



MT5 Multi-Tracer Quick Start Guide



Raydec, Inc.

10255 Corona Ave. NE

Albuquerque, NM 87122

Doc Version 2.04

Jan 2022

(505) 292-5002

info@raydec.com

www.raydec.com

Introduction

The Multi-Tracer 5 System (MT5) provides a complete, self contained, electrical load and data acquisition system for collecting performance data of photovoltaic modules. The MT5 collects two types of data: continuous performance under load and IV curves.

When not taking IV curves, the MT5 operates the PV modules under load conditions defined by the user. While under load, the MT5 samples module voltage and current. Additionally, the system samples temperatures and a set of auxiliary (Aux) inputs (e.g., pyranometers). The MT5 samples all values once per second and averages these values over a period defined by the user from a minimum of 1 minute to a maximum of 1 hour.

The MT5 also takes periodic IV curves of each module. For example, the system can be setup to take curves once each hour.

An MT5 System consists of one MT5 Controller and one to four load units. An MT5 Controller operates the load units and also provides the temperature and Aux input connections. A standard MT5 Controller has 24 temperature (thermocouple) inputs and 8 Aux inputs. An MT5 Load Unit provides an electrical load and data acquisition for up to 16 photovoltaic (PV) modules. The actual load configurations are customized as defined by the user when their MT5 is ordered.

The MT5 system is self contained and once setup, the MT5 will collect and store data internally without any other external equipment. The MT5 is a network device. This means that it connects to an existing computer network via common Ethernet cables and uses standard TCP/IP protocols.

The primary interface used for configuring and monitoring the MT5 system is via common web browsers such as Mozilla Firefox (recommended). The MT5 essentially runs an internal web server. No special software is needed to interact with the MT..

Basic Setup

Basic setup of the MT5 System is straight forward and comprises a few key areas:

- 1) Hardware Installation.
- 2) Establish a network connection.
- 3) Configure operating parameters.

Hardware Installation

Follows these basic steps for proper installation:

- 1) Mount the MT5 Controller and Load Unit
- 2) Connect AC power (but leave units turned off)
- 3) Connect MT5 Load unit to MT5 Control Unit
- 3) Connect PV modules, temperature sensors, and other signals.
- 4) Power up the MT5 Load and Control units.
- 5) Allow approximately 2 minutes for the MT5 System to boot.
- 6) Test Network Connection.

Mounting

Mount the MT5 Controller and Load units in standard 19-inch equipment rack or on a stable surface. Each controller and load require AC power and each load must connect to the controller with a load control cable. The load unit dissipates energy through heat transfer. Fans are mounted on the bottom of the load unit. Make sure the airflow is not blocked. See the discussion of Ventilation below for more details. The cooling fans are relatively noisy when running at full power (approximately 82 dB). Therefore, consider fan noise when locating the system.

AC Power

Both the MT5 Controller and Load units require AC power. Raydec strongly recommends that the MT5 Controller and Load units be powered through an uninterruptible power supply (UPS). The MT5 System includes an internal computer and, as with any computer, clean and stable power helps to ensure trouble free operation. In addition to helping to prevent system damage, a UPS will also reduce the chance of losing data.

Each load unit requires an external electrical ground. While the AC power cord connects the Load unit chassis to AC power ground, this ground connection cannot handle the potential worst-case ground currents that could be produced by the connected PV modules. Therefore, additional grounding is used to ensure safe operation of the unit under worst-case conditions.

Raydec recommends connecting the largest gauge wire possible in your installation from this external ground point to earth ground. Please note, that this external ground is not needed for proper operation, nor is the unit unsafe without this connection. However, this connection provides additional safety if the MT5 Load Unit were to experience a catastrophic failure requiring that all module currents be shunted to ground.

Ventilation

The MT5 Load Units dissipate the electrical energy from the modules as heat in the form of warm air. It is critical that the MT5 Load unit have adequate ventilation that allows cool ambient air to enter the front and exit the back of the load unit with minimal flow restriction. Care must be taken to avoid having the warm exhaust air re-circulate to the intake. This will cause the MT5 Load Unit to overheat requiring that it shutdown, and possibly damage the unit.

Note: If the MT5 System is run inside an air-conditioned area, the heat from the MT5 will add to the load on the air conditioning system. This will require that a cooling system

work harder to remove this heat from the room. Or conversely, this heat will help warm a room in winter months.

Connections

Load Control

Each MT5 Control unit can control up to four MT5 Load Units. For a typical system with one controller and load, connect the load unit to the Load 1 port of the controller. Use the 1-meter controller cable provided.

PV Module Connections

The Multi-Tracer uses a 5-pin connector for each PV module input. The connector and each pin function is shown in Figure 1.

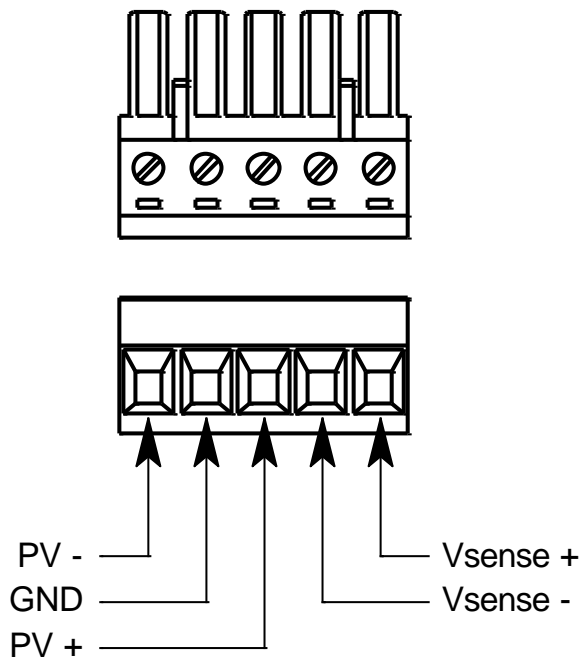


Figure 1. MULTI-TRACER PV Module Input Connector.

While all modules are grounded when connected to the Multi-Tracer, the Multi-Tracer supports grounding either the module negative or module positive terminal. Therefore,

each channel is wired as a positive or negative ground channel. Most modules are connected using negative grounding, and, by default all Multi-Tracer channels are configured this way unless positive grounding is specified by the customer when the unit is ordered. Note: A simple wiring modification is required inside the Multi-Tracer to convert the given channel from positive to negative grounding. Please consult the full Multi-Tracer manual and Raydec if you need to convert one or more of the Multi-Tracer channels from negative to positive grounding

The module output is connected to either the positive input (PV+) and ground (GND) or to the negative input (PV-) and ground (GND). Never connect module to PV+ and PV- at the same time. No damage should result, but the unit will not function properly.

The voltage sense lead is connected the same regardless of the grounding scheme. While the diagrams below show the shield of the voltage sense cable connected to ground at the Multi-Tracer, other shielding connections may perform better depending on the specifics of the installation. Generally, it is better to connect a shield at one end only.

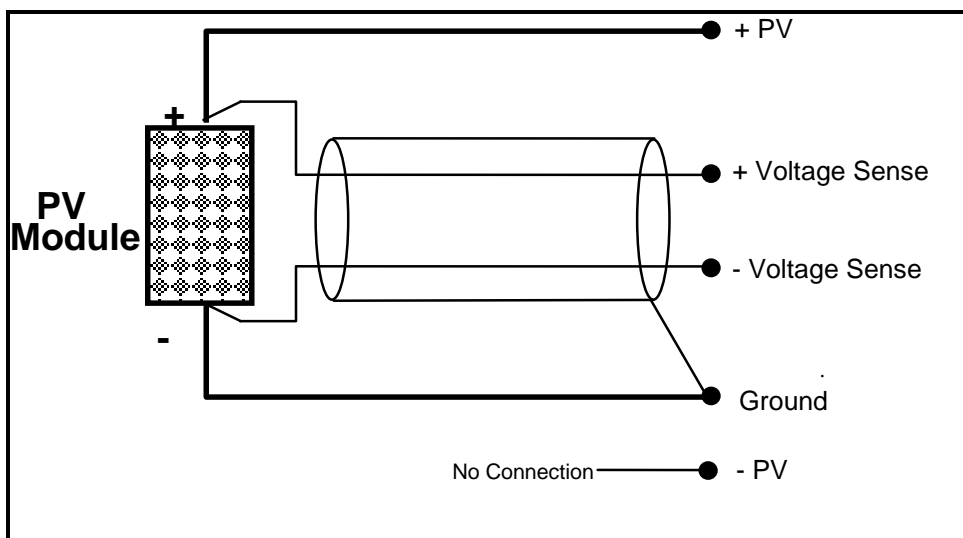


Figure 2. MULTI-TRACER PV Module Wiring. For Negative Grounding

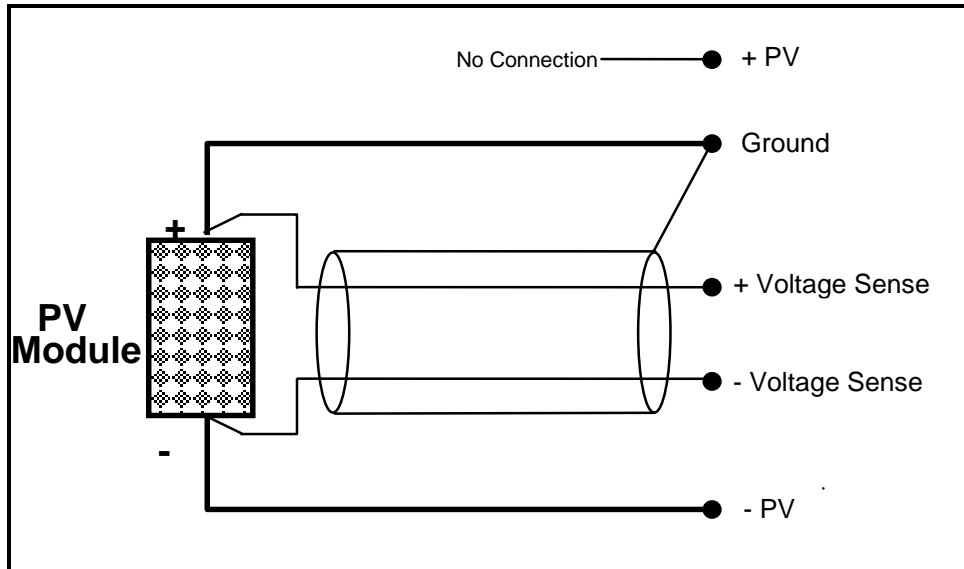


Figure 3. MULTI-TRACER PV Module Wiring. For Positive Grounding

Four wires connect the PV module to the Multi-Tracer:

- Positive PV Power Lead (Large Gauge).
- Negative PV Power Lead (Large Gauge).
- Positive Voltage Sense Lead
- Negative Voltage Sense Lead

Use a shielded, twisted-pair wire with a voltage rating greater than V_{oc} of the PV module for the voltage sense lead. Connect the shield of this cable to the GND pin of the Multi-Tracer module connector or other suitable ground point. Connect the shield at one end only. Keep the power leads as short as possible and use #10 AWG wire. This is the largest wire that can be used with the Multi-Tracer connectors.

Aux Input Connections

The Multi-Tracer uses a 3-pin connector for each auxiliary (Aux) input. These are typically used for pyranometers but may be used for any DC voltage signal within the input range of +/- 5V.

The connector and each pin function is shown in Figure 4.

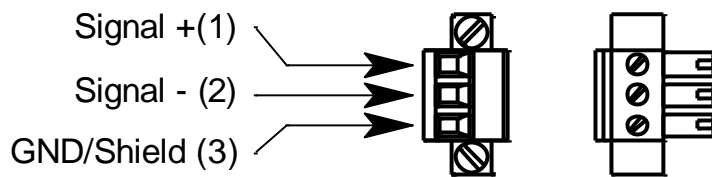


Figure 4. MULTI-TRACER Aux Input Connector.

Note: The Multi-Tracer makes a differential measurement between the signal positive and negative inputs. However, this signal must be referenced to the Multi-Tracer ground (GND). If the signal source (pyranometer) does not reference to ground, then add a reference to ground at this connector. For example, place a jumper from signal negative to the GND connection.

Other referencing techniques may be more appropriate. For example, a resistance rather than a direct shorting jumper. Different grounding schemes may have significant impact on signal noise. If noise appears to be a problem, try alternate methods of referencing the signal and alternate connections for the signal cable shield.

Power Up

Once all AC power, control, module, and signal connection have been made, turn on the AC power switches to both the load and control unit. The system takes approximately 2 minutes to completely power up and boot. The unit will automatically begin collecting data as soon as it completes its startup process.

Network Connection

Establishing a network connection can be the trickiest part of setting up an MT5 System. When possible, MT5 Systems are shipped, pre-configured to work on the user's network. Basic network configuration involves just two network settings: IP address and subnet mask. The MT5 System, as do all network devices, requires a unique network IP address. Currently the MT5 only supports static IP addressing. Therefore, the MT5 must be assigned a unique, static IP address within your network. Your network administrator can provide you with the appropriate IP address and subnet mask.

Note: The static IP address needed by the MT5 must be unique to your local area network (LAN). Do not confuse this with a wide area network (WAN) static address that is unique on the entire, worldwide, internet network.

Several steps are needed to change the MT5 network settings. There are two methods for changing networks settings. The easiest is to connect a keyboard and video monitor to the MT5 control unit. The second is to create a temporary network with the Multi-Tracer and a computer.

Network Change via Keyboard and Monitor

This is a new feature supported by MT5 controller software versions 5.08. Connect a computer keyboard with a USB connect to either of the USB host ports on the front of the MT5 control unit. Plug a standard computer video monitor into the VGA video connector on the front of the MT5 control unit.

Press the “enter” key to have the monitor to display a short menu. Enter the number ‘1’ and press enter. This selects menu item “1) Network Setup.”

The “Network Setup” sub-menu has a list of network settings options:

- 1) Set IP Address
- 2) Set subnet mask
- 3) set gateway address
- 4) Set DNS 1
- 5) Set DNS 2
- 6) Save Changes
- 7) Exit

For example, to change the IP address, enter the number ‘1’ and press enter. You are then prompted to enter the IP address in standard form such as “192.168.1.30” (without quotes). Note The Multi-Tracer accepts the data as entered and does not verify the format. Be sure to enter a properly formatted IP address as shown.

The other parameters are entered in a similar manner. Enter ‘6’ to save any changes and the number ‘7’ to exit this menu. Be sure to save any changes before exiting.

Temporary Network

It is not possible to change the network settings via the network without a working network connection. This dilemma is overcome using the following steps:

- 1) Temporarily connect a computer (PC) to the MT5 directly using an Ethernet crossover cable (included).
- 2) Temporarily change the PC network setting to be compatible with the default MT5 network settings.
- 3) Establish a connection to the MT5.
- 4) Change the MT5 network settings.
- 5) Reset the PC settings back to their original values.
- 6) Re-establish MT5 connection using the new network settings.

If the MT5 was not preconfigured, it ships with default network settings of:

IP Address 192.168.1.30

Subnet: 255.255.255.0

To establish a temporary connection, you must set your computer to a network address compatible with the MT5. This may not work properly if it is done with your computer and MT5 connected to your existing network. It is recommended that you connect the computer to the MT5 directly using an Ethernet crossover cable.

An Ethernet crossover cable is a special Ethernet cable for directly connecting two network devices without the use of a router, hub or network switch.

An alternative to using a crossover cable is to connect the MT5 and computer to the same network switch or hub, yet keep this switch isolated from the main LAN.

In either case, you are effectively creating a small network consisting of just the MT5 and your computer. In order to connect to the MT5, temporarily set the computer's IP address and subnet to values compatible with the default values of the MT5 – see above.

At this point you should be able to establish a connection to the MT5 using these temporary network settings. See the section on testing the network connection and then return here to complete the process of changing the network settings.

Once you have established a successful, temporary network connection, you should change the MT5 network settings to the permanent values provided by your network administrator. Assuming you have a working connection as described in the "Testing Network Connection" section, select the "Network Settings" item under the "System" menu tab. This will open the network settings page.

Warning: It is critical that you know the MT5 IP address. If unknown, you will have to connect a keyboard and monitor to determine the network IP address.

To change the network settings, simply set the IP address and subnet mask values to the required values and press the "Apply" button. This will immediately change the MT5 settings to those values you provided. Since these values will no longer be compatible with the setting used to establish this temporary connection, you will immediately lose connection to the MT5. This is actually good, as it indicates that the MT5 network settings have been changed.

Restore your computer to it's original network settings and reconnect your computer to your network. Also connect the MT5 Controller to your network.

Note: If you were using an Ethernet crossover cable, be sure to replace this with a conventional Ethernet cable.

You should now be able to connect to the MT5 through your network using the network IP address provided by your network administrator. Repeat the network test to confirm that the network connection is functioning properly.

Testing Network Connection

To test the network connection, follow these steps:

- 1) Connect the MT5 Controller to AC power and turn the on the MT5 controller power switch if not already turned on.
- 2) Wait approximately 2 minutes to allow the MT5 Controller to complete it's power up sequence. Note: It is not necessary to have the MT5 Load power on or even connected.
- 3) Using a common web browser (Mozilla Firefox currently required), enter the following URL into the address line of your browser running on a computer within the same network (LAN) as the MT5. The exact IP address to use depends on the current network settings of the MT5.

For example, if the MT5 IP address were 192.168.1.30 enter the URL and hit the return or enter key:

`http://192.168.1.30`

The web browser should immediately display the "Real-Time Data" page of the MT5 System. There will be data tables for modules, temperatures, and aux inputs. Display of this page confirms that you have a functioning network connection to the MT5 System.

If the connection failed, you would get a standard 404 error, page not found.

Note: For convenience, be sure to use your browser's bookmark or favorites feature to provide quick access to the Multi-Tracer.

MT5 System Configuration and Use

The MT5 system automatically collects data any time it is turned on. However, there are many parameters and settings that can be customized. The MT5 collects two forms of data: performance data under load, and IV curves. While some settings affect both types of data, some are specific to one or the other.

This Quick Start manual will discuss key settings for both types of data.

Setting the Time

The first thing to do is set the date and time for the Multi-Tracer to the local time and date. This is done using the “Systems” menu in the software.

Other setup selections are found with the “Settings” menu.

Performance Data

Anytime the MT5 is not taking IV curves, it is collecting continuous data on the PV modules while operating them under load. The primary parameter is the data logging, average period for this data. For example, if the data logging averaging interval is set to 10 minutes (the default), the MT5 will average data for 10 minutes before writing these average values to the data file as a data record.

To change this value, use the “Data Logging” selection under the “Settings” menu. Change the value as required. Minimum is 1 minute averaging. Press the “Apply” button. Subsequent averaging will use this new value.

These data are stored in Multi-Tracer Data files (MTD files). These files are stored inside the Multi-Tracer itself. Refer to the section “Accessing Data Files” for how to move the data from the MT5 to your computer.

Note: All module, temperature and aux input data are stored together in this file using a single comma delineated line or record for each data logging interval (average). The

MT5 automatically creates a new file for every day and automatically appends new data to this file throughout the day.

The MTD file is a text file using commas as delineators. This file can be read into programs such as Microsoft Excel for data viewing or additional processing.

Another important setting is the load configuration. Each PV module load operates independently from the other loads. There are three operating conditions for the load:

- 1) Off
- 2) Peak-Power Track (most common)
- 3) Fixed Voltage

The most common setting is to operate the module at its peak-power point. The MT5 will continuously regulate the load to hold the module near its peak-power point. While it is possible to set each module's load separately, it is often much simpler to set all loads to peak-power track. This is done using the "Global" settings.

To globally set all modules to peak-power track, select "Global" under the "Settings" menu. In the "Global Load Mode" section, select the "All Peak Power" option and press the "Apply" button. All modules will now begin to peak-power track.

Note: It can take some time for the power tracking algorithm to converge. But typically, it will be tracking within 30 seconds.

IV Curve Data

The second type of data collected by the MT5 are IV curves. An IV curve represents a snapshot of module performance. Each module may be independently set to enable or disable automatic IV curves. IV curves do take some time to sweep, and it is recommended that you only enable curves on modules of interest and certainly only on module channels that have a module connected.

There is a single common IV curve sampling interval that applies to all modules. To change this interval, select “IV Curves” under the “Settings” menu. This page presents the curve interval, and this can be expressed as a combination of days, hours, and minutes.

This screen also provides start and stop time-of-day values. For example, it is common to limit IV curves to daylight hours or even hours near solar noon.

Each IV curve is stored in a separate IV curve data file as XML data. See the section “Accessing Data Files” for more details.

However, once you have transferred the IV curve XML files from the Multi-Tracer, you can import these files into Raydec’s IVPC 3 IV curve software (provided). Refer to the IVPC 3 “Help Menu” documentation for details on importing XML data.

Accessing Data Files

The MT5 stores all data within the MT5 Controller as data files. While the MT5 has enough storage capacity to store months of data, Raydec strongly recommends copying data from the MT5 on a regular basis (for example, daily).

The MT5 system provides access to the data files using the file transfer protocol (FTP). Any standard FTP client program should be able to access the MT5 data. You must setup your FTP client using three values: FTP host, username, and password. The MT5 system provides two levels of FTP access: data user and data administrator. The data user can read files but cannot modify or delete files. The data administrator can delete files and perform some other basic file system operations.

The FTP host depends on the IP address of the MT5. For example, if the MT5 IP address is 192.168.1.30, the FTP host should be:

```
ftp://192.168.1.30
```


The two access modes have the following username and password values (do not include quotes):

Data User access:

Username (login): "data_user"

Default Password: "du_rd3200"

Data Administrator:

Username (login): "data_admin"

Default Password: "da_xrd3200"

FTP access defaults to the MT5 "data" directory. Within this directory are two folders "mtd" and "curves". The "mtd" directory contains the daily performance data (MTD) data files. The "curves" directory contains all of the IV curve data files.

Note: A new MTD files is created at midnight every day. Therefore, the current day's MTD file will almost always represent a partial day. To avoid confusion, it is best NOT to copy this partial day. Or if you do, be sure to copy the complete daily file at a later date.

File management is not automatic. Files will stay on the MT5 until deleted by the data administrator. The MT5 can store months of data but you should never rely on the MT5 for data archiving. As with any computer data, you must make regular backups of the data to prevent possible data loss.

Again, Raydec recommends transferring data from the MT5 daily.

As for actual FTP access, FTP client software such as Filezilla is recommended. In addition, browsers such as Firefox, Internet Explorer (IE) and Edge support FTP access. FTP functionality is built into IE and in fact, Internet Explorer can present FTP

directories as standard Windows file system directories. This makes it as easy to work with these files as they would be if they were part of your desktop file system.

Firefox doesn't have a built in FTP client, but there are plugins available such as "FireFTP" that add this functionality to Firefox.

End