PG DRIVES TECHNOLOGY

S-DRIVE CONTROLLER FAMILY

TECHNICAL MANUAL

SK76745/10

TABLE OF CONTENTS

About this manual

The Technical Manual gives an introduction to the S-Drive 'Mark 2' range of scooter controllers. These are identified by part number D51270 onwards.

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.

PG Drives Technology accept no liability for any losses of any kind if the points are not followed.

CHAPTER I - OPERATION

1 Introduction

The relevant contents of this chapter should be included in the scooter 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 S-Drive Scooter 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 scooter manufacturer to ensure that only the relevant sections of this chapter are included in the S-Drive's operating manual.

Please read this chapter carefully - it will help you to keep your scooter 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 scooter, 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 scooter to which the S-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 scooter's motor. Do not use the on/off switch to stop the scooter unless there is an emergency. (If you do, you may shorten the life of the scooter drive components).

Some scooters 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 scooter 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 scooter is switched on. It also indicates the operating status of the scooter. Details are given in section 8.

3.3 Throttle

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

Depending on the scooter 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 scooter 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 scooter is controlled by the throttle. When the throttle is pushed - depending on the position of the reverse switch (refer to section 3.4) - the scooter will drive in either the forward or reverse direction.

3.3.3 Unipolar Throttle

In this configuration, just the speed of the scooter 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 scooter will drive in either the forward or reverse direction.

3.4 Reverse Switch

This switch will be fitted to the scooter 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 scooter. Turn the knob clockwise to increase the maximum speed setting or anti-clockwise to decrease the maximum speed setting.

3.6 Slow/Fast Switch

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

3.7 Audible Alarm

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

4 Getting Ready to Drive

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 scooter is switched on, the controller is performing important safety checks within itself and the rest of the scooter'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 scooter 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 scooter 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 scooter 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 Driving - General

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

5.2 Driving Technique

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

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

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

The scooter user must be capable of driving a scooter 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 scooter moving in an unexpected way RELEASE THE THROTTLE. This action will stop the scooter in any circumstances.

6.1 Hazards

Do not drive the scooter:

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

Do not operate the S-Drive if the scooter behaves erratically, or shows abnormal signs of heating, sparks or smoke. Turn the S-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 vehicle 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 scooter manufacturer to ensure that the scooter 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 scooter user must comply with all scooter 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 S-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 scooter 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 scooter 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 scooter on. The scooter should not move. To show you that you have switched the scooter 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 scooter 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 scooter.

Switch the scooter on.

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

Go to drive the scooter slowly in the forward direction until you hear the parking brake operate. The scooter 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 scooter 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 scooter 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 scooter 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 scooter 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 scooter 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 scooter.

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

- Switch off the scooter.
- Make sure that all connectors on the scooter 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 scooter on again and try to drive. If the safety circuits operate again, switch off and do not try to use the scooter.
- 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.

E.g. 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, charging, 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 shows 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 scooter 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

8.2.3 TruCharge Indicator Stepping Up

The scooter's batteries are being charged.

8.2.4 TruCharge Indicator blinks on every 3.5 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 scooter.

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

- Switch off the scooter.
- Make sure that all connectors on the scooter 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 scooter on again and try to drive. If the safety circuits operate again, switch off and do not try to use the scooter.
- 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 the following table before you contact your service agent. Go to the number in the list that matches the number of flashing bars and follow the instructions.

1 Bar	The battery needs charging or there is a bad connection to the battery. 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 freewheel switch is activated or the manual brake disengagement mechanism is operated. Check the position of the switch or lever.
5 Bar	Not used.
6 Bar	The S-drive is being inhibited from driving. Inhibit 2 is active'. This may be because the battery charger is connected or the seat is not in the driving position.
7 Bar	A throttle fault is indicated. Make sure that the throttle is in the rest position before switching on the scooter.
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 scooter 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 scooter 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 scooter. Like the fuel gauge in a car, it is not completely accurate, but it will help you avoid running out of "fuel".

Depending on the type of scooter you have, the battery gauge may also show you the charging status of the batteries.

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 scooter.

If you are charging the batteries and the scooter type you have is able to show you charging status, this information is accurate 5 seconds after the charger is connected.

When you replace worn out batteries, fit the type recommended by the scooter 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 scooter, the temperature of the batteries, their age and the way they are made. These factors will affect the distance you can travel in your scooter. All scooter 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 8.1 for full details.

9.2 How To Read a TruCharge Battery Gauge

Refer to section 8.2 for full details.

10 Pushing your Scooter

The scooter will be fitted with a freewheel mechanism which allows the scooter 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 scooter to freewheel at potentially dangerous speeds. Therefore, do not push the scooter up or down inclines on which you cannot stop or hold the scooter. Never sit on the scooter if the freewheel mechanism is disengaged. PGDT accept no liability for losses of any kind arising from the scooter 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 that 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 scooter. If they are not, your scooter distributor or service agent or scooter 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 scooter user manual. Note any changes you make for future reference.

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

12 Warranty

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

The warranty will be void if the S-Drive Scooter Controller has:

- Not been used in accordance with the S-Drive Scooter Controller Technical Manual, SK76745.
- Been subject to misuse or abuse.
- Been modified or repaired by non-authorized persons.

The warranty will be void if the S-Drive has not been used in accordance with the S-Drive Technical Manual SK76745, the S-Drive has been subject to misuse or abuse, or if the S-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 S-Drive Scooter Controller.

If the S-Drive Scooter 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

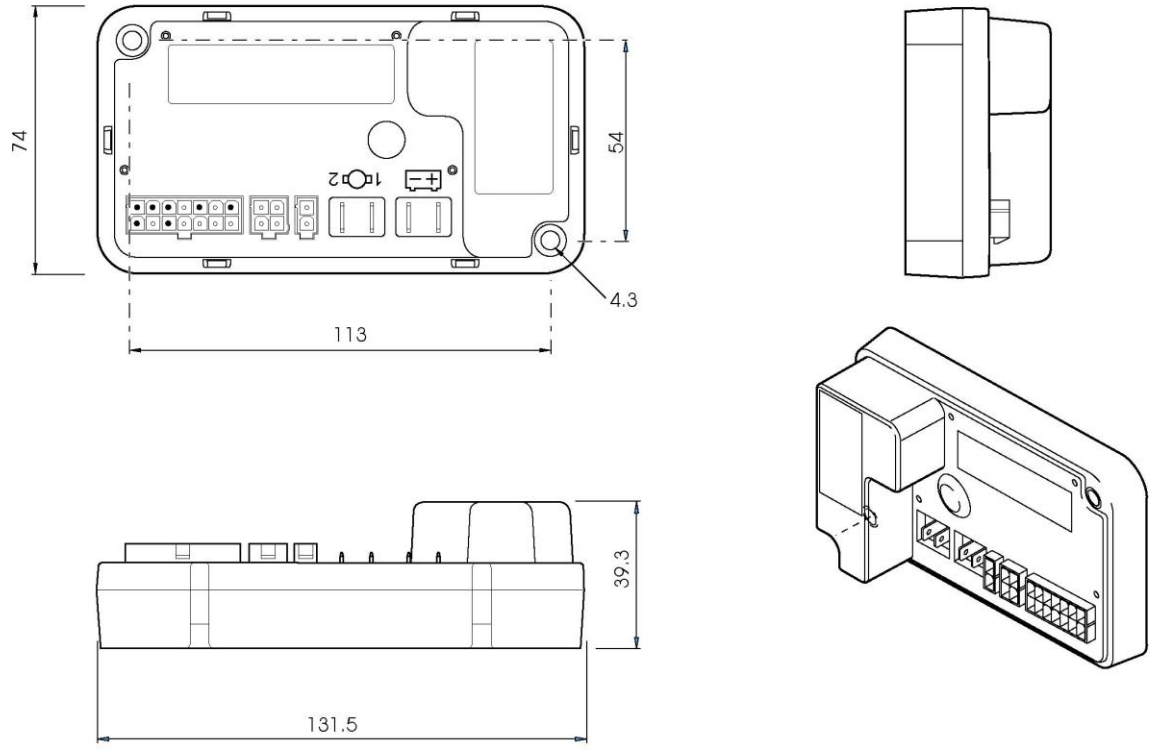
1.1 S-Drive Operation

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

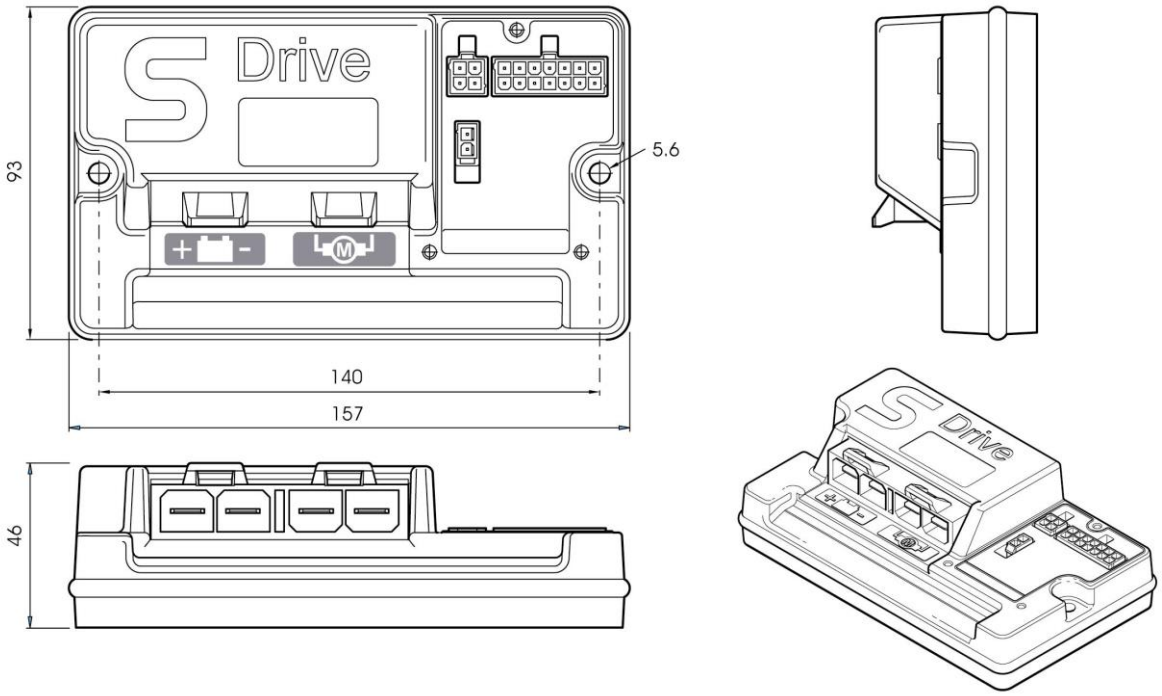
This chapter sets out the installation conditions that must be complied with in order to meet the safety requirements of TÜV (Germany), ISO7176-14 and EN12184.

1.2 Dimensions

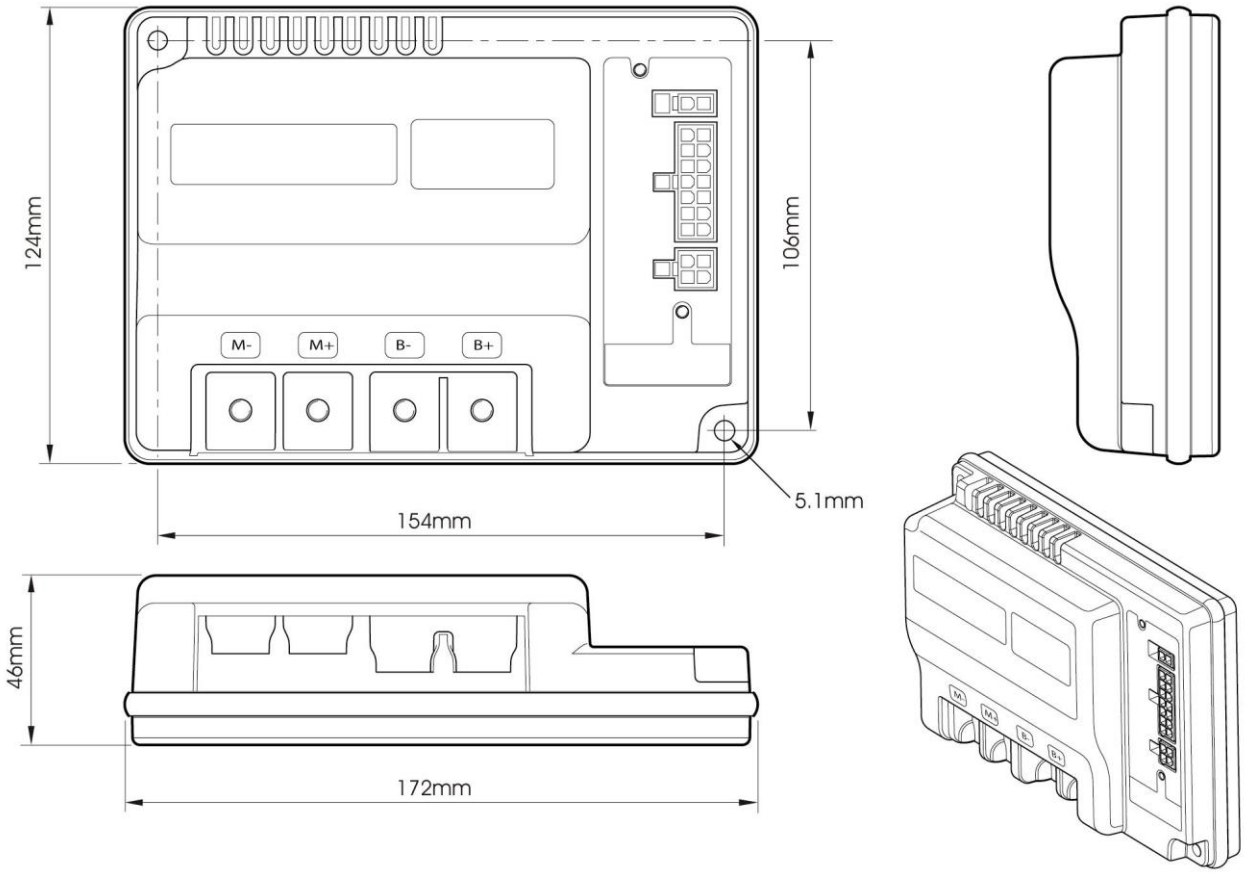
1.2.1 S45A, S70A and S90A Controllers



1.2.2 SI20A and SI40A Controllers



1.2.3 S200A Controller



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 scooter 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 scooter must stop within the maximum distance specified for the country in which the scooter will be used. For countries requiring CE marking this is as specified in EN12184.

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 scooter 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 scooter 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 scooter. Perform suitable tests to establish which programming restrictions are needed to prevent instability. State any programming restrictions in the scooter user handbook.

State in the scooter 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 healthcare professionals with in-depth knowledge of PGDT electronic controllers. Incorrect programming could result in an unsafe setup of a scooter for the user. PGDT accepts no liability for losses of any kind if the programming of the controller is altered from factory preset values. PGDT accepts no liability for losses of any kind if the drive or stability characteristics of the scooter are altered without prior notification and discussion with PGDT.

1.3 Soft-Stop

If the version of S-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 scooter will be used. For countries requiring CE marking this is as specified in EN12184.

1.4 Other Information

You must provide a diagram in the scooter 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 Scooter

2.1 Prevention of Unauthorized Use

Some markets require the scooter 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 scooter while the batteries are being charged. The S-Drive includes 3 inhibit inputs any of which can be used to provide this function. PG Drives Technology recommend either Inhibit 1 or Inhibit 3 for this function. Refer to section 4.11 and 4.12 for details.

Contact PGDT if you need advice.

The scooter manufacturer is responsible for providing a means of preventing the use of the scooter 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 3.4, these depend on the application. You are responsible for establishing the suitability of the particular wiring arrangement used on the scooter. PGDT can make general recommendations for wiring to the S-Drive controller, but PGDT accepts no responsibility for the wiring arrangement used.

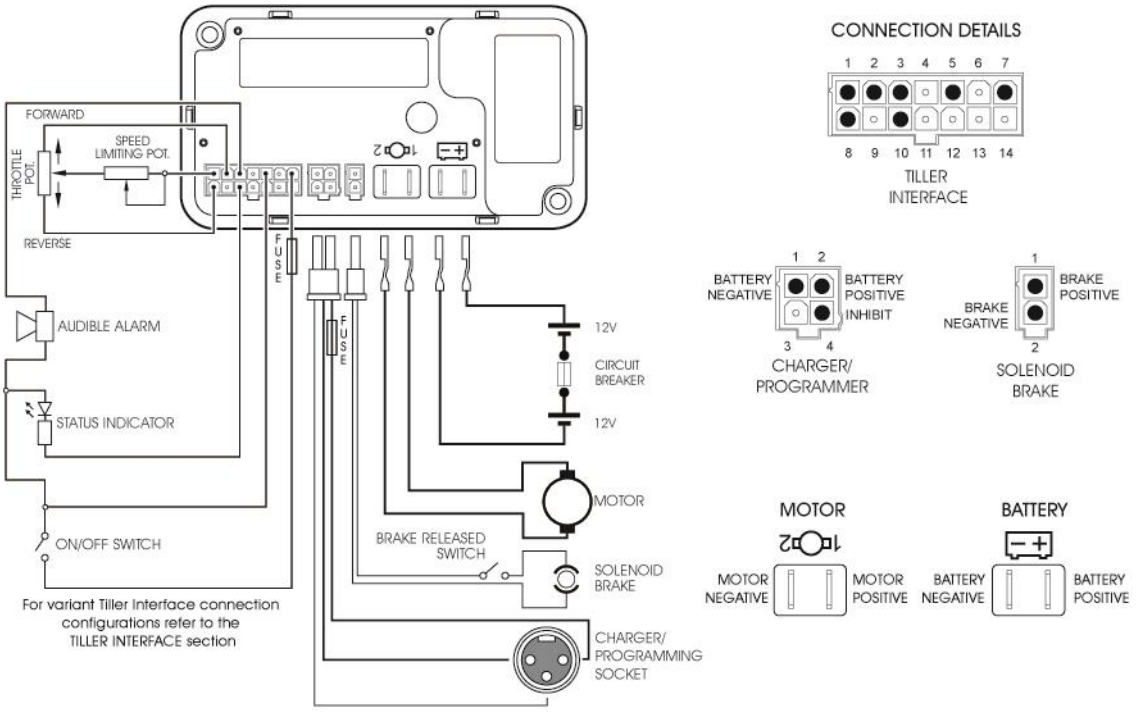
Make sure that the connectors you use are reliable under all operating conditions and correctly wired with no short circuits. Do not use unsuitable components - it may result in poor scooter reliability. Refer to the following illustration for a basic connection detail.

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

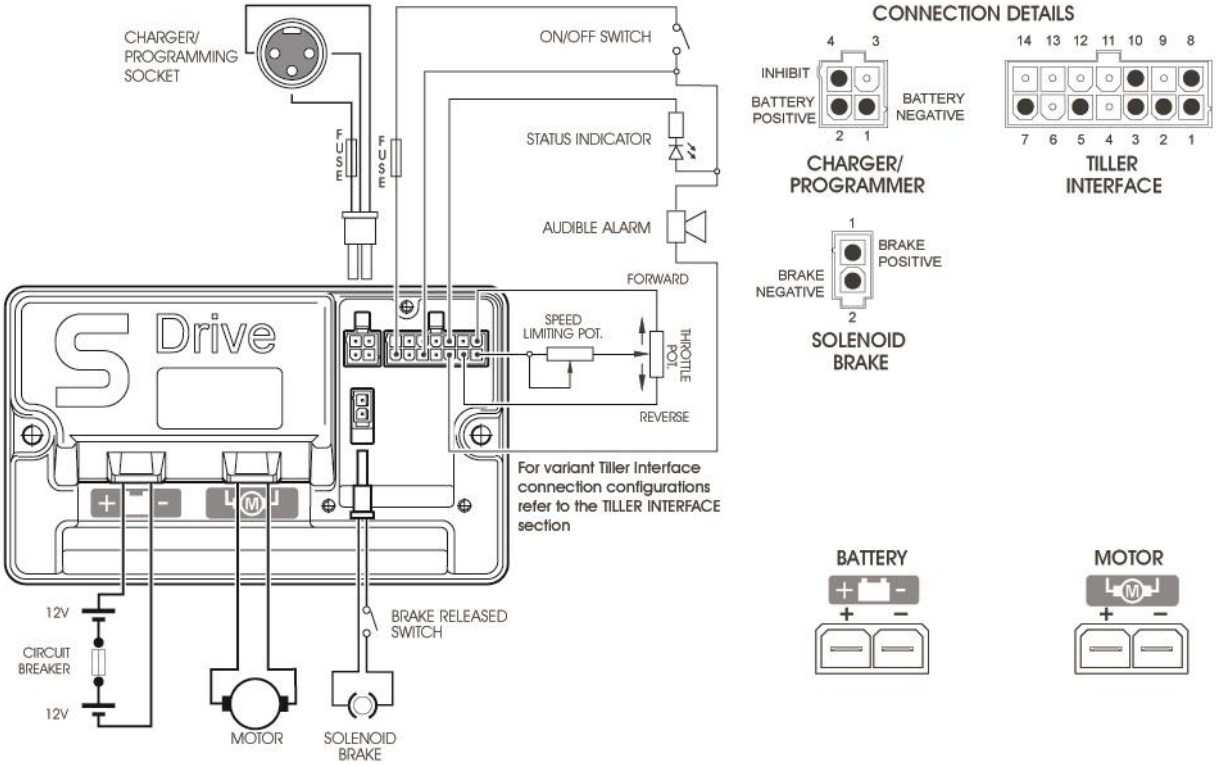
The scooter manufacturer is responsible for ensuring that only the mating connectors specified by PGDT on the controller's specific data sheet or in this manual are used to connect to the controller. PGDT accepts no liability for losses of any kind arising from failure to comply with this condition.

The scooter manufacturer is responsible for ensuring that suitable connectors are used and securely mated throughout the scooter 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

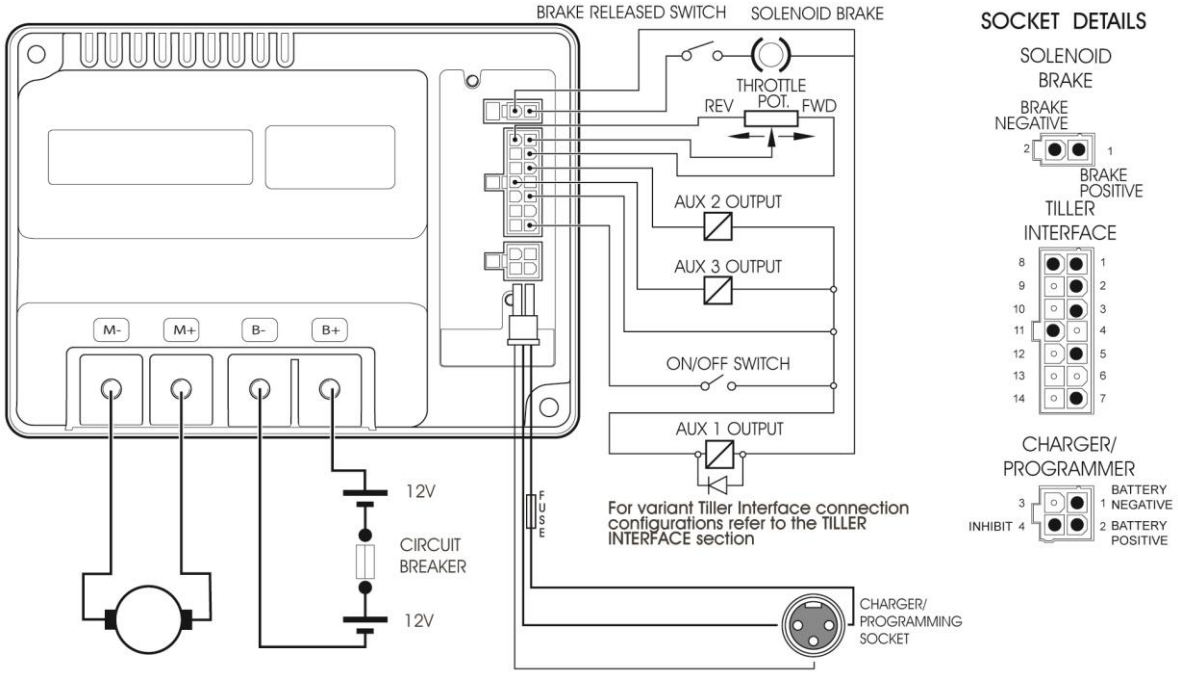
3.1.1 Wiring Configuration S45A, S70A & S90A



3.1.2 Wiring Configuration S120A & 140A



3.1.3 Wiring Configuration S200A



3.2 Connectors & Connector Kits

Motor Connections	Description
S45A & S70A	¼" 6.35mm Faston
S90A	6.3mm RT ANG Faston
S120A & S140A	D51059 - PGDT Connector Kit
S200A	M6 Screw Terminals
Battery Connections	**Description**
S45A & S70A	¼" 6.35mm Faston
S90A	6.3mm RT ANG Faston
S120A & S140A	D51070 - PGDT Connector Kit
S200A	M6 Screw Terminals
Molex Connections	**Description**
S45A – S200A	D50319 - PGDT Connector Kit

The PGDT Connector kits can be purchased from PG Drives Technology, in the cases of D51059 and D51070 they can also be purchased from Inconnect.

PGDT Reference	Inconnect Kit Reference
D51059	IPG-10206-PS
D51070	IPG-10205-PS

Inconnect's details are as follows.

Inconnect UK	Avertronics INC (Taiwan)
+44 (0) 845 25 70 666	+886 (0)4 2358 1581
www.inconnect.uk.net	www.inteam.ws

3.2.1 Motor and Battery

3.2.1.1 S45A, S70A & S90A

The battery and motor connections on the S45A, S70A and S90A controllers use 1/4" 6.35mm Faston type terminals. The mating male parts should be sourced from a reputable manufacturer or supplier and these parts must be tested for suitability by the scooter manufacturer.

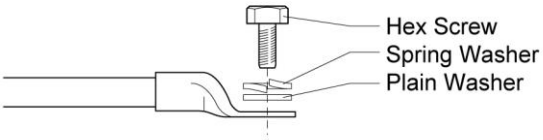
It is the responsibility of the scooter manufacturer to ensure that the mating male Fastons are suitable for use on the intended application. All connectors should be fitted with the appropriate boot. PGDT accepts no liability for losses of any kind arising from failure to comply with this condition.

3.2.1.2 S120A & S140A

The Motor and Battery connections on the S120 and 140A controllers use Inconnect Connectors as listed in section 3.2.

3.2.1.3 S200A

The battery and motor connections on the S200 controllers use M6 threaded holes. These are identified as B+, B-, M+ and M-. The controller is provided with suitable screws, spring washers and flat washers for fastening the battery and motor cables. PGDT recommends the arrangement of screw, spring washer and flat washer as shown below.



Screws should not be tightened too more than 5.5Nm.

If alternate screws or bolts are used, it is essential that the thread insertion depth is less than 14mm. Damage to the controller may occur if this depth is exceeded.

When crimping the S200 high current connections, the use of AMP®, AMPower III™ or Solistrand™ copper tube terminals is recommended.

It is the responsibility of the scooter manufacturer to ensure that the high current crimp connections 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.

3.2.2 Brake Connector

The brake connector fitted to the S-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 3.3 for crimping and extraction tool information

3.2.3 Tiller Interface Connector

The tiller interface connector fitted to the S-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 3.3 for crimping and extraction tool information

3.2.4 Charger/Programming Connector

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

The mating connector part number is as follows:

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

Molex 'Mini-Fit-Jr.' Crimp terminal: 39-00-0078

Refer to section 3.3 for crimping and extraction tool information

3.3 Crimping

Good quality crimping is essential in ensuring the long term reliability of the scooter'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 the crimping and extraction are available from Molex and Tyco Electronics. The references are as follows.

3.3.1 Brake, Tiller Interface & Charger/Programming Connectors

www.molex.com

Crimp tool for 0.5 –1.0mm^2 wire: 0638190900

Extraction tool for 0.5 –1.0mm^2 wire: 0011030044

3.3.2 Motor and Battery Connectors

www.te.com

Crimp tool for 2.5 – 4.0mm^2 wire: AMP 169400 (Handle) + 169404 (Die Set)

Crimp tool for 4.0 – 6.0mm^2 wire: AMP 169400 (Handle) + 169404 (Die Set)

Crimp tool for 6.0 –10.0mm2 wire: AMP-734533-1

Extraction tool for 6.0 –10.0mm2 wire: 1-1579007-7

Crimp tool for 16mm^2 wire: AMP 708777-4

Only use the exact tool as specified.

3.4 Wire Gauge and Types

The table below gives the minimum recommended wire sizes as defined in ISO7176: 2008.

Controller Current Limit (A)	Battery wire size (mm^2)		Motor Wiring size (mm^2)	
	For Length <1000mm	For length 1000mm - 1500mm	For Length <1000mm	For length 1000mm - 1500mm
30	2.5	3.0	2.5	2.5
40	3.0	4.0	2.5	3.0
50	4.0	4.0	3.0	4.0
60	6.0	6.0	3.0	4.0
80	6.0	8.0	4.0	5.0
100	6.0	No guidance	6.0	6.0
150	8.0	No guidance	8.0	8.0

These are recommendations only and the scooter manufacturer must conduct their own tests to confirm the suitability of the selected wiring.

The wire gauges of the Tiller Interface 24V and 0V connections, Pins 7 and 13, may require increasing if the scooter manufacturer wishes to run auxiliary circuits, such as lighting, from these pins.

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

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

3.5 Battery Connection

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

ISO 7176-14 requires you to 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 3.4. It is recommended that the battery positive and negative wiring to the S-Drive is kept as short as possible.

ISO 7176-14 states that the minimum operating time for the circuit breaker when the scooter is stalled is 15 seconds.

The scooter 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.

3.6 Motor Connection

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

3.7 Solenoid Brake Connection

The solenoid brake should be 24V and should not require more than 1.25A to operate. The S-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 scooter then a Brake Released Switch must be fitted and connected as shown in the S-Drive Wiring Diagram in section 3.1.

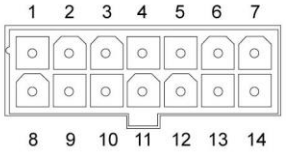
This will result in the S-Drive preventing drive, detecting a freewheel situation and indicating this as a Solenoid Brake Trip. (Trip Type 9).

Due to the S-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 scooter manufacturer to test the effectiveness of the Solenoid Brake(s) over the entire operating range of the S-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 3.2.3 for part numbers and connector details.



Pin Number	Description
1	Throttle Wiper
2	Throttle High Reference
3	Audible Alarm
4	Slow/Fast Switch
5	On/Off Switch
6	Inhibit 2
7	24V B+ (S200 fused 3.75A)
8	Throttle Low Reference
9	Speed Limiting Potentiometer
10	Status Indicator
11	Aux Output
12	Reverse Switch
13	0V
14	Inhibit 3

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

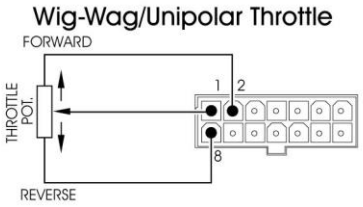
4.1 Throttle Potentiometer Configuration

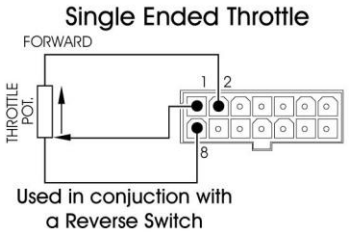
Pins 1,2 and 8 are the connections to the throttle potentiometer. Wig-wag, Single-ended and Unipolar throttle configurations can be used but you should ensure the controller is programmed to the correct type. Refer to Chapter 3.

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 scooter 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.

For compliance with ISO7176-14: 2008, the throttle wiring recommendations in Appendix A (Annex – S-Drive command signal leakage) should be followed.



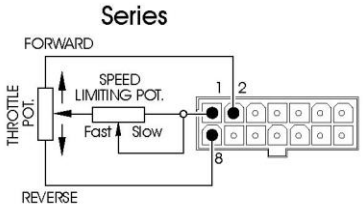


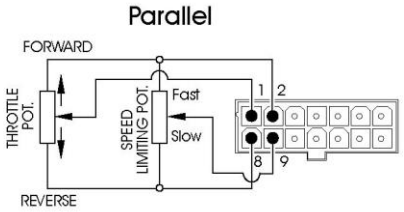
Other factory programmed throttle inputs are available such as a voltage input that accepts signals in the range of 0-5V. Please contact PGDT for details.

4.2 Speed Limiting Potentiometer 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 scooter driving at 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 S-Drive requires to be programmed as follows.

Drive Direction	Potentiometer Position	Scooter Max. 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.

To comply with ISO7176-14: 2008 section 7.2.3.4 PGDT recommends speed limiting potentiometers be fitted in Parallel only.

4.3 ISO-Test Resistor Configuration

If a Speed Limit Pot. is fitted in parallel, or not fitted at all, then it is not necessary to fit an ISO-Test resistor in order to comply with ISO7176-14:2008 section 7.2.3.4.

Fitting a Speed Limit Pot and ISO-Test Resistor in series does NOT comply with ISO7176-14:2008 section 7.2.3.4

To program the S-Drive to suit the scooter installation, Refer to Chapter 3.

4.4 On/Off Switch

Pin 5 is the battery positive supply to the controller from the on/off switch. The maximum power consumption of the controller via this connection will not exceed 1A.

Large capacitances connected between pin 5 and 0V may affect the ability of the S-drive to switch on or off reliably. If it is desired to connect a large capacitance, for example to damp a battery gauge voltmeter or to suppress a horn sounder, then connection should be made between battery 24V (pin 7) and 0V.

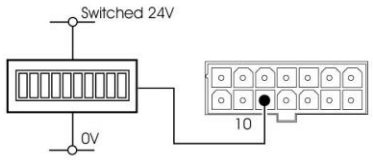
It is the responsibility of the scooter manufacturer to test the effectiveness of the On/Off switch.

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.



If you are using a bulb, the bulb can be connected directly between pin 10 and 0V (Highside) or pin 10 and switched 24V (Lowside). The bulb must be 12V with a maximum rating of 600mW when connected Highside and 24V with a maximum rating of 600mW when connected Lowside.

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

If you are using an Analogue 12V Status Indicator, it is must be connected between pin 10 and 0V.

For each connection and indicator type the controller will require programming to suit. The parameter that will require adjustment is Status Output.

This will require programming to one of the following:

TruCharge - Suitable for Lamp and LED Status Indicators on Highside Drive connections and the TruCharge Status Indicator.

Sink - Suitable for Lamp and LED Status Indicators on Lowside Drive connections.

Analogue - Suitable for Analogue 12V Status Indicator.

4.5.1 Status Indicator Diagnostic setting

For each Status Indicator type the controller will require programming to suit. The parameter that 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.

3 - Alternative twin flash repeated code sequence.

4 - Alternative single flash repeated code sequence.

Refer to Chapter 3 for details.

4.6 24V

Pin 7 is a battery positive supply for the tiller. This pin has a current rating of 5A making it suitable as a lighting circuit supply and to pass charging current. A suitably rated fuse must be fitted as close to pin 7 as possible.

The S200A has an internal, 3.75A self-resetting fuse.

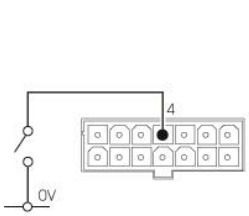
The scooter manufacturer must install a suitable fuse to protect the scooter's wiring. Failure to comply with this could result in a fire hazard. PGDT accepts no liability for losses of any kind arising from failure to comply with this condition.

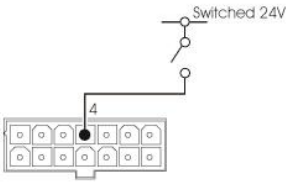
At no time should the current passing through pin 7 of S-Drive Scooter Controller exceed the 5A current rating. Failure to comply with this could result in a fire hazard. PGDT accepts no liability for losses of any kind arising from failure to comply with this condition.

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.

4.7 Slow/Fast Switch

Pin 4 is an input that can be used to limit the forward and reverse speeds, the forward and reverse acceleration and the forward and reverse deceleration of the scooter. Typical uses are: to select between indoor or outdoor use or, as is a requirement in certain countries, to limit the scooter's speed while driving on the sidewalk.





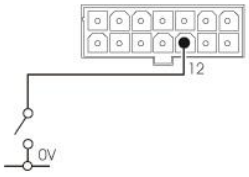
It is possible to connect the switch to Switched 24V or 0V.

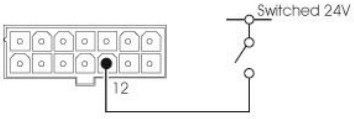
If pin 4 is connected to 0V or switched 24V the controller will drive using the programmed slow speeds and rates. Refer to the chapter 3 for details.

If pin 4 is open then the controller will drive using the programmed fast speeds and rates. Refer to the chapter 3 for details.

4.8 Reverse Switch

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.





It is possible to connect the switch to switched 24V or 0V.

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 or switched 24V.
- With Invert Throttle set to On, the drive will be forwards if pin 12 is connected to 0V or switched 24V.

4.9 Audible Alarm

Pin 3 is an output for a 24V sounder which can operate when the scooter is being driven in reverse. 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.

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

The alarm can be set to On or Off using the Parameters Reverse Alarm and Reverse Alarm Tone.

To create either a pulse or continuous alarm tone, adjust the parameters Pulse Rev Alarm and Pulse Revers Alarm Tone.

The audible alarm can also be programmed to work for 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.

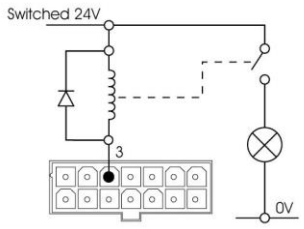
Low Batt alarm - The alarm will sound when the battery level reaches the programmed Low Battery Flash Level.

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.

4.9.1 Brake Light

Pin 3 can also be connected and programmed as a brake light indicator. The brake light bulb must be driven by a relay as show in the illustration.



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.

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

When pin 3 is programmed as a Brake Light there will be no Alarm functions available.

4.10 0 Volts

Pin 13 provides the battery negative connection to the scooter's tiller. This pin has a current rating of 5A making it suitable as a lighting circuit supply and to pass charging current. A suitably rated fuse must be fitted as close to pin 7 as possible.

At no time should the current passing through pin 13 of the S-Drive Scooter 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.

4.11 Inhibit 2

The S-Drive Scooter Controller has 3 highly versatile inputs that can be configured to provide inhibit and speed limiting functions. These inputs are referred to as Inhibit 1, Inhibit 2 and Inhibit 3. Inhibit 2 input is located at pin 6 of the 14 way tiller connector.

If this Inhibit is not to be used PGDT recommends that the Inhibit Speed parameter be set to 100%.

It is possible to connect the switch to 24V or 0V.

Inhibit 2 is intended primarily to detect the presence of external devices such as height switches or brake release switches. These can be used to either limit the maximum speed of the scooter or stop it completely.

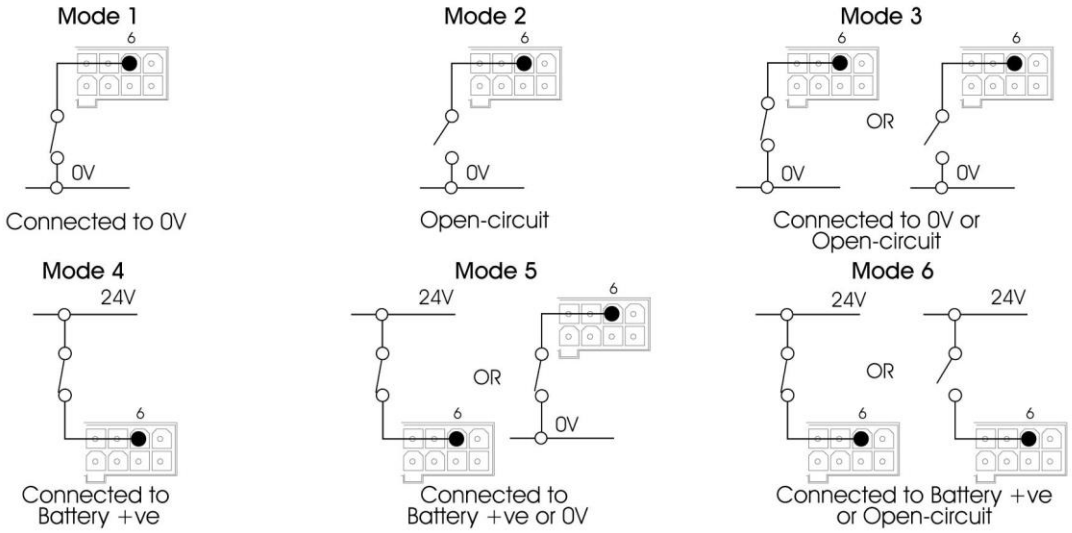
See the example in section 4.11.3

Inhibit 2 input has 3 programmable parameters.

- Inhibit 2 Mode
- Inhibit 2 Speed
- Inhibit 2 Operation

4.11.1 Inhibit 2 Mode

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



4.11.2 Inhibit 2 Speed

This parameter sets the maximum speed of the scooter when the Inhibit 2 input is active. 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.

4.11.3 Inhibit 2 Operation

This parameter is only effective if the Inhibit 2 Speed parameter has been set to 0.

The parameter can be set to one of two states:

Latched - Means the inhibitor, such as a height switch, must be deactivated and the controller turned off and on before the scooter 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 2 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 2 is connected to 0V and is non-latching, program as below.

Mode = 1

Speed Limit Value = 40%

Operation = Non-Latched

If this inhibit is activated then the controller will cause the scooter to decelerate to the programmed speed limit value. This could be activated by a seat position sensor being activated. In this instance the TruCharge indicator will remain unchanged.

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

Mode = 1

Speed Limit Value = 0

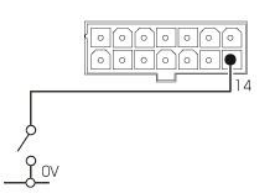
Operation = Latching

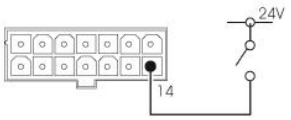
If this inhibit is activated then the controller will cause the scooter to decelerate to a complete stop (as if the throttle has been released).

4.12 Inhibit 3

The S-Drive Scooter Controller has 3 highly versatile inputs that can be configured to provide inhibit and speed limiting functions. These inputs are referred to as Inhibit 1, Inhibit 2 and Inhibit 3. Inhibit 3 input is located at pin 14 of the 14 way tiller connector.

If this Inhibit is not to be used PGDT recommends that the Inhibit Speed parameter be set to 100%.





It is possible to connect the switch to 24V or 0V.

Inhibit 3 is programmed primarily to detect the presence of an external battery charger connected through the tiller and therefore prevent the scooter from being driven whilst connected to the mains.

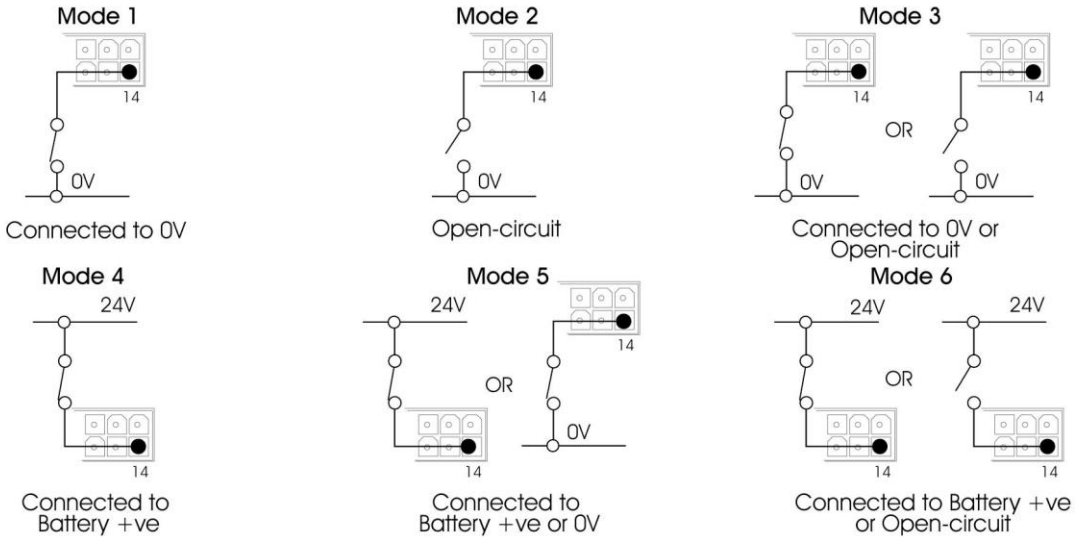
See the example in section 4.12.3

Inhibit 3 input has 3 programmable parameters.

- Inhibit 3 Mode
- Inhibit 3 Speed
- Inhibit 3 Operation

4.12.1 Inhibit 3 Mode

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



4.12.2 Inhibit 3 Speed

This parameter sets the maximum speed of the scooter when the Inhibit 3 input is active. 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.

4.12.3 Inhibit 3 Operation

This parameter is only effective if the Inhibit 3 Speed parameter has been set to 0.

The parameter can be set to one of two states:

Latched - Means the inhibitor, such as the charger plug, must be removed and the controller turned off and on before the scooter 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 3 is active the TruCharge display will step-up to indicate the scooter is charging.

Example - To provide a charge inhibit function that is active when Inhibit 3 is connected to 0V and is latching, program as below.

Mode = 1

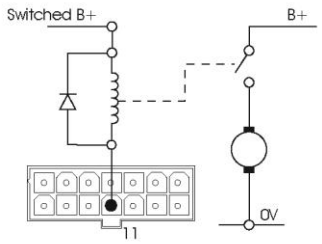
Speed Limit Value = 0

Operation = Latched

If this Inhibit is activated then the controller will cause the scooter to decelerate to a complete stop (as if the throttle has been released).

4.13 Auxiliary Output

Pin 11 is a 1A self-protected output, which can be programmed to operate an external relay. The parameter that must be programmed is aux output mode. Refer to chapter 3 for programming details.



5 Drive Motors

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

In order to optimize the performance of the scooter, 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 S-Drive and the motor. The value is set in milli-Ohms (mOhms). 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 40mOhms.

Example:

Motor has armature resistance of 200mOhms

Cables and connectors are 40mOhms

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

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 scooter 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 scooter uncontrollable and potentially unsafe. PGDT accepts no liability for losses of any kind arising from failure to comply with this condition.

The scooter 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 scooter 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 scooter type to install it on a different scooter 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 scooter. Failure to observe this warning could result in an unsafe setup for the scooter user and may create a fire hazard depending on the motors, wiring, connectors and circuit breakers installed on the unauthorized scooter. 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 scooter. By minimizing these effects, user comfort is improved and drive train reliability increased.

Roll-back occurs when the throttle is released while driving up hill. The scooter 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 scooter is still moving.

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

Motor Compensation, Enhanced Motor Compensation Up, Enhanced Motor Compensation Down and Enhanced Motor Compensation Up Gain. Refer to Chapter 3.

5.2 Freewheeling

There are two typical methods for providing a scooter 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.

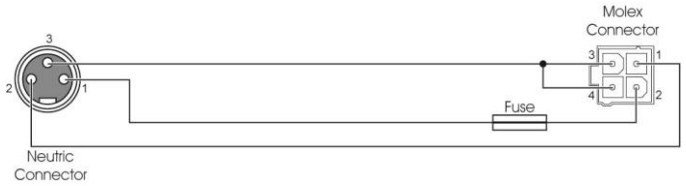
If the latter method is used, the S-Drive can detect the motor rotating above a certain speed and then brake it automatically, thus removing the possibility of the scooter freewheeling at an excessive speed. This function will operate if the scooter is switched off and even if there are no batteries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

It is the responsibility of the scooter manufacturer to ensure that adequate precautions are taken to warn the user against the hazards of freewheeling the scooter at excessive speeds. It is also the responsibility of the scooter 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 scooter.

6 Charger/Programming Connections (Off-board & On-board)

The controller has been designed to allow both Charging and Programming through the Molex 4-way connector. This connector can be used either directly or via a Neutrik NC3MX socket.

In order to use a Neutrik socket the charger/programming loom should be wired as below.



For both Off-board and On-board Charging, the maximum charging current is 9A rms. Refer to Section 3 of this chapter for pin-out details of this connector.

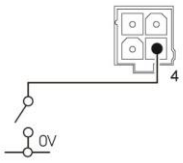
Do not exceed the maximum charging current of 9 A rms. Always use the PGDT specified charger connectors. Failure to observe these conditions could result in poor contact resistance in the charger connector resulting in overheating of the charger plugs. This presents a potential burn hazard for the user. PGDT accepts no liability for losses of any kind arising from failure to comply with this condition. Ensure that the charger plug pins are of the correct type.

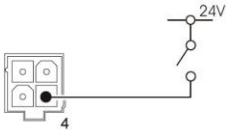
The scooter manufacturer must install a suitable fuse to protect the scooter's wiring. PGDT recommends that the fuse is fitted as close as possible to the 4-way Molex connector. Failure to comply with this could result in a fire hazard. PGDT accepts no liability for losses of any kind arising from failure to comply with this condition.

6.1 Inhibit 1

The S-Drive Scooter Controller has 3 highly versatile inputs that can be configured to provide inhibit and speed limiting functions. These inputs are referred to as Inhibit 1, Inhibit 2 and Inhibit 3. Inhibit 1 input is located on the 4 way charger connector.

If this Inhibit is not to be used PGDT recommends that the Inhibit Speed parameter be set to 100%.





It is possible to connect the switch to 24V or 0V.

Inhibit 1 is programmed primarily to detect a charger inhibit condition, such as an off board charger being connected to the scooter or an onboard charger being connected to the line.

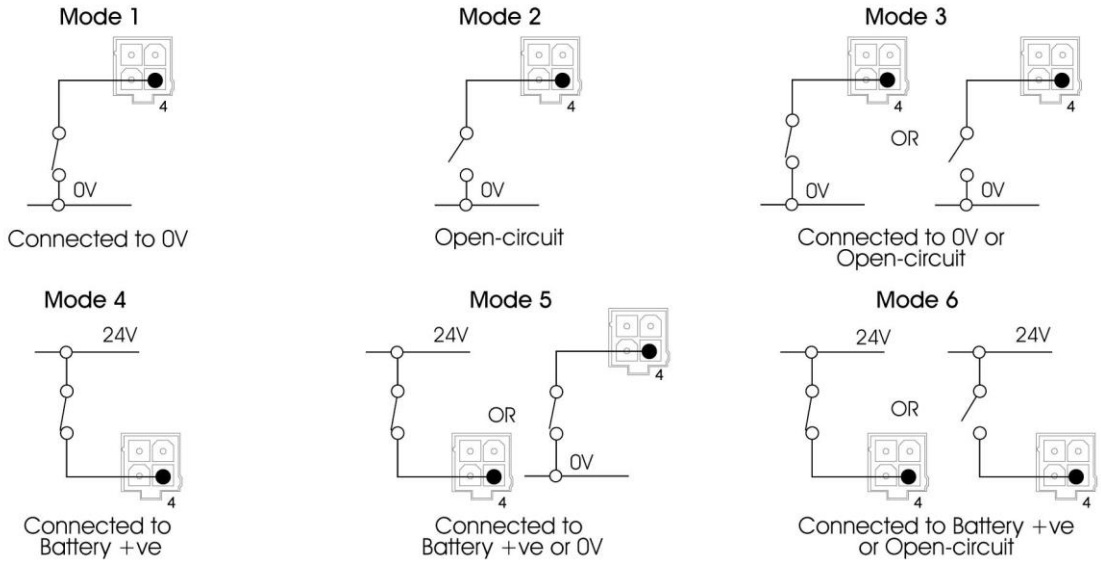
See the example in section 6.1.3

Inhibit 1 input has 3 programmable parameters.

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

6.1.1 Inhibit Mode

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



6.1.2 Inhibit 1 Speed

This parameter sets the maximum speed of the scooter when the Inhibit 1 input is active. 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.

6.1.3 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 the charger plug, must be removed and the controller turned off and on before the scooter 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 step-up to indicate the scooter is charging.

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

Mode = 1

Speed Limit Value = 0

Operation = Latched

If this inhibit is activated then the controller will cause the scooter to decelerate to a complete stop (as if the throttle has been released).

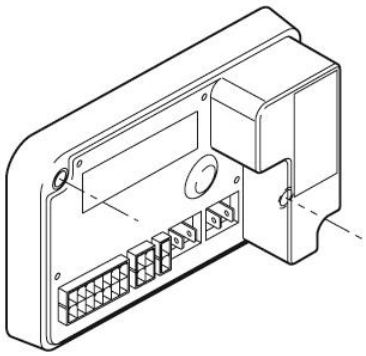
7 Batteries

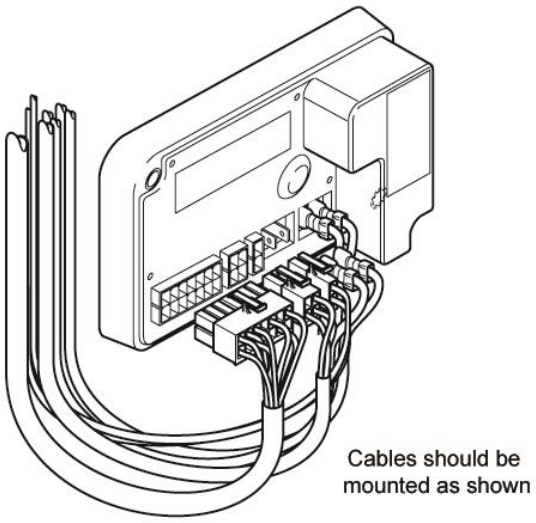
The controller is designed for operation with 24V lead acid batteries. The batteries may be wet or gel electrolyte types.

8 Mounting

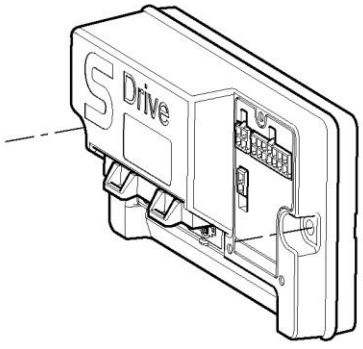
8.1 Mounting of the S-Drive

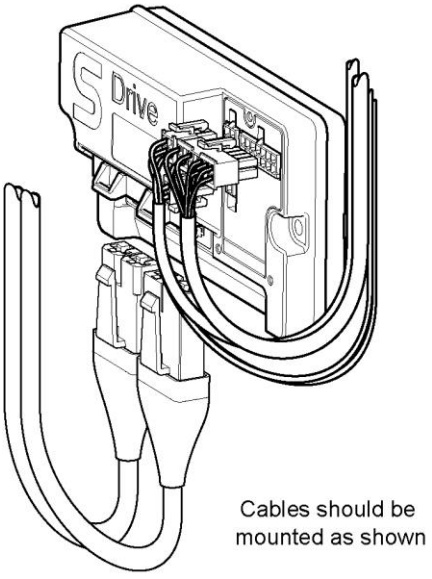
8.1.1 S45A, S70A & S90A



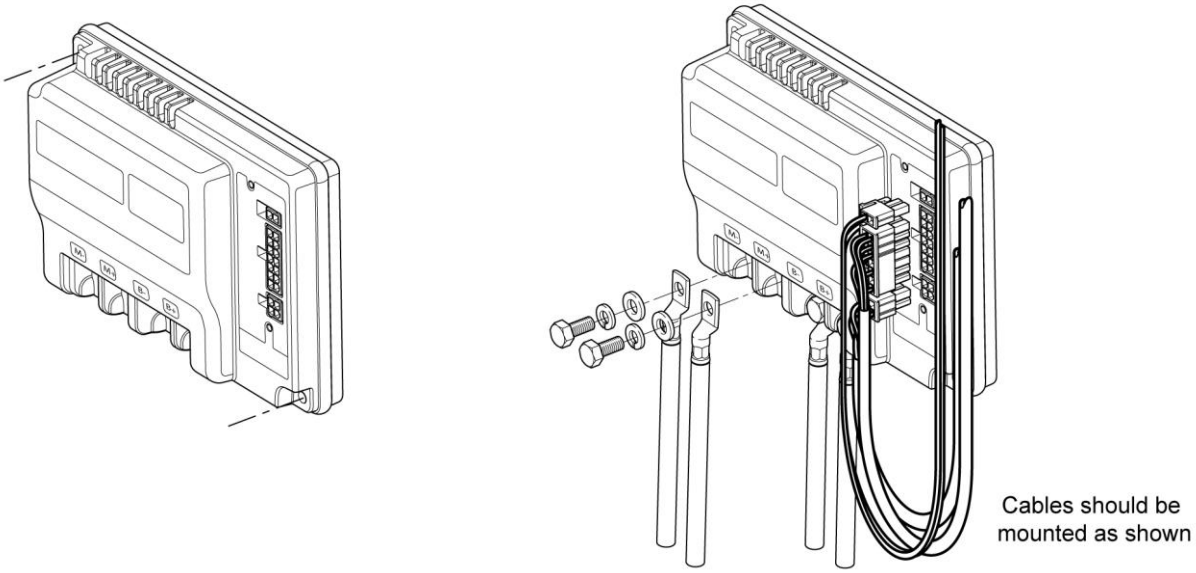


8.1.2 S120A + S140A





8.1.3 S200A



8.1.3 Orientation

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

8.1.4 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 scooter 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 scooter chassis. To provide even better thermal performance, a non-silicone thermally conductive paste or pad may be applied between the baseplate and the scooter 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 scooter 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.

8.1.5 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 S-Drive, therefore minimizing the flow of moisture into the connectors.

See the following illustration.

8.2 Mounting the S-Drive + S-cover system

Once the controller is securely mounted to the scooter the S-cover can be applied. To mount the S-cover use the following procedure:

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

The S45A, S70A and S90A Kit comprises of a rubber gasket (3), a rubber cable seal (2), a molded metalc cover (1) and 4 screws. These items available in kit format from PG Drives Technology.

S45A and S70A S-cover kit number is: D50282

S90A S-cover kit number is: D51424

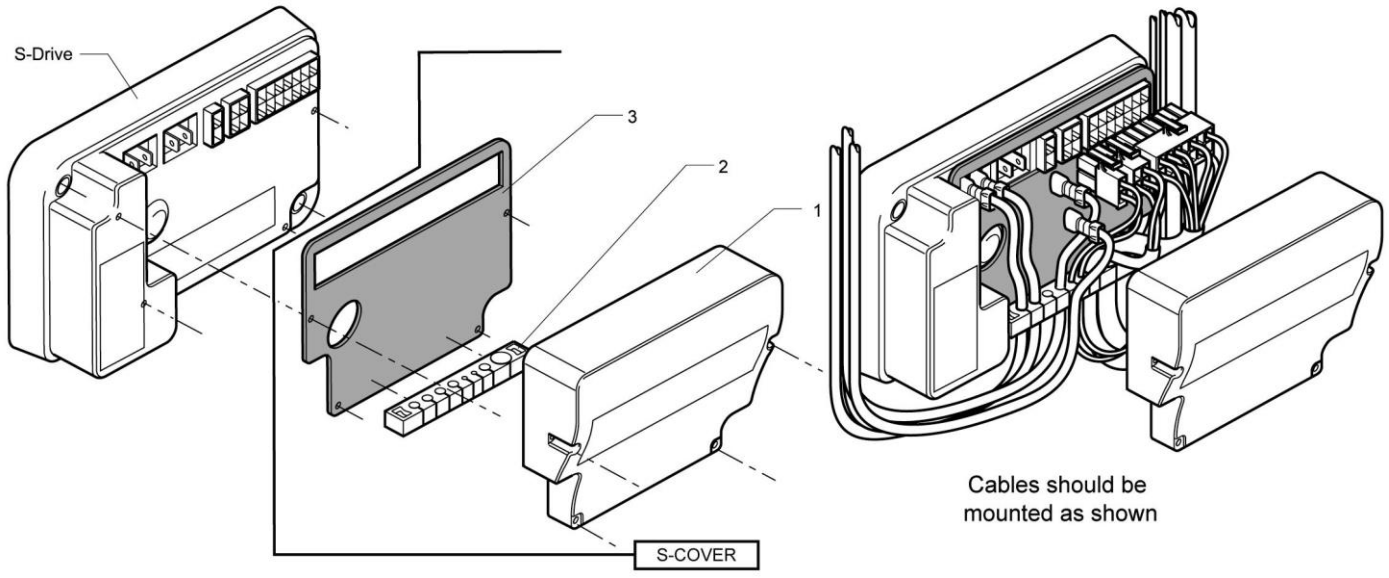
The S120A & S140A Kit comprises of a rubber cable seal / gasket (1), a molded metal cover (2) and 3 screws. These items a available in kit format from PG Drives Technology.

S120A and S140A S-cover kit number is: D51058

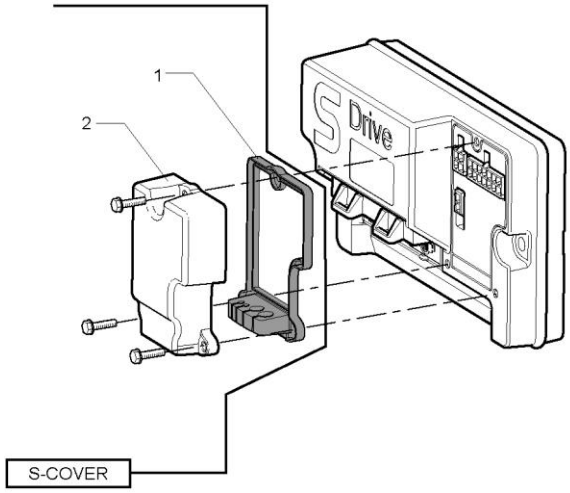
The S200 Kit comprises of a rubber cable seal / gasket (1), a molded metal cover (2) and 2 screws. These items a available in kit format from PG Drives Technology.

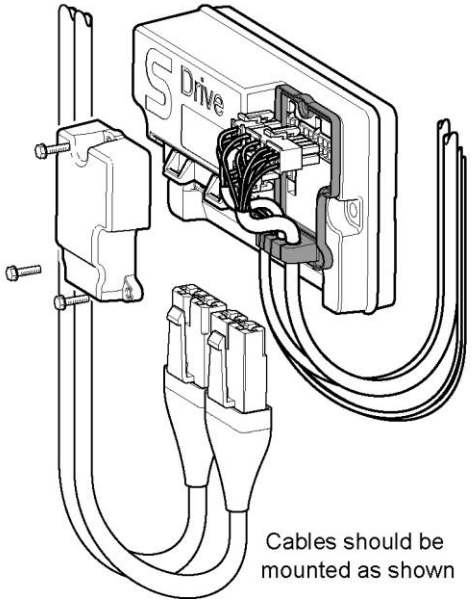
S200A cover kit number is: D51160

8.2.1 S45, S70A & S90A + S-cover

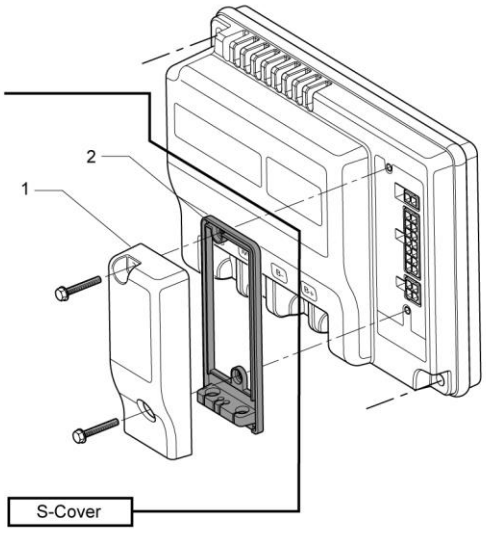


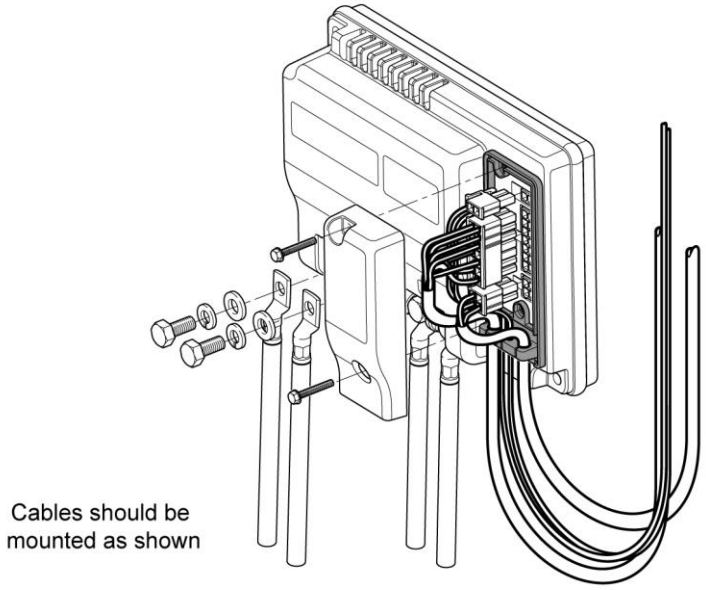
8.2.2 SI20A & SI40A + S-cover





8.2.3 S200A + S-cover





8.2.3 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.

8.2.4 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 scooter 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 scooter chassis. To provide even better thermal performance, a non-silicone thermally conductive paste or pad may be applied between the baseplate and the scooter 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 scooter 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.

8.2.5 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 S-Drive, therefore minimizing the flow of moisture into the connectors.

9 Production Tests

- Perform the following tests, in order, on each scooter 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.

9.1 Mounting

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

9.2 Cables and Connectors

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

9.3 Preset Settings

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

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

9.4 Operational Test

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

- Switch on the controller.

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

9.5 Test Drive

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

9.6 Soft-Stop Test

- Drive the scooter at full forward speed and switch the controller off.
- The scooter must not stop suddenly, but should decelerate to standstill.

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

10 Electromagnetic Compatibility (E.M.C.)

The S-Drive Scooter Controller series has been tested for compliance with the EMC requirements of EN12184, the FDA and the FCC. The guidelines in this section will help you to make sure that your scooter installation will meet the requirements of the directive. You should consider EMC and perform relevant tests as early as possible in the design phase.

10.1 Emissions

A typical scooter and S-Drive installation have been type tested and have passed the requirements of EN55022 Class B.

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 scooter frame over as much of their length as is practical.
- Do not use the controller connectors as the junction points for the battery connections. Separate junction points away from the S-Drive should be provided for the other scooter electrical functions.

10.2 Immunity

The S-Drive controller has been stringently tested for susceptibility to electromagnetic radiation over the frequency range 26 MHz to 1 GHz. The installations passed the FDA requirements and the requirements of EN12184.

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

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

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).

E.S.D. produces very fast pulses of electrical energy which, if allowed to enter an electronic system, may cause disruption of operation or even permanent damage. The S-Drive controller incorporates extensive protection against E.S.D., however, you should take the following precautions to prevent high levels of energy entering the controller.

The area where E.S.D. is most likely to enter the system is the tiller. Users who have become "charged", for example by walking on a nylon carpet, can impart a significant discharge to the scooter via the first point they touch. The best method of protection against such a discharge is to make all user controls and tiller enclosures non-conductive. Switch manufacturers should be able to provide appropriate advice and design rules.

Where controls and enclosures are conductive, a low impedance electrical connection to the main mass of the scooter's metalwork should be provided. If such a connection is used, it should be kept as short as possible to minimize its electrical inductance.

If such a low impedance connection cannot be made because of electrical isolation requirements then an alternative electrical connection should be provided via a varistor. For 24V systems a suitable device is manufactured by Harris, type GE-MOV V82ZA2. The varistor should be connected between the electrical terminal and battery negative.

Charger socket, battery and motor terminals do not normally require protection.

If you need advice please contact PGDT.

11 Battery Gauge

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

The battery gauge typically starts to flash slowly when the battery voltage falls below 23.3V whilst the scooter is driving on a level surface. The controller can be programmed so that the low battery flash can commence at different levels. This is achieved via the parameter Low Battery Flash Level.

For optimum accuracy of the battery gauge and low battery indicator, the controller should be programmed with the approximate nominal capacity of the scooter 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 scooter to make the battery gauge accurate. Refer to Chapter 3.

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

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

If you need advice, contact PGDT.

CHAPTER 3 – PROGRAMMING

1 Introduction

This chapter gives an overview of the programmable parameters within the S-Drive Controller. The S-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 healthcare professionals with in-depth knowledge of PGDT controllers. Incorrect programming could result in an unsafe set-up of a scooter 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 therapists access to the programmable parameters which can be used to adjust the scooter to 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 S-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 and therapist which gives the same access level as the SP1a handheld programmer; and one for scooter OEMs which gives access to all S-Drive Controller parameters. These are known as PCPa and PCPb respectively.

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

1.3 Parameters

The parameters are 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	

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	
Low Battery Flash Level	Cable Resistance
Calibration Factor	Low Battery Alarm
Low Battery Alarm Tone	TruCharge Reset Level
Inhibit - Section 6	
Inhibit 1 Mode, Operation & Speed	Inhibit 2 Mode, Operation & Speed
Inhibit 3 Mode, Operation & Speed	Aux Output mode
General - Section 7	
Soft Stop	Brake Time
Output Voltage	Status Output Type
Diagnostic Flash Sequence	Reverse Alarm
Reverse Alarm Tone	Pulsed Reverse Alarm
Diagnostic Alarm	Diagnostic Alarm Tone
Brake Disconnected Alarm	Brake Disconnected Alarm Tone
Brake Fault Detect	Brake Light
Push Too Fast Threshold	Push Too Fast Time-out
Freewheel Enable	Inhibit 2 Horn Input Enable
Motor - Section 8	
Current Limit Min & Max	Boost Drive Current & Time
Current Foldback Threshold, Time, Level	Current Foldback Temperature
Motor Cooling Time	Motor Compensation
Motor Stall Timeout	Braking Current
Timed Foldback Braking Current	Timed Foldback Speed
Enhanced Motor Compensation (Up)	Enhanced Motor Compensation (Down)
Enhanced Motor Compensation (Up) Gain	
Memory Functions - Section 9	
Read System Log	Clear System Log
Read Timer	Clear Timer

1.4 Safety Fences

Limits (or fences) can be applied to some dealer accessible programmable parameters. These limits are known as safety fences and are programmed by PGDT when the S-Drive is manufactured. The purpose of these fences is to prevent the scooter being programmed to be too fast, or too severe in its acceleration or deceleration. The parameters which can have fences applied to them are:

Forward Speed	Reverse Speed
Acceleration (forward and reverse combined)	Deceleration (forward and reverse combined)

Standard PGDT settings are 0 for the minimum fence value and 100 for the maximum fence value, meaning there is a full range of adjustment. If you wish to apply different fence values, please contact PGDT.

PGDT accepts no liability for losses of any kind if the scooter manufacturer does not specify appropriate safety fence values for a particular scooter application.

2 Speed Parameters

2.1 Forward Acceleration

Adjusts the value for forward acceleration of the scooter, 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 scooter to tip when accelerating up a slope.

2.2 Forward Deceleration

Adjusts the value for forward deceleration (or braking) of the scooter, 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 scooter manufacturer to ensure that the emergency stopping distance is within the distance specified for the country in which the scooter will be used. For countries requiring CE marking this is as specified in EN12184.

2.3 Reverse Acceleration

Adjusts the value for reverse acceleration of the scooter, 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 scooter, 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 scooter manufacturer to ensure that the emergency stopping distance is within the distance specified for the country in which the scooter will be used. For countries requiring CE marking this is as specified in EN12184.

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

2.5 Max Forward Speed

This sets the MAXIMUM forward speed of the scooter.

So long as a Slow/Fast switch is fitted to the scooter 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 scooters total available output. Therefore if the Fast value is set to 80% then the scooter 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 scooter is maintained, especially when cornering, at the programmed Max Forward Speed.

2.6 Min Forward Speed

This sets the MINIMUM forward speed of the scooter.

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 scooter's Speed Limiting potentiometer is set to Slow and the Slow/Fast switch is set to Fast.

Slow This value is used when the scooter'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 scooter's total available output. Therefore if the Fast value is set to 40% then the scooter 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 cannot be set at a greater value than the Max Fwd Speed.

2.7 Max Reverse Speed

This sets the MAXIMUM reverse speed of the scooter.

So long as a Slow/Fast switch is fitted to the scooter 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 scooters total available output. Therefore if the Fast value is set to 60% then the scooter 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 scooter.

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 scooter's Speed Limiting potentiometer is set to Slow and the Slow/Fast switch is set to Fast.
Slow	This value is used when the scooter'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 scooters total available output. Therefore if the Fast value is set to 20% then the scooter 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 cannot be set at a greater value than the Max Rev Speed.

2.9 Speed Limit Pot. Enabled

This sets whether the S-Drive detects if a parallel type Speed Limiting Potentiometer is connected to pin 9 of the Tiller Interface. The parameter can be set to On or Off.

If set to On, then the S-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 S-Drive will default to the programmed minimum speeds.

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

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

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

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 24V or 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 enter sleep mode.

The time can be adjusted in 1minute 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.

Single-ended	Stands for Single-ended Throttle type.
Wig-wag	Stands for Wig-wag Throttle type.
Unipolar	Stands for Unipolar Throttle type.

4.2 Throttle Deadband

This sets the amount of throttle potentiometer movement before the solenoid brake is disengaged and the scooter 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 S-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 S-Drive will drive if it is switched on while the throttle is already deflected.

Inhibit	The S-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 scooter to drive.
Trip	The S-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 scooter 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 scooter 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.

Set to Off If the scooter has no ISO-Test Resistor or the ISO-Test Resistor and Speed Limiting Potentiometer have been fitted in parallel. Both of these conditions comply with ISO7176-14:2008 section 7.2.3.4.

Set to ON if the scooter has an ISO-Test Resistor and Speed Limiting Potentiometer that have been fitted in series. This condition does not comply with ISO7176-14:2008 section 7.2.3.4

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 Low Battery Flash Level

This parameter sets the point at which the Scooters TruCharge battery gauge starts to flash slowly to warn of a low battery condition. The adjustment range is 1 to 10 in steps of 1, and corresponds to the number of bars shown on the battery gauge.

Example: If this value is set to 2, then the flashing will occur when the gauge drops to 2 bars.

5.2 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.

5.3 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.

5.4 Low Battery Alarm

This parameter sets whether the S-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.

5.5 Low Battery Alarm Tone

This parameter sets the tone when the alarm is active. The parameter can be programmed to 0, 1, 2 or 3.

0 - No tone 1 - 2khz 2 - 1kHz 3 - 500hz

5.6 TruCharge Reset Level

This parameter sets the level to which the batteries must be charged in order to reset the TruCharge display. Each time the controller is powered down it will store its TruCharge level. When the controller is powered up it will display the stored TruCharge value and not allow the TruCharge display to rise above this level until the controller reads a value greater than the TruCharge Reset Voltage (to Indicate the scooter has been charged). TruCharge Reset level is programmable between 200 deci-volts (Off) and 450 deci-volts in steps of 0.1 volts.

The TruCharge reset level should be set to an appropriate value that indicates the vehicle has been fully charged and thus the TruCharge display resets. PGDT takes no responsibility for incorrect programming of this value.

6 Inhibit Parameters

6.1 Inhibit 1 Mode, Inhibit 1 Speed, Inhibit 1 Latch

For full details of these parameters refer to Chapter 2 section 6.1

6.2 Inhibit 2 Mode, Inhibit 2 Speed, Inhibit 2 Latch

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

6.3 Inhibit 3 Mode, Inhibit 3 Speed, Inhibit 3 Latch

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

6.4 Aux Output Mode

By connecting a relay to pin 11 of the 14-way connector in a similar fashion to the brake light configuration, as shown in the Installation Chapter, the S Drive can be used to drive an Auxiliary Relay.

Aux Output Mode can be programmed to operate one of a range of functions. The Aux. Output Mode sets when the output will be active. Pin 11 will be active depending on how Aux. Output Mode is programmed and Inhibit 2 being pulled low(0v).

There are 5 modes which can be set.

0 = Off (Aux Output mode not Active)

1 = Standby (Aux. Output is only Active in Standby)

2 = Drive (Aux Output is only Active in Forward and Reverse)

3 = Standby/Drive(Aux Output is only Active in Standby or Drive)

4 = Standby/Drive/Trip (Aux Output is active the entire time the controller is powered up.)

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 scooter 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 scooter will be used. For countries requiring CE marking this is as specified in EN12184.

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 scooter doesn't jerk or skid on a level surface, but short enough to minimize roll-back or roll-forward on slopes.

More details for setting this parameter can be found in Appendix B – Set-up Procedure.

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 scooter'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 Status Output Type

This parameter can be set to one of three options:

TruCharge	Suitable for Lamp and LED Status Indicators on Highside Drive connections and the TruCharge Status Indicator.
Sink	Suitable for Lamp and LED Status Indicators on Lowside Drive connections.
Analogue	Suitable for Analogue 12V Status Indicator.

For details of the functionality of these settings and their associated configurations refer to Chapter 2 section 4.5.

7.5 Diagnostic Flash Sequence

This parameter can be set to 0, 1, 2, 3 or 4.

0	No signal
1	TruCharge indication
2	Sequence flashes which simulate the TruCharge indication.
3	Alternative twin flash repeated code sequence. See following diagram

4 Alternative single flash repeated code sequence. See following diagram

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

7.6 Reverse Alarm

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.

The parameter can be set to On or Off.

7.7 Reverse Alarm Tone

This parameter sets the tone when the alarm is active. The parameter can be programmed to 0, 1, 2 or 3.

0 – Self Resonating 1 - 2khz 2 - 1kHz 3 - 500hz

7.8 Pulse Reverse Alarm

The controller has an output to power an audible reversing alarm. 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.

The parameter can be set to On or Off.

7.9 Diagnostic Alarm

The diagnostic alarm will create a pulsed type alarm which will sound the equivalent to the TruCharge diagnostic indicator

The parameter can be set to On or Off.

7.10 Diagnostic Alarm Tone

This parameter sets the tone when the alarm is active. The parameter can be programmed to 0, 1, 2 or 3.

0 - Self Resonating 1 - 2khz 2 - 1kHz 3 - 500hz

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.

7.11 Brake Disconnected Alarm

The controller has an output to power an audible reversing alarm. The alarm will sound whenever the controllers sense a break in the Alarm circuit.

The parameter can be set to On or Off.

7.12 Brake Disconnected Alarm Tone

This parameter sets the tone when the alarm is active. The parameter can be programmed to 0, 1, 2 or 3.

0 - Self Resonating 1 - 2khz 2 - 1kHz 3 - 500hz

7.13 Brake Fault Detect

Sets whether the S-Drive detects a fault in the scooter's electrical brakes or the connections to them. The parameter can be set to On or Off.

On	Means the S-Drive will detect brake faults.
Off	Means the S-Drive will not detect brake faults.

This parameter should only ever be set to off if there are no electrical brakes fitted to the scooter.

7.14 Brake Light

This parameter can be set to On or Off.

When set to On the S-Drive's Audible Alarm output (pin 3) will provide a brake light function. The brake light will be illuminated as soon as the throttle is released and will remain illuminated for approximately 1-2 seconds after the scooter has stopped completely.

When this parameter is set to Yes then no alarm functions will operate.

For wiring details refer to the illustration in Chapter 2 section 4.9.1.

7.15 Push Too Fast Threshold

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

This parameter is factory set and should not require adjustment. For further details contact PGDT.

It is the responsibility of the scooter manufacturer to ensure that adequate precautions are taken to warn the user against the hazards of freewheeling the scooter at excessive speeds. It is also the responsibility of the scooter 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 scooter.

7.16 Push Too Fast Timeout

The controller can detect the motor rotating above a certain speed and brake it automatically. This parameter sets the amount of time between periodic retesting of the motor speed when a freewheel switch is connected to Inhibit 3.

This parameter is factory set and should not require adjustment. For further details contact PGDT.

It is the responsibility of the scooter manufacturer to ensure that adequate precautions are taken to warn the user against the hazards of freewheeling the scooter at excessive speeds. It is also the responsibility of the scooter 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 scooter.

7.17 Freewheel Enable

This parameter determines if the Inhibit 3 input acts as a Freewheel Enable. The speed will be reduced by the programmed value of Push to Fast Threshold, thus removing the possibility of the scooter freewheeling at an excessive speed.

The programmable options are:

Enable: The Inhibit 3 input will act as a Freewheel input. Connecting the input to 0V will activate the solenoid brake.

Disable: The input will act as per the Inhibit 3 parameter settings.

It is the responsibility of the scooter manufacturer to ensure that adequate precautions are taken to warn the user against the hazards of freewheeling the scooter at excessive speeds. It is also the responsibility of the scooter 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 scooter.

7.18 Inhibit 2 Horn Input Enable

This parameter is operated off of the Inhibit 2 input. It can be programmed On or Off. When programmed to On, and the inhibit is active, an alarm will sound. If Inhibit 2 is set to Off, the Inhibit 2 Horn Input Enable can be used to drive a non self oscillating horn.

7.19 Inhibit 2 Horn Input Enable Tone

This parameter sets the tone when the alarm is active. The parameter can be programmed to 0, 1, 2 or 3.

0 - Self Resonating 1 - 2khz 2 - 1kHz 3 - 500hz

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 S-Drive.
Min	Sets the current output of the S-Drive when it is at 80°C. Refer to section 8.4.

8.2 Boost Drive Current and Boost Drive Time

These parameters provide 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 scooter is being driven up a hill. Refer to the following graph.

The drive boost current can be set in 1A steps between 10 and 140A 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.

The maximum values for these parameters are shown in the table below.

Parameter	S45A	S70A	S90A	S120A	S140A	S200A
Boost Drive Current	45 Amps	70 Amps	90 Amps	120 Amps	140 Amps	200 Apms
Boost Drive Time	-	10 Seconds	10 Seconds	10 Seconds	10 Seconds	10 Seconds

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

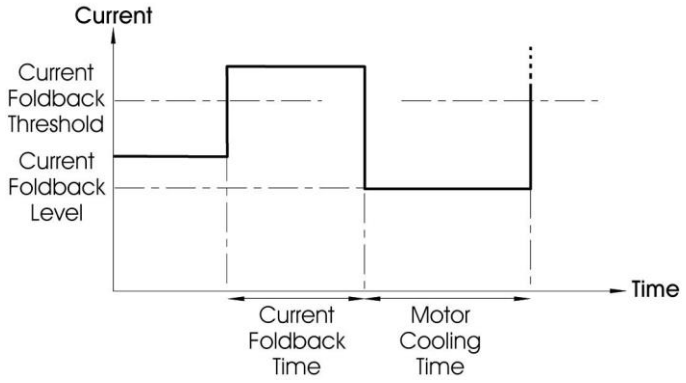
The parameters Threshold, Time, Level and Motor Cooling can be used to protect the motor from overheating. If the motor current exceeds the value set by Threshold for a period set by Time, then the S-Drive's current output will be reduced to a value set by Level. After this has occurred, full current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

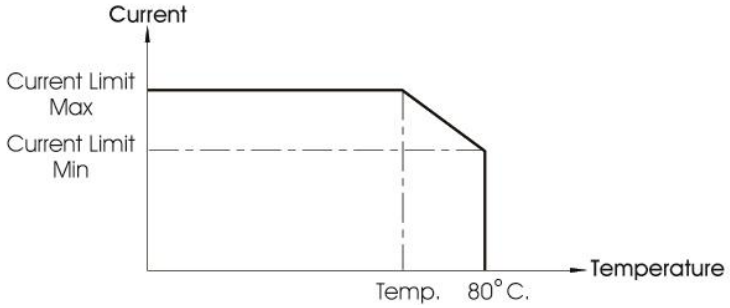


8.4 Current Foldback Temp.

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

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

The graph below shows the operation of this function.



If the S-Drive's internal temperature reaches the value set by Current Foldback 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.

The table below shows the maximum permissible settings for Current Foldback Temp. and Current Limit Min.

Parameter	S45A	S70A	S90A	S120A	S140A	S200A
Current Limit Min	45 Amps	55 Amps	60 Amps	110 Amps	120 Amps	180 Amps
Current Foldback Temp.	80°C	80°C	80°C	80°C	80°C	80°C

8.5 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 60% 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 40mOhms.

You can set this value between 0 and 1000 mOhms in steps of 5 mOhms.

The scooter 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 scooter uncontrollable and potentially unsafe. PGDT accepts no liability for losses of any kind arising from failure to comply with this condition.

The scooter 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 scooter uncontrollable and potentially unsafe. PGDT accepts no liability for losses of any kind arising from failure to comply with this condition.

8.6 Motor Stall Timeout

If the Current Fold back Threshold is exceeded for the duration of Motor Stall Time, drive to the motor and will be cut the brake engaged. Release the throttle back to neutral and try again. This feature can be used to protect the motor from undue stress.

Motor Stall Timeout is programmable between 0 (off) and 180 seconds.

8.7 Braking Current

This parameter sets the braking current of the S-Drive. The parameter is programmable from 45A to the controller's maximum rating. However, it is recommended the parameter is never set less than the controller's maximum as shown in the table below.

Controller	Max (Amps)
S45A	45
S70A	70
S90A	90
S120A	120
S140A	140
S200A	200

This parameter should be set to a value suitable for the motor being used. PGDT accepts no liability for losses of any kind arising from the improper use of the scooter or controller.

8.8 Timed Foldback Braking Current

This parameter sets the maximum braking current when the controller is in 'Timed Foldback' and can be used to protect the motor. Reducing this parameter will result in a greater stopping distance for the scooter, so the parameter Timed Foldback Speed should also be reduced in order to maintain a safe stopping distance.

This parameter should be set to a value suitable for the motor being used. PGDT accepts no liability for losses of any kind arising from the improper use of the scooter or controller.

8.9 Timed Foldback Speed

This parameter can be used to limit the speed of the scooter when the controller is in 'Timed Foldback'. The primary purpose of this adjustment is to maintain a safe stopping distance if the braking current is reduced.

It is the responsibility of the scooter manufacturer to ensure a safe stopping distance is maintained in the event of reduced braking current. PGDT accepts no liability for losses of any kind arising from failure to comply with this condition.

8.10 Enhanced Motor Compensation (Up), Enhanced Motor Compensation (Down), Enhanced Motor Compensation (Up) Gain,

These parameters allow fine-tuning of the scooter's gradient performance, i.e. minimizing rollback when starting and stopping on a slope. Refer to Appendix B – Set-up Procedure for full details of adjusting these parameters.

9 Memory Functions

9.1 Read System Log

The S-Drive has a diagnostic log facility that 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 S-Drive's diagnostic log.

9.3 Read Timer

The S-Drive has a timer which records how long the scooter 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 scooter has been in drive for.

9.4 Clear Timer

This function resets the S-Drive's timer.

CHAPTER 4 – TILLER MODULE

1 Introduction

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

The S-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 Tiller Module. These are:

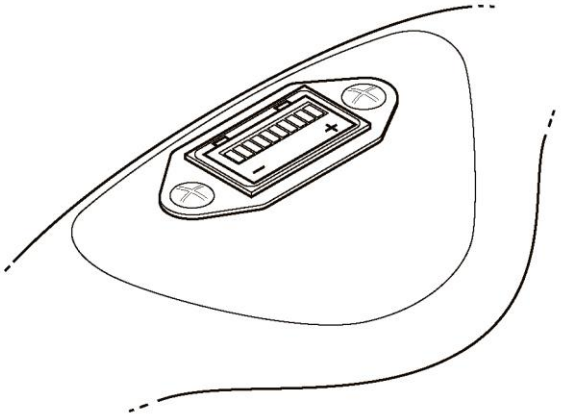
- Surface mount variant.
- Inset variant.

1.1 Surface Variant

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

- Surface mount variants – D50826 (24V-48V operation)

  D50826 consists of: 1 TruCharge Display Module, 1 TruCharge Display Cable, and 1 Gasket



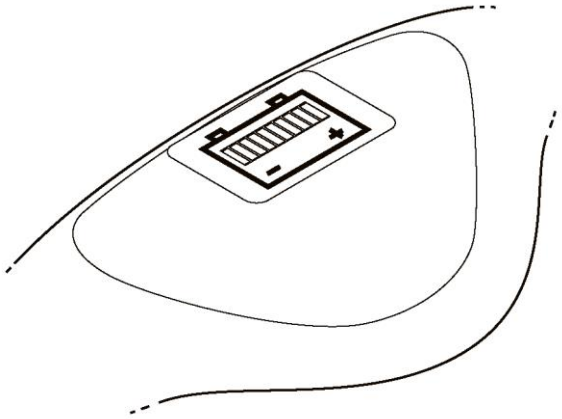
1.2 Inset Variant

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

- Inset variant - D50066 / D50032 (24V operation only)

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

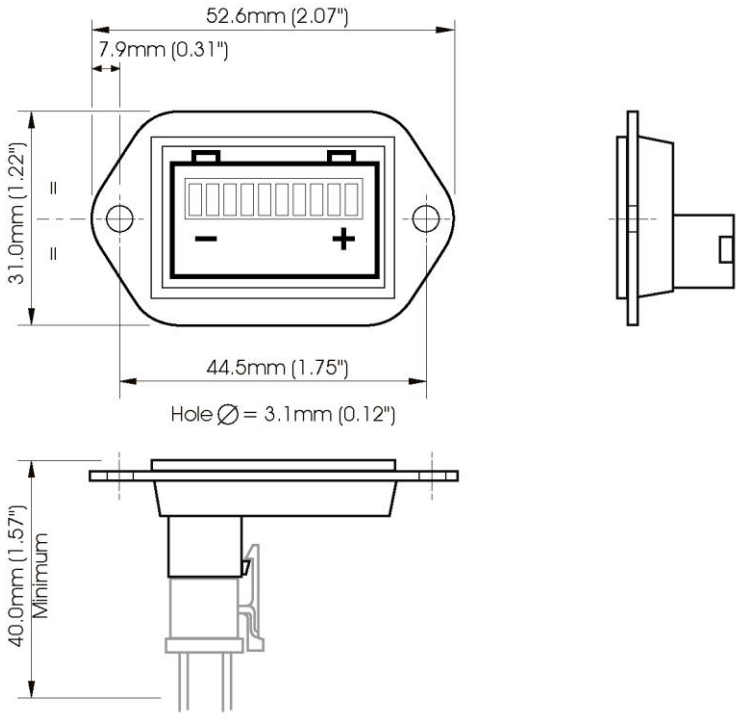
  D50032 Consists of: 1 TruCharge Display Module and 1 Double-sided Adhesive Gasket.



2 Dimensions

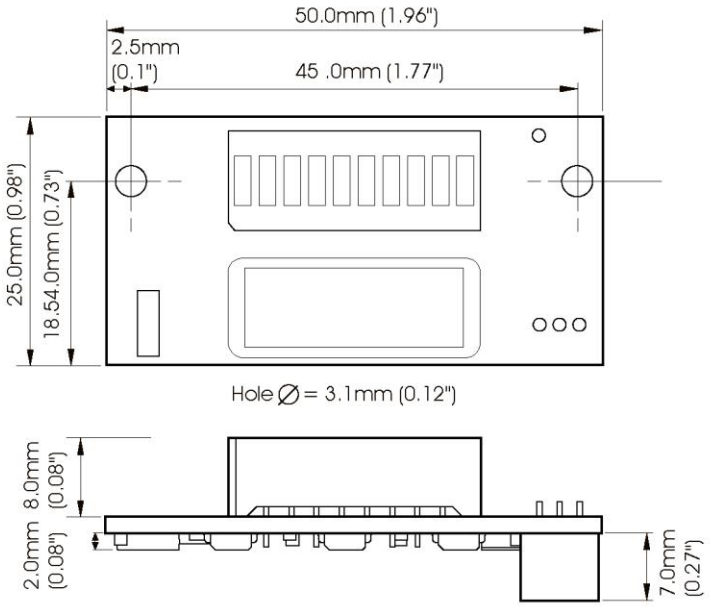
2.1 Surface Variant

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



2.2 Inset Variant

The Inset Tiller Module has the dimensions shown in the following illustration.



3 Mounting

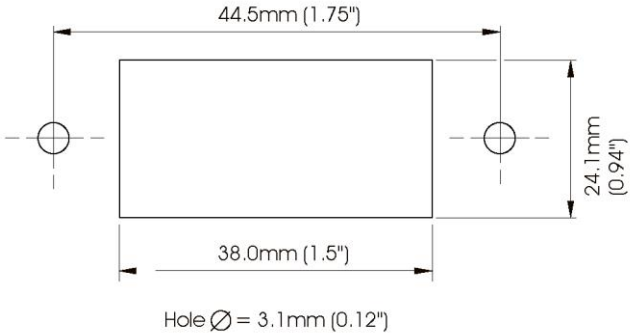
3.1 Handling

The Tiller 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 Variant

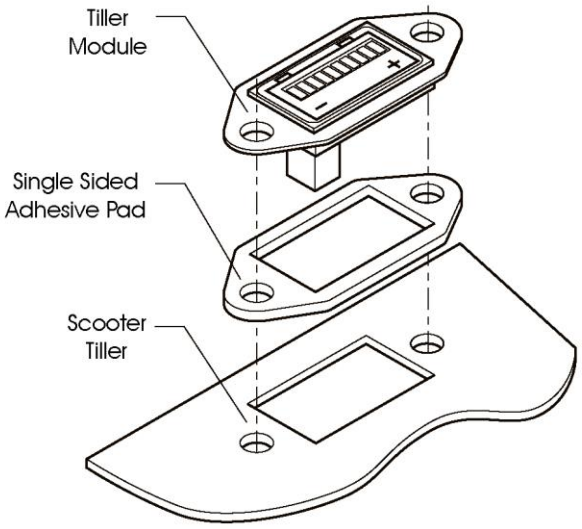
3.2.1 Fixing

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



3.2.2 Sealing

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



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

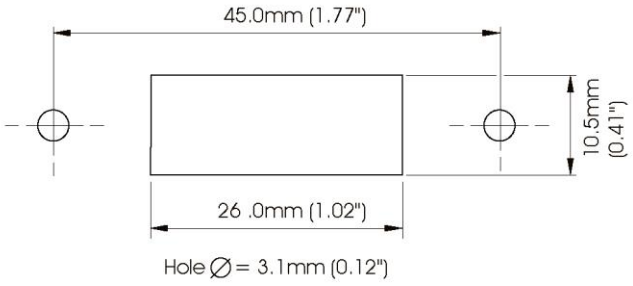
3.3 Inset Variant

3.3.1 Fixing

The scooter'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 Tiller Module to the scooter's control panel. See the following illustration.

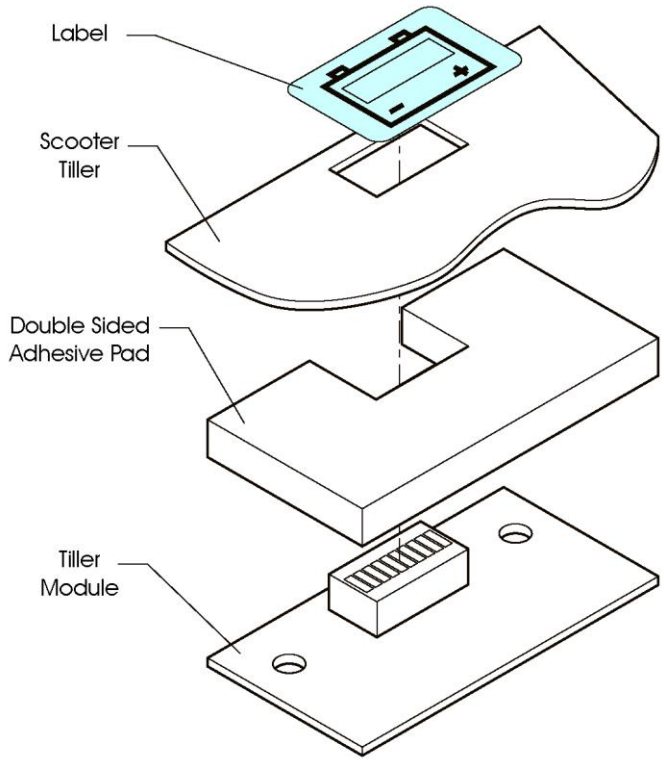
If the Adhesive pad is being used to attach the Tiller Module then the screw holes either side of the central rectangle will not be required.



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 scooter's control panel. Ensure that the metallic fixing hardware (nuts, washers etc.) do not touch the conductive tracks on the printed circuit board.

3.3.2 Sealing

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 Tiller Module kit number D50066.

4 Wiring

You are responsible for establishing the suitability of the particular wiring arrangement used on the scooter. PG Drives Technology can make general recommendations for wiring to Tiller 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 Tiller 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 D50826.

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.

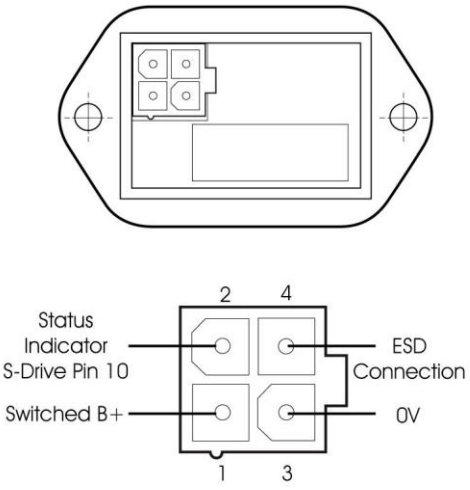
4.2.2 Inset Variant

The Tiller 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.

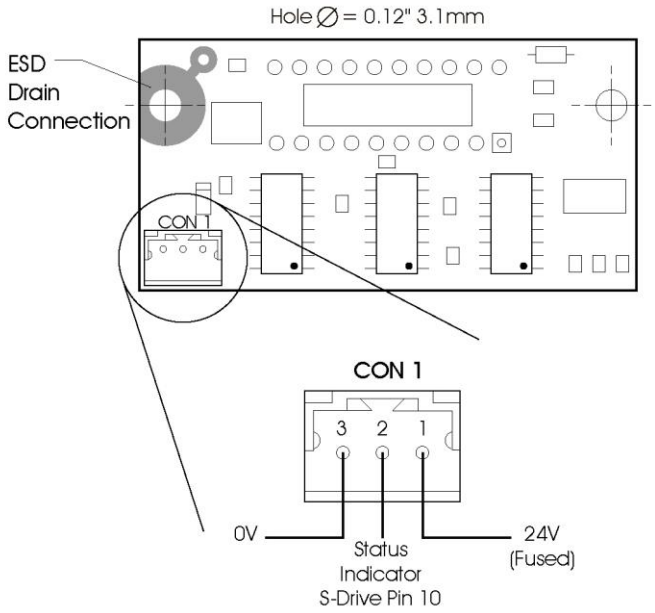
There is also a solder/ring tag point for an Electro-Static Discharge (ESD) drain path wire.

5 Connections

5.0.1 Surface Variant



5.0.2 Insert Variant



5.1 Controller Connections

TruCharge Module Type	TruCharge Module Connector	Function	TruCharge Interface
Inset	1	24V / Switched B+	Pin 5
Inset	2	Status Indicator	Pin 10
Inset	3	0V	Pin 13
Surface	1	24V / Switched B+	Pin 5
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 Tiller 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 scooter 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 scooter to electro-static discharges. These discharges may cause disruption of operation or even permanent damage. The tiller module incorporates extensive protection against E.S.D., however, you should take the following precautions to prevent high levels of energy entering the scooter'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 scooter'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 tiller 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 scooter's metalwork. A suitable device is manufactured by Harris, type GE-MOV V82ZA2.

7 Production Tests

7.1 Mounting

Make sure that the tiller 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 tiller 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 scooter.

With the scooter switched off, displace the throttle and then switch the scooter 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 scooter 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 scooter without reading, understanding and observing the following warnings. Failure to observe these warnings could result in UNSAFE CONDITIONS for the user of a scooter 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 S-Drive warranty.

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

2 Warnings

2.1 Driving Technique

The scooter user must be capable of driving a scooter 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 S-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 scooter instantaneously. If there is any possibility of the user falling out of the scooter as a result of a sudden braking action, it is imperative that a restraining device such as a seat belt is supplied with the scooter and that it is in use at all times when the scooter is in motion. PGDT accept no liability for losses of any kind arising from the unexpected stopping of the scooter, or arising from the improper use of the scooter or control system.

Do not operate the S-Drive if the scooter behaves erratically, or shows abnormal signs of heating, sparks or smoke. Turn the S-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 chair 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 scooter manufacturer to ensure that the scooter 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 scooter user must comply with all scooter 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 scooter 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 TruCharge Indicator Flashes Slowly

Do not operate the scooter 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 8.2.2

2.6 Pushing Your Scooter

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

2.7 Programming

Programming should only be conducted by healthcare professionals with in-depth knowledge of PGDT electronic control systems. Incorrect programming could result in an unsafe set-up of a scooter 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.

2.8 Warranty

The warranty will be void if the S-Drive has not been used in accordance with S-Drive Technical Manual SK76745, the S-Drive has been subject to misuse or abuse, or if the S-Drive has been modified or repaired by unauthorized persons. Chapter 1 section 12.

2.9 Servicing

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

If the S-Drive Scooter 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.

2.10 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 scooter 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 chair are altered without prior notification and discussion with PGDT. Chapter 2 section 1.2.

2.11 Charger Interlock

The scooter manufacturer is responsible for providing a means of preventing the use of the scooter 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.

2.12 Connections - General

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

The scooter 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 scooter manufacturer is responsible for ensuring that suitable connectors are used and securely mated throughout the scooter 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.

2.13 Battery and Motor Connections

S45A, S70A & S90A

It is the responsibility of the scooter manufacturer to ensure that the mating male Fastons are suitable for use on the intended application. All connectors should be fitted with the appropriate boot. PGDT accepts no liability for losses of any kind arising from failure to comply with this condition. Chapter 2 section 3.2.1.1.

S200A

It is the responsibility of the scooter manufacturer to ensure that the high current crimp connections 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 3.2.1.3.

2.14 Crimping

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 3.3.

2.15 Wire Gauge and Types

It is the responsibility of the scooter manufacturer to ensure that all wire gauges are suitable for the intended application. Chapter 2 section 3.4.

2.16 Battery Connection

The scooter 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 3.5.

2.17 ISO-Test Resistor Configuration

If a Speed Limit Pot. is fitted in series then an ISO-Test Resistor MUST be fitted to comply with ISO7176-14 section 6.12.3.3 Chapter 2 section 4.3.

2.18 24V

The scooter manufacturer must install a suitable fuse to protect the scooters wiring. 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.

At no time should the current passing through pin 7 of S-Drive Scooter 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.

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. Chapter 2 section 4.6.

2.19 0 Volts

At no time should the current passing through pin 13 of the S-Drive Scooter 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 4.10.

2.20 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.

2.21 Inhibit 3 Speed

If the Inhibit Speed is greater than 0 then the controller will not enter an inhibit state. Chapter 2 section 4.12.2.

2.22 Drive Motors

The scooter 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 scooter uncontrollable and potentially unsafe. PGDT accepts no liability for losses of any kind arising from failure to comply with this condition.

The scooter 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 scooter 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 scooter type to install it on a different scooter 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 scooter. Failure to observe this warning could result in an unsafe setup for the scooter user and may create a fire hazard depending on the motors, wiring, connectors and circuit breakers installed on the unauthorized chair. PGDT accepts no liability for losses of any kind arising from failure to comply with this condition. Chapter 2 section 5.

2.23 Freewheeling

It is the responsibility of the scooter manufacturer to ensure that adequate precautions are taken to warn the user against the hazards of freewheeling the scooter at excessive speeds. It is also the responsibility of the scooter 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 scooter. Chapter 2 section 5.2.

2.24 Charger Connections

Do not exceed the maximum charging current of 9 A rms. Always use the PGDT specified charger connectors. Failure to observe these conditions could result in poor contact resistance in the charger connector resulting in overheating of the charger plugs. This presents a potential burn hazard for the user. PGDT accepts no liability for losses of any kind arising from failure to comply with this condition. Ensure that the charger plug pins are of the correct.

The scooter manufacturer must install a suitable fuse to protect the scooter's wiring. PGDT recommends that the fuse is fitted as close as possible to the 4-way Molex connector. 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 6.

2.25 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.

2.26 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 scooter 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 8.1.4 & 8.2.4

2.27 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.

2.28 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 scooter 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 chair are altered without prior notification and discussion with PGDT. Chapter 3 section 1.3.

2.29 Introduction

Programming should only be conducted by healthcare professionals with in-depth knowledge of PGDT control systems. Incorrect programming could result in an unsafe set-up of a wheelchair 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.

2.30 Safety Fences

PGDT accepts no liability for losses of any kind if the scooter manufacturer does not specify appropriate safety fence values for a particular scooter application. Chapter 3 section 1.4.

2.31 Forward Acceleration

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

2.32 Forward Deceleration

It is the responsibility of the scooter manufacturer to ensure that the emergency stopping distance is within the distance specified for the country in which the scooter will be used. For countries requiring CE marking this is as specified in EN12184. Chapter 3 section 2.2.

2.33 Reverse Deceleration

It is the responsibility of the scooter manufacturer to ensure that the emergency stopping distance is within the distance specified for the country in which the scooter will be used. For countries requiring CE marking this is as specified in EN12184.

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

2.34 Max Forward Speed

Ensure the stability of the scooter is maintained, especially when cornering, at the programmed Mav Forward Speed. Chapter 3 section 2.5.

2.35 Speed Limit Pot. Enabled

PG Drives Technology recommend this parameter is set to Yes if a parallel type Speed Limiting Potentiometer is fitted. Chapter 3 section 2.9.

2.36 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 scooter manufacturer. PGDT accept no liability for losses of any kind resulting from this parameter being set to Drive. Chapter 3 section 4.4.

2.37 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 scooter will be used. For countries requiring CE marking this is as specified in EN12184. Chapter 3 section 7.1

2.38 Brake Fault Detect

This parameter should only ever be set to off if there are no electrical brakes fitted to the scooter. Chapter 3 section 7.10.

2.39 Push Too Fast Threshold & Push Too Fast Time-out

It is the responsibility of the scooter manufacturer to ensure that adequate precautions are taken to warn the user against the hazards of freewheeling the scooter at excessive speeds. It is also the responsibility of the scooter 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 scooter. Chapter 3 section 7.12

2.40 Motor Compensation

The scooter 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 scooter uncontrollable and potentially unsafe. PGDT accepts no liability for losses of any kind arising from failure to comply with this condition.

The scooter 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 scooter 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.

CHAPTER 6 – SPECIFICATIONS

1 Electrical Specifications

Model	S45A	S70A	S90A	S120A	S140A	S200A
Supply Voltage	24Vdc			24Vdc		24Vdc
Operating Voltage	16 – 30Vdc			16 – 30Vdc		16 – 45Vdc
Peak Voltage	35Vdc			35Vdc		45Vdc
Reverse Battery Voltage	40Vdc			40Vdc		60Vdc
Output Current	45A	70A	90A	120A	140A	200A
PWM Frequency	20kHz + / - 1%					
Power Connection	6.35mm (0.25") Faston spade			D51059 (Battery) D51070 (Motor)		M6 screw terminals
Brake Connection	2-way Molex Mini-fit Jr					
Charger/ Programmer Connection	4-way Molex Mini-fit Jr					
Tiller Connection	14-way Molex Mini-fit Jr					
Brake Voltage	24Vdc					
Brake Current	1.25max continuous					
Status Output	Programmable 0-12V, 50mA sink					
Battery Charging Current	9Arms max-Via charger port 5Arms max- Via tiller socket					
Inhibit Input	Programmable polarity					
Moisture Resistance	Electronics to IPX5 / Connections to IPX4 with cable cover					
Operating Temperature	-25°C to +50°C					
Storage Temperature	-40°C to +65°C					
Safety	Multiple hardware & software strategy designed to ISO7176/14:2008					
EMC Susceptibility	Tested at 30V/m to EN12184 and ANSI/RESNA					
EMC Emissions	To EN55022 Class B					
ESD	IEC 801 part 2					

APPENDIX – A

Compliance of the S-Drive range of Scooter Controllers with ISO 7176-14: 2008

This document reviews the S-Drive range of Scooter controllers against each section of ISO 7176-14: 2008. In each instance statements are made as to whether the S-Drive does or does not meet the requirement. Additionally, if the S-Drive requires the Scooter OEM to take specific measures, then relevant recommendations are made.

This document is for guidance only and it is still the responsibility of the Scooter OEM to ensure the vehicle complies with all relevant requirements.

Release: 1

Date: 21st September 2009

Conformity of the S-Drive product family with ISO 7176-14:2008

1 General

PG Drives Technology has been assessing conformity of the S-Drive product family with the second (2008) edition of ISO 7176-14. This document summarises the findings.

5.3 Slope stopping distance

The stopping distance criteria for a number of tests have changed in the 2008 edition, and the inclination of the test slope has changed from 5° to 6°. Scooters vary with regard to the vehicle dynamics and settings selected for the controller by the scooter manufacturer. Accordingly, scooter manufacturers should determine for themselves whether the results of testing in accordance with the first edition still apply.

7.1 Single-fault safety

S-Drive products are designed for single-fault safety and can provide supporting information to test personnel.

7.2 Command signal failures

7.2.3.2 Open-circuits

S-Drive products meet the open-circuit command signal requirements.

7.2.3.3 Short-circuits

S-Drive products meet the short-circuit command signal requirements.

7.2.3.4 Leakage tests

S-Drive product installations can meet the leakage requirements of the new edition. To do so it is necessary to address the following areas:

1) the configuration of the throttle circuitry;

2) specifications for the throttle potentiometer;

3) minimum values for the deadband setting;

4) managing the risk of moisture-induced leakage.

More information on this topic can be found in the annex "S-Drive command signal leakage".

7.3 Output device failures

S-Drive products meet the output device failure requirement.

7.4 Loss of power

S-Drive products meet this requirement.

8.1 On/off switch

S-Drive products require an on-off switch to be provided by the scooter manufacturer

8.2 Off-state current

S-Drive products draw very low currents when switched off, typically about 1.0 mA with a maximum of 2.0 mA. Providing the scooter has no other circuitry that is connected to the battery other than the S-Drive and its recommended circuitry, it should meet the requirement with a 6 Ah battery or larger.

8.3 Control-signal at switch-on

S-Drive products meet the requirement if the "throttle operated at power up" setting is set appropriately.

8.4 Safe operation as battery is depleted

S-Drive products meet this requirement.

8.5 Over-discharge protection

S-Drive products can provide a visual and/or auditory indication that the battery is nearing depletion that equal or exceed the cut-off voltage range specified in the standard. To support this it is necessary for the scooter manufacturer to provide appropriate visual and/or auditory indicators.

8.6 Over-voltage protection

S-Drive products meet this requirement.

8.7 Soft-stop when switching off

S-Drive products meet the requirement if the "soft stop" setting is set appropriately.

8.8 Measuring devices

S-Drive products meet this requirement. PGDT can provide information concerning conditions that affect the accuracy of the battery gauge.

8.9 Charge inhibit

S-Drive products provide an inhibit input that can be used to prevent driving. To support this it is necessary for the scooter manufacturer to provide appropriate connections to the battery charger.

8.10 Charging voltage drop

S-Drive products provide a very short low-resistance path between the charging connector and the battery terminals. The total path resistance in installed S-Drive systems will be dominated by the wiring and connections provided by the scooter manufacturer. It should be noted that it is only necessary to meet the voltage drop requirement where the battery charger is not supplied with the scooter or specified for use with it.

8.11 Non-powered mobility

Not applicable to S-Drive products.

8.12 Brakes

Single-fault safety of S-Drive products includes the means for activating the solenoid brakes, so they support conformity with the requirement. However, conformity of the scooter depends on other aspects of the braking system (such as the construction of the parking brakes) so it is important for the scooter manufacturer to assess the entire activation path for the brakes.

8.13 Battery enclosures

Not applicable to S-Drive products.

8.14 Symbols

Not applicable to S-Drive products.

8.15 Safety of moving parts

This requirement does not apply directly to S-Drive products, however they support conformity with this requirement by stopping movement of the drive motor when the throttle is released.

8.16 Use in combination with other devices

This requirement does not apply directly to S-Drive products. PGDT should be contacted for guidance if the scooter manufacturer intends other equipment to be connected to the scooter's battery set.

9.1 Isolation

S-Drive products meet the isolation requirements.

9.2 Non-insulated components

Correctly installed S-Drive products do not give access to non-insulated components.

9.3 Circuit protection

Correctly installed S-Drive products will meet these requirements. The scooter manufacturer deals with protection of battery wiring and determines the maximum charging current. If the S-Drive is included in the charging current path, the maximum charging current specified by the scooter manufacturer should not exceed the limit set for the product by PGDT.

9.4 Stalled condition

S-Drive products meet the requirements relating to the stall test. The second edition of the standard includes an extended (thirty minute) stall test. The scooter manufacturer should conduct this test to assess whether any changes to battery protection or controller settings are required.

9.5 Surface temperatures

S-Drive products should not be installed within the specified occupant reach space without other compensating provisions (e.g. a guard).

9.6 Disconnection of battery

Not applicable to S-Drive products.

9.7 Resistance to ignition

S-Drive products have a metal enclosure. Since it is non-polymeric the requirement does not apply to it. S-Drive products should not be installed within 50 mm of any battery terminal, and they do not contain any lamp housings.

The tiller interface, charger/programmer and solenoid brake connectors, as fitted at present, have a flame retardancy rating of UL 94 V-2. The same rating applies to the D50319 connector kit supplied for use with the S-Drive. Corrective action is being taken.

Part numbers for Molex Mini-Fit,Jr™ connectors with UL 94 V-0 rating are shown in the following table:

Connector	Molex part number
Solenoid brake	39-01-3028
Tiller interface	39-01-2145
Charger/programmer	39-01-3048

The scooter manufacturer should confirm the flame-retardancy rating of the connectors used with S-Drive products.

10.1 User interface

Not applicable to S-Drive products.

10.2 Operating forces

Not applicable to S-Drive products.

10.3 Display position

This requirement does not apply directly to S-Drive products. However, displays fitted by the scooter manufacturer for use with the S-Drive should conform to the requirement.

10.4 On/off indicator

S-Drive products support on/off indication in conformity with the standard if a suitable indicator is provided by the scooter manufacturer.

10.5 Connectors

The S-Drive does not have connectors intended for use by the occupant or assistant.

10.6 Audible noise

S-Drive products do not make any contribution to the overall noise produced by the scooter in the drive test or the ancillary equipment test.

10.7 Acoustic warning device

Not applicable to S-Drive products.

11.1 Control device fatigue

This requirement does not apply directly to S-Drive products. However, throttle controls fitted by the scooter manufacturer for use with the S-Drive should conform to the requirement.

11.2 Switch cycle life

This requirement does not apply directly to S-Drive products. However, switches fitted by the scooter manufacturer for use with the S-Drive should conform to the requirement.

11.3 Connector cycle life

No connectors provided on S-Drive are intended for daily use.

12.1 Connector interchange

The smaller S-Drive products (S-45, S-70 and S-90) have motor and battery connectors that are interchangeable. However, they are not intended for use by the occupant or assistant.

12.2 Wire routing

This requirement does not apply directly to S-Drive products, but it does apply to the way they are installed. All wiring used with S-Drive products should be fitted in accordance with this requirement.

12.3 Wire colours

This requirement does not apply directly to S-Drive products. However, battery wiring fitted by the scooter manufacturer for use with the S-Drive should conform to the requirement.

12.4 Battery tapping

Not applicable to S-Drive products.

13.1 Substance/liquid ingress

S-Drive products meet IPX4 as specified in IEC 60529. This implies they meet or exceed the requirements of ISO 7176-9 concerning ingress of liquids.

13.2 Substance leakage

S-Drive products contain small quantities of liquid electrolyte in electrolytic capacitors. The risk of leakage is negligible due to the sealing provided, and the products meet requirement b).

13.3 EMC

S-Drive products are designed and tested meet the requirements of ISO 7176-21:2003 in typical scooter installations. Since the EMC performance is dependent on the properties of the scooter

in which the S-Drive is installed, it is necessary for the scooter manufacturer to confirm that the complete vehicle meets the EMC requirements.

Note that a new edition of ISO 7176-21 has been published in 2009. The new edition of EN 12184 requires conformity with the previous (2003) edition of ISO 7176-21. The requirement in EN 12184:2009 is treated as taking precedence over the undated reference to ISO 7176-21 in ISO 7176-14:2008.

14.1 Reversed battery polarity

S-Drive products meet the reversed battery polarity requirement.

14.2 Integrity of enclosures

S-Drive products should not be installed in locations where they would be at risk of impact with static external structures. Hence this requirement does not apply.

15.1 Information general

PGDT provides all relevant information to use and install S-Drive products safely.

15.2 Wiring diagram

This sub-clause does not apply to S-Drive products. In particular, they have no user-serviceable circuit protection components.

15.3 Operating instructions

PGDT provides all relevant information to operate S-Drive products safely.

15.4 Safety information

PGDT provides information on interpretation of the battery gauge, and can provide additional guidance on the cause and effects of electromagnetic interference if needed. Other requirements in this sub-clause do not apply to S-Drive products.

15.5 Removable parts

S-Drive products have no removable parts.

15.6 Residual risks

PGDT provides information on residual risks. The primary one is the risk due to sudden stopping in the event of a fault, which is accepted by the standard and included in the list specified in 15.4.

16 Test report

Not applicable to S-Drive products.

17 Disclosure

Not applicable to S-Drive products.

Annex A - wiring guidance

The standard includes guidance on wiring sizes, but no requirements. PGDT provides its own guidance on wiring suitable for use with S-Drive products.

Summary

Providing they are installed in accordance with the installation instructions and the recommendations in this document, S-Drive products support conformity with the applicable requirements of ISO 7176-14:2009 of scooters in which they are used, with the following exception, for which corrective action is in progress:

The tiller interface, charger/programmer and solenoid brake connectors presently have a UL 94 V-2 rating. The same rating applies to the D50319 connector kit supplied for use with the S-Drive.

Annex — S-Drive command signal leakage

1 Introduction

It is possible for S-Drive installations to meet the command signal leakage requirements of ISO 7176-14:2008.

To meet the requirements it is necessary to do the following:

1) define limitations for the configuration of the throttle circuitry;

2) define specifications for the throttle potentiometer;

3) specify minimum values for the deadband setting;

4) extend the installation instructions to manage leakage risk.

It is assumed no active circuitry (e.g. amplifiers) is used in the command signal path. If active circuitry is included, or there are other deviations from these instructions, responsibility for the installation meeting the command signal leakage path requirements rests entirely with the scooter manufacturer.

2 Input circuit configuration

Any of the normal input configurations, single-ended, wig-wag or unipolar, may be used.

It is essential that series-connected speed-limiting potentiometer and ISO-test resistor are NOT fitted. A parallel speed-limiting potentiometer may be used.

3 Potentiometer specifications

3.1 Wig-wag/unipolar throttle

At initial installation:

Track resistance	5.0 kilohm ± 20 %
Wiper contact resistance	less than 100 ohm
Centring tolerance (electrical)	50 % ± 2.5 %

At end of service life:

Track resistance	5.0 kilohm ± 20 %
Wiper contact resistance	less than 100 ohm
Centring tolerance (electrical)	50 % ± 3.5 %

3.2 Single-ended throttle

At initial installation:

Track resistance	5.0 kilohm ± 20 %
Wiper contact resistance	less than 100 ohm
End-point tolerance (electrical)	less than 3 %

At end of service life:

Track resistance	5.0 kilohm ± 20 %
Wiper contact resistance	less than 100 ohm
End-point tolerance (electrical)	less than 5 %

3.3 Parallel speed-limiting potentiometer

Initial track resistance: 100 kilohm ± 20 %

4 Programmable settings

4.1 Throttle deadband

Wigwag/Unipolar throttle: setting not less than 15 %

Single-ended throttle: setting not less than 10 %

4.2 ISO-test resistor

Since ISO-test resistors will not be used, the ISO-test resistor setting should be OFF.

5 Installation instructions

5.1 Leakage path management

The evaluation of the S-Drive is based on the premise that the only reasonably foreseeable leakage that can occur is between a defined set of conductors. Consider the pins at the end of the S-Drive tiller interface connector, shown in the following diagram.

pin 1 throttle wiper	pin 2 throttle high reference	pin 3 audible alarm
pin 8 throttle low reference	pin 9 speed-limiting potentiometer	pin 10 status indicator

Leakage paths have been evaluated for all analogue signals in the set to adjacent pins (horizontally, vertically and diagonally). The voltage on the audible alarm and status indicator connections can cover the entire battery voltage range.

The most important signal in this set is the throttle wiper, pin 1. It can meet the ISO leakage requirement for the adjacent pins but it cannot meet the requirement for leakage to any signal with a wider voltage range while keeping a realistic value for the deadband. Therefore, to ensure conformity, it is essential that no reasonably-foreseeable leakage due to contamination by liquids can occur between the throttle wiper and any signals other than those on pins 2, 8 and 9.

There are three main methods to prevent this leakage: physical barriers, creepage distances, and guard conductors. These will be considered in the following sections relating to different parts of the throttle circuitry.

5.2 Printed circuit boards

Where the throttle circuitry is connected via a printed circuit board, the following techniques are recommended.

1) All parts of tracks that are not necessary to expose should be coated in solder resist.

2) All tracks connected to the throttle potentiometer should be conformally coated. This includes the soldered terminals of connectors.

3) The throttle wiper, throttle high reference, throttle low reference and speed limiting potentiometer signal (if used) should be segregated from other conductors on the printed circuit board by large creepage distances. The larger this distance can be made, the better the immunity to leakage will be. At least 3 mm is recommended.

4) Optionally, a guard conductor can be used to surround the throttle wiper conductor. This should be connected to the throttle low reference.

5.3 S-covers (S-Drive connector covers)

It is recommended that S-covers are used to protect the S-Drive tiller interface connector wiring and connections.

5.4 Orientation of the controller

It is recommended that the guidance in the S-Drive Technical Manual (SK76745) is followed concerning controller orientation and cable routing.

5.5 Splash-proofing

It is recommended that the tiller circuitry be protected from exposure to moisture, such as rain-water, splashes from passing vehicles, and water that might be used to wash the tiller.

If the S-cover is not used, it is recommended that the S-Drive be similarly protected from exposure to moisture.

5.6 Connections

Where a cable is used to carry the tiller interface signals from the tiller to the S-Drive, it is important to order the connections so that the throttle wiper is not at risk of leakage to signals other than throttle potentiometer connections (see 5.1).

It is important to avoid damage to such cables, for example by careful routing, avoiding flexing and use of grommets to protect insulation from sharp edges. There is a high risk of non-conformity if cable damage leads to a risk of leakage between the throttle wiper and other conductors.

Where intermediate connectors are used for the tiller interface signals, it is important to order the connections in the connectors so that the throttle wiper is not at risk of leakage to signals other than throttle potentiometer connections (see 5.1).

If intermediate connectors have spare unused terminals it is recommended to order the connections so that the unused terminals will increase the creepage distances between the throttle potentiometer signals and the other connections.

It is recommended that the number of connectors between the tiller and the S-Drive is kept to a minimum.

APPENDIX – B

Set Up Procedure

It is important when setting up the vehicle that the batteries are fully charged and that the motor is cold.

This procedure follows a sequence as below and programming of each parameter should be undertaken in that exact order.

- Set Motor Compensation
- Set Speed, Acceleration and Deceleration
- Set Brake Time
- Set Enhanced Motor Compensation (Up)
- Set Enhanced Motor Compensation (Down)
- Set Enhanced Motor Compensation (Up) Gain – this may not need adjustment

Motor Compensation

This parameter is used to match the S-Drive to the motor. It is necessary to achieve optimal drive performance and control.

It is programmable between 0mOhms and 1250mOhms.

If you know the motor armature resistance program a motor compensation value of around 2/3 of this figure as a starting point e.g. if the armature resistance is 100 milliohms, program a value of 65 milliohms.

If you are unsure of the motor armature resistance, start with a low value - the default motor compensation value is 25mOhms for generic S-Drive units.

Drive the vehicle, at low speed on flat ground. If the vehicle is not controllable and is uncomfortable to drive, the parameter Motor Compensation should be adjusted down in steps of 5mOhms until the scooter feels comfortable to drive on a flat surface.

Drive the vehicle from a flat surface onto an incline, there should be no reduction in speed as the vehicle climbs the gradient. If the speed reduces significantly increase the value of motor compensation in steps of 5mOhms. If the speed of the vehicle increases significantly reduce the value of Motor Compensation

Drive the vehicle downwards off the incline, there should be no noticeable increase in speed between driving off the incline and driving onto a flat surface. If the speed reduces significantly increase the value of motor compensation in steps of 5mOhms. If the speed of the vehicle increases significantly reduce the value of Motor Compensation

Speed, Acceleration and Deceleration

The vehicle should be programmed with appropriate values for Speed, Acceleration and Deceleration.

Brake Time

This parameter 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 scooter doesn't jerk or skid on a level surface, but short enough to minimize roll-back or roll-forward on slopes. Brake time is programmable between 0 and 2000ms in steps of 10ms. The default Value is 1 second (1000ms).

Drive the vehicle on a level surface. Set the brake time such that vehicle is stopped by the solenoid brake engaging. Then gradually increase the brake time in steps of 50ms until the vehicles comes to a stop just before the solenoid brake is engaged.

Fine-tuning

Depending on the application further fine tuning may be required to maximize performance on an incline.

The following parameters have the default values indicated below. – These are theoretically optimal values given a correct value of motor compensation determined for the lowest armature temperature that is likely to be encountered in normal operation.

- Enhanced Motor Compensation (Down) = 150%
- Enhanced Motor Compensation (Up) = 130%
- Enhanced Motor Compensation (Up) Gain = 1%

This parameter is used to fine tune the vehicle performance when stopping on a hill after driving in the Up direction. It is programmable between 100% and 200% in steps of 1%.

If the vehicle rolls backwards after the tiller is released and before the solenoid brake is engaged, increase the value of Enhanced Compensation (Up) in steps of 5%.

If the vehicle rolls forwards after the tiller is released and before the brake comes on decrease the value Enhanced Compensation (Up) in steps of 5%.

If a perfect performance cannot be achieved, i.e. roll-back cannot be eliminated, then choose the best value of Enhanced Motor Compensation (Up) and move on to adjusting the next parameter, Enhanced Motor Compensation (Down).

Enhanced Motor Compensation (Down)

This parameter is used to fine tune the vehicle performance when stopping on a hill after driving in the Down direction. This parameter is adjustable between 100% and 200% in steps of 1%.

Drive the vehicle down the incline at full speed and release the tiller.

The vehicle should come to a complete stop just before the solenoid brake is engaged.

If the vehicle is still moving when the solenoid brake engages, increase the value of Enhanced Motor Compensation (Down) in steps of 5%.

If the vehicle recoils (momentarily drives in reverse) before the solenoid brake engages, decrease the value of Enhanced Compensation (Down) in steps of 5%.

Enhanced Motor Compensation (Up) Gain

This parameter is used to fine tune the vehicle performance when stopping on a hill after driving in the Up direction. If, at this stage, the performance is satisfactory, then do not adjust this parameter.

Enhanced Motor Compensation (Up) Gain is programmable from 0 to 100 in steps of 1%.

Drive the vehicle at full speed up the incline and release the tiller.

If the vehicle rolls backwards after the tiller is released and before the brake engages, increase the value of Enhanced Motor Compensation (Up) Gain until the roll-back after stopping on the incline is satisfactory.

Be aware that the resistance of the motor will alter with the temperature of the motor. Parameter values determined with a hot motor may need to be verified and possibly retuned when the motor has cooled down.