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.

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

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 is done by loading a setup file on the micro-SD card.

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: 0.5mm² – 2.5 mm²
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.
- P: Protective Earth connection.

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: 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.

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**WARNING!**

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

Otherwise wire the two phases to Y & Z
DM Comms Kit/PMU Expansion Board

You will need to fit a DM Comms 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 comms 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

The MPPT scan should be disabled by selecting “Multi-max scan” (“E/D MPPT Scan” on Uno DM Inverter) and choosing Disable.

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 Coms Kit  |  Install Jumpers to Parallel the DC inputs

Inverter Settings:

MPPT disable:

Vin Start & Input mode:

Set RS485 Slave Address (Com port) & Protocol:

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

For setup file:  

```
Inv, DM
COM, 1
```
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”)
6. Select the correct comport
   Click “Connect”
   Click “Read” to load settings
7. Make changes as required, when finished press the “Write” button to send setting to the controller.
   Then press the “Restart” button, so that the controller can restart with the new settings

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. Scroll down to ensure all unused boxes have zero values

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).
Checking Inverter Data is being read

Using the programming software monitor tab, it is possible to check if data is being received from 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 off position when connecting to a single inverter.
Step by step instructions for Trio Inverters

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

Inverter Settings:
- Address
- Display Set
- New address 2
- Language
- VStart
- Set VStart 250 V
- Sleep Mode
- UV Prot. Time
- UV Prot. Time 600 s
- Reactive power
- MPPT
- MPPT Amplitude
- Multi-Max Scan
- Scan En/Dis Disable
- Power reduction
- Protocol
- PMU RS485
- Mod Bus RTU

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

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

P.out With VinStart=250V

Or With VinStart=360V (0-5% output at 70% of 360V)

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%
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.

<table>
<thead>
<tr>
<th>LOAD No., Volt, Watts</th>
<th>LOAD No., Hz, Watts</th>
</tr>
</thead>
<tbody>
<tr>
<td>P00, 100, 0</td>
<td>P00, 5, 0</td>
</tr>
<tr>
<td>P01, 120, 30</td>
<td>P01, 10, 30</td>
</tr>
<tr>
<td>P02, 159, 100</td>
<td>P02, 15, 100</td>
</tr>
<tr>
<td>P03, 200, 400</td>
<td>P03, 20, 400</td>
</tr>
<tr>
<td>P04, 230, 900</td>
<td>P04, 25, 900</td>
</tr>
<tr>
<td>P05, 280, 2000</td>
<td>P05, 28.5, 2000</td>
</tr>
<tr>
<td>P06, 339, 3350</td>
<td>P06, 33, 3350</td>
</tr>
<tr>
<td>P07, 390, 3800</td>
<td>P07, 39, 3800</td>
</tr>
<tr>
<td>P08, 410, 4000</td>
<td>P08, 41, 4000</td>
</tr>
<tr>
<td>P09, 500, 4000</td>
<td>P09, 50, 4000</td>
</tr>
<tr>
<td>P10,,</td>
<td>P10,</td>
</tr>
<tr>
<td>P11,,</td>
<td>P11,</td>
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<td>P12,,</td>
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<tr>
<td>P18,,</td>
<td>P18,</td>
</tr>
<tr>
<td>P19,,</td>
<td>P19,</td>
</tr>
</tbody>
</table>

Max, 4
Rmp, 1.45
Inv, DM
COM, 2
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;

\[ f = \frac{n \times \text{RPM}}{60} \]

\[ \text{RPM} = \frac{f \times 60}{n} \]

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.
**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. With a single inverter, this can typically be left in the off position. (off: UP)