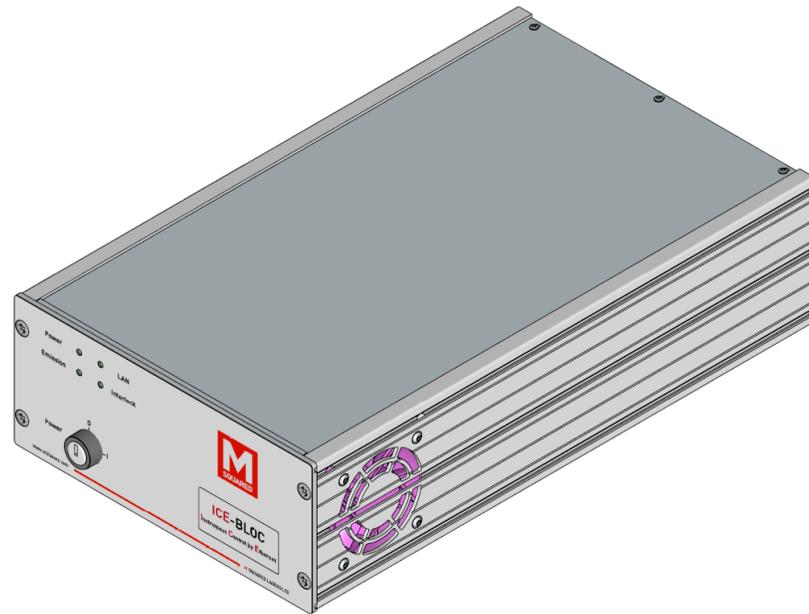




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**M Squared Lasers Ltd**



**DD-TC ICE-BLOC<sup>®</sup>**  
**Laser Diode Driver & Temperature Controller**  
**User Manual v1.0**

Tools to Help You Lead, Not Follow™



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## A Preface

This manual is a guide to your DD-TC ICE-BLOC<sup>®</sup>. It contains important information that you will need for unpacking, installing, operating, maintaining and servicing your system correctly and safely.

**It is strongly advised that you read this manual thoroughly before attempting to unpack or use your DD-TC, to avoid taking actions that may damage your DD-TC or cause safety hazards.**

If, after reading this manual, you are unsure about any aspect of your system, please contact M Squared Lasers Ltd, or your authorised representative, via the contact information listed in Section 8.

Thank you for your purchase of the DD-TC.

## B Warning Symbols

The following symbols are used in this manual to highlight procedures or situations that require extra attention:



Danger!

**Danger!** Laser radiation is present.



Danger!

**Danger!** Condition or action may present an electrical hazard to the user.



Warning!

**Warning!** Condition or action may cause equipment damage, safety hazard, or poor performance.



Caution!

**Caution!** Exercise particular care and/or refer to the manual before proceeding.



Note!

**Note!** Text noting special circumstances or tips.

---

## C Receiving & Unpacking the DD-TC ICE-BLOC



Note!

**Note!** Please keep all shipping containers. You may need these containers in the event that you need to provide evidence of shipping damage, or if you need to return the system for service or upgrade at some later date.

When you receive your system, please inspect the shipping containers immediately. If you discover any damage (holes or dents in the containers or crushing, for example) please notify the carrier immediately, and insist that a representative of the carrier be present to document the damage with you. Please also be sure to inspect each system component carefully for damage as it is removed from its protective packaging. If you find any damage to system components (dents or scratches in covers, for instance), document this damage, and notify the carrier and M Squared Lasers (or your distributor) immediately.

**Note!** If you need to return your system to M Squared Lasers within your warranty period, and your original shipping containers were intact at time of delivery but have since been discarded, M Squared Lasers may levy a charge to replace these containers.

### C.1 Items Packed With Your System

Item	Quantity
DD-TC ICE-BLOC Diode Driver	1
Weidmuller BVZ 7.62/02/180 SN BK BX connector (diode drive output)	1
Phoenix FMC 1,5/ 2-ST-3,5 connector (emission, interlock, 5.5V aux, temp sense)	5
Phoenix FKC 2,5 HC/ 2-ST connector (TEC/heater)	1
BNC to MCX cable (modulation / analogue inputs)	3
DD-TC On/Off key	2
IEC mains cable	1
Ethernet cable	1
USB memory stick (loaded with User Manual)	1

## D Important Safety Information

### D.1 General Safety Precautions



Caution!

**Caution!** Use of controls or adjustments or performance of procedures other than those specified herein, or in associated system manuals, may result in a hazard.

- NO USER SERVICEABLE PARTS INSIDE. REFER SERVICE TO AUTHORISED PERSONNEL.
- REMOVAL OF COVERS IS PROHIBITED AND VOIDS WARRANTY.
- DO NOT OBSTRUCT THE AIRFLOW FROM THE REAR INTAKE TO THE SIDE EXHAUST.

- SYSTEM MUST BE EARTHED.
- DISCONNECT AC CORD BEFORE CHANGING FUSE.
- PRIOR TO USE, REVIEW AND REFER TO ALL INSTRUCTIONS AND SAFETY PRECAUTIONS LISTED IN ALL MANUALS PROVIDED WITH THIS SYSTEM.

## D.2 System Safety Features



Warning!

**Warning!** The DD-TC ICE-BLOC meets the regulatory design & safety standards declared within this manual only if used in the as-designed configuration.



Caution!

**Caution!** To ensure a full understanding of the safety features, labelling and operation of your DD-TC ICE-BLOC, please refer to all manuals associated with the system. If, after consulting your manual(s), anything remains unclear, please consult M Squared Lasers or an authorised representative before attempting to operate your system.

The DD-TC includes the following safety features:

### Key Switch

The DD-TC includes a key switch on the front panel that must be set to the 'On' position before the module can be operated. Once set in the 'On' position, the key cannot be removed without returning it to the 'Off' position.

## Protective Housing



Danger!

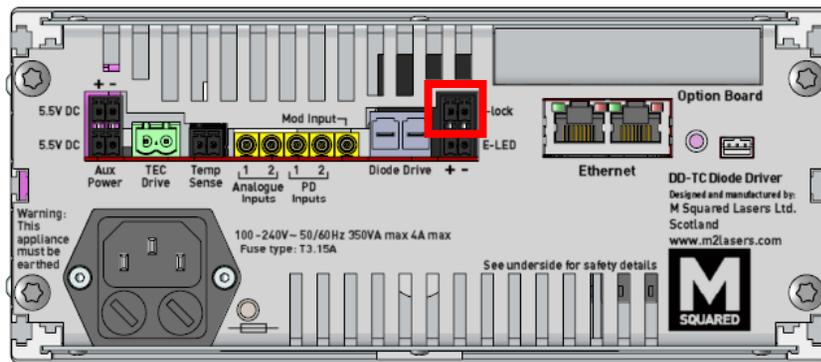
**Danger!** Operating with any cover removed is prohibited, voids your warranty, risks contamination of optical surfaces, and may expose users to high voltages.

The DD-TC contains no user-serviceable parts and must never be opened by the user. All covers are sealed with 'warranty void' stickers. Only M Squared Lasers personnel or their authorised representatives should be allowed to service the system.

### Remote Interlock Circuit

The DD-TC incorporates a safety interlock circuit and connector. This is located on the rear panel of the DD-TC. The interlock circuit is a 'fail-safe' design, in which the DD-TC is enabled when the circuit is closed (the connector is shorted), and operation ceases should the circuit open (become broken). This circuit allows users to set up a perimeter safety switch – attached to an access door or workstation cover, for example – that shuts down the module in the event of unauthorised or inadvertent access to the laser operating area. This prevents unaware personnel from being exposed to hazards. Should the circuit be tripped, the status window on the DD-TC control page displays 'LATCHED (OPEN)'. Completing the interlock circuit again and resetting the interlock latch allows the module to be restarted.

The module is shipped with a shorting plug connected to the interlock connector. To wire an external safety switch to the interlock circuit, either re-wire the supplied connector, or use an identical connector, referring to Figure 1. Wire the safety switch across the connector terminals as ‘normally closed’, so that when the door or safety device is opened, the switch opens and trips the interlock circuit. The status of the interlock circuit is given by an LED indicator on the front panel of the module.



**Figure 1 Remote interlock connector on DD-TC**



**Note!** Before the diode driver channel can turn on, the two safety-interlock contacts must be either wired to a safety switch supplied by the user, or shorted together.

### Emission Indicator

A LED laser emission-warning indicator is located on the front panel of the DD-TC and a connector is provided on the back panel for connection to an external emission LED. The LED indicator starts flashing

immediately upon pressing the laser ‘Start’ button on the DD-TC software web interface to warn of impending laser emission. For safety, there is a delay of at least 5s between activating the laser and laser emission, at which point the emission LED will change from flashing to continuous.

### D.3 Maintaining IEC/CE Safety Compliance

To keep the DD-TC in compliance with applicable safety regulations, once a year, or whenever the product has been subjected to adverse environmental conditions (e.g. fire, excess moisture, mechanical shock, spilled solvent, etc.), check to ensure that all safety features of the module described in the previous section are still functional. Make sure that all warning labels are still attached firmly to the module and are legible, that all covers are still correctly sealed, and perform the following safety checks:

- Verify that the module can only be turned on by using the Key switch and that the key cannot be removed in the ‘On’ position.
- Verify that removing the shorting plug or user-installed safety interlock connector on the rear of the module shuts down the unit and that a manual restart is needed.

If you find that your module fails any of these safety checks, please stop the use of your module immediately, prevent others from using it, and contact M Squared Lasers or an authorised representative to correct the problem.

## E RoHS/WEEE Compliance Statement

M Squared Lasers is committed to minimising the environmental impact of our products and operations, and to complying with related relevant legislation and directives. M Squared Lasers' products are subject to the European Union (E.U.) Restriction of Hazardous Substances Directive (RoHS) that became effective July 1 2006, and also to the PRC Management Methods for Controlling Pollution by Electronic products (more commonly known as China RoHS) effective March 1 2007.

### E.1 RoHS Directive (2002/95/EC)

The RoHS Directive affects manufacturers, sellers, distributors and recyclers of electrical and electronic equipment containing lead, cadmium, mercury, hexavalent chrome, polybrominated biphenyl (PBB) and polybrominated diphenyl ether (PBDE). From July 1, 2006 the use of these materials has been severely restricted in most electrical and electronic products sold in Europe.

All of M Squared's products sold in Europe after July 1, 2006 are fully RoHS compliant, and a full Declaration of RoHS Compliance is available upon request. If you have questions regarding the RoHS compliance of M Squared products, please contact us, or your distributor, using the information listed in Section 8.

### E.2 WEEE Directive (2002/96/EC)

The Waste Electrical and Electronic Equipment Directive (WEEE) applies to companies that manufacture, sell, and distribute electrical and electronic equipment in the E.U. It covers a wide range of large and small electrical and electronic appliances, tools and instruments. This Directive aims to reduce the waste arising from electrical and electronic equipment, and to improve the environmental performance of everything involved in the life cycle of electrical and electronic equipment. This translates into the following requirements for producers (manufacturers or importers) of electrical and electronic equipment: a) register in their countries; b) achieve a series of demanding recycling and recovery

targets; c) mark any products that must NOT be thrown into general waste with a crossed out, wheeled bin icon.



**Figure 2** The E.U. WEEE symbol used to mark products that must not be thrown into general waste, and must be recycled or disposed of according to local regulations.

The symbol shown in Figure 2 indicates WEEE material, and anything carrying this mark should be collected separately and processed according to local regulations. M Squared products subject to the WEEE directive are marked with this symbol. To prevent WEEE, the Directive encourages re-use, recycling and other forms of recovery over disposal. Arrangements for the separate collection of WEEE will vary in each member E.U. country. If disposal is necessary then this should only be undertaken by an approved authorised treatment facility (AATF).

As needed, M Squared will work with end users and/or distributors, to aid in the correct handling of an M Squared product that has reached the end of its useful life. This may include, as appropriate, return shipment of the product free of charge to M Squared Lasers Ltd for re-cycling (only after prior agreement and issue of an RMA number directly by M Squared Lasers Ltd). A copy of M Squared's full WEEE Compliance Policy Statement is available upon request. For more information, please contact M Squared Lasers Ltd, or your distributor, using the information listed in Section 8.

## F CE Declaration of Conformity

---



Note!

**Note!** The attention of the specifier, purchaser, installer, or user is drawn to special measures and limitations to use of this equipment, which must be observed when these products are taken into service to maintain compliance with the above directives. Details of these special measures and limitations to use are available on request, and are also contained in this manual.

---

**The Manufacturer of the Products covered by this Declaration is:**  
M Squared Lasers Ltd.

**The address of the head office is:**  
1 Kelvin Campus,  
West of Scotland Science Park,  
Maryhill Road,  
Glasgow,  
G20 0SP,  
UK

**The product covered by this declaration is:**  
DD-TC ICE-BLOC, laser diode driver and temperature controller.

The above mentioned product complies with the essential requirements, which are specified in the directives 2004/108/EC and 2006/95/EC on the approximation of the Member States relating to electromagnetic compatibility and electrical safety.

The product of the declaration above has been designed and manufactured to be in compliance with the requirements of the following standards and the results of testing and assessment are included in the Technical Documentation:  
EN 60825-1 Edition 2.0 2007-03 Safety of Laser Products

EN 61010-1:2010 3<sup>rd</sup> Edition Safety requirements for electrical equipment for measurement, control and laboratory use

EN 61326-1:2006 (Emissions only) Electrical equipment for measurement, control and laboratory use. EMC Requirements. General Requirements.

EN 55011:2007 (Conducted and radiated emissions to Class B) Equipment electromagnetic disturbance characteristics. Limits and methods of measurement.

EN 55022:2006 (Conducted emissions) Information technology equipment. Radio disturbance characteristics. Limits and methods of measurements

The technical documentation required to demonstrate that the product meets the essential requirements of the above directives has been compiled and is available for inspection by the relevant enforcement authorities.

The CE mark was first applied in November 2013.

Signed: 

Name: *Bill Miller*

Authority: *Director of Systems Engineering*



## G Standard Units & Abbreviations

The following is a list of units, prefixes, and abbreviations used in M Squared Lasers' manuals:

Physical Quantity	Unit	Symbol
Mass	kilogram	kg
Length	metre	m
Time	second	s
Frequency	hertz	Hz
Power	watt	W
Energy	joule	J
Temperature	degrees Celsius	°C
Pressure	pascal	Pa
Electric Current	ampere	A
Electric Potential	volt	V
Resistance	ohm	Ω
Capacitance	farad	F
Inductance	henry	H
Angle	degree (radian)	deg (rad)
Magnetic Flux Density	tesla	T
Force	newton	N

AC	Alternating current
AOM	Acousto-optic modulator
APAM	Automated pump alignment module
AR	Anti-reflection
BRF	Birefringent filter
CDRH	Centre for Devices and Radiological Health
CW	Continuous wave
DC	Direct current

DPSS	Diode-pumped solid-state
DSP	Digital signal processing
EO(M)	Electro-optic (modulator)
fs	femtosecond ( $10^{-15}$ second)
FSR	Free spectral range
GVD	Group velocity dispersion
HR	High reflector
ICE	Instrument Control by Ethernet
IR	Infrared
OC	Output coupler
OPO	Optical parametric oscillator
ns	nanosecond ( $10^{-9}$ second)
PC	Personal computer
ps	picosecond ( $10^{-12}$ second)
PIK	Pump integration kit
POM	(SolsTiS) Pump optics module
PSU	power supply unit
PZT	piezo-electric transducer
RF	Radio frequency
SLM	Single longitudinal (frequency) mode
TEM	Transverse electromagnetic (spatial) mode
Ti:S	Titanium-doped sapphire
THz	Terahertz
(D)UV	(Deep) Ultraviolet
λ	Wavelength

Prefixes					
Tera	$10^{12}$	T	Milli	$10^{-3}$	m
Giga	$10^9$	G	Micro	$10^{-6}$	μ
Mega	$10^6$	M	Nano	$10^{-9}$	n
Kilo	$10^3$	k	Pico	$10^{-12}$	p
Centi	$10^{-2}$	c	Femto	$10^{-15}$	f

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## I Copyright Information

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The information in this manual is provided for information use only, is subject to change without notice, and should not be construed as a commitment by M Squared Lasers Ltd. M Squared Lasers Ltd assumes no responsibility or liability for any errors or inaccuracies that may appear in this manual.

## 1 Introduction

Thank you for your purchase of a DD-TC ICE-BLOC. We pride ourselves on supplying next-generation, reliable products that provide our customers with new, often unique performance capabilities with which they can push their application boundaries. We welcome your feedback, comments and suggestions.

If you have any questions, concerns or comments, please do not hesitate to contact us, or your M Squared Lasers representative (please see contact information listed in Section 8).

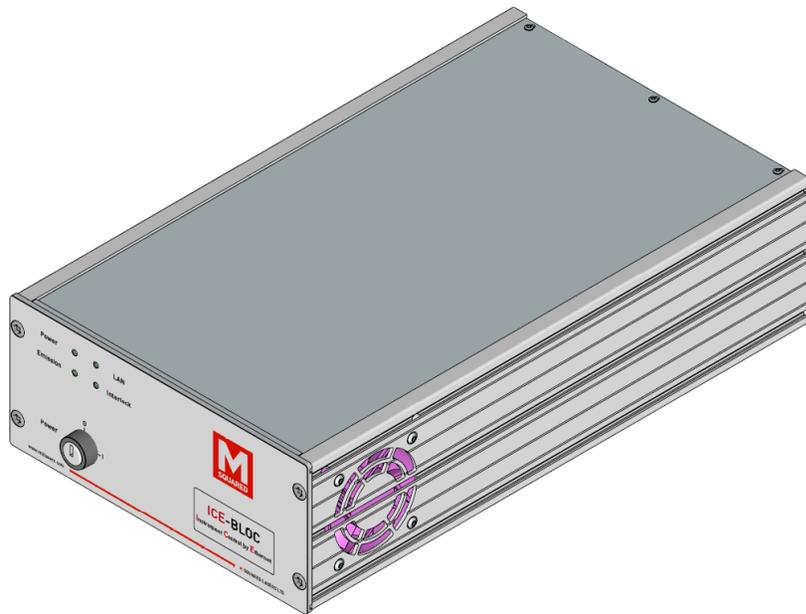


Figure 3 DD-TC ICE-BLOC

## 2 System Description

### 2.1 System Overview



Warning!

**Warning!** The DD-TC ICE-BLOC system meets regulatory design & safety standards declared within this manual only if used in the as-designed configuration.

The DD-TC (shown in Figure 3) is an integrated precision laser diode driver and temperature controller with unique Instrument Control by Ethernet (ICE). ICE functionality allows the users to control and monitor the DD-TC – as well as log diode performance data – all via a standard Ethernet / LAN connection and a standard web browser. The facility to interface between the ICE-BLOC and third party equipment is also available using the IP remote command instruction set; please contact M Squared Lasers or your local representative for further details.

Driving the latest generation of high power laser diodes, the DD-TC combines high current, low noise output with high-accuracy, high-resolution current set points. The temperature controller can control either a TEC or resistive heater with user-programmable output current, current polarity, voltage limits, PID feedback parameters and ramp time. Its compact form factor and customisable software interface allow easy integration of the DD-TC into experiments or OEM setups.

The standard DD-TC specification can be found in Table 1.



## 2.2 DD-TC Standard Specifications

Table 1 lists standard specifications for the DD-TC.

Parameter	Specifications
<b>Diode Driver</b>	
Output Current	0 – 5 A
Output Voltage Compliance	1.2V – 22 V
Total Noise	≤ 0.01 % at 5 A
Current Setting Resolution	1 mA
Current Accuracy	± 0.1 %
Current Temperature Stability	75 ppm / °C
<b>Temperature Controller</b>	
Output Voltage	1.2V – 22V
Output Current	0 – 5A
Set Point Resolution	0.001 °K – typical value, steady state
Set Point Temp. Coefficient	< 5 ppm / °K (ICE-BLOC temperature)
Set Point Range	-20.15 °C to +79.85 °C
Thermistor Range	10kΩ – 100kΩ
Extended Thermistor Range	1kΩ – 1MΩ (slightly lower resolution)
<b>General</b>	
Mains Input Voltage	100 – 240 VAC, 50 / 60 Hz, 350VA (typical power: 15 W)
Fuse Rating	T3.15AL250V (3.15A 250V-rated low-breaking time-lag fuse. Suitable for use with 110-240V power supplies)
Overvoltage category classification as per IEC60664-1	Category II (can withstand 2500V peak mains transient, 300V RMS mains voltage line-to-neutral)

Size (W x H x D)	Half Rack (203mm) x 2U (89mm) x 345 mm (8"x3.5"x13.6")
Weight	4.1 kg

**Table 1 DD-TC specifications.**

Table 2 lists standard environmental operating conditions for the DD-TC.

Parameter	Standard Specifications
Operating Temperature	0°C to 70°C
Storage Temperature	-20°C to 85°C
Relative Humidity	<90% humidity, non-condensing
Indoor/Outdoor Use	Indoor use only
Altitude	<2000m

**Table 2 DD-TC environmental operating conditions**

Table 3 lists modulation input specifications for the DD-TC.

Parameter	Specifications
Modulation Input Sensitivity	100 A / V
Modulation Range	± 5 A around the set point
Mod. Frequency Response	DC – 8 kHz
Modulation Input Resolution	24 bits
Modulation Max Safe Input	± 20 V

**Table 3 Modulation / monitor input specifications.**

Table 4 lists photodiode monitor input specifications for the DD-TC.

Parameter	Specifications
Input Impedance	20 $\Omega$ (transimpedance)
Transimpedance Gain Range	80 V / A – 20 kV / A
Maximum Safe Input	$\pm 5$ V (protected)
Input Linear Range	$\pm 10$ mA
Input Resolution	24 bits

**Table 4 Photodiode monitor input specifications.**

Table 5 lists interlock input specifications for the DD-TC.

Parameter	Specifications
Open Circuit Voltage	3.3 V
Closed Maximum Resistance	5.6 k $\Omega$
Maximum Safe Input Voltage	$\pm 10$ V

**Table 5 Interlock input specifications.**

Table 6 lists emission LED output specifications for the DD-TC.

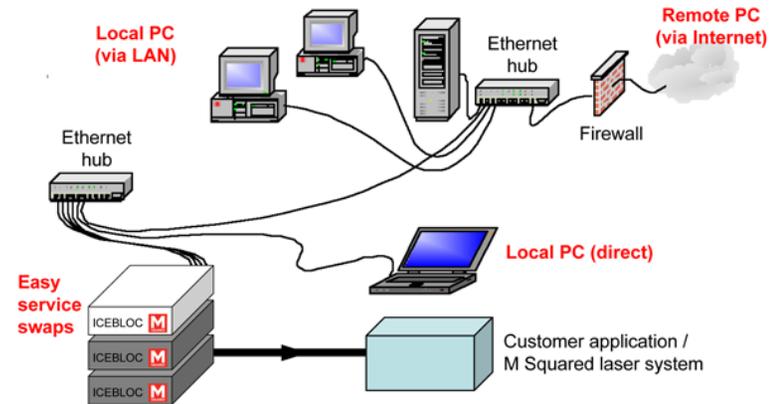
Parameter	Specifications
Output Voltage	+5 V
Current Limiting Resistor	360 $\Omega$

**Table 6 Emission LED output specifications.**

### 2.3 Controlling DD-TC

The DD-TC is controlled by M Squared Lasers' proprietary *ICE-BLOC*<sup>®</sup> photonic control platform, which allows users to communicate with *ICE-BLOC* modules via any standard direct/ LAN/ WAN/ Internet-based Ethernet connection.

The advantages of Ethernet control over more conventional communication protocols are many, making Ethernet control the best choice whether seeking to communicate with an instrument placed next to the control PC (direct cable connection), or remotely over very long distances (via an Internet connection). These many advantages include: higher speed; greater robustness; effectively infinite communication distance without the need for repeaters; elimination of dedicated software drivers (because control is via Web-based browser interface); and the ability to network multiplex multiple *ICE-BLOC* modules, providing simple system expansion and highly flexible control architectures.



**Figure 4 Illustration of the ICE-BLOC control concept.**

### 3 Controls, Indicators & Connectors

This section defines the user controls, indicators and connections of the DD-TC. If your system includes a laptop computer for Ethernet control of the DD-TC, information on the laptop can be found in the accompanying laptop's user's manual.

#### Controls

The module has an On/Off key control on the front panel, Figure 5. All other controls are via the web interface.

#### Indicators

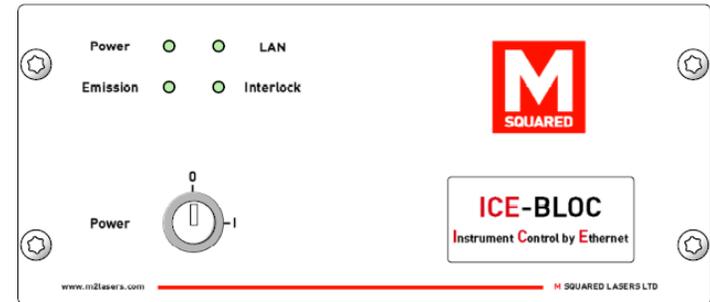
The module has the following LED indicators: Power, LAN, Emission and Interlock. The emission indicator is required by CDRH regulations and illuminates when the diode 'Start' button is pressed on the web interface. There is a delay (for laser safety reasons) before the laser will start. The laser diode current ramps up at a rate set by the user.

The emission indicator will be on if the diode drive channel is on and only goes off when stopped, or the Interlock becomes open circuit.

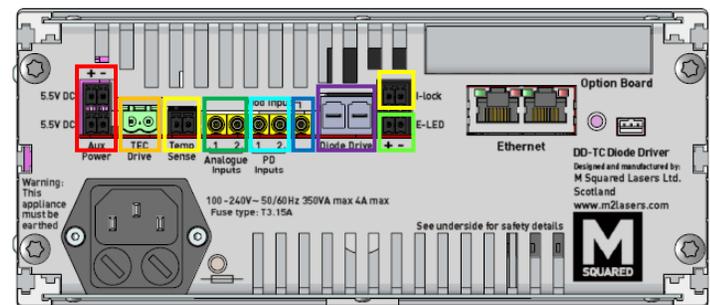
Table 7 shows the connections of the DD-TC.

Connector	Linking	Illustration	
5.5V DC	External power meters	Figure 6	■
TEC Drive	TEC/resistive heater	Figure 6	■
Temp Sense	Thermistor	Figure 6	■
Analogue Inputs 1-2	Analogue input	Figure 6	■
PD Inputs 1-2	Photodiode	Figure 6	■
Mod Input	Modulation source	Figure 6	■
Diode Driver	Laser diode	Figure 6	■
I-lock	Interlock	Figure 6	■
E-LED	Emission LED	Figure 6	■

**Table 7 DD-TC connections**



**Figure 5 DD-TC front panel**



**Figure 6 DD-TC rear panel**



Warning!

**Warning!** An active drive channel outputs  $\geq 1.2$  V with respect to ground. Do not connect any of the drive outputs to ground.

---

## 4 Installation

---



Note!

**Note!** If your system includes a laptop for Ethernet control of the DD-TC, please refer to the manual that accompanied your PC for information on its use.

---

### 4.1 Unpacking Your System

When you receive your system, please inspect the shipping containers immediately. If you discover any damage (holes or dents in the containers or crushing, for example) please notify the carrier immediately, and insist that a representative of the carrier be present to document the damage with you.

Please also be sure to inspect each system component carefully for damage as it is removed from its protective packaging. If you find any damage to system components (dents or scratches in covers, for instance), document this damage, and notify the carrier and M Squared Lasers (or your authorised distributor) immediately.

### 4.2 Installation – An Overview

There are no internal user adjustments needed or permissible in the DD-TC during normal operation.

It is strongly recommended that the instructions contained in the following sections are followed in sequence by the user, namely: start with an overview of general installation guidelines and precautions; review the basic principles of Ethernet control; install and prepare the DD-TC for Ethernet control; learn how to configure the module for Ethernet connection to a control laptop; and complete the installation of all other system components.

### 4.3 Preparing for Installation

In addition to the operating environment please consider the following factors and precautions when planning the installation and placement of your system:

- Avoid placing the system in an area subject to large (uncontrolled) temperature changes, or with high atmospheric particulate / dust / contaminant / moisture content - an air-conditioned laboratory environment is strongly recommended.
  - Avoid placing the system in an area subject to strong vibration.
  - Verify that the shorting plug for the interlock circuit on the DD-TC is in place or, if you are in a limited access laser safety area, remove the shorting plug and wire it to a perimeter safety switch. This switch must be wired so that the switch opens and laser output is terminated in the case of unauthorised/inadvertent access to the designated laser hazard area.
- 



Warning!

**Warning!** Attach all power cords first to the electronic instrument, then to the power source.

---



Warning!

**Warning!** All controllers for your system (e.g., ICE-BLOC modules, pump laser, laptop control computer) must always be positioned so that the laser-emission warning indicator on the pump laser head is <2m (< 6ft) away, and easily visible, from all of them. Failure to follow this instruction could result in a laser safety hazard for the user.

---



Warning!

**Warning!** Do not cover vents or restrict airflow around electronic modules. Allow at least 15cm (6 inches) of clearance on all sides to ensure proper cooling. Position all modules to prevent heated air exhausted from any unit returning to its own intake, or entering the intake of another unit.



Caution!

**Caution!** If a laptop was supplied with your system, it should be used only with your M Squared laser system and supplied web interface. Use of the laptop for any other purpose and/or with other software could corrupt your system control interface, which may cause system damage, result in a safety hazard, and void your warranty.

#### 4.4 Installing the ICE-BLOC DD-TC

1. Ensure that the interlock circuit is shorted. The interlock system is an Open/Closed system. For options for an active interlock system please contact M Squared Lasers.
2. Connect the red and black flying leads from the laser diode to the pluggable screw terminals on the Diode Drive channel taking care to observe the polarity.
3. Connect the required thermistor to the Temp Sense channel and TEC/resistive heater to the TEC Drive channel.
4. Connect an Ethernet cable to the DD-TC then to the laptop or Ethernet hub. See Appendix B for an overview of Ethernet.

#### 4.5 Factory Default Password Settings

Three password levels are provided. In order of increasing access privileges, these are:

**User** – user level accounts are designated for normal, everyday operation of the laser. These accounts can be accessed using a user or supervisor username/password, or by M Squared Lasers personnel.

**Supervisor** – supervisor level account can define and alter passwords, network settings, system firmware and safety-related parameters. These accounts can only be accessed using the supervisor username/password, or by M Squared Lasers personnel.

**Factory** – factory level accounts are for factory set-up only, and are accessible by M Squared Lasers personnel only.

Typical factory default settings for these passwords are given in Appendix A. The User Account page of the web interface is shown in Figure 12.

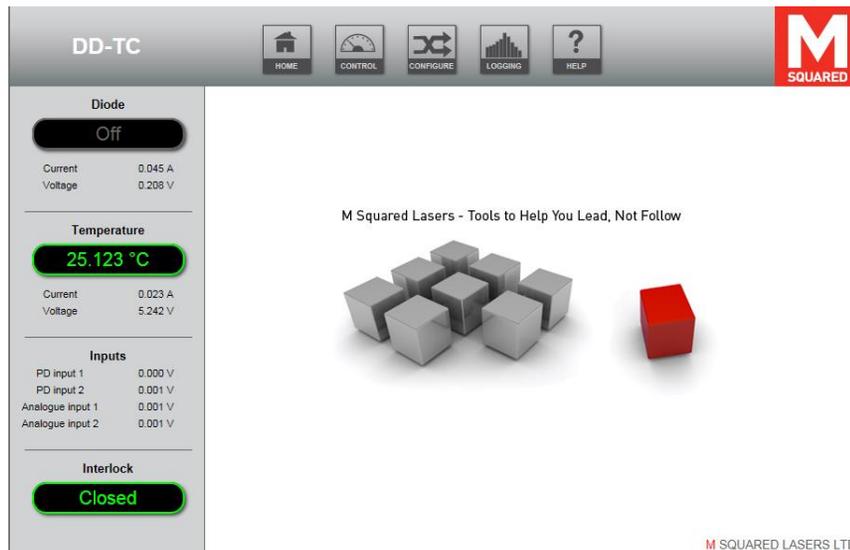
## 5 Laptop and Software User Interface



Caution!

**Caution!** Please refer to your laptop manual for all precautions, safety, operating and maintenance instructions for the laptop.

The DD-TC incorporates M Squared Lasers' proprietary Instrument Control by Ethernet (ICE) web interface, which enables the user to control modules current using a standard web browser. The HTML/JavaScript-based web interface is embedded in the on-board memory and may be accessed by connecting the module to a personal computer via any standard RJ45 cable/ WAN/ LAN/ Internet-based Ethernet connection.



**Figure 7** DD-TC web interface – Home page

The DD-TC software interface consists of a multi-page web interface (starting with the *HOME* page, Figure 7, which appears at software initialisation). Depending on the DD-TC & accessories you purchased, and your password access level and software revision, the number and content of your web interface pages may differ from those shown below.

The *HOME* page will appear when the browser has been successfully connected to the control unit. The navigation icons at the top of the *HOME* page may be used to access other web interface pages. The DD-TC is generally set up and controlled via the *CONTROL*, *CONFIGURE* and *LOGGING* pages (The *HELP* page is not currently used). A username and password will be requested on entering any page other than the home page; this password can be set to be either a user or supervisor level password by the system administrator (further details on password access levels may be found in Section 4.5). The panel on the left hand side of the *HOME* screen is used for status information, appears on several of the other web interface pages, and displays the following parameters:

**Diode On/Off** – Status of the diode driver channel

**Current and Voltage** – Output values of the diode driver channel

**Temperature** – The temperature of the external laser diode as measured by the DD-TC.

**Current and Voltage** – Output values of the temperature controller

**Inputs** – Reading of each photodiode and analogue input

**Interlock** – Interlock Status (Latched Open / Closed)

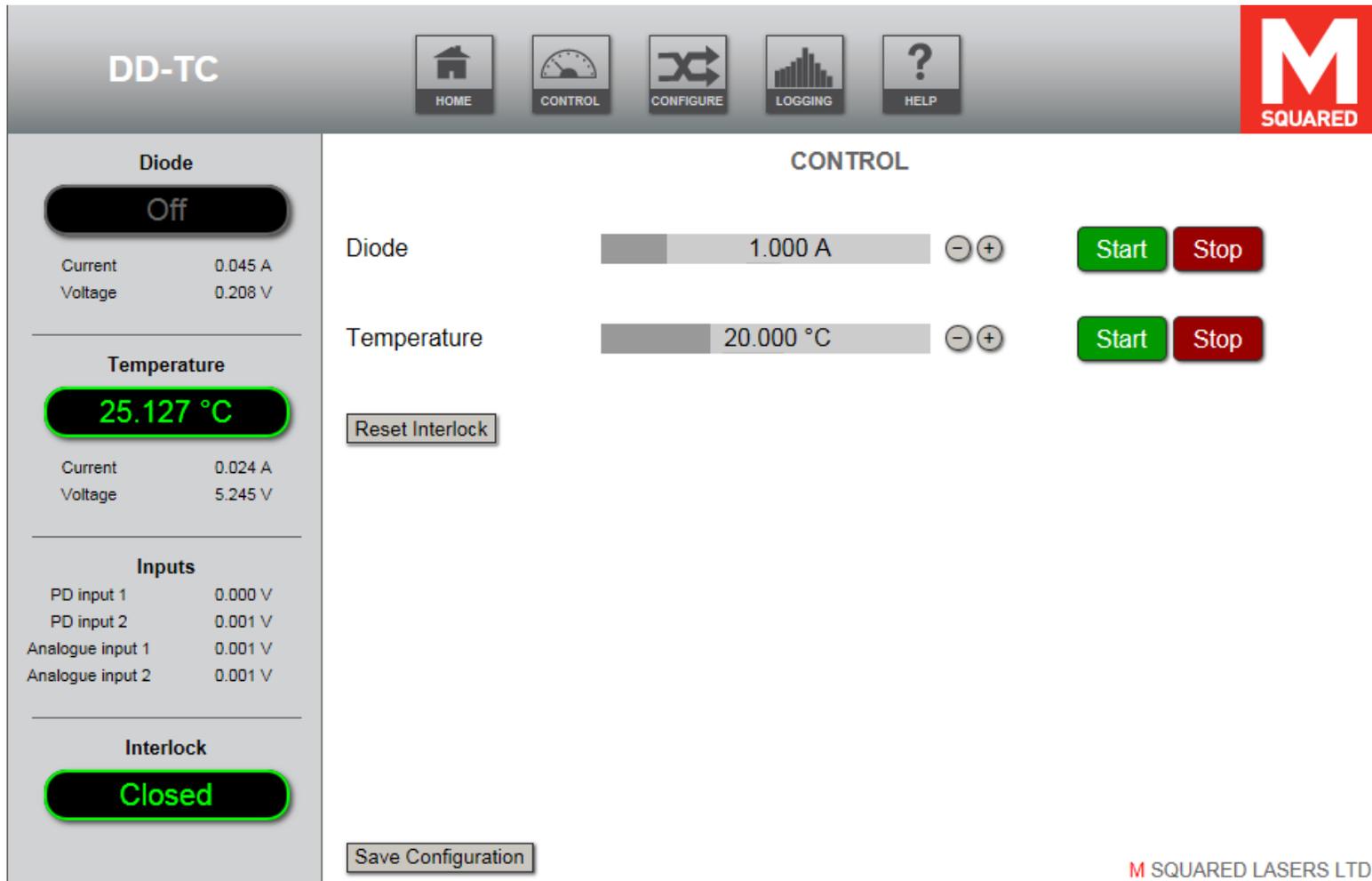


Figure 8 DD-TC web interface – Control screen page

Figure 8 shows the *Control* page of the web interface, accessed by selecting *CONTROL* from the top menu bar. This page allows the user to operate the module. Please refer to Section 6 for a more detailed description of the functions of this page and how to use them.

The *Configure* page accessed by selecting *CONFIGURE* from the top menu bar is shown in Figure 9. This page gives the User/Supervisor access to a number of the DD-TC settings, which are shown by Figure 10 to Figure 18.

The *Clock Set* page, shown in Figure 10, allows the User to set the time and date for the system. The time and date can be set using the buttons beside each element, or *Quick Initialise* can be used to derive the time based on the laptop controller's system clock. Click *Set Clock* to confirm the new time and date.

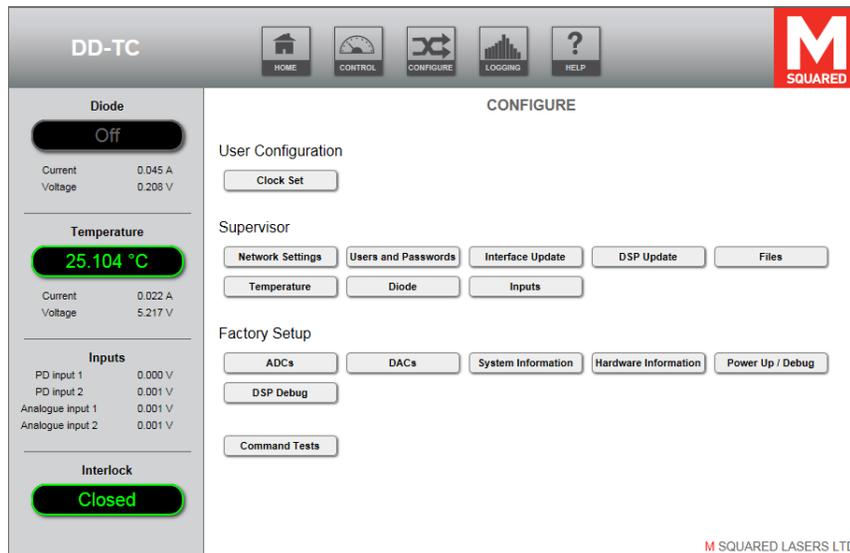


Figure 9 DD-TC web interface – System configuration page

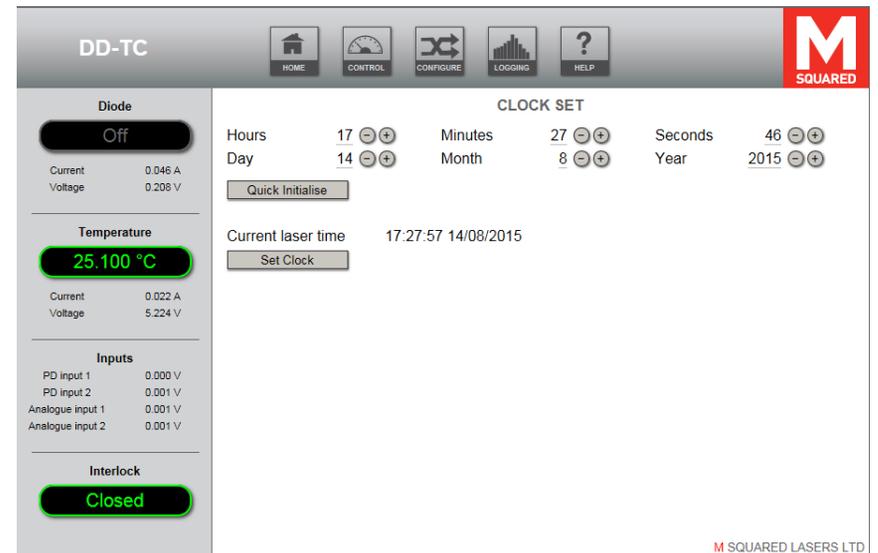


Figure 10 DD-TC web interface – Clock Set page

The *Network Settings* page, shown in Figure 11, allows the Supervisor to change the IP address of the DD-TC so that it can be connected to an existing network by entering new values then clicking *Save Configuration*.

A link can also be set up with external devices that can use a command set to control and/or retrieve the status of the DD-TC (contact M Squared Lasers for details of the command set). The IP address and port number of an external controlling PC can be entered in the *Remote Interface* boxes, and can be enabled/disabled by the corresponding buttons.

The *Users and Passwords* page, shown in Figure 12, allows the Supervisor to amend usernames and passwords and password timeout; changes are saved by clicking *Save Configuration*.

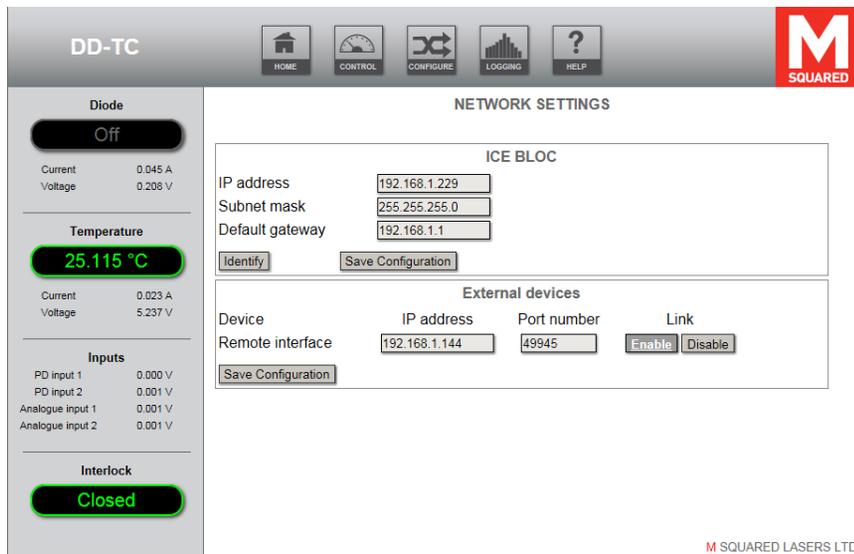


Figure 11 DD-TC web interface – Network Settings page

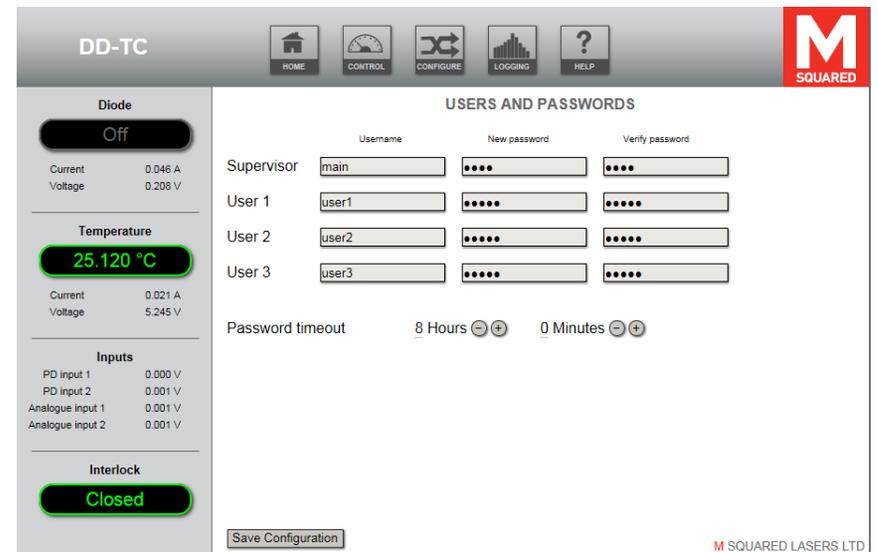


Figure 12 DD-TC web interface – User accounts setup page

The *Interface Update* page, shown in Figure 13, allows the Supervisor to update the interface firmware by selecting a file supplied by M Squared Lasers, by browsing to the file then clicking *Submit*.

The *DSP Update* page, shown in Figure 14, allows the Supervisor to update the DSP by selecting a file supplied by M Squared Lasers, by browsing to the file then clicking *Submit*.

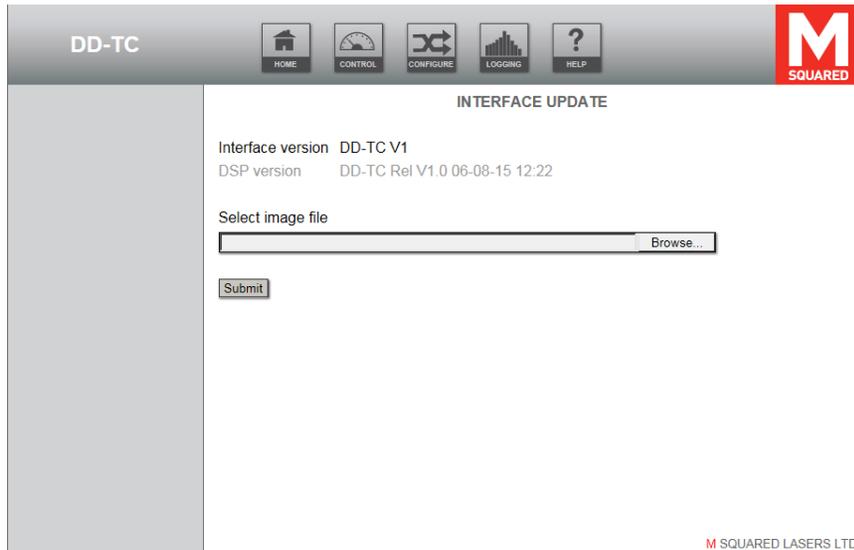


Figure 13 DD-TC web interface – Interface Update page

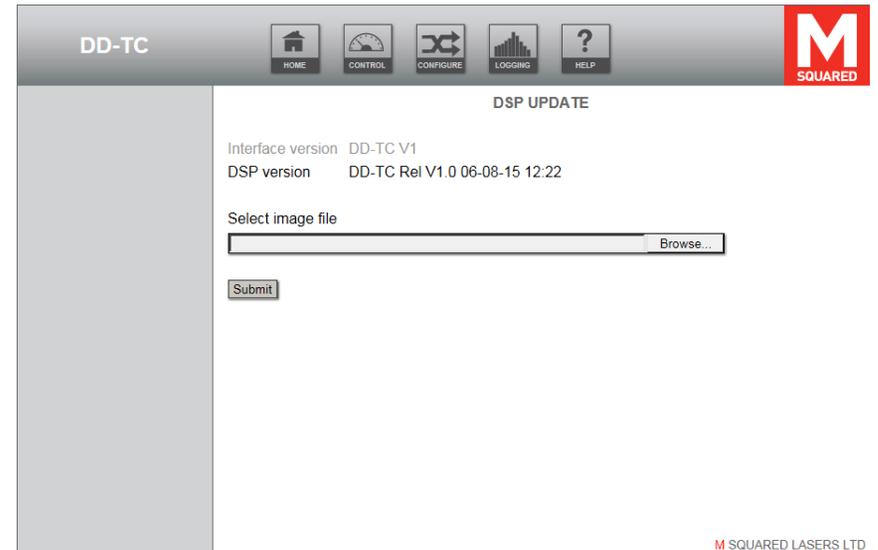


Figure 14 DD-TC web interface – DSP Update page

The *Files* page, shown in Figure 15, allows the Supervisor to manage files stored on the ICE-BLOC filestore. The *Factory* folder is not currently used on this system. The *Logs* folder contains any files captured during system logging if enabled. The *Sys\_Restore* folder contains configuration files used for storing and retrieving a snapshot of all settings across the system, and as such has additional *Save* and *Load* buttons to allow this. Files can be added from the connected computer's hard drive by clicking *Upload File*. Files can be saved to the connected computer's hard drive by right clicking a filename (not the icon) and selecting *Save Target As...*

System restore and logging files are tab-spaced text files, and can therefore be viewed in a spreadsheet program.

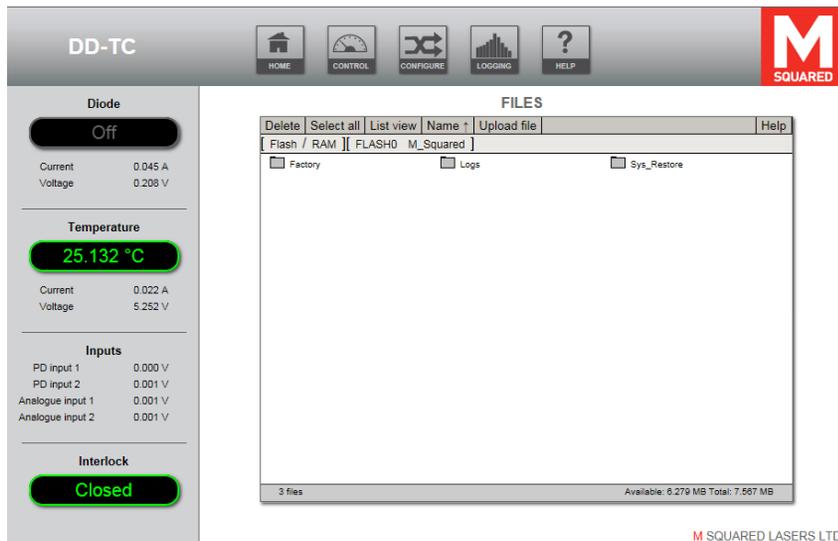


Figure 15 DD-TC web interface – Files page

The *Temperature* page, shown in Figure 16, allows the Supervisor to configure the drive, sensor and control loop options for the temperature control channel.

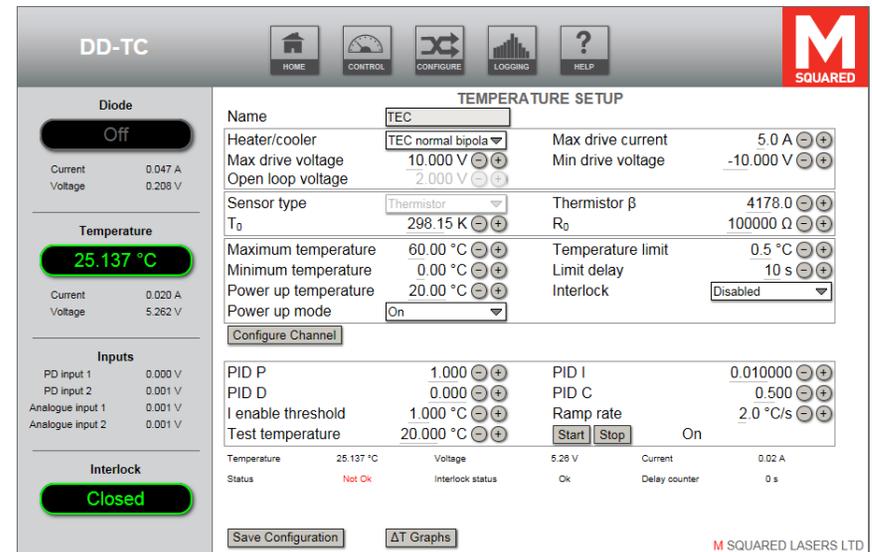


Figure 16 DD-TC web interface – Temperature Channel Setup

- Channel** Select channel for configuration.
- Channel name** Give the selected channel a descriptive name; this will appear in the status panel.
- Heater/cooler** Select drive type: *TEC normal bipolar*, *TEC inverted bipolar*, *Heating only*, *Cooling only* or *Open loop* (for fan drive etc.).

<b>Max drive current</b>	Set maximum/minimum output parameters for the selected channel; for TEC applications these values are bipolar.
<b>Min drive voltage</b>	
<b>Max drive voltage</b>	For low-resistance devices (e.g. thermoelectric coolers), it is advisable to set the maximum current to a safe low value. If the current output exceeds the maximum current set, the channel will shut down and a pop-up window will inform the user that an overcurrent event has occurred.
<b>Open loop voltage</b>	Set fixed voltage for open loop drive (only available when <i>Open loop</i> selected for Heater/cooler).
<b>Sensor Type</b>	Set sensor type. This is automatically set to <i>Thermistor</i> when <i>TEC</i> , <i>Heating</i> or <i>Cooling</i> is selected. For <i>Open loop</i> , this can be selected as <i>Thermistor</i> to show an associated temperature, or <i>None</i> to hide the associated field in the status panel.
<b>Thermistor <math>\beta</math>, <math>T_0</math>, <math>R_0</math></b>	Set thermistor parameters: see thermistor datasheet for these values unless this has already been configured by M Squared Lasers. Greyed out if <i>None</i> is selected for <i>Open loop</i> .

## Temperature Parameters

*Maximum / Minimum temperature* sets limits beyond which the channel will shut down.

*Temperature limit* sets a window around the set point and *Limit delay* sets a time duration window; when the measured temperature is outside the temperature limit range for the duration of the limit delay an out of range warning will appear.

*Power up temperature* and *mode* determine whether the channel should automatically drive the output to this temperature on power up (or if *open loop*, whether the output will enable at the selected voltage on power up).

*Interlock* is used to determine whether the channel's temperature out-of-range status can take action by shutting down the diode drive channel.

## PID Parameters

For closed loop channels, these parameters allow the supervisor to optimise the temperature control loop. A *Test temperature* setting and *Start / Stop* buttons are provided to allow control of the channel while optimising.

## $\Delta T$ Graphs

The  *$\Delta T$  Graphs* button opens a window with graphical traces of the temperature channel errors to assist with optimisation of the PID closed loop parameters.

The *Diode Setup* page, shown in Figure 17, allows the Supervisor to set the maximum drive current, ramp time, minimum / maximum permitted voltages and current sense trim of the module. The ramp time is the time taken by the module to reach the desired current.

The overcurrent and external interlock latches can be reset by clicking the appropriate buttons once the triggering conditions have been resolved.

The *Inputs* page, shown in Figure 18, allows the Supervisor to configure the channel names, gains, low/high calibration points and web interface units for both the photodiode and analogue inputs.

For the low calibration point, use an external measurement device (e.g. voltmeter, power meter) and set the signal to be measured to its lowest value. Take the measured value from the external device and enter it into the Low Calibration edit box and confirm by clicking the green tick box. Similarly, set the signal to be measured to its highest value and enter the measured value into the High Calibration edit box. Confirm by clicking the associated green tick box.

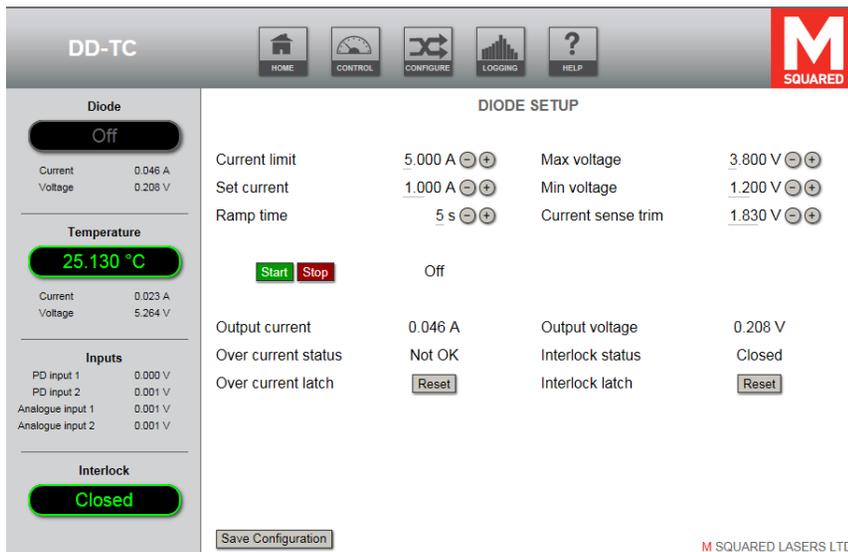


Figure 17 DD-TC web interface – Diode Setup page

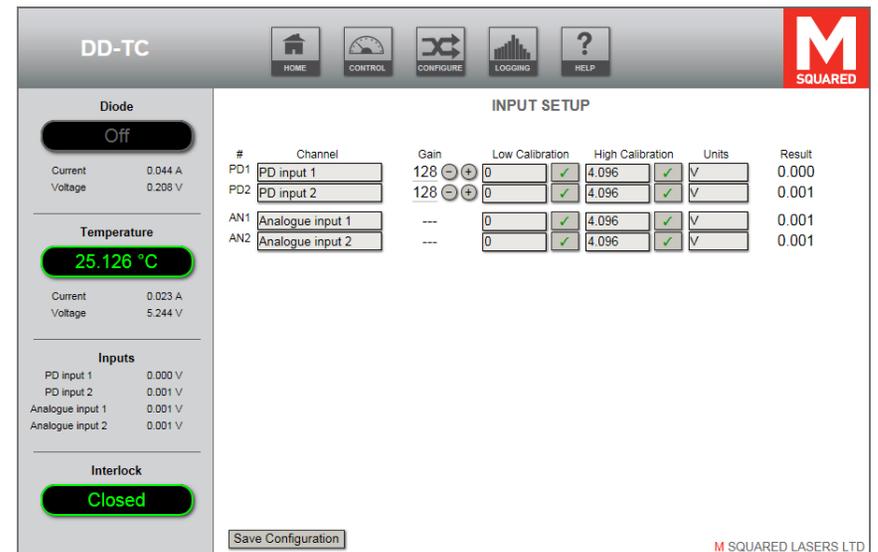
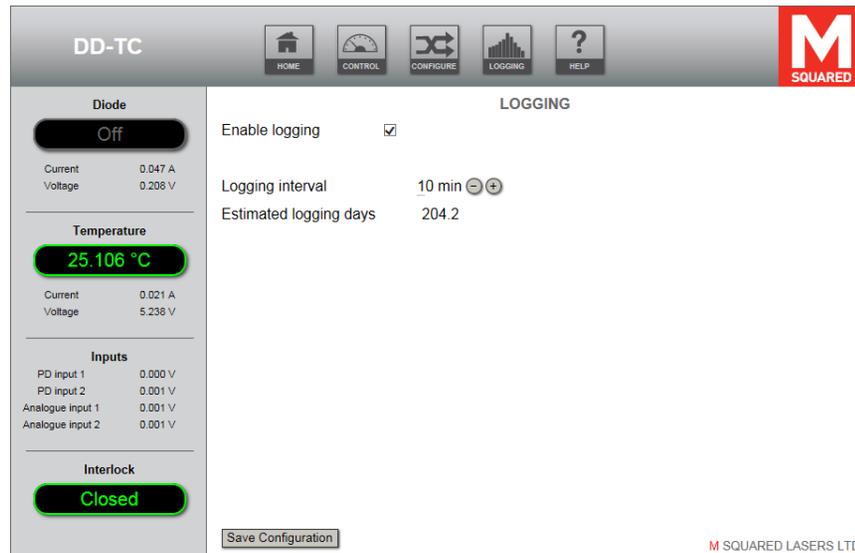


Figure 18 DD-TC web interface – Inputs page

The *Logging* page is shown by Figure 19, accessed by selecting *LOGGING* from the top menu bar. This page allows the user to configure logging of system parameters. Changes to logging options are saved by clicking *Save Configuration*.



**Figure 19** DD-TC web interface – Logging page

## 6 Operating the ICE-BLOC DD-TC



Caution!

**Caution!** Use of controls, adjustments or procedures other than those described in this manual may result in a hazard.

Before starting the module ensure that all suitable safety precautions have been taken.

### 6.1 Stopping the Diode Channels

The module will stop immediately on breaking the continuity of the external interlock circuit. The diode channel can also be stopped by pressing the associated red Stop button on the browser pages.

### 6.2 Starting from Complete Power Off Condition

1. If the temperature channel has not already been configured, ensure the cooler/heater is disconnected from the DD-TC before powering on to protect them from possible damage.
2. Turn on the DD-TC module.
3. Turn on any other components of your system.
4. Start up the laptop computer.
5. Open the web browser by clicking on the icon on the desktop of the computer.
6. In the web browser, enter the module's IP address (given on the rear of the unit) into the browser address bar.

7. Check that the external interlock circuit for the DD-TC is complete.

The user should now follow the instructions for module operation below.

### 6.3 Power Down

To power down the module, turn the front panel key switch to the 'Off' position.

### 6.4 DD-TC Operation

The following section gives a detailed description of the controls given in Figure 8.

The module allows the user to set the current for the diode drive channel shown in Figure 20. To alter the current output, the user should select a digit of the Diode value (depending on the magnitude of the change) and either use the current adjustment buttons or use the keyboard's up/down arrow keys to increment/decrement the digit. The left/right keyboard arrow keys can also be used to change the currently selected digit. Alternatively, by selecting the most significant digit, the current can be typed in using the keyboard numeric keys.

The temperature control is similarly adjusted to set the required temperature set-point.

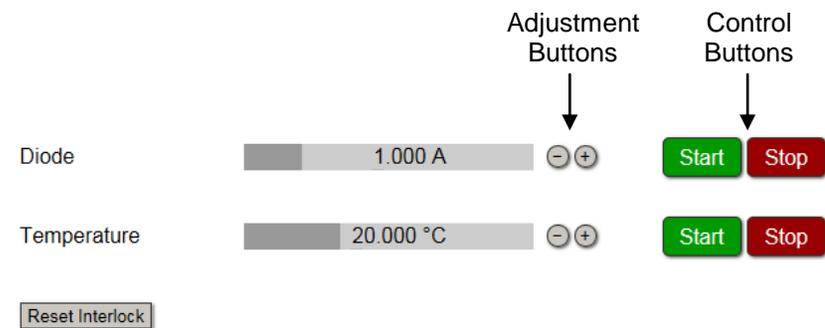
If the external interlock has been opened, ensure the operating area has been made safe and close the interlock. Click "Reset Interlock" to reset the latch.

The module is activated/de-activated by clicking on the corresponding *Start/Stop* Control button for the desired channel. The current and voltage being driven by the appropriate channel is displayed on the left

status panel.

When the diode drive channel is activated the associated Emission indicator on the left panel of the web interface will change to *Delay* and the Emission LED on the front panel (and, if fitted, the external emission LED controlled by the back panel) will flash for a few seconds. The Emission indicator will then change to *On* and the Emission LEDs will illuminate continuously.

If the module does not activate please refer to the troubleshooting guide in Section 7.1



**Figure 20** DD-TC web interface – Current and temperature control

## 7 Maintenance & Troubleshooting

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**Warning!** There are no user-serviceable parts inside the DD-TC. Removal of any covers will void your warranty.

---



**Warning!** Please refer to all information contained in all instruction manuals associated with your system. Failure to follow all instructions in these manuals may cause safety hazards, may damage your system, and will void your warranty.

---



**Note!** If, after consulting our manuals and reviewing the tips below you find you are unable to recover the specified performance of your system, please contact M Squared Lasers or your authorised representative using the contact information in Section 8.

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### 7.1 Troubleshooting Tips

Below is a check list to go through if the DD-TC fails when using the Control page of the web interface.

1. Is the interlock shorted on the DD-TC unit?
2. Are all the electrical connections made?
3. Is the Ethernet cable connected?
4. Is the DD-TC unit switched on?

If it is suspected that the IP address has been changed to something other than the address printed on the back of the unit, pressing the white button on the back panel for 5 seconds will reset the IP address to 192.168.1.222. The IP address can then be configured as required from the Network Settings page.



## 8 Customer Service

If you experience any difficulties with your laser system, require maintenance not described in this manual, require repairs, or if you have questions or concerns, please do not hesitate to contact M Squared Lasers Ltd or your authorised representative:

### **Contact Details:**

#### **M Squared Lasers Ltd.**

1 Kelvin Campus,  
West of Scotland Science Park,  
Maryhill Road,  
Glasgow,  
G20 0SP,  
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Tel: +44-(0)141-945-0500  
Fax: +44-(0)141-945-0505  
E-mail: [mail@m2lasers.com](mailto:mail@m2lasers.com)  
Web: [www.m2lasers.com](http://www.m2lasers.com)

#### **M Squared Lasers Inc.**

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Fax: +81-3-6278-9480  
E-mail: [sales@oceanphotonics.com](mailto:sales@oceanphotonics.com)  
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Web: [www.pulsepower.cn](http://www.pulsepower.cn)  
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Tel: +86-27-87807925  
+86-27-87170152  
+86-27-87412681  
Fax: +86-27-87807133  
E-mail: [sales@etsc-tech.com](mailto:sales@etsc-tech.com)  
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Tel: +65-6565 7300  
Fax: +65-6565 7005  
E-mail: [sales@acexon.com](mailto:sales@acexon.com)  
Web: [www.acexon.com](http://www.acexon.com)

## 9 Warranty

This Warranty supplements the warranty contained within the sales order specific to your purchase of this laser system. In the event of a conflict between documents, the terms and conditions of your sales order shall prevail.

This Warranty applies only to products manufactured by M Squared Lasers Ltd (hereinafter referred to 'M Squared'.) This Warranty does not extend to any third-party accessories purchased with or used in conjunction with M Squared products, such as pump lasers or wavemeters. The warranty for all third-party accessories supplied with M Squared products is provided by the manufacturer of those products – please inquire.

The warranty period for the system you have purchased is for 1 year from the date of shipment, or 2000 hours of operation, whichever comes first. This Warranty extends only to the original purchaser and is not transferable. Optional extended warranty calendar periods and/or extended warranty hours for M Squared products are available for purchase – please inquire.

During the warranty period, all mechanical, electronic, and optical parts and assemblies are warranted to be free of defects in workmanship and material. Liability under this warranty is limited to repairing, replacing, or giving credit of an amount up to and including the purchase price of any equipment that proves defective during the warranty period, provided prior authorisation for such return has been given by an authorised representative of M Squared. Any repairs or replacement equipment is then warranted only for the remainder of the original warranty period that is applicable to the repaired or replaced items. All exchanged parts and products replaced under this Warranty will become the property of M Squared.

This Warranty is valid only if M Squared products are assembled, installed and operated according to the instructions included with the products. This warranty is void if the product is subjected to any of the following mistreatment:

- Any deviation from the installation, operating and maintenance instructions provided with the system.
- Opening or modifying the product.
- Operation in any hostile environment outlined in the instructions.
- Any substantial mechanical shock.
- Any damage caused by static discharge (this will not occur under normal operation).
- Any damage due to operation in unclean environments.

The definition of mistreatment in its applicability to the warranty is at the reasonable discretion of M Squared.

Except as expressly set forth in the Warranty, M Squared makes no other warranties, expressed or implied, including any implied warranties of merchantability and fitness for a particular purpose. M Squared expressly disclaims all warranties not stated in this Warranty. Any implied warranties that may be imposed by law are limited to the terms of this Warranty. Neither M Squared nor any of its affiliates shall be responsible for any incidental or consequential damages. Some jurisdictions do not allow limitations on how long an implied warranty lasts or the exclusion or limitation of incidental or consequential damages, so the above limitations or exclusions may not apply to you.



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## Appendix A: Additional Information

Supervisor user name:       main  
Supervisor user password:    main

User accounts can access key, commonly needed control pages only:

User 1 name:                user1  
User 1 password:           user1

User 2 name:                user2  
User 2 password:           user2

User 3 name:                user3  
User 3 password:           user3

## Appendix B: Ethernet Overview

The DD-TC ICE-BLOC connects using Ethernet allowing it to be controlled and monitored using a standard web browser as well as allowing ICE-BLOCs to communicate with each other.

Every device on a network requires a unique identifying address. This is provided in different levels, the lowest of which is the Media Access Controller address (MAC). The MAC address is unique to every individual network-connected device and is comprised of six pairs of hexadecimal digits (0-F). This is set at the hardware level—often coded into memory—and is not (usually, nor intended to be) changeable by the user.

Although unique, the MAC address alone is not convenient for network administration because in a large network there could be many devices, all of which will have completely random, but unique, MAC addresses. To make it easier to manage a network and to provide some structure to it, an IP (Internet Protocol) address superimposed on top of the MAC address. In IPv4 this is comprised of four groups of three decimal numbers in the range 0-255. An IP address is mapped on to a MAC address using the web interface of the networked device, be it a computer, printer, server or M Squared *ICE-BLOC* module. When two devices have been assigned IP addresses they can start to talk to each other over a TCP/IP network, including the Internet. The IP address becomes the externally visible address of the device on the network, rather than the MAC.

When a computer is plugged into a network, it will have a MAC address, but commonly it will not already have an IP address. Through a standard process called DHCP (Dynamic Host Configuration Protocol) the computer requests an IP address from a DHCP server, which (assuming all security requirements are met) will automatically issue an IP address to the computer, which it will keep until removed from the network for a period of time. The DHCP server keeps a record of the MAC address of every device connected and the IP address assigned to that device.

It is possible to set a fixed IP address for a computer or other network device, although this can result in the assigned name being the same as another device. This could potentially result in communications problems if a device with a fixed IP address is added to an extensive network, but using fixed IP address is not unusual practice if the device is connected directly to a PC, or is added to a small, secure and/or safety-critical network.



Note!

**Note!** The DD-TC ICE-BLOC module that was shipped was factory pre-configured with fixed IP addresses. This means that it can be connected and powered up without the need for a network connection.

If a PC and a network device are to be connected directly together the network rules discussed still apply. As there is no network or DHCP server between the PC and network device in this case, the PC will not be automatically assigned an IP address, so will not be able to communicate with the network device automatically. To resolve this, the PC must be given a fixed IP address if it is to control the network device.

## Appendix C: PID Optimisation Procedure

The following process is used to optimise the PID parameters of the temperature channel for the specific application.

1. Before connecting anything to the temperature channel, check the electrical parameters in the datasheet of the thermoelectric heater/resistive heater to be used. Go to the “Temperature” page under the “Configure” tab and ensure the following parameters for Channel 0 are appropriately set to the datasheet values to avoid accidental damage to the device:
  - Max Drive Current
  - Max Drive Voltage

Click on “Configure Channel” to save the changed settings.

2. Click the “Stop” button on each channel and confirm that each channel is Off.
3. Connect a thermistor and thermoelectric cooler/resistive heater to the temperature channel drive. Select the appropriate temperature channel and choose the device type from the *Heater/Cooler* dropdown box.
4. Enter the following values into the PID parameters:
  - P = 1.000
  - I = 0.000
  - D = 0.000
  - C = 0.5 (this parameter is not used in optimisation)
  - I enable threshold = 1°C
  - Ramp rate = 1°C/s

5. Setting the I enable threshold setting as above means the Integral term is enabled when the error becomes less than 1°C. The I enable threshold setting holds the Integral term at zero until the error is low to avoid the Integral term winding up.
6. Once the temperature has settled, enter a Test Temperature several degrees away from the ambient temperature (typically 5°C lower for a TEC, 5°C higher for a resistive heater) and Start the channel.
7. Click on the  $\Delta T$  Graphs button. Check if the error falls to within 1°C without oscillating. Use the mousewheel to zoom in on the Y-axis if necessary.
8. If the error is more than 1°C, increase the value of P. If the error oscillates or overshoots, reduce the value of P.
9. Continue iterating the changes in P while stepping the Test Temperature up and down until the error is within 1°C and does not overshoot or oscillate.
  - If the error cannot be reduced to within 1°C using the P term then increase the I enable threshold to the achievable error signal.
10. Change the I parameter to 1/100<sup>th</sup> of the final P value and repeat the iterative Test Temperature procedure. Increase I until the error oscillates then decrease it until the I value is approximately half this value. Adjust P slightly if necessary.
  - The final error is dependent on the temperature control setup, but typically falls within 1mK for small tightly coupled systems.

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11. Further optimisation can be performed by setting the D parameter to  $1/10^{\text{th}}$  of the value of I. This speeds up the initial response of the control loop to a temperature demand. Monitor the speed at which the loop settles while adjusting D.
  12. When the PID loop has been optimised, Stop the channel and set the Ramp rate to a value appropriate to the system being controlled. This sets the rate at which the system will ramp from one temperature setting to another.