

Voltsys

Wind Turbine
Controller
With Disconnect
Contactor

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INTRODUCTION and SAFETY NOTE

This controller provides rectification, smoothing capacitors, disconnect contactor, power curve control and various functions for ABB inverters

The controller also provides datalogging to a micro-SD card. There is an option to add an anemometer to include wind speed as part of the datalogging. The card can also datalog data from the pulse of an export meter.

In using the controller you need to understand some functions and adjust settings on the inverter.

Remote Control

The controller uses remote control to shut down the inverter in the event of a fault. The inverter should have remote controller set to ENABLED. This is done using the settings on the inverter front panel. Please see inverter manual for instructions on doing this.

Control of the power converted by inverter

All turbines require a power curve telling the inverter(s) how much power to convert at various levels of voltage or RPM. This is done by entering a power curve or table into the controller. The controller will communicate with the Inverter and tell it how much power to convert.

Contactor Control

The contactor will disconnect the turbine from the inverter to protect the inverter in the event of voltage exceeding a safe level for that model of inverter, and for the capacitors in the controller (usually 580V for single phase inverters and 750V for three phase). There is a second connection to the controller from the turbine side of the contactor. This is used to monitor voltage and decide when it is safe to re-connect.

When overvoltage occurs, the following sequence takes place;

- Contactor opens isolating turbine from rectifier and inverter.
- The remote control and power curve signals to the inverter both tell the inverter to stop exporting power
- The voltage on the turbine is monitored until it falls to a safe level
- At this point, if the contactor were closed again, there is risk that inrush current to capacitors would cause damage, so a smaller contactor connects, bringing the voltage on the capacitors back up to the turbine voltage
- The main contactor is then closed
- The remote control and power curve signals are used to instruct the inverter to start converting power.

Important Safety Instructions

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



WARNING!

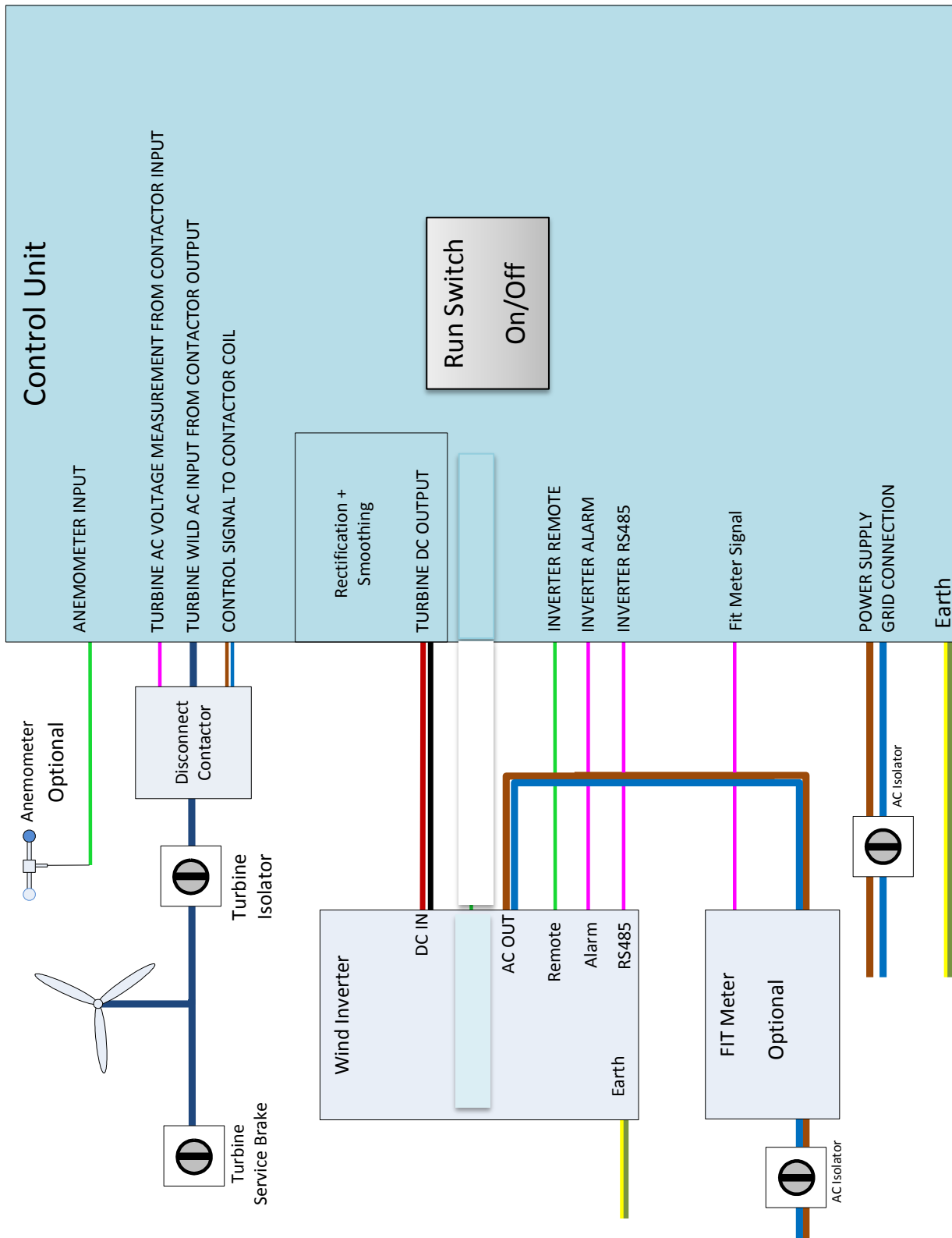
Indicates a potentially hazardous situation, if not heeded could result in serious injury or death.



CAUTION!

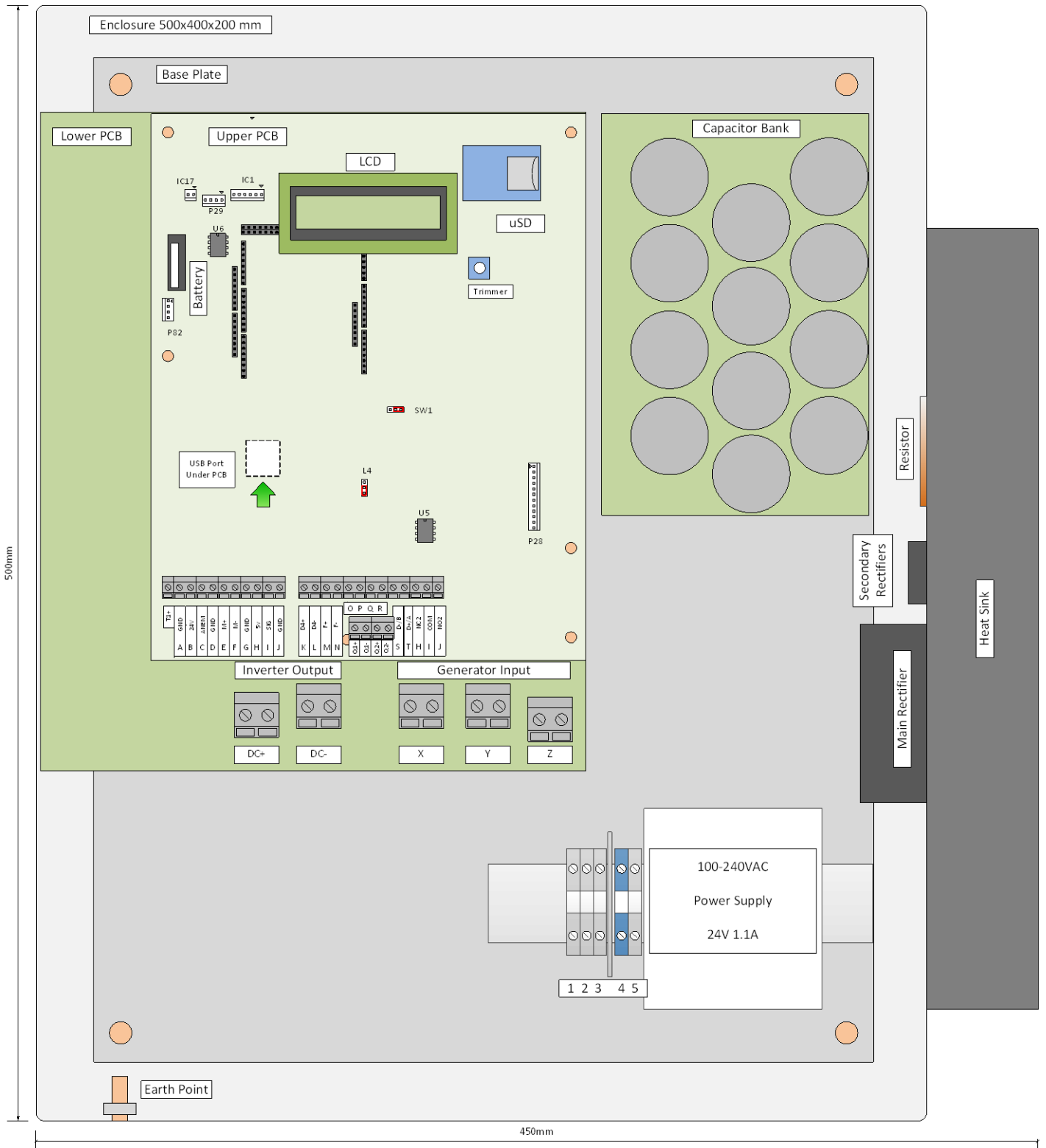
Indicates a potentially hazardous situation, if not heeded could result in moderate injury or damage to controller.

System Overview Diagram



Main Control Unit

Controller Layout



Installation



CAUTION!

When installing controller allow adequate space around sides of the controller for heatsink cooling, at least 300mm recommended.

Controller should not be placed in area where somebody is likely to accidentally come into contact with the heatsink

The controller should be installed in a location without excessive oscillation or electromagnetic noise

Ambient Temperature should be -10C ~ 40C



WARNING!

The unit should only be opened and handled by electricians or electronics engineers. Dangerous grid, generator and DC voltage are present inside this unit. The unit should be stickered with “Dual Supply” warning stickers on commissioning the system. When opening and working on controller always stop generator and take necessary precautions to ensure that the controller is safe to work on.

Before opening take measures to stop the generator and ensure generator can't restart by applying external manual brake and/or isolator. Disconnect Controller AC power supply from the grid. Ensure inverter disconnected from grid and powered off. Allow 5 minutes for capacitors to discharge.

The controller contains capacitors that can store high voltage. This charge is typically discharged through the inverter when the generator is stopped. Before working on or servicing the controller, measure DC voltage across DC+ & DC- to check voltage is low.



WARNING!

Don't operate the controller if there is any evidence of damage or if it's not functioning as expected.



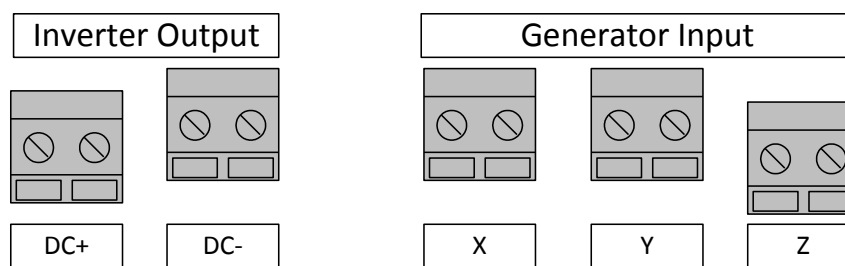
WARNING!

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.

Lower Board Connections



Inverter Output

- DC+ Positive DC Voltage Output to Inverter (Max 6AWG/16mm² per terminal – please make parallel connections if current is above 40A)
- DC- Negative DC Voltage Output to Inverter

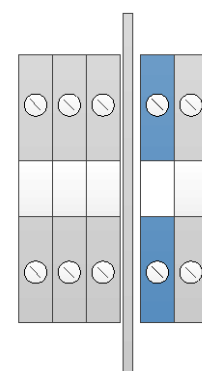
Turbine / Generator Input (via Contactor)

For 3-Phase generator, this should be connected to X, Y & Z.

- X Generator Phase 1 (Max 6AWG/16mm² per terminal.)
- Y Generator Phase 2
- Z Generator Phase 3
- Please use parallel connections for current over 40A

Connections to External contactor box

- 1 Voltage Measurement Phase 1 (from generator side of contactor)
- 2 Voltage Measurement Phase 2
- 3 Voltage Measurement Phase 3
- 4 AC Control Signal to power contactor coil
- 5 AC Neutral to power contactor coil



Grid Supply to Controller

AC supply input for controller, controller will typically be rated for 230V AC/50Hz or 115V AC/60Hz, this will be indicated on the controller. Maximum Power Consumption 30W

- L Grid Supply Live (brown)
- N Grid Supply Neutral (blue)

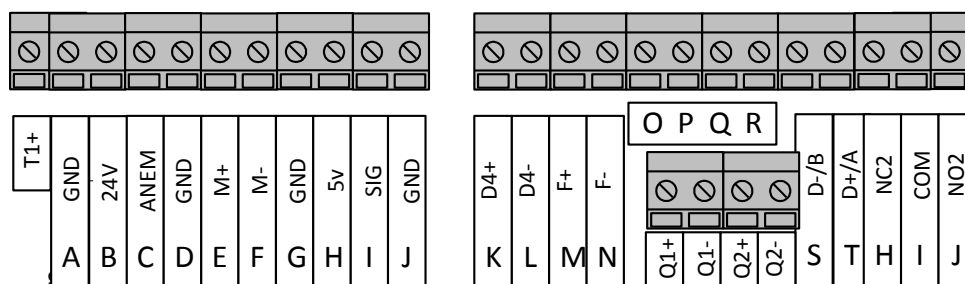


WARNING!

Earth Controller requires Protective Earth Connection. Earth should be connected to Earth point inside of enclosure



Upper Board Connections



Many of these connections are optional and depend on whether the functionality is required.

T1+	PT1000 Temp sensor Signal (Not used)
A	GND/0V – Connect to Inverter RS485 RTN (Required when using ABB Solar inverters)
B	Anemometer +20v (20mA max) ¹ (Optional)
C	Anemometer Signal (23V internal pull up resistor 3.3k)
D	Anemometer GND/0V
E	M+ 24V Supply – (Not Connected)
F	M- External Pulse Meter Collector (20V, 3.3k pullup) ² (Optional)
G	GND/0V – External Pulse Meter Emitter
H	5V – 20mA (Not Connected)
I	Signal Input - Connect to Inverter Alarm Relay N.O. ³ (Recommended – See footnote below)
J	GND/0V – Connect to Inverter Alarm Relay Common C. (Recommended)
K	D4+ Run Switch Contact (prewired to Run Switch 1)
L	D4- Run Switch Contact (prewired to Run Switch 3)
M	Frequency + to Inverter WT+ (Required if interface is to control wind inverter output) ⁴
N	Frequency – to Inverter WT- (WT+/- Not used for solar inverters)
O/P	Relay Connection for charging capacitors (prewired)
Q/R	Relay Connection for charging capacitors (prewired) (Aux Relay if no Q1/Q2 connectors)
Q1+/Q1-	Relay Connection for controlling contactor (prewired)
Q2+/Q2-	Relay 2 (Aux Relay, can be used to switch 24v relay for mechanical brake, Coil 350 Ohm Min) ⁵
S	D-/B to inverter RS485 T/R- ⁶ (Required when using ABB solar inverters, See footnote below)
T	D+/A to inverter RS485 T/R+ (Required when using ABB solar inverters)
NC2	For connection to inverter remote connection ⁷ (R ON/OFF) (Required)
COM2	For connection to inverter remote connection (GND COM)
NO2	Normally open relay connection (Not used)



See P22/23

¹ Hall effect anemometer can be wired to B, C & D. For reed switch anemometer wire between C & D. For logging windspeed

² External generation meter with pulse open collector output can be wired with collector wired to F and Emitter wired to G to log power exported through meter on SD card

³ Alarm Function on inverter should be set to production, found in Settings menu on ABB inverters

⁴ Output dependant on jumper L4. See Frequency Jumper description

⁵ Relay energised when controller running, releases on error or fault condition

⁶ Wind Inverter address should be set to 2 to match default controller setting, inverter RS485 RTN connected to any GND/0V. For Trio 27 connect to PMU RS485, for Trio 5.8/7.5/8.5 use Slave +S RS485 connections. Shielded twisted pair cable recommended

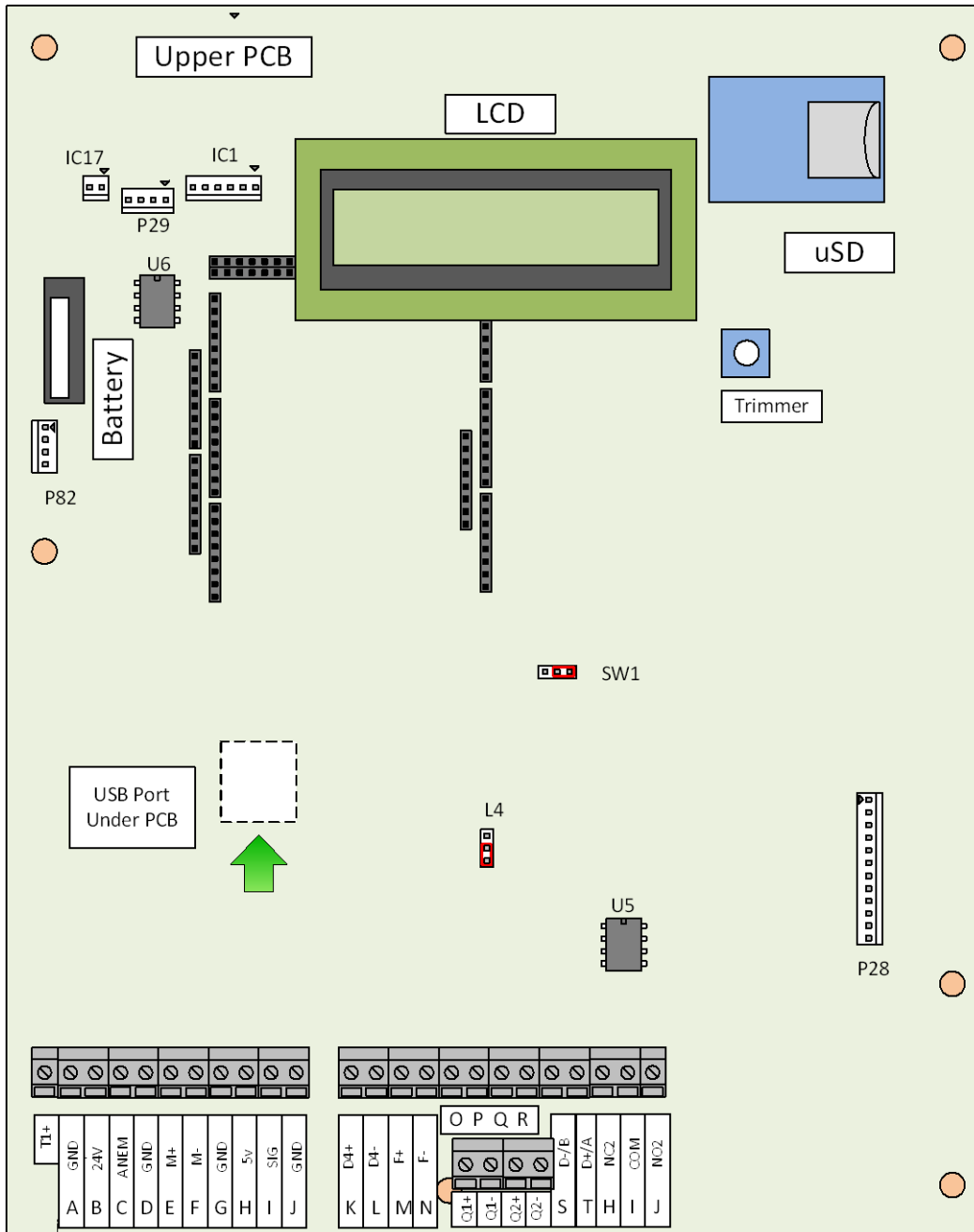
⁷ Remote option should be enabled in inverter menu if user wants inverter output disabled on fault such as overvoltage limit reached. Total dump load and inverter load should not exceed controller rating.

Main Control PCB

The Control PCB is fitted with the following

- Real Time Clock Battery, CR2032
- Micro SD Slot.

Voltsys Control PCB Layout



Internal Clock

With backup power from CR2032 coin cell. Time is set using EEPROM programmer.

MicroSD(uSD) card logging

This is located at the top on the printed circuit board.

The MicroSD memory card should be formatted as FAT32 and should only be fitted or removed when the controller is completely powered down. Log files are stored on the memory card in CSV text files. Use at least class 4. See separate manual for details of headers on CSV files.

A new file is created every night at midnight.

USB Port for Computer

This is used to connect a computer to the processor for changing settings and uploading new firmware. The USB port is located under the control PCB. The system uses a standard USB printer cable.

Frequency Jumper

Note: The frequency output is only used with wind inverters and is not needed for solar inverters

There is a jumper switch marked L4 on the control PCB. There are two modes;

- For single phase ABB inverters you can pass the generator frequency to F+ & F. If the power curve is on the inverter, and not on the controller, the jumper should be positioned up.
- For three phase ABB inverters, the controller must be programmed with a power curve and it sends a frequency to control the Trio. In this mode, jumper should be positioned down.

Trimmer

Used to adjust the voltage to the anemometer, voltage is pre-set to 18V, can be measured across anemometer output.

Troubleshooting

LCD Display

In running mode with no errors, LCD will display from left to right, DC voltage, generator RPM, Wind speed in mph (or kph,m/s).



right,

At Start up or due to fault

"Contactor Open" is displayed. The controller should still give open circuit voltage reading in this state but will not read rpm contactor open.



an
when

If no errors are present

The controller will countdown the delay time before being ready to connect to generator

"Start in 6...5...4" is displayed when counting down. Controller will wait at 0 until the DC voltage is low enough to connect.

Once the voltage is low enough, the controller will charge the capacitors before closing the contactor and connecting the generator. **"Charging..."** is displayed when charging the capacitors and the inverter. **"Running"** is shown when the contactor is closed. When **"Running"** and after the inverter connects to the grid, the alarm relay on the inverter should close. At this stage the controller should start controlling the inverter power output as per the power curve. **If no power is being generated please check connections I & J are getting connected by the alarm relay (or that I & J connected together directly if not connecting to relay)**

Fault Conditions

If the controller experiences a fault with the generator being out of range the following errors may be displayed:

- **"Over-Volt Err"** is displayed when the DC voltage has exceeded the Over-Voltage limit set with the software.
- **"Over-Freq Err"** is displayed when the generator has exceeded the Over-Freq limit set with the software.
- **"Over-Curr Err"** is displayed if over current limits set in software have been exceeded
- **"Inverter Err"** is displayed if inverter error has been reported by an inverter connected on RS485 bus
- **"Remote Lock"** is displayed if internal software lock set. Reset can only be done with software.
- **"EM Stop"** or **"Run Switch Off"** is displayed if the run switch (or stop button) is in the off position.
- **"PSU Low"** is displayed if power supply voltage has fallen below warning level. Check AC supply to controller.
- **"Controller Err"** is displayed if on board handshake between internal microprocessors is not detected, this may appear when programming the controller, when AC power is lost or when there's a problem with controller. If error doesn't clear check PSU supply to controller connections.

Resetting errors on the controller

To clear errors and reset the controller, switch the run switch (or stop button on older controllers) three times within 10 seconds. After switching from on to off three times leave the switch in the off position and wait for the controller to restart. Once the controller has restarted, switch the run switch to on and wait for the controller to close the contactor.

Software

Changing Parameter Settings

In some cases we will have set up the controller to match the generator specified. However, the settings can subsequently be modified using the supplied Voltsys Programmer application.

Voltsys Programmer

In order to use the programmer software, you need to connect the pc running the software to the controller. You can download the software and drivers from our website at <http://www.voltsys.com/home/index.php/software/> . If you have not already done this, please do so and refer to page 14 to install the drivers on your computer first.

To connect to the controller -

- Power off controller
- Connect USB cable from controller to computer (for details see Installation Instructions near end of document)
- Wait for the driver to install
- Run programmer file

The top third of the application window allows you to communicate with the controller. Below that there are four tabs with further options. The application defaults to the “Monitor” tab.



To connect to the controller, you will need to know which com port number your pc has assigned to the controller (usually found in the computer’s device manager)

Select your com port from the drop down option and click “Connect”

To set the controller Time and Date from the computer clock, click the “Set Time” button

To read the current control panel settings click the “Read” button and wait for settings to be read

To write changes to the control panel settings click the “Write” button and wait for the control panel to restart.

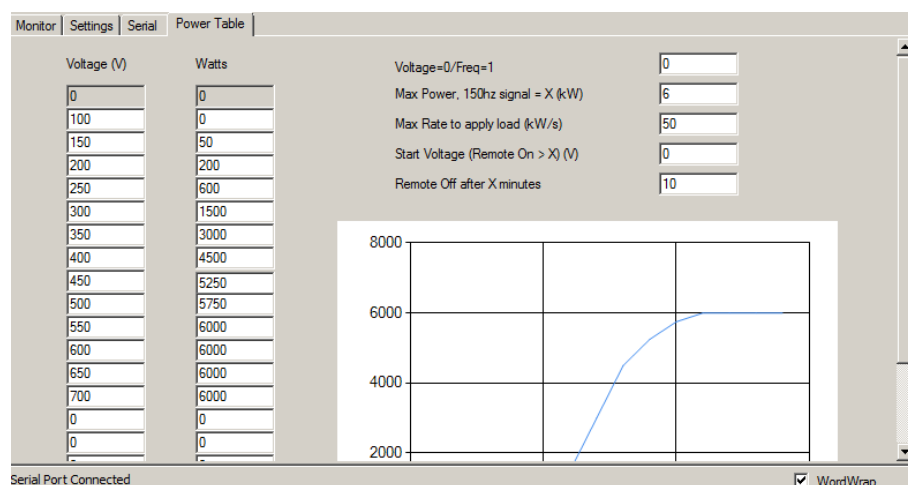
Settings Menu

Monitor	Settings	Serial	Power Table
Contactor Delay (Sec)	50	Over Frequency 2 (Hz)	30
Charge inverter below X volts	400	Over Frequency 2 for x Sec	2.0
Anemometer Upper Limit	20	Over Frequency Timeout (Sec)	600
Anemometer Timeout	5	Perm Shutdown Frequency (Hz)	35
Anemometer Lower Limit	15	Perm Shutdown Frequency for x Sec	1.0
Anemometer Multiplier	0.76	OverTemp PCB (C)	65
		OverTemp1 (C)	255
Over Voltage	500	Grid detect Level (v)	0
Over Voltage Timeout	600	Current Setting (A)	40
Perm Shutdown Voltage	520	RPM Multiplier	5.0
Over Frequency 1 (Hz)	28		
Over Frequency 1 for x Sec	25		

Contactor delay	Time delay in seconds before the controller is ready to close contactor and connect generator.
Charge Inverter below X volts	Once above delay has counted down, controller will wait for the DC voltage to fall below this setting before closing the contactor.
Anemometer Upper Limit	Windspeed limit in m/s for wind speed error
Anemometer Timeout	Time in seconds that anemometer wind speed must remain below Anemo Lower Limit , to clear the above error
Anemometer Lower Limit	Windspeed limit in m/s for restart.
Anemometer Multiplier	Anemometer transfer function, slope. Convert frequency from anemometer into wind speed reading. E.g. 0.40 m/s/Hz
Anemometer Offset	Anemometer transfer function, offset. Convert frequency from anemometer into wind speed reading. E.g. +1 m/s
Over voltage	If controller measures a DC generator voltage above this, controller will disconnect the generator by opening contactor. Eg. 500V in above screenshot
Over Voltage Timeout	Time in seconds DC generator voltage must remain below Over Voltage setting for controller to clear the Over Voltage state and allow the controller to reconnect the generator.
Over Frequency	If controller measures a generator frequency above this for x seconds (Over Freq for x Sec), controller will disconnect the generator by opening contactor. Eg 27hz for 25seconds
Over Frequency For x Sec	See Above.
Over Frequency Timeout	Time in seconds, generator frequency must remain below Over Freq setting for controller to clear the Over Freq state and allow the controller to reconnect the generator.
Over Frequency 2	As Over Freq, but provides a second set of limits, usually a higher frequency for a shorter period
Over Frequency 2 for x Sec	Period for over-frequency 2 setting
Current Setting	Limit inverter power output above this current. Set to 0 to disable or set to match controller current rating.
RPM Multiplier	Amount to multiply frequency by to get RPM. This is calculated as = $60/N$ where N = number of pole pairs, or $120/n$ where n is the number of poles

Power Curve Settings

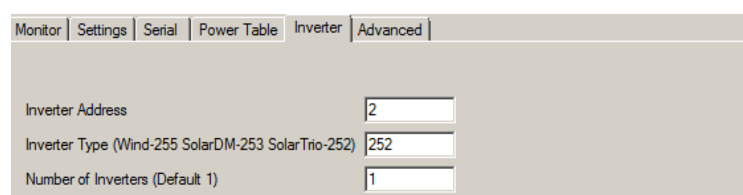
If using an ABB Wind Trio inverter or ABB solar inverters, you will need to enter a power curve into the controller which will then manage the power conversion of the inverter.



Voltage/Freq	Enter 0 if using voltage power curve and 1 if using frequency. Press the "Write" button & then "Read" button to refresh table header
Max Power	Max inverter power. For 20kw Trio should be 22. For 27.5kw Trio should be 30, For PVI inverter this will depend on power curve entered.
Max rate to apply load	Ramp rate at which load can be increased. The value to use will depend on generator characteristics.
Start voltage	Voltage above which to use the inverter "Remote" signal to connect inverter to grid and begin exporting. Inverters own Vin Start setting can be used in which case this can be left at 0
Remote off after X minutes	If voltage falls below the above start voltage setting for this time period, use "Remote" signal to inverter to disconnect inverter from grid

Inverter Settings

Please set the inverter settings to match the type of inverter(s) being used. For Solar inverters to work with the controller power curve it is critical to wire to the correct RS485 terminal on the inverter and set the RS485 protocols correctly.



The screenshot shows the 'Inverter' tab in the software. It has three input fields: 'Inverter Address' with the value 2, 'Inverter Type (Wind-255 SolarDM-253 SolarTrio-252)' with the value 252, and 'Number of Inverters (Default 1)' with the value 1.

Inverter Address	The RS485 Address or Port that the controller connects to. For Multiple inverters, input the lowest address. (eg. 2 if inverters set to 2,3,4,5) For multiple inverters addresses should be sequential and not exceed 9.
Inverter Type	This sets the inverter protocol. For monitoring a single ABB wind inverters use 255, for Uno DM inverters use 253 (Modbus RTU), for Trio inverters use 252 (Modbus RTU).
Number of Inverter	If using multiple solar inverters enter the number of inverters here.

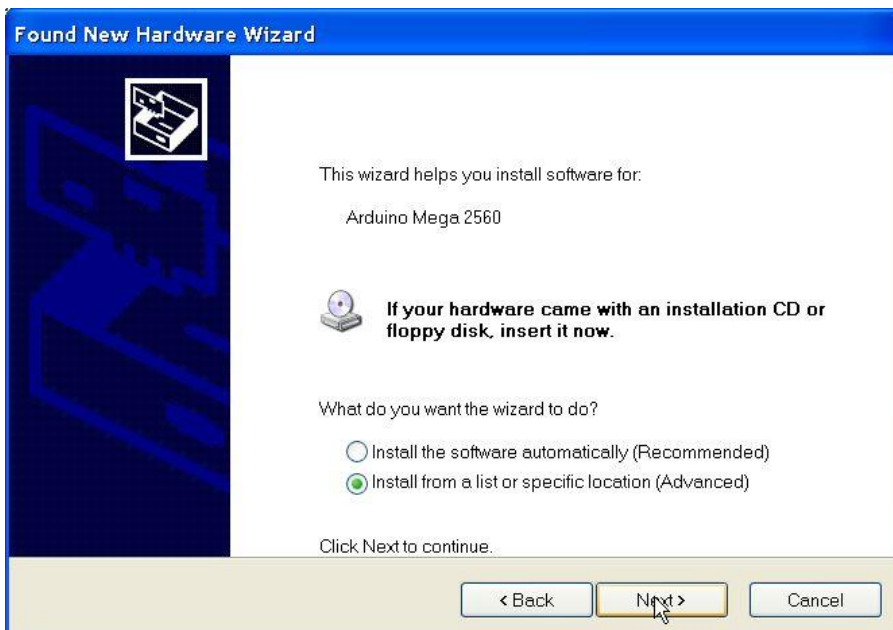
Driver installation

The controller uses the Arduino core and libraries under LGPL licence. This can be downloaded from the software page at <http://www.voltsys.com/home/index.php/software/>

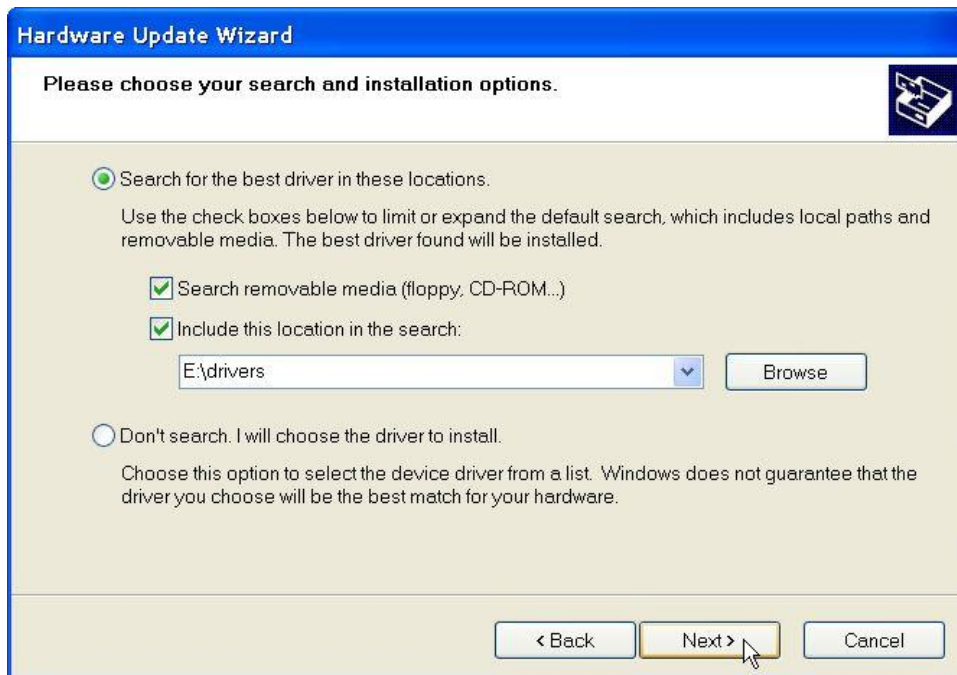
1. Power off panel
2. Connect USB cable to computer.
3. When prompted that new hardware found, select “No, not this time” and click Next



4. Select “install from a list or specific location” and click Next



- Browse to the driver folder on the supplied media or download.



- If a warning is displayed, press "Continue Anyway"



7. Click Finish to complete the driver installation.



Inverter settings

For the controller to function properly please adjust the following setting from the inverter front panel

Please check the inverter manual for additional details on navigating the front panel menu and details on inverter settings.

Inverter settings

1. Navigate to the main menu (press ESC if needed) and press up and down to find "Settings" and then press "Enter"
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 "Address", "VStart", "Alarm", "Remote Control" etc.

Address

Typically the address for the first inverter should be set to 2 for the controller to log inverter data.

Alarm

The inverter includes an alarm relay which can be set to "Alarm" or "Production". Please set alarm to "Production" mode so the controller knows when the inverter is connected to the grid.

Remote On/Off

Please set the "Remote On/Off" setting to "Enabled". This allows the controller to reduce the DC load at start up when charging the system.



Solar Inverter Settings

PMU RS485

Some inverter models may need a comms kit fitted. 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"

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. This typically involves fitting wire or bus-bar links at the DC input and changing a switch in the inverter from IND -> to PAR, or selecting Parallel as the Input Mode in the menu on smaller Trio or DM inverters.

MPPT

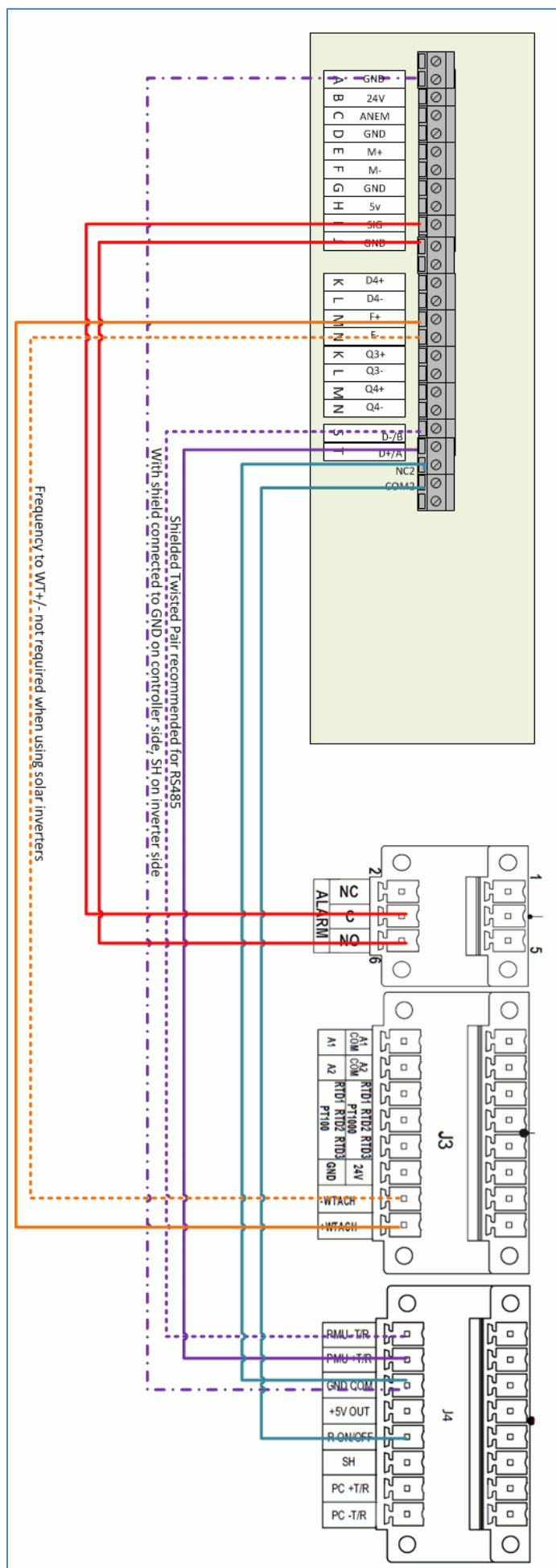
The MPPT scan should be disabled by selecting "Multi-max scan" ("E/D MPPT Scan" on Uno DM Inverter) and choosing **Disable**.

VStart /UV Prot. Time

Start up voltage can be set according to the characteristics of the wind 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. The UV Prot time controls the length of time the inverter stays connected to the grid, after the voltage falls below 70% of VStart.

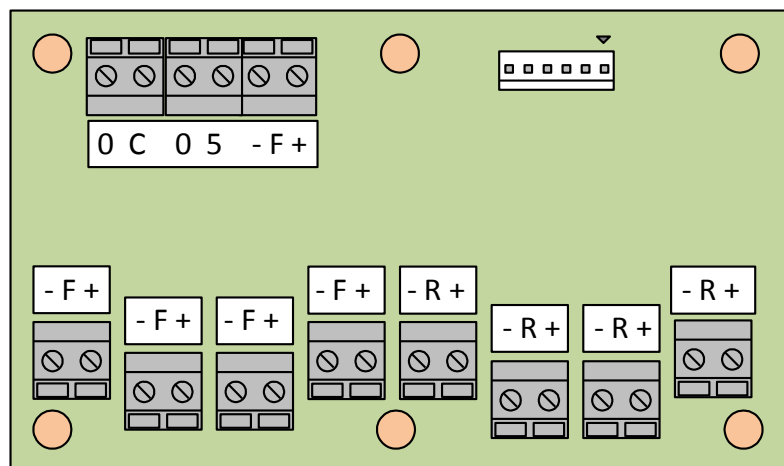
In dual channel inverters, it is important to **set VStart for both channels to the same value.**

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 start at 250V and then work as low as 175V DC.



Multiple Inverters

For Multiple PVI wind inverters we use an add on board to split the control connections. For multiple Uno DM inverters, this will not be required. With solar inverters the RS485 connection will control the inverters and this add on board is not needed.



Add-On Circuit Board

Input Connections (Pre-wired):

- 0 Connects to Gnd/0V
- C Connects to **Relay Com**
- 5 Connects to 5V
- F- Connects to Freq Out Negative
- F+ Connects to Freq Out Positive
- On Control PCB 24V to **Relay NC**

Output Connections

- F+ Connect to inverter Wt-/Wt+
- R+ Connect to inverter remote

Inverter remote should be enabled in the settings menu of each inverter. This way controller can disconnect inverters on overvoltage or other fault and charge and reconnect the inverters with no grid load

To pass turbine frequency through to inverters put frequency jumper up and program power curves into each inverter

Setting up the Inverter in light wind

In light wind it may not be possible to get the inverter to power up with voltage from the wind turbine: For the purpose of setting up the inverter, it is possible to charge and power the inverter by disconnecting the input to the contactor from the turbine. And connecting Grid Live and Neutral instead. See Diagram

CAUTION!: The DC generated from a direct grid connection will not be isolated. Contact with rectified DC from a direct grid connection can be lethal. An isolation transformer like below should be used.

<http://uk.farnell.com/block/tim100/transformer-isolating-2-x-115v/dp/1131597>

1. Isolate & Disconnect the Turbine. Wire in 230V AC through the isolating transformer. Don't power on
2. Ensure run switch (front of the controller) is "Off" and contactor open before powering on (or plugging in) the input voltage. Also ensure the inverter cannot connect the grid by isolating its AC grid connection.
3. Power on the AC voltage, the Voltage reading on the LCD should change to about 350V DC
4. Turn the run switch to "On", wait for the controller to count down, charge the inverter and close the contactor.
5. The inverter should now power up.
6. When finished with setting up the inverter, open the contactor by turning the run switch to "Off"
7. Power off the grid AC to the contactor U & V connections
8. Rewire the turbine



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230V
to

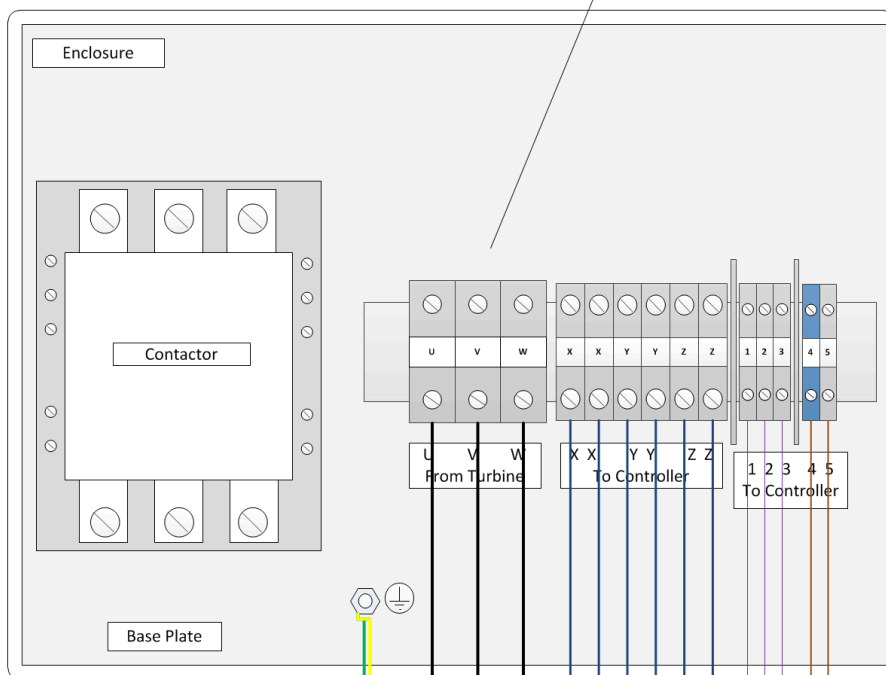




NOTE: For the purpose of setting up the inverter It is possible to charge and power the inverter by disconnecting the input from the turbine. And connecting Grid Live and Neutral into the U & V
CAUTION!: The DC generated from a direct grid connection will not be isolated. Contact with rectified DC from the grid can be lethal. An isolation transformer should be used. Ensure Run switch is off and contactor open before switching on (or plugging in) the 230V input

230V Input from isolator or plug

Isolation Transformer 230V-230V 100W



From Wind Turbine Isolator

Max 35mm²

Earth 16mm²