fwmanger*** make sure that no other Battery Metric software is running otherwise there will be a conflict disrupting communications. Always be sure to use the latest available firmware. Power OFF/ON to exit update mode when done.

Thermal Management

The MK module has some regulator power limits. If the power limits are exceeded the module will be shut down to avoid over heating. Heat is generated during both charging and discharging as follows:

Charging The analyzer employs a linear charge regulator. As such the heat generated while regulating the charge current can be calculated as: ***P = (Vps-Vbat) x Ireg***
This charge regulator power is how much power the analyzer's internal regulator needs to dissipate to

regulate current at the desired value. This dissipated power will appear as heat on the heat sink. It is not a measure of how much power is being delivered to the battery. The charge power limit could become evident when charging low voltage batteries with a higher voltage power supply at high charge currents. In the event you experience an *Overload* situation while charging you will need to decrease the charge current or use a lower voltage power supply or use a battery with a higher terminal voltage. If you experience an *Overload* situation while performing the charge calibration you will need to use a battery with a higher terminal voltage.

Since the charge regulator heat production is a function of the power supply voltage ***Vps,*** it follows that heating during charge can be reduced by using the minimum power supply voltage required to meet charge voltage requirements. Keep in mind that the regulator will need some voltage headroom above the maximum charge voltage required. A rule of thumb is to provide an extra 5V above the maximum charge voltage required. If the power supply voltage is too low then the charge current can be reduced below the specified value. For example if the device is being used to charge LiIon batteries with a maximum voltage requirement of 4.2V then a 12V power supply will be more than sufficient to provide the required voltage head room. In this example a 12V power supply is a better choice than a 24V power supply because it reduces heating significantly from 19.8W to 7.8W when charging at the full 1A. This can significantly extend the life of the module.

Discharging: The heat generated during discharge can be calculated as: ***P = Vbat x Ireg***
This is equal to how much power the battery is delivering. All of this power is dissipated as heat using the module's heat sink. In the event you experience an *Overload* situation while discharging you will need to decrease the discharge current.
(***P*** is the power dissipated in Watts, ***Vps*** is the DC voltage of the power supply, ***Vbat*** is the battery voltage at any given time, ***Ireg*** is the current in effect)

Fan Control

The 2.5” head sink provided can dissipate an approximately 20W load when it is located in open air with an ambient temperature of 25°C. When the heat sink is located in an enclosure or air movement is restricted in any other way or more than 20W heat dissipation is needed then a fan will be required.

There is a heat sink temperature sensor built into the module and it will shut down all charge and discharge current if the heat sink is detected to be over temperature. However care should still be taken to ensure the heat sink does not over heat to avoid damaging the module.

The MK201 board has provision to control a DC fan. The integrated fan control circuit uses the heat sink temperature sensor and a PWM output control signal to operate the fan at an appropriate speed. A fan should be used when the MK201 is installed in an enclosure and additional cooling is required.

A 2 pin connector is used to connect a DC fan. Note that in order to use the fan, the module needs to be configured appropriately for the selected power supply and fan. This configuration is performed by selecting and installing K1. This will be either a jumper or a zener diode depending on the power supply used and the rated voltage of the selected fan. The maximum fan current the circuit supports is 250mA. Exceeding this current limit may damage the fan control circuit. A jumper for K1 will suffice when the rated voltage of the selected fan is the same as the power supply voltage. For example if using a 12V power supply and a 12V fan. However if the power supply voltage is greater than the rated voltage of the fan then a zener diode will be required to reduce the voltage. For example if the power supply voltage is 24V and the fan is rated at 12V then a 10V, 5W zener diode such as Digikey :

1N5347BGOS or Mouser:863-1N5347BG must be installed. This should be soldered in place at K1 with the cathode nearest the DC input jack. The MK module is provided with a two pin header for fan connection . See Mechanical section in this guide for mating details. Observe proper polarity when connecting a fan. The Fan Pos (+) is on the side closest to the USB connector. The Fan Neg (-) wire is on the side closest to the DC power input. It is the users responsibility to ensure that there is enough airflow to ensure sufficient cooling for the power control transistors mounted on the heat sink. A capacitor can be installed at E4 to provide fan noise filtering if required.

Battery Connection

The voltage sense V+ and V- connections are connected to the B+ and B- current carrying terminals on the board. See copper traces X & X. This means only two wires B+ and B- are required to connect to the battery to both carry the current and measure the battery voltage. However, if remote Vsense directly at the battery is required then a 4 wire connection can be employed. Configure this by cutting the X & X copper traces. In this case then all 4 wires will be required to connect at the battery V+ / B+ and V- / B-. A 4 wire connection is only needed when concerned that the resistance of the battery leads is causing voltage measurement/regulation deviation while current is flowing. Usually this is insignificant and a simple two wire battery connection utilizing B+ and B- is perfectly fine.

Battery Temperature Measurement

The MK module has provision to measure battery temperature by using a thermistor. This can be done by making a two wire cable terminated with a thermistor. The module has provision for connecting the thermistor cable to the T+ and T- terminals. The recommended thermistor is:

10K - NTC Thermistor Vishay NTCLE100E3103HB0, Digikey: BC2311, Mouser: 594-2381-640-66103

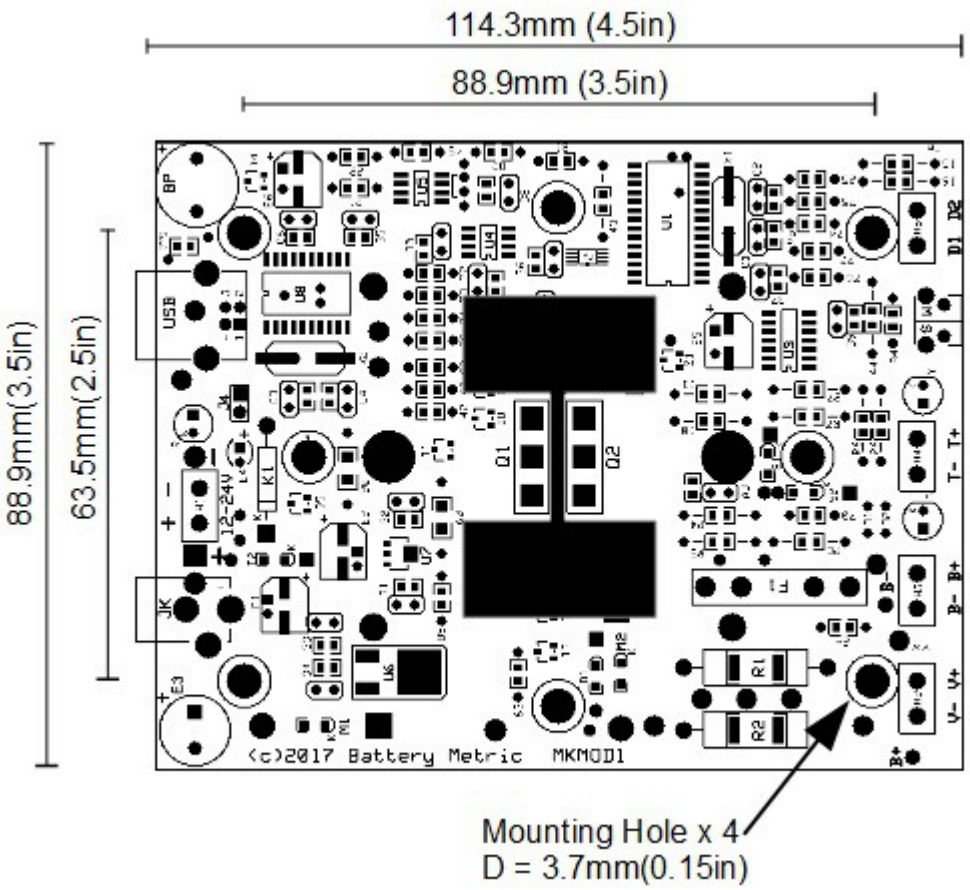
This thermistor can then be affixed externally to the battery under test with tape. It is possible to use a single wire to connect the module T+ terminal to the T contact of a battery. However this method will require a good knowledge of the internal wiring of the battery. Also be aware that the thermistor inside a battery often share the Bat(-) terminal. This can cause temperature measurement deviations while charging because the B- connection moves up above ground due to current flowing through the cable to B- and then through the ground side current sense resistor. In this case compensation will be required when programming the module to account for this offset. This T offset is only seen during charge, not discharge. Also, any deviation between the battery internal thermistor and the recommended 10KΩ thermistor will cause additional Temperature measurement error requiring additional compensation.

High Input Resistance Configuration

The MK module is provided with a standard input resistance value of approximately 150KΩ. This is quite high and sufficient for most applications. This standard input resistance will cause negligible drain of the battery when the module is idle. However there is provision to configure the module with an input resistance of up to 10MΩ if required. When using this provision the maximum battery voltage must be less than 10V. To implement this change: Cut copper trace J1 and place a jumper to connect J2. Then install a 10K resistor for R70. Due to the high input resistance you may pick up stray voltage measurements when a battery is not connected. To reduce this effect a 10MΩ pull down resistor can be installed at R8.

Mechanical

- Dimensions: 114.3L x 88.9W x 68.6H mm
- Weight: 140g
- Cooling: Open frame convection or optional fan
- Screw terminals wire size: max 14AWG , min 26 AWG
- Fan connection terminal: 2 pos Molex header 0022272021 (Digikey WM4111)
  mates with Molex housing 0022013027 (Digikey WM2000) &
  Molex terminals 0008500159 (Digikey WM9847) or equiv.
- Battery connection: Screw terminals or direct solder
- DC Power Input: 2.1 mm barrel plug or screw terminals or direct solder



Board available with optional Half-Brick style heat sink. Order MK201-Half Brick. This is a lower profile (H=38mm) option to facilitate a board mounted Fan. Four fan mount holes (D=3.7mm) provided. The Half-Brick heat sink option can accommodate a 60x60mm fan, rotated 90°, mounted to board using 38mm stand offs.