USER MANUAL

TLV1000 SERIES THYRISTOR STACKS

Caledon Controls Ltd

REVISION HISTORY

R1   First issue June 2012   Preliminary information, may be subject to change

R2   June 2012   Added information on toggling 'comms established' bit and other minor changes

R3   May 2013   Added information on Profinet and other fieldbus networks and revised information regarding config. parameters set by jumpers 3A to 3C.

R4   September 2020   Corrected description of position of PE terminal (bottom, not top) on page 7. Added basic wiring scheme on page 13.

R5   October 2020   Corrected terminal assignations on wiring scheme. Terminal 11 is +24V, terminal 12 is 0V

Table of Contents

CONTACTING US

Please feel free to contact us by telephone, e-mail or fax if you require further information or advice on the application, installation or maintenance of these units. Contact details are on the front of this manual.

IMPORTANT SAFETY INFORMATION

WARNING - SERIOUS DANGER OF ELECRIC SHOCK!

These thyristor stacks must be earthed. The earthing arrangements must be able to carry the fault current associated with a short circuit of the main load circuit to the metalwork of the stack, until the protection device opens.

Thyristor stacks must never be used as a means of supply isolation, as even in the 'off' state lethal leakage currents will flow. An independent means of isolation, complying with local standards must always be fitted.

The clear polycarbonate cover provides protection against accidental contact with live parts, and must never be removed unless the main supply has been isolated elsewhere. Busbars and circuitry on the printed circuit boards under this cover carry the full line voltage. The stacks are intended for mounting in an enclosure which requires a tool to gain access.

Maintenance and installation work on these units should only be carried out by suitably qualified and trained personnel who have read and are familiar with the contents of this manual.

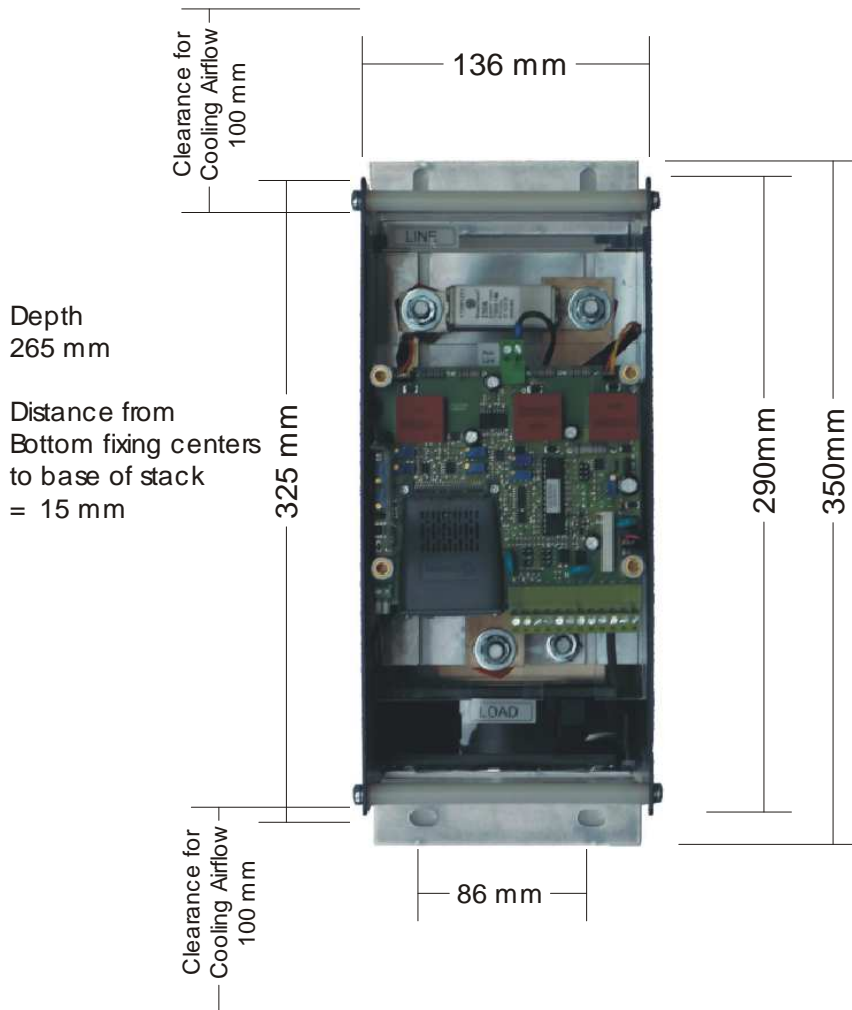Additional information is provided under 'Installation – General Requirements'.

GENERAL DESCRIPTION

A range of single phase thyristor stacks with digital communications facilities for use with transformer loads or other loads requiring phase angle control.

SPECIFICATIONS

Voltage Rating	Up to 480V nominal supply voltage. (Isolation between the main supply and the 24V control circuits meets the requirements for reinforced insulation, overvoltage category III for supply voltages up to 300V line to earth)
Current Ratings (at 50^{0}C ambient)	80A, 125A, 160A, 200A, 250A.
Supply Frequency (Main terminals)	50Hz +/- 8% or 60Hz +/- 8%
Control Circuit Supply Voltage	24V DC +/- 20%.
Control circuit supply current	Without fan (80A model) 150mA With fan (125A to 200A) 1,150mA With fan (250A model) 1,650mA
Dimensions	All current ratings have the same dimensions: Height - excluding mounting clamps 290mm Width 136mm Depth 265mm
High Current Connections	M8 studs (Supply at top, load at bottom, earth at bottom).
Control Wiring Connections	Plug and socket connections accepting wire size up to 1.5mm^2
Operating Temperature Range	0-50 degrees C.
Analogue Inputs (Not isolated from 24V supply)	0-5V, 1-5V, 0-10V, 0-20mA, 4-20mA, potentiometer, (jumper selectable) Analogue input 1 - Control input Analogue input 2 - Current control / current limit
Digital Inputs	Activated by link / contact closure or 5 to 24V. Digital Input 1- Enable (stack disables within 20ms when disabled) Digital Input 2 - Not set = phase angle; set = soft start burst fire control
Communications	Various Fieldbus types supported in data exchange mode only, using HMS Anybus CompactCom plug-in modules.

DIMENSIONS

Clearance for Cooling Airflow 100 mm

136 mm

Depth
265 mm

Distance from
Bottom fixing centers
to base of stack
= 15 mm

325 mm

290mm

350mm

Clearance for Cooling Airflow 100 mm

86 mm

INSTALLATION

General Installation Requirements

The following notes are a guide to ensuring sound system design, and compliance with the requirements of the European Low Voltage Directive and other international standards.

The stacks should be installed in a cabinet requiring a tool to gain access, and access should be restricted to suitably trained and qualified personnel. Provision should be made to exclude conductive pollution (eg graphite dust) from the cabinet, and to avoid condensation.

Caledon thyristor stacks are designed with an impulse withstand voltage (power circuits to earth) of 4kV. This meets the requirements of IEC and European standards for installation (over-voltage) category 3, and supply voltage (line to earth) up to 300V (AC RMS). This corresponds to 520V line to line on most distribution systems, in which the distribution transformer is star connected with earthed star point. This does not preclude the use of the stacks in higher voltage systems (provided the thyristor devices are suitably rated), but the over-voltage category will be reduced to 2 and precautions may be necessary (eg surge arrestors) to limit the expected impulse voltage level, if systems compliance with the above standards is required.

All stacks in the TLV range incorporate an integral semiconductor fuse. This is intended to provide short circuit protection for the thyristor devices, by limiting the peak half cycle surge current and total energy let through. It only provides limited protection against long term overload. The stack ratings are co-ordinated with standard HBC fuse values, and the supply cables should be protected with gL / gG fuses or circuit breakers of current rating the same as, or lower than the stack. All the stacks with fan cooling also incorporate automatically resetting thermal cut outs, which monitor the temperature of the heatsink, and ensure that it does not rise to an unsafe level.

The stacks must be fitted with a protective earth conductor, and the earth connection must be capable of carrying the prospective fault current for the main load circuit until the protective fuse blows. An important reason for this is to protect against short circuit to ground which might occur in one of the semiconductor modules, should the internal structure rupture under severe fault conditions. Provided the correct semiconductor fuses are fitted, which limit the maximum energy let-through under short circuit conditions, a short cable of 6mm^2 cross section connecting between the stack earth stud and the chassis

plate will provide an adequate local earth. Care must be taken to ensure that the panel in which the stack is installed is adequately earthed, with an earth loop impedance less than 0.03Ω (400 / 230V, 800A system), and taking account of local regulations.

The stacks are rated for a maximum ambient operating temperature of 50°C . This refers to the ambient air temperature entering the heatsink at the base of the stack. The design of an installation must however take into account the ratings of cables and other switchgear within the cabinet. Elevated temperatures also shorten the life of some electronic components, notably electrolytic capacitors, which dry out. A major cause of elevated temperatures in a cabinet containing thyristor stacks is the power dissipated by the thyristor devices, which may be approximated in watts as 1.5 x (RMS current) x (Number of controlled lines). The exhaust air temperature from the stack will be higher than ambient by up to 20°C. It is not good practice to mount other items of control gear directly in the exhaust airflow. In particular the current carrying capability of fuses or circuit breakers will be significantly reduced if this is done. A tidy solution is to mount circuit breakers or fuses supplying the stack on a sub-chassis mounted forward from the main chassis on which the stack is mounted. The exhaust air then passes behind these components. Alternatively they should be mounted to the side of the thyristor stack. Thyristor stacks should not be mounted one above the other, as this will significantly derate the upper unit, which, for rating purposes will be operating in an ambient equal to the exhaust air temperature of the lower unit. Heat from the thyristors, together with that dissipated by the semiconductor fuses will also raise the temperature of the stack busbars to which outgoing cables are connected, and high temperature cables should be used. The cross-section of the cables and their ventilation will influence the temperature of the connection studs, and the guide in the wiring section of this manual shows recommended cross sections.

Consideration must be given to fault conditions. In particular a short circuited thyristor could result in loss of control of the load current. If this could cause a dangerous temperature to arise in the controlled load, then an independent means of monitoring and switching off the current should be provided. This could take the form of an independent over-temperature controller switching a contactor or under voltage release on a circuit breaker fitted in the main supply lines. Contacts should be arranged to de-energise in the alarm (over temperature) state. European standard EN 60519-2 Safety in electroheat installations, part 2: Particular requirements for resistance heating equipment, para 13.3 requires independent protection of electronic heating controllers and frequently operated heating control contactors, where temperature rise in the load could otherwise be excessive under fault conditions.

Independent provision for electrical isolation of the power and control circuit power supply must be provided.

Mounting

The stack must be mounted vertically, with the load terminal (and fan if fitted) at the bottom of the unit. Allow a minimum of 100mm above and below the stack body. to allow free airflow. Do not mount stacks one above the other. The stacks are designed to be mounted closely side by side in multi-zone applications. We recommend a minimum gap between units of 15mm.

The mounting arrangement is shown in figure 2. Screw the upper and lower mounting brackets (1 and 2) to the mounting plate using M6 x 16mm screws or similar and plain washers, but do not fully tighten. (Suitable holes should be drilled and tapped in the mounting plate, dimensions on page 5). Hook the stack over the lower mounting bracket, and raise the upper mounting bracket to the limit allowed by the slotted holes so that the stack may be installed against the mounting plate and the bracket hooked down over it. Tighten up first the screws on the top bracket, and then the lower bracket.
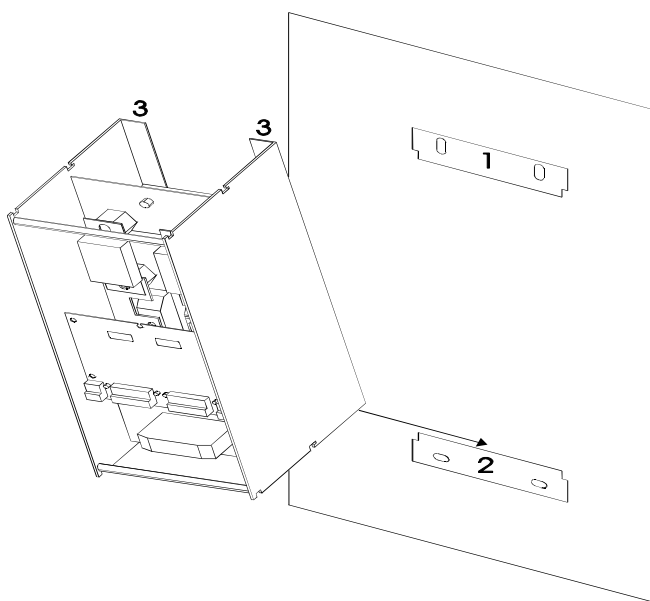
Cover Removal and Replacement

A 3-part clear polycarbonate cover is provided. The top and bottom cable entry covers are held in place by the front cover.

To remove the covers:-

1   Remove the M5 screws which fasten the front cover to pillars which extend from the printed circuit board.
2   Grip the front cover at the top centre and pull forward. The cover will unclip.
3   The top and bottom cover plates are now free to be lifted off.

To replace the covers

1   Line and load cables must be fed through the slots provided in the top and bottom covers. The top cover is
         provided with an additional slot for the auxiliary line cable. The bottom cover has two slots for the control cables and a
         slot for the earth cable.

2   Slide the ears on the top and bottom covers into the slots in the stack sides.

3   Clip the bottom ears of the front cover into the slots in the side of the stack, so that the front cover traps the bottom
         cover against the crossbar.

4   Clip the top ears of the front cover over the top cover and into the slots in the side of the stack. Press home on top to
         secure.

5   Fit the M5 front cover retaining screws.

Wiring

Recommended Power Cable Sizes

The following is a guide only, as installation conditions will vary. A maximum control cabinet internal temperature of 45°C has
been assumed, with cables routed in free air in the immediate vicinity of the stack, and passing into trunking in groups of three.
The cable protective fuse or circuit breaker rating has been assumed to be equal to the stack current rating. A cable suitable for
operating at 90°C has been assumed. A high temperature cable is required because the semiconductor fuses and the
thyristors run hot, and contribute to the heating of the cable. Use of cable of smaller cross section may result in overheating of
the cable / fuses.

STACK RATING	CABLE X SECTION
80A	25mm^2
125A	50mm^2
160A	70mm^2
200A	120mm^2
250A	120mm^2 (Temperature rating 120°C)

Power Connections and Auxiliary Line Connection

Use the guide in the previous paragraph when determining cable type and cross section. Cables should be connected using
heavy duty tube type ring crimp terminals. The stud diameter is 8mm.

The terminal marked 'LINE' is connected to the supply via a suitable fuse or circuit breaker (see section on General
Requirements). The terminal marked 'LOAD' is connected to one end of the load. The other end of the load may be connected
(depending on the voltage rating of the thyristor stack) either to a second supply line via a fuse / circuit breaker, or to the supply
neutral. A connection must be made from this end of the load to the terminal on the top of the control card marked 'Aux Line'.
This connection is required to enable the controller to synchronise to the supply frequency and to measure the line and load
voltages. This connection should be wired with cable of 1mm^2 or 1.5mm^2 cross section. If this connection is to a supply line
(rather than neutral) the cable should be protected at source against short circuit by a fuse or circuit breaker of 6A rating.

A protective earth connection of suitable cross section should be made to the stud at the bottom of the unit. More information is
provided under 'Installation - General Requirements'.

Note that all studs are fitted with a plain and spring washer. The recommended tightening torque is 12Nm

Signal Wiring

Signal cables should, as far as possible, be segregated from power cables, and long runs parallel to power cables should be
avoided. Care should be taken to avoid signal flow and return paths which form loops enclosing a large area. The flow and
return paths should run parallel to each other.

Signal connections are made direct to the printed circuit board connectors. Connectors are suitable for cable up to 1.5mm^2
cross section. Note that all connectors are unpluggable for ease of maintenance.

Control Board Connector Assignments

Number	Function	Comment
1	+3.3V Output	Supply to energise a single 10k ohm potentiometer for use with an analogue input
2	Analogue input 1 +	
3	Analogue input 2 +	
4	Analogue inputs 0V	
5	Digital input 1 - Stack Enable	Digital inputs are activated by applying a voltage of 5V to 24V DC between the input and the input common. Voltage may be either polarity. These terminals are galvanically isolated from all other terminals.
6	Digital input 2 - Phase angle (not activated) / Soft start burst fire (activated)	
7	Common for digital inputs	
8	Alarm contact N/C	Volt free contacts. Maximum rating 250V AC resistive 2A, 30V DC resistive 2A. Isolation from 24V circuits meets requirements for basic insulation, overvoltage category II
9	Alarm contact N/O	
10	Common for alarm contacts	
11	+24V Supply for control circuits and fan	+24V supply should be protected with a 6A antisurge fuse or circuit breaker.
12	0V Supply	

Fieldbus connections are made to the connector on the Anybus CompactCom (grey) module on the left of the control card and will follow the standard for the relevant fieldbus.

COMMISSIONING AND OPERATION

Configuration Jumpers

The position of various configuration jumpers etc is shown in the PCB layout drawing below.
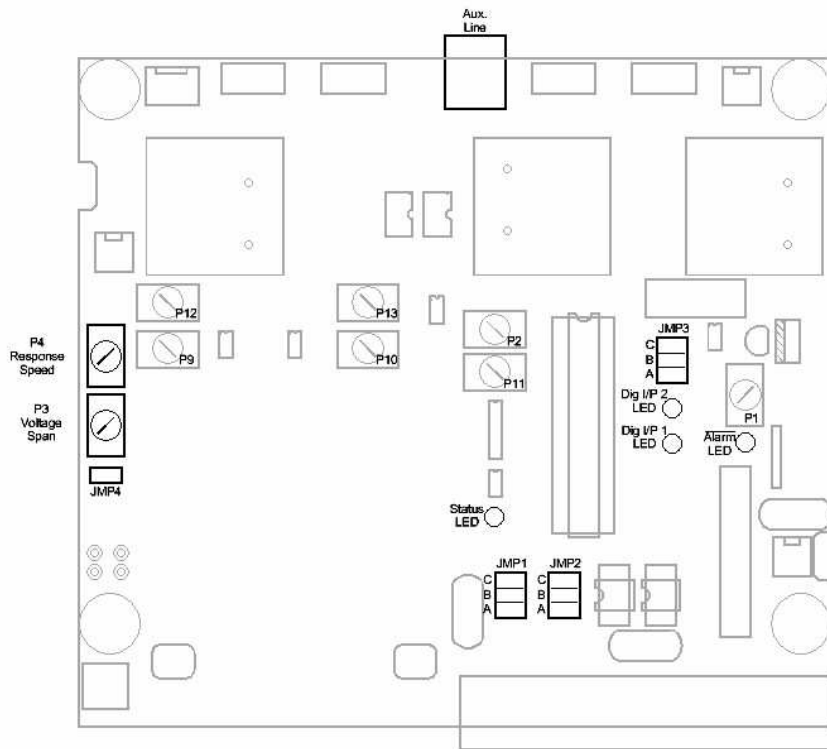
Set the jumpers for analogue inputs as required according to the following tables. Note that if inputs with offset are required (1-5V, 4-20mA) then both analogue inputs must have offsets.

Analogue Input 1				
	Jumper 1A	Jumper 1B	Jumper 1C	Jumper 3A
0-5V		on		
0-10V			on	
0-20mA	on	on		
1-5V		on		on
4-20mA	on	on		on
10k ohm Potentiometer Input				

Analogue Input 2				
	Jumper 2A	Jumper 2B	Jumper 2C	Jumper 3A
0-5V		on		
0-10V			on	
0-20mA	on	on		
1-5V		on		on
4-20mA	on	on		on
10k ohm Potentiometer Input				

Jumper 3B   Communications   Read Write if not fitted / Read only if fitted
Jumper 3C   Controlled parameter for setpoint 1 V^2 if not fitted / Power if fitted
*If comms are in read / write mode then this jumper is ignored and parameter must be set in status register 2.

Jumper 4   Activates setup mode when removed**. Otherwise do not remove.**
In setup mode jumpers 3A to 3C enable setting of additional parameters by counting flashes of the Status LED (see section below):-
    3A   Set communications address
    3B   Set communications baud rate
    3C   Set burst fire cycle time   default value 10s @ 50% duty cycle.

Operation of Jumpers 3A to 3C in Setup Mode / Communications Network Address and Baud Rate

When jumper 4 is removed, jumpers 3A to 3C take on their setup roles. Before removing jumper 4, jumpers should be removed from 3A to 3C. Then, when jumper 4 is removed, initially there will be no change to the parameters which are adjustable by 3A to 3C. When the stack is first shipped these parameters will have default values. The stack is now waiting for one of the jumpers 3A to 3C to be fitted. When it is fitted the Status LED will start flashing, and the number of flashes counted determines the value of the parameter. When the required number of flashes has been observed the jumper is removed. The new values are stored when the jumper 4 is replaced and the stack reverts to normal operating mode. (As shown in the table below, for addresses the first flash represents zero, the second flash represents 1 etc.; for burst fire cycle time the first flash represents 5s, the second flash represents 6s etc. Depending on the fieldbus fitted, the address and / or baud rate jumper may have no function.

3A   Counts address from 0 to 63
3B   Changes baud rate - Baud rate 1, baud rate 2, baud rate 3 (increasing)
3C   Counts burst fire cycle time in seconds from 5 to 30 seconds.

While undertaking the above procedure, normally only one of the jumpers 3A to 3C should be fitted at any one time. If the count is allowed to exceed the above ranges the value will not be updated and the LED will stop flashing. If two jumpers are fitted counting will stop and no value will be updated. **If all 3 jumpers are fitted together all parameters will revert to the default values** when jumper 4 is replaced.

Note that while jumper 4 is removed the span adjustment potentiometer does not operate.

Table of Jumper 3A to 3C Count Values / Default Values						
Fieldbus Network Type	**3A Address (Profinet Station Name)**		**3B Baud Rate**		**3C Burst fire Cycle Time**	
	Range	Default	Range	Default	Range	Default
DeviceNet	0 to 63	63	125k, 250k, 500k	125k	5 - 30s	10s
Profibus	0 to 63	63	N/A (Auto detect)	N/A	5 - 30s	10s
Profinet	Thyristor-000 to Thyristor-063	Blank	N/A	N/A	5 - 30s	10s
Modbus TCP	N/A	255	N/A	N/A	5 - 30s	10s
Modbus RTU	0 to 63	63	9,600, 19,200, 57,600	9,600	5 - 30s	10s

For Ethernet based networks the IP address and subnet mask cannot be set from the TLV1000. They must be set using the user's network configuration software, or alternatively the Anybus IPconfig utility which is available from the downloads page of our website, www.caledoncontrols.co.uk or from the HMS website, www.hms.se

Preset Potentiometers - Adjusting the Response Speed and Voltage Span

Two potentiometers, P3 and P4 are available for adjustment by the user. These are accessible with the front cover fitted. **None of the other potentiometers should be adjusted at all otherwise the calibration will be compromised and difficult to reinstate.**

P4 (upper)   Adjusts the response speed (phase angle ramp speed) for setpoints 1 and 2 when controlling in phase angle mode. Response is fastest when the potentiometer is fully anticlockwise. This potentiometer can be adjusted while the stack is operational. It does not affect the soft start ramp time in burst fire mode, which is preset at approximately 10 cycles of the supply. It does affect the speed of response of current limit (controlled by setpoint 2) when in burst fire mode.

P3 (lower)   Is used to set the voltage span of the controller to the supply voltage. (Adjustable over the range 300V to 600V on 480V model). There are two possibilities for setting this:-

1   If communications are established the span voltage may be read in production register 8 and observed while adjusting the potentiometer.

2   If communications are not available then the simplest way to span the stack is to run it in phase angle mode, controlling V^2 with a setpoint of 100%. The potentiometer is adjusted until the voltage measured across the load is the desired span voltage. Note that this value is best approached from below, and that the supply voltage must be greater than or equal to the desired voltage. If the supply voltage is low then a lower setpoint may be chosen. For example, with a setpoint of 80% the output voltage should be ($\sqrt{0.8}$ x Voltage span).

Control Setpoints

Two setpoints are active at any one time, and may each control a different variable (eg V^2 and I). A setpoint takes control if its controlled variable rises above the setpoint setting.

If communications are set as read only, setpoints 1 and 2 will be derived from analogue inputs 1 and 2. If operation in current control mode is required (analogue input 2) analogue input 1 must be tied high. If operation is required in voltage^2 or power mode (analogue input 1) with current limit only at the stack rating, then analogue input 2 must be tied high.

If communications are set as read/write then each of the two setpoints may be sourced either from the analogue input or from a comms register, as selected by bits in status register 2 in the write / consumption registers. If current limit at the stack rated current is required the current setpoint must be set to 100%.

Controlled Parameters

Setpoint 2 always controls current (initial versions of software), and its primary function will be as a current limit setpoint.

If communications are configured as read only Setpoint 1 can be set to control either V^2 or Power, as determined by jumper 3C. If communications are configured as read / write the controlled parameter for setpoint 1 is determined by the comms using status register 2, and other parameters are available. Jumper 3C is ignored.

Communications Data

Communications may be configured as read only or read/write by jumper 3B.

In read only mode (jumper 3B fitted) the stack does not care whether or not communications are established. All operating parameters are determined by the hardware. The user may read parameters such as load voltage etc to determine the operating state.

In read / write mode (jumper 3B not fitted) the operation of the stack can also be controlled by the user (eg sending setpoints). In this mode the stack will not operate unless Status Register 2 bits 1 and 2 are activated by the user. Bit 1 is an additional 'enable'. This performs a similar function to the hardware enable, and if it is not set the stack will be disabled but will not alarm. Bit 2, 'comms established' must be toggled approximately once per second. If it is not toggled the stack will disable and alarm. The purpose of this is to ensure that if communications are lost the stack will disable rather than continuing to operate with the same setpoint as when communication was lost. The toggle function may be performed by the user's own timer, or alternatively the 'heartbeat' (bit 9) in Status Register 1 may be read by the user and reflected back to status register 2 bit 2. In addition the user may write values (eg an incrementing number) into Consumption Register 4 which will be returned in Production Register 15 enabling the operation of the communication loop to be ascertained.

The function of the communications registers is defined in the tables below. Each register is 16 bits wide. Numerical parameters are expressed as 16 bit binary values representing the parameter value in engineering units multiplied by 10, except energy consumption which is in kWh not multiplied by 10.

Setpoints must be supplied in percent 0.0-100.0, multiplied by 10, whatever the controlled parameter:-

Voltage setpoint	100% corresponds to stack voltage span
Current setpoint	100% corresponds to stack rated current
Power setpoint	100% corresponds to (Voltage span x rated current)
Voltage^2 setpoint	100% corresponds to voltage span, but operation is non linear so that voltage output = (voltage span) x $\sqrt{(setpoint \% / 100)}$
Current^2 setpoint	100% corresponds to current rating, but operation is non linear so that current output = (current rating) x $\sqrt{(setpoint \% / 100)}$

Read Only (Production) Registers (19 registers are configured)		
Number	**Name**	**Additional Information**
1	Status Register 1	Operating status
		Bit 0 Line present
		Bit 1 Phase lock achieved
		Bit 2 Heatsink temperature OK
		Bit 3 Phase angle / burst fire mode (burst fire when set)
		Bit 4 Hardware enable
		Bit 5 Stack enabled
		Bit 6 Alarm
		Bit 7 Setpoint 1 Controlling (not set) (default) / setpoint 2 controlling (set)
		Bit 8 Setup mode (not set) / Run mode (set)
		Bit 9 Heartbeat. This bit is toggled once per second
2	Status Register 2	The same as Consumption Status Register 2
3	Line Voltage	
4	Load Voltage	In burst fire mode these values show the voltage and current in real time (ie they
5	Load Current	switch on and off)
6	Load Power (%)	As a percentage of Span voltage x stack rated current
7	Firing Angle	.0-180 degrees where 180 corresponds to fully conducting
8	Voltage Span	In Volts - The value set on the span potentiometer
9	Working Setpoint	
10	Analogue setpoint 1	In %
11	Analogue setpoint 2	In %
12	Setpoint 1 (comms)	In %
13	Setpoint 2 (comms)	In %
14	Energy Consumption (kWh)	Energy supplied to the load since last reset. Maximum value before roll over is 50,000 kWh.
15	User Value	This register returns the value entered in Consumption Register 4

Write (Consumption) Registers (6 registers are configured)				
Number	**Name**	**Additional Information**		
1	Status Register 2	Bit 0 Digital Input 2 Set = Burst fire, Not set = Phase angle		
		Bit 1 Comms enable		
		Bit 2 Comms established		
		Bit 3 Use comms for setpoint 1 (analogue setpoint 1 not used)		
		Bit 4 Use comms for setpoint 2 (analogue setpoint 2 not used)		
	When comms are in read / write mode bits 5 and 6 MUST be set as required.	Bit 5	Bit 6	
		0	0	Setpoint 1 controlled parameter = V^2
		1	0	Setpoint 1 controlled parameter = Power
		0	1	Setpoint 1 controlled parameter = Volts
		1	1	Setpoint 1 controlled parameter = I^2
		Bit 7	If not set, setpoint 2 controls current. If set, setpoint 2 parameter is defined by bits 8 and 9	
	(Bits 7 to 10 are not implemented in the first software versions. Setpoint 2 always controls current).	Bit 8	Bit 9	
		0	0	Setpoint 2 controlled parameter = V^2
		1	0	Setpoint 2 controlled parameter = Power
		0	1	Setpoint 2 controlled parameter = Volts
		1	1	Setpoint 2 controlled parameter = I^2
		Bit 10 Toggle high to reset energy counter.*		
2	Setpoint 1	Active if Bit 3 in SR2 is set. Range 0.0 to 100.0%		
3	Setpoint 2	Active if Bit 4 in SR2 is set. Range 0.0 to 100.0%		
4	User Value	A value entered in this register is returned in Production Register 15		
* After the stack has reset the energy counter it will ignore this bit for 1 minute. After the energy counter is observed to have been reset this bit must be reset by the user otherwise the energy counter will be continually reset.				

LED Indicators

Four green LED indicators (see diagram on page 8) show the operating status of the controller. (For information on the LED indicators on the CompactCom fieldbus communications module see the information appended at the end of the manual).

If no LEDs are illuminated the 24V power supply to the driver PCB is not present - the board is unpowered.

Status LED

1 second slow flash	The board is powered but is not enabled. For the controller to enable there must be no alarms, the hardware enable input must be activated, and if comms read / write mode is selected the comms enable bit must be set (consumption register 1; status register 2).
Fast flicker	The board is powered and enabled and is either operating in phase angle mode or is at zero setpoint
Fast flicker / full on	The board is powered and enabled and is operating in burst fire mode. The LED is full on in the 'on' periods and fast flickers in the off periods
Off	Either the board is unpowered or the stack is in 'Setup' mode (jumper 4 off) and awaiting action by the user.

Alarm LED

This LED illuminates when there are no alarms. The alarm relay will be energised. The relay de-energises in the alarm state.

Alarms which cause the LED to extinguish are; Main power supply (50 / 60 Hz load power) under-voltage, loss of phase lock, heatsink temperature too high, comms established bit in status register 2 not set (comms read / write mode only)

Dig In 1

Illuminates to indicate that digital input 1 (hardware enable) is activated.

Dig In 2

Illuminates to indicate that digital input 2 is activated; the controller will operate in soft start burst fire mode.

MAINTENANCE

Semiconductor Fuse Types

Checking or changing of any fuse must not be attempted unless both main and driver supplies are isolated. To do so is extremely dangerous, and may also cause damage to the controller.

See 'Cover removal and Replacement' for instructions on how to remove and replace the cover.

The semiconductor fuses listed in the table below may be used. Consult us before using other fuse types.

Stack Current Rating		Nominal Fuse Current Rating	Fuse I^{2}t Rating (Approx A^{2}s)	Fuse Type (BS88 Fixing Centres)	DIN43 653/80/000 80mm fixing centres
80A	Bussmann Siba	110A	6,800	E330100C 170M1485 20 559 20 110	M330038* 170M1317 20 282 20 125 *
100A 125A	Ferraz Bussmann Siba	160A	15,400	F330055C 170M1469 20 559 20 160	N330039 170M1319 20 282 20 160
160A	Ferraz Bussmann Siba	250A	44,000	H330057 170M1487 20 559 20 250	Q330041 170M1321 20 282 20 250
200A	Ferraz Bussmann Siba	315A	77,000	J330058C 170M1488 20 559 20 300	R330042 170M1322 20 282 20 315
250A	Bussmann Siba	350A (DIN 00 size)	110,000		170M2670 20 189 20 350
*125A rating					

The line terminal fuse support pillar has alternative mounting points on the heatsink to cater for the different pitch of

alternative fuses. If necessary unscrew the pillar from the heatsink and re-fit in the alternative position.

Note that a serrated lockwasher is fitted behind the fuse on the line stud. It is most important that this is not omitted, otherwise excessive torque may be transmitted to the stud when the fuse / cable retaining nut is tightened. The recommended tightening torque for these nuts is 12Nm

ORDERING INFORMATION

Select the desired options from the following table (the nominal supply voltage range is for information only):-

Typical example TLV1000-125A-480V-24V-DeviceNet

Series	Current Rating	Load Supply Voltage	Control Supply Voltage	Communications	Nominal load supply voltage range
TLV1000	80A	690V	24V DC	None	# 500V to 690V
	125A	480V		DeviceNet	380V to 480V
	160A	230V		Profibus DP	200V to 270V
	200A	150V		Profinet	115V to 150V
	250A			Modbus TCP	
				Modbus RTU	
				Other*	

* Please enquire
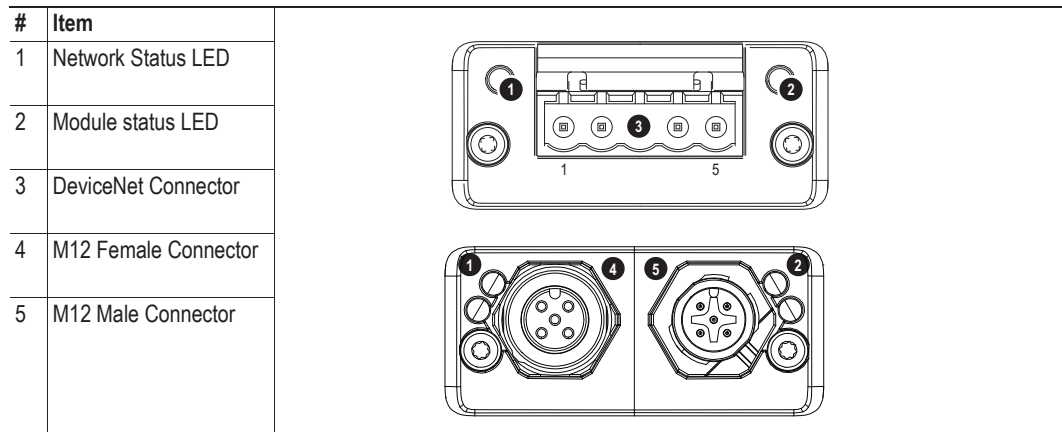
Over voltage category 2.

BASIC WIRING SCHEME
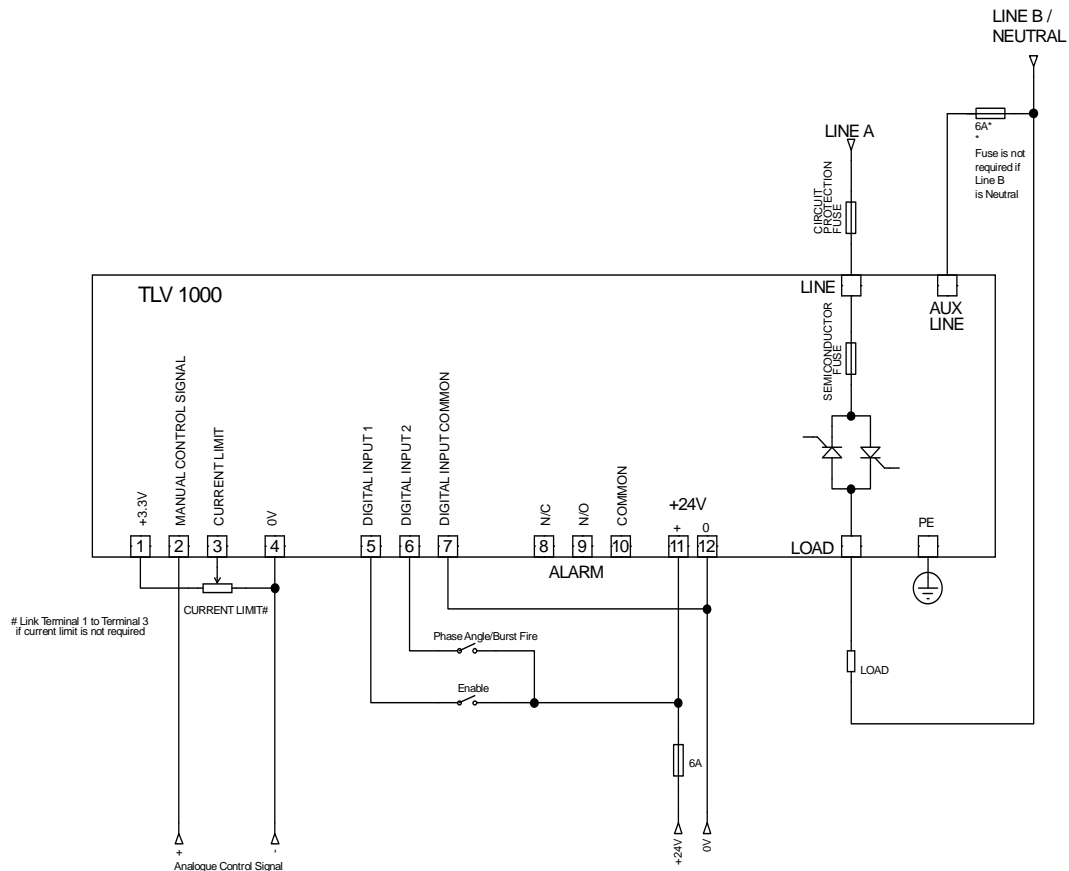
If communications are used to send setpoints no connections to terminals 1 to 4 are required.

If analogue input setpoints are used but current limit is not required link terminal 1 to terminal 3. This sets the current limit to the stack rating value. Analogue input 1 is the main control setpoint. Input 2 is the current limit setpoint.

1.3 Front View

#	Item
1	Network Status LED
2	Module status LED
3	DeviceNet Connector
4	M12 Female Connector
5	M12 Male Connector

Network Status

State	Indication
Off	Not online / No power
Green	On-line, one or more connections are established
Flashing Green (1 Hz)	On-line, no connections established
Red	Critical link failure
Flashing Red (1 Hz)	One or more connections timed-out
Alternating Red/Green	Self test

Module Status

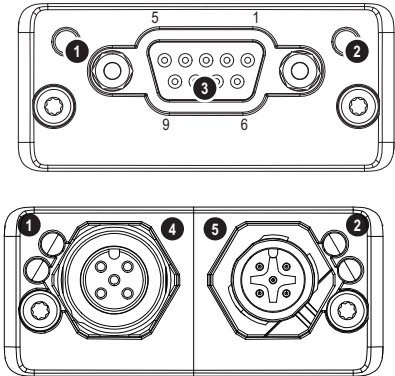| State	Indication
Off	No power
Green	Operating in normal condition
Flashing Green (1 Hz)	Missing or incomplete configuration, device needs commissioning
Red	Unrecoverable Fault(s)
Flashing Red (1 Hz)	Recoverable Fault(s)
Alternating Red/Green	Self test

DeviceNet Connector

This connector provides DeviceNet connectivity.

Pin	Signal	Description
1	V-	Negative bus supply voltage[a]
2	CAN_L	CAN low bus line
3	SHIELD	Cable shield
4	CAN_H	CAN high bus line
5	V+	Positive bus supply voltage[a]

a. DeviceNet bus power. For more information, see D-48 "Technical Specification".

1.3 Front View

#	Item
1	Operation Mode
2	Status
3	PROFIBUS Connector
4	M12 Female Connector
5	M12 Male Connector

Operation Mode
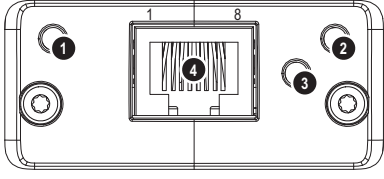
State	Indication	Comments
Off	Not online / No power	-
Green	Data exchange	-
Flashing Green	Clear	-
Flashing Red (1 flash)	Parametrization error	See "Parametrization Data Handling" on page 15
Flashing Red (2 flashes)	PROFIBUS Configuration error	See "Configuration Data Handling" on page 16

Status

State	Indication	Comments
Off	Not initialized	Anybus state = 'SETUP¨' or 'NW_INIT'
Green	Initialized	Anybus module has left the 'NW_INIT' state
Flashing Green	Initialized, diagnostic event(s) present	Extended diagnostic bit is set
Red	Exception error	Anybus state = 'EXCEPTION'

1.3 Front View

#	Item
1	Network Status LED
2	Module Status LED
3	Link/Activity LED
4	Ethernet Interface

Network Status LED

Note: A test sequence is performed on this LED during startup.

LED State	Description	Comments
Off	Offline	- No power - No connection with IO Controller
Green	Online (RUN)	- Connection with IO Controller established - IO Controller in RUN state
Green, flashing	Online (STOP)	- Connection with IO Controller established - IO Controller in STOP state

Module Status LED

Note: A test sequence is performed on this LED during startup.

LED State	Description	Comments
Off	Not Initialized	No power - *or* - Module in 'SETUP' or 'NW_INIT' state
Green	Normal Operation	Module has shifted from the 'NW_INIT' state
Green, 1 flash	Diagnostic Event(s)	Diagnostic event(s) present
Green, 2 flashes	Blink	Used by engineering tools to identify the node on the network
Red	Exception Error	Module in state 'EXCEPTION'
Red, 1 flash	Configuration Error	Expected Identification differs from Real Identification
Red, 2 flashes	IP Address Error	IP address not set
Red, 3 flashes	Station Name Error	Station Name not set
Red, 4 flashes	Internal Error	Module has encountered a major internal error

LINK/Activity LED

LED State	Description	Comments
Off	No Link	No link, no communication present
Green	Link	Ethernet link established, no communication present
Green, flickering	Activity	Ethernet link established, communication present

Ethernet Interface

The Ethernet interface operates at 100 Mbit, full duplex, with autonegotiation enabled as default.

IMPORTANT:
For information on how to connect the PROFINET cable, see "Protective Earth (PE) Requirements" on page 150.