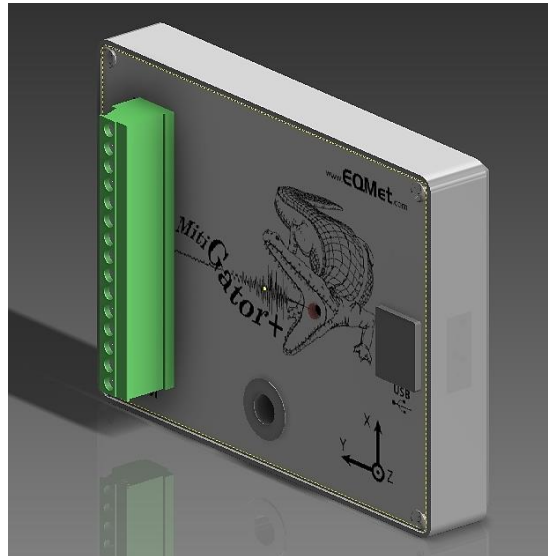


KINEMETRICS, Inc.

EQMET SEISMIC SWITCH



Mitigator+ Seismic Switch

Document 300996
Revision A
April 2015

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Safety

Symbols & Terms

These symbols may appear on Kinemetrics equipment or in this manual:



When you see this symbol, *pay careful attention*. Refer to the similarly marked, relevant part of this manual before servicing the instrument.



This symbol means a *low-noise earth ground*. The noted item should be grounded to ensure low-noise operation, and to serve as a ground return for EMI/RFI and transients. Such a ground *does not work as a safety ground* for protection against electrical shock!



This symbol means an alternating current (AC) power line.

These safety-related terms appear in this manual:

NOTE: Statements identify information that you should consider before moving to the next instruction or choice.

Caution: Statements identify conditions or practices that could result in damage to the equipment, the software, or other property.

WARNING! Statements identify conditions or practices that could result in personal injury or loss of life.

Specific Precautions

Follow the precautions below to ensure your personal safety and prevent damage to the MitiGator+.

Power Source

Caution: The MitiGator+ must be supplied with power from a 5-48V power supply that is safely grounded and meets all applicable local regulations.

User-Supplied Power/Charging System

WARNING! If you supply your own power/charging system, be sure that the system provides the correct voltage and current required by the MitiGator+ under all operating conditions. You are responsible for the safety of your charging system. Be sure you have supplied adequate grounding for all the equipment. If you supply your own batteries, follow the manufacturer's safety recommendations.

Do Not Operate in Explosive Atmosphere

WARNING! The MitiGator+ provides no explosive protection from static discharges or arcing components. Do not operate the equipment in an atmosphere where explosive gases are present.

Relays

WARNING! The MitiGator+ should never be used to switch AC power. It should always be used in conjunction with appropriate high-power relays.

External Battery

WARNING! Follow the precautions in this manual when handling and replacing external batteries. Metallic instruments of any kind could short the battery terminals, resulting in fire or explosion. Do not drop the battery or attempt to disassemble it. When charging the battery, use a properly rated charger and do not overcharge the battery. The only correct replacement battery is a sealed lead-acid battery with relief vents and ratings comparable to the original battery. Never try to use a non-rechargeable battery with the unit.

Do not use in Life Support or Life Critical Systems

The Kinometrics Mitigator+ Seismic Switch is not to be used for Life Support or Life-Critical Systems.

These products are not designed for operating life critical support systems and should not be used in applications where failure to perform can reasonably be expected to create a risk of harm to property or persons (including the risk of bodily injury and death).

Introduction

This document describes the setup and operation of the Kinometrics MitiGator+ seismic switch that will be described throughout this document as the MitiGator+.

For the MitiGator+, the following part numbers are used:

113180 – The MitiGator+
300996 – This manual
300997 – MitiGator+ Seismic Switch Application Firmware
300998 – MitiGator+ USB Device Driver
300999 – MitiGator+ USB Firmware Upgrader
851688 – Terminal Block Mating Connector, 15 Pin

You will already have seen document 300992 the MitiGator+ Quickstart guide which ships with the unit.

System Overview

The MitiGator+ (KMI P/N 113180) is a small self-contained seismic switch capable of detecting and reacting to seismic events. The MitiGator+ allows the definition of varying threshold levels that in turn will cause the actuation of up to three relays. These relays may be used to cause alarms and/or the starting or stopping of connected systems.

In many control applications, the MitiGator+ will be used to control a second set of high current/voltage relays that are integral to the control system. Figure 1 below shows the dimensions of the unit, the location of the mounting hole, and the orientation of the axis looking down on the unit.

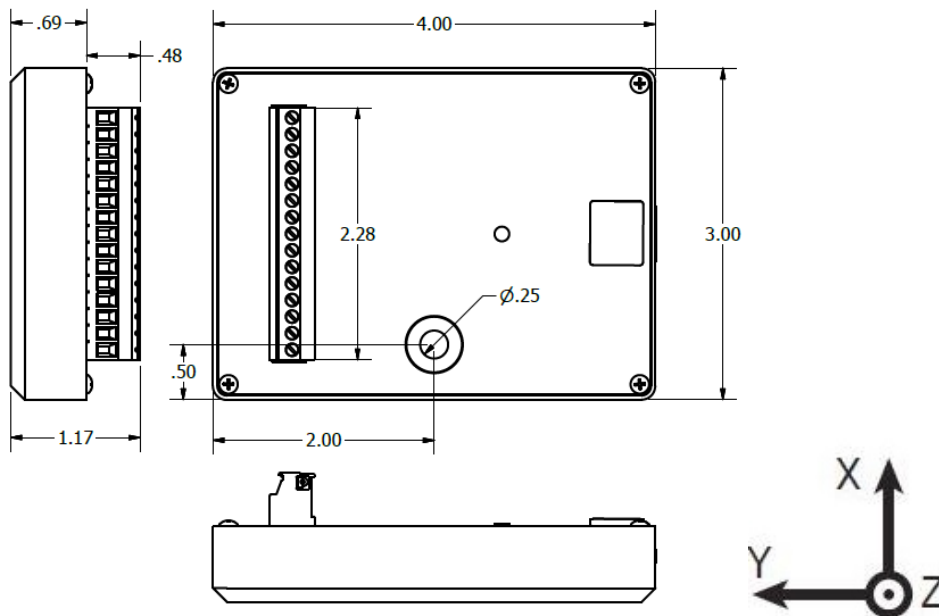


Figure 1 – MitiGator+ dimensions

The connections to provide power to the unit and connect the relays are shown in Figure 2 below.

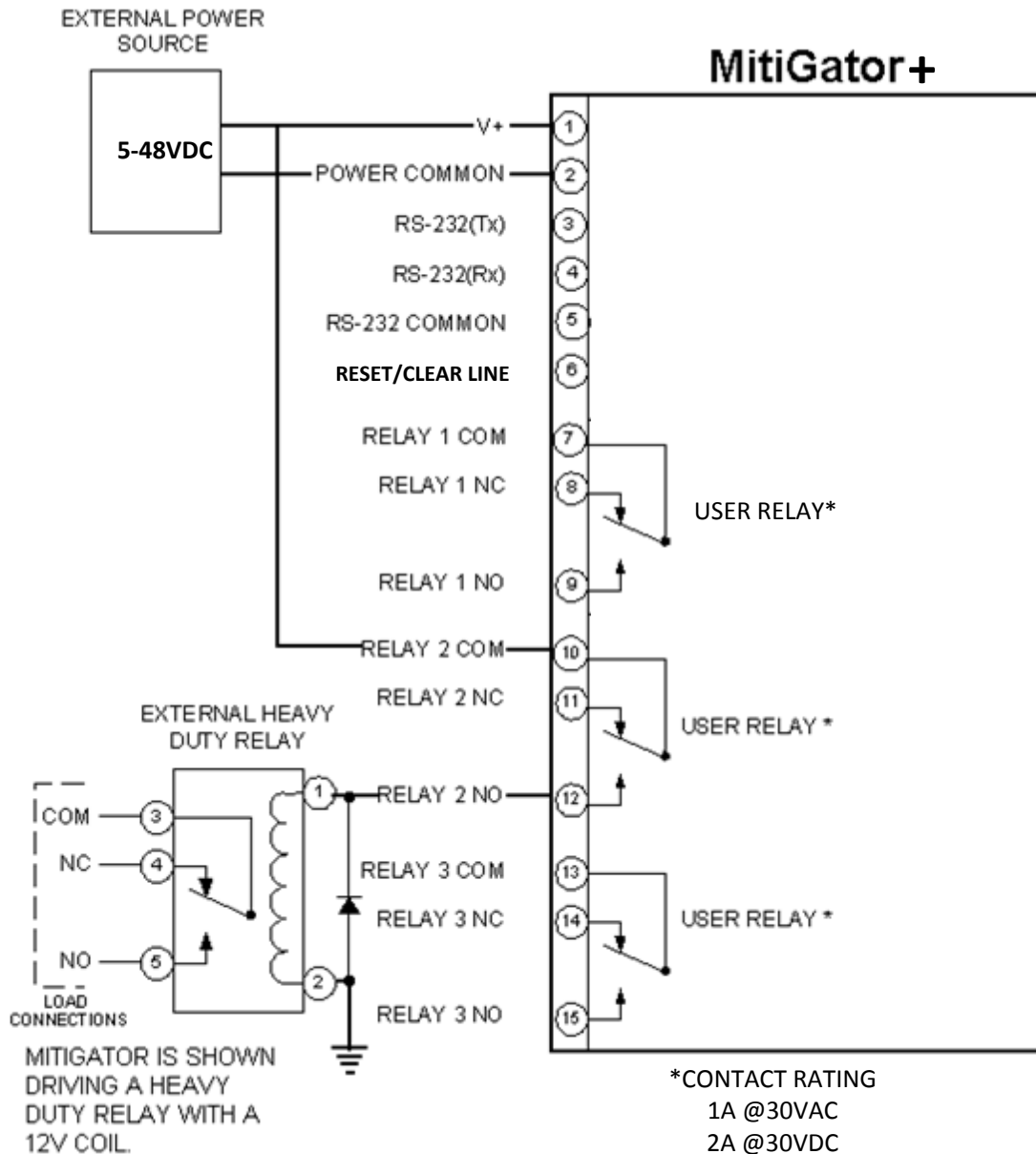


Figure 2 - External power and relay connections

Caution: Potential equipment damage. Clamping diodes should be added if the MitiGator+ is used for switching inductive loads such as relays.

If an inductive load generates spike voltages which exceed the absolute maximum rating, the spike voltage must be limited. Typical circuits are shown below (Figure 3), where the diodes D1 and D2 act as clamps to reduce the transient switching spike voltage of the relay coils.

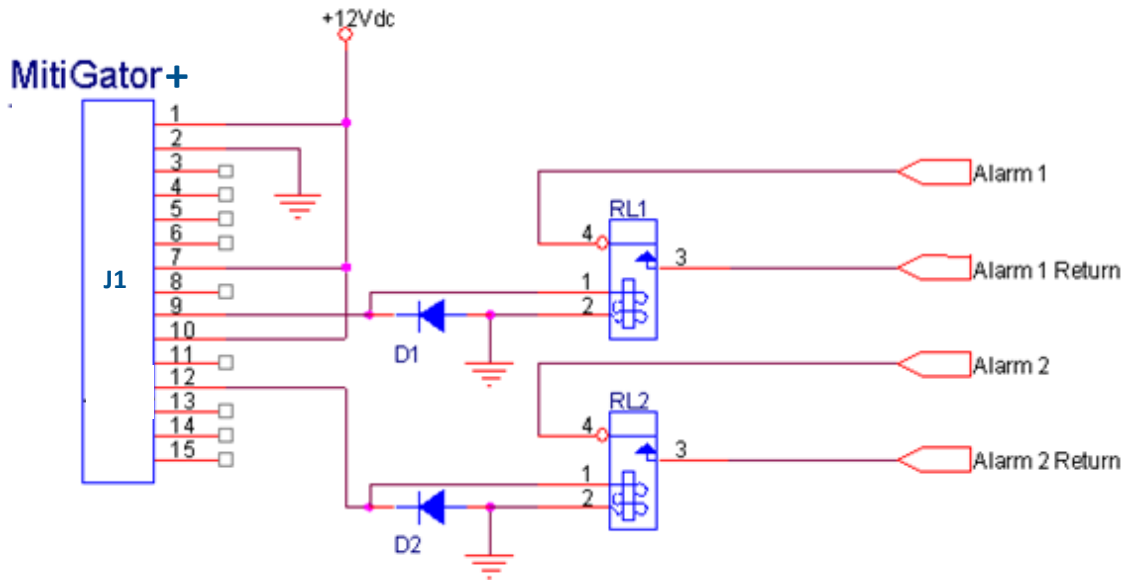


Figure 3 - Example application of clamping diodes

Even if spike voltages generated at the load are limited with a clamp diode, if the circuit wires are long, spike voltages will occur by inductance. Keep wires as short as possible to minimize inductance.

Typical Applications

Typical applications of the MitiGator+ include:

- Elevator Shutdown
- Industrial Machinery
- Earthquake Alarms
- Transportation Equipment
- Industrial Vibration Monitoring (custom firmware available on request)

Improvements and Differences from the First Generation MitiGator

The MitiGator+ is the second generation of the seismic switch known broadly as the MitiGator. From the outside the MitiGator+ is similar to the original MitiGator, but there are some significant improvements and differences as follows:

- The MitiGator+ includes a USB port
- The MitiGator+ has a wider voltage range than the original MitiGator
- The MitiGator+ has a bi-color LED that supplies more information during operation
- The MitiGator+ relays have a higher current specification
- The MitiGator+ does not have a separate bootloader application
- The MitiGator+ adds the following diagnostic commands: TFREQ, UPDATE, VCC
- The MitiGator+ changes functionality of the following diagnostic commands: LED, DGSEQ
- The MitiGator+ replaces the diagnostic command BAT with EXT
- The MitiGator+ deletes the following edit commands: BAUD
- The MitiGator+ deletes the following diagnostic commands: NEWBOOT, NEWAPP, CSBL, RAM, SMPGET, SMPSEND, XCODE, XEVENT, XRCLK, XTEMP, XTIME
- The MitiGator+ no longer uses the KMICON software to update firmware

Filter Description

The MitiGator+ uses a pair of digital filters to process the incoming acceleration data to accurately determine whether or not to trigger the relays while at the same time rejecting false triggers caused by spurious input signals.

There are two stages of filtering:

- A low pass anti-alias filter that attenuates high frequency signals above 15Hz (Figure 4)
- A band-pass trigger filter that attenuates frequencies outside the band of interest

The low pass anti-alias filter is always used but there are two different trigger filters available that the user can select:

- The “standard” MitiGator+ trigger filter of 1-15Hz (Figure 5)
- A special trigger filter used in ASCE-2597 applications of 1-5Hz (Figure 6)

The basic stages of data through the MitiGator+ are as follows:

- Input Acceleration at 400sps from the MEMS Sensor
- Anti-alias filter
- Decimate data to 100sps
- Band pass filter
- Trigger detection

The plot below shows the frequency response of the anti-alias filter:

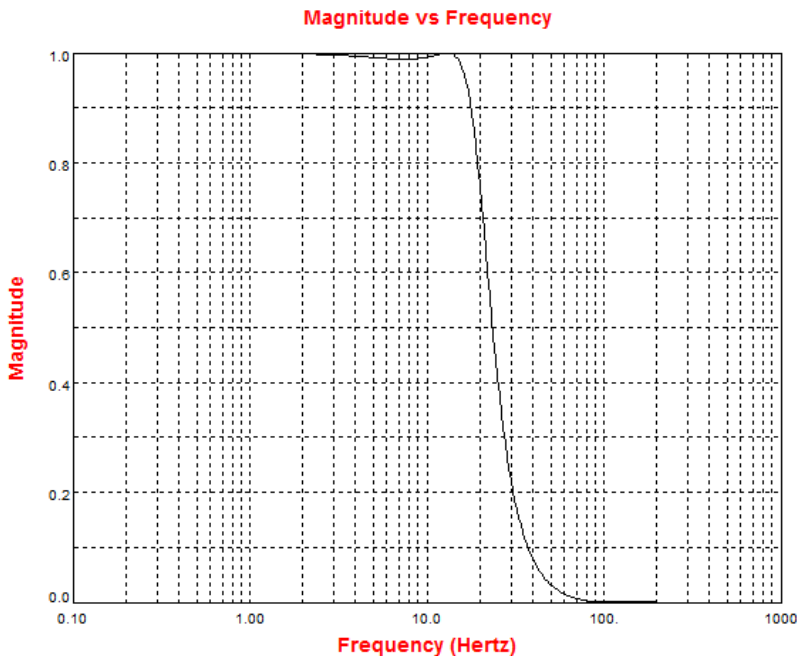


Figure 4 - MitiGator+ anti-alias filter response

The plot below shows the frequency response of the standard MitiGator+ trigger filter:

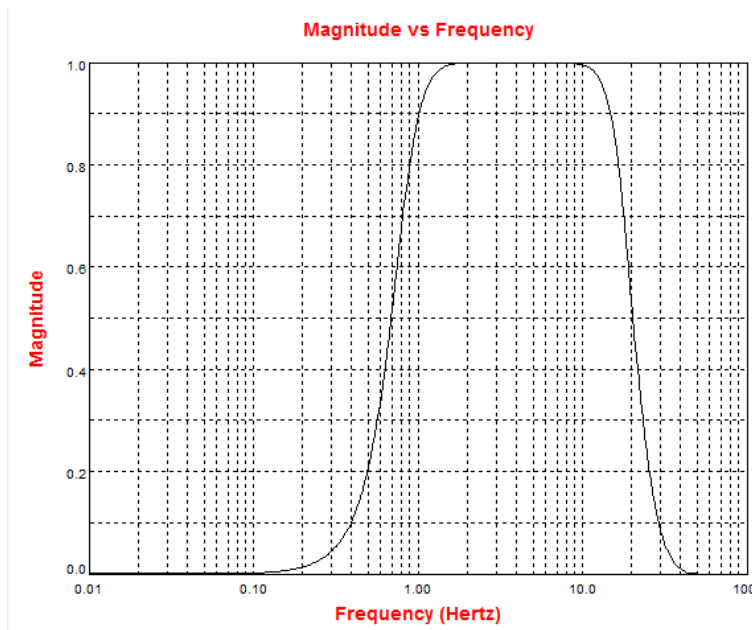


Figure 5 - MitiGator+ standard trigger filter response

The plot below shows the frequency response of the ASCE-2597 MitiGator+ trigger filter:

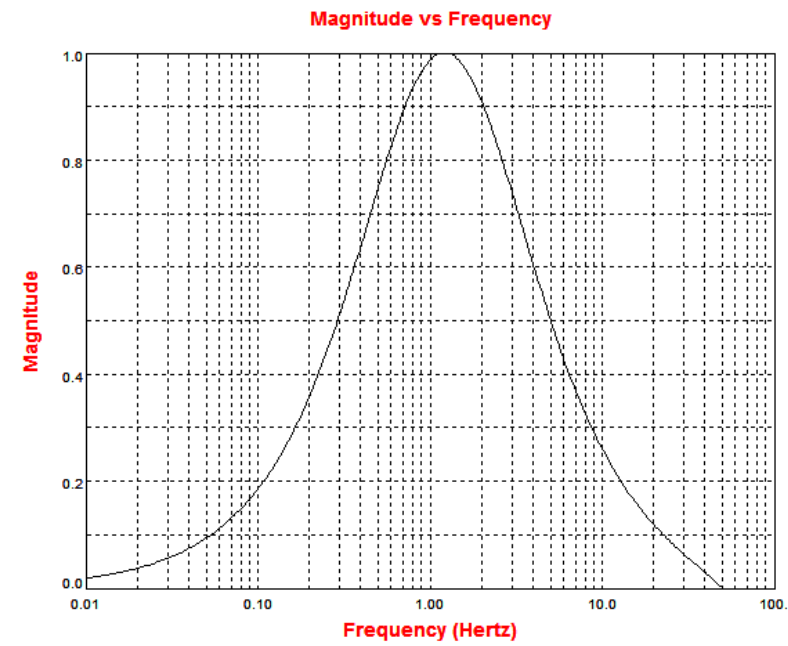


Figure 6 - MitiGator+ ASCE-2597 trigger filter response

See the FILTER command for more information.

User Electronic Interface Information

Power Requirements:

5-48V DC input

The MitiGator+ draws less than 10 mA from a 12V supply with no relays engaged and less than 75 mA from a 12V supply with all three relays engaged.

Relays:

3 Type 1 Form C (Single Pole Double Throw Non-Latching Relay)

Maximum Current DC 2 Amps @ 30VDC (resistive load), 1 Amp @ 30VDC (inductive load)

Maximum Current AC 1 Amp @ 30VAC

Maximum Voltage 30 Volts AC/DC

Dielectric Strength 1000 VAC, 50/60Hz, 1 Minute between Contacts of Same Pole

Contact Type Gold-clad Silver

Rated Electrical Life >500,000 cycles @30VDC

Warning The MitiGator+ should never be used to switch AC power. It should always be used in conjunction with appropriate high-power relays.

Reset/Clear Line:

Connecting the reset/clear line (pin 6) to power common (pin 2) will cause the MitiGator+ to perform one of two actions, depending on the RESET parameter setting.

- RESET = 0 causes a seismic event clear, which resets the alarm and clears the relays
- RESET = 1 causes a MitiGator+ system reset

Pin 2 and Pin 6 should be connected by a normally-open switch. Closing the switch causes the unit to re-start or clear the alarm.

The relays will revert to their normal configuration in the event of a power loss. It is important to use the MitiGator+ with this in mind. In most applications, of course, the device controlled by the MitiGator+ will lose power and cease to function at the same time.

Power Drop:

Should the unit detect a drop in power, it will attempt to avoid a total shutdown by shutting the relays down. The unit will go into a standby mode while it awaits a return of power. The voltage that this occurs at is initially set at 9V for typical operation with a 12V power system. This can be changed to other voltages see the LOWVDC command.

The connections to the terminal plug on the Mitigator are illustrated in Figure 7.

USB Connection:

The USB connection is a standard Micro-B receptacle allowing the Mitigator to connect to a computer acting as a host. The unit is supplied with a USB A Male to USB Micro B 5-Pin Male cable (KMI Part Number 853745) to connect the unit to a PC. A compliant USB device can supply sufficient power to operate the unit. If full operation from USB power is required the LOWVDC should be set to 4.3V. The location of the USB is shown in Figure 7.

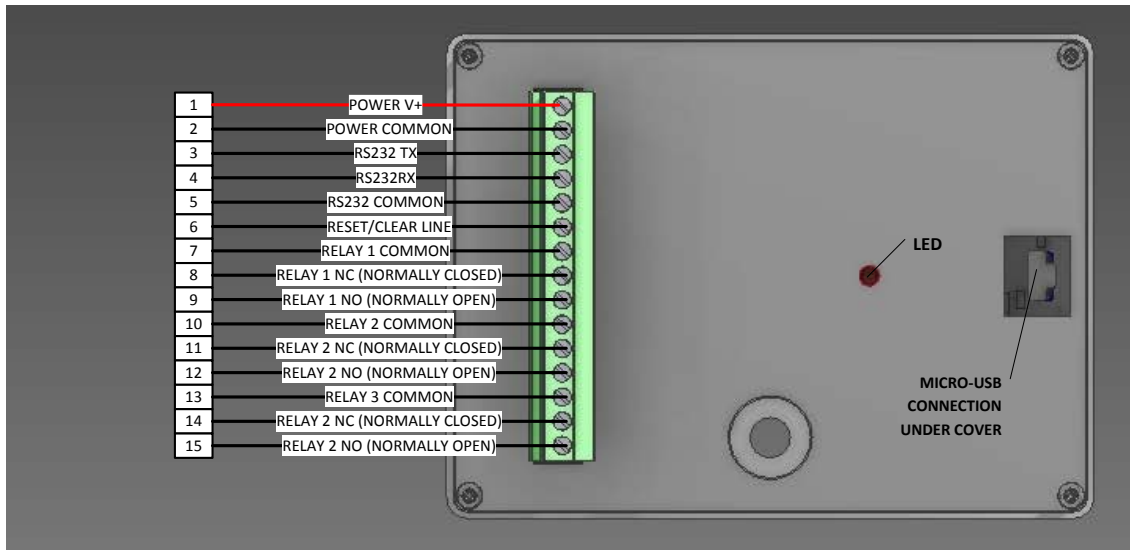


Figure 7 - MitiGator+ wiring diagram

Firmware relay control

The MitiGator+ is provided with three relays that can be used to control processes that require intervention in the event of seismic activity. The relays are single pole double throw (SPDT) relays with both a normally open and a normally closed connection. Each of the relays can be configured for the following options:

- Polarity: Normal or inverted (firmware)
- Usage: Threshold, threshold/fault, vector, vector/fault, power indicator, fault
- Hold time at trigger: In milliseconds, or set to zero to hold until manually reset
- Threshold: Set in percentage of g for X,Y,Z axes

At initial power on, all relays will be de-energized. Once the MitiGator+ application firmware is started and the self-test is successfully completed, the relays will be set to the state indicated by the configured firmware usage and the firmware controlled polarity. When the usage condition is met (threshold exceedance, fault, etc.) the relay will change state to the opposite condition. If a hold time is specified, the triggered condition of the relay will be held until the hold time elapses, and the relay will be restored to its initial condition.

For example: To connect to a relay such that a contact closure will interrupt a given process in the event of seismic activity or power loss, connect to the normally closed contact. Then, set the polarity of that relay to inverted. This will cause the firmware to energize the relay on startup, causing the relay to open. In the event of seismic activity the MitiGator+ will reverse the state of the relay causing it to close. The relay will also revert to its normally closed (de-energized) state in the event of power failure. The command to set relay 1 to inverted would look like (letter arguments must be in upper case):

```
EDIT>> relay 1 I T 0
```

Another example: To set the MitiGator+ up such that relay 1 would be used to detect motion in the X axis, relay 2 in the Y axis, and relay 3 in the Z axis, the THR command would be used. In this example, we assume that all threshold levels are the same at 2.0% of g. The commands to set thresholds in this manner would look like:

```
EDIT>> thr 1 2.0 0 0
EDIT>> thr 2 0 2.0 0
EDIT>> thr 3 0 0 2.0
```

Fault Detection

The MitiGator+ provides several options allowing you to create a more robust final system. Selection and use of these options is very application specific and is left to the user.

NOTE: If you choose not to implement one or more of these fault detection options, your system may not alert you to problems that will cause improper operation of the MitiGator+.

Fault detection options include:

- Relay outputs configured to indicate presence of power
- Relay outputs configured to indicate self-test fault or a failed seismic sensor
- Relay outputs configured to provide combined fault status and trigger indication
- Redundant relay outputs

Implementation of some of these options will require additional circuitry to properly process the additional outputs. In other cases, your application may allow you to obtain significant information from a single relay output.

For example, a relay set to indicate combined fault status and trigger information that is also configured for inverted polarity would allow you to detect loss of power, failed self-test, a failed seismic sensor, or a seismic trigger - although the single output will not provide enough information to determine which event occurred.

See the RELAY command for further details.

LED

The MitiGator+ includes a bi-color LED (green/red) that is used to indicate presence of power, results of the MitiGator+ self-test, or indication of a detected seismic event.

- LED OFF indicates lack of power or that the MitiGator+ is just starting.
- LED RED indicates input voltage below the LOWVDC threshold.
- LED RED FLASHING indicates a failed self-test or acquisition fault.
- LED GREEN FLASHING indicates that the MitiGator+ has triggered.
- LED GREEN indicates normal non-triggered operation.

Reset / Clear Switch

The MitiGator+ is provided with a reset/clear switch that consists of a set of contacts that if closed will cause a user selected action to take place. The reset/clear switch can be defined by the user as causing a seismic event clear or a system reset.

If configured for system reset, closing the clear switch will cause the MitiGator+ to perform a complete system reset by restarting the application code. The system will reset and will then enter the MitiGator+ application firmware that begins with a self-test.

If configured for seismic event clear, closing the clear switch will cause the relays to be restored to their configured startup state, the LED to stop flashing and return to the ON state, and any seismic event detection messages to cease. When the clear switch is used to clear an alarm, the messages displayed to the console will look something like the following:

```
TRIGGER: X0.032g Y0.021g Z0.003g
TRIGGER: X0.032g Y0.021g Z0.003g
TRIGGER: X0.032g Y0.021g Z0.003g
TRIGGER: X0.032g Y0.021g Z0.003g
Reset alarm
```

Communication port

The MitiGator+ is equipped with a three wire RS-232 serial port that can be used for communication with and control of the MitiGator+. The port is configured for 8 data bits, 1 stop bit, no parity and is fixed at 38400 baud.

The port can be used to check or change the configuration of the MitiGator+. Normal operation of the MitiGator+ does not require connection of the port.

Changing configuration parameters requires use of a computer or dumb terminal capable of interacting with the port at 38400 baud. If using a computer to communicate with the MitiGator+, most standard communications programs such as ProComm, HyperTerminal or PuTTY are suitable.

USB port

The MitiGator+ also includes a USB port that can be used for any of several purposes:

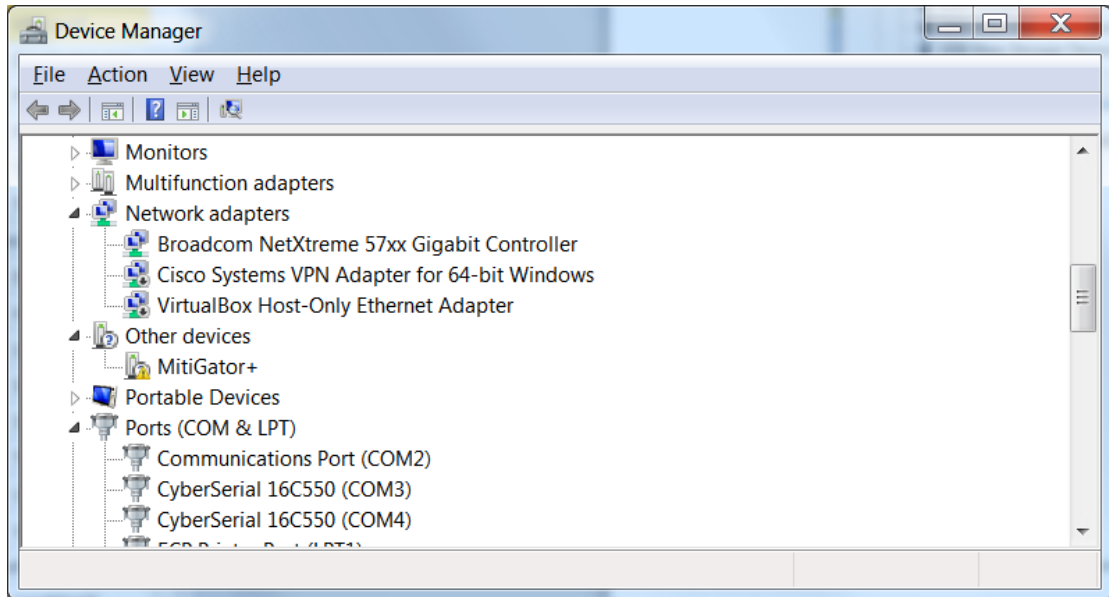
- The MitiGator+ can use the USB connection as a virtual COM port to communicate with a PC. Note that it is necessary to install the MitiGator CDC driver on your PC so that it will recognize the MitiGator as a COM port.
- Updating firmware, if needed, is done through the USB port.
- The MitiGator+ can be powered through the USB connection, if the USB connection provides the specified 500mA, 5V power. If using USB to power the MitiGator, it will be necessary to lower the LOWVDC threshold from its default of 9V to 4.3V.

Notes:

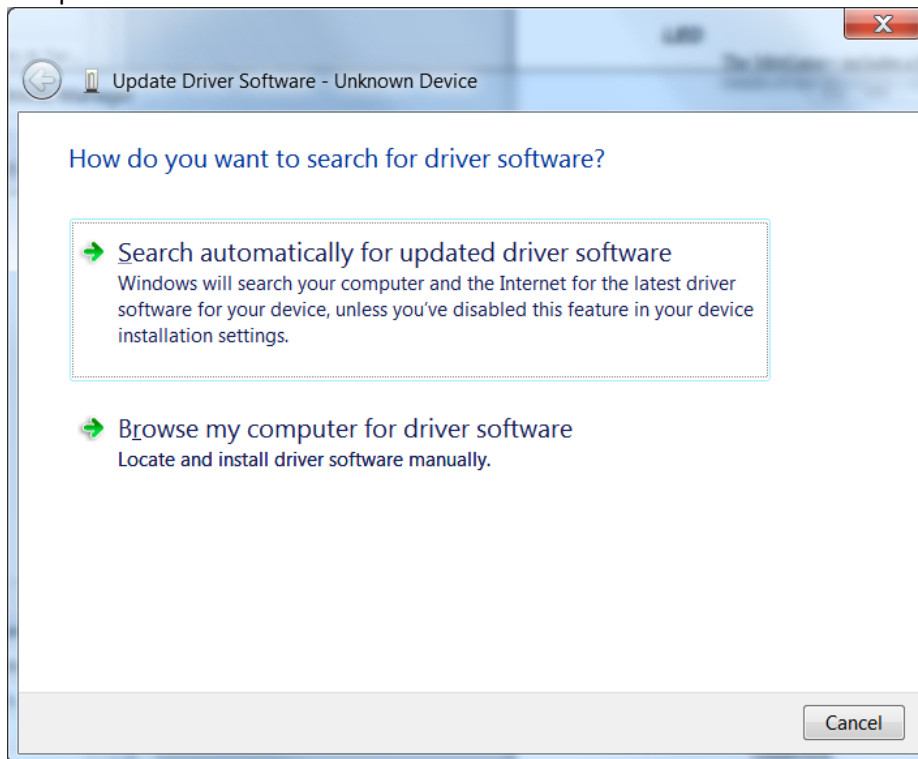
- The USB device driver is not digitally signed. Depending on security policies, your computer may require additional steps to install the driver.
- The serial communication port and the USB port operate in parallel as a “console” in all modes except firmware updates or system reset. Any characters read or received on one connection will be mirrored to the other connection.
- Since the USB connection is a virtual COM port, the port is only valid when the MitiGator+ application is running. If you power off the MitiGator+ or reset it, the USB virtual COM port connection will be broken and you’ll have to restart your terminal software.
- As with the serial connection, normal operation of the MitiGator+ does not require a USB connection.
- Updating MitiGator+ firmware is discussed later in this manual. See [Loading MitiGator+ Firmware](#)

To install the MitiGator+ USB device driver, the following basic steps are followed:

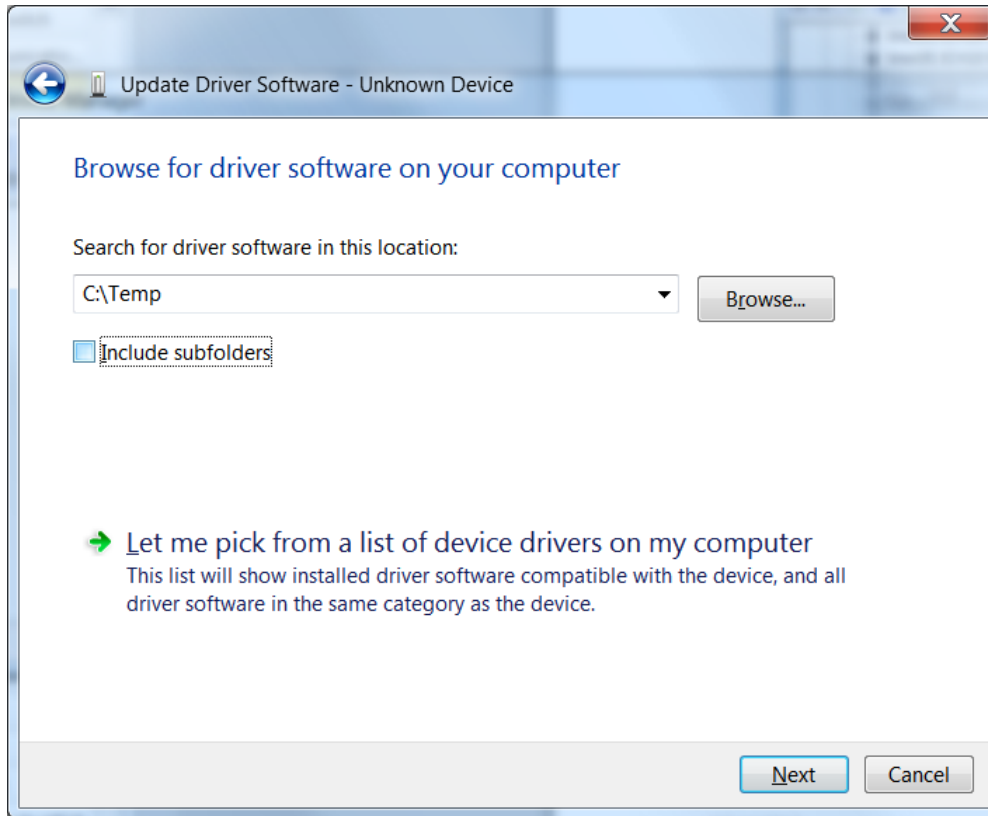
- Plug the USB cable into your computer and the MitiGator+
- The PC will report that the device is unrecognized or it is unable to find a suitable device driver. This is OK, and even expected. If the PC is off searching “Windows Update” you can abort that process.
- Find the MitiGator+ device in the Device Manager:



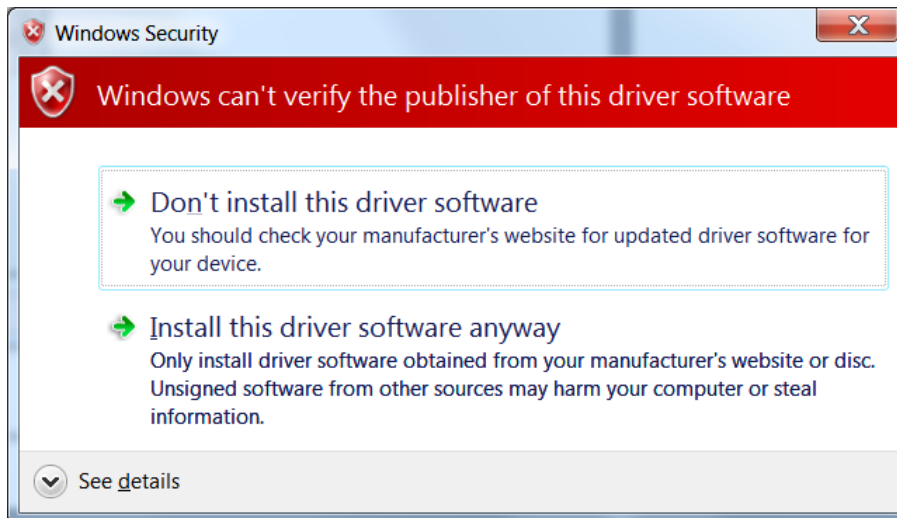
- Right click on the device and select “Update Driver Software”, then select “Browse my computer for driver software”:



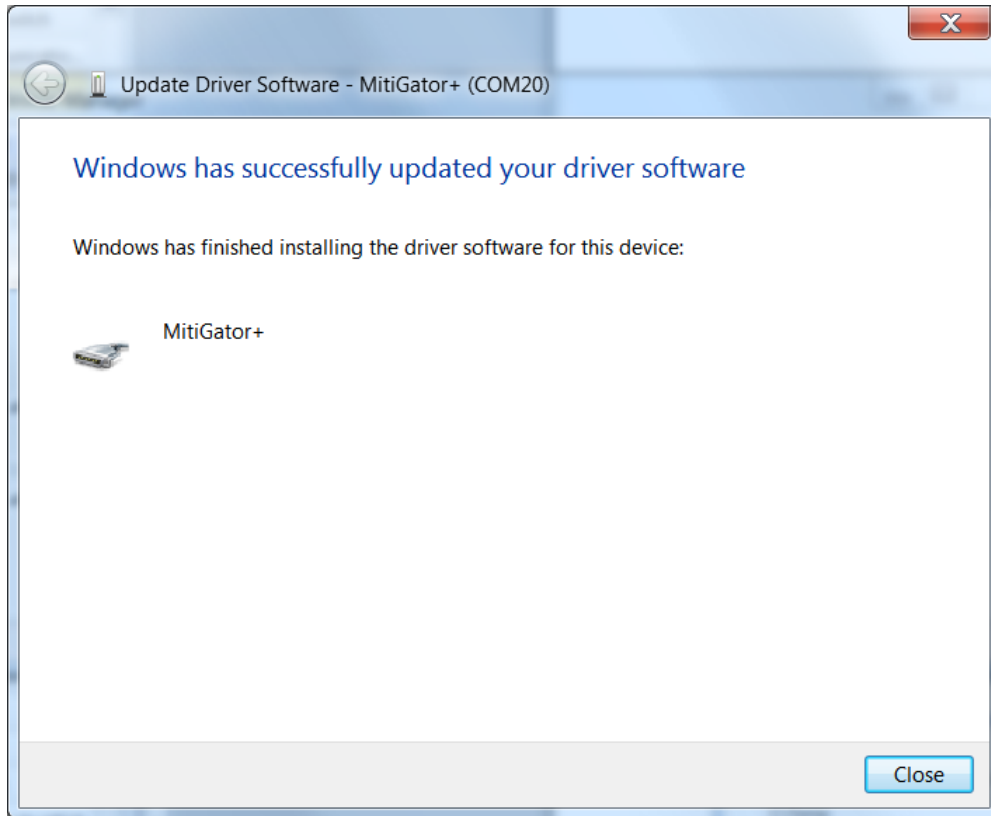
- Browse to the directory where the driver MitiGator_CDC.inf is located, and click NEXT:



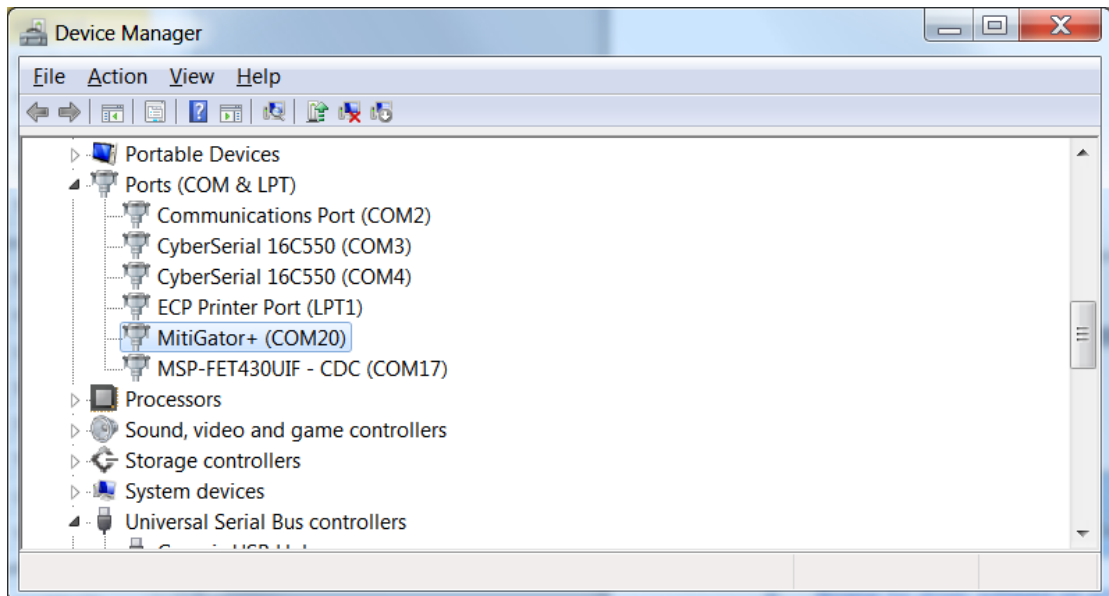
- When the driver is found, tell Windows to install it:



- When the driver is successfully installed, you should see this:



- And the MitiGator will now show up as a COM port:



You can now use a terminal Program such as HyperTerminal or PuTTY to communicate with the MitiGator+.

Displaying peaks

When the system is triggered due to a threshold or vector detect, the MitiGator+ will display the peak values detected in g. The peak values for each channel that have been detected since the time of the system trigger, will be sent to the console every second until the alarm condition is cleared. The reported peaks will be of the form:

```
TRIGGER: X0.032g Y0.021g Z0.003g
```

The peaks are displayed in the channel order X, Y, and Z.

Power up

When power is applied to the MitiGator+, the LED will be turned off and all relays will set to their initial power up condition (de-energized). The MitiGator+ will begin executing the MitiGator+ application firmware. The application firmware will produce a sign-on message similar to the following:

```
KMI MitiGator+ Application Code v2.0  
S/N: 5012  
>>  
Trigger initializing. Please wait.  
Trigger initializing. Please wait.  
READY
```

At this point, the MitiGator+ will perform a diagnostic self-test. If the self-test fails, a message will be produced describing the results of the self-test, and any relays configured to indicate faults will be set as specified. If the self-test fails, the LED will flash RED.

If the self-test succeeds, the relays will be set to their configured initial states - that may not be the same as the initial power up states - this depends on the firmware selected polarity for each relay. The LED will turn GREEN, indicating a successful self-test.

At this point, the MitiGator+ will begin operating as a seismic switch and will control the state of its relays based upon the configured usages and thresholds.

The messages "Trigger initializing. Please wait." occur during initial startup of the MitiGator+ or after editing MitiGator+ parameters using EDIT mode. The message indicates that the digital filters are being initialized before use. This process takes between five and ten seconds. Completion of the trigger initialization is indicated by the "READY" message.

Power down

Powering down the MitiGator+ is not complicated. For the most part, the power can simply be removed. All firmware and programs are stored in FLASH memory, so they are not volatile and will be retained.

Care should be taken NOT to power off the MitiGator+ during the process of updating the FLASH memory. Updating the FLASH memory occurs only under the following conditions:

- When exiting the parameter editor of the MitiGator+ application firmware, the parameters that may have been changed are written back to FLASH memory. This operation takes place very quickly (in well under one second) so the risk of interruption is small. Should the parameters become corrupted; the MitiGator+ will default to factory default parameters.

- When downloading new application firmware for the MitiGator+. This is done after executing the UPDATE diagnostic command, followed by use of the USB Firmware Upgrader program. The process of updating the application firmware takes less than ten seconds. The MitiGator+ has a fixed, permanent bootloader, so if power is inadvertently lost during a firmware update, just repeat the process when power is stable. You cannot “brick” the MitiGator+ during a failed update.

Firmware Overview

The MitiGator+ is designed to begin operating automatically shortly after application of power. Once set up, no user intervention is required in order for the MitiGator+ to function normally. Even during setup only the RELAY and THR commands are generally used for most applications. See the following subsection on RELAYS for some examples. Refer to the detailed descriptions of the various setup options if the application requires a more complex setup.

Once power is applied, the firmware will begin running the MitiGator+ application firmware. If the user does nothing (as is the normal case in unattended startup) then the MitiGator+ application firmware will be automatically started after approximately ten seconds.

The MitiGator+-IND Version

The -IND version of the MitiGator+ provides a convenient enclosure and backup battery power for the basic modular units. The enclosure is intended for use in control rooms and other indoor environments. The IND enclosures should never be used outdoors, in corrosive environments, or in other hostile environments. For these applications, contact Kinometrics for a custom enclosure.

The pair of 6V batteries provided with the IND are rated at 1 Amp-hour and connected in series to provide the required 12V. These provide over 48 hours of backup power for the MitiGator+. This will be reduced considerably if the relays are engaged. With all three relays engaged, the unit will have at least 10 hours of backup power.

Input Voltage 100 - 240VAC, 0.5A

Frequency 50/60Hz

Output 13.8VDC, 1.1A

Indoor use only.

Charger dimensions: 2"W X 3.5"L X 1.25"H

Input cord length: 6ft

Output cord length: 6ft

The enclosure is shown in Figure 9, and Figure 10 shows how both the IND and the Mitigator can be rigidly mounted to a concrete foundation. Figure 11 shows the internal wiring of the Mitigator-IND.

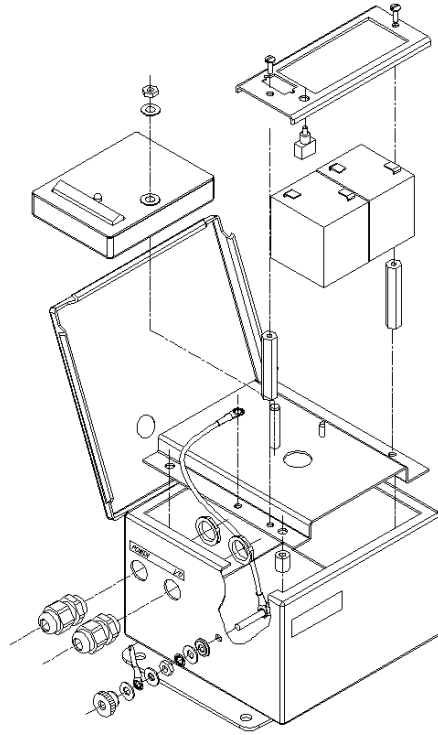


Figure 8 - MitiGator+-IND Enclosure

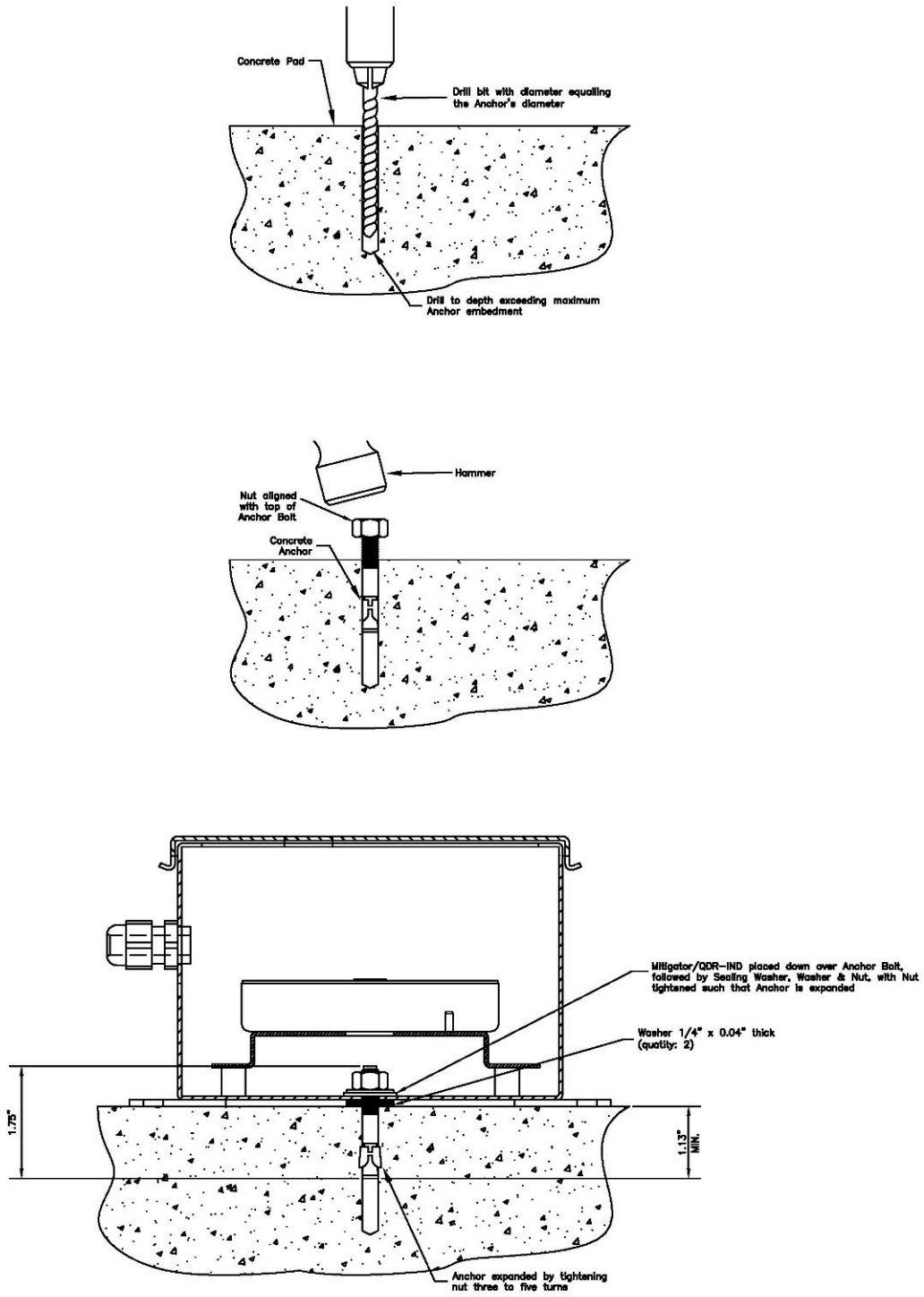


Figure 9 - MitiGator+-IND Mounting

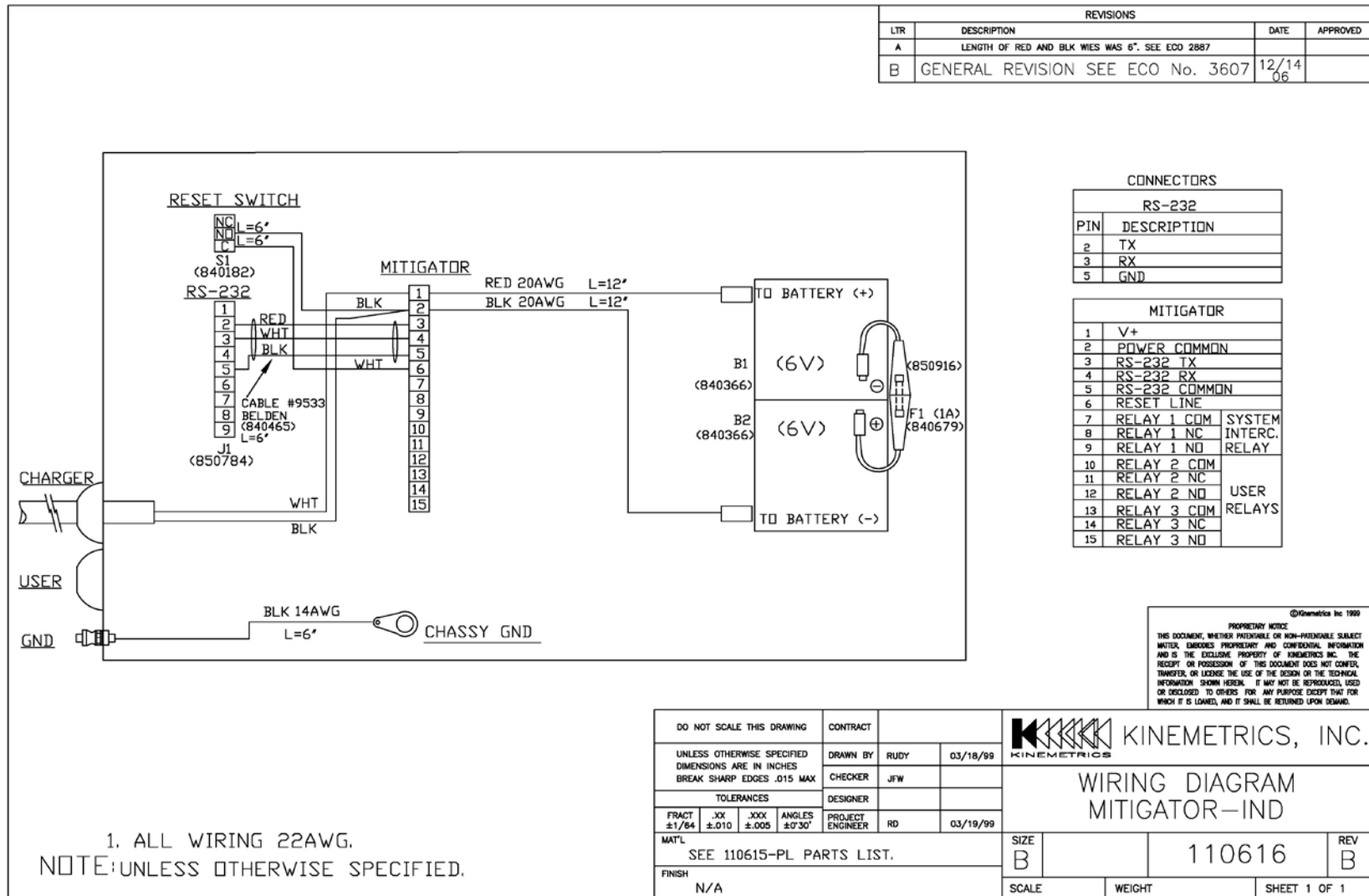


Figure 10 - MitiGator+-IND Wiring Diagram

Commands

The MitiGator+ can be controlled and configured using a command based interface via the console over serial or USB. The prompt that is displayed to indicate that the MitiGator+ is ready to receive and act on user commands is two greater than characters, as shown:

```
>>
```

At this command prompt, you can type MitiGator+ commands, that are further described in this section.

Entering an invalid command will result in a message:

```
>> PARAM
<PARAM not a valid command>
>>
```

Entering an invalid parameter list, or a parameter out of range will result in various messages, such as:

```
>> cmd -1
<Value must be in range 1 to 9999>
>> cmd one two
<Usage: cmd counter>
>>
```

NOTE: The CMD example command is not a real command.

In most cases, if a command is accepted without error, no specific response is provided. Instead, you will be presented with another prompt.

The HELP command will list the available commands at any level. See the HELP command for more detail.

EDIT

The EDIT command places the application firmware into a mode that allows the user to edit various MitiGator+ parameters. Upon entering EDIT mode, a copy is made of the parameters so that they may be viewed and altered without affecting the current operation of the MitiGator+.

Upon exiting EDIT mode, the copy of the parameters is either discarded or is used to replace the active parameters and is also written to the parameter sector of the FLASH memory. There are two commands used to exit EDIT mode:

QUIT will exit EDIT mode without saving the altered parameters. Resulting message (presumes commands are unlocked):

```
>> edit

[EDIT MODE]
EDIT>> sn
Serial Number: 5012
EDIT>> quit
Parameter edit has been aborted.
>>
```

EXIT will save the modified parameters to FLASH memory and exit EDIT mode. Resulting message:

```
>> edit

[EDIT MODE]
EDIT>> sn 5012
EDIT>> exit
Parameters have been updated.
>>
```

A complete list of EDIT mode commands is given in the Configuration section.

HELP

The HELP command provides an abbreviated command list that summarizes the available commands. The result of the HELP command is a list of all available commands in that mode, followed by a brief explanation of the purpose of the command. HELP for the MitiGator+ application firmware is as follows:

```
>> help
DIAG: Diagnostic mode functions
EDIT: Edit mode for altering parameters
HELP: Displays command help summaries
LOCK: Locks restricted functions
SETUP: Display Data Sheet
SYSRESET: System reset
TEST: Self Test as performed at power up
UNLOCK password: Unlocks restricted functions
VER: Displays system version
>>
```

An identical HELP mechanism is provided for EDIT mode and for DIAG mode. See the HELP commands for those modes for a list of HELP details.

LOCK

The MitiGator+ application firmware provides a mechanism for password protecting certain commands. This prevents casual alteration of important data. The password can be changed for those customers who require the ability to alter these critical parameters.

The LOCK command relocks the password protected commands without restarting the MitiGator+ application code.

See UNLOCK.

SETUP

The SETUP command causes the MitiGator+ to display a data sheet containing current setup of the MitiGator+ parameters as follows:

```
>> setup

KMI MitiGator+ Application Code v2.0

S/N: 2174

Current calibration values: Y:523, Z1:530, X:516, Z2:514

Low voltage threshold: 9.0

Relay parameters:
  Relay 1: N T 0
  Relay 2: N T 0
  Relay 3: N T 0

Trigger filter type: 0 (Standard)

Reset usage: 1 (Reboot)

Thresholds:
  Relay 1: X2.0%g Y2.0%g Z2.0%g
  Relay 2: X2.0%g Y2.0%g Z2.0%g
  Relay 3: X2.0%g Y2.0%g Z2.0%g
>>
```

The data sheet displayed indicates current firmware version, serial number, calibration values, low voltage threshold, relay usage and setup, use of the reset switch input, and current threshold settings.

This data sheet may be captured to a text file using your terminal program (such as HyperTerminal or PuTTY) or may be captured as an image using the "Print Scrn" feature of a PC and then pasted into an e-mail or document.

See EDIT.

SYSRESET

The SYSRESET command causes the MitiGator+ to restart the firmware by resetting and restarting of the MitiGator+ application firmware.

See Power-up.

Since the USB connection is a virtual COM port, the port is only valid when the MitiGator+ application is running. If you power off the MitiGator+ or reset it, the USB virtual COM port connection will be broken and you'll have to restart your terminal software.

This means that if you issue the SYSRESET command from USB that the terminal software you will not be able to see the MitiGator+'s startup messages because you won't be able to restart the terminal software fast enough. If these messages are important to you then you should issue the SYSRESET from the serial connection.

Aside from rebooting the unit, the SYSRESET causes the system to re-run the self-test as part of rebooting. The self-test can be run at any time using the TEST command. In the case of the TEST command "no news is good news", so if the test simply returns the prompt with no error messages then the self-test has succeeded.

TEST

The TEST command causes the MitiGator+ to re-execute the system self-test as performed at power up. This test runs automatically when the MitiGator+ application firmware is started.

When the self-test is run, the LED is turned off, and the following items are checked:

- Clear switch should be cleared
- External voltage is checked against the specified threshold
- The sensor is tested for normal operation

If an error is detected, a message indicating the failure will be displayed and the LED will flash RED. If no error is detected by the self-test, the LED will turn GREEN at the end of the test to indicate success. The self-test process takes approximately four seconds.

No message is displayed if the self-test succeeds.

See Power-up.

UNLOCK

The UNLOCK command allows the user to unlock password protected commands so that they can be used to alter critical parameters. The UNLOCK command takes one argument, that is the MitiGator+ password.

NOTE: The only commands protected by the password are those to recalibrate the sensor and to change the serial number. There is typically no reason for the customer to use either command. Unlocking is not required for normal operational parameter changes.

If the password is entered incorrectly, the command will be rejected with a message and the commands will remain locked. For obvious reasons, the password is not listed in this manual.

See LOCK.

VER

The VER command displays the system banner that includes the version number of the application firmware in use, as well as the MitiGator+ serial number. For example:

```
>> ver
KMI MitiGator+ Application Code v2.0
S/N: 5012
>>
```

See Power-up.

Configuration

The MitiGator+ application firmware includes an EDIT mode that allows the user to alter the MitiGator+'s operating parameters. After entering the EDIT command, the firmware will make a copy of the current parameters for display and alteration within EDIT mode.

Some of these commands may be password protected, and as such may require use of the UNLOCK command in order to access them. Upon entering the EXIT or QUIT commands, EDIT mode will be terminated - with or without saving the modified parameters to FLASH memory.

While in EDIT mode, command entry behaves identically to when the MitiGator+ is not in EDIT mode, except that the prompt is changed to the word EDIT followed by two right angle brackets, as follows:

```
EDIT>>
```

The following commands are included in EDIT mode.

CALIBRATE

The CALIBRATE command determines the full scale calibration values for each of the four accelerometer channels of the MitiGator+.

Upon entering the CALIBRATE command, the user will be shown the current values of the full scale values for each channel. After confirming that a recalibration is desired, the user will be guided through an eight step process of turning the MitiGator+ so that each sensor is oriented positive and negative in order to obtain the range of each sensor. Upon EXITing EDIT mode, the updated parameters will be stored in FLASH memory.

The CALIBRATE sequence appears as follows:

```
EDIT>> calibrate
Current calibration values: X:32425, Y:32558, Z:32646,

Recalibrate (Y/N)? y

Position X positive
Position X negative
Position Y positive
Position Y negative
Position Z positive
Position Z negative

Calibration values: 32404, 32553, 31765,

Enter YES to accept: YES

New calibration values ACCEPTED
EDIT>>
```

The default full scale values are 32767 counts for all channels.

This command is password protected.

See also THR command.

DEF

The DEF command is used to set MitiGator+ defaults. Setting MitiGator+ defaults will not affect baud rate, serial number, calibration, or password. Example:

```
EDIT>> def mtg
This command will default most MitiGator+ parameters
Are you SURE you want to do this (Y/N)? y
```

At this time, four default options are available:

DEF MTG restores the defaults for a standard MitiGator+, using threshold triggering and the standard MitiGator+ trigger filter with threshold values of 3.0%g.

DEF ASCE2597 restores the defaults for a MitiGator+ configured to meet ASCE 25-97, an ASCE standard for gas shutoff devices, including use of vector triggering and the ASCE specific trigger filter with threshold values of 17.5%g.

DEF ASMEA17 restores the defaults for a MitiGator+ configured to meet ASME A17.1, an ASME standard for elevators, using vector triggering and the standard MitiGator+ trigger filter with threshold values of 7.5%g.

DEF CA3137H restores the defaults for a MitiGator+ configured to meet California Code 3137, a California code of regulation for hospital elevators, using vector triggering and the standard MitiGator+ trigger filter with threshold values of 30.0%g.

WARNING: You should contact a California Registered Professional Engineer before using the CA3137H setting.

Command syntax: DEF (MTG/ASCE2597/ASMEA17/CA3137H)

EXIT

Upon exiting EDIT mode, the copy of the parameters is either discarded or is used to replace the active parameters and is also written to the parameter sector of the FLASH memory.

EXIT will save the modified parameters to FLASH memory and exit EDIT mode. Resulting message:

```
EDIT>> exit
Parameters have been updated.
>>
```

FILTER

The FILTER command is used to select between the standard MitiGator+ trigger filter and the filter as used to meet the ASCE 25-97 gas shutoff standard. Example:

```
EDIT>> filter 0
EDIT>> filter
Filter type: 0 (Standard)
EDIT>>
```

At this time, two options are available:

Type 0 - Standard MitiGator+ trigger filter

Type 1 - Trigger filter used to meet ASCE 25-97

Command syntax: FILTER n

Edit mode HELP

The EDIT mode has a help mechanism that operates identically to the HELP command of the MitiGator+ application firmware, with the exception that the actual commands available in EDIT mode are different.

The HELP available for EDIT mode is as follows:

```
EDIT>> help
CALIBRATE: Calibrates sensor channels
DEF type: Defaults most MitiGator+ parameters
EXIT: Exits edit mode saving parameters
FILTER type: Select trigger filter type
HELP: Displays edit command help summaries
LOWVDC voltage: Sets low voltage threshold
PASSWORD password: Enter new system password
QUIT: Quits edit mode NOT saving parameters
RELAY n polarity usage holdtime: Set relay 'n' parameters as
follows:
    polarity=N (normal) or I (inverted)
    usage=T (threshold), TF (threshold/fault), V (vector), VF
(vector/fault),
    P (power), F (fault), H (heartbeat)
    holdtime=hold time in MS (0=infinite)
RESET usage: Set reset line usage: 0=Reset alarm, 1=Reboot
SN n: Set serial number to 'n'
THR n Xthr Ythr Zthr: Set thresholds for relay 'n' for X, Y, Z
    as %g (0=unused)
EDIT>>
```

LOWVDC

The LOWVDC command specifies the level at which the MitiGator+ will determine that the input voltage level is too low for reliable operation, and will perform a firmware commanded power down.

After the power down, the LED will turned RED, the relays will revert to their default power on condition (de-energized) and the firmware will wait for restoration of power at least 0.5Vdc above the shutdown level for a period of two seconds.

If entered with no parameters, the LOWVDC command will display the current value of the Low Voltage Threshold parameter.

If entered with the parameter, the LOWVDC command accepts a Low Voltage Threshold value in volts DC. This value can range from 4.3Vdc to 50Vdc.

The low voltage sequence looks similar to the following:

```
LOW POWER: Voltage input 9.5Vdc
LOW POWER: Voltage input 9.4Vdc
LOW POWER: Voltage input 9.3Vdc
LOW POWER: Voltage input 9.2Vdc
LOW POWER: Voltage input 9.1Vdc
LOW POWER: Voltage input 9.0Vdc
LOW POWER: Voltage input 9.1Vdc
LOW POWER: Voltage input 9.4Vdc
LOW POWER: Voltage input 9.5Vdc
LOW POWER: Voltage input 9.7Vdc
LOW POWER: Voltage input 9.8Vdc
LOW POWER: Voltage input 9.8Vdc
LOW POWER: Voltage input 9.9Vdc
POWER restored. System re-initializing.
Trigger initializing. Please wait.
Trigger initializing. Please wait.
READY
```

NOTE: Because a low voltage level will cause the MitiGator+ to shut down and can make it difficult to communicate with the MitiGator+, be careful not to set the low voltage alert level too high.

The default voltage threshold value is 9.0Vdc.

See Power down.

PASSWORD

The PASSWORD command allows you to change the MitiGator+ password that is used to password protect critical parameters.

Since the password is entered as a parameter, it is recommended that the password NOT contain spaces, tabs, or other specialized characters. The password may be a maximum of 11 bytes in length (12 including the internally required terminating NULL).

The password may contain alphabetic or numeric characters, as well as most special characters like *, %, or \$. The password is case sensitive, so "abc" is not the same as "ABC".

NOTE: The only commands protected by the password are those to recalibrate the sensor and to change the serial number. There is typically no reason for the customer to use either command. Unlocking is not required for normal operational parameter changes.

This command is password protected.

See LOCK and UNLOCK

QUIT

Upon exiting EDIT mode, the copy of the parameters is either discarded or is used to replace the active parameters and is also written to the parameter sector of the FLASH memory.

QUIT will exit EDIT mode without saving the altered parameters. Resulting message:

```
EDIT>> quit
Parameter edit has been aborted.
>>
```

RELAY

The RELAY command is used to determine how relays behave, and under which conditions they are changed. The RELAY command may be entered with or without parameters.

If entered with no parameters, the RELAY command will cause the current settings of the RELAY parameters to be displayed as follows:

```
EDIT>> relay
Relay parameters:
  Relay 1: N T 5000
  Relay 2: N T 6000
  Relay 3: N T 7000
EDIT>>
```

If entered with parameters, the RELAY command accepts four parameters that are:

- The relay number - ranging from 1 to 3
- The state - N for Normal, I for Inverted. If normal, the 'set' state will be relay energized, and the 'reset' state will be relay de-energized. If inverted, the 'set' state will be relay de-energized, and the 'reset' state will be relay energized.
- The usage - T for Threshold, TF for Threshold/Fault, V for Vector, VF for Vector/Fault, P for Power, F for Fault, H for Heartbeat.

T usage will cause the relay to set when the corresponding threshold is exceeded.

TF usage will cause the relay to set when the corresponding threshold is exceeded or when a fault is detected. Note that fault indication is not subject to automatic reset by the hold time parameter.

V will cause the relay to be set when the total vector (acceleration in any direction) exceeds the threshold.

VF will cause the relay to be set when the total vector (acceleration in any direction) exceeds the threshold or when a fault is detected. Note that fault indication is not subject to automatic reset by the hold time parameter.

P usage will cause the relay to set when power is detected.

F usage will cause the relay to set when the self test is detected as successful. A failed seismic sensor will be indicated as a fault.

H usage will cause the relay to alternate between set and reset - unless a fault is detected.

- The hold time - Once triggered due to a threshold or vector trigger, the hold time specifies the amount of time in milliseconds that the relay remains set before being cleared again. If the hold time is zero, then the relay will remain set until the clear switch is activated, clearing the alarm.

NOTE 1: Heartbeat mode is useful for testing but is not recommended for long term use as it may shorten the service life of the MitiGator+'s mechanical relays.

NOTE 2: For vector detection usage, the MitiGator+ will compute the vector sum of the acceleration and compare it against the threshold. This means for example that if the threshold is set for 0.020g, that movement on an almost 45 degree angle along any two axes of 0.014g in both directions and a small movement in the third axis would be enough to trigger the system. This allows the MitiGator+ to trigger based upon the total vector of acceleration in ANY DIRECTION. The following calculations would be used:

$$\begin{aligned} & \text{SQRT}((X * X) + (Y * Y) + (Z * Z)) \\ & = \text{SQRT}((0.014 * 0.014) + (0.014 * 0.014) + (0.005 * 0.005)) \\ & = \text{SQRT}(0.000196 + 0.000196 + 0.000025) \\ & = \text{SQRT}(0.000417) \\ & = 0.0204205... \end{aligned}$$

NOTE 3: When using vector detection, all threshold values of the relay must be set to the same non-zero value.

The default settings are normal polarity, vector triggering, and hold time of zero for all relays.

See THR command.

RESET

The RESET command is used to determine the behavior of the MitiGator+ when the Clear Switch is pressed. The Clear Switch can either be used to clear a pending seismic alarm, or to cause reset and reboot of the MitiGator+.

If entered with no parameters, the RESET command will display the currently defined function of the Clear Switch as follows:

```
EDIT>> reset
Reset usage: 0 (Reset alarm)
EDIT>>
```

If entered with the parameter, the RESET command specifies the action of the Clear Switch when it is pressed. 0 indicates that the Clear Switch should clear any pending seismic alarm, while 1 indicates that the MitiGator+ should be completely reset and rebooted.

The default value is 0 - Clear switch resets alarm.

See Clear Switch and Displaying peaks

SN

The SN command is used to set the serial number of the MitiGator+. The serial number may be any number in the range 0 through 99999.

If entered without a parameter, the SN command will display the current serial number of the MitiGator+. For example:

```
EDIT>> sn
Serial Number: 5012
EDIT>>
```

If entered with a parameter, the SN command will set the serial number of the MitiGator+ to the value specified.

The default serial number (before setting at factory) is 0.

This command is password protected.

See VER, PASSWORD, LOCK and UNLOCK commands

THR

The THR command sets the threshold levels for each channel and for each relay as a percentage of g. If entered without parameters, the THR command will display the current settings of the relay thresholds. For example:

```
EDIT>> thr
Thresholds:
Relay 1: X2.0%g Y2.0%g Z2.0%g
Relay 2: X2.0%g Y2.0%g Z2.0%g
Relay 3: X2.0%g Y2.0%g Z2.0%g
EDIT>>
```

If entered with parameters, the THR command specifies the current settings as a percentage of g for each axis for the specified relay. Threshold values may range between 0 (unused) and 50%.

NOTE 1: If any one channel exceeds the specified threshold, then that relay will be considered triggered and will be set accordingly.

NOTE 2: When using vector detection, all threshold values of the relay must be set to the same non-zero value.

The default thresholds are 3.0% of g on all axes.

See RELAY and CALIBRATION commands.

Diagnostic commands

The MitiGator+ contains a number of diagnostic commands that cover a wide range of capabilities, from factory testing through items of interest to some MitiGator+ users. Most of these diagnostic commands will be of no interest to the typical MitiGator+ user.

NOTE: The system will not trigger when in diagnostic mode.

The diagnostic commands available are as follows.

AQDVM

The AQDVM command displays the current values of the XYZ axes. The values are displayed in g for the XYZ axes.

AQDVM defaults on start up to display the raw data values output by the sensors. This raw data includes a significant offset that must be removed by offset subtraction or another method of mean removal.

The AQDVM function will continue until one of the following types of keys are pressed:

- "Z" will cause the next sample read from each channel to be treated as zero, so that future displayed samples are offset by this value. "Z" is useful in checking for sensor drift.
- "C" will clear the offset value previously set by "Z".
- Any other key will terminate AQDVM.

The AQDVM display appears as follows:

```
DIAG>> aqdvms
Reading Sensor samples - Z to zero, C to clear offset
... any other key to stop.
X: +0.000g      Y: +0.002g      Z: -0.001g
DIAG>>
```

CLKLOK

The CLKLOK command displays the current state of the internal CPU clock lock test. The CPU is able to detect whether or not the CPU clock has locked to the supplied frequency.

The CLKLOK command will continue to monitor and display the state of the CPU clock lock test until a key is pressed. The CPU clock lock test display looks as follows:

```
DIAG>> clklok
Checks CPU Clock lock. Any key to stop.
Locked
Locked
Locked
Locked
DIAG>>
```

CSW

The CSW command is used to indicate the current state of the MitiGator+ clear switch. The switch input is scanned periodically, and when the state changes between pressed and released, a message is displayed.

The CSW command will continue to monitor and display the state of the clear switch until a key is pressed. The clear switch test display looks as follows:

```
DIAG>> csw
Reading Clear Switch. Press any key to stop
Switch released
Switch pressed
Switch released
Switch pressed
Switch released
DIAG>>
```

CSAPP

The CSAPP command performs a checksum on the MitiGator+ application firmware sectors. The computed checksum is displayed something like the following:

```
DIAG>> csapp
Checksum: 0x8BEE
DIAG>>
```

DGSEQ

The DGSEQ command performs a canned diagnostic sequence means to help determine that most of the MitiGator+ hardware is functioning normally.

This test command is intended primarily for internal Kinometrics testing. Unless you have access to the reset switch for the 2nd and 3rd parts of the test sequence, it is recommended that this command not be used by the end user as the test sequence will wait "forever" for the switch to be put into the expected states.

After entering the DGSEQ command, the following sequences are performed:

- Computes the checksum of the application FLASH sector
- Checks to make sure the clear switch is cleared
- Checks to make sure the clear switch is set
- Cycles the LED 2 times
- Cycles each relay 8 times
- Checks and reports the processor VCC
- Checks and reports battery voltage 10 times

The diagnostic sequence display looks as follows:

```
DIAG>> dgseq
Application Checksum: 0xC81A
Waiting for switch to clear...
Waiting for switch to be pressed...
Cycling LED...
Cycling Relay 1...
Cycling Relay 2...
Cycling Relay 3...
Checking MCU VCC.
VCC: 3.35
```

```
Checking input voltage.
VDC: 11.49
VDC: 11.49
VDC: 11.49
VDC: 11.49
VDC: 11.49
VDC: 11.49
VDC: 11.49
VDC: 11.49
VDC: 11.47
VDC: 11.47
VDC: 11.49
Diagnostic Sequence Completed - No errors detected
DIAG>>
```

EXT

The EXT command displays the value of the external DC voltage. The displayed value is updated once per second, and displays the detected voltage in VDC. The voltage can theoretically range from 4.3VDC to 50VDC.

The EXT command will continue to monitor and display the external voltage until a key is pressed. The External voltage test display looks as follows:

```
DIAG>> ext
External Voltage. Press any key to stop
VDC: 14.02
VDC: 14.02
VDC: 14.02
VDC: 14.02
VDC: 14.02
DIAG>>
```

Diag mode HELP

The DIAG mode has a help mechanism that operates identically to the HELP command of the MitiGator+ application firmware, with the exception that the actual commands available in DIAG mode are different.

The HELP available for DIAG mode is as follows:

```
DIAG>> help
AQDVM: Sensor input test
CLKLOK: CPU Clock lock test
CSW: Clear Switch test
CSAPP: Compute checksum of Application
DGSEQ: Canned DIAG sequence
EXT: External Voltage test
HELP: Displays DIAG command help summaries
LED state: Turn LED RED, GREEN or OFF
RELAY relay# state: Turn relay ON (1) or OFF (0)
RMS: Noise test via RMS (RETURN when done)
QUIT: Quits DIAG mode
TFREQ: Test sensor frequency
UPDATE: Enters firmware update mode
VCC: Processor VCC test
DIAG>>
```

LED

The LED command is used to control the LED for testing.

Entering a parameter allows you to set the LED RED, GREEN, or OFF.

Example:

```
DIAG>> led green
```

RELAY

The RELAY command is used to turn on or off the specified relay for testing.

The RELAY command accepts two parameters. The first parameter is the relay number (1-3), and the second parameter is the state. 0 turns the relay off (reset state), while a 1 turns the relay on (set state).

RMS

The RMS command collects 100 samples each from all three sensor channels per second. This operation is performed continuously, with the values from each set of readings displayed at the end of each cycle. When the user enters a RETURN key to terminate the test, the peak RMS values detected are displayed in counts and g. The System RMS is displayed in g as XYZ.

The RMS display looks as follows:

```
DIAG>> rms
Checks RMS noise level. RETURN to stop.
0.0025g    0.0028g    0.0029g
0.0026g    0.0029g    0.0028g
0.0025g    0.0027g    0.0029g
0.0025g    0.0027g    0.0022g
0.0024g    0.0027g    0.0023g
0.0025g    0.0028g    0.0022g
Peak RMS[0] = 1.343 counts, 0.0026g
Peak RMS[1] = 1.521 counts, 0.0029g
Peak RMS[2] = 1.528 counts, 0.0029g
System RMS:
X: 0.0022g, Y: 0.0024g, Z: 0.0025g
DIAG>>
```

The RMS process will run until terminated by user input.

Diag mode QUIT

QUIT will exit DIAG mode, and return to the main command prompt.

TFREQ

The TFREQ command computes the frequency error between the CPU clock and the sensor clock. This error is compensated in firmware, and can be up to 10%.

The output of the TFREQ command is as follows:

```
DIAG>> tfreq
Sensor frequency OK: +5.2%
DIAG>>
```

UPDATE

The UPDATE command is used to prepare the MitiGator+ to have updated application firmware installed. When the command is run, the user will be asked to confirm the operation. Once done, brief instructions will be listed on how to install the update.

The process looks as follows:

```
DIAG>> update
Load new MitiGator+ firmware?

Are you SURE you want to do this (Y/N)? y
Do the following:
Close the terminal program
Unplug the USB cable from the PC
Wait 5 seconds
Re-connect the USB cable
Start the Firmware Update program and load new firmware

START NOW
```

The process of updating the MitiGator+ application firmware is listed later in this manual. See [Loading MitiGator+ Firmware](#)

VCC

The VCC command displays the value of the processor VCC voltage. The displayed value is updated once per second, and displays the detected voltage in V_{DC} . The voltage can theoretically range from $3.2V_{DC}$ to $3.5V_{DC}$.

The VCC command will continue to monitor and display the VCC voltage until a key is pressed. The VCC test display looks as follows:

```
DIAG>> vcc
Processor VCC. Press any key to stop.
VCC: 3.4
VCC: 3.4
VCC: 3.4
VCC: 3.4
DIAG>>
```

Distribution

The MitiGator+ firmware and support software is distributed on the EQMet web site at www.eqmet.com in the Downloads section.

The distribution consists of the following components:

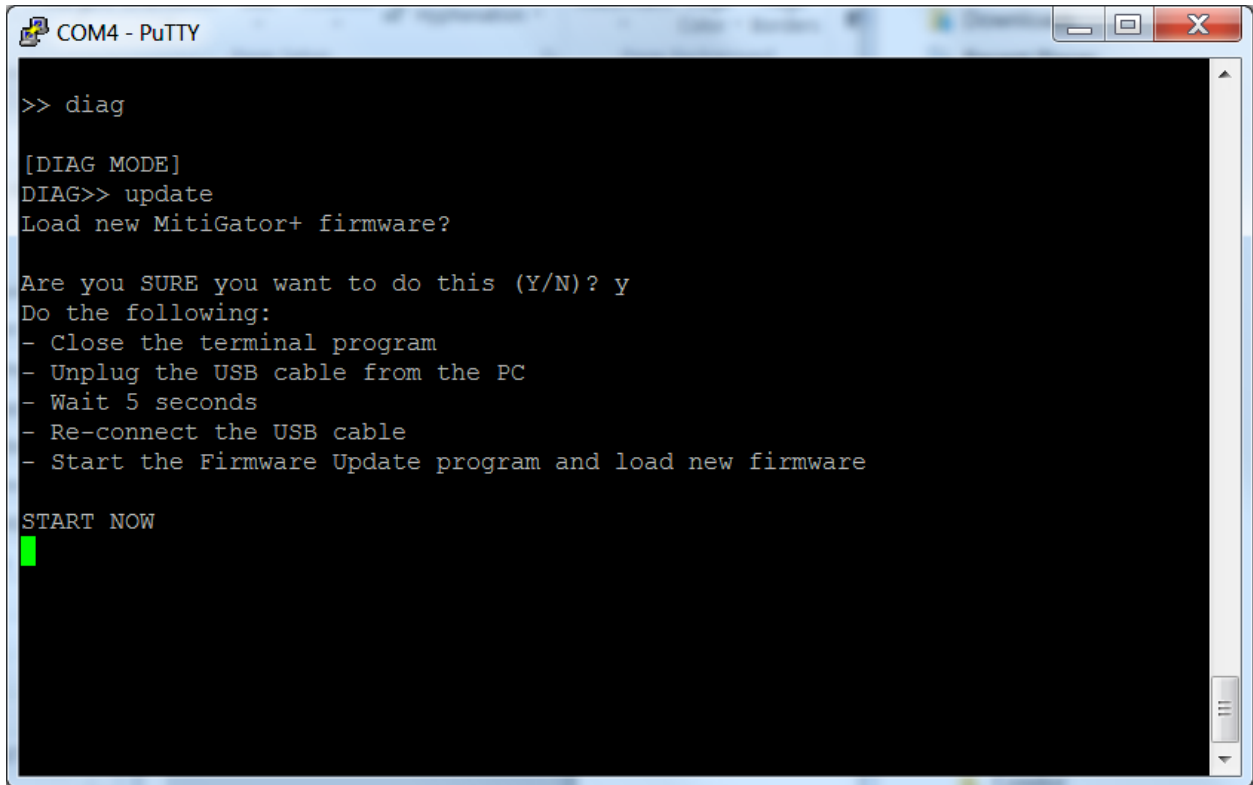
- MTGPlus_xxx.TXT - MitiGator+ application image file
- README.1ST - MitiGator+ change history
- 300996.PDF - This manual in Adobe PDF format
- MitiGator_CDC.inf – The USB CDC COM driver for Windows
- MitiGator_BSL_GUI.exe – The MitiGator+ USB firmware upgrader

Loading MitiGator+ Firmware

Loading new firmware to the MitiGator is a two-step process:

- Enter diagnostic mode with the DIAG command, then type and confirm the UPDATE command. This will cause the current firmware to be erased so that new firmware can be loaded by the hardware-based bootloader.
- Use the MitiGator+ USB firmware upgrader and load the new firmware with the following steps:
 - If you are communicating with the MitiGator+ via USB, close the terminal program.
 - Unplug the USB cable from the computer.
 - Wait 5 seconds
 - Re-connect the USB cable to the computer
 - Start the MitiGator+ USB firmware upgrader
 - Wait for the firmware upgrader to indicate that the device is found
 - Click “Next”
 - Accept the Kinometrics license agreement
 - Click “Select Firmware”
 - Click the “Browse” button and locate the MTGPlus_xxx.TXT image file
 - Click “Upgrade Firmware”
 - Wait for the message “Done!”
 - Your MitiGator+ firmware is now updated. You can now close the MitiGator+ firmware upgrader

The complete firmware update process looks like this:



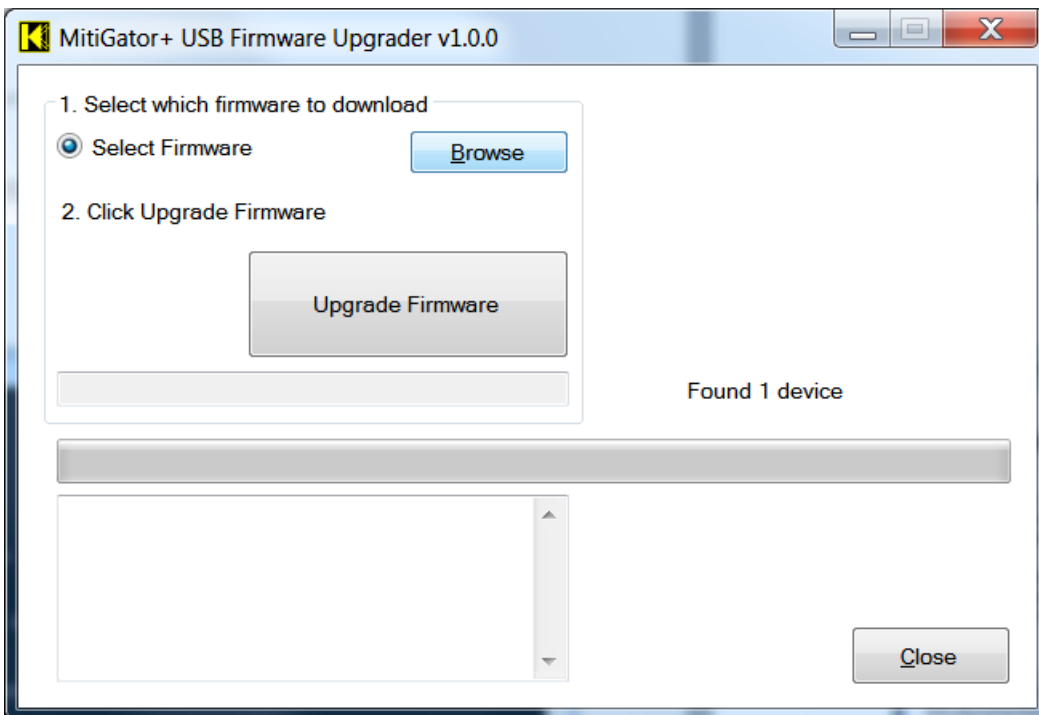
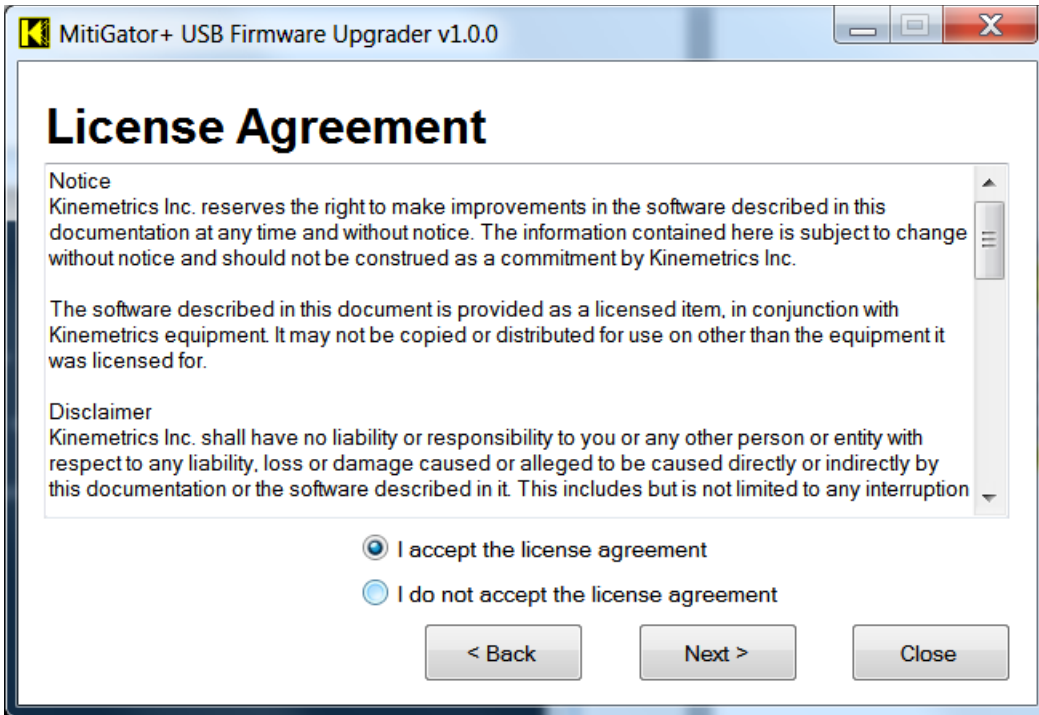
```
COM4 - PuTTY
>> diag
[DIAG MODE]
DIAG>> update
Load new MitiGator+ firmware?

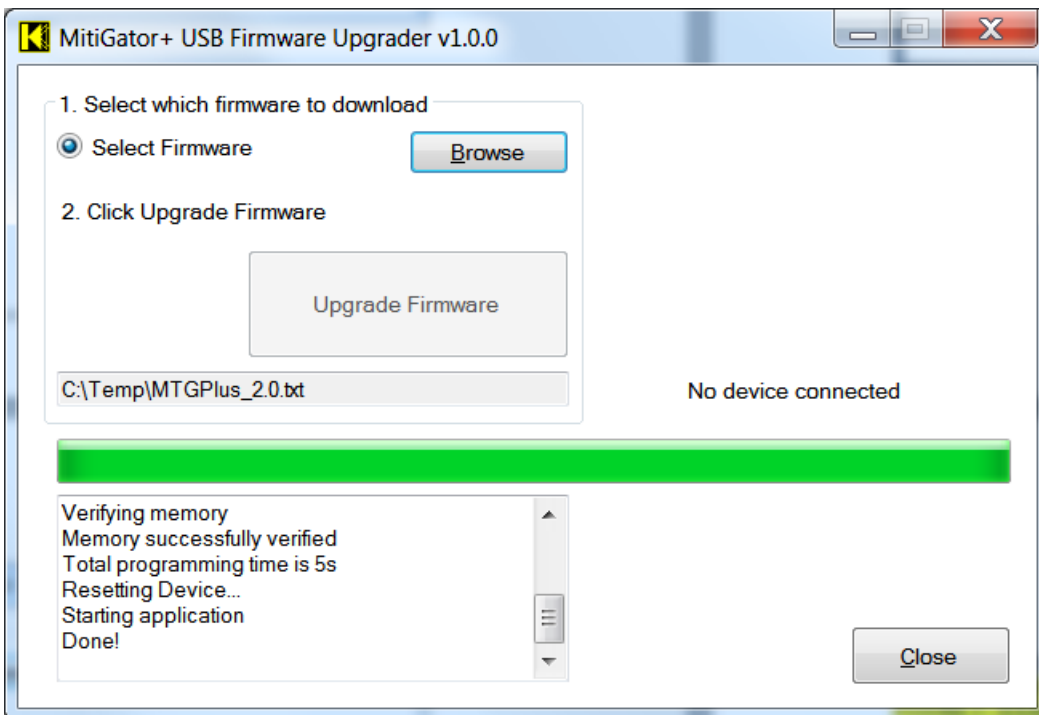
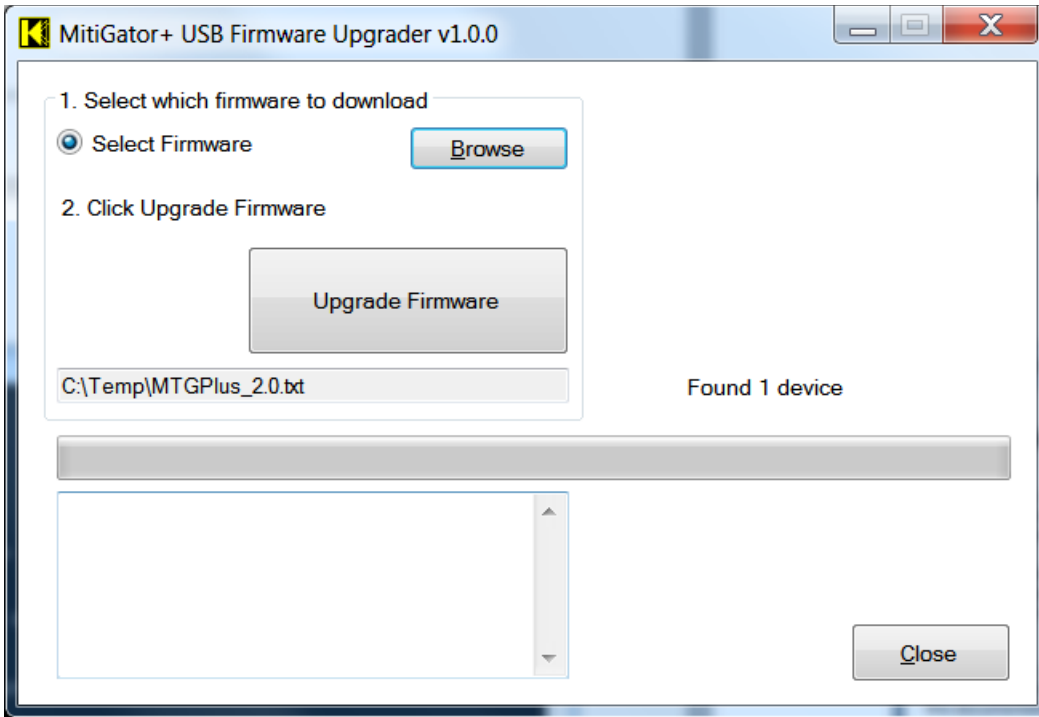
Are you SURE you want to do this (Y/N)? y
Do the following:
- Close the terminal program
- Unplug the USB cable from the PC
- Wait 5 seconds
- Re-connect the USB cable
- Start the Firmware Update program and load new firmware

START NOW
█
```

Figure 11 - Firmware Update Process







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