

# Voltsys

## Inverter Control Unit



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## Important Safety Instructions

Read this manual before installation, operation, maintenance or inspection of the inverter control unit. Only authorized personnel should be permitted to perform maintenance, inspections or parts replacement.



WARNING!

Indicates a potentially hazardous situation, if not heeded could result in serious injury or death.



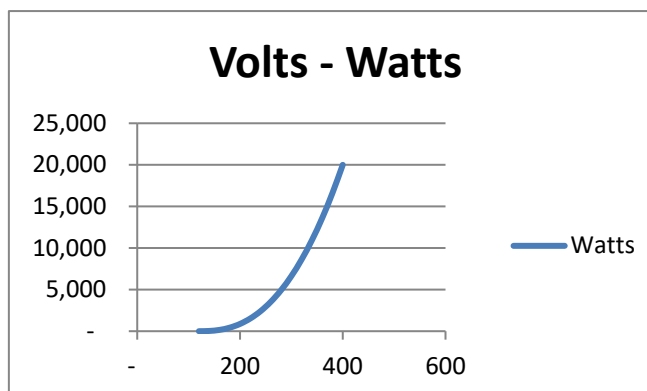
CAUTION!

Indicates a potentially hazardous situation, if not heeded could result in moderate injury or damage to equipment.

## INTRODUCTION

Wind and most hydro turbines need power extracted at different rates, depending on the RPM or turbine voltage. This is known as a power curve, or power table, and usually the ratio is non-linear as per the example graph on the right. In the past, wind inverters provided the ability to enter a power curve.

The Voltsys Inverter Control Unit provides power curve control for ABB solar inverters, including the Trio and Uno DM range of inverters.



This means that solar inverters can now be used as wind inverters, and controlled in a manner which makes them suitable to use with isolated DC voltage from a wind or hydro turbine. The load on the generator is increased based on a generator speed or DC voltage and that power is then exported to the grid by the inverter.

The control unit also provides data logging to a micro-SD card. Programming the power curve and other settings can be done by loading a setup file on the micro-SD card or connecting to a laptop.

In using the control unit you need to understand some functions and adjust settings on the inverter. Please read the inverter manual and carry out the settings shown later in this manual.

### Monitoring via USB

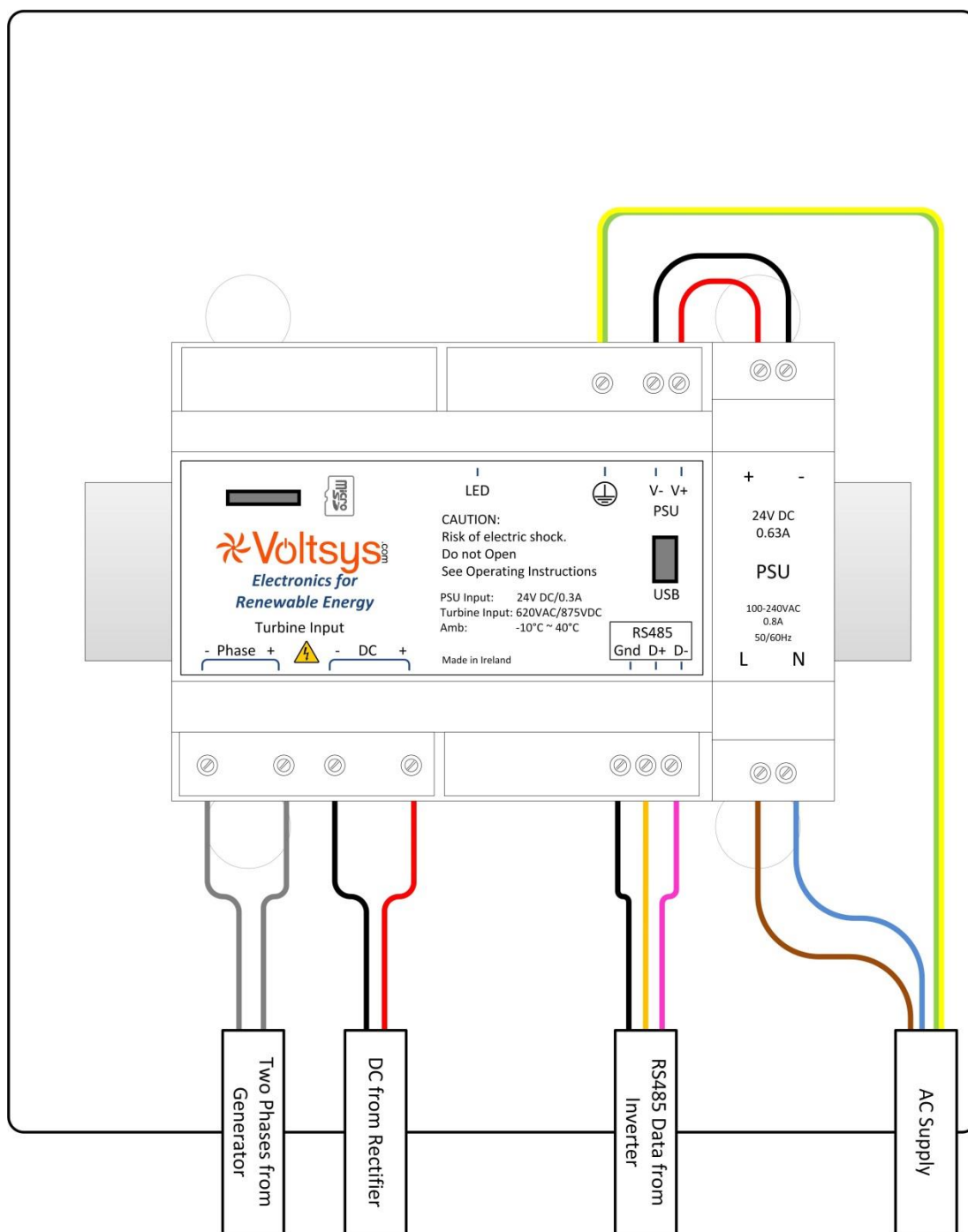
The controller also has a USB port which can be used for monitoring via a laptop. On request we can provide serial monitoring software for this purpose.

**MC4 Connectors on inverter.** Connections to solar inverters are made with solar MC4 connectors. These are rated 20A and it is generally best to parallel connect these to reduce current. To prevent arcing and a potential fire hazard, the cable **must** be stranded wire crimped using the correct crimping tool which we can supply. The U section of the crimp is inserted into the crimping tool as shown. The wire is crimped only on this U section.



There are male and female plastic holders, and male and female crimped connectors. The male crimp connector goes into the female holder and vice-versa. Crimp the wire then push wire and crimp into the connector until it clicks firmly into place. Then screw down the plastic cap and seal to make a water-tight connection.


## Controller Layout & Wiring



Cable size:  $0.5\text{mm}^2 - 2.5\text{mm}^2$   
 Generator cable rated to 1000V  
 AC supply cable rated to 300V  
 RS485: Shielded cable, D+/D- on twisted pair

## Connections

### Power Supply Connections

- L Live grid connection to power supply.
- N Neutral grid connection to power supply.
-  Protective Earth connection.



WARNING!

WARNING: The control circuits such as R485 and DC supply are isolated from the turbine voltages, however it is still important to wire a connection to earth.

### Controller Power (pre-wired)

- +V Positive 24V from power supply.
- V Negative (Gnd) from the 24V power supply.

While the control unit may function on USB power from a laptop alone, this is not recommended.

### RS485 Comms to Inverter

RS485 connection is required to control the level of power converted by the inverter

**Note:** Uno DM will require a comms kit add on  
Trio 5.8/7.5/8.5 will require a PMU expansion board fitted.

- D+ Connect to the inverter RS485 positive **+T/R**  
(See inverter manual. For Trio use **PMU +T/R** or for Trios with the PMU expansion board use **S +T/R**).
- D- Connect to the inverter RS485 negative **-T/R**.
- Gnd Connect to the inverter RS485 RTN.

### Turbine Input

- To measure turbine voltage, the unit requires a connection to the DC output from the rectifier.
- To measure turbine RPM, the unit requires a connection to any two of the three phases from the turbine PMG

For datalogging, it would be normal to connect both the AC and the DC, but the controller only requires one or the other connected to function, depending on whether the power curve is based on voltage or RPM.

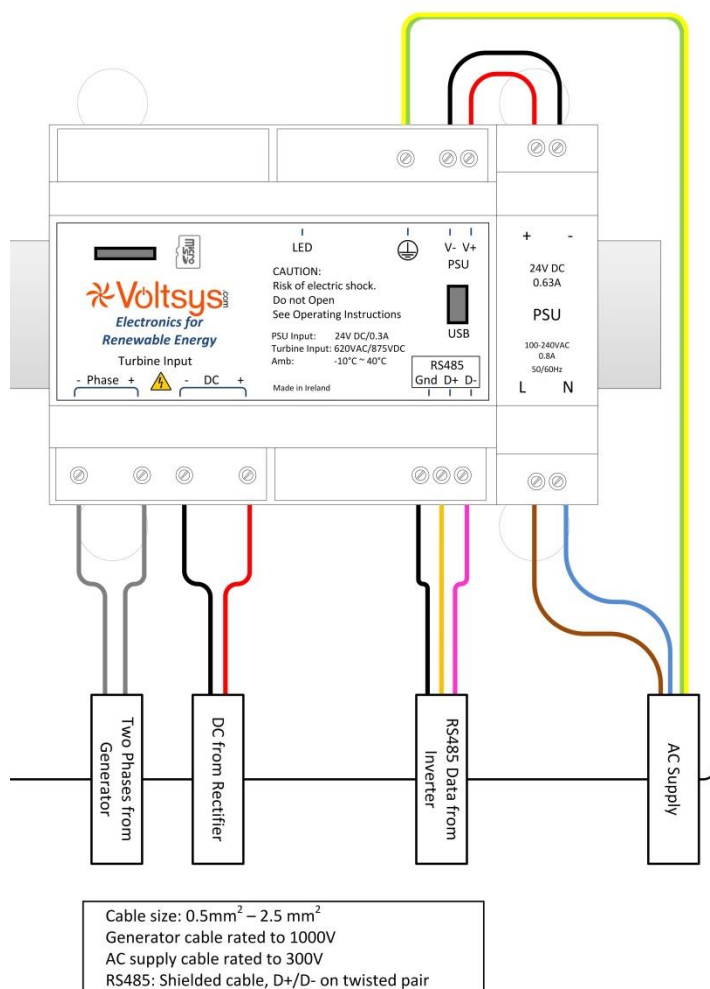


WARNING!

WARNING: AC and DC Voltages from the turbine can carry dangerous voltage. Check the turbine is stopped, can't restart and is suitably isolated before making these connections. Also ensure any connected equipment is off, isolated and any voltage stored in capacitors has been discharged.

- DC+ Connect to inverter DC positive. Ensure polarity it correct.
- DC- Connect to inverter DC negative.

- Phase + Connect to one phase of the turbines three phase generator. This is an AC connection so polarity is not important and only used here to distinguish between the two connections.
- Phase - Connect to second phase of the turbines three phase generator.



## Additional Frequency Input

Typically the two phases from the generator are wired to Phase – (Y) and Phase + (Z)

An additional input (z) to the left of Phase +(Z) is provided for lower voltage generators (<550VDC). This can be used if frequency readings are not being generated



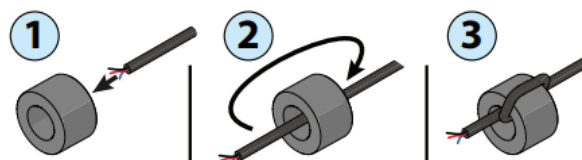
WARNING!

Only for lower voltage generators wire the two phases to **Y & z**

Otherwise wire the two phases to **Y & Z**



The wiring of the RS485 line must also be wrapped around the EMI ferrite, where it is supplied with the inverter coms kit or expansion board. This should be fitted where the cable exits, inside the inverter. No excess cable should be used inside the inverter and the wiring should not be grouped with AC wiring.



See com kit instructions for more details

Before connecting the inverter to the grid it is important to configure the inverter and to check that the controller is communicating with the inverter. Please read through the steps on configuring the inverter. Ensure the inverter level is at 0% before connecting the inverter to the grid (Setting this level is not possible with the standard wifi setup, in this case please ensure the controller is communication with the inverter before connecting the grid, see p.12.)

## DM Com Kit/PMU Expansion Board

You will need to fit a DM Com kit into UNO-DM inverters or a PMU Expansion Board in the case of the Trio 5.8/7.5/8.5. This kit is an optional extra and is required for the Voltsys controller to communicate with the inverter. The coms comes as standard on larger Trio inverters.

## Inverter Settings

You will need to change some setting on the inverter in order for the Voltsys Inverter Control Unit to over-ride MPPT tracking normally used by solar inverters. These settings can vary slightly depending on the type of inverter. Please check the inverter manual for additional details on navigating the front panel menu and for more details on the inverter settings.

## Inverter Menus

1. Navigate to the main menu (press ESC if needed) and press up and down to find “Settings” and then press “Enter”. (On the Uno DM inverter there are both system settings and inverter settings)
2. The default password is “0000”, press “Enter” to move to next character
3. Once in the “Settings” menu, press up and down to navigate options, options should include “Set RS485 Coms”, “Address”, “VStart”, etc.

## RS485 Coms, Address or Port

This is used to set the address and protocol for the inverter. It is important that this matches the setting in the controller. For the examples in the setup file above, the inverter address would be set to 2 (2/63)

## RS485

The RS485 setting on the inverter should be set to “**ModBus RTU ABB**” or “**Aurora Modbus**”. Baud rate should be left at 19200. Parity should be left at “none”. On inverters with more than one RS485 port, please connect to a port that supports Modbus RTU.

## Input Mode

The input mode should be set to **Parallel**. Please follow the connection information given in the inverter manual regarding paralleling the DC inputs and do not exceed the input rating of the DC connectors. ***Please ensure you have a proper crimping tool to crimp MC4 connections. Otherwise they may arc and present a fire hazard.***

## MPPT & Inverter Level

The MPPT scan should be disabled by selecting “Multi-max scan” (“E/D MPPT Scan” on Uno DM Inverter) and choosing **Disable**. The Inverter level should be set to 0% before the inverter is connected to the grid.

## VStart/UV Prot. Time

Start up voltage can be set according to the characteristics of the turbine generator. Once the set voltage is reached the inverter should begin its procedure for connecting to the grid. For most turbines, you set this voltage to the lowest level at which you want the inverter to start up. Once the inverter has started, it will generally continue working until the voltage falls below 70% of VStart. **UV Prot. Time** can be adjusted to change the number of seconds the inverter stays grid connected after voltage falls below 70% of VinStart

For example, on a Trio 20kw inverter, the default setting for VStart is 430V. You can set it as low as 250V. If you set it to 250V, it will connect to the grid at 250V and then work as low as 175V DC.



## Step by step instructions for Uno Single Phase Inverters

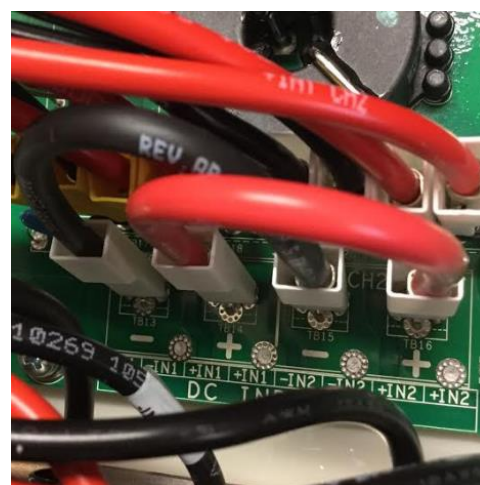
### Example RS485 Connection to the RS485 on the Uno DM Inverter



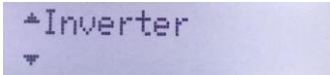
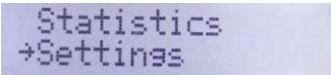
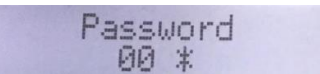
Inverter Controller

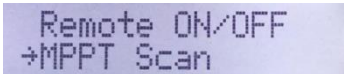
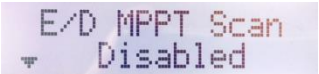


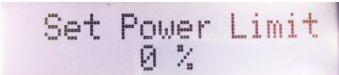
Uno DM Com Kit

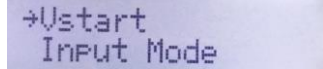
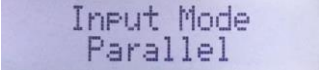


Install Jumpers to Parallel the DC inputs

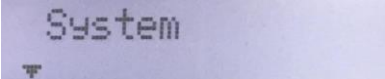
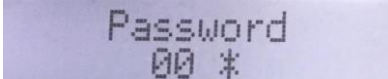
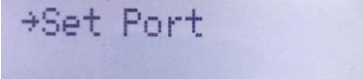
Inverter Settings:  →  → 

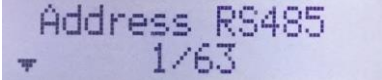
MPPT disable:  → 

Set Power Limit to zero:  → 

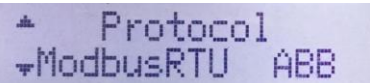
Vin Start & Input mode:  → 

Set RS485 Slave Address (Com port) & Protocol:

 →  → 

→ Set Address 

→ Change Protocol (from Aurora Slave to ModbusRTU)



Ensure programmer setting (or setup file) matches inverter setting:

For setup file: Inv, DM  
COM, 1





## Setting up Uno DM Inverter using Wifi

### Recommended

Please check the inverter Coms Kit is fitted inside the inverter (see the guide supplied with the coms kit) and check the DC inputs are paralleled using the supplied links (See Inverter Quick Installation Guide)

Take a photo or make a note of the WiFi product key (PK) sticker

To power on, the Inverter will need at least 110VDC connected to the DC input. It is recommended that the AC is disconnected during setup. The DC supply should be increased gradually or of limited current, a high inrush current could damage the inverter.

For more detailed instructions see the Commissioning Section of the full product manual.

### Powered On

A short time after the inverter is powered on, a WiFi access point should be visible to a smartphone or laptop. The access point name will be in the format "ABB XX-XX-XX-XX-XX-XX" (MAC)

Connect to this access point using the 16 digit product key (PK) (include dashes) on the side of the inverter

### Web browser

Once connected to the Inverter WiFi access point open a web browser on the laptop or smartphone

While connected to the Inverter WiFi internet on the device may stop working

In the web browser address bar, type in the inverter IP address, this will be 192.168.117.1 and press enter. If this is the first time connecting to the inverter, a setup wizard should appear

#### Step 1

Create an Admin user account and password. The password should be at least 8 characters. The username and password are case sensitive. Create a standard user account; this does not need a password

#### Step 2

Connect the inverter to a local WiFi network. This is optional but will give the inverter a local IP address so it can be accessed by any device on the local network. This is also required for updating firmware. Once connected to the WiFi network, **take a note of the new IP address, e.g. 192.168.0.xxx**

#### Step 3

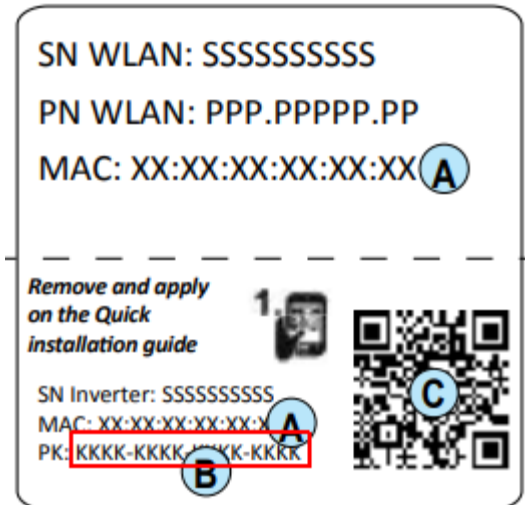
Set the Time and Date

#### Step 4

Set the required grid standard (note this cannot be changed to a different grid standard after 24 hours has passed).

Set the input channel configuration to Parallel

After completing Step 4 the inverter will reboot. When this happens the WiFi connection on the phone or laptop might change. Please reconnect to the inverter WiFi or change to the local network and new IP Address



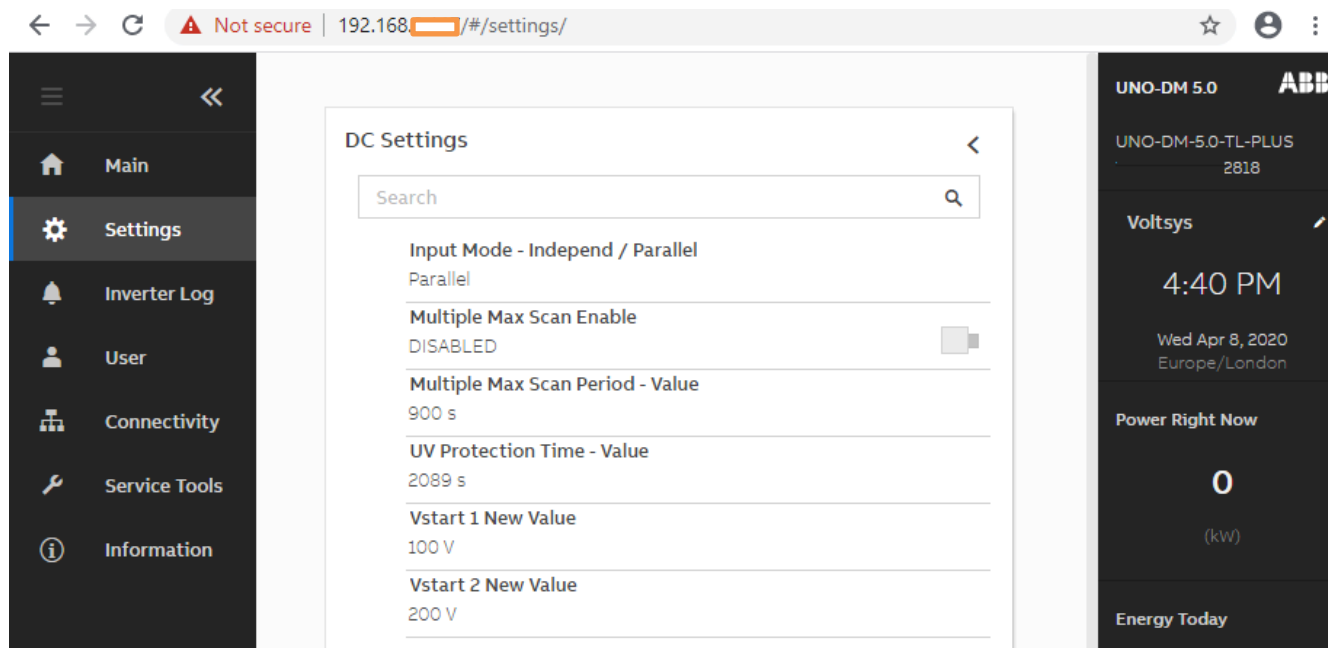
## Typical setting to modify

Input Mode: Set to Parallel

Multiple Max Scan: Set to Disable

UV Protection Time: Keeps the inverter grid connected for a time after the voltage falls, set to 600s for 10mins

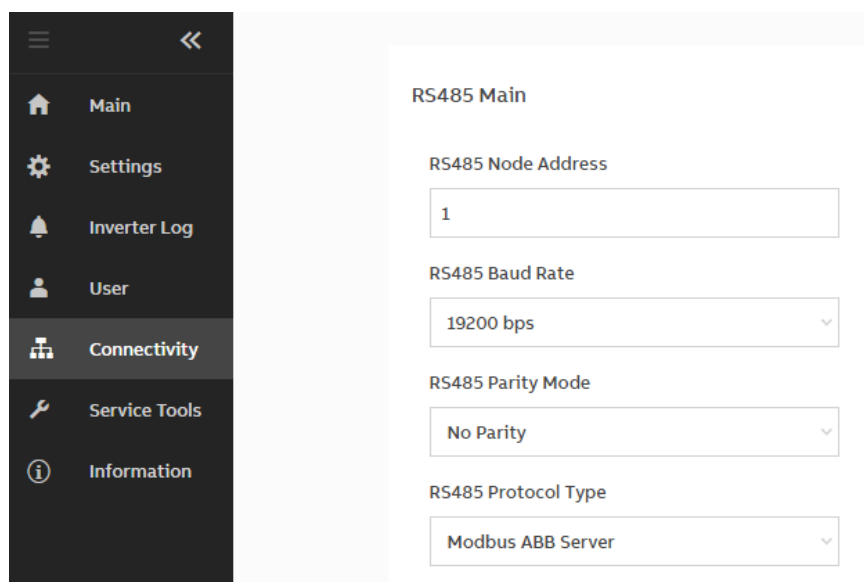
Vstart 1: Set to 100V or suitable value for starting generation



Check the RS485 Main settings

Set the address to match the controller address

Set RS485 the protocol to Modbus ABB Server (Only set to ABB Slave if using Aurora Manager Software)



Caution: Please check on a laptop that the controller is able to read inverter data before connecting the grid

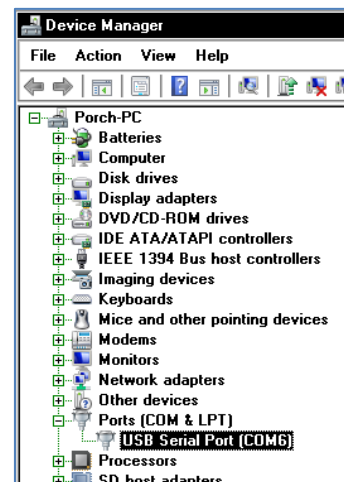
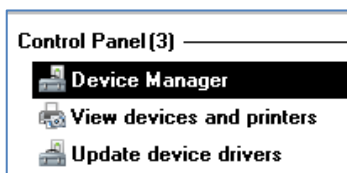
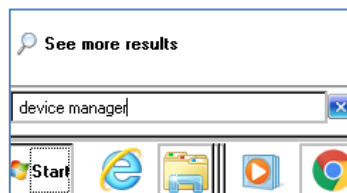
## USB programming Instructions

Programming software can be downloaded at

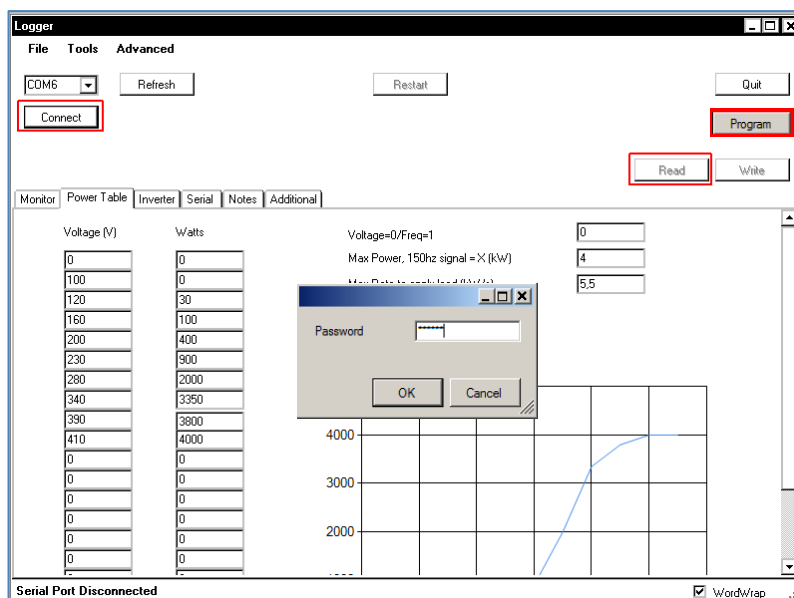
<https://www.voltsys.com/inverter-control-unit-software/>

1. Plug in USB cable
2. Click on "Start Button", type "device manager" in search box
3. From the search results, open Device Manager

4. In Device Manager  
Click to expand "Ports"  
And note the USB Serial Port com port number



5. Run the Inverter Control Software  
(Windows 10 may display a "Unknown publisher" warning, click "More info" and "Run anyway". If the Software is blocked by Windows Store, open computer "Settings", click on "Apps", "Apps & Features", under "Installing Apps", select either "Warn me before installing apps outside the store" or "install apps from anywhere" and retry)
6. Select the correct comport  
Click "Connect". Click "Program" and use the default password "000000".  
Click "Read" to load settings
7. Make changes as required, when finished press the "Write" button to send setting to the controller.



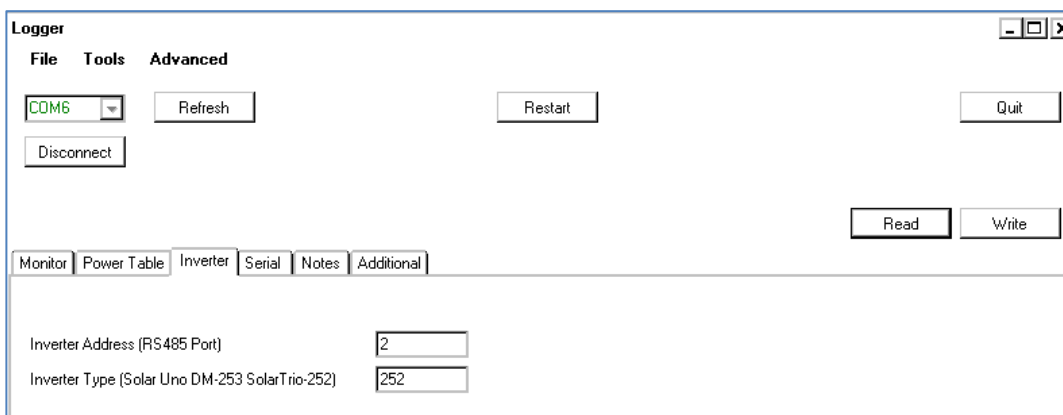
For voltage power curves, enter 0 in the top right text box or 1 for working with frequency

For the power curve please fill any unused text boxes with zeros.

Frequency values can have 1 decimal place. (Note: Euro Language settings may use commas for decimals)

Ensure the **Max power** is set to the **maximum** AC output power of the inverter (check the inverter data sheet as this is often higher than the rated power).

**Max power to apply load** sets the ramp rate in kW per second that will apply to the power curve. For a voltage power curve, as the voltage increases the loading of the generator will not exceed this rate. The value to use will depend on inverter and generator characteristics. No limit applies when reducing loading.



Under the inverter tab check that the inverter type is correct.

INVERTER	Max Power	Inverter Type	Setup.csv File	RS485 Port
Uno DM4/3.6	4	253	Inv,DM	Coms kit RS485
Uno DM6	6	253	Inv,DM	Coms kit RS485
Uno Trio 5.8	5.8	251	Inv,tr	Slave RS485 PMU Expansion Board
Trio 20kW	22	252	Inv,TR	PMU RS485
Trio 27.6kW	30	252	Inv,TR	PMU RS485

## Checking Inverter Data is being read

Using the programming software monitor tab, it is possible to check if data is being received form the inverter.

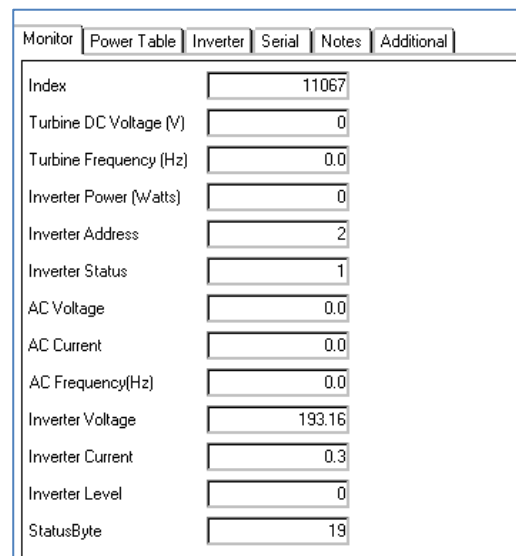
The “Inverter Voltage” will show the Inverter DC input voltage when the inverter is powered on

If grid is present “AC Voltage” reading will be shown

Index will count up every second

When the inverter successfully connects to the grid, the “Inverter Status” will change to 6

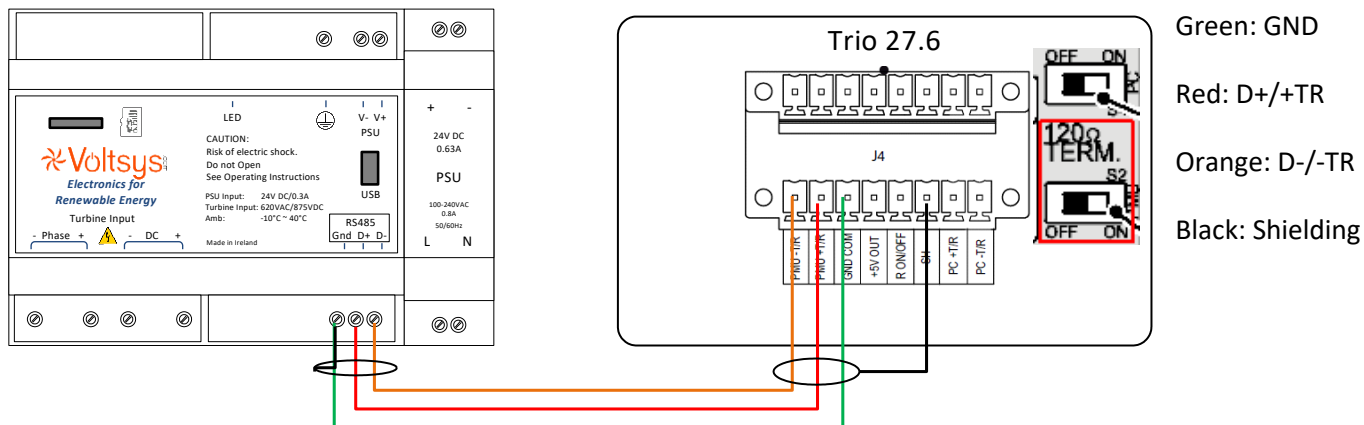
If data is not being received, please check the RS485 wiring is correct and wired to the RS485 port that supports Aurora Modbus or ModBus RTU ABB. Also check that the correct inverter setting has been used in the programming software. 120 Ohm terminating resistor should typically be in the ON position when connecting to a single inverter. Also on the inverter COM kit the resistor should be set ON. (See page 16)



Index	Value
Turbine DC Voltage (V)	0
Turbine Frequency (Hz)	0.0
Inverter Power (Watts)	0
Inverter Address	2
Inverter Status	1
AC Voltage	0.0
AC Current	0.0
AC Frequency(Hz)	0.0
Inverter Voltage	193.16
Inverter Current	0.3
Inverter Level	0
StatusByte	19

## Step by step instructions for Trio Inverters

### Example RS485 Connection to the RS485 PMU on the TRIO-20, 27.6



Inverter Settings:



Set/Check Address:



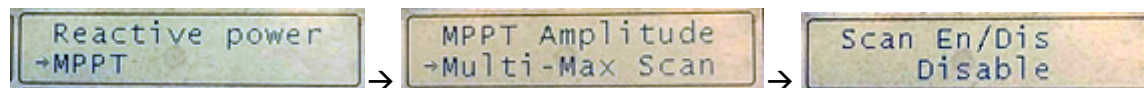
Vin Start:



UV Prot.Time:



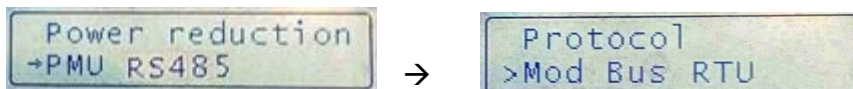
MPPT disable:



Set Default Power Reduction to 0%:

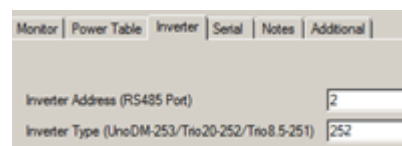


Set RS485 Protocol:



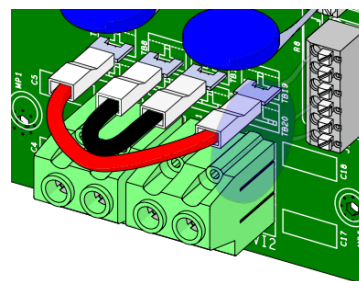
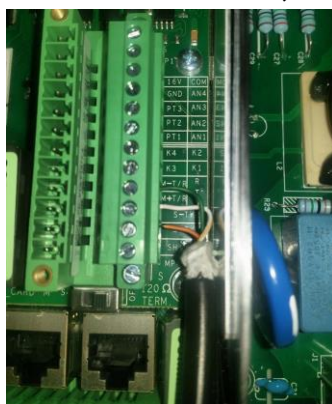
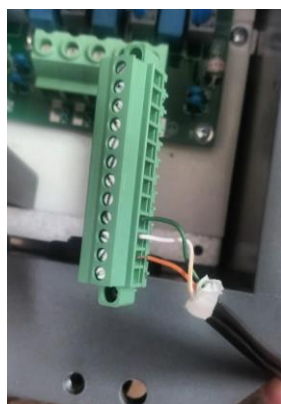
Ensure setup file (or programmer) matches inverter setting:

Inv, TR  
COM, 2





## Example RS485 Connection to the RS485 slave on the TRIO-5.8, 7.5, 8.5-TL-OUTD



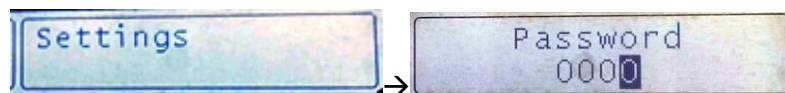
On the Trio 7.5 & 8.5, install links  
Set the Input Mode to PARALLEL

Inverter Controller

Screw Connector

Trio 5.6kW PMU Expansion card RS485 Slave

Inverter Settings:



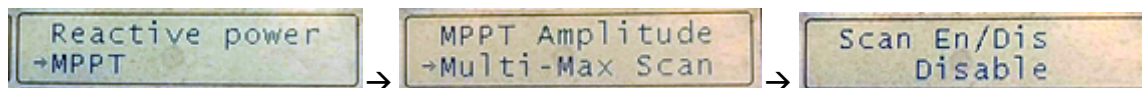
Vin Start:



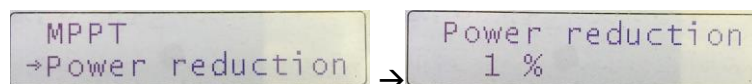
UV Prot.Time:



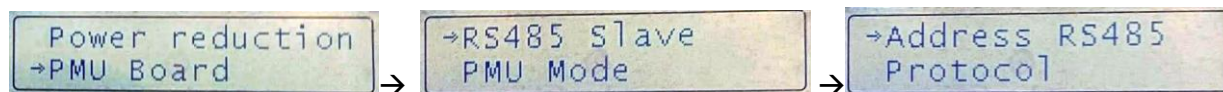
MPPT disable:



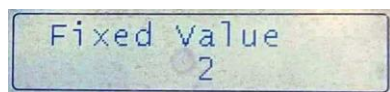
Set Default Power Reduction (1%-4%):



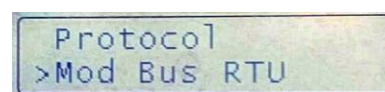
Set RS485 Slave Address (Com port) & Protocol:



→ Check Address

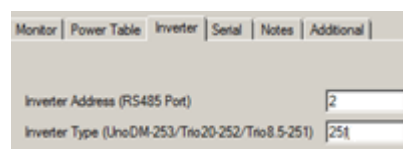


→ Set Protocol



Ensure setup file (or programmer) matches inverter setting:

Inv, tr  
COM, 2



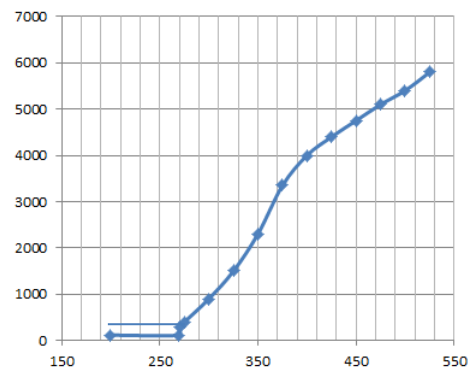
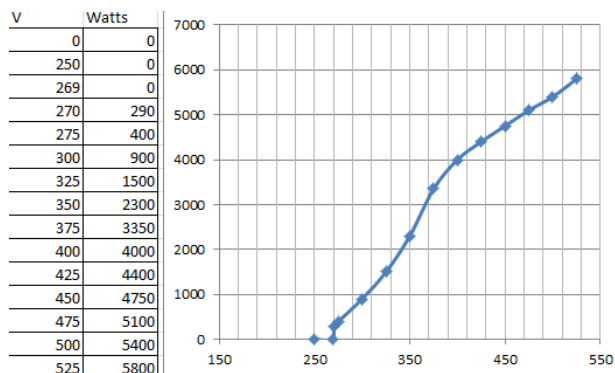


## Notes on TRIO-5.8, 7.5, 8.5-TL-OUTD power curve

The Trio 5.8-8.5kW has a workable range of 5%-100% of its max power.

Programmed Curve

With Vin Start =250V & Power Limit Set to 2% on Screen



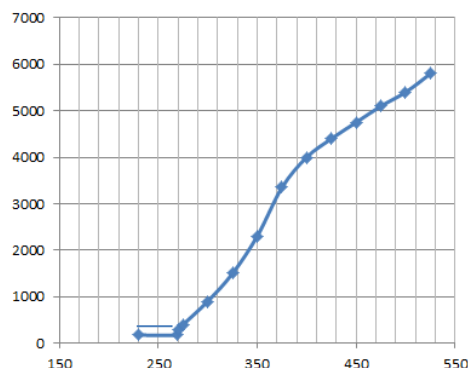
Initially Power out will be 5% at 200-270V

After 1min below 270V Power out will be 2% at 200-270V,

Switching back to 5% at 270V

With VinStart = 330V & Power Limit Set to 3% on Screen

After 1min below 270V P.out will switch from 5% to 3%



## PVS-10/15 inverter

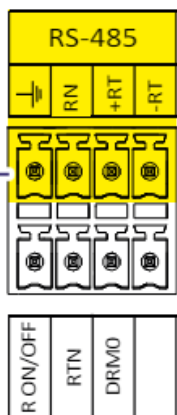
When using with the PVS Inverter please request the non standard PVS controller firmware.

The PVS inverter setup uses Wifi similar to the Uno DM above. Also use wifi to first check the ethernet IP address.



CAUTION!

The PVS Inverter has no option to parallel DC inputs, connect to both MPPT1 and MPPT2 with 2 or 4 pairs of DC. Do not operate the built in DC isolator switch when the Turbine is spinning or DC voltage is high



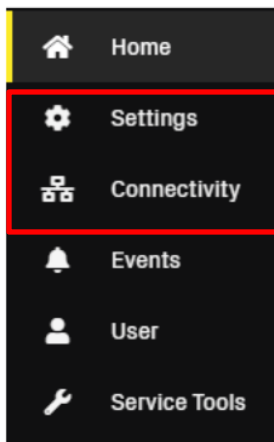
RS485 connections to Controller

+RT to Controller D+

-RT to Controller D-

Use RTN(RN) to

Controller GND



Adjust the Inverter DC Settings and Power Limiting: Settings->Inv Parameters->DC Settings:

Channel 1/2 Vstart -> 250VDC or as Required  
UV Timeout -> 600 Seconds or as required  
Multiple Scan En/Disable -> Disabled

Settings -> Active Power Control-> Active Power Curtailment:

P set point en/dis -> power\_curtailment  
P set point .-> 0pu

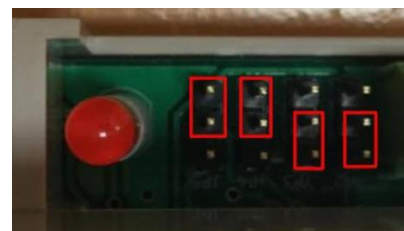
Under Connectivity -> Communication protocol ->RS485 (Main): Set address to 1, Protocol to "Modbus Server" and Baudrate to B19200. (Parity N) and save. Controller inverter setting can be 253

## Default Position of Jumper links

The plastic covers above the screw connectors can be removed with a small flat head screwdriver



Programming jumpers to the right of the LED should be left in their default position. (Left to Right: UP,UP,DOWN,DOWN)



To the left of the RS485 connections is a jumper for a RS485 termination resistor.

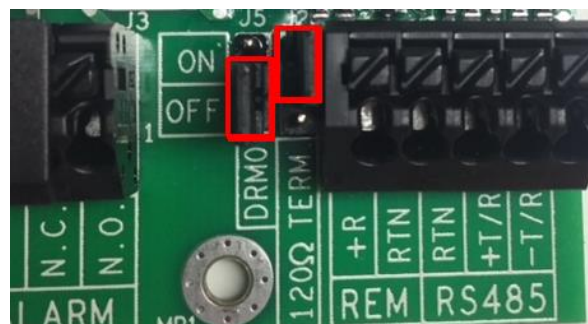
120R Resistor is OFF when the jumper is in the up position.

120R Resistor is ON when jumper is in the down position. Resistor ON (as shown in photo) may help reduce noise on the cable and is recommended.



The inverter should have its jumper set to match the controller.

DRM0 set OFF and 120 Ohm set ON



## Setup file

There are two ways to program the controller; using a setup file written to the MicroSD card, or by connecting your laptop to the controller. Using a laptop is recommended. See details on connecting your computer earlier in this manual but it is useful to read this section to understand the parameters in the setup programme.

A setup file on the micro sd card can be used to load the power curve and other settings to internal memory. **It is best to only remove or insert the microSD card with the controller powered off**

The microSD card can be released by pressing it in with a small screwdriver and then removing it.

File name should be SETUP.CSV and saved on the root of the card.

### Write setup file using Excel

Voltsys provides an Excel spreadsheet that can be used to prepare the CSV file. However, the following is an explanation of the content of the file.

The example on the left is for a voltage based power curve, the example on the right is for a frequency based curve.

### Setup File Explanation

The first line of setup file is used to tell the control unit if it should LOAD or SKIP reading the setup file. After reading the setup file, SKIP will be written to the config file to prevent the setup file being programmed a second time. When updating the power curve, check the first line is **LOAD**

The second line determines if the power curve will be voltage based or frequency based. For a voltage based power curve the second line should be **No.,Volt, Watts** or for frequency **No.,Hz,Watt**

The power curve can contain up to 20 points programmed with **P00-P19**. The first point would typically have 0 watts of power, with the power increasing for subsequent points as the voltage or frequency values increase.

Unused points should be programmed with zero or blank value. eg. if P10 was the top of the power curve P11,0,0 would be the next line and P12,0,0 up to P19,0,0 completing the power curve. In the example tables (right) any voltage above 500V or frequency above 50Hz would apply a load of 4kW.

LOAD	LOAD
No., Volt, Watts	No., Hz, Watts
P00,100,0	P00,5,0
P01,120,30	P01,10,30
P02,159,100	P02,15,100
P03,200,400	P03,20,400
P04,230,900	P04,25,900
P05,280,2000	P05,28.5,2000
P06,339,3350	P06,33,3350
P07,390,3800	P07,39,3800
P08,410,4000	P08,41,4000
P09,500,4000	P09,50,4000
P10,,	P10,,
P11,,	P11,,
P12,,	P12,,
P13,,	P13,,
P14,,	P14,,
P15,,	P15,,
P16,,	P16,,
P17,,	P17,,
P18,,	P18,,
P19,,	P19,,
Max,4	Max,13.8
Rmp,1.45	Rmp,3
Inv,DM	Inv,TR
COM,2	COM,2
RST	RST
<blank line>	

### Converting RPM to Frequency:

If an RPM based power curve is required, this can be done by converting RPM to frequency Hz. Divide the RPM value by 60 and multiply by the number of pole pairs. Be sure you use the number of pole pairs and not the number of poles.

Eg. for a 9 pole pair generator, 360rpm converts to 54Hz.

So where n = number of pole pairs and f=frequency;

$$f = n \times \text{RPM} / 60$$

$$\text{RPM} = f \times 60 / n$$

The **Max** line in the setup file should be used to set the Maximum AC output power of the inverter in kW. This should match the value given on the inverter data sheet.

For the Uno DM4.0 this is 4. For the Trio 12.5, this will be 13.8. For the Trio 20kW use 22 and for the Trio 27.6 use 30.

The **Inv** line is used to set the type of inverter, for the single phase Uno DM inverter use Inv,DM and for the three phase Trio 20/27.6 use Inv,TR. For Trio 5.8/8.5 use Inv,tr.

The **Rmp** line is used to set the ramp rate in kW/s that will apply to the power curve. For a voltage power curve, as the voltage increases the loading on the generator will not exceed this rate. The value to use will depend on inverter and generator characteristics.

**COM** is used to set the RS485 address. This should match the address of the inverter (see "Inverter Settings" further in this document).

The final line of the file **RST**, should trigger a reset to restart the control unit with the new power curve. A blank line after this ensures the RST get triggered.

LOAD No., Volt, Watts	LOAD No., Hz, Watts
P00, 100, 0	P00, 5, 0
P01, 120, 30	P01, 10, 30
P02, 159, 100	P02, 15, 100
P03, 200, 400	P03, 20, 400
P04, 230, 900	P04, 25, 900
P05, 280, 2000	P05, 28.5, 2000
P06, 339, 3350	P06, 33, 3350
P07, 390, 3800	P07, 39, 3800
P08, 410, 4000	P08, 41, 4000
P09, 500, 4000	P09, 50, 4000
P10,,	P10,,
P11,,	P11,,
P12,,	P12,,
P13,,	P13,,
P14,,	P14,,
P15,,	P15,,
P16,,	P16,,
P17,,	P17,,
P18,,	P18,,
P19,,	P19,,
Max, 4	Max, 13.8
Rmp, 1.45	Rmp, 3
Inv, DM	Inv, TR
COM, 2	COM, 2
RST	RST
<blank line>	

Inverter state values:

Integer Value	Global State
0	Initializing (configuring power control)
1	Waiting sun or grid
2	Connecting to grid (checking grid)
3	Initializing (system startup)
4	Connecting to grid (switching-on DC/DC)
5	Connecting to grid (switching-on DC/AC)
6	Connected to grid
7	Post-alarm actions (recovery)
8	Post-alarm actions (pause)
9	Ground fault
10	Over-temperature fault
12	Connecting to grid (grid protection interface self-test)
13	Grid protection interface self-test fault
14	Connecting to grid (safety checks)
15	Leakage fault
24	Under-temperature fault
25	Interlock (remote off)
26	Interlock (emergency stop)
27	Executing auto-test
29	Grounding-kit fault
30	SW bundle not valid fault
41	Temperature sensors fault
42	Grid sequence fault
51	Arc fault
53	Arc detector self-test fault
116	Power stage off-line
118	Arc detector wrong configuration fault
119	Arc detector self-test
120	Configuration fault (bad model)
124	Latch with "Reset by hand"
150	Power stage communication fault
151	Configuration fault (bad global-settings)
200	Programming power stage

**NOTE:** the inverter can export power into the grid if and only if the global state of the inverter is Run (6)