PG DRIVES TECHNOLOGY

I-DRIVE

PERMANENT MAGNET MOTOR CONTROL SYSTEM

OPERATION, INSTALLATION, & PROGRAMMING

SK76977/3

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About this manual

This manual is split into 6 chapters which are in turn split into separate sections. Each chapter deals with a specific issue.

Chapter 1 - Operation

This chapter deals with the controls and functionality of the I-Drive Machine Controller.

Chapter 2 - Installation

This chapter deals with the mounting, connection, wiring and setup procedures for the I-Drive Machine Controller.

Chapter 3 - Programming

This chapter gives an overview of the programmable parameters within the I-Drive Machine Controller.

Chapter 4 - Control Panel Module

This chapter deals with the mounting, connection, wiring and setup procedures for the TruCharge Control Panel Module.

Chapter 5 - Warning Summary

Lists all the Warnings used within the manual.

Chapter 6 - Specifications

Lists all the Electrical Specifications of the I-Drive Machine Control System.

ICONS

PG Drives Technology. will be abbreviated to PGDT throughout the manual.

Throughout the manual icons are used to draw the reader's attention.

The icons used are:

Note - A general point for best practice.

Caution - A point of safety which if ignored could result in damage to the control system or the vehicle.

Warning - A point of safety which if ignored could cause injury to the individual.

CHAPTER I
OPERATION

1 Introduction

The relevant contents of this chapter should be included in the machine operating guide. Further copies are available from PGDT in either written or disk (Adobe PDF) format. Copies should not be made without the express permission of PG Drives Technology.

The operation of the I-Drive machine Controller is simple and easy to understand. The controller incorporates state-of-the-art electronics, the result of many years of research, to provide you with ease of use and a very high level of safety. In common with other electronic equipment, correct handling and operation of the unit will ensure maximum reliability.

This chapter covers all types of operation. It is the responsibility of the machine manufacturer to ensure that only the relevant sections of this chapter are included in the I-drive's operating manual.

Please read this chapter carefully - it will help you to keep your machine reliable and safe.

2 General

2.1 Handling

Avoid knocking your controller and especially the connectors. Be careful not to strike obstacles with the controller. Never drop the controller.

When transporting your machine, make sure that the controller is well protected. Avoid damage to cables.

2.2 Operating Conditions

Your controller uses industrial-grade components throughout, ensuring reliable operation in a wide range of conditions. However, you will improve the reliability of the controller if you keep exposure to extreme conditions to a minimum.

Do not expose your controller or its components to damp for prolonged periods.

3 Controls

Depending on the specification of the machine to which the I-Drive is fitted, some or all of the following controls will be used.

3.1 On/Off Switch

The on/off switch applies power to the controller electronics, which in turn supplies power to the machine's motor. Do not use the on/off switch to stop the machine unless there is an emergency. (If you do, you may shorten the life of the machine drive components).

Some machines may have a keyswitch in addition to the normal on/off switch, the function of the keyswitch is the same as the on/off switch.

3.2 Status Indicator

Depending on the machine model, the status indicator may be a single bulb (or LED) or a PGDT TruCharge battery and diagnostics indicator.

The status indicator shows you that the machine is switched on. It also indicates the operating status of the machine. Details are given in section 8.

3.3 Throttle

The throttle controls the speed of the machine. The further you push the throttle, the faster your machine will move. When you release the throttle the brake is automatically applied.

Depending on the machine model, the throttle configuration may be one of three types - wig-wag, single-ended or Unipolar.

3.3.1 Wig-wag Throttle

In this configuration, both the speed and the direction of the machine are controlled by the throttle. To drive forwards, push the throttle in one direction: to drive in reverse, push the throttle in the other direction.

3.3.2 Single-ended Throttle

In this configuration, just the speed of the machine is controlled by the throttle. When the throttle is pushed - depending on the position of the reverse switch (refer to section 3.4) - the machine will drive in either the forward or reverse direction.

3.3.3 Unipolar Throttle

In this configuration, just the speed of the machine is controlled by the throttle. When the throttle is moved, in either direction, - depending on the position of the reverse switch (refer to section 3.4) - the machine will drive in either the forward or reverse direction.

3.4 Reverse Switch

This switch will be fitted to the machine if the throttle configuration is single-ended or Unipolar (refer to sections 3.3.2 & 3.3.3). The switch is used to change between

forward and reverse drive.

3.5 Speed Limiting Potentiometer

This control sets the maximum speed of the machine. Turn the knob clockwise to increase the maximum speed setting or anti-clockwise to decrease the maximum speed setting.

3.6 Belly Button

This device is a safety feature which is activated each time the vehicles is placed in reverse. If the button is triggered the vehicle will stop it's reverse drive and immediately begin to move forwards at a programmed speed.

3.7 Slow/Fast Switch

This switch selects the driving mode - either slow or fast - of the machine. You can use this switch to limit the machine's driving behavior in environments where that may be desirable or necessary, e.g. if you are driving indoors or on the sidewalk.

3.8 Audible Alarm

This provides an audible warning when the machine is being driven in the reverse direction. The alarm may also be used to signal other conditions, such as low battery warning.

4 Getting Ready to Operate

Check that the speed limiting control is turned to a position which suits you.

- Operate the on/off switch. Either:
- A TruCharge type status indicator will blink and remain on after half a second.
- A single bulb (or LED) type status indicator will blink and remain on after half a second.

During the first half-second after the machine is switched on, the controller is performing important safety checks within itself and the rest of the machine's electrical system. Therefore, if you push the throttle during this time, you will not be able to drive until you have returned the throttle to the rest position and switched the controller Off and On again.

If the machine has a single-ended throttle, use the reverse switch to select the direction you want to drive and then push the throttle to control the speed. If the machine has a wig-wag throttle, push the throttle in the direction you want to drive.

If you do not push the throttle as you switch the machine on and the status indicator flashes rapidly, then there may be a trip. Refer to section 8 for details.

5 Tips for Using Your Controller

5.1 Operation - General

Make sure that all the controls are within easy reach and are comfortable to operate.

5.2 Operating Technique

The controller interprets the throttle movements and reverse switch setting (if fitted) and drives the machine in the correct direction at the appropriate speed. You will need very little concentration to control the machine, which is especially useful if you are inexperienced.

The further you push the throttle away from the rest position, the faster the machine will go.

The intelligent speed controller minimizes the effects of slopes and different types of terrain.

The machine user must be capable of operating a machine safely. PGDT accepts no liability for losses of any kind arising from failure to comply with this condition.

6 Precautions for Use

In the event of the machine moving in an unexpected way RELEASE THE THROTTLE. This action will stop the machine in any circumstances.

6.1 Hazards

Do not drive the machine:

- Beyond restrictions indicated in your machine user manual, for example inclines, curb heights etc.
- In places or on surfaces where a loss of wheel grip could be hazardous, for example on wet grassy slopes.
- If you know that the controller or other crucial components require repair.

Although the I-drive is designed to be extremely reliable and each unit is rigorously tested during manufacture, the possibility of system malfunction always exists (however small the probability). Under some conditions of system malfunction the controller must (for safety reasons)

stop the machine instantaneously. If there is any possibility of the user falling out of the machine as a result of a sudden braking action, it is imperative that a restraining device such as a seat belt is supplied with the machine and that it is in use at all times when the machine is in motion. PGDT accept no liability for losses of any kind arising from the unexpected stopping of the machine, or arising from the improper use of the machine or controller.

Do not operate the I-Drive if the machine behaves erratically, or shows abnormal signs of heating, sparks or smoke. Turn the I-Drive off at once and consult your service agent. PGDT accepts no liability for losses of any kind arising from failure to comply with this condition.

Electronic equipment can be affected by Electro Magnetic Interference (EMI). Such interference may be generated by radio stations, TV stations, other radio transmitters and cellular phones. If the machine exhibits erratic behavior due to EMI, turn the controller off immediately and consult your service agent. PGDT accepts no liability for losses of any kind arising from failure to comply with this condition.

It is the responsibility of the machine manufacturer to ensure that the machine complies with appropriate National and International EMC legislation. PGDT accepts no liability for losses of any kind arising from failure to comply with this condition.

The machine user must comply with all machine safety warnings. PGDT accepts no liability for losses of any kind arising from failure to comply with this condition.

7 Safety Checks

The electronic circuits in the I-Drive have been designed to be extremely safe and reliable. The on-board microcomputer carries out safety checks at up to 100 times per second. To supplement this safety monitoring you should carry out the following periodic checks.

If the controller fails any of these checks, do not use the machine and contact your service agent.

These checks should be conducted in an open space and a restraining device such as a seat belt should always be used. PGDT accepts no liability for losses of any kind arising from failure to comply with this condition.

7.1 Daily Checks

Throttle: With the machine switched off, check that the throttle mechanism is not bent or damaged and that it returns to the rest position when you push and release it. If there is a problem do not continue with the safety checks and contact your service agent.

7.2 Weekly Checks

Throttle: Put the throttle to the full speed forward position and switch the machine on. The machine should not move. To show you that you have switched the machine on with the throttle already pushed, a TruCharge Trip type status indicator will display 7 Bars, whereas a single bulb (or LED) type status indicator will flash seven times in sequence.

If the machine does move, contact your service agent.

Parking brake: This test should be carried out on a level surface with at least one meter clear space around the machine.

Switch the machine on.

Check that the status indicator remains on, or flashes slowly, after half a second.

Go to drive the machine slowly in the forwards direction until you hear the parking brake operate. The machine may start to move.

Immediately release the throttle. You must be able to hear the parking brake operate within a few seconds.

Repeat the test in the reverse direction.

Cables and connectors:

Check that all connectors on the machine are securely mated, and ensure that all cables are free from damage.

7.3 Servicing

To ensure continued satisfactory service, we suggest you have your machine and controller inspected by your service agent after a period of one year from commencement of service. Contact your service agent for details when the inspection is due.

8 Status Indication

Depending on the machine model, the status indicator may be a single lamp (or LED) or a TruCharge battery gauge and diagnostics display. Both types indicate the status of the controller.

A number of supposedly faulty controllers returned to PGDT are subsequently found to operate correctly. This indicates that many faults are due to problems on the machine rather than within the controller.

8.1 Single Lamp and LED Status Indicators

8.1.1 Status Indicator Steady

This indicates that all is well.

8.1.2 Status Indicator Flashes Slowly

The controller is functioning correctly, but you should charge the batteries as soon as possible.

Do not operate the machine if the battery is nearly discharged. Failure to comply with this condition may leave the user stranded in an unsafe position, such as in the middle of a road. PGDT accepts no liability for losses of any kind arising from failure to comply with this condition

8.1.3 Status Indicator Blinks On Every 5 Seconds

The controller has entered Sleep Mode.

8.1.4 Status Indicator Flashes Rapidly (even with throttle released)

The controller safety circuits have operated and the controller has been prevented from moving the machine.

This indicates that there is a trip. Please follow this procedure:

- Switch off the machine.
- Make sure that all connectors on the machine are mated securely.
- Check the condition of the battery.
- If you can't find the problem, try using the self-help guide in section 8.3.
- Switch the machine on again and try to drive. If the safety circuits operate again, switch off and do not try to use the machine.
- Contact your service agent.

If a system trip occurs then a series of flashes, on the Lamp or LED Status Indicator, will display the Trip Type. The Trip Type will be represented by a series of repeated flash sequences. The sequences will mimic the TruCharge Status Indicator Trip Types. Refer to section 8.3.

Eg. when the LED flashes 6 times, pauses, then flashes 6 times again the controller is being inhibited.

8.2 TruCharge Indicator

The way in which the battery gauge should be read depends on whether the controller is driving, in Sleep Mode or in Trip Mode . Each case is explained below.

8.2.1 TruCharge Indicator Steady

If the TruCharge gauge shows red, yellow and green, the batteries are charged.

If the TruCharge gauge show just red and yellow, then you should charge the batteries as soon as you can.

If the TruCharge gauge shows just red then you should charge the batteries immediately.

8.2.2 TruCharge Indicator Flashing Slowly

The controller is functioning correctly, but you should charge the batteries as soon as possible.

Do not operate the machine if the battery is nearly discharged. Failure to comply with this condition may leave the user stranded in an unsafe position, such as in the middle of a road. PGDT accepts no liability for losses of any kind arising from failure to comply with this condition

8.2.4 TruCharge Indicator Blinks on Every 5 Seconds

The controller has entered Sleep Mode.

8.2.5 TruCharge Indicator Flashing Rapidly

The controller safety circuits have operated and the controller has been prevented from moving the machine.

This indicates that there is a trip. Please follow this procedure:

- Switch off the machine.
- Make sure that all connectors on the machine are mated securely.
- Check the condition of the battery.
- If you can't find the problem, try using the self-help guide in section 8.3.
- Switch the machine on again and try to drive. If the safety circuits operate again, switch off and do not try to use the machine.
- Contact your service agent.

If a system trip occurs you can find out what has happened by counting the number of bars that are flashing on the TruCharge Indicator. Refer to section 8.3.

8.3 Self-Help Guide

Below is a list of self-help actions. Try to use this list before you contact your service agent. Go to the number in the list which matches the number of flashing bars and follow the instructions.

1 Bar 	The battery needs charging, there is a bad connection to the battery or dependent on programming, may indicate that the battery lockout function is active and the controller is in a restricted mode of operation Check the connections to the battery. If the connections are good, try charging the battery.
2 Bar 	There is a bad connection to the motor. Check all connections between the motor and the controller.
3 Bar 	The motor has a short circuit to a battery connection. Contact your service agent.
4 Bar 	The battery charge level has fallen below the Battery Lockout Level and the controller is inhibiting certain machine functions. Charge the battery.
5 Bar 	Not used.
6 Bar 	The controller is being inhibited from driving, this may be because the battery charger is connected.
7 Bar 	A throttle fault is indicated. Make sure that the throttle is in the rest position before switching on the machine.
8 Bar 	A controller fault is indicated. Make sure that all connections are secure.
9 Bar 	The parking brakes have a bad connection. Check the parking brake and motor connections. Make sure the controller connections are secure.
10 Bar 	An excessive voltage has been applied to the controller. This is usually caused by a poor battery connection. Check the battery connections.

8.4 Slow or Sluggish Movement

If the machine does not travel at full speed and the battery condition is good, check the position of the speed limiting control. If adjusting the speed limiting control does not remedy the problem then there may be a non-hazardous fault.

Contact your service agent.

9 Battery Gauge

Depending on the type of machine you have, the battery gauge may be a single bulb (or LED) or a TruCharge display. How to read each type is described in the following sections.

The battery gauge is included to let you know how much charge is left in your batteries. The best way for you to use the gauge is to learn how it behaves as you drive the machine. Like the fuel gauge in a car, it is not completely accurate, but it will help you avoid running out of "fuel".

The battery gauge works in the following way.

When you switch on the controller, after half a second, the battery gauge shows an estimate of the remaining battery charge.

The battery gauge gives you a more accurate reading about a minute after you start driving the machine.

When you replace worn out batteries, fit the type recommended by the machine manufacturer. If you use another type the battery gauge may be inaccurate.

The amount of charge in your batteries depends on a number of factors, including the way you use your machine, the temperature of the batteries, their age and the way they are made. These factors will affect the distance you can travel in your machine. All machine batteries will gradually lose their capacity as they age.

The most important factor that reduces the life of your batteries is the amount of charge you take from the batteries before you recharge them. Battery life is also reduced by the number of times you charge and discharge the batteries.

To make your batteries last longer, do not allow them to become completely flat. Always recharge your batteries promptly after they are discharged.

If your battery gauge reading seems to fall more quickly than usual, your batteries may be worn out.

9.1 How To Read a Single Bulb (or LED) Battery Gauge

Refer to section 8.1for full details.

9.2 How To Read a TruCharge Battery Gauge

Refer to section 8.2 for full details.

10 Pushing your machine

The machine will be fitted with a freewheel mechanism which allows the machine to be pushed if there is a fault or the batteries are disconnected or not fitted.

Depending on the type of freewheel mechanism, then it may be possible for the machine to freewheel at potentially dangerous speeds. Therefore, do not push the machine up or down inclines on which you cannot stop or hold the machine. Never sit on the machine if the freewheel mechanism is disengaged. PGDT accept no liability for losses of any kind arising from the machine being moved while the freewheel mechanism is disengaged.

11 Programming

If you cannot find a position on the speed limiting control that suits you, the controller can be programmed to meet your needs. The controller can be programmed in two ways – with an SP1 Programmer or specialist PC software and interface cable.

The SP1 is a small hand-held unit which can be plugged into your controller to alter the program.

The PC Programmer is a piece of PC software and an interface cable. When the software is installed onto a PC, it can then be connected to the controller by using the special interface cable. The controller can then be programmed using a windows type environment

The programming tools may be included with your machine. If they are not, your machine distributor or service agent or machine manufacturer will be able to program your controller for you.

If you have a programmer, read the user guide before you use it.

If you re-program your controller, make sure that you observe any restrictions given in your machine user manual. Note any changes you make for future reference.

Programming should only be conducted by Electronic professionals with in-depth knowledge of PGDT electronic controllers. Incorrect programming could result in an unsafe set-up of a machine for a user. PGDT accept no liability for losses of any kind if the programming of the controller is altered from factory pre-set values.

12 Warranty

The I-Drive machine Controller is covered by a warranty period defined by the machine manufacturer. For details of the warranty period, please contact your service agent.

The warranty will be void if the I-Drive machine Controller has:

- Not been used in accordance with the I-Drive machine Controller Technical Manual, SK76977.
- Been subject to misuse or abuse.
- Been modified or repaired by non-authorized persons.

The warranty will be void if the I-Drive has not been used in accordance with I-Drive Technical Manual SK76977, the I-Drive has been subject to misuse or abuse, or if the I-Drive has been modified or repaired by unauthorized persons.

13 Servicing

All repairs and servicing must be carried out by authorized service personnel. Opening or making any unauthorized adjustments or modifications to the controller or its components will invalidate any warranty and may result in hazards to yourself or other people, and is strictly forbidden.

PGDT accept no liability for losses of any kind arising from unauthorized opening, adjustment or modifications to the I-Drive machine Controller.

If the I-Drive machine Controller is damaged in any way, or if internal damage may have occurred through impact or dropping, have the product checked by qualified personnel before operating. PGDT accepts no liability for losses of any kind arising from failure to comply with this condition.

CHAPTER 2
INSTALLATION

1 Documentation

1.1 I-Drive Operation

Study Chapter 1: Operation. It is important that the operation information in chapter 1 is supplied with the machine, either as part of the machine user handbook or as a separate document.

This chapter sets out the installation conditions that must be complied with in order to meet the safety requirements of EN60335-2-72.

1.2 Program Settings

You must supply the controller programmed with the manufacturer's preset settings. Controllers are always supplied by PGDT with the preset settings shown on the data sheet.

The preset settings are chosen with the machine manufacturer to ensure safe operation and compliance with relevant legal requirements over the whole of the operating range of the throttle, and speed control.

The machine must stop within the maximum distance specified for the country in which the machine will be used.

If users with particular disabilities need very low braking rates and this results in a longer stopping distance, the maximum speed must be reprogrammed so that the stopping distance requirement is satisfied.

State in the machine user handbook that it is the responsibility of the person programming the controller to make sure that the stopping distance requirement is satisfied. If the braking rate is low, the forward and reverse maximum speed settings may need to be reprogrammed.

To assist the person in this task, include a graph in the machine user handbook showing the relationship between the maximum forward/reverse speed settings and the forward/reverse braking rate which is required to ensure the correct stopping distance.

It may be possible to program settings which compromise the stability of the machine. Perform suitable tests to establish which programming restrictions are needed to prevent instability. State any programming restrictions in the machine user handbook.

State in the machine user handbook that it is the responsibility of the person programming the controller to make sure that the settings are safe and to note any programming changes that they make.

Programming should only be conducted by electrical professionals with in-depth knowledge of PGDT electronic controllers. Incorrect programming could result in an unsafe setup of a machine. PGDT accepts no liability for losses of any kind if the programming of the controller is altered from factory pre-set values. PGDT accepts no liability for losses of any kind if the drive or stability characteristics of the machine are altered without prior notification and discussion with PGDT.

1.3 Soft-Stop

If the version of I-Drive you have has the Soft-Stop function enabled (see controller data sheet), you must ensure that the emergency stopping distance is within the distance specified for the country in which the machine will be used.

1.4 Other Information

You must provide a diagram in the machine user handbook showing the user controls. In addition, you should include a brief specification of operating supply voltage range and operating temperature range.

2 Immobilizing the Machine

2.1 Prevention of Unauthorized Use

Some markets require the machine to have a means of preventing unauthorized use. This typically means fitting a keyswitch which can prevent the controller from being switched on.

2.2 Charger Interlock

ISO 7176-14 requires you to provide a means of preventing the use of the machine while the batteries are being charged. The I-Drive includes 2 inhibit inputs either of which can be used to provide this function. Refer to section 4.12 and 6.1 for details.

Contact PGDT if you need advice.

The machine manufacturer is responsible for providing a means of preventing the use of the machine while the batteries are being charged. PGDT accepts no liability for losses of any kind arising from failure to comply with this condition.

3 Connections

3.1 General

Study the data sheet for the controller to identify:

- The output current, ratings and restrictions
- The connector pin assignments

Recommendations for the cross-sectional area, ratings and materials for wiring are given in the table in section 3.1.6. These depend on the application. You are responsible for establishing the suitability of the particular wiring arrangement used on the machine. PGDT can make general recommendations for wiring to I-Drive controller, but PGDT accepts no responsibility for the wiring arrangement used.

Make sure that the connectors you use are reliable under all operating conditions and correctly wired with no short circuits. Do not use unsuitable components - it may result in poor machine reliability. Refer to the following illustration for a basic connection detail.

The machine manufacturer is responsible for establishing the suitability of the particular wiring arrangements used on the machine, for both normal use and stalled conditions. PGDT can make general recommendations for wiring the I-Drive Machine Controller, but PGDT accepts no responsibility for, and accepts no liability for losses of any kind arising from, the actual wiring arrangement used.

The machine manufacturer is responsible for ensuring that only the mating connectors specified by PGDT on the controller's specific data sheet or in this manual are used to connect to the controller. PGDT accepts no liability for losses of any kind arising from failure to comply with this condition.

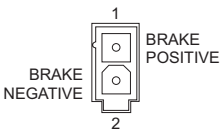
The machine manufacturer is responsible for ensuring that suitable connectors are used and securely mated throughout the machine wiring system and that the workmanship associated with the wiring system is of a good enough quality. Failure to meet this condition could result in intermittent operation, sudden stopping or veering, or even create a burn or fire hazard. PGDT accepts no liability for losses of any kind arising from failure to comply with this condition

3.1.1 Battery and Motor Connections

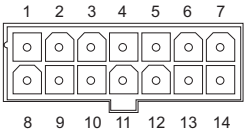
The battery and motor connections on the I-Drive use 1/4" 6.35mm male Faston type terminals. The mating female parts should be sourced from a reputable manufacturer or supplier and these parts must be tested for suitability by the machine manufacturer.

TYPICAL I-DRIVE WIRING DIAGRAM

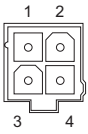
SOCKET CONNECTION DETAILS



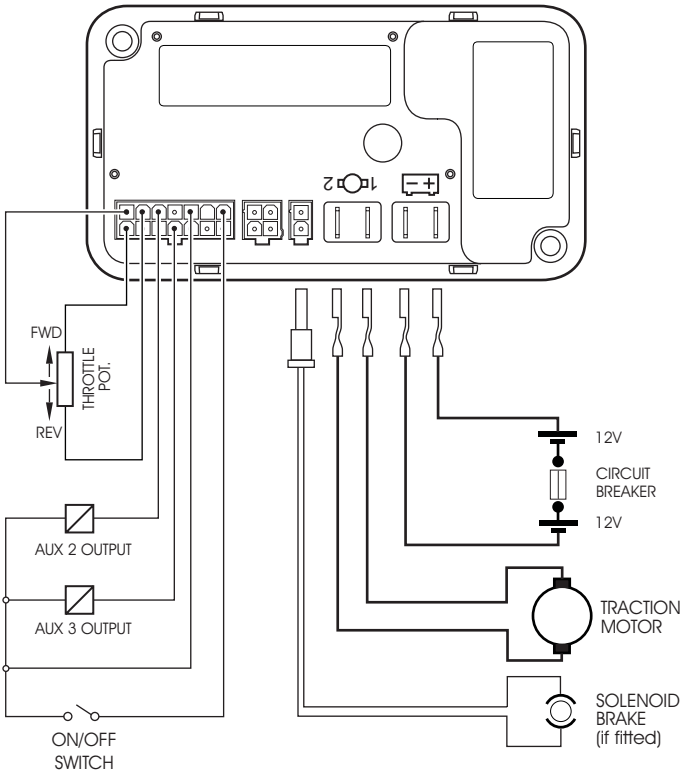
AUXILIARY 1 OUPUT



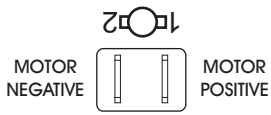
CONTROL INTERFACE



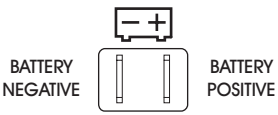
PGDT PROGRAMMER



TRACTION MOTOR CONNECTION DETAILS



BATTERY CONNECTION DETAILS



It is the responsibility of the machine manufacturer to ensure that the mating female Fastons are suitable for use on the intended application. PGDT accepts no liability for losses of any kind arising from failure to comply with this condition.

3.1.2 Brake Connector

The brake connector fitted to the I-Drive is a Molex 'Mini-Fit Jr' part.

The mating connector part number is as follows:

Molex 'Mini-Fit-Jr.' 2 socket receptacle:	39-01-2020
Molex 'Mini-Fit-Jr.' Crimp terminal:	39-00-0039

Refer to section 3.1.4 for crimping and extraction tools information

3.1.3 Tiller Interface Connector

The tiller interface connector fitted to the I-Drive is a Molex 'Mini-Fit Jr' part.

The mating connector part number is as follows:

Molex 'Mini-Fit-Jr.' 14 socket receptacle:	39-01-2140
Molex 'Mini-Fit-Jr.' Crimp terminal:	39-00-0039

Refer to section 3.1.5 for crimping and extraction tools information

3.1.4 Crimp Tooling

Good quality crimping is essential in ensuring the long term reliability of the machine's electrical system. Poor quality crimps may initially appear to be satisfactory but, over time, they may cause problems. It is recommended that crimp quality is maintained by implementing the procedures detailed in IEC-60352-2 1990.

Defective or poor quality crimps may affect the warranty of the controller. PGDT accepts no liability for losses of any kind arising from failure to comply with this condition.

Hand tools for crimping and extraction are available from Molex. The references are as below.

Molex 'Mini-Fit-Jr.' Crimp tool:	69008-0724
Molex 'Mini-Fit-Jr.' Extraction tool:	11-03-0044

Only use the exact tools specified.

For information on your closest Molex distributor refer to www.molex.com.

PG Drives Technology can supply all the Molex connectors and crimps required by the I-Drive, excepting the Motor and Battery connections, in a kit form.

The PGDT kit number is as follows:

I-Molex connector kit:	D50319

3.1.5 Wire Gauge and Types

The table below gives the minimum recommended wire sizes for the various I-Drive specifications.

Model	Battery Wires	Motor Wires	Brake Wires	Tiller & Inhibit Wires	Charger Wires
45A	2.5mm^2	2.5mm^2	0.5mm^2	0.22mm^2	1.0mm^2
70A	4.0mm^2	4.0mm^2	0.5mm^2	0.22mm^2	1.0mm^2

The wire gauges of the Tiller Interface 24V and OV connections, Pins 7 and 13, may require increasing if the machine manufacturer wishes to run auxiliary circuits, such as lighting, from these pins.

It is the responsibility of the machine manufacturer to ensure that all wire gauges are suitable for the intended application.

These recommendations are derived from well proven field experience of various international machine manufacturers. Nevertheless, manufacturers must confirm these recommendations by carrying out suitable tests. Keep wire lengths as short as possible

Battery , motor and charger wires should use Tri-rated PVC equipment wire rated at 105°C.

3.2 Battery Connection

The controller incorporates sophisticated current limiting circuitry as protection for the circuits in the controller.

ISt is recommended that you provide protection against short circuits in the battery wiring and the power loom or the extremely unlikely event of a short circuit in the controller.

Place a suitable circuit breaker in series with the battery supply, for example in the link between two 12V batteries. If your batteries are held in separate enclosures, you must provide a circuit breaker with each of them.

The rating of the circuit breaker must match the capacity of the wiring specified in section 3.5. For I-Drive 45A and 70A models the circuit breaker rating should not exceed 40A.

It is recommended that the battery positive and negative wiring to the I-Drive is kept as short as possible.

ISO 7176-14 states as a guide that the minimum operating time for the circuit breaker when the machine is stalled should be 15 seconds.

The machine manufacturer must install a suitable circuit breaker to provide protection against short circuits in the battery wiring, power loom or the controller. Failure to comply with this could result in a fire hazard. PGDT accepts no liability for losses of any kind arising from failure to comply with this condition.

3.3 Motor Connection

If a circuit breaker is fitted in series with the motor, it is essential that the machine assumes a safe condition the moment the circuit breaker operates. You must therefore fit a circuit breaker with an auxiliary switch which inhibits the machine from driving, refer to section 7.1.

3.4 Solenoid Brake Connection

The solenoid brake should be a 24V type and should not require more than 1.25A to operate. The I-Drive's brake output has a continuous rating of 1.25A. If the continuous current is greater than this level, then the controller may shut down the brake output in order to protect it. If the solenoid brake current is less than 10mA, the controller will detect an open-circuit brake condition.

If the brake is manually disengaged in order to freewheel the machine then a Brake Released Switch must be fitted and connected as shown in the I-Drive Wiring Diagram in section 3.1.

This will result in the I-Drive preventing drive, detecting a freewheel situation and indicating this as a Solenoid Brake Trip. (Trip Type 9).

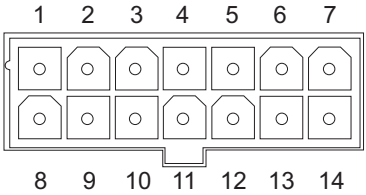
Due to the I-Drive's ability to operate at low voltages, the Solenoid Brake(s) fitted must be capable of operating over the same range.

It is the responsibilities of the machine manufacturer to test the effectiveness of the Solenoid Brake(s) over the entire operating range of the I-Drive.

4 Tiller Interface

The Tiller Interface connections are via a 14 way Molex 'Mini-Fit-Jr.' connector. PGDT can supply these parts or Molex can be contacted directly. Refer to section 3.1.3 for part numbers and connector details.

I-DRIVE TILLER INTERFACE SOCKET DETAILS



PIN NUMBER	DESCRIPTION
1	Throttle Wiper
2	Throttle High Reference
3	Auxiliary 2 Output
4	Slow/Fast Switch
5	On/Off Switch
6	Inhibit 1
7	Fused 24V Supply
8	Throttle Low Reference
9	Speed Limiting Potentiometer/Belly Button Input
10	Status Indicator
11	Auxiliary 3 Output
12	Reverse Switch
13	0V
14	Inhibit 2

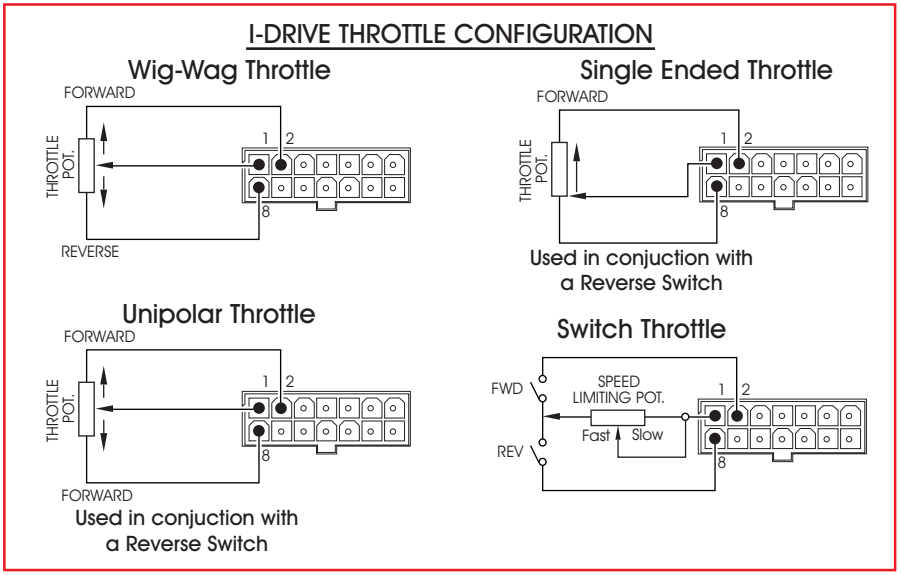
The I-Drive Machine Controller is a versatile method of machine control. To maximize this versatility the Tiller Interface can be wired in many different ways to suit a range of machine functionality. Each method of connection is individually described in this section.

4.1 Throttle Potentiometer Configuration

Pins 1,2 and 8 are the connections to the throttle potentiometer. Wig-wag, Single-ended and Unipolar throttle configurations can be used but you should ensure the controller is programmed to the correct type. Refer to Chapter 3.

The value of the potentiometer should be 5kΩ ± 20%. If the full electrical span of the potentiometer is not used, Throttle Gain can be programmed such that full speed can be achieved. Refer to the chapter 3.

If the machine has a wig-wag throttle configuration it is possible, by programming, to reverse the polarity of operation of the throttle. For single ended throttles the polarity of operation of the reverse switch can be selected. Refer to Chapter 3.



If a Switch operated throttle is required the parameter Trottle Type must be set to 1 and the parameter Throttle Reference Test must be switched OFF.

Other factory programmed throttle inputs are available such as a voltage input that accepts signals in the range of 0-5V. Please contact PGDT for details.

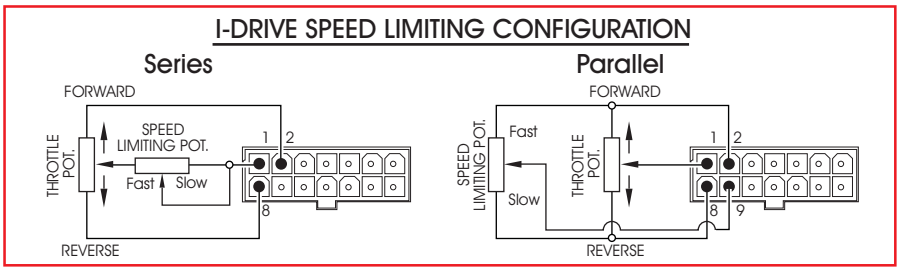
4.2 Speed Limiting Potentiometer/Belly Button Input

4.2.1 Speed Limiting Potentiometer Configuration

A speed limiting potentiometer may be connected in two ways.

- In series with the throttle potentiometer wiper.
- In parallel with the throttle potentiometer, through pin 9.

The illustration shows both connection variants with a wig-wag throttle.



If a series type connection is made a value of 25KΩ will result in the machine driving at approximately 30% of maximum speed.

If a parallel type connection is made a potentiometer of 100KΩ value should be used. The potentiometer should be connected so its wiper is connected to the throttle high reference when the potentiometer is in the fast position. The effect of the potentiometer is explained in the table below.

When a parallel type connection is made the I-Drive requires to be programmed as follows.

Drive Direction	Potentiometer Position	Vehicle Maximum Speed
Forward	Slow Position	As set by Min. Fwd Speed
Forward	Fast Position	As set by Max. Fwd Speed
Reverse	Slow Position	As set by Min. Rev Speed
Reverse	Fast Position	As set by Max. Rev Speed

The parameter Speed Limit Pot. Enabled should be set to On.

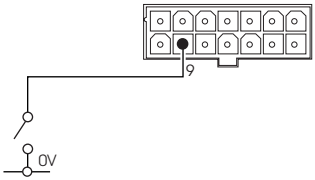
4.2.2 Belly Button Input Configuration

A belly button is a safety feature used on pallet trucks, floorcare machines etc. which prevents the operator being trapped between the machine and obstructions such as walls. when reversing. It is normally a protruding switch which is mounted on the control handle / vehicle body at waist height, which is automatically depressed by the operator's body as the machine reverses against the obstruction. Once actuated, the machine instantly stops reversing, and automatically drives forward away from the obstruction at a set speed for a set time.

It is the responsibility of the machine manufacturer to ensure the mechanical arrangement of the belly button is suitable for the intended application. PGDT accepts no liability for losses of any kind arising from the incorrect mechanical arrangement of the belly button or the type of belly button switch used.

Pin 9 allows the connection of a belly button switch as follows:

I-DRIVE BELLY BUTTON INPUT CONFIGURATION



Belly Button Function Associated Parameters:

Speed Limit Pot Enabled

Belly Button Normally Open

Belly Button Speed

Belly Button Time

Setting the parameter " Speed Limit Pot Enabled" to "Belly Button" enables the belly button function.

Set the parameter "Belly Button Normally Open" to Yes for a belly button switch that is open when not activated. Select No for a belly button switch which is closed when not activated.

The parameter "Belly Button Speed" selects the speed at which to travel forward when the belly button is pressed, as a percentage of maximum speed.

The parameter "Belly Button Time" sets the duration of forward travel when the belly button is pressed in seconds.

When suitably programmed, the switch is actuated AND the controller is in reverse drive, the "belly button mode" is initiated which will:

- Instantly reduce reverse drive to 0%
- Accelerate in the fwd direction to the programmed Belly Button Speed within 0.5 second
- Drive fwd at the programmed Belly Button Speed for a time set by the programmed Belly Button Time
- Decelerate from the belly button speed to a halt in 1 second

- Exit belly button mode and resume normal operation once the next throttle signal is received.

Once initiated, the belly button mode will complete this sequence regardless of throttle commands.

The machine manufacturer is responsible for ensuring that the wiring of the belly button switch and the programming of the belly button parameters are suitable for the intended application. PGDT accepts no liability for losses of any kind arising from the incorrect wiring or programming of the belly button function.

4.3 Fused B+ Supply

Pin 7 is a battery positive supply for the Keyswitch circuit. The output has a self resetting fuse internally fitted. PGDT recommend that no more than 1.5A is drawn from this output.

This connection should have no external capacitance connected to it, and care should be taken not exceed the fuse rating if lights or other auxiliary functions are connected.

4.4 On/Off Switch

Pin 5 is the on/off switch input to the I-Drive.

Due to the I-Drive's low current drain when in the Off state, the positioning of large capacitors on the On/Off line, between pins 5 & 7, could have a detrimental effect on the controller's ability to switch off and on.

It is the responsibility of the machine manufacturer to test the effectiveness of the On/Off switch.

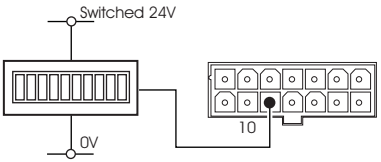
4.5 Status Indicator

This output controls either a PGDT TruCharge type status indicator or a single bulb (or LED) type Status Indicator.

If you are using a PGDT TruCharge indicator, the data connection must be to pin 10.

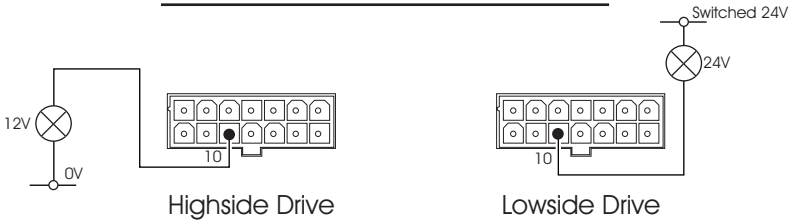
The maximum current rating of the output is 50mA, you must ensure that the indicator does not draw more current than this value.

I-DRIVE TRU-CHARGE STATUS CONFIGURATION



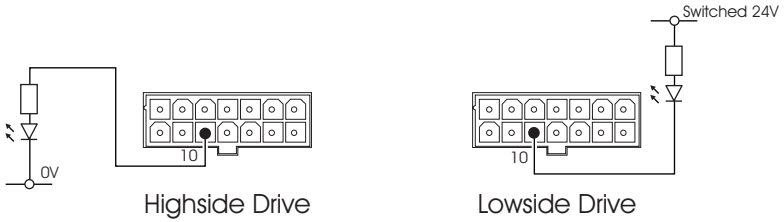
If you are using a bulb, a 12V bulb with a maximum rating of 600mW must be connected directly between pin 10 and 0V or Switched 24V.

I-DRIVE STATUS LAMP CONFIGURATION



If you are using an LED, it is connected between the same points but you must provide a series connected current limiting resistor.

I-DRIVE STATUS LED CONFIGURATION



4.5.1 Status Indicator Diagnostic setting

For each Status Indicator type the controller will require programming to suit. The parameter which will require adjustment is Diagnostic Flash Sequence.

This will require programming to one of the following:

0 - No diagnostic indication.

1 - PGDT diagnostic information. Refer to Chapter 1 section 8.

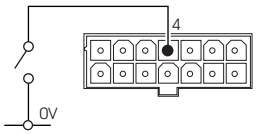
2 - Suitable for Lamp or LED Status Indicators. The Status Indicator will flash the equivalent message of the TruCharge display.

Refer to Chapter 3 for details.

4.6 Slow/Fast Switch

Pin 4 is an input which can be used to select the forward and reverse speeds, the forward and reverse acceleration and the forward and reverse deceleration of the machine.

I-DRIVE SLOW/FAST SWITCH CONFIGURATION



If pin 4 is connected to 0V the controller will drive using the programmed slow speed and rates. These speeds are listed below.

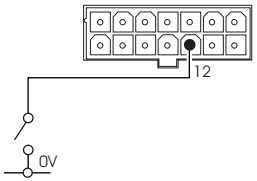
If pin 4 is open then the controller will drive using the programmed fast speed and rates. Refer to the chapter 3 for programming details. These speeds are listed as follows:

Forward Accel'n	fast : xx	slow: xx
Forward Decel'n	fast : xx	slow: xx
Reverse Accel'n	fast : xx	slow: xx
Reverse Decel'n	fast : xx	slow: xx
Max Fwd Speed	fast : xx	slow: xx
Min Fwd Speed	fast : xx	slow: xx
Max Rev Speed	fast : xx	slow: xx
Min Rev Speed	fast : xx	slow: xx

4.7 Reverse Switch/Auxiliary 3 Input

Pin 12 is a connection to a reverse switch. This is required to select reverse drive only if the controller is being used with Single-ended or Unipolar throttle configurations.

I-DRIVE REVERSE SWITCH CONFIGURATION



If a Wig-wag throttle is fitted to the machine then this input can be used to control the Auxiliary 3 Output.

The polarity of the input is programmable and can be changed using the Invert Throttle parameter refer to chapter 3 for details.

- With Invert Throttle set to Off, the drive will be in reverse if pin 12 is connected to 0V.
- With Invert Throttle set to On, the drive will be forwards if pin 12 is open.

4.8 Auxiliary 2 Output

Pin 3 is a self protected output with a 500mA rating which can be programmed to operate one of a range of functions depending on the machines specifications. The parameter which must be programmed is Auxiliary 2 Output Mode.

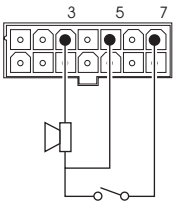
The Auxiliary 2 Output Mode parameter sets when this output will be active.

The output can be used as a Reverse Alarm, a Brake Light or to drive an Auxiliary motor. (Refer to sections 4.9.1,4.9.2 & 4.9.3 respectively for wiring details).

4.8.1 Reverse Alarm

To install a 24V sounder the positive terminal of the sounder should be connected, via the on/off switch, to battery positive. The negative terminal of the sounder should be connected to pin 3.

I-DRIVE REVERSE ALARM CONFIGURATION



For the Reverse Alarm to operate the Auxiliary 2 Output Mode must be set to - Reverse Alarm and the Reverse Alarm Output Mode must then be configured.

To create either a pulse or continuous alarm tone adjust the parameter Pulsed Reverse Alarm.

Once configured as a Reverse Alarm the output can be programed to work three further functions. Each parameter must be programmed individually.

The parameters are:

Brake alarm- If an Open-circuit in the brake wiring is detected, such as when the freewheel switch is activated, then the alarm will sound.

Low Batt alarm - The alarm will sound when the battery level reaches the programmed Low Battery Flash Level.

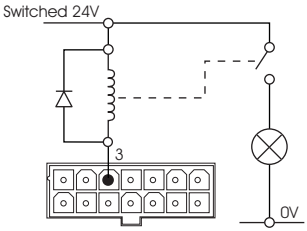
Diagnostic al'm - This will create a pulse type alarm which will sound the equivalent of the TruCharge diagnostic indicator.

The diagnostic alarm will sound a warning signal to alert the user that a diagnostic alarm pattern is about to be sounded. The signal will be a set of fast beeps lasting two seconds. The slower diagnostic pattern will then be sounded once.

4.8.2 Brake Light

Pin 3 can also be connected and programmed as a brake light indicator.

I-DRIVE BRAKE LIGHT CONFIGURATION



If the current drawn is less than 500mA the relay is not required.

The parameter which requires adjustment to enable this function is - Brake Light

Off - Pin 3 is not active as a Brake Light.

On - Pin 3 is activated as a Brake Light.

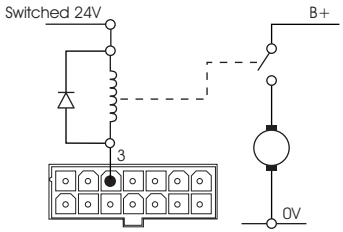
4.8.3 Auxiliary Motor

Pin 3 can also be used to drive an auxiliary motor, via a relay, such as a Brush or Vacuum motor.

Pin 3 will be active depending on how the parameter Auxiliary 2 Output Mode is programmed. The three modes which should be used to control an auxiliary motor are Forward Only, Fwd & Rev or Continuous.

Forward Only	Means the Output is only active when the machine is driving forwards.
Fwd & Rev	Means the Output is active when the machine is driving in either direction.
Continuous	Means the output is active the entire time the control system is powered-up.

I-DRIVE AUXILIARY LOAD CONFIGURATION



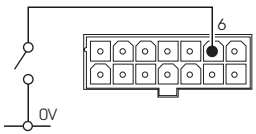
4.9 0 Volts

Pin 13 provides the battery negative connection to the machine's tiller. This pin has a current rating of 3A via an internal self-resetting fuse.

4.10 Inhibit 1

Inhibit 1 input is located at pin 6 of the 14 way tiller connector.

I-DRIVE INHIBIT 1 SWITCH CONFIGURATION



The Inhibit inputs have been designed to either inhibit a specific function or control an Auxiliary function such as a brush or vacuum motor. The inhibits can be used to either limit the maximum speed of the machine, stop it completely or in the case of an

auxiliary output stop and start the output device.

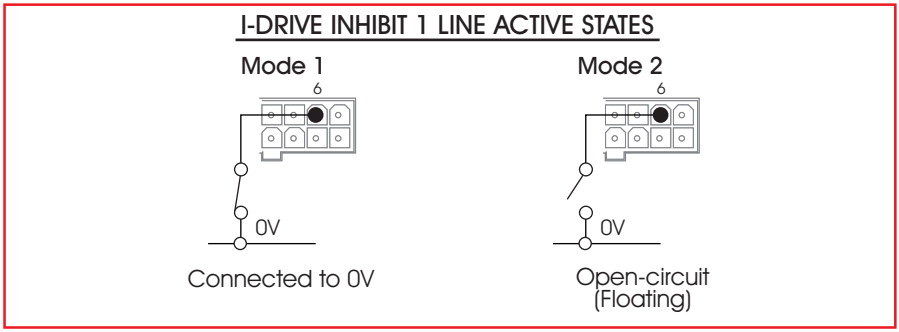
See the example in section 4.11.4

Inhibit 1 input has 4 programmable parameters.

- Inhibit 1 Mode
- Inhibit 1 Target
- Inhibit 1 Speed
- Inhibit 1 Operation

4.10.1 Inhibit 1 Mode

The Mode parameter refers to the state in which the inhibit is active.



4.10.2 Inhibit 1 Target

This parameter sets the function which will be affected when the inhibit switch is in the required state.

The functions which can be affected are:

Traction	All traction is inhibited. The Operation and Speed parameters will control how the traction is inhibited.
Reverse	Reverse Traction only is inhibited.
Forward	Forward traction only is inhibited.
Aux 1	Auxiliary 1 output is inhibited.

Setting this parameter to Aux 1 will allow control of the Auxiliary 1 Output, so the Inhibit 1 input can be used to switch Aux 1 output on and off.

4.10.3 Inhibit 1 Speed

This parameter sets the maximum speed of the machine when the Inhibit 1 input is active and the Target is set as Traction. The parameter is adjustable between 0 and 100% in steps of 1%.

When Inhibit Speed = 0 this acts as an inhibit. At this time the controller will refer to the Inhibit Operation parameter to establish what type of inhibit will be created.

If the Inhibit Speed is greater than 0 then the controller will not enter an inhibit state.

4.104 Inhibit 1 Operation

This parameter is only effective if the Inhibit 1 Speed parameter has been set to 0.

The parameter can be set to one of two states:

Latched - Means the inhibitor, such as a safety switch, must be deactivated and the controller turned off and on before the machine can be operated again.

Non-Latched - Means the controller can be reset to an operational state by removing the inhibitor.

If set to Latched, then when Inhibit 1 is active the TruCharge display will flash 6 bars and a trip will appear in the diagnostic log.

Example 1 - To provide a speed inhibit function that is active when Inhibit 1 is connected to 0V and is non-latching, program as below.

Mode = 1

Target = Traction

Speed Limit Value = 40%

Operation = Non-Latched

If this inhibit is activated then the controller will cause the machine to decelerate to the programmed speed limit value. This could be activated by a microswitch on a Brush Head Lever being activated when the Brush is lowered to the ground. In this instance the TruCharge indicator will remain unchanged.

Example 2 - To provide a trip inhibit function that is active when Inhibit 1 is connected to 0V and is latching, program as below.

Mode = 1

Target = Traction

Speed Limit Value = 0

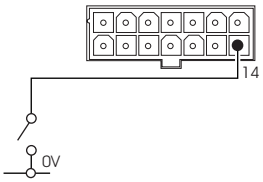
Operation = Latching

If this inhibit is activated then the controller will not allow drive. This could be activated by an On-board Charger being connected to the line. The TruCharge indicator will display a 6-bar trip.

4.11 Inhibit 2

Inhibit 2 input is located at pin 14 of the 14 way tiller connector.

I-DRIVE INHIBIT 2 SWITCH CONFIGURATION



The Inhibit inputs have been designed to either inhibit a specific function or control an Auxiliary function such as a brush or vacuum motor. The inhibits can be used to either limit the maximum speed of the machine, stop it completely or in the case of an auxiliary output stop and start the motor.

Inhibit 2 input has 2 programmable parameters.

- Inhibit 2 Mode
- Inhibit 2 Target

4.11.1 Inhibit 2 Mode

The Mode parameter refers to the state in which the inhibit is active.

I-DRIVE INHIBIT 2 LINE ACTIVE STATES

4.11.2 Inhibit 2 Target

This parameter sets the function which will be affected when the inhibit switch is in the required state.

The functions which can be affected are:

Traction	All traction is inhibited. The Operation and Speed parameters will control how the traction is inhibited.

Reverse	Reverse Traction only is inhibited.
Forward	Forward traction only is inhibited.
Aux 2	Auxiliary 2 output is inhibited.

Setting this parameter to Aux 2 will allow control of the Auxiliary 2 Output, so the Inhibit 1 input can be used to switch Aux 1 output on and off.

5 Traction Motors

The controller is designed to be connected to permanent magnet DC motor, fitted with a suitable gearbox and solenoid brake (if required).

In order to optimize the performance of the machine, the controller must be matched to the motor terminal impedance. This matching is implemented by programming the controller. The parameter for adjustment is Motor Compensation. Refer to Chapter 3.

The Motor Compensation value should be set in accordance with the armature resistance of the motor and all cables and connectors between the I-Drive and the motor. The value is set in milli-Ohms (mΩ). A recommended value is:

- 60% of the (armature resistance + cables and connectors)

Motor manufacturers should be able to supply figures for armature resistance and cable and connectors may typically be 40mΩ.

Example:

Motor has armature resistance of 200mΩ

Cables and connectors are 40mΩ

Set Motor Compensation to 0.6 x (200 + 40) = 145mΩ

Failure to match the controller with the motors may result in poor control characteristics.

If you have any doubts about the suitability of a particular motor type or you need advice on measuring motor impedance, contact PGDT.

The machine manufacturer is responsible for ensuring that the controller is matched to the motor resistance. Failure to do this may result in poor control characteristics, which in extreme instances can make a machine uncontrollable and potentially unsafe. PGDT accepts no liability for losses of any kind arising from failure to comply with this condition.

The machine manufacturer is responsible for always ensuring that any replacement motors or gearboxes are fully compatible with the originals that the controller was designed to match. Failure to do this may result in poor control characteristics, which in extreme instances can make a machine uncontrollable and potentially unsafe. PGDT accepts no liability for losses of any kind arising from failure to comply with this condition.

Users or service personnel must not move a controller from one machine type to install it on a different machine type. Controllers with different part numbers may have both hardware and software differences to ensure that they are

compatible with the electrical and dynamic characteristics of their specific target vehicles. The characteristics of one type of controller may not be compatible with a different machine. Failure to observe this warning could result in an unsafe setup for the machine user and may create a fire hazard depending on the motors, wiring, connectors and circuit breakers installed on the unauthorized machine. PGDT accepts no liability for losses of any kind arising from failure to comply with this condition.

5.1 Gradient Performance

To achieve the most comfortable performance on a gradient, it is desirable to minimize the roll-back and roll-forward of the machine. By minimizing these effects, user comfort is improved and drive train reliability increased.

Roll-back occurs when the throttle is released while driving uphill, the machine will stop and then may roll-back slightly before the brake is applied.

Roll-forward occurs when the throttle is released while driving downhill and results in the brake being applied while the machine is still moving.

The following programming is provided to allow these two conditions to be minimized.

Motor Compensation, Slope Factor and Anti-Rollback Level. Refer to Chapter 3.

5.2 Freewheeling

There are two typical methods for providing a machine freewheel function.

- Disengaging the motor and brake assembly from the remainder of the drive train and allowing the wheels to freely rotate.
- Disengaging the solenoid brake from the motor and allowing the wheels and motor to rotate.

If the latter method is used, the I-Drive can detect the motor rotating above a certain speed and then brake it automatically, thus removing the possibility of the machine freewheeling at an excessive speed. This function will operate if the machine is switched off and even if there are no batteries fitted or connected.

It is the responsibility of the machine manufacturer to ensure that adequate precautions are taken to warn the user against the hazards of freewheeling the machine at excessive speeds. It is also the responsibility of the machine manufacturer to utilize a suitable freewheel mechanism to reduce these risks. PGDT accepts no liability for losses of any kind resulting from excessive freewheel speeds of a machine.

6 Programming Connection

The I-Drive controller has a dedicated connector for a PGDT Programming device. This connector can only be used for a PC Programmer communication cable.

The programmer connector details can be found in Section 3 of this chapter.

The Molex 4-way connector can only be used as a communications port for a PGDT PC Programmer cable. PGDT accepts no liability for losses of any kind arising from failure to comply with this condition.

7 Batteries

The controller is designed for operation with 24V lead acid batteries. The batteries may be wet or gel electrolyte types.

8 Mounting

There are two methods for mounting the I-Drive Machine Controller. They are:

8.1 I-Drive

8.2 I-Drive + I-cover

8.1 I-Drive

8.1.1 Orientation

The recommended mounting orientation is such that the connectors must be lowermost. See the following illustration. The function of the controller is not sensitive to mounting orientation. The electronics compartment of the controller has an IPX5 ingress protection rating.

8.1.2 Position

The controller must be mounted in a position where it is not exposed to levels of water, dust, shock or vibration above those expected on a mobility machine application. The controller has been tested in accordance with IS07176/14 with respect to these conditions.

The controller has excellent thermal performance but, to improve this further, the baseplate may be secured against a metal part of the machine chassis. To provide even better thermal performance, a non-silicone thermally conductive paste or pad may be applied between the baseplate and the machine chassis.

Contact PGDT if you need further advice.

Under strenuous driving conditions it is possible for metal sections of the controller's case to exceed 41°C (106 °F) in temperature. Under such conditions, the machine manufacturer should ensure that either the user cannot touch these surfaces, or that the user is warned not to touch these surfaces. While 41°C (106 °F) is very close to normal body temperature, prolonged contact with surfaces above 41°C (106 °F) can result in burns to the skin. PGDT accepts no liability for losses of any kind arising from failure to comply with this condition.

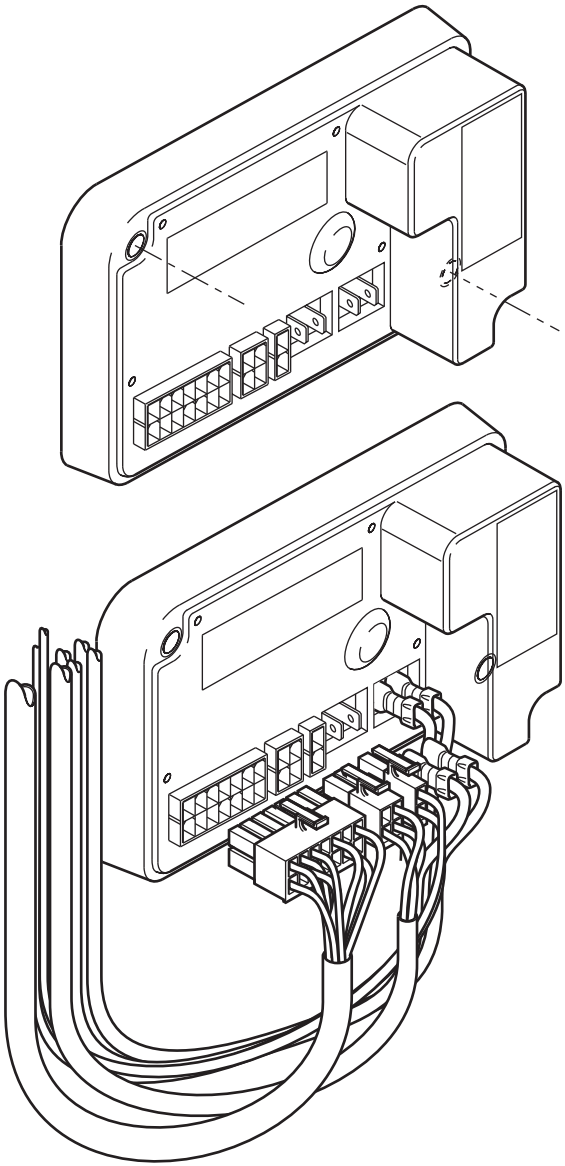
8.1.3 Cables

The cables to the controller must be routed and secured in such a way as to prevent damage to them, for example by cutting or crushing.

It is suggested that the cables are mounted so that they loop up to the I-Drive, therefore minimizing the flow of moisture into the connectors.

See the following illustration.

I-DRIVE MOUNTING



Cables should be mounted as shown

8.2 I-Drive + I-cover system

8.2.1 Orientation

The recommended mounting orientation is such that the connectors must be uppermost. The function of the controller is not sensitive to mounting orientation. The electronics compartment of the controller has an IPX5 ingress protection rating.

8.2.2 Position

The controller must be mounted in a position where it is not exposed to levels of water, dust, shock or vibration above those expected on a mobility machine application. The controller has been tested in accordance with IS07176/14 with respect to these conditions.

The controller has excellent thermal performance but, to improve this further, the baseplate may be secured against a metal part of the machine chassis. To provide even better thermal performance, a non-silicone thermally conductive paste or pad may be applied between the baseplate and the machine chassis.

Contact PGDT if you need further advice.

Under strenuous driving conditions it is possible for metal sections of the controller's case to exceed 41°C (106 °F) in temperature. Under such conditions, the machine manufacturer should ensure that either the user cannot touch these surfaces, or that the user is warned not to touch these surfaces. While 41°C (106 °F) is very close to normal body temperature, prolonged contact with surfaces above 41°C (106 °F) can result in burns to the skin. PGDT accepts no liability for losses of any kind arising from failure to comply with this condition.

8.2.3 I-cover Mounting

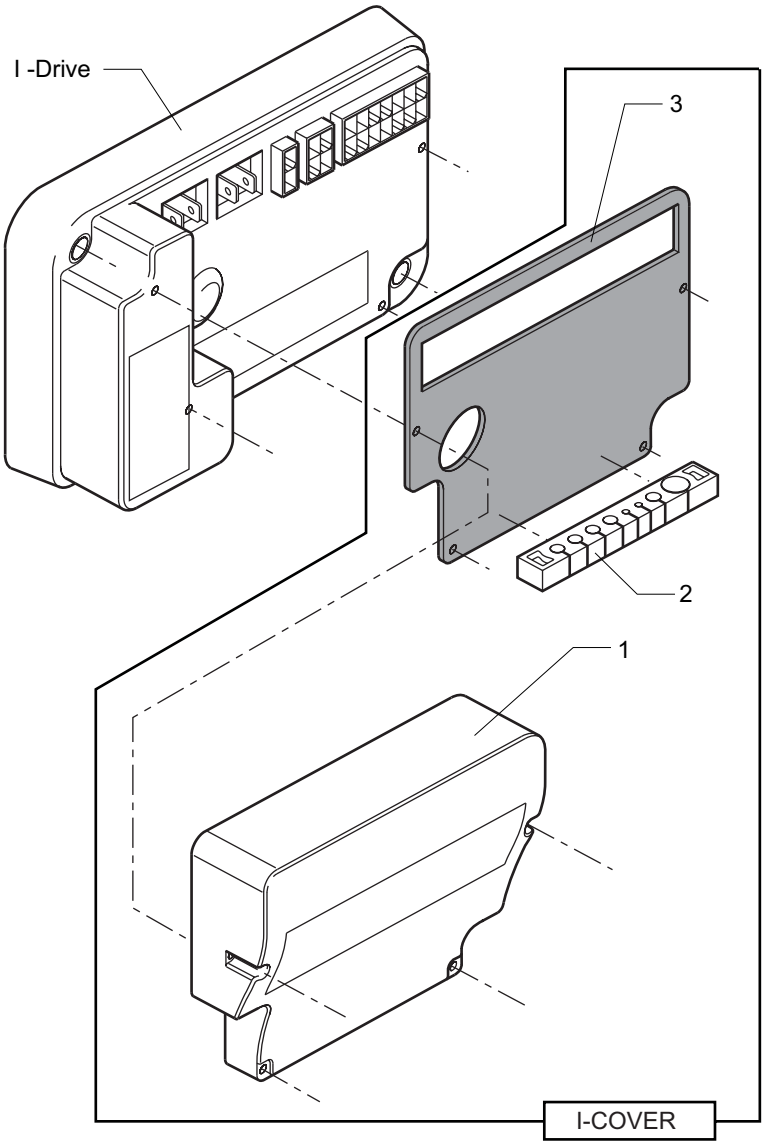
Once the controller is securely mounted to the machine the I-cover can be applied. To mount the I-cover use the following description:

- Position the rubber gasket.
- Push the connector cables into the rubber cable seal.
- Connect the cables to the I-Drive.
- Position the I-cover over the gasket and seal.
- Place the four screws into position and secure.

The I-cover comprises of a rubber gasket (3), a rubber cable seal (2), a molded plastic cover (1) and 4 screws. These items a available in kit format from PG Drives Technology.

The I-Cover kit number is: D50282

I-DRIVE + COVER MOUNTING

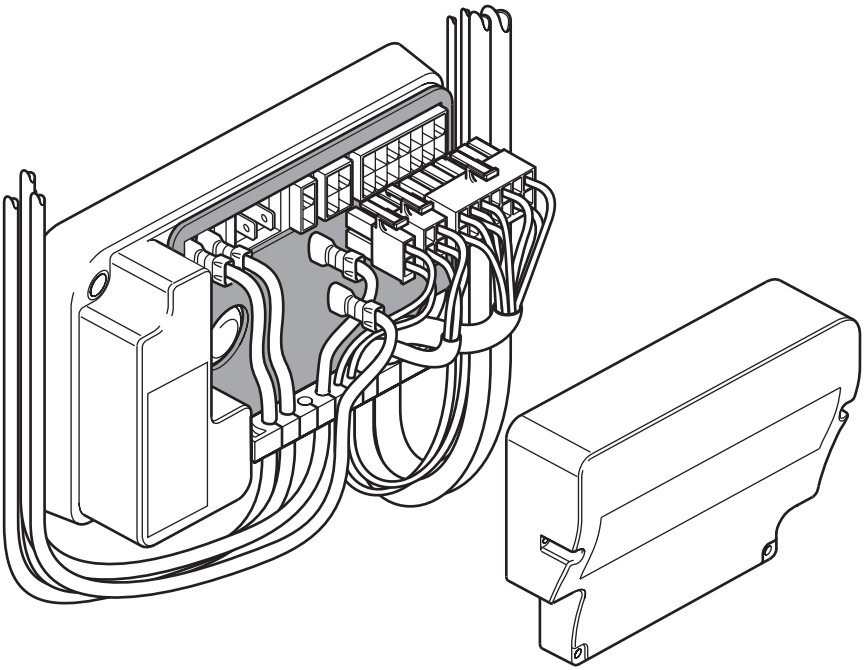


8.2.4 Cables

The cables to the controller must be routed and secured in such a way as to prevent damage to them, for example by cutting or crushing.

It is suggested that the cables are mounted so that they loop up to the I-Drive, therefore minimizing the flow of moisture into the connectors.

CONNECTOR MOUNTING



9 Battery Gauge

Refer to Chapter 1 sections 8 and 9 for how to read the battery gauge.

The battery gauge will start to flash one bar slowly when the Battery Lockout function has been triggered. The Battery Lockout Voltage setting controls the level at which this indication is given.

For optimum accuracy of the battery gauge and low battery indicator, the controller should be programmed with the approximate nominal capacity of the machine battery. However, accuracy is not greatly affected if the programmed type and capacity do not closely match the battery.

The most important factor affecting the accuracy of the battery gauge is the resistance of the cable and connections between the battery and the controller. The controller must be matched approximately to the cable resistance of your machine to make the battery gauge accurate. Refer to Chapter 3.

As a guide, 2.5 mm^2 cable has a resistance of about 8 mΩ per meter; 4 mm^2 cable has about 5 mΩ per meter and 6 mm^2 has about 3.3 mΩ per meter. Circuit breakers and connectors usually account for about 15 mΩ.

These values will be chosen at the time the controller is being specified by the machine manufacturer. Once these values are decided they are programmed into controllers during manufacture and should never need changing.

If you need advice, contact PGDT

10 Electromagnetic Compatibility (E.M.C.)

The I-Drive control system has been tested for compliance with EMC requirements of EN55022 Class B. The guidelines in this section will help you to make sure that your machine installation will meet the requirements. You should consider EMC and perform relevant tests as early as possible in the design phase.

10.1 Emissions

Observe the following recommendations to minimize radio frequency emissions:

10.1.1 Motor Suppression

Solder a suitable suppression capacitor between the brush holders of each motor, inside the motor cases. Keep the lead length as short as possible. We recommend a value of 4n7F 250V AC ceramic. The maximum value you should use is 10nF. A typical type is Roderstein WY0472MCMCF0K.

For 4 pole motors, a capacitor should be fitted between each pair of brushes.

10.1.2 Cables

You do not need to use screened battery and motor looms, but:

- Keep the length of all wiring to a minimum.
- Make sure the loop area of the wiring is minimized. Route the positive and negative wires to each motor together.
- Route the battery positive and negative wires together. Where possible, route the battery and motor looms together.
- Secure the motor and battery looms to the machine frame over as much of their length as is practical.
- Do not use the control system connectors as junction points for the battery connections. Separate junction points away from the I-Drive should be provided for the other machine electrical functions.

10.2 Immunity

The I-Drive control system has been stringently tested for susceptibility to electromagnetic radiation over the frequency range 26 MHz to 1 GHz.

Follow the recommendations in section 10.1.2 to ensure maximum immunity to electromagnetic radiation.

II Electro-Static Discharge (E.S.D.)

With electronic control systems being installed in more small electric vehicle applications it is important to understand how to prevent ESD (Electrostatic Discharge) damaging or disrupting systems.

Electrostatic Discharges occur when a charged body comes into close contact with an electrically conductive surface. In the case of the vehicle the causes are:-

- A charged operator touching the control panel or machine.
- The machine becoming charged and touching an operator or obstacle
- One part of the machine becoming charged through movement or operation (e.g. cleaning brushes) and a flashover occurring to another part of the machine or the electrical system.

When a discharge occurs the currents flowing can be very high with a very fast rise time. This may cause damage or disruption to the control system either directly or indirectly via transient coupling effects.

In all cases prevention of the prime cause is better than cure. Although measures can be taken to route ESD away from sensitive areas or protection components added to the system, subtle changes to the system often make cures unreliable. Different batches of components, slightly different wiring paths or atmospheric conditions etc. will make the system behave differently.

Designing ESD protection is concerned with the performance of the complete operating system not the individual components. Items which are exposed to the outside world must normally be protected against high ESD voltages and currents. "Under-bonnet" is either concerned with preventing charge build up or preventing flashover under ESD transient conditions.

There are various international standards currently under development for this aspect of the system's performance. At present, most of the standards are specifying the system to be tested to requirements of IEC801-2 Severity Level 3. Tests are carried out at 8kV air discharge (to non-conductive surfaces) and 6kV contact discharge (to conductive surfaces).

II.I Electrical Masses.

In most electric vehicle systems there are several large electrically conductive masses. The first is the electrical wiring system itself including the control system and battery. The others are any electrically conductive mass around the vehicle. The major one will be the chassis or other major parts of the structure. However, not only can the chassis on some vehicles be non-conductive (plastic, GRP) but there are often sub-chassis or large metallic components which are electrically isolated form each other.

Each of these electrically conductive masses may become charged by various means. If the charge voltage becomes sufficiently high then a flashover to another electrically conductive mass such as the electrical system can occur. The electrostatic discharge produced by this method can be very large and damaging.

Items such as motor cases are also electrically conductive masses that can charge up and cause flashover.

Flashover can either take the form of intermittent large scale events or as continuous small discharges depending on the voltage and charge levels. The latter can be the cause of failure when conducting radiated emissions testing for EMC approvals.

11.2 Prevention.

Prevention mainly concerns preventing differential charge build up on all the different electrical masses around the vehicle. The electrically conductive masses comprise the electrical system and any large metallic masses around the vehicle such as sub-chassis and large electrical components etc.

There are two main methods: -

1) **Provide electrically conductive discharge or drain paths between the electrically conductive masses around the machine.**

This is best achieved by providing a drain wire, which connects all the electrically conductive masses around the vehicle together. The path of the wire or wires should be kept as short as possible. In some applications a resistor of a suitable value may be inserted in all or one of these lines. Varistors may also be used in some applications.

- **Resistors can prevent large ESD currents flowing that may cause unpleasant shocks to operators but at the same time prevent differential charge build up occurring.**
- **Varistors appear open circuit to battery voltages but will limit charge build up to a safe level. They can be used where a battery ground circuit is the only drain path available.**

2) **Prevent charge build up.**

The action of the vehicle travelling over certain surfaces or certain actions carried out by the vehicle (e.g. cleaning brush operation) may cause a significant charge build up by all or part of the vehicle. Static dissipating straps, wheel materials or careful material selection can reduce or prevent charge build up.

Ensure repeatability. Paths, paint.

11.2.1 Control Panels.

Control panels and their components should be made form non-conductive materials in order to prevent any form of electrostatic discharge. This not only protects the control system but also prevents the operator experiencing shocks.

If the panel is made from a conductive material then a drain wire must be connected to the main chassis or other conductive masses around the vehicle.

On some designs the only available solution is to connect the panel to a battery ground via a varistor. However, ESD may still cause disruption to the signals from the control panel as large discharges will cause disturbances in the ground line.

Where conductive user control systems are used (e.g. metal toggle switches) the body must be connected to the panel (assuming it is conductive). If the control panel is not conductive then the body of the control must be connected to the chassis by drain wire or battery ground via a varistor. Some user control systems will be unsuitable, as they will provide an ESD path to and from the outside world (perhaps by a hidden path) but no means of providing a drain path.

Membrane keyboards can provide a high degree of protection – however they must be made of sufficiently thick material (the supplier should be able to advise). Other design details such as ensuring the switch tracks are well away from the edge of the keyboard and providing conductive barrier tracks can also improve reliability.

11.2.2 Electrical System to Chassis paths.

It is important to provide an ESD discharge path between the electrical/control system and any electrically conductive masses in close proximity to it (chassis etc.). Failure to do say may result in uncontrolled flashovers leading to damage or malfunction.

All PGDT control systems incorporate conduction paths between the battery 0V connection and the heatsink/case. The screws that mount the controller case or heatsink to the vehicle chassis or metalwork normally complete the circuit path between electrical system and chassis. If the control system is mounted on a non-conductive surface then another means of providing the circuit path must be provided.

PGDT control systems either incorporate an internal varistor or resistor in series with the battery 0V to heatsink/case connection. The resistor is adequate for most purposes. However, if system ESD tests show a problem then a varistor should be fitted externally.

11.2.3 Electrical Components.

Large electrical components such as motor casings can store appreciable amounts of ESD energy if they are not grounded. This can flashover to sensitive circuitry. If a separate drain wire is not possible then a drain resistor or varistor connected to a power circuit connection can be used. However, issues such as circuit isolation, potential standby battery drain and noise propagation must be considered.

11.2.4 Ensuring repeatability.

Various precautions should be taken to ensure repeatable protection from ESD. Connections to ESD drain wires etc. should not be made through painted surfaces. The routing of drain wires must be consistent. Any significant modifications to components or routings should be tested for its effect on ESD performance.

11.2.5 Drain path components.

There are various options on providing drain paths for ESD.

DRAIN WIRES

These components are not suitable for use in ESD discharge paths.

- Advantages:- low cost, low impedance maximizes protection from ESD by minimizing transients.
- Disadvantages:- ESD currents can be high and unpleasant if experienced by operators. Connecting to a battery terminal may compromise safety as chassis components etc. will become “live”. Drain wires may also contribute to ground loops in some system or compromise EMC performance.

RESISTORS

Resistors provide a suitable discharge path for charges occurring or generated between the electrical masses of the system. Typical values range from 10 kOhm to 10 mOhm.

- Advantages: - can limit ESD discharge currents (unless a flashover occurs) to

operators etc. Can be used in series with drain paths to battery ground (0V) terminals as chassis isolation is provided, however leakage currents must be at a safe level. Resistors also limit the possibility of creating ground loops or propagating electrical noise (compromising EMC performance).

- Disadvantages:- does not provide a low impedance path for ESD so may be ineffective when large ESD discharges occur.

VARISTORS

These components provide an effective ESD path where isolation from battery voltages is required. The varistor continuous voltage rating is normally around twice the battery voltage (1.5 times minimum). Harris varistor type V82Z2 has proven effective in many 24V and 36 V applications.

- Advantages: - provides circuit isolation and low impedance.
- Disadvantages: - the low impedance implies that varistors will not protect operators from large ESD discharges.

CAPACITORS & INDUCTORS

These components are not suitable for use in ESD discharge paths. Capacitors tend to offer protection by breaking down and operating like a varistor - by implication the capacitor is progressively damaged. Inductors have a high impedance to fast transients. However, ferrite beads may provide some additional protection where other solutions prove marginal.

SPARK GAPS

Spark gaps designed into PCBs may provide some very useful "front line" defence against large ESD discharges. However, they need careful design, a low impedance ground connection and their performance will vary with surface finish and contamination.

12 Production Tests

- Perform the following tests, in order, on each machine before dispatch.

These tests should be conducted in an open space and a restraining device such as a seat belt should always be used. PGDT accepts no liability for losses of any kind arising from failure to comply with this condition.

12.1 Mounting

- Make sure that the controller is securely mounted. Do not overtighten any securing screws.

12.2 Cables and Connectors

- Check all cables and connectors for damage. Make sure that all connectors are securely mated.

12.3 Preset Settings

- Make sure that the controller is using the correct program settings for the machine. Refer to the programming and fault finding manual for detailed instructions.

Controllers are always supplied with the settings shown on the relevant data sheet.

12.4 Operational Test

This test should be carried out on a level floor with at least one meter clear space around the machine.

- Switch on the controller.
- Check that the status indicator remains on, or flashes slowly, after one second.
- Go to drive the machine slowly in the forwards direction until you hear the solenoid brake operate (if fitted). The machine may start to move.
- Immediately release the throttle. You must be able to hear the solenoid brake operate within a few seconds (if fitted).
- Repeat the test in the reverse direction.

12.5 Test Drive

- Drive the machine and make sure that it operates correctly for all positions of the user controls.

12.6 Soft-Stop Test

- Drive the machine at full forward speed and switch the controller off.

- The machine must not stop suddenly, but should decelerate to standstill.

In addition, ensure that the requirements in section 1.3 of this chapter are satisfied.

CHAPTER 3
PROGRAMMING

1 Introduction

This chapter gives an overview of the programmable parameters within the I-Drive Controller. The I-Drive can be programmed with a SP1a Handheld Programmer or a PG Drives Technology PC Programmer.

This chapter does not give details of how to make adjustments, for these details please refer to the relevant documentation for the programmer you are using.

Programming should only be conducted by electronic professionals with in-depth knowledge of PGDT controller. Incorrect programming could result in an unsafe set-up of a machine for a user. PGDT accept no responsibility for losses of any kind if the programming of the control system is altered from the factory pre-set values.

1.1 SP1a Programmer

The SP1a handheld programmer is intended to give dealers and our service engineers access to the programmable parameters which can be used to adjust the machineto an individual user. These parameters are:

Acceleration

Deceleration

Forward Speed

Reverse Speed

Throttle Invert

Sleep Timer

Read System Log

Read Timer

The SP1a can also be used to Read Trip Log and Read Timer. For details of how to use the SP1a with the I-Drive, refer to the SP1a Programming and Diagnostics guide, SK73762.

1.2 PC Programmer

There are two versions of the PC Programmer – one for dealers which gives the same access level as the SP1a handheld programmer; and one for machine OEMs which gives access to all I-Drive Controller parameters. These are known as PCPa and PCPb respectively.

For details of how to use these software packages with the I-Drive, refer to the documentation supplied with the software.

1.3 Parameters

The parameters are have all been separated into workable groups for easy referencing.

The groups and their sections are:

Speeds - Section 2

Forward Acceleration
Forward Deceleration
Reverse Acceleration
Reverse Deceleration
Max. Forward Speed
Min. Forward Speed
Max. Reverse Speed
Min. Reverse Speed
Speed Limit Pot. Enabled
Belly Button Normally Open
Belly Button Speed
Belly Button Time

Operation - Section 3

Sleep Timer
Throttle Invert

Throttle - Section 4

Throttle Type
Throttle Deadband
Throttle Gain
Throttle Operated at Power-up
Throttle Reference Test
ISO Test Resistor

Battery - Section 5

Cable Resistance
Calibration Factor
Low Battery Alarm
Battery Lockout Parameterst

Inhibit - Section 6

Inhibit 1 Mode, Target, Speed & Operation
Inhibit 2 Mode, Target, Speed & Operation

General - Section 7

Soft Stop
Brake Time
Output Voltage
Diagnostic Flash Sequence
Reverse Alarm Output Mode
Pulsed Reverse Alarm
Diagnostic Alarm
Brake Disconnected Alarm
Brake Fault Detect
Brake Light
Freewheel Speed Limit
Freewheel Time-out
Auxiliary 1 Output Mode
Auxiliary 2 Output Mode
Auxiliary 3 Input
Auxiliary 3 Output Mode
Auxiliary 3 Output Voltage

Motor - Section 8

Current Limit Min & Max
Boost Drive Current & Time
Current Foldback Threshold, Time, Level & Temp
Motor Cooling Time
Motor Compensation
Anti Rollback Level
Slope Factor
Pull-away Delay

Memory Functions- Section 9

Read System Log
Clear System Log
Read Timer
Clear Timer

2 Speed Parameters

2.1 Forward Acceleration

Adjusts the value for forward acceleration of the machine, in increments of 1. There are two settings:

Fast This value is used when the slow/fast switch is set to fast.

Slow This value is used when the slow/fast switch is set to slow.

The values are approximately displayed in "units" of 100ms and correspond to the time taken to reach full forward speed from standstill, i.e. the higher the value the slower the acceleration.

Setting this value too low could cause the machine to tip when accelerating up a slope.

2.2 Forward Deceleration

Adjusts the value for forward deceleration (or braking) of the machine, in increments of 1. There are two settings:

Fast This value is used when the slow/fast switch is set to fast.

Slow This value is used when the slow/fast switch is set to slow.

The values are approximately displayed in "units" of 100ms and correspond to the time taken to reach standstill from full forward speed, i.e. the higher the value the slower the deceleration.

It is the responsibility of the machine manufacturer to ensure that the emergency stopping distance is within the distance specified for the country in which the machine will be used.

2.3 Reverse Acceleration

Adjusts the value for reverse acceleration of the machine, in increments of 1. There are two settings:

Fast This value is used when the slow/fast switch is set to fast.

Slow This value is used when the slow/fast switch is set to slow.

The values are approximately displayed in "units" of 100ms and correspond to the time taken to reach full reverse speed from standstill, i.e. the higher the value the slower the acceleration.

2.4 Reverse Deceleration

Adjusts the value for reverse deceleration (or braking) of the machine, in increments of 1. There are two settings:

Fast This value is used when the slow/fast switch is set to fast.

Slow This value is used when the slow/fast switch is set to slow.

The values are approximately displayed in "units" of 100ms and correspond to the time taken to reach standstill from full reverse speed, i.e. the higher the value the slower the deceleration.

It is the responsibility of the machine manufacturer to ensure that the emergency stopping distance is within the distance specified for the country in which the machine will be used.

Setting this value too low could cause the machine to tip when stopping whilst reversing down a slope.

2.5 Max Forward Speed

This sets the MAXIMUM forward speed of the machine.

So long as a Slow/Fast switch is fitted to the machine then there are two available settings.

Fast This value is used when the slow/fast switch is set to fast.

Slow This value is used when the slow/fast switch is set to slow.

The value is displayed as a percentage of the machines total available output. Therefore if the Fast value is set to 80% then the machine will be able to drive at up to 80% of the total available speed when the Slow/Fast switch is in the Fast position.

This value is adjustable between 0 and 100% in steps of 1%.

If there is no Slow/Fast switch fitted then only the Fast value will be relevant.

Ensure the stability of the machine is maintained, especially when cornering, at the programmed Max Forward Speed.

2.6 Min Forward Speed

This sets the MINIMUM forward speed of the machine.

For this parameter to operate, a Speed Limiting Potentiometer must be fitted and correctly programmed. The Speed Limiting Potentiometer must be fitted in Parallel, refer to Chapter 2 section 4.2. Under these conditions there are two available settings.

Fast This value is used when the machine's Speed Limiting potentiometer is set to Slow and the Slow/Fast switch is set to Fast.

Slow This value is used when the machine's Speed Limiting potentiometer is set to Slow and the Slow/Fast switch is set to Slow.

The value is displayed as a percentage of the machines total available output.

Therefore if the Fast value is set to 40% then the machine will be able to drive at up to 40% of the total available speed when the Slow/Fast switch is in the Fast position and the Speed Limiting Potentiometer is in the Slow position.

This value is adjustable between 0 and 100% in steps of 1%.

If there is no Slow/Fast switch fitted then only the Fast value will be relevant.

This parameter can not be set at a greater value than the Max Fwd Speed.

2.7 Max Reverse Speed

This sets the MAXIMUM reverse speed of the machine.

So long as a Slow/Fast switch is fitted to the machine then there are two available settings.

Fast	This value is used when the slow/fast switch is set to fast.
Slow	This value is used when the slow/fast switch is set to slow.

The value is displayed as a percentage of the machines total available output. Therefore if the Fast value is set to 60% then the machine will be able to drive at up to 60% of the total available speed when the Slow/Fast switch is in the Fast position.

This value is adjustable between 0 and 100% in steps of 1%.

If there is no Slow/Fast switch fitted then only the Fast value will be relevant.

2.8 Min Reverse Speed

This sets the MINIMUM reverse speed of the machine.

For this parameter to operate, a Speed Limiting Potentiometer must be fitted and correctly programmed. The Speed Limiting Potentiometer must be fitted in Parallel, refer to Chapter 2 section 4.2. Under these conditions there are two available settings.

Fast	This value is used when the machine's Speed Limiting potentiometer is set to Slow and the Slow/Fast switch is set to Fast.
Slow	This value is used when the machine's Speed Limiting potentiometer is set to Slow and the Slow/Fast switch is set to Slow.

The value is displayed as a percentage of the machines total available output. Therefore if the Fast value is set to 20% then the machine will be able to drive at up to 20% of the total available speed when the Slow/Fast switch is in the Fast position and the Speed Limiting Potentiometer is in the Slow position.

This value is adjustable between 0 and 100% in steps of 1%.

If there is no Slow/Fast switch fitted then only the Fast value will be relevant.

This parameter can not be set at a greater value than the Max Rev Speed.

2.9 Speed Limit Pot. Enabled

This selects whether pin 9 is to be unused, or used for a parallel type speed limiting potentiometer or a belly button switch. The parameter can be set to Off, On, or Belly Button.

If set to Off, the I-Drive will not perform any checks on pin 9.

If set to On, then the I-Drive will check for the presence of a valid Speed Limiting potentiometer signal at pin 9, Refer to Chapter 2 section 4.2. If a valid signal is not detected the I-Drive will default to the programmed minimum speeds.

If set to Belly Button, the I-Drive will operate as per the belly button function, see Chapter 2, section 4.2.2.

PG Drives Technology recommend this parameter is set to Yes if a parallel type Speed Limiting Potentiometer is fitted.

If a speed limiting pot and a belly button switch are both required, the speed limiting potentiometer must be wired in series with the throttle wiper input. IT is the machine manufacturers responsibility to ensure that any such arrangement I suitable for the intended application.

If a series type Speed Limiting Potentiometer is fitted then this parameter must be set to On or the machine will only drive at the minimum programmed speed settings.

2.10 Belly Button Normally open

This parameter selects the input state in which the belly button mode will be active. Set to Yes for a belly button switch that is open when not activated. Select No for a belly button switch which is closed when not activated.

2.11 Belly Button Speed

This parameter sets the belly button speed as a % of the maximum speed of the machine. The parameter is adjustable between 0 and 100% in steps of 1%

2.12 Belly Button Time

This parameter sets the time in seconds that the belly button speed will be applied for. The parameter is adjustable between 0 and 5 seconds in steps of second.

The machine manufacturer is responsible for ensuring that the wiring of the belly button switch and the programming of the belly button parameters are suitable for the intended application. PGDT accepts no liability for losses of any kind arising from the incorrect wiring or programming of the belly button function.

3 Operation Parameters

3.1 Throttle Invert

This selects the polarity of operation of a wig-wag throttle or, on a single-ended throttle system, the polarity of operation of the reverse switch. You can set the Throttle Invert Polarity to On or Off.

On a wig-wag system, setting Throttle Invert Polarity to Off means that if the throttle potentiometer wiper is approaching the high reference then direction will be forwards, On is opposite to this.

On a single-ended type system, Off means that if the reverse switch input is connected to switched 0V then direction will be reverse, On is opposite to this.

3.2 Sleep Timer

A length of time can be set, such that if the controller accepts no valid input for that period of time, it will power down safely.

The time can be adjusted in 1 minute steps between 0 to 20 minutes.

If the value is set to 0, no power down will occur.

4 Throttle Parameters

4.1 Throttle Type

This parameter can be set to one of three modes.

0: Single-ended Throttle type.

1: Wig-wag Throttle type.

2: Unipolar Throttle type.

4.2 Throttle Deadband

This sets the amount of throttle potentiometer movement before the solenoid brake is disengaged and the machine starts to drive. It is expressed as a percentage of the potentiometer full forward/reverse movement.

The following two examples cover the cases of single-ended and wig-wag throttle types.

Example 1 For a single-ended throttle, if the throttle deadband is 10% and the potentiometer is 5kΩ, then there will be no drive until the potentiometer wiper is at the 500Ω position.

Example 2 For a wig-wag throttle if the throttle deadband is 10% and the potentiometer is 5kΩ, then there will be no drive when the potentiometer wiper is between the 2.25kΩ and 2.75kΩ positions.

This value is adjustable between 3 and 100% in steps of 1%, and should always be set greater than the mechanical repeatability of the throttle mechanism.

4.3 Throttle Gain

This parameter amplifies the drive signal to the I-Drive, thus allowing throttle mechanism's that do not employ the full electrical angle of the throttle potentiometer to be used. The parameter can be set between 5% and 1250% in steps of 5%. A value of 100% means no amplification is applied.

Example 1 If a 5kΩ throttle potentiometer is being used in a wig-wag configuration and the mechanical arrangement of the throttle means the potentiometer's wiper reaches the high reference when the throttle is fully deflected, the Throttle Gain should be set to 100%

Example 2 If a 5kΩ throttle potentiometer is being used in a wig-wag configuration and the mechanical arrangement of the throttle means the potentiometer's wiper reaches only 4kΩ when the throttle is fully deflected, then Throttle Gain should be set as follows.

This example assumes a Throttle Deadband setting of 10%.

Full electrical angle = 5kΩ - 2.75kΩ = 2.25kΩ

Actual electrical angle = 4kΩ - 2.75kΩ = 1.25kΩ

Required gain = 2.25 / 1.25 = 1.8

Set Throttle Gain to = 180%

4.4 Throttle Operated At Power-up

The parameter sets the behavior of the controller when it is switched on with the throttle already deflected. There are three options:

Drive	The I-Drive will drive if it is switched on while the throttle is already deflected.
Inhibit	The I-Drive will not drive if it is switched on while the throttle is already deflected but once the throttle has been returned to its home position it will then allow the machine to drive.
Trip	The I-Drive will not drive if it is switched on while the throttle is already deflected and it will record a trip in the system log and it will require the machine to be switched off and on again.

Setting this parameter to Drive will contravene international mobility vehicle safety legislation. If, under exceptional circumstances, the condition set by Drive is required, it becomes the sole responsibility of the machine manufacturer. PGDT accept no liability for losses of any kind resulting from this parameter being set to Drive.

4.5 Throttle Reference Test

If set to "Off" then all throttle reference checks are disabled to allow the use of a voltage source input.

4.6 ISO Tests Resistor

This parameter can be set to On or Off.

If the machine has no ISO-Test resistor fitted (Refer to Chapter 2) the parameter must be set to Off. This will still offer full compliance with ISO7176-14 section 6.12.3.3.

If the machine already has an ISO-Test resistor fitted, then to ensure the machine can reach maximum speed, the parameter should be set to On.

If an ISO-Test resistor is fitted and a series connected speed limiting potentiometer is used, then depending on the setting of the potentiometer, it may not be possible to detect a short-circuit between the Throttle side of the potentiometer and either of the throttle references.

5 Battery Parameters

5.1 Cable Resistance

This sets the value of cable and connector resistance between the controller and the batteries. The value corresponds to the total resistance in both the positive and negative paths.

You can set this between 10mΩ and 250mΩ in steps of 5mΩ.

5.2 Calibration Factor

This allows further fine calibration of the TruCharge battery gauge. This is normally set at the factory and should not need adjustment.

Please contact PGDT if you are considering altering this factor.

5.3 Low Battery Alarm

This parameter sets whether the I-Drive will give an audible alarm to signal a low battery condition. The point at which the alarm will sound corresponds to the Low Battery Flash Level setting. The parameter can be set to On or Off. Yes being on.

5.4 Battery Lockout Parameters

The battery lockout parameters allow the functionality of a machine to be restricted once the battery voltage has dropped below the battery manufacturers' recommended discharge level. Typically, these parameters allow the OEM to configure the machine such that the operator is forced to return the machine to the charging point before the batteries are damaged.

5.4.1 Battery Lockout Voltage

This parameter sets the threshold voltage at which the controller will lockout the function as set by the Battery Lockout Type parameter, and is adjustable in 0.1V steps from 0-24V

5.4.2 Battery Lockout 2 Voltage

This parameter sets an alternate threshold voltage at which the controller will lockout the function as set by the Battery Lockout Type parameter, and is adjustable in 0.1V steps from 0-24V

5.4.3 Battery Lockout Time

This parameter sets the time for which the battery voltage must be below the programmed Battery lockout Voltage or Battery Lockout 2 voltage in 1 second steps between 0 and 60 seconds.

5.4.4 Battery Lockout Type

This parameter selects which function will be "locked out" or inhibited once the voltage is below the programmed threshold level. Any combination of the following functions can be selected:

Traction

Auxiliary 1

Auxiliary 2

Auxiliary 3

5.4.5 Battery Lockout 2 Input Select

This parameter allows the OEM to select which input will be used to select the alternate programmed threshold voltage, Battery lockout 2 Voltage. One of the following inputs can be selected:

Inhibit 1

Inhibit2

Reverse Switch

Example:

An I-drive is being used to control the traction and other functions of a small pedestrian operated floorcare machine. The Inhibit 1 input and Aux 1 Output are used to control a relay which controls the machine's cleaning brushes. The machine can be used with 2 types of batteries "A" and "B", which should not be discharged below 22.3 and 21.8V respectively. The inhibit 2 input is connected to 0V via a 3rd pin on the Type "B" battery connector, allowing the I-drive to detect which battery type has been fitted. The parameters are set as follows:

Battery Lockout Voltage	22.3V
Battery Lockout 2 Voltage	21.8V
Battery Lockout Time	20 seconds
Battery Lockout Type	Aux 1
Battery Lockout 2 Input Select	Inhibit 2

The machine is in use with a Type A battery; when the voltage drops below 22.3V, the timer is initiated. Once 20 seconds have elapsed, the Aux 1 output is inhibited, so that the cleaning brushes switch off. The operator returns to the charging point, removes the type A batteries and places them on charge. The operator then fits the type B batteries, and the machine is fully functional until the voltage drops again, this time below 21.8V for 20 seconds before the brushes are "locked out" .

When the Diagnostic Flash Sequence is set to PGDT or TruCharge, The BDI will produce the 1-bar low battery fault code.

6 Inhibit Parameters

6.1 Inhibit 1 Mode, Target, Speed, Operation

For full details of these parameters refer to Chapter 2 section.4.11

6.2 Inhibit 2 Mode, Target, Speed, Operation

For full details of these parameters refer to Chapter 2 section 4.12

7 General Parameters

7.1 Soft-Stop

This selects whether the soft-stop facility is enabled. Soft-stop means that if you switch the control system off whilst driving, the machine will steadily decelerate to standstill.

You can turn this function on or off.

If this function is on, you must ensure that the emergency stopping distance is within the distance specified for the country in which the machine will be used.

7.2 Brake Time

This sets the period of time between the controller detecting zero motor speed and the application of the solenoid brake.

This value should be set long enough to ensure the machine doesn't jerk or skid on a level surface, but short enough to minimize roll-back or roll-forward on slopes.

You can set this between 0 and 200 in steps of 1 which roughly represents 10ms.

7.3 Output Voltage

This sets the value of voltage applied to the motor when the throttle potentiometer is at the full drive position and the relevant speed, forward or reverse, is set to 100%. This feature allows you to choose a motor voltage value such that the machine's top speed will remain constant all the time the battery voltage is above that value.

This value can be set between 20 and 28V in steps of 1V.

7.4 Diagnostic flash Sequence

This parameter can be set to 0, 1, or 2.

0	No signal
1	TruCharge indication
2	Sequence flashes which simulate the TruCharge indication.

For details of the TruCharge and sequence indication of these settings refer to Chapter 1 section 8.

7.5 Reverse Alarm

The Reverse alarm can be set to Yes or No.

Yes sets the alarm to an active status. The alarm will sound whenever the scooter is being reversed. On Single-ended throttle scooters the alarm will be activated when the Reverse Switch is activated.

7.6 Pulse Reverse Alarm

The controller has an output to power an audible reversing alarm. This output can be set to give a steady or a pulsing signal, the pulsing signal is approximately 1Hz.

You can set this function to On or Off.

On Is pulsing

Off Is steady.

7.7 Diagnostic Alarm

This parameter can be set to On or Off.

When set to On the Diagnostic alarm will create a pulse type alarm which will sound the equivalent of the TruCharge diagnostic indicator.

The diagnostic alarm will sound a warning signal to alert the user that a diagnostic alarm pattern is about to be sounded. The signal will be a set of fast beeps lasting two seconds. The slower diagnostic pattern will then be sounded once.

7.8 Brake Disconnected Alarm

The brake alarm can be set to On or Off.

On means that when the brake is disconnected, for example during freewheel, an audible alarm will sound.

7.9 Brake Fault Detect

Sets whether the I-Drive detects a fault in the Auxiliary 1 Output load or the connections to it. The parameter can be set to On or Off.

On Means the I-Drive will detect Auxiliary 1 faults.

Off Means the I-Drive will not detect Auxiliary 1 faults.

7.10 Freewheel Speed Limit & Freewheel Time-out

If the solenoid brake is disconnected from the motor, allowing the wheels and motor to rotate, the I-Drive can detect the motor rotating above a certain speed for a programmed period of time and brake it automatically, thus removing the possibility of the machine freewheeling at an excessive speed. This function will operate if the machine is switched off and even if there are no batteries fitted or connected.

These parameters are factory set and should not require adjustment. For further details contact PGDT.

It is the responsibility of the machine manufacturer to ensure that adequate precautions are taken to warn the user against the hazards of freewheeling the machine at excessive speeds. It is also the responsibility of the machine manufacturer to utilize a suitable freewheel mechanism to reduce these risks. PGDT accepts no liability for losses of any kind resulting from excessive freewheel speeds of a machine.

7.11 Auxiliary 1 Output Mode

This parameter sets the operating mode for the Auxiliary 1 Output. This output could be programmed to operate a Brake, for example.

There are four modes:

Solenoid Brake	The output will correctly control a Solenoid Brake.
Forward Only	The Output is only active when the machine is driving forwards.
Reverse Only	The Output is only active when the machine is driving backwards.
Off	The Output is never active.

7.12 Auxiliary 1 Output off delay

This parameter sets the time in seconds that the Auxiliary 1 Output remains switched on when Inhibit 1 is active. Note that this parameter only applies when the parameter Inhibit 1 Target is set to "Aux 1"

This parameter can be set between 0 and 60 seconds in 1 second steps.

7.13 Auxiliary 2 Output Mode

This parameter sets the operating mode for the Auxiliary 2 Output. This output could be programmed to operate a vacuum or brush motor.

There are six modes:

Reverse Alarm	The output will operate as per the Reverse Alarm parameter settings.
Brake Light	The output will operate as per the Brake Light parameter settings.
Forward Only	The Output is only active when the machine is driving forwards.
Fwd & Rev	The Output is only active when the machine is driving in either direction.
Continuous	The output is active the entire time the control system is powered-up.
Off	The Output is never active.

7.14 Auxiliary 2 Output off delay

This parameter sets the time in seconds that the Auxiliary 2 Output remains switched on when Inhibit 2 is active. Note that this parameter only applies when the parameter Inhibit 2 Target is set to "Aux 2"

This parameter can be set between 0 and 60 seconds in 1 second steps.

7.15 Auxiliary 3 Input

This parameter allows the reverse switch input to be used as an input switch to control Auxiliary 3 Output. This parameter can only be used when fitted to a machine using a Wig-wag Throttle type.

The two modes:

None	The output will be active as per the parameter Auxiliary 3 Output Mode.
Reverse Switch	The Auxiliary 3 Output will only be active when the switch is made. At this time Auxiliary 3 Output Mode will be active as per the parameter settings.

7.16 Auxiliary 3 Output Mode

This parameter sets the operating mode for the Auxiliary 3 Output. This output could be programmed to operate a vacuum or brush motor.

There are five modes:

Continuous	The output is active the entire time the control system is powered-up.
Forward Only	The Output is only active when the machine is driving forwards.
Reverse Only	The Output is only active when the machine is driving backwards.
Fwd & Rev	The Output is only active when the machine is driving in either direction.
Off	The Output is never active.

7.17 Auxiliary 3 Output off delay

This parameter sets the time in seconds that the Auxiliary 3 Output remains switched on when Inhibit 3 is active. Note that this parameter only applies when the parameter Inhibit 3 Target is set to "Aux 3"

This parameter can be set between 0 and 60 seconds in 1 second steps.

7.18 Auxiliary 3 Output Voltage

This parameter allows the a specific voltage to be selected for Auxiliary 3 Output.

Either 12 or 24V can be selected.

12V	The output will maintained at 12V relative to the battery positive supply via PWM (Pulse Width Moderation)
24V	The output will be a constant sink when active.

8 Motor Parameters

8.1 Current Limit

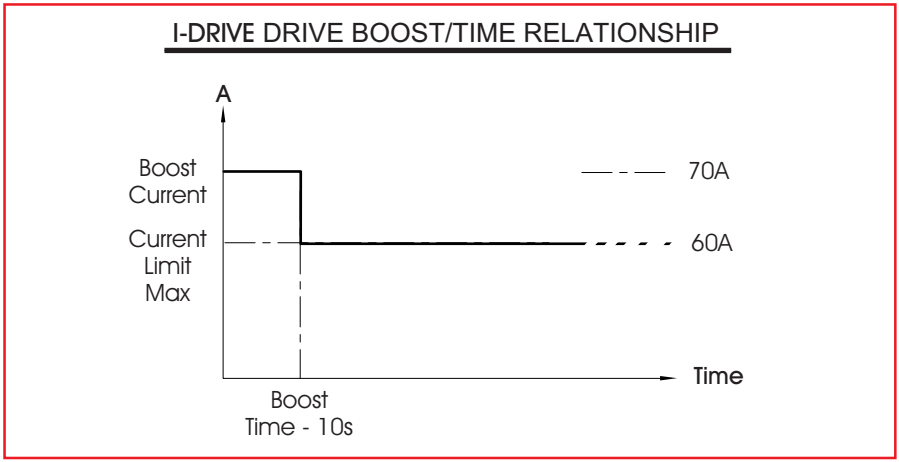
Will allow the min and max current limits to be altered in 1 Amp steps between 10 and 60A if dependencies permit.

Max — Sets the continuous current output of the I-Drive.

Min — Sets the current output of the I-Drive when it is at 80°C. Refer to section 8.3.

8.2 Boost Drive

This parameter provides a current boost for a set length of time if the controller recognizes a drive requirement which causes the motors to require more current, such as when the machine is being driven up a hill. Refer to the following graph.



The drive boost current can be set in 1A steps between 10 and 70A but not less than the 'current limit max' setting, and the drive boost time to be altered in 1 second steps between 0 and 10 seconds.

8.3 Current Foldback Threshold, Current Foldback Time, Current Foldback Level, Current Foldback Temp, Motor Cooling Time

The parameters Threshold, Time, Level and Motor Cooling can be used to protect the motor from overheating. If the motor current exceeds the value set by Threshold for a period set by Time, then the I-Drive's current output will be reduced to a value set by Level. After this has occurred, full current is only permissible after a time period set by Motor Cooling.

Threshold — Adjustable between 1A and the value of Current Limit Max. in steps of 1A.

Time — Adjustable between 0s and 250s in steps of 1s.

Level Adjustable between 0% and 100% in steps of 1%.

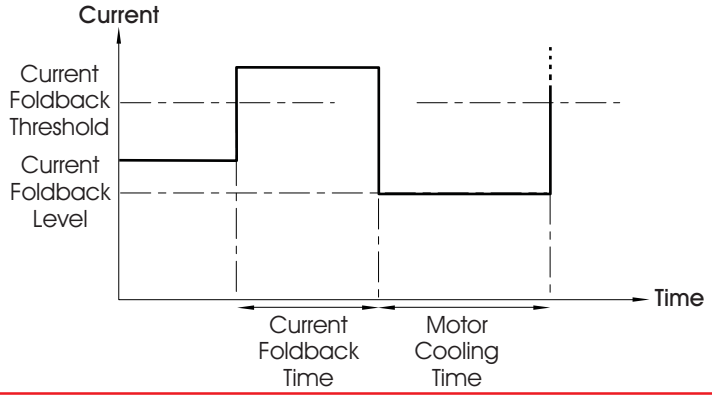
Motor Cooling Adjustable between 0s and 3825s in steps of 15s.

This is useful for protecting motors against potential damage when the machine is being used on a long gradient.

Example Current Limit Max.= 60A, Threshold = 40A, Time = 30s, Level = 50% and Motor Cooling = 150s.

If the motor current is greater than 40A for 30s, then the I-Drive's maximum output current will be reduced to 50% of 60A = 30A. The maximum possible output current will then be 30A for the next 150s. After that time, full current capability will be restored.

I-DRIVE CURRENT FOLDBACK DESCRIPTION

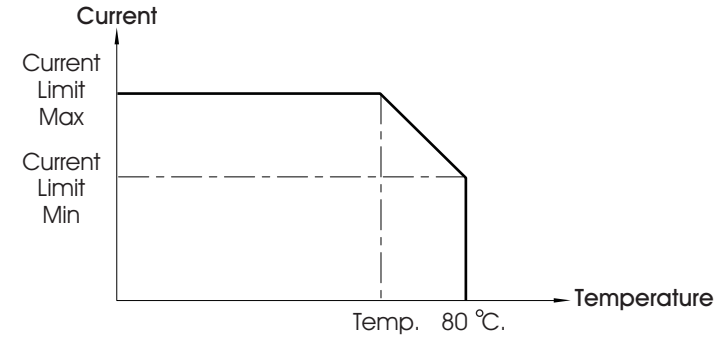


The parameter Temp. sets the temperature at which the I-Drive starts to reduce its maximum current capability. The temperature is measured at the I-Drive's heatsink.

Temp. Adjustable between 0°C and 80°C in steps of 1°C

The graph below shows the operation of this function.

I-DRIVE CURRENT OUTPUT



If the I-Drive's internal temperature reaches the value set by Temp., then the maximum current output will be reduced from the value set by Current Limit max. The reduction will be a linear reduction to a value set by Current Limit min. at a fixed internal temperature of 80°C.

	I-Drive 45	I-Drive 70
Current Limit Max	45 Amps	60 Amps
Boost Drive Current	45 Amps	70 Amps
Boost Drive Time	-	10 Seconds
Current Limit Min	10 Amps	10 Amps
Current Foldback Temp.	80°C	80°C

8.4 Controlling a Machine on a Slope

The I-Drive controller contains a revolutionary set of anti roll back parameters, which allow smooth precise control, especially when starting and stopping on inclines. This section explains how to set this group of co-relational parameters.

Motors and gearboxes due to their construction, normally display evidence of gear backlash. This will be evident by a small amount of wheel rotation as the solenoid brake is engaged / disengaged.

8.4.1 Motor Compensation

This matches the controller to different motor types in order to achieve optimal performance and control, especially regarding anti-rollback and braking on gradients. PGDT recommend that you set this value to 50% of the resistance of the motor armature and all connectors and cables to it.

Motor manufacturers should be able to supply figures for armature resistance, and typical cable and connectors would be about 40mΩ.

You can set this value between 0mΩ and 1250mΩ in steps of 5mΩ.

If you do not have the exact values of resistance, some basic test driving can be used to determine the value required for this parameter.

Motor Compensation should never exceed 60%.

The machine manufacturer is responsible for ensuring that the controller is matched to the motor resistance. Failure to do this may result in poor control characteristics, which in extreme instances can make a machine uncontrollable and potentially unsafe. PGDT accepts no liability for losses of any kind arising from failure to comply with this condition.

The machine manufacturer is responsible for always ensuring that any replacement motors are fully compatible with the originals that the controller was designed to match. Failure to do this may result in poor control characteristics, which in extreme instances can make a machine uncontrollable and potentially unsafe. PGDT accepts no liability for losses of any kind arising from failure to comply with this condition.

8.4.2 Anti-Rollback Level

This parameter is used to fine tune the performance of its co-relational parameters. The parameter is a scaling multiplier associated with the parameters Slope Factor and Motor Compensation.

This parameter can be adjusted in steps of 1 between 0 and 255.

Setting this parameter to 0 turns off the anti roll back parameters. Consequently when on an incline the parameter Slope Factor has no effect, motor compensation is not suitably augmented, and the machine will in all probability roll-back on an incline.

Smaller machines may become unstable when subjected to sudden stopping and starting conditions on a slope. If there is any possibility of the user falling out of the machine as a result of a sudden braking action, it is imperative that a restraining device such as a seat belt is supplied with the machine and that it is in use at all times when the machine is in motion. PGDT accept no liability for losses of any kind arising from the unexpected stopping of the machine, or arising from the improper use of the machine or controller.

The higher the parameter value, the higher and more effective the AntiRollback effect becomes.

When this parameter is set correctly, the machine should:

- Have almost no roll-back while stopping on a slope. Driving up or down a slope from low speed.
- Be almost completely stopped before the brake is applied.

The optimum value for this parameter is 12, but this can best be determined by test driving the machine, as a slightly higher value may be required if roll back is being experienced, especially on a medium / heavy machine.

Test drive the machine in accordance with the procedure described in section 8.5 Set-up Procedure.

8.4.3 Slope Factor

This parameter can also be used to fine tune the performance of the machine when stopping and starting on a gradient. The parameter can be adjusted in steps 5 between 0 and 1275. When this parameter is set correctly, the machine should:

- Have almost no roll-back while stopping on a gradient from high speed. Driving up or down a slope.

- Be almost completely stopped before the brake is applied.

The optimum value for this parameter can only be determined by test driving the machine. Use the set up procedure described in section 8.5 Set-up Procedure.

8.5 Set-up Procedure

The following outlines the sequence of events that need to be followed in order to best optimise the performance of a machine on a slope. Use both Forward and Reverse for this Set-up Procedure.

1 Set parameters AntiRollback Level and Slope Factor to 0.

2 Set the parameter Motor Compensation, see 8.4.1.

3 Check the performance of the machine on a level surface. If the acceleration of the machine feels too severe, especially at small throttle displacements, the Motor Compensation is too high.

4 Set parameter AntiRollback Level to 12.

5 Check the performance of the machine by driving on a gentle slope using small acceleration and deceleration throttle deflections. If the machine rolls back before the brakes are applied, whilst coming to a halt when driving up the slope, then incrementally increase Motor Compensation but do not exceed 60%. If however the machine rolls forward before the brakes are applied, whilst coming to a halt when driving up the slope, then incrementally decrease AntiRollback Level.

6 Set the parameter Slope Factor to 110.

7 Check the performance of the machine by driving on a level surface using full throttle acceleration and deceleration. If the machine rolls back before the brakes are applied, whilst coming to a halt, then incrementally increase Slope Factor. If however the machine rolls forward before the brakes are applied, whilst coming to a halt, then incrementally decrease Slope Factor. If the value of the parameter is set too low or too high, then one or more of the following effects may be noticeable.

Performance Criteria	Slope Factor
Rolling back while stopping after driving forwards up a slope.	Increase Value
Rolling forwards while stopping after driving forwards down a slope.	Decrease Value
Rolling forwards while stopping after reversing up a slope.	Increase Value
Rolling back while stopping after reversing down a slope.	Decrease Value

Effect	Cause
When stopping in the forward direction, machine reverses slightly before the brake is applied.	Value too Low
When stopping from reverse, machine drives forward slightly before the brake is applied.	Value too Low
When stopping while driving up a slope, machine Runs-on in the same direction	Value too High

8 If the parameter Slope Factor is set to 255, and the machine still experiences roll back whilst stopping when driving either forwards or backwards up a slope, then increase the value of the parameter AntiRollback Level by one increment and repeat the Set-up Procedure from step 5 until a satisfactory slope performance is achieved.

8.6 Pull-away Delay

This parameter can be used to reduce Roll-back or Roll-forward when the scooter is being started on a slope. The parameter can be adjusted in steps of 10ms between 0 and 1 second.

The delay represents the amount of time between the scooter's motor starting to drive and the brake being released. If the parameter is incorrectly set then one of the following conditions will be noticeable:

Too Low — On gradients the scooter may Roll-backwards or Roll-forwards prior to the motor properly engaging and moving the scooter in the desired direction.

Too High — On a level surface the scooter will not react swiftly enough to throttle displacement.

PGDT recommend a value of 300ms for the Pull-away Delay as an optimum setting. This should be verified for each application by the scooter manufacturer.

9 Memory Functions

9.1 Read System Log

The I-Drive has a diagnostic log facility which stores the number of occurrences of the last eight detected system problems. This allows you to view the contents.

9.2 Clear System Log

This function clears the I-Drive's diagnostic log.

9.3 Read Timer

The I-Drive has a timer which records how long the machine is in use. The timer runs whenever the throttle is moved into a drive state, and stops when the throttle is returned to the home position. The timer records the number of hours the machine has been in use.

9.4 Clear Timer

This function resets the I-Drive's timer.

CHAPTER 4
CONTROL PANEL MODULE

1 Introduction

Study Chapters 1 & 2, they describe the intended functionality of the Control Panel Module and the details for connection to the I-Drive Controller.

The I-Drive Status Output Type parameter will require adjustment before the TruCharge indicator will work correctly. The parameter must be set to TruCharge. Refer to Chapter 2 section 4.5.

There are two variants of the Control Panel Module. These are:

- Surface mount variant.
- Inset variant.

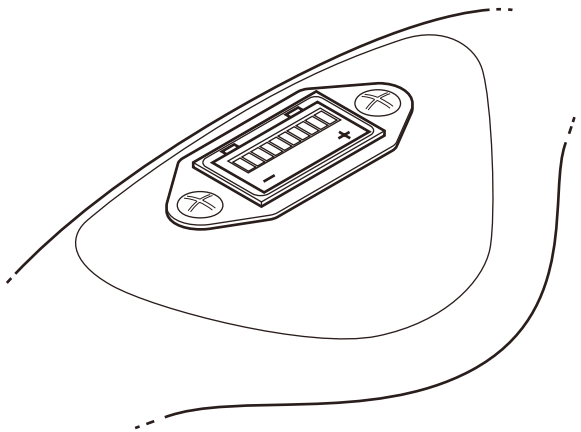
1.1 Surface Mount Variant

The Surface Mount variant attaches to the Control Panel Module from the outside (See the following illustration). The electronics compartment of the Control Panel Module has an IPX5 ingress protection rating.

- Surface mount variants - D50133

D50133 consists of: 1 TruCharge Display Module, 1 TruCharge Display Cable, and 1 Gasket

CONTROL PANEL MODULE - SURFACE



1.2 Inset Variant

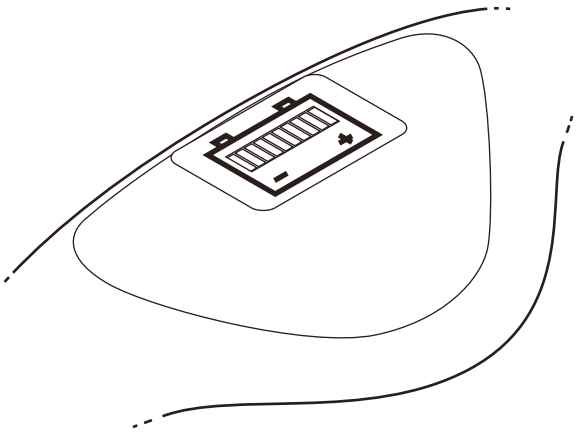
The Inset variant must be embedded within the Machine Tiller's housing(See the following illustration). The electronics of the controller will then take on the ingress protection rating of the Machine Tiller.

- Inset variant - D50066 / D50032

  D50066 Consists of: 1 TruCharge Display Module, 1 Label and 1 Double-sided Adhesive Gasket.

  D50032 Consists of: 1 TruCharge Display Module and 1 Double-sided Adhesive Gasket.

CONTROL PANEL MODULE - INSET

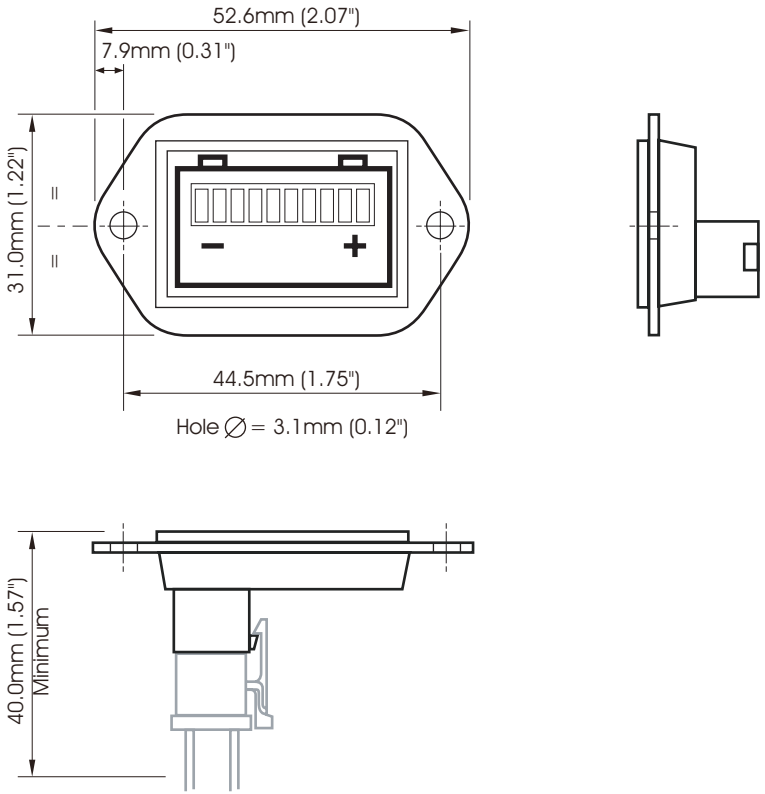


2 Dimensions

2.1 Surface Mount Variant

The Surface Mount Control Panel Module has the dimensions shown in the following illustration.

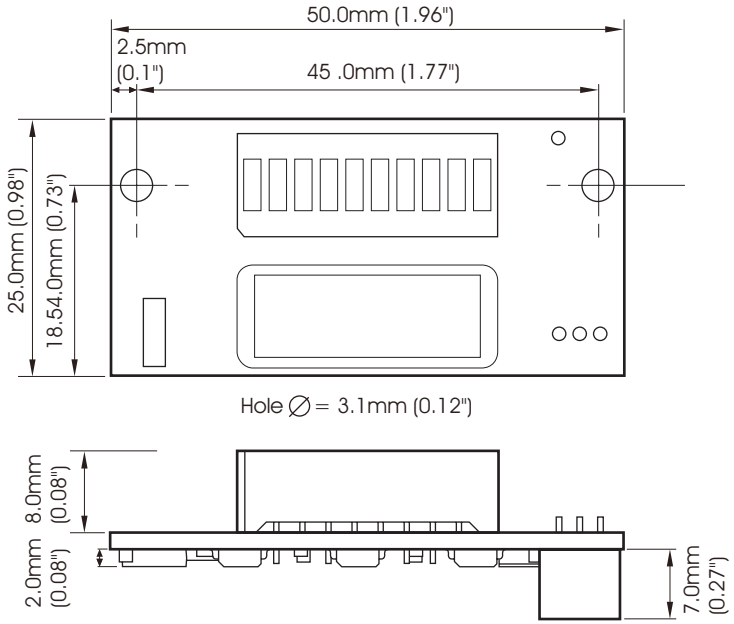
CONTROL PANEL MODULE DIMENSIONS - SURFACE



2.2 Inset Variant

The Inset Control Panel Module has the dimensions shown in the following illustration.

CONTROL PANEL MODULE DIMENSIONS - INSET



3 Mounting

3.1 Handling

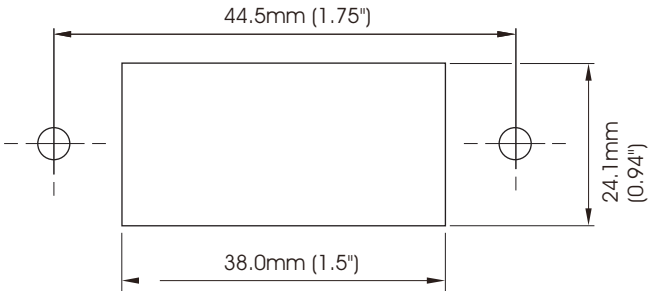
The Control Panel Module contains electronic components which may be sensitive to static electricity. Always store the modules in the original packaging until they are ready to be used. When the modules are removed from the packaging, ensure correct anti-static precautions are taken.

3.2 Surface Mount Variant

3.2.1 Fixing

The machine's Tiller should be fitted with holes as suggested in the diagram below.

CONTROL PANEL MODULE FIXING HOLES - SURFACE



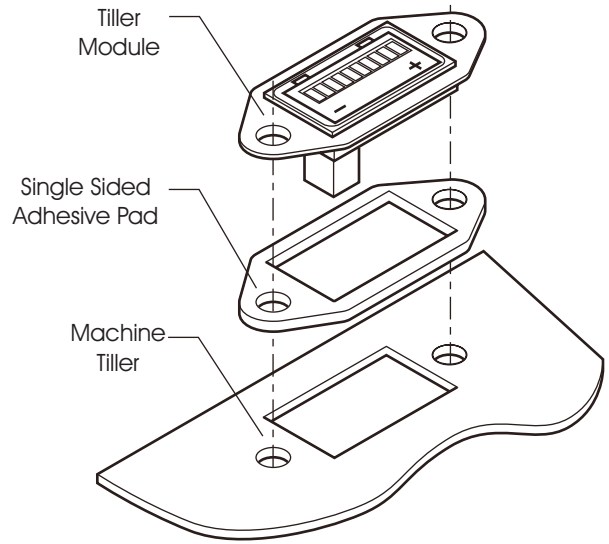
Hole ∅ = 3.1mm (0.12")

3.2.2 Sealing

The supplied single-sided adhesive gasket should be used to create a seal between the Control Panel Module and the machine's control panel. See the following illustration

When correctly fitted this arrangement will give the Control Panel Module an IPX5 ingress protection rating.

CONTROL PANEL MODULE MOUNTING - SURFACE



3.3 Inset Variant

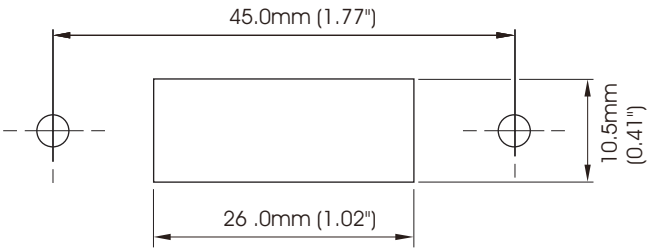
3.3.1 *Fixing*

The machine's control panel should be fitted with holes as suggested in the diagram below.

The supplied double-sided adhesive pad should be used to secure the Control Panel Module to the machine's control panel. See the following illustration.

If the Adhesive pad is being used to attach the Control Panel Module then the screw holes either side of the central rectangle will not be required.

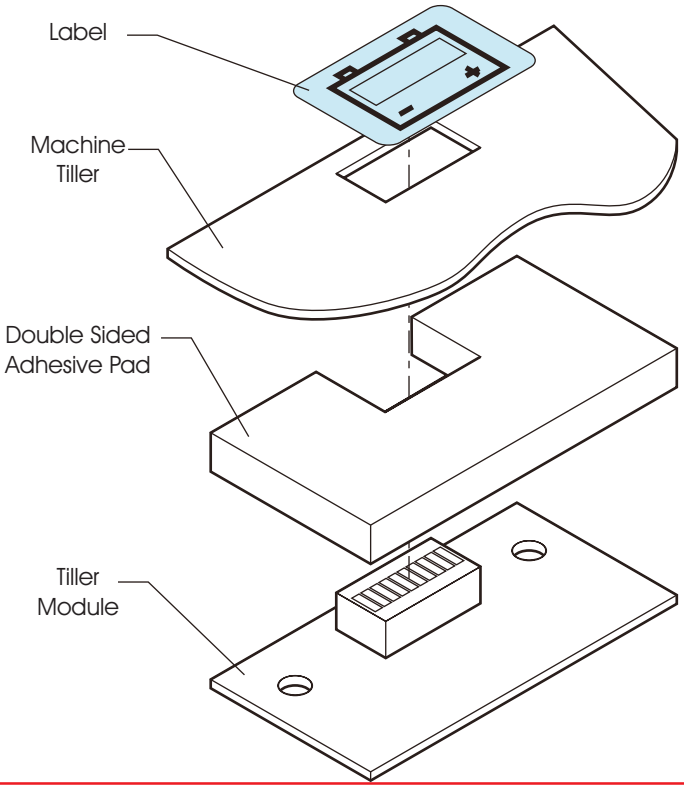
CONTROL PANEL MODULE FIXING HOLES - INSET



Alternatively M3 (4-40 UNC) hardware can be used. The height of the display from the printed circuit board is 8.0mm (0.31"). Suitable spacers should be used so that the display is fixed slightly below the machine's control panel. Ensure that the metallic fixing hardware (nuts, washers etc.) do not touch the conductive tracks on the printed circuit board.

3.2.2 Sealing

CONTROL PANEL MODULE MOUTNING - INSET



The module should be sealed against the ingress of water and dust by a placing an adhesive waterproof overlay over the display cut-out. The overlay should contain a suitably sized transparent window and the overall dimensions should be at least 36.0mm x 20.5mm (1.41" x 0.81")

The sealing label is only supplied with the Control Panel Module kit number D50066.

4 Wiring

You are responsible for establishing the suitability of the particular wiring arrangement used on the machine. PG Drives Technology can make general recommendations for wiring to Control Panel Modules, but PG Drives Technology accepts no responsibility for the wiring arrangement used.

4.1 Wire Gauge

The minimum recommended wire size is 0.22mm^2 for all connections.

4.2 Connectors

4.2.1 Surface Mount Variant

The Control Panel Module is fitted with a Molex 'Mini-fit jr' 4 way connector.

See www.molex.com for your local distributor.

Part Numbers are as follows:

Molex 'Mini-Fit-Jr.' 4 socket receptacle: 39-01-2040

PG Drives Technology Tru-Charge Display Cable.

PGDT Part number: SA76199

Only use the PG Drives Technology TruCharge Display Cable number SA76199 supplied with kit D50133.

Hand tools for crimping and extraction are available from Molex. The references are as below.

Molex 'Mini-Fit-Jr.' Crimp tool: 69008-0724

Molex 'Mini-Fit-Jr.' Extraction tool: 11-03-0044

Only use the exact tools specified.

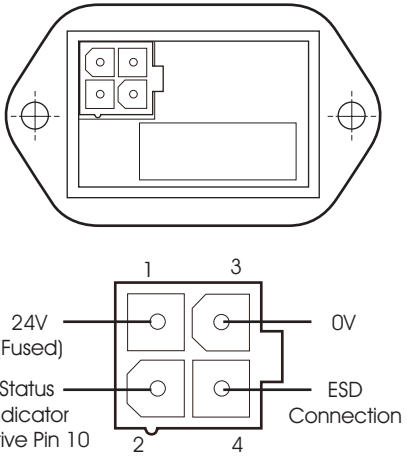
4.2.2 Inset Variant

The Control Panel Module is fitted with a 3 way AMP CT series connector, part number 175487-3. The mating crimps and connector housing have Amp part numbers 179227-1 and 179228-3 respectively. Only these parts should be used.

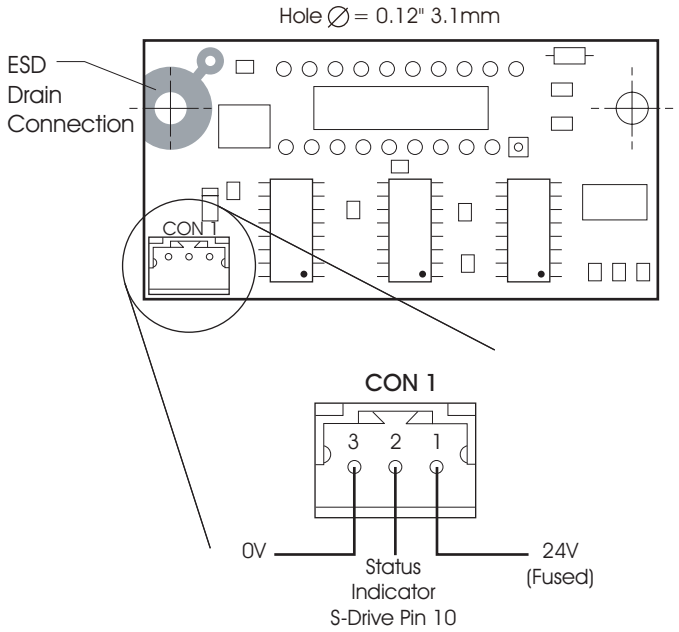
There is also a solder/ring tag point for an Electro-Static Discharge (ESD) drain path wire.

5 Connections

CONTROL PANEL MODULE CONNECTION - SURFACE



CONTROL PANEL MODULE CONNECTION - INSET



5.1 Controller Connections

Control Panel Module Type	Control Panel Module Connector	Function	Control Panel Module Interface
Inset	1	24V	Pin 7
Inset	2	Status Indicator	Pin 10
Inset	3	0V	Pin 13
Surface	1	24V	Pin 7
Surface	2	Status Indicator	Pin 10
Surface	3	0V	Pin 13
Surface	4	ESD	--

5.2 ESD Connection

5.2.1 Surface Mount Variant

This is an optional connection and may not be required, refer to section 6.2 for details.

If the connection is required then connection point 4 in the Molex 'Mini-fit jr' 4 way connector must be utilized

5.2.2 Inset Mount Variant

This is an optional connection and may not be required, refer to section 6.2 for details.

If the connection is required there are two methods available. Firstly, a solder hole for wires or electrical suppression components. Secondly, if screws are used to secure the Control Panel Module, then a ring terminal can be used.

6 Electromagnetic Compatibility (EMC)

The controller has been tested for compliance with EC directive 89/336/EEC, and the EMC requirements of prEN12184, the FDA and the FCC. The guidelines in this section will help you to make sure that your machine installation will easily meet the requirements of the directive. You should consider EMC and perform relevant tests as early as possible in the design phase.

6.1 Immunity and Emissions

Refer to the Electromagnetic Compatibility section in the controller's technical manual.

6.2 Electro-Static Discharge (E.S.D.)

The tiller is the most vulnerable area on the machine to electro-static discharges. These discharges may cause disruption of operation or even permanent damage. The Control Panel Module incorporates extensive protection against E.S.D., however, you should take the following precautions to prevent high levels of energy entering the machine's electronic system.

- The highest degree of protection can be achieved by making the tiller enclosure, switches and other controls non-conductive. Membrane keypads in particular provide good E.S.D. protection, keypad manufacturers will be able to give appropriate design rule guidance. It should also be considered that high voltages can jump through gaps in enclosures, thereby gaining access to the electronics. Enclosures should therefore be as closed as possible.
- If controls or enclosures are conductive, a low impedance electrical connection to the machine's metalwork should be provided. If such a connection is used, it should be kept as short as possible to minimize its electrical inductance.
- The Control Panel Module has a connection point, ESD: this can be used to provide an ESD drain path. The path should be via a varistor connected between the ESD pin and the machine's metalwork. A suitable device is manufactured by Harris, type GE-MOV V82ZA2.

7 Production Tests

7.1 Mounting

Make sure that the Control Panel Module is securely mounted. Do not overtighten any securing screws.

Ensure that the adhesive sealing overlay is fully pressed down.

7.2 Cables and Connections

Check all cables and connections to the Control Panel Module for damage. Ensure there are no dry solder joints.

7.3 Operational Test

The following tests should be carried out on a level floor with at least one meter of clear space around the machine.

With the machine switched off, displace the throttle and then switch the machine on. The TruCharge display should "ripple" up and down. When you have observed that all the bars illuminate, release the throttle and the display should now become steady and indicate the battery condition.

There are two conditions when this test cannot be performed. Firstly, if the controller is programmed (Throttle Displaced at Power-up) to instantly trip if it is powered-up with the throttle displaced. Secondly, if the controller is programmed (High Pedal Disable) to drive immediately after power-up regardless of throttle position.

If this test cannot be performed due to the above conditions, then the only other test method is to power-up the machine with fully charged batteries and check that all the TruCharge bars illuminate.

CHAPTER 5
WARNING SUMMARY

1 Introduction

This section summarizes all of the very important warnings that appear throughout the text of this manual. Do not install, maintain or operate the machine without reading, understanding and observing the following warnings. Failure to observe these warnings could result in UNSAFE CONDITIONS for the user of a machine or affect the reliability of the controller. PG Drives Technology accepts no liability for losses of any kind arising from failure to comply with any of the conditions in the warnings listed below. Failure to observe these warnings will invalidate the I-Drive warranty.

The machine manufacturer may wish to use this section as a check list, to ensure the risk areas identified below have been addressed within their own machine designs and associated documentation.

2 Warnings

2.1 Driving Technique

The machine user must be capable of driving a machine safely. PGDT accepts no liability for losses of any kind arising from failure to comply with this condition. Chapter 1 section 5.2.

2.2 Hazards

Although the I-Drive is designed to be extremely reliable and each unit is rigorously tested during manufacture, the possibility of system malfunction always exists (however small the probability). Under some conditions of system malfunction the control system must (for safety reasons) stop the machine instantaneously. If there is any possibility of the user falling out of the machine as a result of a sudden braking action, it is imperative that a restraining device such as a seat belt is supplied with the machine and that it is in use at all times when the machine is in motion. PGDT accept no liability for losses of any kind arising from the unexpected stopping of the machine, or arising from the improper use of the machine or control system.

Do not operate the I-Drive if the machine behaves erratically, or shows abnormal signs of heating, sparks or smoke. Turn the I-Drive off at once and consult your service agent. PGDT accepts no liability for losses of any kind arising from failure to comply with this condition.

Electronic equipment can be affected by Electro Magnetic Interference (EMI). Such interference may be generated by radio stations, TV stations, other radio transmitters and cellular phones. If the machine exhibits erratic behavior due to EMI, turn the control system off immediately and consult your service agent. PGDT accepts no liability for losses of any kind arising from failure to comply with this condition.

It is the responsibility of the machine manufacturer to ensure that the machine complies with appropriate National and International EMC legislation. PGDT accepts no liability for losses of any kind arising from failure to comply with this condition.

The machine user must comply with all machine safety warnings. PGDT accepts no liability for losses of any kind arising from failure to comply with this condition. Chapter 1 section 6.1.

2.3 Safety Checks

These checks should be conducted in an open space and a restraining device such as a seat belt should always be used. PGDT accepts no liability for losses of any kind arising from failure to comply with this condition. Chapter 1 section 7.

2.4 Status Indicator Flashes Slowly

Do not operate the machine if the battery is nearly discharged. Failure to comply with this condition may leave the user stranded in an unsafe position, such as in the middle of a road. PGDT accepts no liability for losses of any kind arising from failure to comply with this condition. Chapter 1 section 8.1.2

2.5 Pushing Your Machine

Depending on the type of freewheel mechanism, then it may be possible for the machine to freewheel at potentially dangerous speeds. Therefore, do not push the machine up or down inclines on which you cannot stop or hold the machine. Never sit on the machine if the freewheel mechanism is disengaged. PGDT accept no liability for losses of any kind arising from the machine being moved while the freewheel mechanism is disengaged. Chapter 1 section 10.

2.6 Programming

Programming should only be conducted by professionals with in-depth knowledge of PGDT electronic control systems. Incorrect programming could result in an unsafe set-up of a machine for a user. PGDT accept no liability for losses of any kind if the programming of the control system is altered from factory pre-set value. Chapter 1 section 11.

2.7 Warranty

The warranty will be void if the I-Drive has not been used in accordance with I-Drive Technical Manual SK76977, the I-Drive has been subject to misuse or abuse, or if the I-Drive has been modified or repaired by unauthorized persons. Chapter 1 section 12.

2.8 Servicing

PGDT accept no liability for losses of any kind arising from unauthorized opening, adjustment or modifications to the I-Drive Machine Control System.

If the I-Drive Machine Control System is damaged in any way, or if internal damage may have occurred through impact or dropping, have the product checked by qualified personnel before operating. PGDT accepts no liability for losses of any kind arising from failure to comply with this condition. Chapter 1 section 13.

2.9 Program Settings

Programming should only be conducted by healthcare professionals with in-depth knowledge of PGDT electronic controllers. Incorrect programming could result in an unsafe setup of a machine for the user. PGDT accepts no liability for losses of any kind if the programming of the controller is altered from factory pre-set values. PGDT accepts no liability for losses of any kind if the drive or stability characteristics of the machine are altered without prior notification and discussion with PGDT. Chapter 2 section 1.2.

2.10 Charger Interlock

The machine manufacturer is responsible for providing a means of preventing the use of the machine while the batteries are being charged. PGDT accepts no liability for losses of any kind arising from failure to comply with this condition. Chapter 2 section 2.2.

2.11 Connections - General

The machine manufacturer is responsible for establishing the suitability of the particular wiring arrangements used on the machine, for both normal use and stalled conditions. PGDT can make general recommendations for wiring the I-Drive Machine Controller, but PGDT accepts no responsibility for, and accepts no liability for losses of any kind arising from, the actual wiring arrangement used.

The machine manufacturer is responsible for ensuring that only the mating connectors specified by PGDT on the controller's specific data sheet or in this manual are used to connect to the controller. PGDT accepts no liability for losses of any kind arising from failure to comply with this condition.

The machine manufacturer is responsible for ensuring that suitable connectors are used and securely mated throughout the machine wiring system and that the workmanship associated with the wiring system is of a good enough quality. Failure to meet this condition could result in intermittent operation, sudden stopping or veering, or even create a burn or fire hazard. PGDT accepts no liability for losses of any kind arising from failure to comply with this condition. Chapter 2 section 3.1.

2.12 Battery and Motor Connections

It is the responsibility of the machine manufacturer to ensure that the mating male Fastons are suitable for use on the intended application. PGDT accepts no liability for losses of any kind arising from failure to comply with this condition. Chapter 2 section 3.1.1.

2.13 Crimp Tooling

Defective or poor quality crimps may affect the warranty of the controller. PGDT accepts no liability for losses of any kind arising from failure to comply with this condition. Chapter 2 section 3.1.5.

2.14 Wire Gauge and Types

It is the responsibility of the machine manufacturer to ensure that all wire gauges are suitable for the intended application. Chapter 2 section 3.1.6.

2.15 Battery Connection

The machine manufacturer must install a suitable circuit breaker to provide protection against short circuits in the battery wiring, power loom or the controller. Failure to comply with this could result in a fire hazard. PGDT accepts no liability for losses of any kind arising from failure to comply with this condition. Chapter 2 section 3.2.

2.16 Belly Button Input Configuration

It is the responsibility of the machine manufacturer to ensure the mechanical arrangement of the belly button is suitable for the intended application. PGDT accepts no liability for losses of any kind arising from the incorrect mechanical arrangement of the belly button or the type of belly button switch used.

The machine manufacturer is responsible for ensuring that the wiring of the belly button switch and the programming of the belly button parameters are suitable for the intended application. PGDT accepts no liability for losses of any kind arising from the incorrect wiring or programming of the belly button function. Chapter 2 section 4.2.2.

2.17 0 Volts

At no time should the current passing through pin 13 of the I-Drive Machine Controller exceed the 5A current rating. Failure to comply with this could result in a fire hazard. PGDT accepts no liability for losses of any kind arising from failure to comply with this condition. Chapter 2 section 4.9.

2.18 Inhibit 2 Speed

If the Inhibit Speed is greater than 0 then the controller will not enter an inhibit state. Chapter 2 section 4.11.2.

2.19 Traction Motors

The machine manufacturer is responsible for ensuring that the controller is matched to the motor resistance. Failure to do this may result in poor control characteristics, which in extreme instances can make a machine uncontrollable and potentially unsafe. PGDT accepts no liability for losses of any kind arising from failure to comply with this condition.

The machine manufacturer is responsible for always ensuring that any replacement motors or gearboxes are fully compatible with the originals that the controller was designed to match. Failure to do this may result in poor control characteristics, which in extreme instances can make a machine uncontrollable and potentially unsafe. PGDT accepts no liability for losses of any kind arising from failure to comply with this condition.

Users or service personnel must not move a controller from one machine type to install it on a different machine type. Controllers with different part numbers may have both hardware and software differences to ensure that they are compatible with the electrical and dynamic characteristics of their specific target vehicles. The characteristics of one type of controller may not be compatible with a different, unauthorized machine. Failure to observe this warning could result in an unsafe setup for the machine user and may create a fire hazard depending on the motors, wiring, connectors and circuit breakers installed on the unauthorized machine. PGDT accepts no liability for losses of any kind arising from failure to comply with this condition. Chapter 2 section 5.

2.20 Freewheeling

It is the responsibility of the machine manufacturer to ensure that adequate precautions are taken to warn the user against the hazards of freewheeling the machine at excessive speeds. It is also the responsibility of the machine manufacturer to utilize a suitable freewheel mechanism to reduce these risks. PGDT accepts no liability for losses of any kind resulting from excessive freewheel speeds of a machine. Chapter 2 section 5.2.

2.21 Programming Connections

The Molex 4-way connector can only be used as a communications port for a PGDT PC Programmer cable. PGDT accepts no liability for losses of any kind arising from failure to comply with this condition. Chapter 2 section 6.

2.22 Inhibit I Speed Limit Value

If the Inhibit Speed is greater than 0 then the controller will not enter an inhibit state. Chapter 2 section 6.1.2.

2.23 Position

Under strenuous driving conditions it is possible for metal sections of the controller's case to exceed 41°C (106 °F) in temperature. Under such conditions, the machine manufacturer should ensure that either the user cannot touch these surfaces, or that the user is warned not to touch these surfaces. While 41°C (106 °F) is very close to normal body temperature, prolonged contact with surfaces above 41°C (106 °F) can result in burns to the skin. PGDT accepts no liability for losses of any kind arising from failure to comply with this condition. Chapter 2 section 8.1.2 & 8.2.2

2.24 Production Tests

This test should be conducted in an open space and a restraining device such as a seat belt should always be used. PGDT accepts no liability for losses of any kind arising from failure to comply with this condition. Chapter 2 section 10.

2.25 Introduction

Programming should only be conducted by professionals with in-depth knowledge of PGDT control systems. Incorrect programming could result in an unsafe set-up of a machine for a user. PGDT accept no responsibility for losses of any kind if the programming of the control system is altered from the factory pre-set values. Chapter 3 section 1.

2.26 Forward Acceleration

Setting this value too high could cause the machine to tip when accelerating up a slope. Chapter 3 section 2.1.

2.27 Forward Deceleration

It is the responsibility of the machine manufacturer to ensure that the emergency stopping distance is within the distance specified for the country in which the machine will be used. Chapter 3 section 2.2.

2.28 Reverse Deceleration

It is the responsibility of the machine manufacturer to ensure that the emergency stopping distance is within the distance specified for the country in which the machine will be used.

Setting this value too high could cause the machine to tip when stopping whilst reversing down a slope. Chapter 3 section 2.4.

2.29 Max Forward Speed

Ensure the stability of the machine is maintained, especially when cornering, at the programmed Mav Forward Speed.

2.30 Speed Limit Pot. Enabled

If a series type Speed Limiting Potentiometer is fitted then this parameter must be set to On or the machine will only drive at the minimum programmed speed settings. Chapter 3 section 2.9.

2.31 Belly Button Time

The machine manufacturer is responsible for ensuring that the wiring of the belly button switch and the programming of the belly button parameters are suitable for the intended application. PGDT accepts no liability for losses of any kind arising from the incorrect wiring or programming of the belly button function. Chapter 3 section 2.12.

2.32 Throttle Operated At Power-up

Setting this parameter to Drive will contravene international mobility vehicle safety legislation. If, under exceptional circumstances, the condition set by Drive is required, it becomes the sole responsibility of the machine manufacturer. PGDT accept no liability for losses of any kind resulting from this parameter being set to Drive. Chapter 3 section 4.4.

2.33 Soft-Stop

If this function is on, you must ensure that the emergency stopping distance is within the distance specified for the country in which the machine will be used. Chapter 3 section 7.1

2.34 Freewheel Speed Limit & Freewheel Time-out

It is the responsibility of the machine manufacturer to ensure that adequate precautions are taken to warn the user against the hazards of freewheeling the machine at excessive speeds. It is also the responsibility of the machine manufacturer to utilize a suitable freewheel mechanism to reduce these risks. PGDT accepts no liability for losses of any kind resulting from excessive freewheel speeds of a machine. Chapter 3 section 7.12

2.35 Motor Compensation

Never exceed the 70% relationship described above.

The machine manufacturer is responsible for ensuring that the controller is matched to the motor resistance. Failure to do this may result in poor control characteristics, which in

extreme instances can make a machine uncontrollable and potentially unsafe. PGDT accepts no liability for losses of any kind arising from failure to comply with this condition.

The machine manufacturer is responsible for always ensuring that any replacement motors are fully compatible with the originals that the controller was designed to match. Failure to do this may result in poor control characteristics, which in extreme instances can make a machine uncontrollable and potentially unsafe. PGDT accepts no liability for losses of any kind arising from failure to comply with this condition. Chapter 3 section 8.4.1.

2.36 AntiRollback Level

Smaller machines may become unstable when subjected to sudden stopping and starting conditions on a slope. If there is any possibility of the user falling out of the machine as a result of a sudden braking action, it is imperative that a restraining device such as a seat belt is supplied with the machine and that it is in use at all times when the machine is in motion. PGDT accept no liability for losses of any kind arising from the unexpected stopping of the machine, or arising from the improper use of the machine or controller. Chapter 3 section 8.4.2.

CHAPTER 6
SPECIFICATIONS

I Electrical Specifications

Supply Voltage:	24Vdc
Operating Voltage:	16Vdc to 30Vdc
Peak Voltage:	36Vdc
Reverse Battery Current:	40Vdc
Output Current:	45A / 70A
PWM Frequency:	20kHz ± 1%
Brake Voltage:	24Vdc
Auxiliary 1:	1.25A max. continuous
Status Output:	Programmable 0-12V, 50mA sink or source
Auxiliary 2:	Programmable 24V, 500mA sink
Auxiliary 3:	Programmable 12V, 24V or 500mA sink
Inhibit Input:	Programmable polarity

Power Connection:	6.35mm (0.25") Faston Spade
Brake Connection:	2-way Molex® Mini-fit, Jr™
Charger Connection:	4-way Molex® Mini-fit, Jr™
Tiller Connection:	14-way Molex® Mini-fit, Jr™

Moisture Resistance:	Electronics to IPX5

Operating Temperature:	-25°C to +50°C
Storage Temperature:	-40°C to +65°C

Safety:	Multiple hardware and software strategy designed to ISO7176/14
EMC tested:	
Susceptibility:	Tested at 30V/m to EN12184 and ANSI/RESNA requirements
Emissions:	To EN55022 Class B
ESD:	IEC801 part 2