MSEL Competition & Development Electronics

Master Relay User's Manual

For Professional and Club Master Relays

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Contents

Description

The MSEL Master Relay Club and Professional battery isolators have more than safety in mind. They have been primarily designed for the motorsport environment, and can be used in many other applications running between 12 & 24V. Utilising solid state switching components, the Master Relay has excellent temperature resistance. The aluminium enclosure is lightweight and robust even in the harshest motorsport environment.

The Master Relay features built-in engine shutdown functionality in accordance with FIA Regulations. It also incorporates alternator load dump protection unavailable on most rival devices. This helps to avoid damaging voltage spikes often seen when disconnecting the battery source whilst the alternator is still charging.

The Master Relay can safely shut down the vehicle under a number of different events including: external kill switch press, over current / short circuit, over temperature. It can even be shut down via a remote CAN message. For example, in the event of a severe impact or an overturned vehicle.

When connected to a data logger on a CAN bus, the Master Relay provides valuable information about the current, voltage, internal temperature, and diagnostic information that makes finding problems a lot easier. Alongside transmission to a data logger, the Master Relay features a multi-coloured LED that shows a unique colour combination for each of the 10 different states. The driver switch can also be connected to an LED to indicate when the battery is isolated.

Difference Between Pro & Club Relays

The only difference between the Professional and Club Master Relays is the connection interface. The Professional relay features a motorsport connector (8STA6-04-06SN), while the Club relay has a 6-wire flylead (no connector). This can be easily differentiated throughout this User's Manual as the Professional unit is associated with pins, while the Club unit associated with wire colours.

It is important to note that all units from and including serial number 64666 (Firmware 2.0F) have additional technical information. This is specified where relevant.

Safety Precautions

This manual provides vital information for the safe and desired installation of the MSEL Master Relay.

Please ensure you are familiar with the entire installation process before installing this device into your car.

Failure to comply with these instructions could damage the Master Relay or other components in the vehicle.

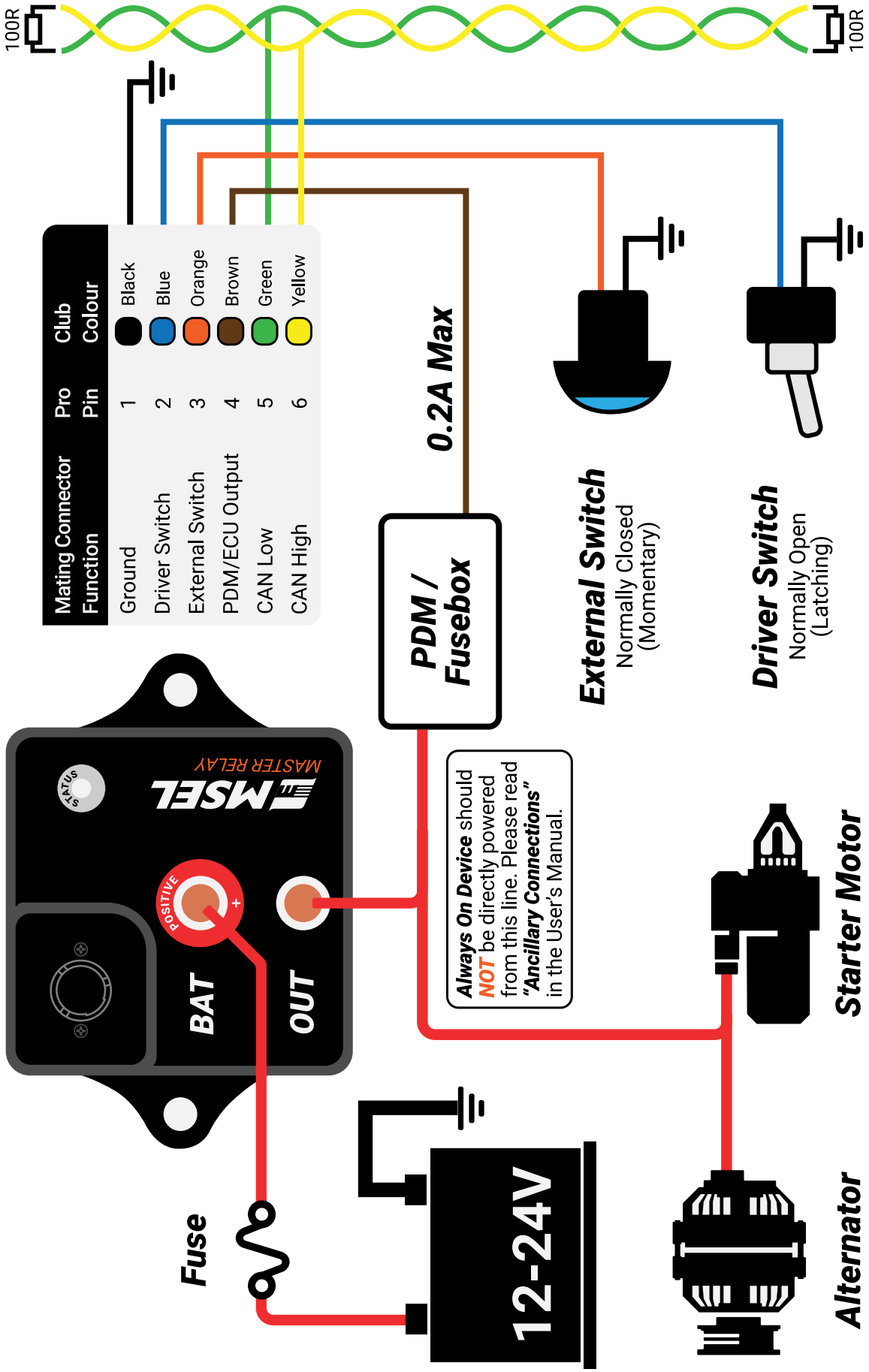
The Master Relay must be completely disconnected before any welding is conducted on the installed vehicle.

The Master Relay must always have the PDM / ECU output connected to a system for correctly shutting the engine down (i.e. ignition system). Failure to do so could damage not only the Master Relay but also other electronics devices connected in the vehicle such as Engine Control Units, displays and control units.

While all efforts are made to ensure the accuracy of the information in this manual, no responsibility will be taken for the consequences of any omissions in this manual.

Master Relay Connection Diagram

Figure 1: Connection Diagram



Master Relay Installation Steps

Before installation, it is essential to read the entire user's manual thoroughly. The manual contains critical safety information, wiring diagrams, tables, and procedures to ensure a safe installation. Familiarising yourself with the manual helps prevent costly mistakes, protects both the relay and your vehicle's electronics, and ensures that all safety features function as intended.

Preparation

- ☐ Disconnect the vehicle battery before starting any installation.
- ☐ Read the safety precautions in the manual.
- ☐ Ensure you have all required parts and tools.

Mounting the Relay

- ☐ Choose a flat, well-ventilated location away from fluids and high vibration as close to the battery as practical.
- ☐ Use the supplied anti-vibration mounts.
- ☐ Secure the relay using M6 hardware; torque nuts to 3.0 Nm.
- ☐ The spacing is 84 mm.

Ground Connection

- ☐ Connect ground first:
  - ☐ ***Pro:*** Pin 1
  - ☐ ***Club:*** Black wire
- ☐ Do not connect 12 V cables until ground is connected.

High-Current Wiring

- ☐ Connect the battery terminal (M6 stud) to the battery positive, using a short cable.
- ☐ Install a fuse between the battery and relay.
- ☐ Connect the output terminal (M6 stud) to the vehicle's positive power supply.
- ☐ Ensure all cables are insulated and have strain relief.
- ☐ Do not power high-inrush devices directly from the relay. Use a Power Distribution Model / Unit channel or external relay.

Low-Current / Interface Connector Wire

- ☐ Wire the connector as follows (Club wire colours in brackets):
  - ☐ Pin 1: Ground (Black)
  - ☐ Pin 2: Driver Switch (Blue)
  - ☐ Pin 3: External Switch (Orange)
  - ☐ Pin 4: PDM/ECU Output (Brown)
  - ☐ Pin 5: CAN Low (Green)
  - ☐ Pin 6: CAN High (Yellow)
- ☐ Use 30–24 AWG wire for the connector (Pro Only).
- ☐ For custom harnesses, ensure the pinout is correct and the connections are secure.

Switch Connections

- ☐ Driver Kill Switch:
  - ☐ Latching type (toggle or push button)
  - ☐ One side to Pin 2 (blue), other to ground
  - ☐ Optional: Add LED indicator as per manual
- ☐ External Kill Switch:
  - ☐ Momentary, normally closed (NC)
  - ☐ One side to Pin 3 (orange), other to ground
  - ☐ If not used, permanently connect Pin 3 to ground
  - ☐ Multiple external switches can be wired in series

PDM / ECU Output

- ☐ Pin 4 (brown) provides logic output for engine shutdown (max 200 mA).
- ☐ Configure output drive as required (see manual for options).

CAN Bus Connection

- ☐ Connect CAN Low (Pin 5, green) and CAN High (Pin 6, yellow) to the vehicle CAN bus.
- ☐ Ensure 120 Ω termination resistors at both ends of the CAN bus.
- ☐ Default settings: 1 Mbps, 10 Hz update rate, base address 0x6E4/0x6E5.

Final Checks

- ☐ Double-check all connections for correct polarity and secure mounting.
- ☐ Ensure all wiring is insulated and protected from abrasion.
- ☐ Reconnect the vehicle battery.
- ☐ Power up and check LED status indicators for normal operation.

Testing

- ☐ Test driver and external kill switches for correct operation.
- ☐ Verify CAN communication with data logger or ECU.
- ☐ Confirm engine shutdown and battery isolation functions.

Safety Reminders

Disconnect the Master Relay before welding
Never disconnect ground while powered.
Do not power high-inrush loads directly from relay output.
Use correct fuse rating and cable sizes.

Installation

Mounting

The MSEL Master Relay has two tags designed for mounting the device to a flat surface. The spacing between the mounting holes is 84mm (see *Drawing* for details). The rear cover can be unscrewed and rotated 90 deg if necessary. The location of the Master Relay, as well as the total current load, can have significant effect on its internal temperature. Some air flow is essential. Although the Master Relay is robust, consideration should be given to minimise heat and vibration exposure when choosing a mounting location. The supplied anti-vibration mounts are suggested to isolate some of these effects. **Do not** mount in a high vibration area (i.e. on a differential mount). **Do not** mount where there is a chance of fluid coming into contact with the Master Relay.

Electrical Connection

The Master Relay is connected between the positive terminal of the battery and the rest of the vehicles positive power supply. The device should be positioned as close to the battery as possible, keeping the positive lead as short as you can. See the *Connection Diagram* for a typical installation.

A fuse is recommended between the battery and the relay (see *Figure 1*).

IMPORTANT: Read Before Install

The ground connection must be made before connecting the battery and output terminals.
Do not connect 12V cables until Pin 1 (*Pro*) or Black Wire (*Club*) is connected to ground.
Do not disconnect the ground wire without first removing the battery cable.
Do not disconnect the ground while the Master Relay is operational.

Power Studs

The battery and output terminals are copper plated steel M6 studs. Care should be taken to ensure that cables are insulated from the housing and neighbouring studs. The recommended torque for the nuts is 3.0Nm. It is recommended to use the supplied nut caps with insulated battery cable lugs. For maximum protection, rubber insulating boots can be used on each stud. Ensure that the cables have adequate strain relief to minimise stress on the studs. Ensure the battery cables are properly restrained to reduce stress on the studs.

External Battery Connection / Charging

External / jump batteries should be connected to the battery side of the device to avoid unwanted powering of the vehicle. Any battery chargers should also be connected directly to the battery side of the device.

Ancillary Connections

Any device that draws current immediately when powered, such as headlights or fuel pump, **should not** be directly powered from the Output Terminal of the Master Relay. These devices must be powered via a relay or PDM / PDU, to prevent triggering the over current device startup protection. See the *Troubleshooting* section for further information.

Interface Connector

The mating connector for the Pro version (Souriau 8STA6-04-06SN) can be purchased individually for custom installs or a breakout harness with a DTM connector is available for generic installs. On the Club version, these are 24AWG fly leads to which you can fit your own connector.

Table 1: Interface Connector Pinout

Pin (Pro)	Function	Colour (Club)
1	Ground	Black
2	Driver Switch	Blue
3	External Switch	Orange
4	PDM / ECU Output	Brown
5	CAN Low	Green
6	CAN High	Yellow

Table 1 shows the pinout along with standard wiring colours supplied with the breakout harness. For those making a custom harness, the Souriau connector has #26 terminals, and it can accept 30AWG through to 24AWG wire.

Switch Connection

The Master Relay has two switches, the driver kill switch and an external switch.

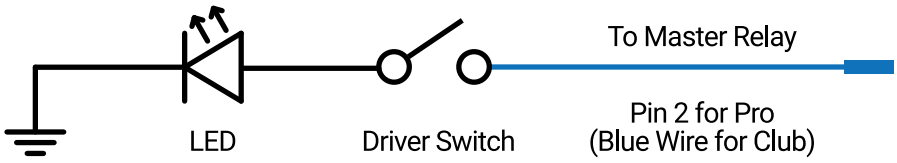
Driver Kill Switch

The driver kill switch is generally operated from within the vehicle and is the main control for the battery isolation. Generally, just a single driver kill switch is used. However multiple switches can be wired as shown in *Figure 3*, the extra switch could be hidden and used as an additional security measure.

Wiring of the driver kill switch is carried out as shown in the *Connection Diagram*. The switch used should be of a latching type (either toggle or push button). When the switch is in the off position there should be an open circuit between the two terminals. One side of the switch connected to the Pin 2 (blue wire) of the Master Relay Interface Connector, and the other side to the ground.

A LED can be added to the circuit as shown in *Figure 2*. This LED will be ON solid when the device is in the normal state, flash when the battery is isolated by Master Relay and be turned off when the driver switch is off. A 5V LED with a 5-30mA current draw is suitable.

Figure 2: LED indicator wiring



External Kill Switch

The external kill switch allows remote triggering of the Master Relay. It is often mounted on the exterior of the vehicle and indicated by a red lightning bolt on a blue triangle. Multiple external switches can be wired as shown in *Figure 3*. If an external switch is not required, Pin 3 (orange wire) of the Master Relay connector should be permanently connected to ground.

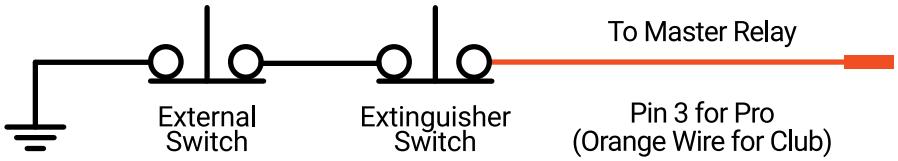
Wiring of the external kill switch is carried out as shown in the *Connection Diagram*. The switch should be a momentary non-latching type with a normally closed (NC) configuration. When the switch is pressed there should be an open circuit across the switch. One side of the switch is connected to Pin 3 (orange wire) of the Master Relay Interface connector, and the other side to the ground.

There is an option to have a latching external switch which operates the same as the Driver Kill Switch (no LED functionality) from S/N 64666 (Firmware: 2.0F) with black torx drive screws on the top of the unit.

Multiple Switches

Multiple external kill switches can be connected in series provided that when all switches are in the 'ON' position there is continuity between the input to the Master Relay and ground. When any switch is in the 'OFF' position the connection to ground should be open circuit. *Figure 3* shows a typical multiple switch configuration.

Figure 3: Example multiple external switch configuration



PDM / ECU Connection

Pin 4 (brown wire) of the Master Relay connector provides a logical output for a PDM / ECU allowing engine shutdown functionality in accordance with FIA regulations. The drive of this output can be configured in the combinations shown in *Table 2* below. The device ships standard with configuration 0 (active high, half bridge). In this configuration when the Master Relay is in an 'On' or 'Normal' state the output is connected to the battery supply, and when 'Off' the output is connected to ground.

Table 2: PDM / PDU output drive configurations

Active State	Output Drive	Config.	Output 'On'	Output 'Off'
High	Half Bridge	0	$V_{battery}$	GND
	Low Side	2	-	GND
	High Side	1	$V_{battery}$	-
Low	Half Bridge	4	GND	$V_{battery}$
	Low Side	6	GND	-
	High Side	5	-	$V_{battery}$

In order to change the output drive to one of the other configurations please refer to section *Changing the PDM Output Drive Configuration*, or specify your requirements when purchasing.

The PDM / ECU output is short circuit protected and current limited to 200mA. To drive larger loads, an external relay is required.

CAN Bus Connection

To receive status and channel information from the Master Relay it must be connected to a compatible device on the same CAN bus. Examples of these include a data logger, dash display, or ECU. The Master Relay transmits two messages with a configurable base address and is compatible with most CAN capable data loggers on the market. For further information on the format and transmission refer to the *CAN Communications* section.

The Master Relay does not have any internal termination resistors and therefore requires 120Ω termination resistors at each end of the CAN bus.

A .dbc CAN database file is available at msel.co.nz that can be imported into supported devices.

The latest version has additional messages from unit S/N 64666 (Firmware: 2.0F) onward, identifiable with black torx drive screws on the top of the unit. Refer to *Table 7* and *Table 9*.

Master Relay States

LED Indicator States

Table 3 below shows the corresponding states for each possible colour code displayed on the status LED.

Table 3: LED indicator states

Status	LED Colour		Status Enumeration	Warnings Bit Mask
Normal	✱	Green	1	-
Normal (CAN Error)	✱/✱	Green Flashing		
Over Temperature Warning	✱/✱	Blue Flashing	2	0x01
Over Current Warning	✱	Yellow	3	0x02
Low Voltage Warning	✱/✱	Green/Blue Flashing	4	0x04
High Voltage Warning	✱/✱	Green/Red Flashing	5	0x08
Over Temperature Kill	✱/✱	Blue/Red Flashing	6	0x10
Driver Switch Kill	✱	Red	7	0x20
External Switch Kill	✱/✱	Red Flashing	8	0x40
CAN Trigger Kill	✱	Blue	9	0x80
Power On Reset	✱	Purple	10	-

Battery Connected

✱ Normal Operation

The battery is connected to the output and the device is operating normally.

✱/✱ Normal Operation (CAN Error)

The device is operating normally; however, the CAN bus has been unresponsive for more than 2 transmission cycles. CAN communications have been disabled until the CAN bus is back online (this is checked every 5 seconds).

✱/✱ Low Voltage Warning

The device voltage has dropped below the lower warning limit (7V). The device will try to continue to function normally, however the voltage is getting close to the device limits. This should be remedied to avoid undesired performance and / or potential damage. Once the fault is remedied the device will automatically return to Normal Operation.

✱/✱ High Voltage Warning

The device voltage has exceeded the upper warning limit (28V). The device will try to continue to function normally, however the voltage is getting close to the device limits. This should be remedied to avoid undesired performance and / or potential damage. Once the fault is remedied the device will automatically return to Normal Operation.

✱/✱ Over Temperature Warning

The device temperature has exceeded the warning temperature (90°C). The device will continue to function normally; however, the temperature is getting close to the device limits. This should be remedied to avoid undesired performance and / or potential damage. Once the fault is remedied the device will automatically return to Normal Operation.

Battery Isolated

✱ *Driver Kill*

The driver kill switch has been turned off or the connection has broken. The battery is isolated, and the indicator will be solid red. The device will remain in this state for 30 seconds before entering a *Power Saving Mode*. To return to the normal operation, the device needs to be reset (see *Resetting the Device*).

✱/✱ *External Kill*

The external kill switch has been triggered or the connection has broken. The battery is isolated, and the indicator will be flashing red. To return to the normal operation, the device needs to be reset (see *Resetting the Device*).

✱ *CAN Kill*

A CAN message has triggered shutdown. The battery is isolated, and the indicator will be solid blue. See *CAN Shutdown* for further details on the CAN kill function. To return to the normal operation, the device needs to be reset (see *Resetting the Device*).

✱/✱ *Over Temperature Kill*

The device temperature has exceeded the maximum allowed temperature (110°C). The battery is isolated, and the indicator will be flashing blue. Once the fault is remedied the device will automatically return to normal operation.

✱ *Power On Reset*

The device has been powered on while the Driver & External switches were both on. The battery remains isolated and the indicator will be solid purple. To return to the normal operation, the device needs to be reset (see *Resetting the Device*).

✱ *Over Current Kill*

The device current has exceeded the maximum allowed current. The battery is disconnected, and the indicator will be solid yellow.

Check for any short circuits between the output terminal and the chassis ground. Once the fault is resolved, to return to the normal operation, the device need to be reset (see *Resetting the Device*).

Resetting the Device

To reset the Master Relay, switch off the driver kill switch, wait a few seconds, then switch it back on.

Once the device has been triggered by the external kill, driver kill, CAN kill or over-current kill, the device will remain in the off state until reset. The LED indicator will show the current fault, as outlined in the *LED Indicator States* section. Once the fault has been remedied the device can be reset by cycling the driver kill switch off and then back on.

Load Dump Protection

The Master Relay has on board circuitry that will help protect sensitive electronic devices in the event of a shutdown during engine operation. The PDM / ECU output will be turned off immediately therefore stopping the engine. However, the battery is not disconnected until the alternator is no longer charging. This avoids the situation where the alternator may still be generating as the battery is disconnected, resulting in voltage spikes as large as 120V that can damage sensitive electronic components.

The Master Relay has a 5 second timeout where by even if for some reason the battery is still being charged it will be disconnected regardless. This can be extended by specifying a longer shutdown delay, see *Shutdown Delay*.

Shutdown Delay

The Master Relay can be programmed to delay switching the battery power off to allow for diagnostic data logging. The shutdown delay is in addition to the load dump protection delay described in *Load Dump Protection*. Therefore, the battery is guaranteed to be connected for the duration of the shutdown delay, except for an over current event where the battery is disconnected immediately to prevent potential damage.

The recommended procedure for this is to use a PDM / PDU or ECU to shut down the engine by disabling fuel and ignition but leaving the data logging system(s) running. This allows these devices to receive the shutdown event information and store it before shutting down. *Table 4* below indicates the recommended delay times for different data logging systems:

Table 4: Recommended shutdown delay times

Data Logging Device	Shutdown Delay
All Products	1.0 seconds

The default shutdown delay is 1.0 seconds, this can be reprogrammed (see *Device Configuration*) or it can be requested at the time of purchase.

Temperature Monitoring

The Master Relay has an on-board temperature sensor for monitoring the internal temperature of the unit. The temperature is transmitted on the CAN bus as well as used internally to isolate the battery in case of excessive temperatures. A warning is displayed with a Blue / Red flashing on the LED indicator at 90°C and the device is shut down at 110°C with a Blue flashing indication on the LED.

The device will automatically attempt to restart when the temperature drops back down below 100°C, or with a device reset (and temperature is below 110°C).

Load Current Monitoring

The Master Relay has internal bi-directional current sensing for the load to / from the battery. This current is transmitted as part of message 1 on the CAN bus (see *CAN Communications*). The current will be transmitted as a positive value to indicate that current is being pulled from the battery (discharging) and a negative current value indicates the battery is being charged.

The load current is designed as an indication of the total system draw and is accurate to ±10% or 1A (whichever is greatest). It is not intended to be used for detailed, smaller current draw analysis. The Master Relay should be used in conjunction with a PDM / PDU for accurate measurement of current for individual devices.

The Master Relay has integrated short-circuit protection and will isolate the battery in the event of a major short circuit on the main output terminal.

Power Saving Mode

After 30 seconds in the Driver Kill mode the Master Relay will enter a power saving mode. In this mode the following functions of the device are turned off to save power.

- CAN transmission is disabled
- The LED indicator is turned off
- Temperature and load monitoring are turned off
- The microcontroller is put into a standby state

The device resumes operation as soon as the driver switch is turned on again.

CAN Communications

The Master Relay comes preprogrammed with a baud rate of 1 Mbps. The user can configure the device to a baud rate of 500 Kbps or 250 Kbps as detailed in *Changing the CAN Messaging Transmit Rate*.

Message Format

The Master Relay transmits status and information on the CAN bus over three addresses for relays with and above Serial Number 64666, and two addresses for Serial Numbers below 64666. These addresses are defined by the base CAN address (Default: 0x6E4). This can be configured using the process detailed in *Changing the Base CAN Identifier*, or alternatively by requesting a particular address at time of purchase.

Table 5 & *Table 6* below show the format of the transmitted channels. Each message is transmitted by default at a rate of 10Hz, and all multi-byte channels are in Big-Endian format (MSB first). See *Changing the CAN Messaging Transmit Rate* for how to increase the transmit rate to 100Hz.

Table 5: Base Address (Default: 0x6E4)

Byte	Channel	Units	Length	Base	Signed	Value	Transmitted
0 1	Voltage Out	V	2	0.01	Unsigned	12.56	1256
2 3	Current Load	A	2	0.1	Signed	54.5	545
4 5	Internal Temperature	°C	2	0.1	Signed	25.2	252
6	Warnings	-	1	1	-		See (2)
7	Status	-	1	1	-		See (1)

Table 6: Base Address (Default: 0x6E5)

Byte	Channel	Units	Length	Base	Signed	Value	Transmitted
0 1	Voltage In	V	2	0.01	Unsigned	12.56	1256
2 3	Serial No.	-	2	1	Unsigned	-	-
4 5	Configuration (3)	-	2	1	Unsigned	-	-
6	Time Since Shutdown	s	1	0.1	-	15.5	155
7	Shutdown Cause 2 (4) Shutdown Cause 1 (4)	- -	4 MSB 4 LSB	1 1	- -		See (1) See (1)

(1) List of 'Status' enumerations are available in *Table 8*.
(2) 'Warning' bit masks are available in *Table 8*.
(3) 'Configuration' composition is available In *Table 10*.
(4) 'Shutdown Cause 1' is the most recent shutdown event, and 'Shutdown Cause 2' is the previous event (from serial no. 61061), serial no. prior to 61061 just give last event.

Table 7: Base Address (Default: 0x6E7)

Byte	Channel	Units	Length	Base	Signed	Value	Transmitted
0	-	-	-	-	-	-	-
1	Current/Switch State	-	1	1	Unsigned	See (5)	-

(5) *Only for Club and Pro Master Relays with black torx drive screws. See Table 9.*

Status and Warning Formats

The status and warning channels transmitted in CAN message 1 contain the current status of the warnings and faults on the device. The status enumerations are listed in *Table 8* below.

The warning channel is made up from 8 individual bits, corresponding to the status or switch states. Multiple warnings may be present at any single instance. For example, if both the external switch (0x40) and the driver switch (0x20) are off, the warning channel will be equal to 0x60.

Table 8: Status enumeration & warning channel bit masks

Status	Status Enumeration	Warnings Bit Mask
Normal	1	-
Over Temperature Warning	2	0x01
Over Current Warning	3	0x02
Low Voltage Warning	4	0x04
High Voltage Warning	5	0x08
Over Temperature Kill	6	0x10
Driver Switch Kill	7	0x20
External Switch Kill	8	0x40
CAN Trigger Kill	9	0x80
Power On Reset	10	-

Table 9: Current/Switch State Translation

Status	Value Translation
Normal Current Calibration / Normal External Switch	0x01
Normal Current Calibration / Internally acting External Switch	0x02
Legacy Current Calibration / Normal External Switch	0x03
Legacy Current Calibration / Internally acting External Switch	0x04

Configuration Format

The configuration channel contains information on the current configuration stored in the Master Relay. *Table 10* below shows the composition of this channel from the features programmed as detailed in *Device Configuration*.

Table 10: Configuration channel composition

Byte 4								Byte 5							
7	6	5	4	3	2	1	0	0	1	2	3	4	5	6	7
CAN Kill Enable		CAN Baud Rate		Output Drive				Shutdown Delay							
0= Disabled 1= Enabled 2= ADR		0= 1Mbps 1= 500Kbps 2= 250Kbps		0= Active-Hi, Half Bridge 1= Active-Hi, High Side 2= Active-Hi, Low Side 4= Active-Lo, Half Bridge 5= Active-Lo, High Side 6= Active-Lo, Low Side				Shutdown Delay (in 0.1 seconds) E.g. 10=1 second shutdown delay							

CAN Shutdown

The Master Relay has the ability to be shut down remotely via a CAN message. As default this functionality is disabled. Refer to *Setting up CAN Shutdown* for information about how to enable and set up this function, or alternatively request this functionality to be programmed when ordering the device.

When enabled, upon receiving a message with the format shown in *Table 11*, and on the configured CAN kill address, the Master Relay will shut down the engine and isolate the battery.

Table 11: Example CAN shutdown message for CAN Kill address 0x6E6

Received Address	Byte							
	0	1	2	3	4	5	6	7
0x6E6	0xFF	0x00	0xFF	0x00	0xFF	0x00	0xFF	0x00

This feature can also be programmed to work with an Accident Data Recorder (ADR) and trigger after a severe event. To enable this feature set the CAN Kill Enable byte to '2', and the CAN Kill address to the address of the status information transmitted by the ADR2 (default is 0x7B). See *Setting up CAN Shutdown* for further instructions.

IMPORTANT: Read Before Activating CAN Shutdown

Please check previous logged data carefully to ensure that the severe event threshold in the ADR does not false trigger on normal impacts such as 'curb strikes'.

Device Configuration

Changing the Base CAN Identifier

The default base CAN address is 0x6E4, can be changed using any CAN bus interface device capable of transmitting a message onto the CAN bus. The following procedure changes the CAN identifier on the Master Relay:

1. Configure the CAN interface device to transmit a single message on address 0x789 with the following format:

Table 12: Example CAN ID configuration message

Byte	0	1	2	3	4	5	6	7
Data	0x07	0x89	CAN_ID		CAN_ID		0x07	0x89
Example*	0x07	0x89	0x06	0xE4	0x06	0xE4	0x07	0x89

* Shows the correct message format to change the address to 0x6E4.

Where 'CAN_ID' is the desired new CAN address in Big-Endian format (MSB first).

Please note that the CAN address must not exceed a length of 11 bits (0x000 to 0x7FF), and must not conflict with any other CAN devices on the network.

2. Press and hold the external kill switch while sending the above message.

3. The Master Relay will send a response message on the base CAN address. See *Table 13* for a list of responses.

Table 13: Responses for CAN ID configuration

	0	1	2	3	4	5	6	7
Successful	0x00	0x00	0x00	0x00	0x00	0x00	0x00	0x00
IDs do not match	0x11	0x11	0x11	0x11	0x11	0x11	0x11	0x11
Frame check error	0x22	0x22	0x22	0x22	0x22	0x22	0x22	0x22
Invalid ID	0x33	0x33	0x33	0x33	0x33	0x33	0x33	0x33

4. After a successful response the Master Relay will be configured to send all CAN information on the new base address.

Changing the CAN Messaging Transmit Rate

The device comes preconfigured with a default CAN transmit rate of 10Hz. This can be increased to 100Hz if desired using the following procedure:

1. Configure the CAN interface device to transmit a single message on address 0x789 with the following format:

Table 14: Example CAN Baud Rate & Shutdown Delay configuration message

Byte	*0*	*1*	*2*	*3*	*4*	*5*	*6*	*7*
Data	0x0D	0xEF	UPDATE RATE	UPDATE RATE	0x00	0x00	0x0D	0xEF
Example*	0x0D	0xEF	0x0A	0x0A	0x00	0x00	0x0D	0xEF

* Shows the correct message format to set the transmit rate to 100Hz.

Where 'UPDATE RATE' is from the table below:

Table 15: List of transmit rate enumerations

Transmit Rate	*'UPDATE RATE'*
10Hz (Default)	0x01
100Hz	0x0A

2. Press and hold the external kill switch while sending the above message.

3. The Master Relay will send a response message on the base CAN address. See *Table 16* for a list of responses.

Table 16: Responses for CAN Baud Rate & Shutdown Delay configuration

	0	*1*	*2*	*3*	*4*	*5*	*6*	*7*
Successful	0x00	0x00	0x00	0x00	0x00	0x00	0x00	0x00
IDs do not match	0x11	0x11	0x11	0x11	0x11	0x11	0x11	0x11
Frame check error	0x22	0x22	0x22	0x22	0x22	0x22	0x22	0x22
Invalid ID	0x33	0x33	0x33	0x33	0x33	0x33	0x33	0x33

4. After a successful response the Master Relay will need to be restarted (by removing or isolating the power supply to the input stud) before the new CAN transmit rate is implemented.

Changing the CAN Baud Rate & Shutdown Delay

The device comes preconfigured with a default CAN baud rate of 1Mbps, and a shutdown delay of 1.0 seconds. These values can be changed using any CAN bus interface device capable of transmitting a message onto the CAN bus. The following procedure is used to change the CAN baud rate and shutdown delay on the Master Relay:

1. Configure the CAN interface device to transmit a single message on address 0x789 with the following format:

Table 17: Example CAN Baud Rate & Shutdown Delay configuration message

Byte	*0*	*1*	*2*	*3*	*4*	*5*	*6*	*7*
Data	0x04	0x56	BAUD RATE	BAUD RATE	SHUT DELAY	SHUT DELAY	0x04	0x56
Example*	0x04	0x56	0x01	0x01	0x0A	0x0A	0x04	0x56

* Shows the correct message format to set the Baud Rate to 500Kbps and the shutdown delay to 1 second.

Where 'BAUD RATE' is from the table below and 'SHUT DELAY' is the delay in tenths of a second that the power is kept on after a shutdown event (in hex).

Table 18: List of Baud Rate enumerations

Baud Rate Value	*'Baud Rate'*
1Mbps (Default)	0x00
500Kbps	0x01
250Kbps	0x02

2. Press and hold the external kill switch while sending the above message.

3. The Master Relay will send a response message on the base CAN address. See *Table 19* for a list of responses.

Table 19: Responses for CAN Baud Rate & Shutdown Delay configuration

	0	*1*	*2*	*3*	*4*	*5*	*6*	*7*
Successful	0x00	0x00	0x00	0x00	0x00	0x00	0x00	0x00
IDs do not match	0x11	0x11	0x11	0x11	0x11	0x11	0x11	0x11
Frame check error	0x22	0x22	0x22	0x22	0x22	0x22	0x22	0x22
Invalid ID	0x33	0x33	0x33	0x33	0x33	0x33	0x33	0x33

4. After a successful response the Master Relay will need to be restarted (by removing the power) before the new CAN baud rate is implemented. The shutdown delay is effective immediately.

Changing the PDM / PDU Output Drive Configuration

The device comes preconfigured with a default PDM / PDU drive output of active high, half-bridge. This configuration can be changed using any CAN bus interface device capable of transmitting a message onto the CAN bus. The following procedure is used to change the PDM / PDU output drive on the Master Relay:

1. Configure the CAN interface device to transmit a single message on address 0x789 with the following format:

Table 20: Example PDM / PDU Output Drive configuration message

Byte	*0*	*1*	*2*	*3*	*4*	*5*	*6*	*7*
Data	0x0A	0xBC	OUTPUT DRIVE	OUTPUT DRIVE	0x00	0x00	0x0A	0xBC
Example*	0x0A	0xBC	0x06	0x06	0x00	0x00	0x0A	0xBC

* Shows the correct message format to set the PDM / PDU output drive to active low, low side.

Where 'OUTPUT DRIVE' is selected from the table below:

Table 21: List of Output Drive enumerations

Active State	*Drive*	*'OUTPUT DRIVE'*
High	Half Bridge	0x00
	Low Side	0x02
	High Side	0x01
Low	Half Bridge	0x04
	Low Side	0x06
	High Side	0x05

2. Press and hold the external kill switch while sending the above message.
3. The Master Relay will send a response message on the base CAN address. See *Table 22* for a list of responses.

Table 22: Responses for PDM / PDU Output Drive configuration

	0	*1*	*2*	*3*	*4*	*5*	*6*	*7*
Successful	0x00	0x00	0x00	0x00	0x00	0x00	0x00	0x00
IDs do not match	0x11	0x11	0x11	0x11	0x11	0x11	0x11	0x11
Frame check error	0x22	0x22	0x22	0x22	0x22	0x22	0x22	0x22
Invalid ID	0x33	0x33	0x33	0x33	0x33	0x33	0x33	0x33

4. After a successful response, the Master Relay will need to be reset before the new PDM / PDU output drive is implemented.

Setting up CAN Shutdown

The CAN shutdown function is disabled by default. This configuration can be changed using any CAN bus interface device capable of transmitting a message onto the CAN bus. The following procedure enables / disables the CAN shutdown function of the Master Relay, as well as sets the address for shutdown commands to be received. For more information on how to use the shutdown once enabled, please refer to *Configuration Format*.

1. Configure the CAN interface device to transmit a single message on address 0x789 with the following format:

Table 23: Example CAN Shutdown configuration message

Byte	*0*	*1*	*2*	*3*	*4*	*5*	*6*	*7*
Data	0x01	0x23	CAN_KILL		CAN_KILL		0x01	0x23
Example*	0x01	0x23	0x16	0xE6	0x16	0xE6	0x01	0x23

* Shows the correct message format to enable CAN Shutdown on address 0x6E6.

Where 'CAN_KILL' is composed as in *Table 24* below. The first 4 bits ('EN'), set the CAN shutdown mode, where 0 is disabled, 1 is enabled, and 2 is for a MoTeC ADR. The last 12 bits ('KILL_ID') set the receive CAN address in Big-Endian format (MSB first).

Table 24: Example 'KILL_ID' composition

Byte	*0*		*1*	
Mask	*0xF0*	*0x0F*	*0xF0*	*0x0F*
Data	EN	KILL_ID		
Example*	0x1	0x6	0xE	0x6

* Shows the correct byte composition to enable CAN shutdown on address 0x6E6.

'EN' must be less than 0x2 to enable the function. Setting 'EN' to any other value will disable the CAN shutdown function.

Please note that the CAN address must not exceed a length of 11 bits (0x000 to 0x7FF), and must not conflict with any other CAN devices on the network.

2. Press and hold the external kill switch while sending the above message.

The Master Relay will send a response message on the base CAN address. See *Table 25* for a list of responses.

Table 25: Responses for CAN ID configuration

	0	*1*	*2*	*3*	*4*	*5*	*6*	*7*
Successful	0x00	0x00	0x00	0x00	0x00	0x00	0x00	0x00
IDs do not match	0x11	0x11	0x11	0x11	0x11	0x11	0x11	0x11
Frame check error	0x22	0x22	0x22	0x22	0x22	0x22	0x22	0x22
Invalid ID	0x33	0x33	0x33	0x33	0x33	0x33	0x33	0x33

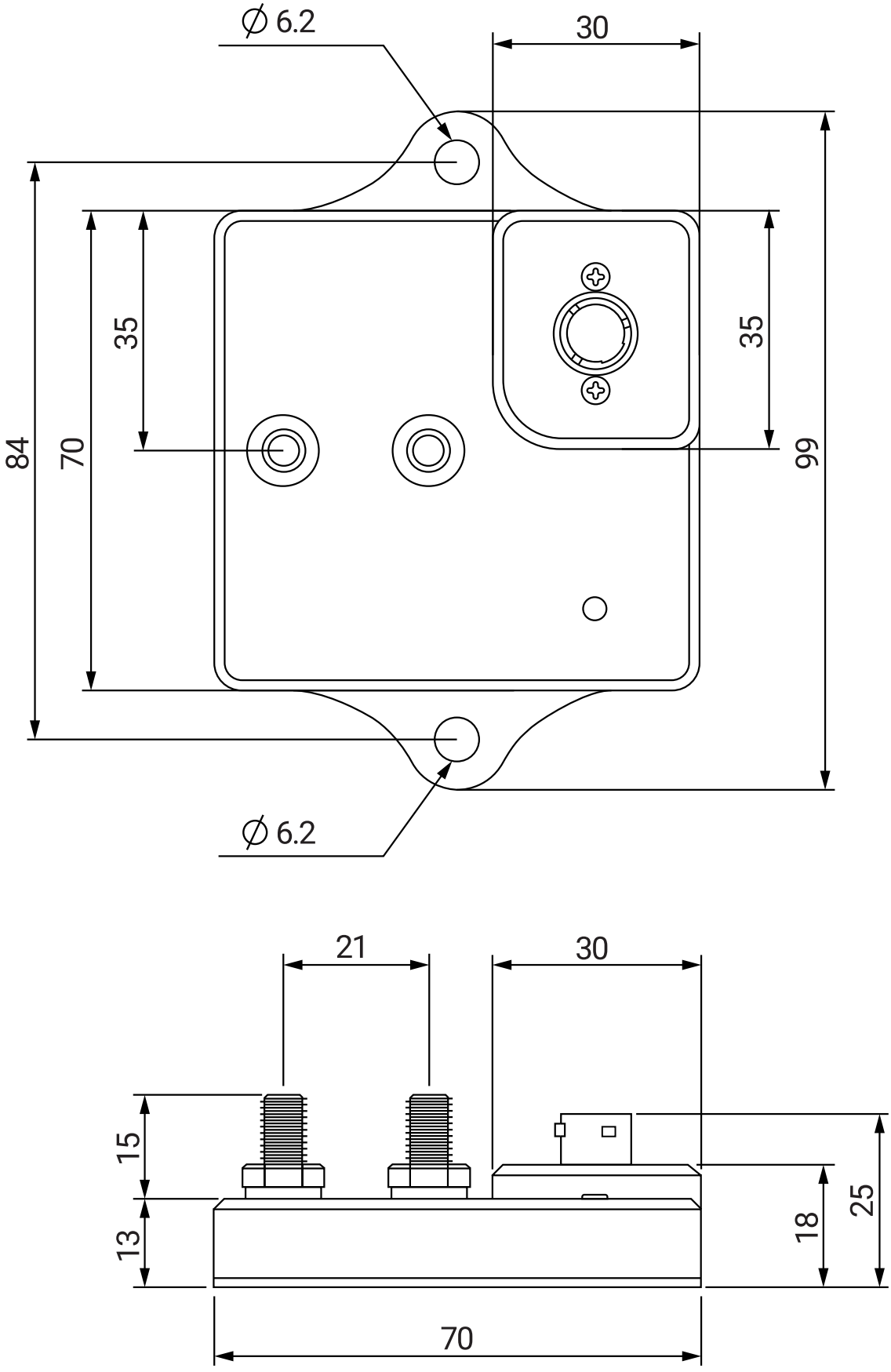
3. After a successful response, the Master Relay will need to be restarted (by removing the power) before the CAN shutdown is enabled.

Specifications

	Pro	Club
Connection		
Battery Terminal	Copper Plated Steel Stud M6. Torque nut to 3.0Nm	
Output Terminal	Copper Plated Steel Stud M6. Torque nut to 3.0Nm	
Physical		
Interface	8STA6-04-06SN	Flylead (no connector)
Mass (with caps and nuts on studs)	115 g	120 g
Dimensions	99 x 70 x 28mm	99 x 70 x 45mm
Electrical		
Supply Voltage (V_s)	8 to 30 V	
Operating Current (I_s)	0.03 A (Normal) 0.02 A (Isolated) 0.01 A (Standby)	
Operating Conditions		
Temperature	-20 to 100˚C	
IP Rating	IP63	
PDM / ECU Output		
Drive Type	Configurable	
Output Voltage	Supply Voltage	
Max Current	200mA	
Switched Current		
Maintained Current	200 A @ 25˚C	
Peak Current	1000A	
Current Measurement		
Sensitivity	0.5 A (Up to 100A) 5.0 A (Over 100A)	
Calibration Error	±10% or 1 A	
Range	-255 to 600 A	
Temperature Measurement		
Sensitivity	0.2˚C	
Calibration Error	±3˚C	
Range	0 to 125˚C	
CAN Bus		
Baud Rate	Configurable (Default: 1Mbps)	
Transmit Addresses	Configurable (Default: 0x6E4, 0x6E5)	
Termination Resistor	External Required	

Drawing

Figure 4: Drawing of Relay with measurements (all dimensions are in mm)



Troubleshooting

Problem	Possible Cause	Solution or Diagnosis Tips
Relay does not turn on. Instant yellow LED on Status	Permanently connected device has high inrush current	During the first 1ms of power up the relay checks the short circuit of the output terminal. If any load is connected to this stage, such as an incandescent lamp (rain light for example) that has a high inrush current, will cause a faulty short circuit protection. This can be diagnosed by disconnecting various circuits in the car (pull fuses) until the culprit is found. The solution maybe to change the device to something with less inrush (such as LED lamp) or power it via a relay (the relay will delay the switch-on, so it doesn't trip the short test.
Relay trips during cranking	Start motor current exceeding 1000A	To diagnose, temporarily bypass the relay (move "out" cable to battery post), try cranking engine. If it doesn't crank or sounds slow then that would indicate a mechanical problem, a short in the starter wiring or a flat battery (flat battery can increase peak starter current). If it does crank ok during this test then the next step would be to reconnect the relay, but remove spark plugs to reduce compression then try cranking while monitoring current. If current is still high with no compression, then that would indicate a mechanical or internal starter motor problem.
Relay does not communicate on CAN bus (no data received by logger or ECU)	CAN wiring is incorrect (CAN High and CAN Low swapped, or not connected). Missing or incorrect termination resistors on the CAN bus. Incorrect baud rate or base address configured on the relay or receiving device.	Double-check that CAN High (Pin 6/Yellow) and CAN Low (Pin 5/Green) are correctly wired and not reversed. Ensure 120 Ω termination resistors are installed at both ends of the CAN bus. There is no interal terminating resistor in the relays. Verify that the baud rate and base address settings on the relay match those expected by the logger or ECU (default is 1 Mbps, base address 0x6E4/0x6E5). Inspect for any loose or damaged CAN wiring and repair as needed.
LED indicator shows unexpected colour or flashes after installation	One or more switches (driver or external kill) are not wired correctly or are stuck in the "off" position. The relay is detecting a fault condition (e.g., over-temperature, over-current, or voltage out of range).	Check the wiring and operation of both the driver and external kill switches. Ensure the driver switch is latching and the external switch is momentary normally closed (NC). Refer to the LED indicator table in the manual to identify the meaning of the colour/flashing pattern. If a fault is indicated (e.g., over-temperature, over-current, low/high voltage), resolve the underlying issue (improve cooling, check for shorts, verify battery voltage) and reset the relay as described in the manual. If the issue persists, disconnect power, inspect all wiring, and repeat the installation checklist.

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