3.1 Connections and Wiring

SHARK Power Module connections are located along the front panel of the case.

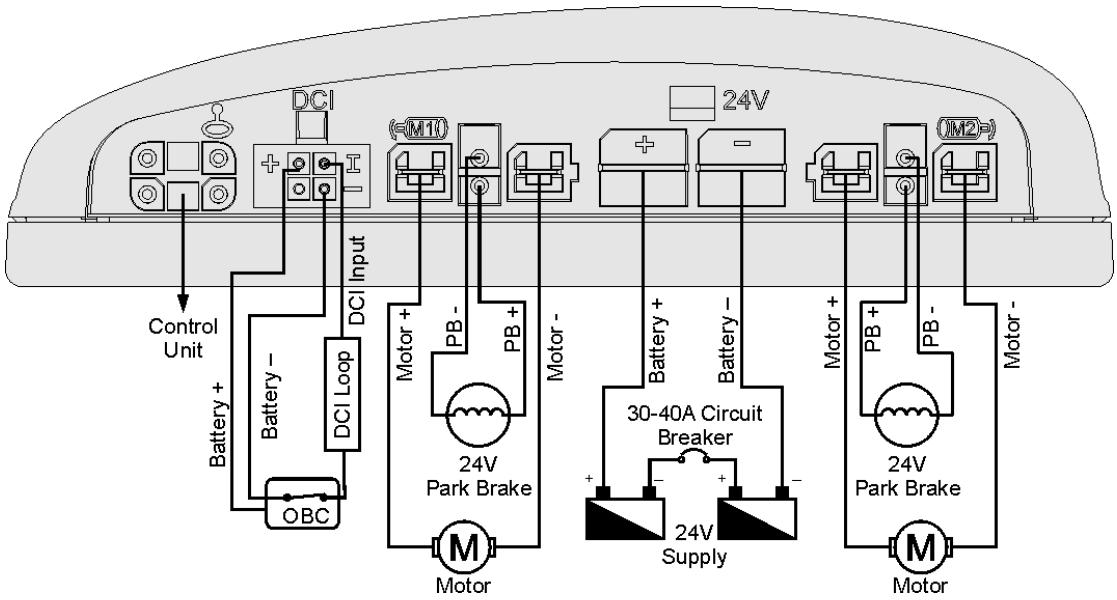
3.1.1 General Wiring Notes and Recommendations.

The following notes apply to all wiring on the powerchair. Notes specific to particular component wiring can be found under each component's designated sub-section (i.e. battery connections). It is the installer's responsibility to ensure the finished wiring package is safe and fit for purpose.

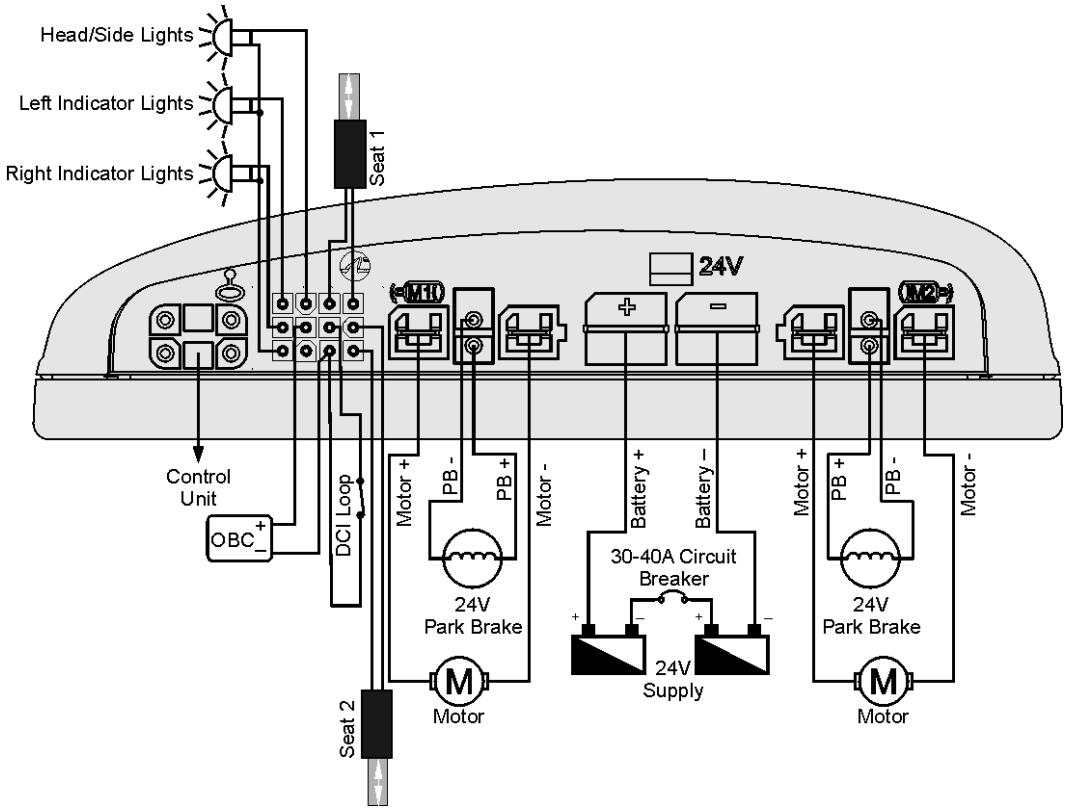
1. Before making any connections to the controller, disable the powerchair by one of the following means to prevent accidental movement.
    - Place the battery charger circuit breaker in the open position.
    - Disconnect the motor or batteries and/or elevate the drive wheels.
2. All wiring should be as short as possible to prevent voltage loss at high current.
3. The type of cable used must be appropriate for the mechanical and environmental abuse it is likely to encounter.
4. Heavy gauge wire is mandatory for high current connections (batteries and motors). For lower current wiring a gauge heavier than required to meet the current carrying requirements is recommended for mechanical robustness. Generally speaking, wire gauges smaller than 0.5 mm^2 are not recommended because they are not sufficiently robust for this application. Further details can be found in the sections detailing component specific wiring requirements.
5. Wiring should be suitably restrained to prevent snagging and securely fastened to the powerchair frame to ensure there is no strain on the connectors.
6. Take particular care of the routing and securing of wiring on chairs with moving or movable structures, such as seat raise, tilt, recline etc. Such moving structures have the potential to crush and shear wiring, causing potential safety issues.
7. To minimise EMC issues:
    - Wiring should be kept as short as possible.
    - To minimise EMC generating "loops", pairs of wires should be run together where possible (e.g. run Motor Positive and Motor Negative leads together).
    - Avoid running wires in close proximity to the motors.

3.1.2 Typical Cabling Installation

PMA Wiring Diagram

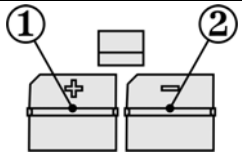


PMB Wiring Diagram



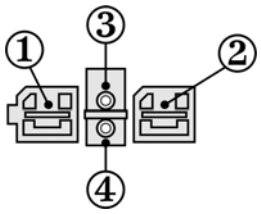
Refer to Section 3.1.9.4 for SHARK TÜV Compliant Lighting Installation.

Battery Connector Pinout



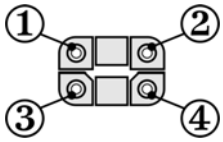
Pin	Function
1	Battery Positive
2	Battery Negative

Motor Connector Pinout



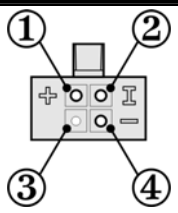
Pin	Function
1	Motor Positive
2	Motor Negative
3	Park Brake Negative
4	Park Brake Positive

SHARK Bus Connector Pinout



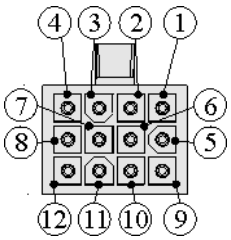
Pin	Function
1	Battery Positive
2	SHARK Communications BUS High
3	SHARK Communications BUS Low
4	Battery Negative

Drive Control Input (DCI) Connector Pinout



Pin	Function
1	Battery Positive
2	DCI Input
3	Inhibit or No Connection
4	Battery Negative

SHARK Port Connector Pinout



Pin	Function
1	Actuator 1 (-)
2	Actuator 1 (+)
3	Head/Side Light Indicator (-)
4	Left Light Indicator (-)
5	Actuator 2 (-)
6	Drive Control Input
7	Battery (+)
8	Right Light Indicator (-)
9	Actuator 2 (+)
10	Battery (-)
11	Inhibit
12	Lighting Supply (+)

3.1.3 Battery Connections

The Battery connector has two terminals: Battery Positive (+) and Battery Negative (-).

For a 60 Amp controller, the recommended MINIMUM battery wire size is 4 mm^2 for runs of up to 800 mm, increasing by 1.0 mm^2 for each additional 400 mm run length. The heavier the wire, the better chair performance will be, particularly for controllers which feature current "boost".

The final connection to the Battery Positive (+) terminal should not be made until the wheelchair is completely wired and ready for testing as described in the Testing section.

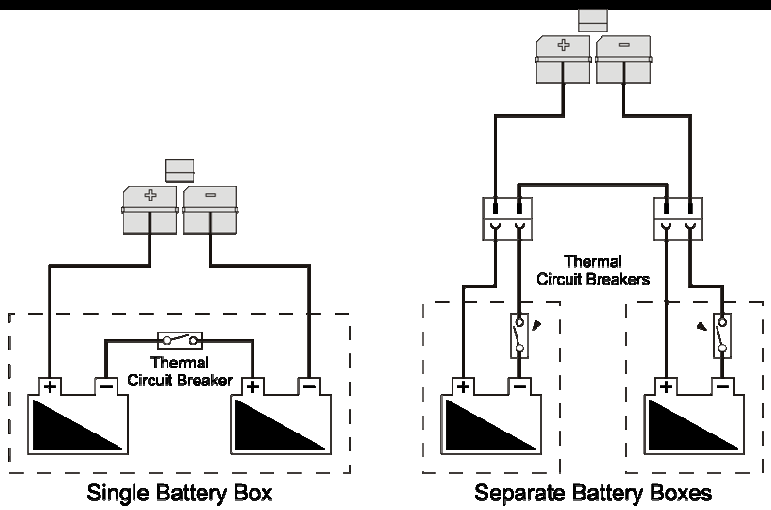
SHARK has been designed to perform optimally with either Lead-Acid or Gel Cell 24 V deep cycle batteries, rated between 20 - 120 Amp hours.

A thermal circuit breaker must be installed between the batteries and the Power Module - as close as possible to the batteries - to protect both the batteries and the system wiring. If the two batteries are permanently wired together (single battery box), the best position for the circuit breaker is between the two batteries. If the batteries are separated (individual battery boxes), each battery requires a circuit breaker.

Warning:

A 30-40 Amp slow-acting, thermal type circuit breaker is suggested for the PMA and PMB series.

The thermal circuit breaker should have a trip rating no higher than the current limit of the Power Module. Check thoroughly to ensure that it provides the necessary degree of protection.



3.1.4 Battery Charger Connections

Batteries may be charged either using an off board charger plugged as required into the charging socket mounted on the SHARK Remote, or an On Board Charger (OBC) permanently connected to the Shark Port as described in Section 3.2.7.

3.1.5 Motor and Park Brake Connections

The SHARK Power Module has two motor connectors – M1 and M2. These are typically Right and Left motor, respectively (see note 4 below). Each motor connector has two motor pins (Positive and Negative), as well as two Park Brake pins (Positive and Negative). The motor connectors are 'keyed' so they cannot be swapped or inserted incorrectly.

These notes are in addition to the "General Wiring Notes and Recommendations" described in Section 3.2.1.

1. It is preferred that the left and right motor harnesses – M1 and M2 – are of equal length.

2. For a 60 Amp controller the recommended MINIMUM motor wire size is 3 mm^2 for runs of up to 400 mm, increasing by 0.5 mm^2 for each additional 200 mm run length. The heavier the wire, the better chair performance will be, particularly for controllers which feature current "boost".

3. The length and gauge of wire effects the wire resistance and hence the optimum Load Compensation setting. Ensure the "Load Compensation" parameter is tuned to match the chair wiring.

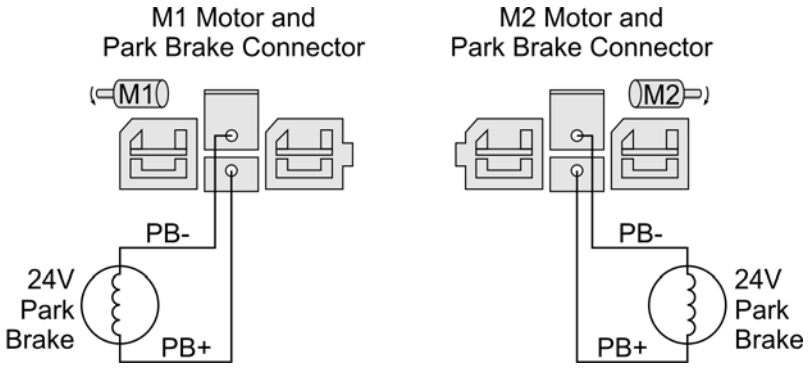
4. Left and right motors must not be physically interchangeable. The preferred method to ensure this is to use the polarised motor connectors (Left Motor Connector Housing = GSM61191P, Right Motor Connector Housing = GSM61192P). However alternative methods to prevent transposing the motor wiring can be used, such as cable tying the wiring in a suitable position.

If necessary, the motor connections can be swapped when programming SHARK. For this reason, the connectors are not labeled Left and Right, but M1 and M2, as shown.

SHARK supports both 24V and 12V park brake wiring.

24-Volt Park Brake Wiring - Dual

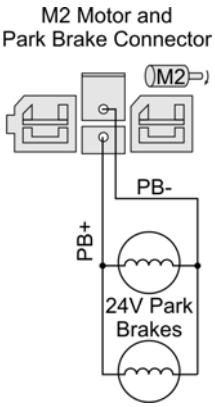
If the wheelchair has two 24V Park Brakes (or 'Dual'), the park brakes are wired as below.



For this configuration, the Park Brake setting must be set to 'DUAL'.

24-Volt Park Brake Wiring - Single

Alternatively, two 24V park brakes can be wired in parallel from the M2 connector as below. For this purpose the M2 connector must be used. If the Park Brakes are connected to the M1 connector instead of M2, a Left Park Brake fault (Flash Code 5) will occur.

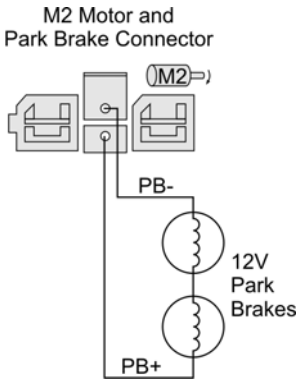


For this configuration, the Park Brake setting must be set to 'Single'.

If set to 'DUAL' a Right Park Brake fault (Flash Code 6) will occur.

12-Volt Park Brake Wiring - Single

If the wheelchair has two 12V Park Brakes, the wiring may be driven from just one Park Brake output. If this is the case, the M2 connector must be used.



For this configuration, the Park Brake setting must be set to 'Single'.

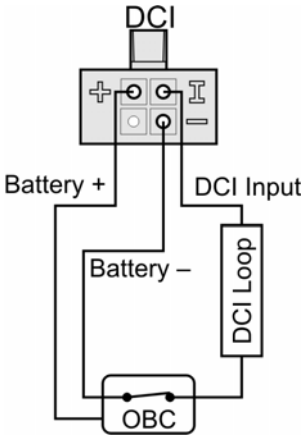
If set to 'DUAL' a Right Park Brake fault (Flash Code 6) will occur.

3.1.6 SHARK Communications Bus

The SHARK Power Module communicates to the Remote through the SHARK Communications Bus. The Bus also supplies power to the Remote. The connector is 'keyed' and can only be plugged in one way.

3.1.7 PMA - Drive Control Input (DCI) Connections

SHARK provides support for an On-board Battery Charger (OBC), an 'inhibit', a 'speed limit' and a 'swivel' function through the Drive Control Input (DCI) socket as shown right. Alternatively, for inhibit signals that are not zero resistance, including certain OBC's, a dedicated input is provided (see Section 3.2.8).



It is recommended that the largest gauge wire supported by the Shark contacts (16 AWG/1.3 mm^2) be used.

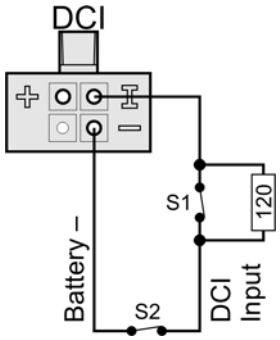
Drive Control Input (DCI)

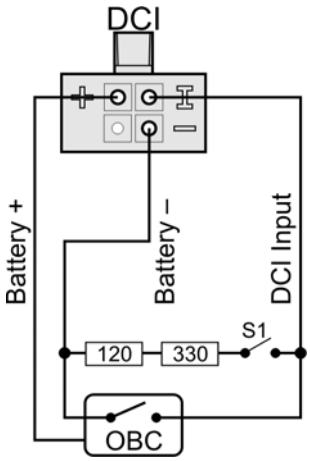
The DCI allows the powerchair speed and configuration to be adjusted depending on the resistance placed between the DCI Input pin ("I") and the DCI ground ("-") pin, as follows:

Nominal DCI Loop Resistance (+/- 5%)	Resulting Function	SHARK Information gauge
0 (>560)* Ω	**"Normal"** – the chair drives at "Normal" speed (i.e. as set by "Max Forward Speed", etc)	-
120 Ω	**"Speed Limit**" – drive speed is limited to a pre-programmed value, typically to limit top speed when a seat is raised or tilted and driving too fast may be dangerous.	Right GREEN indicator will flash
330 Ω	**"Swivel"** - swaps the drive motor polarities, typically used to maintain correct joystick interpretation for powerchairs that convert between front and rear wheel drive by swiveling the seat. When the 'Active Drive Program' is set to 'DCI Input 1+2', Swivel will change into a 'Drive Program Swap' mode and will automatically swap from Drive Program 1 to Drive Program 2 whenever the DCI "Swivel" is active. In this case, the motor polarities will not reverse, unless specified within the set up of the Drive Program.	Right GREEN indicator will flash
120 + 330 Ω (450 nominal)	**"Swivel + Speed Limit"** – causes both Swivel AND Speed Limit functions, as described individually above	Right GREEN indicator will flash
>560 (0)*	**"Inhibit"** – the chair is inhibited from driving, typically when the battery charger is plugged in, or the seat is raised to a height at which it would be unsafe to drive	Right to left chase followed by steady display

* When DCI Operation is set to Normally Open, Normal and Inhibit functions will be swapped.

DCI examples:





A powerchair has a seat raise function. SHARK will automatically limit speed to 60% when the seat is raised (S1), and inhibit drive (S2) when the seat is raised above a certain height.		A powerchair has a swivel function. SHARK will automatically reconfigure itself for FWD when the seat is swiveled (S1) and limit speed to 80%. When the seat is swiveled: 1. SHARK will automatically change to Drive Program 2, which contains drive settings and a Stability Profile optimized for FWD. 2. SHARK will limit speed to 80%. When the OBC is plugged into a power socket, an inhibit switch internal to the OBC will close (0 resistance), inhibiting drive.	
DCI Operation	Normally Closed	**DCI Operation**	Normally Open
DCI Speed Limit	60%	**DCI Speed Limit**	80%
Active Drive Program	Drive Program 1	**Active Drive Program**	DCI Input 1+2

Warning:

The switch configuration must ensure that driving is inhibited when the chair is being charged, or when the chair/seat is in an undefined position (i.e. partially swiveled).

The DCI function can be enabled and disabled. Additionally, the speed to which the chair reduces while in Speed Limit can also be set.

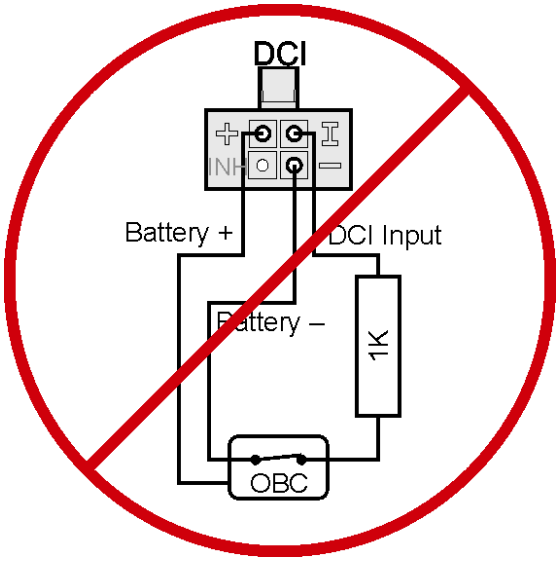
OBCs have either normally closed or normally open Inhibit outputs. By setting the DCI Operation parameter to Normally Open, SHARK will swap the Normal and Inhibit values in the above table. An open circuit (>560 ohms) will allow normal drive, while a circuit resistance of 0 will prevent driving. All other values stay the same. Check the documentation that came with your OBC for product specifications.

For instance, an OBC that has an open Inhibit contact when the charger is ***not*** *plugged in should be set to Normally Open.*

3.1.8 DCI Inhibit Input

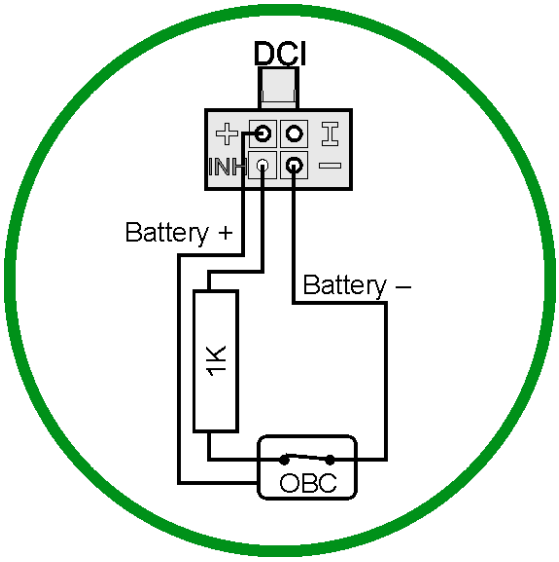
The DCI "I" pin is the input of choice for interfacing Inhibit signals that are based on a "zero resistance" switch closure or equivalent (eg, an open collector transistor signal).

Inhibit signals that are not zero resistance, however, may not be compatible with the DCI. Take, for example, a battery charger that has a 1K resistor fitted in series with its Inhibit output.



This arrangement will not operate correctly because the inhibit loop resistance switches between 1K and open circuit when the battery charger is plugged in. Since the DCI interprets both 1K and open circuit as "Inhibit" the chair would never drive.

For this reason an additional, dedicated Inhibit input ("INH") that is not so resistance dependent is provided.



3.1.9 PMB SHARK Port Connections

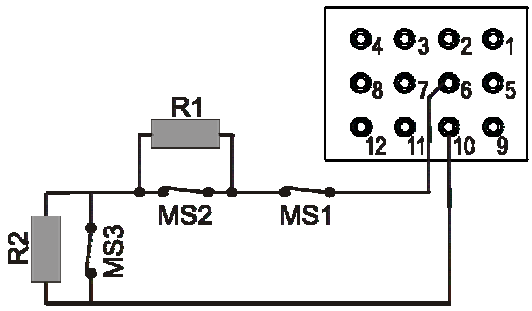
Approved SHARK Port connector components are included in the GSM80226 SHARK Port Connector Kit which includes the 12 Pin Housing and compatible contacts.

3.1.9.1 DCI Connections

The DCI allows the powerchair speed and configuration to be adjusted depending on the resistance of the DCI "Loop". Typical uses of the DCI are:

- **Inhibit** – Prevents the powerchair from driving, typically when the chair is being charged, or when a seat is raised or tilted.
- **Speed Limit** – Limits the drive speed to a pre-programmed value, typically when a seat is raised or tilted and driving too fast may be dangerous.
- **Swivel** – Automatically swaps the drive motor polarities when the powerchair swaps (or swivels) between front and rear wheel drive.

Shark continually monitors DCI loop resistance and interprets particular resistance values as being a request for a particular action. Typically microswitches that change state in particular chair configurations are used to switch resistors in and out of the DCI loop, requesting Shark to change it's driving characteristics appropriately to the new configuration.



TYPICAL DCI LOOP SHOWING MICROSWITCHES TO SWITCH RESISTANCE

For further details on the DCI, and the resistances required to perform specific actions, refer Section 4.2.

While the DCI loop is a low current circuit it is recommended that a wire gauge of not less than 0.5 mm^2 be used for mechanical robustness.

Warning:

Activation of seat lift / seat tilt beyond certain limits may cause the chair to be unstable whilst driving. The Drive Inhibit / Speed Limitation functions allow the wheelchair to be configured such that drive is not possible, or speed is limited, when the seat is in such a position.

Warning:

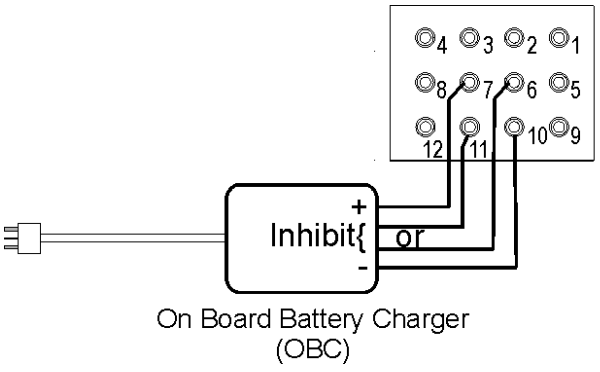
User to be informed regarding proper actuator operation - particularly with regard to safe control of seat lift / seat tilt.

Precaution:

Installer to ensure DCI inhibits driving when the chair is being charged or if the seat is in an extended position.

3.1.9.2 OBC Input

An On Board Charger (OBC) of up to 5 Amps continuous may be connected at Pins 7 and 10. As with all battery charger connections provision MUST be made to inhibit driving when the charger is plugged in. For an OBC, this is done either by wiring the chargers' inhibit contact into the DCI loop, along with any other microswitches or by connecting to the Inhibit Pin (11). Reference Sections 3.2.7 and 3.2.8 for more detailed information on which configuration is appropriate for your application.

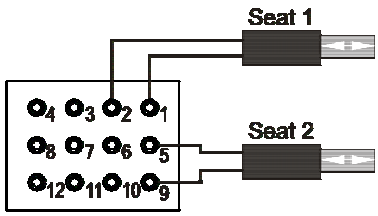


On Board Battery Charger (OBC)

The wiring to pins 7 and 10 should be compatible with the current rating of the OBC. It is recommended that the largest gauge wire supported by the Shark Port contacts (16 AWG/1.3 mm^2) is used. The wiring to Pin 6 is low current and can be lighter, typically 0.5 mm.

3.1.9.3 Seat Functions

Several variants of Power Module support one or two seat control outputs, available on the Shark Port on Pins 1 and 2 for Seat Function 1, Pins 5 and 9 for Seat Function 2. Available seat functions may then be operated depending on the functionality of Shark Remote used.



Pin 2	ACT 1 (+)
Pin 1	ACT 1 (-)
Pin 9	ACT 2 (+)
Pin 5	ACT 2 (-)

Precaution:

Installer to set current limit so it is adequate for actuator operation, but trips when a reasonable force is exceeded. Refer Section 4.2 for programming details related to Seat Functions.

Since the actuators may draw relatively high currents it is recommended that the largest gauge wire supported by the Shark Port contacts (16 AWG/1.3 mm^2) be used.

3.1.9.4 SHARK TÜV Compliant Lighting Installation

This guidance allows OEM wheelchair manufacturers and installers to meet the TÜV lighting requirements. The installer should ensure the installation of lights and indicators is safe and reliable. It is the responsibility of the installer to ensure any additional risks are appropriately assessed.

Specifications

Bulbs	Headlamp/Tail light	24V (maximum combined rating 50W)
	Indicators – Left	12V x 2 *identical* bulbs in series connection (maximum rating 24W)
	Indicators – Right	12V x 2 *identical* bulbs in series connection (maximum rating 24W)
Fuses	Headlamp Indicators (Left/Right)	2A slow-blow

Refer to the recommended wiring diagram below.

Since lighting circuits draw relatively high currents it is recommended that the largest gauge wire supported by the Shark Port contacts (16 AWG/1.3 mm^2) be used.

Installation

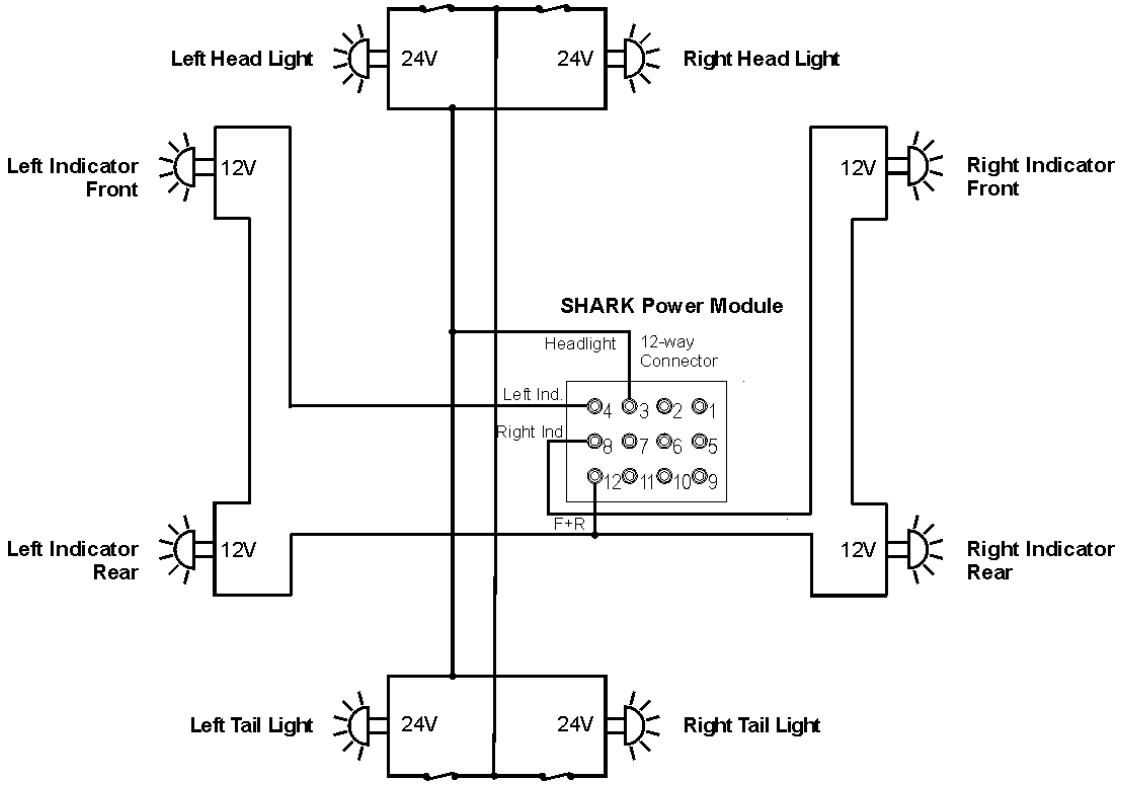
For safe and reliable operation, the installation of lights and indicators must follow basic safety principles for all power wiring. The wiring must be adequate to carry the desired load and be properly routed and secured to prevent cutting, crushing, chaffing or other physical damage or abuse. Care is required to prevent dangling wiring which can allow snagging on external objects.

Electrical Protection

The Shark Power Module provides internal electrical overload and short circuit protection. However, it is the responsibility of the installer to fit individual fuses to protect against short circuit conditions.

Warning:

Ensure all light circuits are isolated from the chair frame.



Care & Maintenance

The wheelchair user must be instructed to undertake routine maintenance and servicing, including frequent inspection and appropriate care to ensure all lights, fuses, connectors, cables and wiring are maintained in good working order.

Warning:

It is the responsibility of the installer to ensure adequate protection exists for the Lighting system. Use of appropiate gauge of wiring, bulbs and independent fusing is recommended.

3.2 Testing

To ensure that the powerchair meets a minimum level of safety, the following procedure should be undertaken. This procedure should be carried out in a spacious environment and with due regard to any possible unexpected powerchair movement in the event of faulty installation.

1. Raise the wheels off the ground using blocks under the powerchair frame so that the wheels can turn freely.
2. Recheck all wiring, paying particular attention to polarities of batteries, motors and park brakes.
3. Make the final connection to the Battery Positive (+) terminal and close the circuit breakers.
4. Press the Power button to turn SHARK on. Ensure it turns on correctly.
5. Press the Power button again to turn SHARK off. Ensure it turns off correctly. Press the power button again to turn SHARK back on.
6. Ensure the horn is functioning correctly by pressing the Horn button.
7. Turn each drive wheel by hand to check that the park brakes are engaged. The wheels should not move.
8. Push the joystick slightly out of neutral and listen for the "click" as the park brakes disengage.
9. Move the joystick in all directions and ensure that the wheels respond smoothly and in the correct direction.
10. Release the joystick to neutral and listen for the click of the park brakes re-engaging.
11. Turn off SHARK and remove the blocks from under the powerchair.
12. Turn SHARK back on and turn the speed dial to the lowest speed setting (fully counter-clockwise).
13. Sit in the powerchair and drive in all directions slowly, checking for precise and smooth control.
14. Repeat at higher speeds.
15. Drive the wheelchair on a 1:6 ramp and check for normal power, smoothness and parking.
16. Test for Actuator if fitted.
17. Test for Lights if fitted
18. Repeat testing as required until chair performance is as expected.

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