Commando

The New Force in Powerchair Control...

From DYNAMIC™

innovative - smooth - ergonomic - strong - compact - sensitive - powerful - innovative - smooth - compact

Installation Manual Re-order Information
(Please quote this information when re-ordering this manual)

Commando Installation Manual - GBK38039

or visit the Dynamic Mobility web site to download the latest version (in PDF format)

http://www.dynamicmobility.co.nz

GBK38039 - Issue 1 - January 2001

Contents

1 Introducing Commando

This chapter provides a description of the Commando series of powerchair controllers. Here you can find out the basics of what makes Commando the new benchmark in powerchair controls.

Introducing Commando

The Commando series of integral powerchair controllers has been designed specifically for light to medium weight powerchairs. All models can deliver 50 Amps to each motor and include the latest technology and software to give superb performance on all wheelchair types (Front, Mid and Rear Wheel Drive).

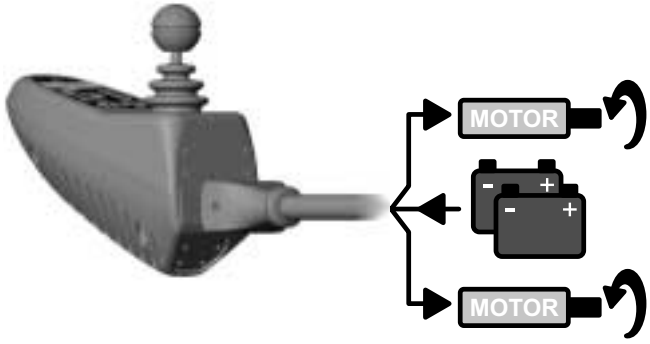
Control is smooth, direct and responsive, with improved load compensation to keep the chair on track no matter what obstacles it encounters. The performance of Commando sets new driving and safety standards for the notoriously difficult to control front wheel drive configuration.

Commando has been specifically designed as a drop-in replacement for most existing integral controllers and is fully programmable both by the powerchair manufacturer and in the field.

The four Commando variants are physically very similar and differ only in their ability to control non-driving functions such as seating and lighting.

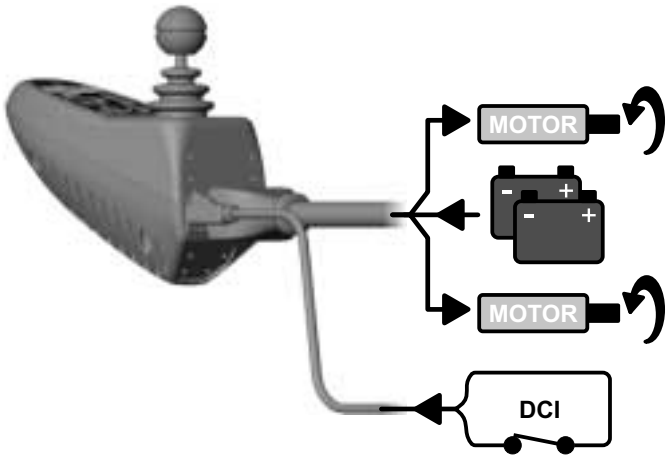
Commando

Controls driving only, a drop-in replacement for most existing integral controllers.



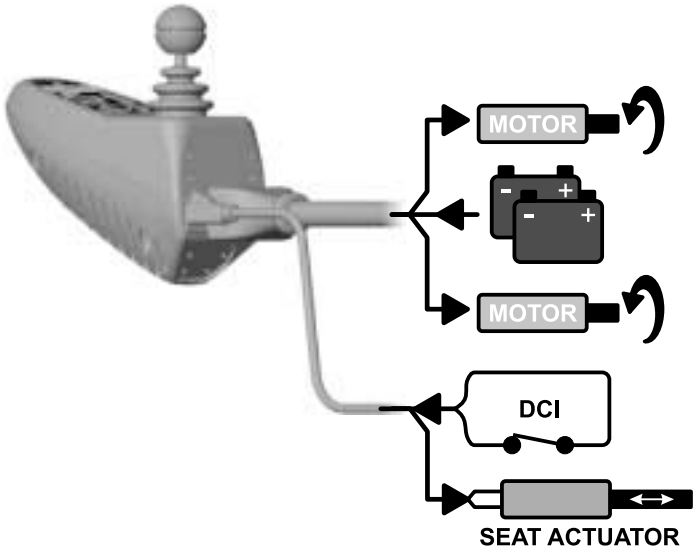
Commando S

Has a "Drive Control Input" (DCI) to provide interlocks between driving and other functions, such as slowing the chair when the seat is partially raised, or stopping the chair when the seat is totally raised.



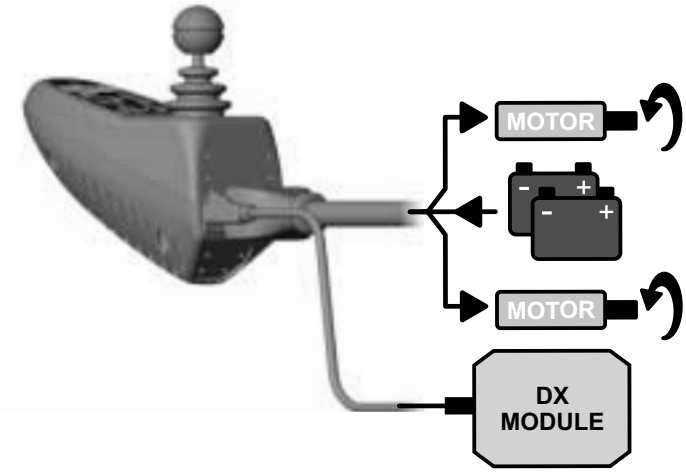
Commando Plus

As per Commando S, but has built-in control of a single seat function.



Commando DX

An entry level DX Module which, when used in conjunction with DX Accessory Modules, can support up to 5 seat functions, full lighting and attendant control.



Because of the similarity of the Commando variants, this manual describes the operation of the standard Commando with separate chapters describing the additional features of the other variants.

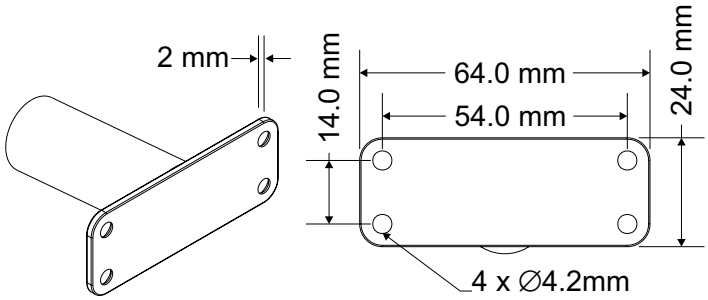
This chapter contains the information required to install Commando on a powerchair. This includes mounting details, motor, battery and park brake wiring, and details on batteries and battery charging.

Mounting Commando

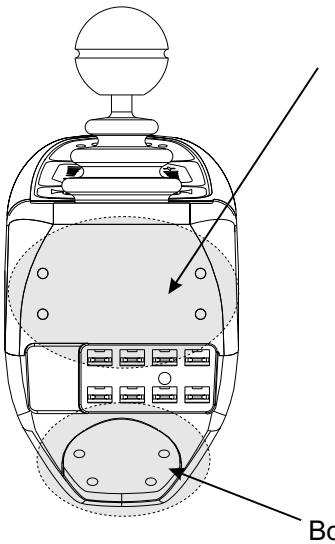
Commando has two alternative mounting points, at top or bottom of the rear of the unit. Suitable mounting brackets are available from Dynamic and are suitable for welding square or round mounting tubes of up to 20mm in diameter.

Warning:

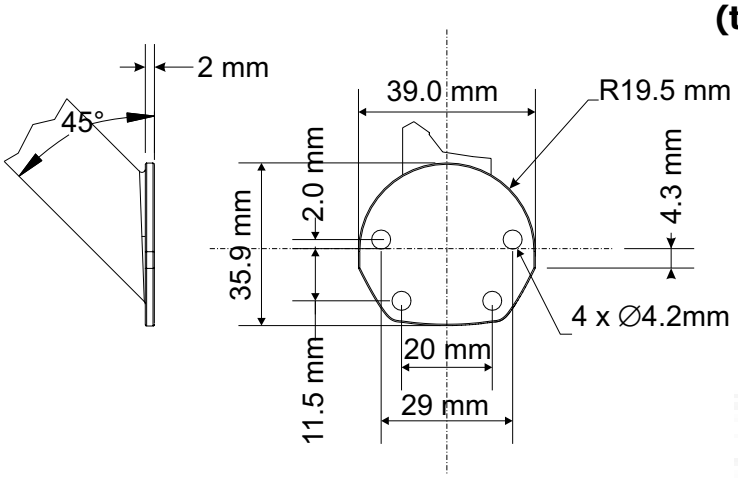
For safe installation, select a screw length that engages 6mm into the case.

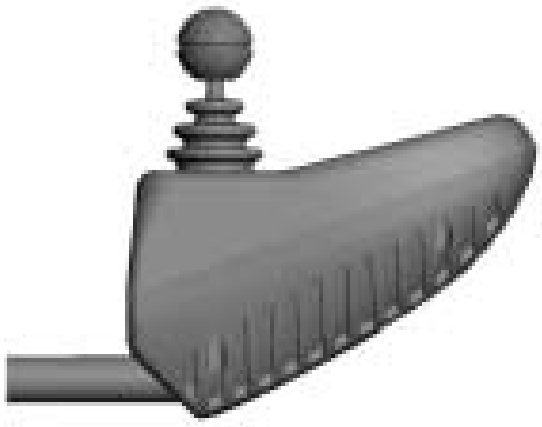


Dynamic Part #: GME38048
Commando Mounting Bracket - Top
(to be welded onto mounting tube)



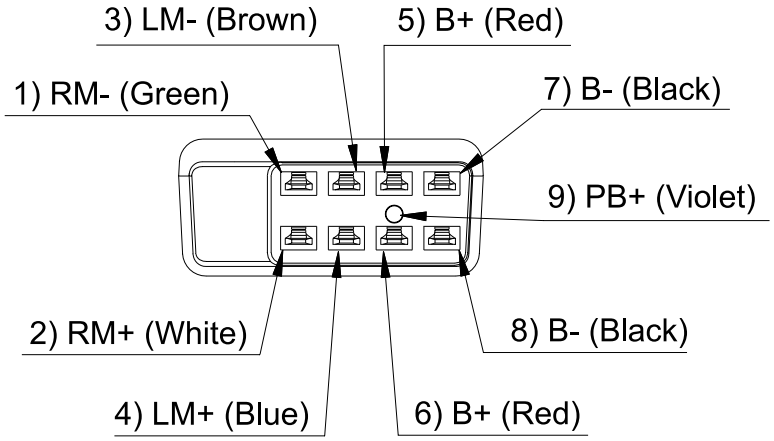
Dynamic Part #: GME38047
Commando Mounting Bracket - Bottom
(to be welded onto mounting tube)





Connecting to Motors and Batteries

Connections to Commando are terminated at the connector shroud at the rear of the unit. All variants have the standard 9-pin Beau connector, for the connection of the batteries, motors and park brakes. The pin out is shown below.



Pin	Description	Colour
1	Right Motor -	Green
2	Right Motor +	White
3	Left Motor -	Brown
4	Left Motor +	Blue
5	Battery +	Red
6	Battery +	Red
7	Battery -	Black
8	Battery -	Black
9	Park Brake +	Violet

Pins 5 and 6 (Battery +) are connected together inside the controller. This means you can either connect one heavy wire to Pin 5 or 6, or connect a lighter wire to both Pins 5 and 6. Similarly, Pins 7 and 8 (Battery -) are connected together inside the controller. Pins 5 & 6, and Pins 7 & 8 should also be connected together on the mating plug.

General Wiring Notes and Recommendations

1. All wiring should be kept as short as possible.

2. To minimise Radio Frequency Interference (RFI) susceptibility, all pairs of wires should be run together as much as possible. For example, run **B+** and **B-** together. Twisting wire pairs will help further.

3. Avoid running the motor leads along the motor case, where possible.

4. Avoid forming loops in any of the wiring harnesses.

For best performance, wire cross-sections should be as large as possible...

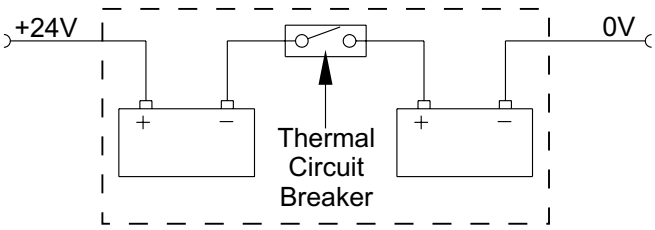
4. Motor wiring should be a minimum of 2.5mm² for lengths up to 800mm. Add 0.5mm² for every additional 400mm.

5. Battery wiring should be a minimum of 5.0mm² for lengths up to 800mm. Add 1.0mm² for every additional 400mm.

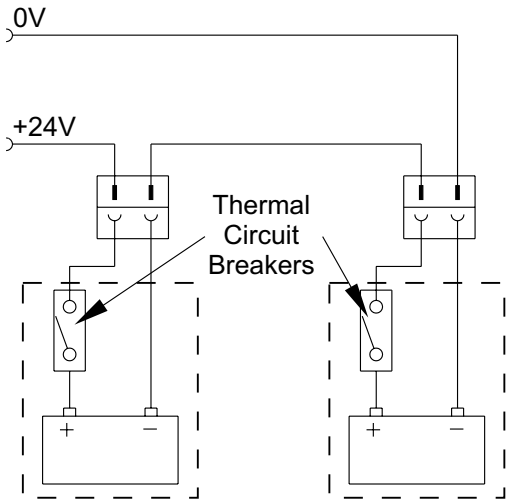
6. Park brake wiring is typically 0.5 - 1.0mm². Choose a physically robust wire size.

Battery Protection

A 40 Amp thermal circuit breaker **MUST** be installed in the wheelchair's battery wiring to protect the batteries and wiring from external short circuits. For batteries permanently wired together in a single battery box, the best position for this circuit breaker is in the link between the two batteries. If the batteries are individually plugged together (separate battery boxes), each battery requires a circuit breaker.



Single Battery Box



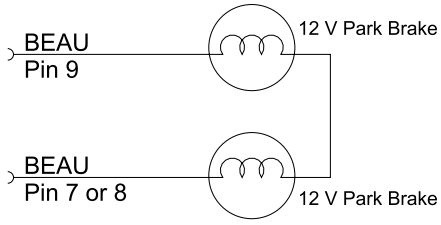
Separate Battery Box

Park Brake Wiring

Commando has been designed for use with fail-safe electromagnetic park brakes fitted to each motor. If these park brakes are not connected, Commando will detect a fault and prevent driving.

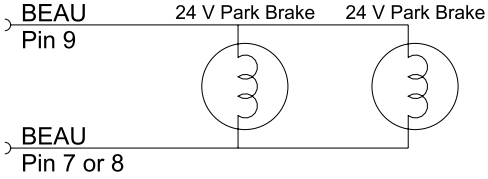
Two 12V Park Brakes in Series

This diagram shows the wheelchair wiring that must be used for 12V park brakes. This is the recommended configuration as Commando can detect an open circuit fault in either park brake.



Two 24V Park Brakes in Parallel

This diagram shows the wheelchair wiring that must be used for 24 V park brakes.



Batteries and Charging

General Battery Notes and Recommendations

1 Commando performs optimally with either Lead-Acid or Gel Cell 24 V deep cycle batteries, rated at 20 - 120 Amp hours. Battery capacity must be compatible with the conditions of use, both to ensure good battery life and to ensure the required chair range and/or operating time is achieved.

2 The satisfactory performance of Commando is critically dependent on the type and state of the batteries.

3 Some new batteries can start with as little as 80% capacity, developing higher capacity in their early life, before slowly deteriorating.

4 The battery charger used must be correctly selected and adjusted according to the battery manufacturer's instructions. Failure to do so may damage or destroy the batteries, give poor range, or be potentially dangerous.

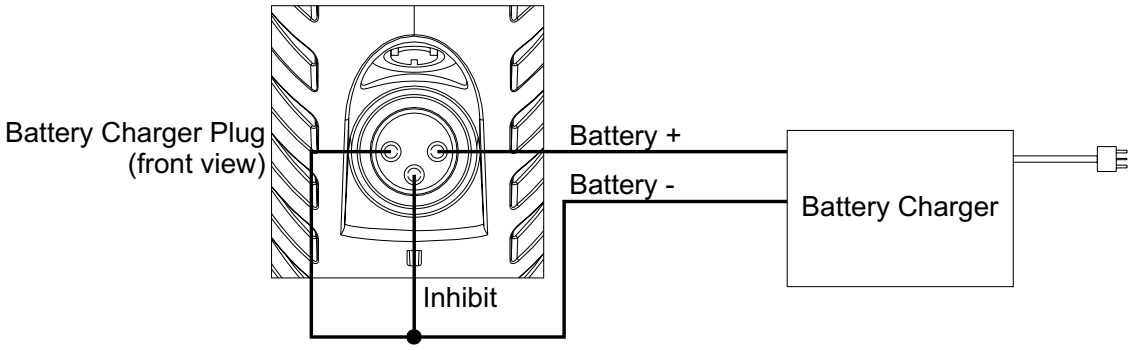
5 Batteries should not be abused (for example by deep discharging or overcharging) and must be operated and maintained according to the manufacturer's instructions.

6 Do not disconnect batteries or open circuit the circuit breaker during charging. This is dangerous to both people and equipment.

Battery Charging

The battery charger socket is a 3-pin XLR type with pin configuration as shown below. Ensure that the charger used is compatible with this pin-out before connection. The safety link between B- and the Inhibit pin must be fitted so that the wheelchair is prevented from driving when the batteries are being charged.

The seven-segment display will show '  ' to indicate that the wheelchair is inhibited when charging.



Charging is completed only when indicated by the battery charger. Do not confuse indication from the Commando battery gauge with the indicator on the battery charger. The Commando battery gauge has been designed to show capacity while driving, not during charging and may incorrectly show full battery charge.

Note:
It is normal for the battery gauge to flash when it is nearing the end of charging.

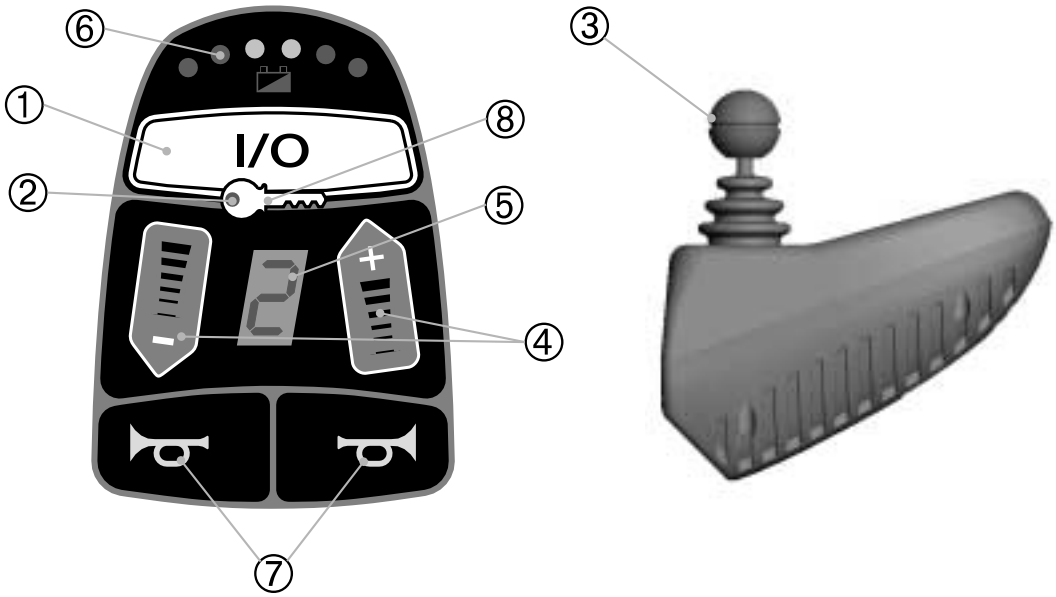
Battery Saver

Whenever battery voltage drops below 21 volts, the 'Battery Saver' feature will reduce the speed of Commando by limiting the power available to it. This feature is designed to prevent over discharge of the batteries, as well as to maximise the 'reserve charge' range. The 'Battery Saver' feature will also contribute towards extending battery life by reducing the risk of over charging.

3 Using Commando

This chapter describes how to use Commando and explains the function of the keypad buttons and displays.

Using Commando



❶ On/Off Button

Turns the system On and Off.

❷ Status Indicator

ON steady - Commando is ON and the entire control system is normal.
Flashing - Commando is ON but an off-normal condition has been detected somewhere in the control system.
Pulsing - Commando is ON but locked.

Note:
Flashing = bursts of 1 or more flashes, separated by a pause of 1 second. **Pulsing** = a quick single flash, repeated every 5 seconds. This will stop after 1 minute and Commando will power down automatically.

❸ Joystick

Controls speed and direction. The further you push, the faster you go in that direction.

❹ "Speed Up" and "Speed Down" Buttons

Increases or decreases the Top Speed of the chair between Speed 1 (slowest) and Speed 5 (fastest).

❺ Top Speed Indicator

This indicator displays the currently selected Top Speed, ranging from 1 through to 5. '1' means the chair will drive slowly with the joystick fully deflected, through to '5' which gives the highest speed with the joystick fully deflected.

A '-' is displayed whenever Commando is in Drive Inhibit state, for example during battery charging, or when a seat is reclined or raised.

❻ Battery Gauge

Shows how much battery charge is remaining. When battery charge has dropped to a single red LED, that LED will begin flashing indicating an 'Empty' battery warning. This display will also flash if Commando senses a battery over-voltage or under-voltage condition.

❼ Horn Buttons

Press either button to sound the horn.

❽ Magnetic Key Lock

An optional feature that locks the chair to prevent unauthorised use.

Note:
This feature is disabled by default and, if required, must be enabled by programming.

Locking the chair - Swipe the magnetic key over the key symbol. Commando will beep and turn off into a locked state.

Unlocking the chair - Press the On/Off Button and swipe the magnetic key across the key symbol. Commando will turn on into an unlocked state and will be able to be driven normally.

If the On/Off button is pressed but the key is not swiped, the LED in the key symbol will pulse every 5 seconds to indicate Commando is turned on, but locked. If, within 1 minute of turning the power on the lock is not disarmed, Commando will automatically turn itself off.

4 Programming Commando

This chapter explains Commando's new, simplified programming philosophy and contains a guide for the dealer or therapist to quickly program Commando. Detailed information about the responsibilities of the wheelchair manufacturer when pre-programming the chair is also described.

The programmable parameters that enhance safety and performance for chairs are described, along with some sensible tips about how to improve chair stability, controllability and performance.

Programming Commando

Commando is fully programmable to optimise performance with particular chair types, and to suit the driving environment and preferences of individual users.

Commando can be programmed at 3 points:

During manufacture by Dynamic

Prior to shipping each Commando is loaded with a sensible "generic" program.

By the Wheelchair manufacturer

The wheelchair manufacturer uses the PC based "Wizard" programming tool to develop programs optimised for particular wheelchair models. Each program defines the technical attributes necessary to match the controller to the chair (current limits, etc), as well as a drive performance that suits the "typical" user. The resulting programs are copied into each Commando as part of the chair production process.

In the field by the Dealer or therapist

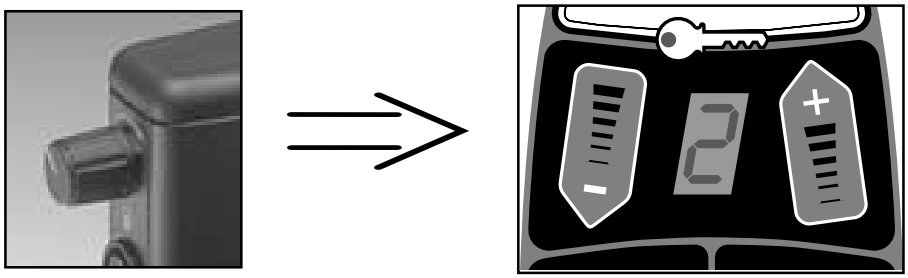
A Hand Held Programmer (HHP) is used to tune the "typical" driving performance to a drive performance optimised for the individual chair user.

Programming Concepts

Digital Speed Pot

Like most integral controllers, Commando has a "Speed Pot" that allows the user to change the top speed of the chair according to their needs at the time. For instance, driving indoors favours a lower top speed, while for driving outdoors a high top speed would be more appropriate.

Traditionally, integral controllers use a mechanical Speed Pot - a physical knob that ramps up the top speed when turned. With the knob turned fully clockwise, pushing the joystick causes the chair to move at high speed, with the knob fully anti-clockwise, the same joystick movement results in a slow speed.



Mechanical Speed Pot **Digital Speed Pot**

Commando has a speed pot, but it is not implemented as a mechanical knob. Instead it uses a "Digital Speed Pot" that gives the ability to choose between 1 of 5 pre-set top speeds. A display shows the current speed setting, with 1 being the slowest and 5 being the fastest. Pressing the "Speed Up" or "Speed Down" buttons moves between the 5 speeds.

Note to DX Users:

DX uses a system of 5 Drive Programs or Drive Modes which looks very similar to Commando's Speed Pot, however the two systems work completely differently.
A display of "3" on Commando always means Drive Speed 3 (of 5). A display of "3" on a DX Remote may mean many things depending on how it is programmed – Speed 3 out of 5, the same speed as Drive Program 2 but more responsive, the same speed as Drive Program 2 but operated by a different input device, etc.

Commando's Simplified Programming Philosophy

Traditionally the drive performance of powerchair controllers has been specified by programming a large number of adjustments, typically...

Maximum Speed – Forward, Reverse, Turning
Acceleration – Forward, Reverse, Turning
Deceleration – Forward, Reverse, Turning

The combination of these settings defined a chair "personality" - anything from a slow, smooth personality to a fast, aggressive personality. While this programming system is very versatile, the process of adjusting so many interdependent settings can be relatively time consuming.

Commando uses a new programming approach designed to make programming fast, simple and intuitive. The simplified programming scheme is based on the fact that any chair's drive performance can be defined by just two settings:

Top speed - the maximum speed the chair will go (joystick full forward in Drive Speed 5).

Response - the way the chair responds to joystick movements - is it very sensitive, gentle, or somewhere in between?

Or to put it in other words,

CHAIR PERSONALITY = RESPONSE + SPEED

In practise, there are only a few types of "responses" a chair can usefully have - a very sedate, relaxed response, a very aggressive and zippy response, and maybe two or three less extreme responses in between. Programming can be reduced simply to making a selection between one of 5 preset responses, rather than creating responses from scratch each time.

The Commando programming philosophy is based on the chair manufacturer creating 5 preset responses from which the dealer or therapist chooses the one that best suits the particular user. These 5 preset responses are created by the chair manufacturer by modifying the usual array of "technical" parameters using the Dynamic Wizard programming tool, for example...

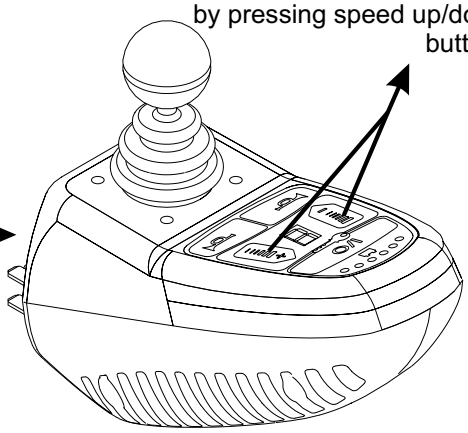
RESPONSE 1	RESPONSE 2	RESPONSE 3	RESPONSE 4	RESPONSE 5
Fwd Speed 1	Fwd Speed 2	Fwd Speed 3	Fwd Speed 4	Fwd Speed 5
Fwd Accel 1	Fwd Accel 2	Fwd Accel 3	Fwd Accel 4	Fwd Accel 5
Fwd Decel 1	Fwd Decel 2	Fwd Decel 3	Fwd Decel 4	Fwd Decel 5
Rev Speed 1	Rev Speed 2	Rev Speed 3	Rev Speed 4	Rev Speed 5
Rev Accel 1	Rev Accel 2	Rev Accel 3	Rev Accel 4	Rev Accel 5
Rev Decel 1	Rev Decel 2	Rev Decel 3	Rev Decel 4	Rev Decel 5
Turn Speed 1	Turn Speed 2	Turn Speed 3	Turn Speed 4	Turn Speed 5
Turn Accel 1	Turn Accel 2	Turn Accel 3	Turn Accel 4	Turn Accel 5
Turn Decel 1	Turn Decel 2	Turn Decel 3	Turn Decel 4	Turn Decel 5

Using the Wizard, the Wheelchair Manufacturer uses the traditional "technical" settings to create a set of 5 preset "responses"

MANUFACTURER

Downloads wheelchair program to Commando

User selects Drive Speed by pressing speed up/down buttons



The Dealer or Therapist customises the chair for a user by choosing a Response and Chair Speed.

Normally the manufacturer would set up these 5 Responses so that:

RESPONSE 1 = very unresponsive to joystick movements, relaxed response, for less confident users who may lack fine motor control and/or cognitive ability;

Through to...

RESPONSE 5 = very responsive to joystick movements, zippy response, for more confident users with better motor control and/or cognitive ability.

All a therapist, dealer or user has to do to change the chair personality is to specify which of the 5 pre-set responses to use, and what the top speed should be limited to.

A typical Commando programming sequence would be:

Plug the programmer into Commando.

It will come up with a screen like:

Set the "CHAIR SPEED".

The number of "#"s represent the top speed the chair will go with the joystick fully forward while in Drive Speed 5. 10 "#"s indicate Commando can potentially drive at the maximum speed the chair is capable (for example, 6 km/hr for a 6 km/hr chair). Such a setting might be appropriate for users that regularly travel longer distances outdoors.

For somebody that drives mainly or totally indoors, or has a chair that is faster than necessary, press the "DOWN" button to reduce the top speed to, say 5 "#"s.

In this case, a 6 km/hr chair would be limited to a top speed of around 3 km/hr, with the joystick fully forward, while in Speed 5.

Commando automatically scales the **Turn** and **Reverse Speed** settings to maintain relativity with the chosen top forward speed.

Set the "RESPONSE".

Press the NEXT button to get:

As shown, Commando is currently set at Response 2 - since Responses are normally set so that a higher number gives a more zippy response, Response 2 typically means the chair will behave relatively tamely. To make the chair more responsive, simply press the "UP" button.

The chair is now fully tuned to the individual and the programmer can be unplugged.

This system makes programming in the field very simple and makes it nearly impossible to program a chair badly. It does however, require some understanding and planning on the part of the chair manufacturer when defining the 5 standard responses.

Note:
The HHP can modify some of the options that define each 'Response' as well as some Motor/Brake options. See the **"Responses" Set Up Guidelines and "Motor/Brake" Options** sections.

Creating Programs Using the Wizard

Introduction

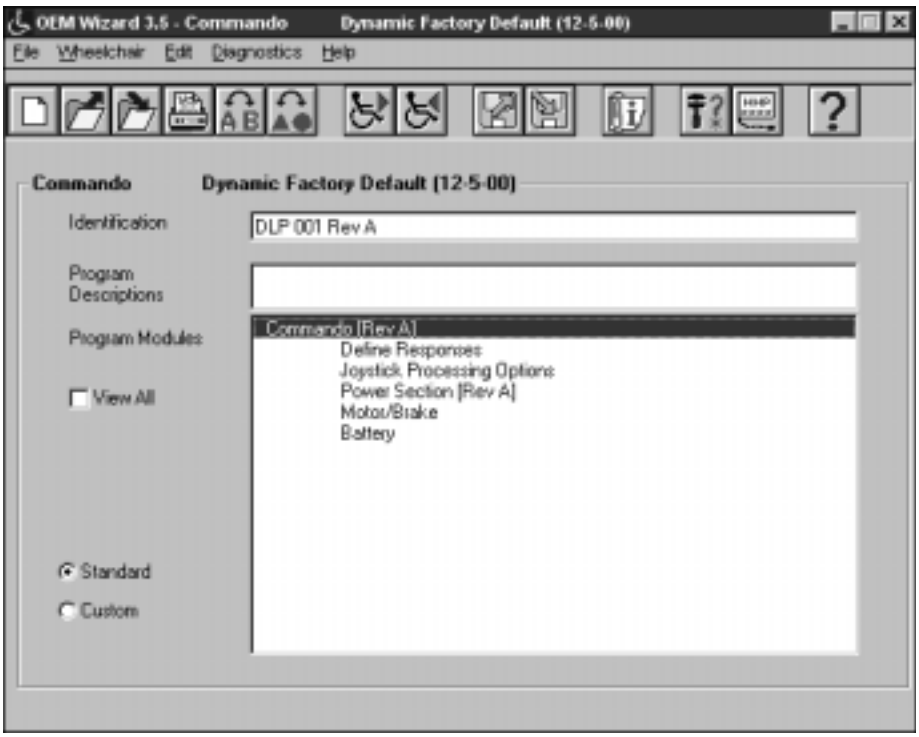
The chair manufacturer uses a Wizard to create standard wheelchair programs for different Commando variants on different chairs. For example, the chair manufacturer might create:

- Standard program for Commando on Chair Model 1
- Standard program for Commando on Chair Model 2
- Standard program for Commando dx on Chair Model 1
- Etc.

New Commando programs may be created by either:

1. Opening one of the Commando templates, modifying it and saving it under a new name.
   Or,
2. Opening a previously created program, modifying it and saving it under a new name.
   Or,
3. If a program has already been created for a particular Commando variant and a duplicate of that program is desired for a different Commando variant, select "Change Module Type", and save under a new name.

Opening a Commando Template or Program brings up the screen:



From here the various programmable options can be accessed, grouped into the following categories.

Commando [Rev A] - displays all settings in one screen.

Define Responses - to define the 5 alternate responses from which the Dealer or Therapist can choose.

Joystick Processing - to define the "transfer function" of the joystick, or in other words, the absolute output, and rate of change of output as the joystick is moved from one position to another. Since they affect the entire command chain from hand movement to wheel movement, these settings influence the perceived drive performance and in effect are additional to the "Define Responses" set up.

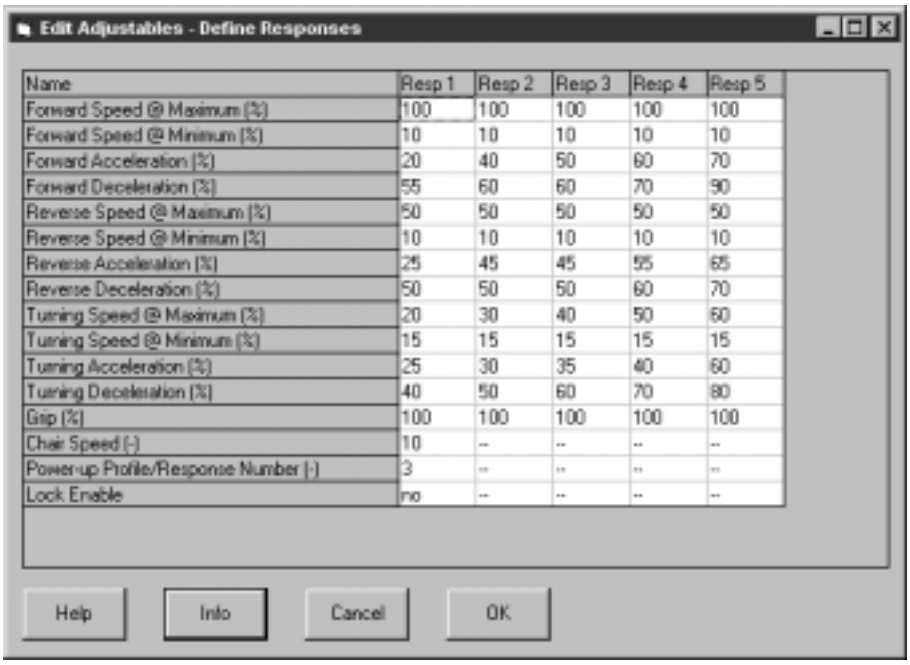
Power Section [Rev A] - displays all 'Motor/Brake' and 'Battery Gauge' settings in one screen.

Motor/Brake - allows the controller to be optimally matched to the motor and brakes.

Battery Gauge - allows the battery gauge type to be selected.

"Define Responses" Options

Double clicking on **Define Responses** brings up the following screen:



Chair Speed is the equivalent of the HHP **Chair Speed** parameter and is described on Page **19**. **Power-up Profile/Response Number** is the equivalent of the HHP **Response** parameter and is described on Page **20**.

Lock Enable is described in the **Using Commando** section on Page **13**.

This allows the 13 options that together define each of the 5 predefined Responses to be viewed and edited.

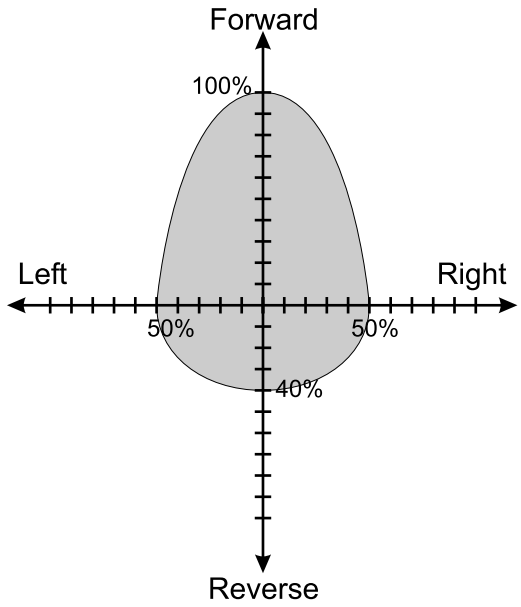
Forward Speed @ Maximum
Forward Speed @ Minimum
Forward Acceleration
Forward Deceleration
Reverse Speed @ Maximum
Reverse Speed @ Minimum
Reverse Acceleration
Reverse Deceleration
Turning Speed @ Maximum
Turn Speed @ Minimum
Turning Acceleration
Turning Deceleration
Grip

These 13 parameters can themselves be split up into groups...

Speeds @ Maximum - Defining Speed 5

Forward Speed @ Maximum, **Reverse Speed @ Maximum**, and **Turning Speed @ Maximum** define the maximum speeds when the joystick is fully deflected in the stated direction, when Commando is in Speed setting 5.

Forward Speed @ Maximum
Forward Speed @ Minimum
Forward Acceleration
Forward Deceleration
Reverse Speed @ Maximum
Reverse Speed @ Minimum
Reverse Acceleration
Reverse Deceleration
Turning Speed @ Maximum
Turning Speed @ Minimum
Turning Acceleration
Turning Deceleration
Grip

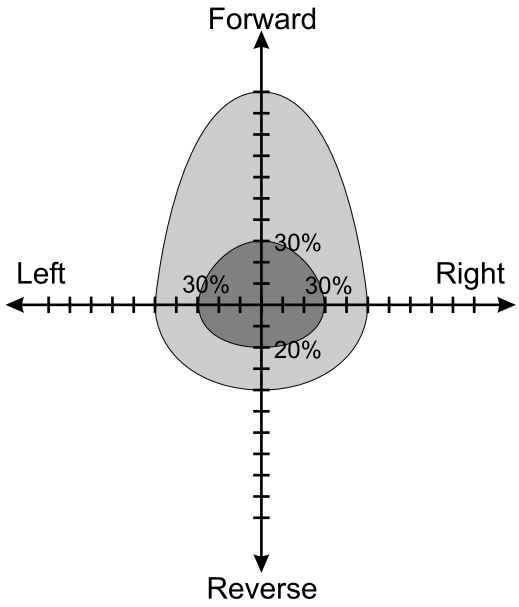


The above diagram gives a pictorial representation of the resulting Speed 5 characteristics for **Forward Speed @ Maximum**, **Reverse Speed @ Maximum**, and **Turning Speed @ Maximum** set to 100%, 40%, and 50% respectively.

Speeds @ Minimum - Defining Speed 1

Forward Speed @ Minimum, **Reverse Speed @ Minimum**, and **Turning Speed @ Minimum** define the maximum speeds when the joystick is fully deflected in the stated direction, when Commando is in Speed setting 1.

Forward Speed @ Maximum
Forward Speed @ Minimum
Forward Acceleration
Forward Deceleration
Reverse Speed @ Maximum
Reverse Speed @ Minimum
Reverse Acceleration
Reverse Deceleration
Turning Speed @ Maximum
Turning Speed @ Minimum
Turning Acceleration
Turning Deceleration
Grip

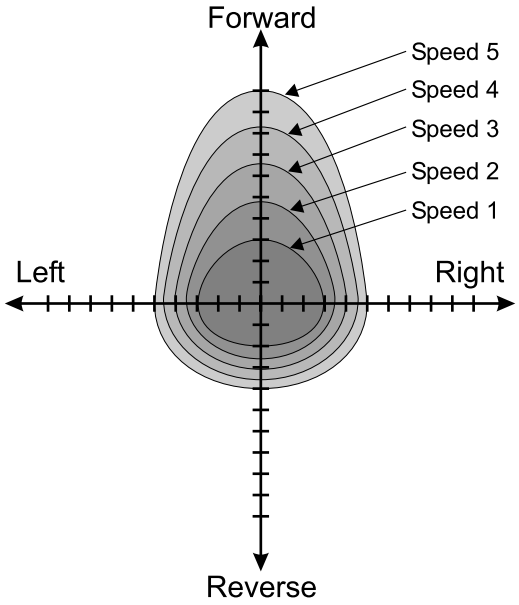


The above diagram gives a pictorial representation of the resulting Speed 1 characteristics for **Forward Speed @ Minimum**, **Reverse Speed @ Minimum**, and **Turning Speed @ Minimum** set to 30%, 20%, and 30% respectively.

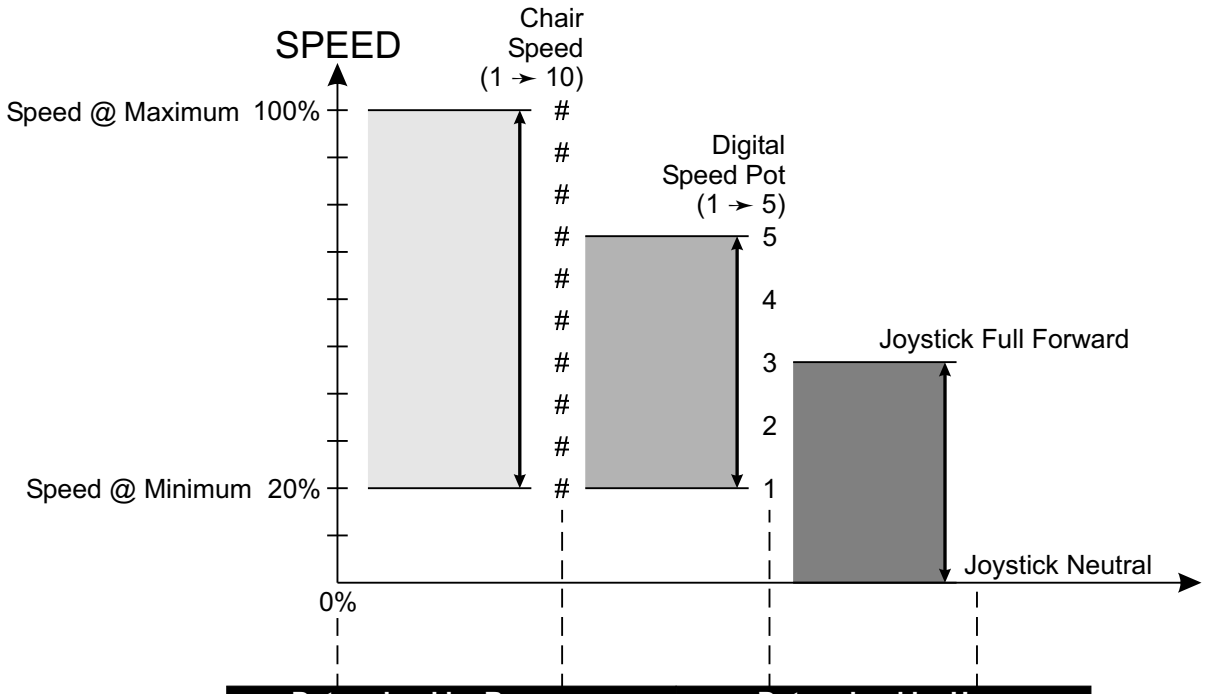
Defining Speeds 2, 3, and 4

We have now defined the extremes of speed performance in Speed Setting 1 (equivalent to turning a mechanical Speed Pot fully anti-clockwise) and Speed Setting 5 (equivalent to turning a mechanical Speed Pot fully clockwise).

From these extremes, Commando's software automatically generates the speeds corresponding to Speed Settings 2, 3 and 4.



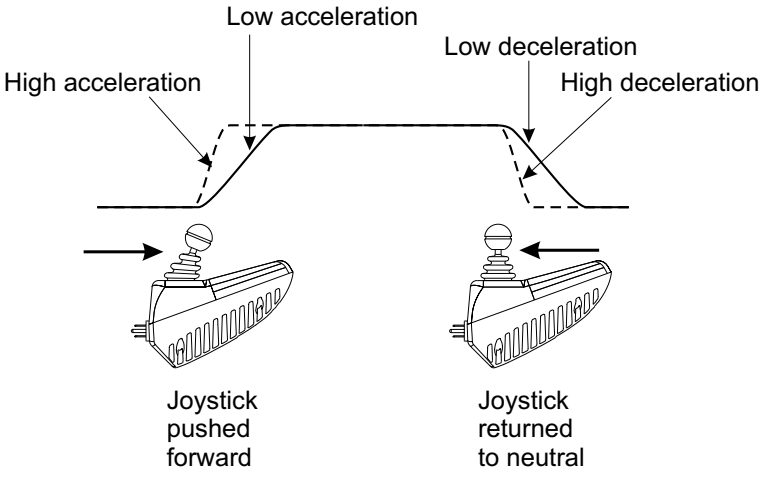
Summary of factors affecting Chair Speed



	Determined by Response		Determined by User	
Factors affecting Speed	**Forward Speed @ Maximum Forward Speed @ Minimum**	**"Chair Speed" Setting**	**Digital Speed Pot Settings**	**Joystick Deflection**
What it does	These define the absolute widest range of top speeds available (i.e., it defines the speed range corresponding to 10 #'s on the CHAIR SPEED bar graph.	Allows a dealer or therapist to easily reduce the speed range, depending on the number of #'s set on the CHAIR SPEED bar graph.	Splits the CHAIR SPEED range, giving a choice of 5 top speed settings.	Allows variation of speed between 0 and the current top speed setting.
Example	Forward Speed @ Maximum = **100%** Forward Speed @ Minimum = **20%**	CHAIR SPEED = **7 #'s**	Speed Pot Setting = **3**	

Accelerations and Decelerations - Defining Response

Forward Speed @ Maximum
Forward Speed @ Minimum
Forward Acceleration
Forward Deceleration
Reverse Speed @ Maximum
Reverse Speed @ Minimum
Reverse Acceleration
Reverse Deceleration
Turning Speed @ Maximum
Turning Speed @ Minimum
Turning Acceleration
Turning Deceleration
Grip



Response does not define Speed, rather it defines the way in which the chair changes from one speed to another. If the joystick is pushed forward quickly, the chair will eventually reach full speed - but does it get there like a rocket or like a snail? Conversely, if the chair is driven at full speed and the joystick is released, does the chair stop uncomfortably fast or does it come to a stop very slowly.

It follows that a gentle, passive, sedate Response is characterised by low accelerations and low decelerations, while a zippy, sporty, more aggressive Response is characterised by high accelerations and high decelerations.

Grip - Increasing chair stability

Since Commando is computer controlled, it is capable of monitoring the current forward and sideways speed of the chair as well as user joystick movements. Joystick requests can then be evaluated as to their possible impact on chair stability. For instance, while it might be quite reasonable to action a request for a sharp turn on the spot, it may not be such a good idea to action that request if the chair is moving forward at top speed.

"Grip" is a parameter that defines the level of assistance Commando will provide in an effort to improve chair stability. The lower the **"Grip"** setting, the more impact Commando will have on joystick requests. For instance, a request for a full turn at high speed will be executed, but only after Commando has automatically reduced forward speed first.

A **Grip** of 100% means Commando will not assist with driving the chair at all, while a **Grip** of 0% means Commando will apply maximum interlocks to any user requests.

Since the primary goal of Grip is to improve chair stability, it is of most value with chair configurations whose inherent designs are mechanically unstable. Rear wheel drive chairs are stable by nature and a grip of 100% is normally appropriate. Front wheel drive chairs are inherently unstable, and have a high degree of variability dependent on weight distribution, wheel-base, height of the centre of gravity, etc. This is where Grip comes into its own and is an invaluable tool for taming Front Wheel Drive (FWD) chairs or preventing unnecessary wheel spin.

The term "Grip" is used to imply the mechanical concepts behind it. Scenarios in which the "grip" between the wheel and the surface on which it is driving is low favour setting a low grip value. For instance, front wheel drive chairs often have low grip between the wheels and the ground because of the relatively small weight over the drive wheels and therefore they skid easily. Additionally, when driving outdoors on slippery surfaces (grass, metal, dirt) the grip between the wheels and the surface is low no matter the chair type, and this would favor a low grip setting as well. Alternatively, a rear wheel drive chair on non-slip surfaces is a high grip scenario for which a high grip setting is appropriate.

"Responses" Set Up Guidelines

Following is a guide to setting the Response Parameters. Follow this to ensure the successful application of Commando's simplified field programming approach.

The key point to note is that Maximum and Minimum speeds should remain constant from response to response (with the possible exception of Turn Speed, which can benefit from increasing slightly across the responses). It is the 6 accelerations and decelerations that are the main difference between responses, and which contribute most to differentiate the 5 "personalities".

Warning:

Do not set up the 5 RESPONSES like the 5 "Drive Programs" in a DX System, i.e. with different speeds in each Response! If this is done, the 5 RESPONSES will become more than just RESPONSE selectors. They will become RESPONSE and SPEED selectors, which defeats the programming philosophy of having separate CHAIR SPEED and RESPONSE settings, each of which can be tuned independently.

DRIVE PERFORMANCE GUIDELINES		
PARAMETER	**GUIDELINES**	**HHP EDITABLE?**
Forward Speed @ Maximum	Set at 100% for all Responses.	Y
Forward Speed @ Minimum	Set at any value, typically 10-20% but should be the same for all Responses.	Y
Forward Acceleration *	Set at any value but should increase markedly from Response 1 to Response 5.	Y
Forward Deceleration *	Should be flat across the Responses at a value that meets the maximum safe stopping distance requirements for the chosen speed. However you may want to increase the value in Responses 4 and 5, consistent with the more aggressive set ups normally associated with these responses.	Y
Reverse Speed @ Maximum	Set at any value, typically 20-40% but should be the same for all Responses.	Y
Reverse Speed @ Minimum	Set at any value, typically 10-20% but should be the same for all Responses.	Y
Reverse Acceleration *	Set at any value but should increase quite markedly from Response 1 to Response 5 (Reverse acceleration is normally not as critical as Forward Acceleration because of the low reverse speeds normally used).	Y
Reverse Deceleration *	Should be flat across the responses at a value which meets the maximum safe stopping distance requirements for the chosen speed. Because Reverse speeds are typically set much lower than forward speeds, this constant value can be less than the Forward Deceleration value and will still comply with stopping distance requirements. However you may want to increase the value in Responses 4 and 5, consistent with the more aggressive set ups normally associated with these responses.	Y
Turning Speed @ Maximum	Set at any value but should increase slightly from Response 1 to Response 5.	Y
Turning Speed @ Minimum	Set at any value, typically 10-20% and should be flat across the responses.	Y
Turning Acceleration *	Set at any value but should increase markedly from Response 1 to Response 5.	Y
Turning Deceleration *	Set at any value but since there are no regulatory turn stopping requirements this may increase quite markedly from Response 1 to Response 5.	Y
Grip	Rear Wheel Drive Chair = normally 100% Mid Wheel Drive Chair = 0-100% (determined experimentally) Front Wheel Drive Chair = 0-100% (determined experimentally)	Y

* Ensure that deceleration parameters are always higher than acceleration for a safe response. Increasing the difference between the parameters will increase the "Tremor Damping" effect.

Some typical examples resulting from the guidelines listed on the previous page are given below.

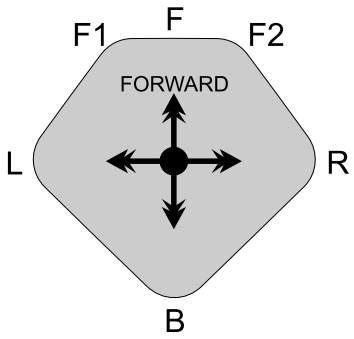
DRIVE PERFORMANCE EXAMPLES					
PARAMETER	**Response 1**	**Response 2**	**Response 3**	**Response 4**	**Response 5**
Forward Speed @ Maximum	100	100	100	100	100
Forward Speed @ Minimum	15	15	15	15	15
Forward Acceleration	20	40	50	60	70
Forward Deceleration	60	60	60	70	90
Reverse Speed @ Maximum	40	40	40	40	40
Reverse Speed @ Minimum	10	10	10	10	10
Reverse Acceleration	25	35	45	55	65
Reverse Deceleration	50	50	50	60	70
Turning Speed @ Maximum	20	30	40	50	60
Turning Speed @ Minimum	15	15	15	15	15
Turning Acceleration	25	30	35	40	60
Turning Deceleration	40	50	60	70	80
Grip	100	100	100	100	100

"Joystick Processing" Options

Joystick Basics

Since it is the physical interface by which the user requests changes of speed and direction, the joystick is the key component in the entire control process.

The joysticks fitted in most Dynamic product are fitted with a "Restrictor Plate" which, as the name suggests, restricts the physical movement of the joystick to certain positions. The standard restrictor plate is shaped like a diamond, flattened at the front.

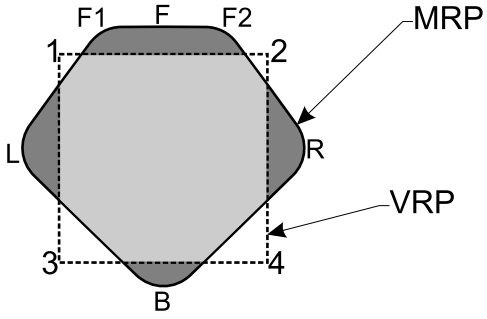


Points **F**, **L**, **B**, and **R** define requests for full forward, full left, full back and full right respectively. As there is a slight variation in the characteristics of individual joysticks, each joystick is matched to the controller in which it is fitted using a calibration process.

The notches at **B**, **L** and **R** make it simple to execute a turn on the spot or drive backwards. The flat at **F** (**F1** to **F2**) allows the user to request a certain degree of turning while travelling at full speed forward. The straight lines between **F1** and **L**, **L** and **B**, **B** and **R**, **R** and **F2**, mean that it is not physically possible to request a sharp turn at high speeds, which is at best discomforting and at worst dangerous in certain types of chairs.

While physical restrictor plates are a good start to ensuring safe driving, they have their limitations. For instance, in high-speed settings (e.g. Speed Settings 4 and 5) the chair may get fast enough to require turn limiting, in which case the restrictor plate performs a useful function. However in low speed settings (e.g. in Speed Settings 1, 2 or 3) the chair may not go fast enough to become unsafe, meaning the turn limitations by the restrictor plate are unnecessary and annoying.

Ideally what is required is a "dynamic" restrictor plate, one that changes shape automatically depending on the current speed. Clearly this can not be done mechanically, but it can be implemented with software to create a "Virtual Restrictor Plate" (VRP) that overlays the Mechanical Restrictor Plate (MRP). For instance, the diagram to the side shows the standard diamond MRP overlaid by a square VRP.



Mechanically, the joystick can be moved anywhere within the MRP area **F1-L-B-R-F2**. However the software implementing the VRP will recognise when the joystick is outside the square (**1-2-3-4**) and limit the joystick output to these values. This means that the dark shaded areas are effectively "dead zones" in which the joystick is free to move but which have no effect on chair movement.

Many of the Commando joystick processing options are implemented using the VRP concept. Some of the Commando VRPs are "static" - meaning they are fixed no matter the speed of the chair and/or how much or how fast the joystick is deflected. Others are "dynamic" - meaning their shape automatically changes depending on chair speed and/or at what rate the joystick is deflected.

Optimising Chair Stability and Controllability

These options are set by the manufacturer to get optimal drive performance, safety and control for each particular chair design.

Preventing Front Wheel Drive Chairs from Spinning

The 3 options **Speed X Turn for Grip**, **Accel out of a Turn for Grip** and **Accel into a Turn for Grip** are a set of parameters that define a Virtual Restrictor Plate (VRP) specifically designed to improve the safety and controllability of Front and Mid wheel drive chairs.

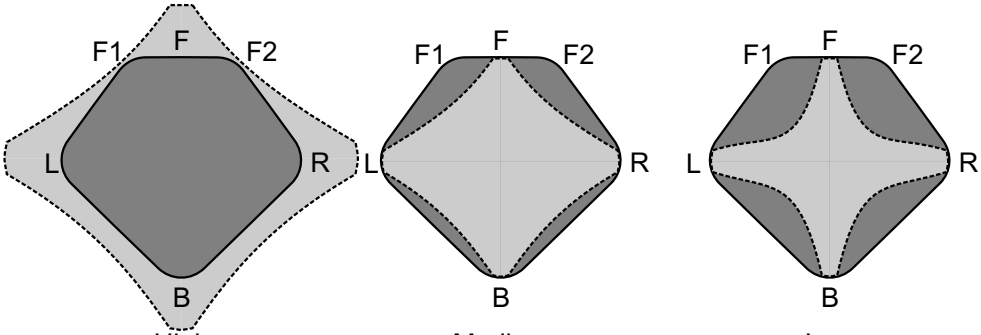
These 3 "Speed X Turn" parameters together define the mechanical properties that affect the stability of the chair and are set by the manufacturer for each particular chair design.

They are NOT designed to be tuned for specific users.

Chair stability is defined by the ability of the chair to make a turn at speed without losing control. A chair may be stable turning slightly while moving at a high speed forward, or it may be stable making a fast turn on the spot, but it may be unstable making a sharp turn at high speed. For any chair design, there is a maximum combined value of Speed and Turn for which the chair will not lose control. Loss of control means the chair's inertia and turn component are such that the tyres skid, rendering any action from the controller ineffective. Skidding is affected by the chair design, the state and inflation of the tyres, the friction of the driving surface, and the position of the user.

Speed X Turn for Grip is the absolute maximum combined speed and turn values the controller will allow to be passed through to the motors. A high value implies a highly stable chair, one that can turn at quite high speeds without spinning out. A low value implies a low stability chair, one that must prevent the user requesting simultaneous high Speed and Turn combinations.

Speed X Turn for Grip overlays a curved VRP over the MRP:



High "Speed X Turn for Grip" Value

Medium "Speed X Turn for Grip" Value

Low "Speed X Turn for Grip" Value

The VRPs limit the combined Speed and Turn values to the constant amount specified by the **Speed X Turn for Grip** parameter. The higher the SpeedxTurn value the more mild the curve. The lower the Speed X Turn value the sharper the curve, until the VRP approximates a cross.

The optimum **Speed X Turn for Grip** should be determined experimentally for each chair type under "typical worst case" stability conditions. It will be necessary to judge how many worst case conditions should apply that still results in a value that is practical for normal circumstances. These may include:

- Heaviest weight user in worst possible position (back reclined)
- Typical to worst case target driving surface (e.g. grass)
- Tyres typically to worst case over-inflated or worn.

Accel out of Turn for Grip and **Accel into a Turn for Grip** define two dynamic VRPs that automatically modify the **Speed X Turn for Grip** VRP under certain conditions. Accelerating makes increased demands on the friction between the wheel and drive surface, increasing the tendency to skid and lose control. Therefore it is highly desirable to automatically reduce the Speed X Turn limit as a user requests high acceleration, which would occur when requesting a rapid increase in speed, or a rapid increase in turn. These two options then define if and how the **Speed X Turn for Grip** VRP will be temporarily reduced while accelerating.

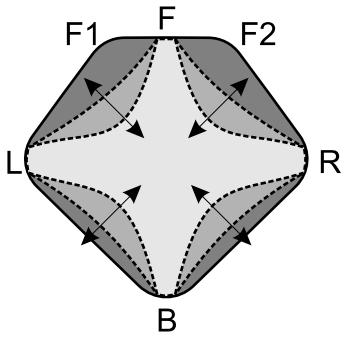
A value of **0%** means there will be zero reduction of the **Speed X Turn for Grip** VRP under high acceleration conditions. A value of **200%** means there will be a maximum reduction of the **Speed X Turn for Grip** value under high acceleration conditions.

These 3 "Speed X Turn" settings form a set of parameters that can be applied collectively to any or all of the Commando's 5 pre-set responses, to a degree that is determined by the **Grip** setting for each response.

A Response with a high **Grip** setting implies, "This response is for use with high grip/traction drive scenarios, therefore there is no need to apply much, if any of the TurnxSpeed interlocks."

A Response with a low **Grip** setting implies, "This response is for use with low grip/traction drive scenarios, therefore the TurnxSpeed interlocks should be applied to keep the chair stable".

As illustrated, **Grip** moves the chosen SpeedxTurn curve in and out along the diagonals of the MRP depending on the chosen setting.



Preventing Front Wheel Drive Chairs from Snaking

Another classic problem of FWD chairs is the tendency to "snake" when attempting to drive in a straight line, due to:

1. The turn delays caused by the low turn accelerations and decelerations traditionally programmed to prevent the chair from spinning out.

2. The psychological effect of the user's head not only moving sideways on turning, but moving in what is intuitively the wrong way (i.e. when you turn the chair to the left your head swings to the right).

With correct use of the Speed X Turn options it is not necessary to lower turn accelerations and decelerations in order to preserve stability, which means that this problem is reduced from the outset.

While there is not much that can be done to overcome the root cause of any psychological effects, it can be made easier for the user to stay in control by desensitising the chair response to turn requests while driving at full speed so that joystick movements have less effect. If required, this can be achieved by reducing the **Turning @ Full Speed** value. A value of **100%** means the turning speed while driving at full speed will be the same as at low speed. A value of **50%** will reduce the turn speed while at full speed to half the turning speed used. The higher the speed, the more turning speed will be reduced.

For low turn speeds it is particularly important that accelerations and decelerations are high - a low acceleration to a low endpoint takes a long time, causing steering delays that give rise to over steering and snaking. If **Turning @ Full Speed** is reduced, it is therefore desirable to simultaneously request an automatic increase in turn acceleration when the chair is moving at speed. This can be done, if required, by increasing the **Turning Accel @ Full Speed** parameter.

Dealer/Therapist Options to overcome user hand problems

These options can be set by the dealer or therapist to tune the joystick to the mechanical abilities of specific users.

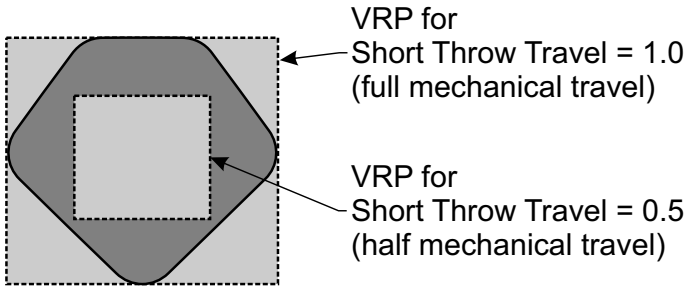
Reducing the Pressure or Movement to Operate a Joystick

The **Short Throw Travel** and **Short Throw Shape** parameters are used together to create custom VRPs on a user by user basis. These are not for the purpose of maintaining chair stability, but to make the joystick more sensitive.

As supplied, Commando will reach full speed only when the joystick is pushed as far as it can mechanically go (i.e. when it hits the restrictor plate).

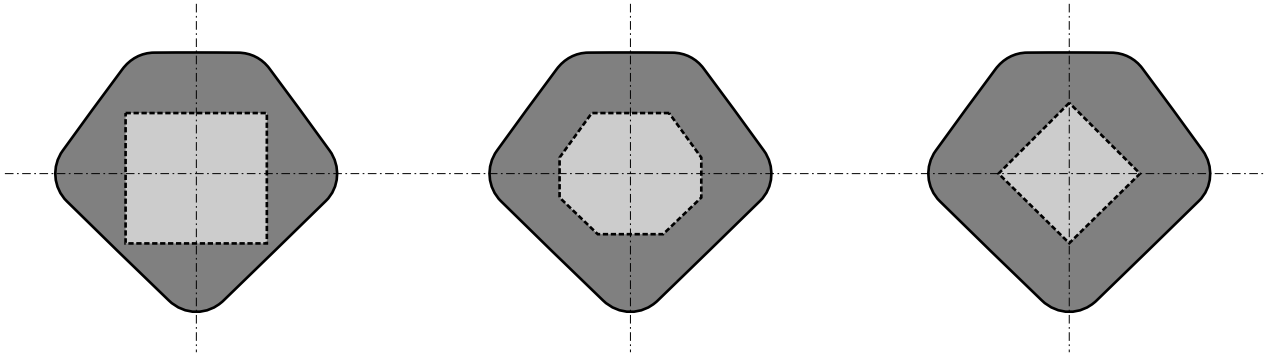
For some users it may be difficult, if not impossible, to provide either the force or deflection to move the joystick this far, in one or more directions. In these cases it may be useful to use the **Short Throw Travel** parameter to reduce the amount of deflection (and therefore pressure) required.

The **Short Throw Travel** parameter places a square VRP over the MRP. The default value of **1.0** will place this VRP just outside the MRP (no effect). Reducing **Short Throw Travel** below **1.0** brings the VRP inside the MRP, with a value of **0.5** meaning the user only has to move the joystick half as far to reach full speed. Intermediate values give a response determined by the combination of the VRP and MRP. Setting **Short Throw Travel** to any value below **1.0** will result in a "dead band" in which there will appear to be no response to joystick movement perpendicular to the VRP side through which the joystick passes.



As **Short Throw Travel** is reduced from 1.0 to 0.5, the shape of the overall restrictor plate changes from pentagonal (5-sided), to octagonal (8-sided), to square (4-sided). While this may have the positive effect of reducing required joystick deflection, it has the negative effect of eliminating the turn/speed interlock provided by the diamond sides of the MRP. The resulting square restrictor plate allows the simultaneous request of full forward speed and full turn, which can be dangerous. Also, turning is achieved by speeding up the outer wheel. This may mean the chair appears to speed up going into a turn, which can be somewhat disconcerting.

This can be overcome using the **Short Throw Shape** parameter to "knock the corners" off the square VRP. As the value is decreased from **200%** to **100%**, the corner knocked off is successively increased, so that a value of **200%** has no effect on the square, a value of **150%** creates an octagonal (8-sided) VRP, and a value of **100%** totally knocks the corners off to create a diamond (effectively rotating the square 45°).



VRP for Short Throw Travel = 0.5
Short Throw Shape = 200%

VRP for Short Throw Travel = 0.5
Short throw Shape = 150%

VRP for Short Throw Travel = 0.5
Short Throw Shape = 100%

Between them, **Short Throw Travel** and **Short Throw Shape** are powerful tools that can create any custom VRP to suit any chair type and/or user abilities.

While the effects of the **Short Throw Shape** and **Speed X Turn for Grip** parameters may appear similar, their differences are more than just shape. **Short Throw Shape** affects the joystick demand, so it applies even in low speed settings. **Speed X Turn for Grip** applies to the demand after the speed setting has been included, so it does not usually apply to low speed settings. It is also a "dynamic" parameter.

"Joystick Processing" Options Summary

Short Throw Travel

Reduces the amount of joystick deflection needed to get full speed. Set to **0.5** to get the same amount of speed with half the joystick deflection.

Short Throw Shape

Used in conjunction with **Short Throw Travel** to create octagonal VRPs which limit the amount of turning possible when the chair is moving at speed. Default is **200%**. Reduce to progressively 'chop the corners off' the **Short Throw Travel** VRP.

Speed X Turn for Grip

The absolute maximum speed/turn product for which the chair is unconditionally stable. Commando will assist a user to ensure this value is not exceeded, to a degree dependant on the **Grip** programmed for the response in use. The optimum value of **Speed X Turn for Grip** is determined experimentally for each chair design.

Accel out of a Turn for Grip

A temporary modifier of **Speed X Turn for Grip** when a user requests fast acceleration forward while the chair is turning. A value of **0** does not effect **Speed X Turn for Grip** at all, up to a value of **100%** which causes a progressive temporary reduction in **Speed X Turn for Grip** under these acceleration conditions.

Accel into a Turn for Grip

A temporary modifier of **Speed X Turn for Grip** when a user requests fast sideways acceleration while the chair is moving forward. A value of **0** does not effect **Speed X Turn for Grip** at all, up to a value of **100%** which causes a progressive temporary reduction in **Speed X Turn for Grip** under these acceleration conditions.

Turning @ Full Speed

A modifier of **Turning Speed @ Maximum** when the joystick is pushed full forward. A value of **100%** has no effect, a value of **50%** will desensitise steering (at full speed) by a factor of 50%.

Turning Accel @ Full Speed

Used in conjunction with **Turning @ Full Speed** to achieve a less sensitive but more responsive turn characteristic at high speed.

Joystick Switch Threshold

Commando Plus/dx only.
This defines how far the joystick must be moved before seat actuator movement begins. A low value means the joystick only has to be moved slightly, a high value means a larger deflection is required.

"Motor/Brake" Options

Clicking on **Motor/Brake** Options allows programming of the following options:

Load Compensation - HHP Programmable

Load Compensation is the key setting to match Commando to the motors it controls. It tells Commando the motor resistance, so that it can automatically compensate for the motor's natural tendency to slow down under load, for instance going up curbs and ramps. Commando will not control the chair correctly unless this is carefully set.

Current Limit

Sets the peak current Commando will deliver to each motor, up to a maximum of **50** amps.

Stall Time

For safety reasons, regulations in some countries require that the controller automatically stop supplying current if the current limit has been exceeded for more than a certain period of time. Set to the length of time determined by regulation in your area of usage.

"Temp Roll Back Minimum" and "Temp Roll Back Maximum"

These settings define the way Commando reacts to excessive internal temperatures. Commando will slow down the chair and soften response while under a heavy load, therefore reducing the amount of heat generated internally. This speed reduction in no way affects the driving torque, and therefore its ability to climb slopes.
Speed reduction will begin as the case temperature rises above **Temp Roll Back Minimum**. Speed and response will be reduced as the case temperature rises from **Temp Roll Back Minimum** to **Temp Roll Back Maximum**. At this point Commando will stop and a Stall Timeout Fault will be indicated.

Test Park Brake Driving

Commando routinely checks the integrity of the park brakes before it starts driving. If you want the added safety of Commando constantly checking the integrity of the brakes, even while it is driving, set this to **Yes**. The mechanism by which Commando has to do this may result in some audible noise from the park brakes - if this is a problem, set to **No**.

Motor Continuity Test

Set to **Yes** if you want the motors checked for continuity before driving - this is the normal setting.

Maximum Motor Volts

Defines the maximum voltage Commando will apply to the motor. When the joystick is pushed full forward in Speed 5, for a **Chair Speed** setting of 10 #'s and with **Forward Speed @ Maximum** set to 100%, Commando applies this voltage to the motors.

Emergency Deceleration

The rate at which Commando will come to a stop in fault conditions.

Veer Compensation - HHP Programmable

Applies a bias to the left or right motor to compensate for motors that have slightly mismatched speed characteristics.

"Battery" Options

Voltmeter Battery Gauge

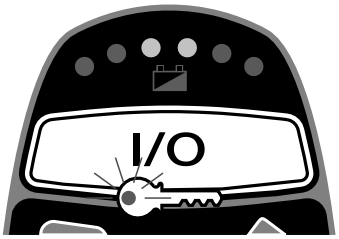
This allows the battery gauge to be based on either a **Capacity (No)** sensing algorithm or a battery **Voltage (Yes)** algorithm. Both types of gauge have their advantages and disadvantages. **No** (capacity) is the usual choice as it gives the truest indication of remaining fuel.

5 Diagnostics & Fault Finding

This chapter describes how to diagnose faults within the entire chair control system including faults within Commando, the batteries, motors and brakes.

Introducing Diagnostics and Fault Finding

A flashing "System Status Indicator" (the LED in the Key symbol) indicates Commando has detected an "abnormal" condition somewhere in the control system.



The nature of the condition is indicated by the number of flashes in each burst, referred to as the **"Flash Code"**. It is important to realise that most of these flash codes relate to problems with components other than Commando - the batteries, motors and brakes - so a flashing LED normally has nothing to do with Commando at all.

Commando reacts differently to each possible "abnormal" condition depending on its severity and impact on safety. It may...

1. Simply give a "Flash Code" as a warning and let driving continue as usual.

2. Let the chair drive but at a reduced speed. This is known as "Limp Mode" and is used for intermediate level conditions in which maintaining some degree of driving is the preferred and safest option. Limp Mode should only be used with caution and to get back to a point where the fault can be diagnosed and remedied.

3. Automatically stop the chair and indicate the "condition" by giving a Flash Code. Conditions of a transient nature, for example Stall Time Out, may be cleared simply by powering down and up again. Conditions of a permanent nature, for example Park Brake Fault, will prevent the chair from driving until the fault is physically removed.

Overview of Commando Flash Codes (refer to following page for details)	
Flash Code	**Probable Condition**
Bursts of **1** flash	Commando may be faulty
Bursts of **2** flashes	Accessory fault (fault related to seating or lighting)
Bursts of **3** flashes	Left Motor Fault
Bursts of **4** flashes	Right Motor Fault
Bursts of **5** flashes	One of the Park Brakes is open circuit
Bursts of **6** flashes	unused
Bursts of **7** flashes	Battery dangerously low
Bursts of **8** flashes	Battery voltage is too high. Refer ***Battery Charging*** section.
Bursts of **9** flashes	Internal Comms Fault 1 (CANL)
Bursts of **10** flashes	Internal Comms Fault 2 (CANH / Wakeup)
Bursts of **11** flashes	Stall time out
Quick pulse every 5 seconds	Commando is powered up but locked
Rapid flashing	"Out Of Neutral At Power Up" (OONAPU) fault Commando powered up with the joystick deflected

This information can also be obtained by plugging in the HHP and pressing NEXT, NEXT, DIAG (for HHP diagnostics). A more detailed report of both the current status and history of the control system can be obtained by interrogating Commando with the Wizard. For a more detailed description of each flash code and probable causes and remedies, refer to the following section.

The battery gauge is used to indicate faults or warnings related to the battery. When battery charge has dropped to a single red LED, that LED will begin flashing indicating an 'Empty' battery warning.

If more than one of the battery gauge LEDs are flashing, this means the battery voltage has temporarily gone too high or too low - two or three LEDs flashing normally indicate a low voltage warning, 3 to 6 LEDs flashing normally means a high voltage warning.

Joystick Out Of Neutral At Power Up ('OONAPU')

If Commando is turned on with the joystick out of neutral, the Status Indicator will rapidly flash for as long as the joystick is held out of neutral - up to a maximum of 5 seconds.

After 5 seconds, a Commando Fault (Flash Code 1) will be displayed on the Status Indicator. This condition can be reset by turning the power off and then back on again with the joystick in the neutral position.

Detailed Flash Code Descriptions

Commando Status LED Flash Code	Likely Cause of Condition and Probable Action
1	**Commando Fault**
	Cause: Commando is not correctly programmed or may have an internal fault. Action: • Try reprogramming Commando. Action: • Check DXBUS connections and replace where necessary (Commando dx only) • If Status LED on other Module is flashing, replace Module (Commando dx only) • An expected module may not be present (Commando dx only)
2	**Accessory Fault**
	Cause: On Commando S or Commando Plus, this means the DCI input is activated (i.e., the chair is in 'Slowdown', 'Inhibit' or any other Out of Normal condition). Cause: On **Commando dx**, this means there is a fault in an accessory device driven by one of the attached DX Modules, for example… a light bulb is short or open circuit; an actuator terminal is shorted to Battery +. Action: • Check all accessory devices connected to Commando.

Commando Status LED Flash Code	Likely Cause of Condition and Probable Action
3	**Left Motor Fault**
	Cause: The connection from Commando to its associated motor, or the motor itself, is defective. The connection is either open or short circuit. Action: • Check continuity between the motor pins. • Ensure there is no continuity between motor and park brake terminals. • Ensure brushes in motor are moving freely.
4	**Right Motor Fault**
	Cause: The connection from Commando to its associated motor, or the motor itself, is defective. The connection is either open or short circuit. Action: • Check continuity between the motor pins. • Ensure there is no continuity between motor and park brake terminals. • Ensure brushes in motor are moving freely.
5	**Park Brake Fault**
	Cause: The connection from Commando to the Park brakes is either open or short circuit. Action: • Check continuity between the park brake pins. • Ensure there is no continuity between motor and park brake terminals. Cause: Mechanical park brake release lever may be activated. Action: • Re-engage the park brake release lever.
6	**Unused**
7	**Low Battery Fault**
	Cause: The battery charge is not sufficient to allow safe driving. It has fallen below 17V. Action: • Check battery connection and terminals. The battery voltage should be similar when the battery is on charge and when it isn't. • Charge the batteries. • If this condition occurs regularly or with increasing frequency, check the state of the batteries. Replace if necessary and/or install larger batteries. **Note:** The wheelchair will behave sluggishly and the Battery Gauge will flash indicating low battery voltage prior to the display of this fault.
8	**Over Voltage Fault**
	Cause: The battery voltage has exceeded 32V. Action: • If this fault occurs during battery charging, the battery charger is defective or incorrectly adjusted. • Check the battery charger open circuit voltage. Cause: The battery connector is making intermittent contact when the wheelchair is stopped, or travelling down a slope. Action: • Check that the battery wiring and terminating is secure.

Commando Status LED Flash Code	Likely Cause of Condition and Probable Action
9	**DX BUS Fault 1 (Commando dx only)**
	Cause: 1. An invalid voltage has been detected on the DXBUS CANL line. 2. Communication is not possible using the CANL wire. Action: • Check the continuity of the DXBUS cable. • Check for shorts between DXBUS pins. An open or short circuit on another DX Module can cause this fault.
10	**DX BUS Fault 2 (Commando dx only)**
	Cause: 1. An invalid voltage has been detected on the DXBUS CANH line. 2. Communication is not possible using the CANH wire, or the CANH and CANL wires are shorted together. 3. Hazard lights were turned on when Commando was turned on. 4. CANH is used to generate a Kill signal by any DX Module which detects an unsafe condition, or by an external device such as an emergency stop switch. 5. The CANH wire is pulled to either Battery + or Battery - and causes the DX System to shut down. Action: • Check the continuity of the DXBUS cable. • Check for shorts between DXBUS pins. An open or short circuit on another DX Module can cause this fault. • If the Hazard Lights were already switched on when Commando was turned on, Flash Code 10 and Limp Mode (slow driving) may result. To clear this fault, turn the Hazard Lights off, then turn Commando off then on again. • If generated by a Kill signal, the cause of the fault is severe.
11	**Stall Timeout Fault**
	Cause: The motor current has been at, or close to, current limit for longer than the Stall Timeout parameter value. Action: • Turn Commando off then on again. Cause: Motor(s) are faulty. Wheel(s) may be rubbing on frame. Action: • Ensure wheels turn freely while under no load. Have motor(s) checked by a service technician.

Diagnostics Using the Wizard

The Status report generated by the Wizard provides the current and historical status of the wheelchair, including faults and warning conditions currently active. The Status Report will also provide a fault history of the module, listing the 16 most recent faults and the total number of times a fault has occurred.

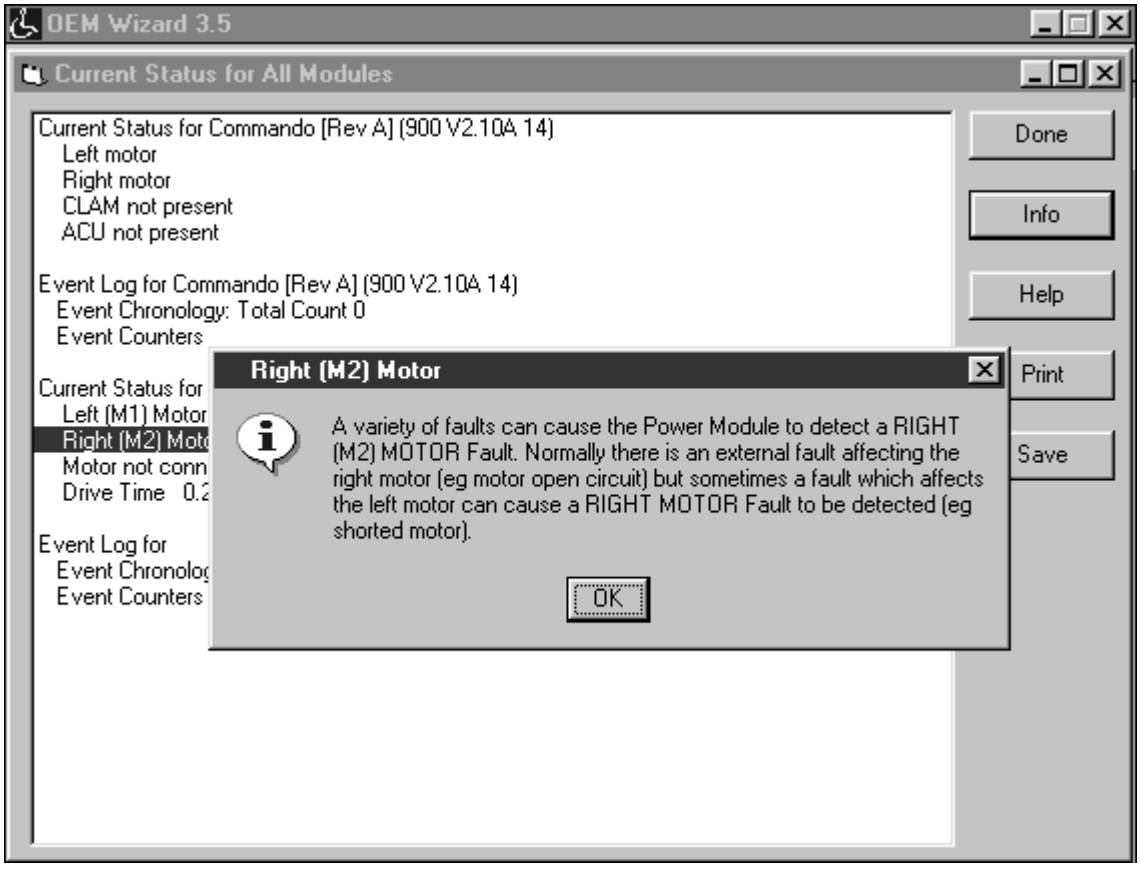
1. Plug the Wizard communications cable into the Programming socket at the base of the Commando.

2. Launch the Wizard.

3. Select 'System Status Report' from the 'Diagnostics' menu.

4. The Wizard will download any fault information from Commando and display it in a simple dialog box.

5. Select a fault and click the 'Info' button to get an explanation of the fault. Alternatively, the Status Report can be printed or saved for later investigation.



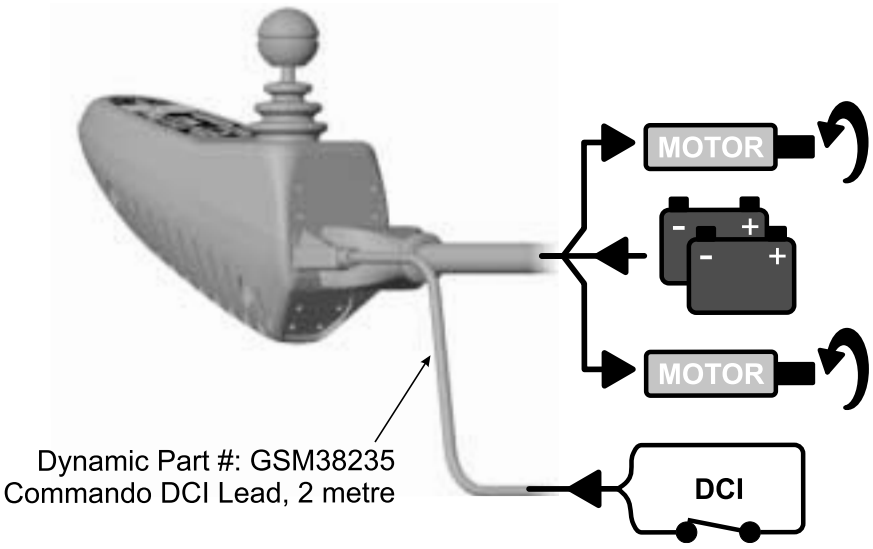
Note:
Supplying a paper or electronic version of the diagnostics report when returning a Dynamic product for servicing is extremely valuable information to a service centre.

6 Commando S

This chapter describes Commando S, the Commando variant with a Drive Control Input. The Drive Control Input is explained as well as the additional programming necessary to configure it.

Introducing Commando S

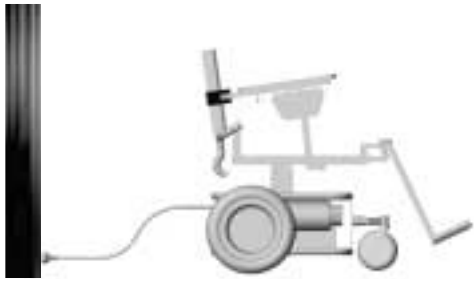
The only difference between Commando S and a standard Commando is the addition of a "Drive Control Input" (DCI) situated next to the main connector at the rear of the unit. The lead is available for purchase from Dynamic.



The DCI acts as a link between Commando S and other chair functions and is specifically designed to support:

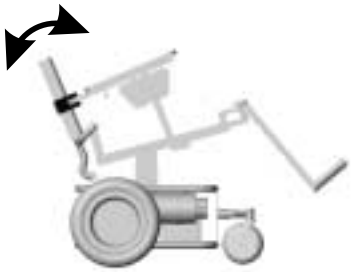
Chairs with an on-board battery charger:

Chair driving inhibited while chair is on charge.



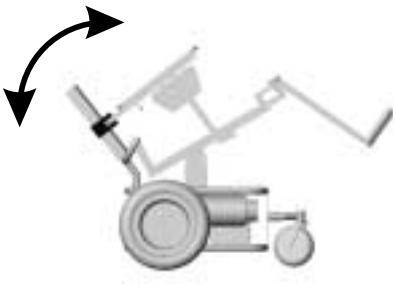
Chairs with a seating function:

Chair driving slowed while seat partially reclined or raised.



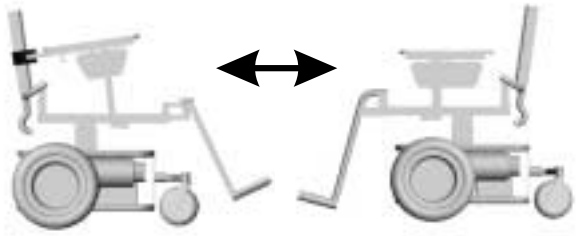
Or...

Chair driving inhibited while seat totally reclined or raised.



Chairs designed to convert between Front Wheel Drive and Rear Wheel Drive:

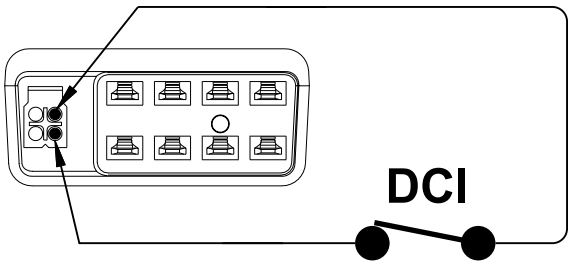
Motors automatically swapped on swivelling seat.



RWD **FWD**

Each of these scenarios requires some means of telling Commando S the current state of these external functions so that it can change the way that it drives.

Drive Control Input (DCI)



The DCI allows an external device to request Commando S to either:

STOP - do not allow driving at all, typically when a battery charger is plugged in, or when a seat is fully raised or reclined.

Or...

SLOW DOWN - allow driving but at a reduced speed, typically when a seat is partially raised or reclined. The factor by which the speed is reduced is adjustable in the Wizard.

Or...

SWIVEL - change joystick interpretation when the seat is swiveled to change between FWD and RWD modes.

It is also possible to simultaneously request a chair reversal AND limiting of top speed, or to slow the chair by an amount dependent on the DCI loop resistance.

Note :
Whenever Commando is in an 'Out of Normal' condition, a Flash Code 2 will be indicated. This will clear and stop flashing as soon as the 'Out of Normal' is cleared.

"Speed Limit" Options

External DCI Speed Limit

Sets the percentage of maximum wheelchair speed allowed when the DCI Loop is not in its programmed 'normal' state. The **Use DCI Safety Speed Limit** Option must be set to **'Yes'** for this option to function.

"Drive Control Input" Options

Operation of the DCI Loop is defined by the following Wizard programmable parameters:

DCI Slow Down Speed is Fixed

If set to **'Yes'**, a loop resistance of 120 Ohms will cause the chair to be slowed down by a fixed factor defined by the **DCI Slows Down to . .** adjustable.

If set to **'No'**, the chair will slow down by an amount dependent on the loop resistance. A loop resistance between 56 and 220 Ohms will slow the chair to a value proportional to the loop resistance. A loop resistance of 220 Ohms will cause no speed reduction, while a loop resistance of 56 Ohms will cause the chair to slow down to the factor defined by the **DCI Slows Down to . .** adjustable. Intermediate resistances cause a slow down linearly between these two values.

DCI Loop is Normally Open

This defines whether the DCI loop state that Commando is to interpret as "Normal", is a completely open (>560 Ohms) or a completely closed loop (short circuit <10 Ohms). **'No'** is the preferred option since it results in a failsafe system in which DCI loop faults can be detected.

Swivel Enable

If set to **'Yes'**, adding a DCI resistance of 330 Ohms causes the chair to revert to a front wheel drive mode (motors and polarities swapped). If both 330 Ohms and 120 Ohms are added to the DCI loop, the chair will change to FWD mode and will slow down to the value specified by the **DCI Slows Down to . .** adjustable. Set **Swivel Enable** to **'No'** if you do not want to use this feature.

Note :

For safety reasons, **"DCI Loop is Normally Open" MUST** be set to **'No'** if **"Swivel Enable"** is set to **'Yes'**.

DCI Slows Down to . .

As described above, defines the factor by which the chair will be slowed down in response to a DCI slowdown request.

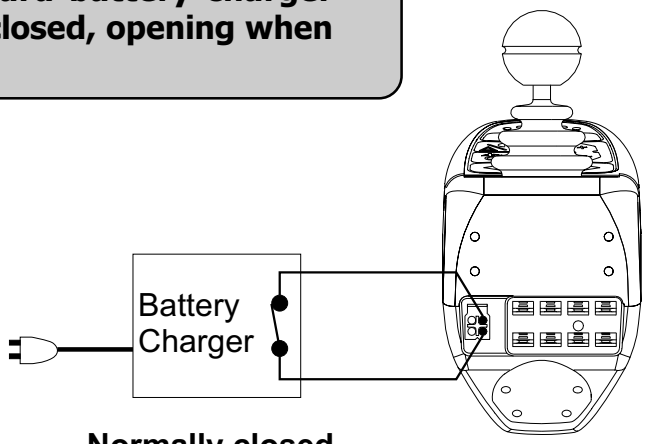
Use DCI Safety Speed Limit

Set to **'Yes'** for safety critical applications. This invokes an absolute speed limit (set by **External DCI Speed Limit**) whenever the DCI loop is not in its normal state (a normal state is defined by the **DCI Loop is Normally Open** option). The status LED will flash (Flash Code 2) while this 'speed limit' is active. The 'speed limit' is independent of any other programmed speed settings.

Drive Control Input Usage Examples

❶ **Commando used with an on-board battery charger who's inhibit output is normally closed, opening when the charger is plugged in.**

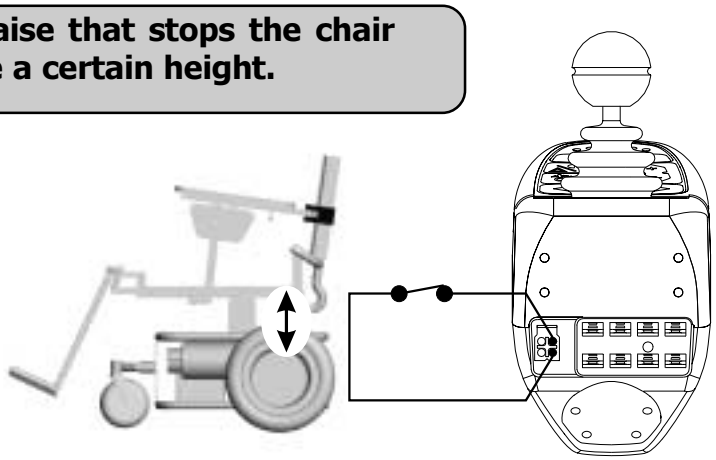
Wizard Option	Set to...
DCI Loop is Normally Open	No
DCI Slow Down Speed is Fixed	Either
DCI Slows down to . .	Any
Swivel Enable	No



Normally closed
Opens when charger is plugged in

❷ **Commando used with seat raise that stops the chair when the seat is raised above a certain height.**

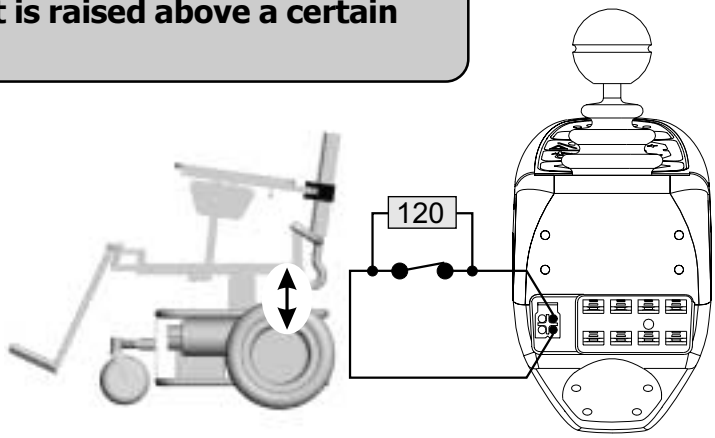
Wizard Option	Set to...
DCI Loop is Normally Open	No
DCI Slow Down Speed is Fixed	Either
DCI Slows down to . .	Any
Swivel Enable	No



Normally Closed
Microswitch opens when critical height reached

❸ Commando used with seat raise that reduces chair speed to 50% when the seat is raised above a certain height.

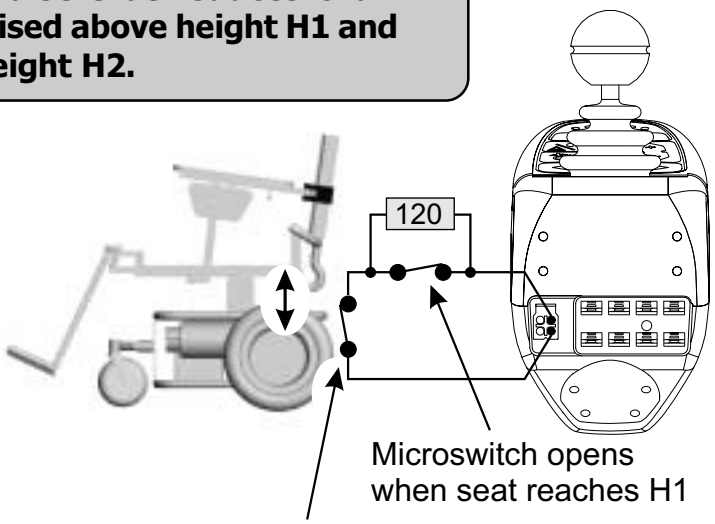
Wizard Option	Set to...
DCI Loop is Normally Open	No
DCI Slow Down Speed is Fixed	Yes
DCI Slows down to . .	50%
Swivel Enable	No



Normally Closed
Microswitch opens when critical height reached

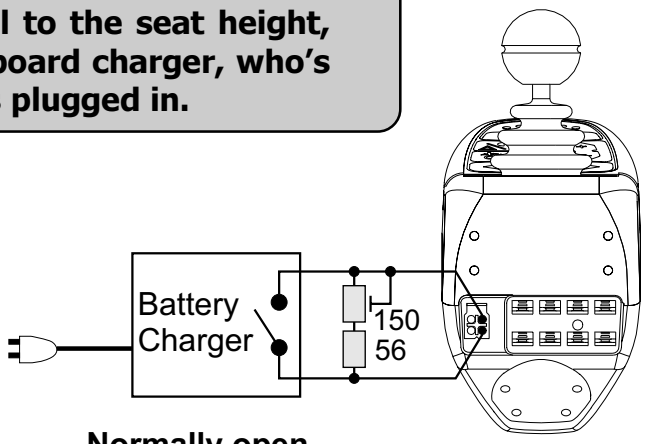
❹ Commando used with seat raise that reduces chair speed to 60% when seat is raised above height H1 and stops it when raised above height H2.

Wizard Option	Set to...
DCI Loop is Normally Open	No
DCI Slow Down Speed is Fixed	Yes
DCI Slows down to . .	60%
Swivel Enable	No



❺ Commando used with seat raise that reduces chair speed by an amount proportional to the seat height, and stops the chair when an on-board charger, who's inhibit output is normally open, is plugged in.

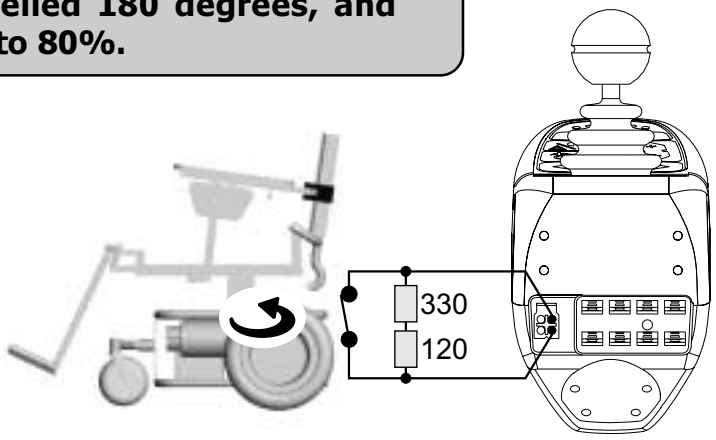
Wizard Option	Set to...
DCI Loop is Normally Open	Yes
DCI Slow Down Speed is Fixed	No
DCI Slows down to . .	0%
Swivel Enable	No



Normally open
Closes when charger is plugged in
Slows proportionally to seat height

❻ Commando that automatically reconfigures itself for FWD when the seat is swivelled 180 degrees, and automatically reduces speed to 80%.

Wizard Option	Set to...
DCI Loop is Normally Open	No
DCI Slow Down Speed is Fixed	Yes
DCI Slows down to . .	80%
Swivel Enable	Yes



Microswitch opens when chair swivelled to FWD position

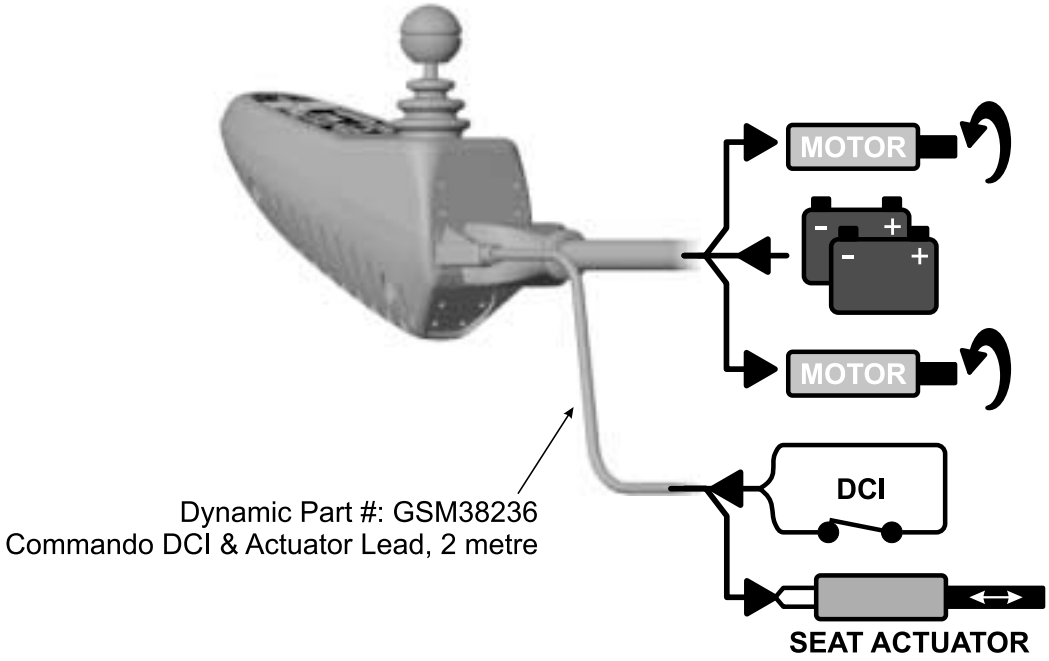
Note :

The switch configuration must ensure that driving is inhibited when the chair/seat is in an undefined position (e.g., partially swivelled).

This chapter describes Commando Plus, a special Commando variant with a built-in actuator drive to control a single seat function.

Introducing Commando Plus

Commando Plus is a special Commando variant with a built-in actuator drive to control a single seat function, such as seat raise, seat recline, etc. Physically, it has the same DCI connector as Commando S, but with two additional pins that provide the actuator output. The lead is available for purchase from Dynamic. There is also an additional button on the keypad to change between Drive and Seat Control modes.



Commando Plus Operation

Commando Plus operates in the same way as the standard Commando with the addition of a "Drive/Seat" Button.

"Drive/Seat" Button

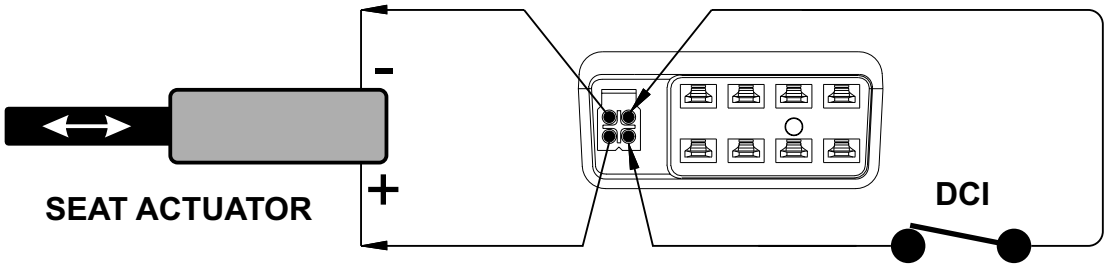
Pressing this button toggles Commando Plus between Drive and Seating modes.

When the display shows a number (between 1 and 5), moving the joystick will cause the chair to drive at the selected speed.

Press the "Drive/Seat" Button to put Commando Plus into Seating mode - the display changes to display the  symbol, to indicate Seating mode is selected.

Move the joystick forward and backward to operate the seat function. Press the "Drive/Seat" Button again to put Commando Plus back into Drive Mode when required.

Commando Plus Actuator and DCI Connections



The Drive Control input (DCI) of Commando Plus is identical to that of Commando S.

See **Chapter 6 - Drive Control Input (DCI)** for a description and installation details.

Programming Commando Plus with the Wizard

Operation of the Commando Plus seat output is defined by the following Wizard programmable parameters. For operation of the DCI Loop refer to **Chapter 6 - Programming Commando S with the Wizard.**

"Internal Actuator" Options

Soft Start Actuator

Provides a smooth increase in the speed of the actuator from stationary.

Soft Stop Actuator

Smoothly decreases actuator speed until stationary.

Actuator Current Limit

Sets the maximum current Commando Plus can supply to the actuator. Commando Plus automatically deactivates the actuator output if this current is exceeded. This is used both to protect the actuator and the Commando Plus seat output, as well as to provide an automatic cutoff when the actuator reaches the end of it's stroke.

This chapter describes Commando dx, the fully featured DX compatible Commando variant.

Commando dx specifics (including programming) are explained here, although information about specific DX Accessory Modules is contained within each module's dedicated installation manual.

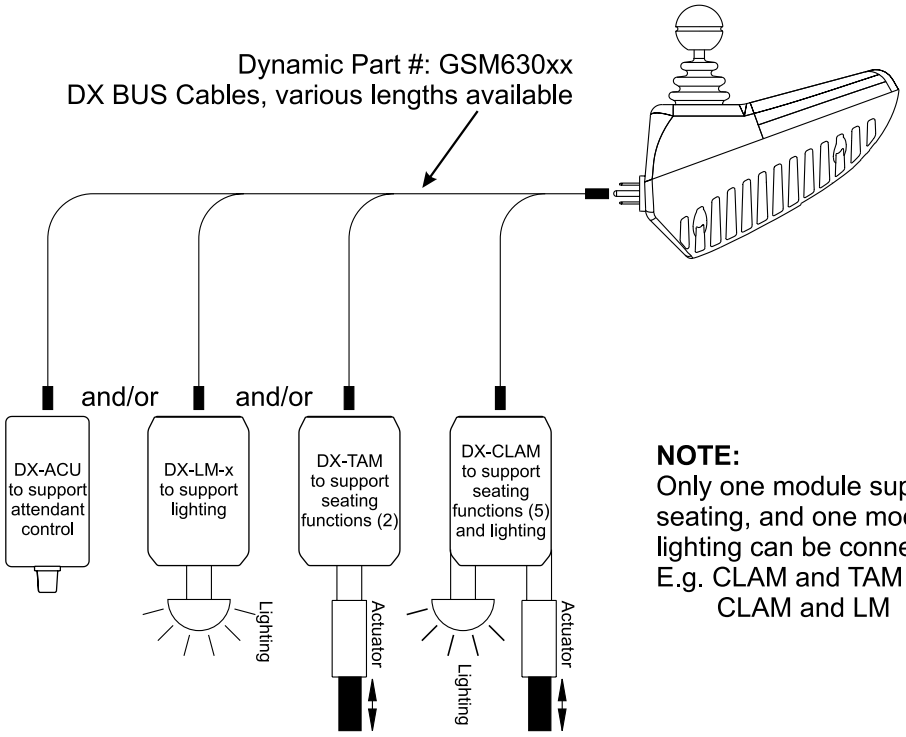
Introducing Commando dx

Commando dx differs from the standard Commando in that it can support a number of DX accessory modules. These provide support for non-drive functions typically used with low to mid range chairs.

Commando dx supports the following DX modules:

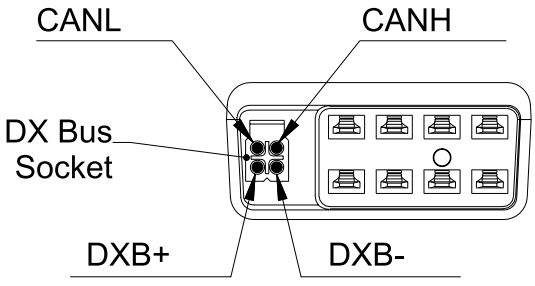
DX-TAM - to support 2 seat functions
DX-CLAM - to support 5 seat functions and/or non TUV compliant lighting
DX-LM-Z - to support non TUV compliant lighting
DX-LM-TUV - to support TUV compliant lighting
DX-ACU - to provide attendant control.

A number of these modules can be used simultaneously, with the condition that only one module supporting seating, and one module supporting lighting can be connected at any time.



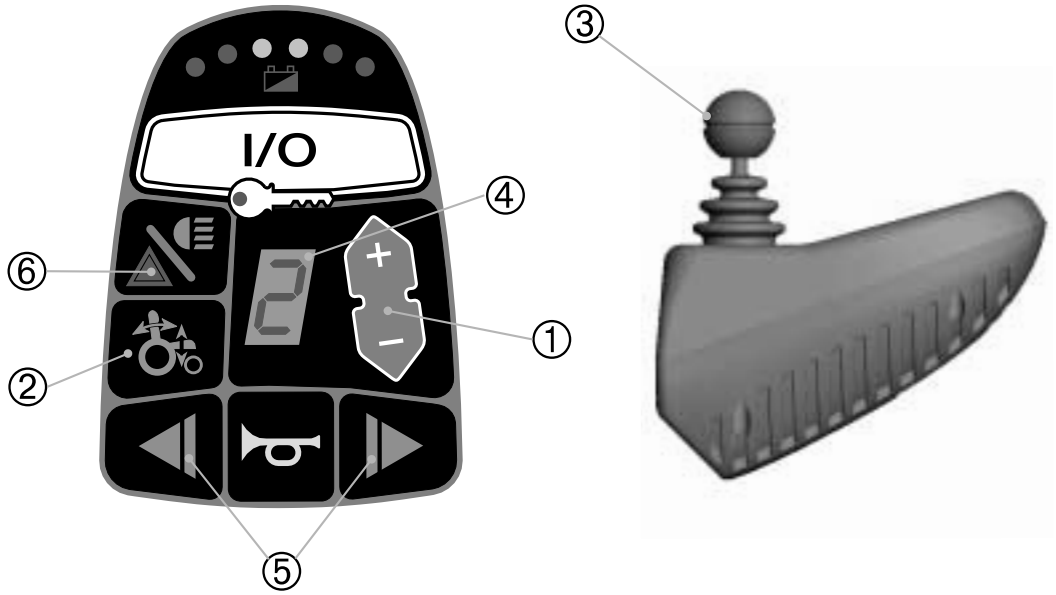
NOTE:
Only one module supporting seating, and one module supporting lighting can be connected at any time.
E.g. CLAM and TAM
CLAM and LM

Commando dx has a DX BUS socket situated next to the main connector at the rear of the unit , and a more sophisticated keypad to operate the extra supported devices. A standard DX BUS cable is used to connect DX Modules to Commando dx. These cables are available for purchase from Dynamic.



Commando dx Operation

Commando dx has additional buttons to support the control of seating and lights.



❶ "Speed Up/Down" Button

While in Drive Mode, every press at the top of the button increases the top speed of the chair. Every press at the bottom of the button decreases the top speed of the chair.

❷ "Drive/Seat" Button

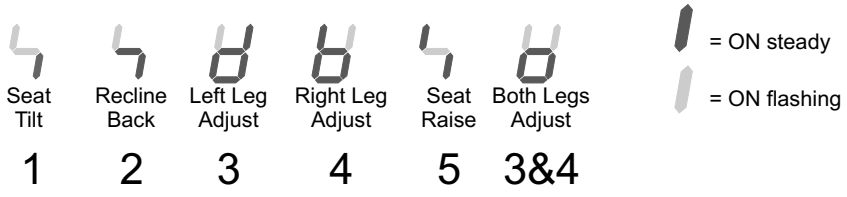
Pressing this button toggles Commando dx between Drive and Seating modes. In Drive Mode, the last selected speed is displayed i.e., 1 -5. In Seating Mode, the last selected seat function is displayed. See ❹ below for further details.

❸ Joystick

When in Drive Mode, the joystick controls speed and direction. When in Seating Mode, left and right joystick commands cycle through the seating functions programmed for that unit. Forward and reverse commands operate the selected seating function.

❹ Top Speed/Seat Function Display

When in Drive Mode, this displays the currently selected top speed i.e., 1-5. In Seating mode, this will display the last selected seat function. The different seat functions are indicated as follows.



❺ Left & Right Indicator Buttons

Pressing these buttons turns the Left or Right Indicator on and off. The associated LED will flash while the indicator is on.

❻ Side & Hazard Lights Button

A short press (less than 1 second) toggles the Side lights on and off. The associated LED will light while the side lights are on. A long press (greater than 1 second) toggles the Hazard lights On and Off. The left and right indicator LEDs will flash together while the Hazard lights are on.

Programming Commando dx with the Wizard

"CLAM/TAM Actuators" Options

This set of parameters define the number and attributes of seat functions to be used on the chair.

CLAM is Critical

Insists to Commando dx that a seating module (CLAM or TAM) must be present and operating correctly for Commando dx to function correctly. Set to **'Yes'** if the seating module's slow-stop input is required to ensure safety.

Actuator 1 Enable
|
Actuator 5 Enable

Set to **'Yes'** to enable each actuator so that it is available for selection and operation. While it is possible to omit one or more seat functions, it is not possible to change the order in which they are presented.

Actuator 1 Current Limit
|
Actuator 5 Current Limit

Sets the maximum current the CLAM/TAM can supply to each actuator. Commando dx automatically deactivates the actuator output if this current is exceeded.

This is used both to protect the actuator and the CLAM or TAM seat output, as well as to provide an automatic cutoff when the actuator reaches the end of its stroke.

CLAM/TAM Speed Limit

Sets the percentage of maximum wheelchair speed allowed when the CLAM/TAM Loop is open circuit. Refer to the CLAM/TAM manual on setting the hardware for slow/stop operation.

"Lighting" Options

This set of parameters define the lighting configuration to be used on the chair.

Lighting Module Enable

Tells Commando dx to talk to a lighting module (LM-Z or LM-TÜV). If set to **'Yes'**, a lighting module will be used to control the lights, and the CLAM lighting outputs will be disabled. Set to **'No'** if either lighting is not required, or a CLAM is used to control the lights.

Lighting Module is Critical (TÜV)

Set to **'Yes'** if the DX-LM-TÜV is used. Set to **'No'** in all other cases.

Side Lights Enable
Indicators Enable
Hazard Lights Enable

Set to **'Yes'** to enable each lighting function so that it will operate when the appropriate button is pressed.

Remember Hazard State (TÜV)

Set to **'Yes'** to store the hazard light status when Commando is turned off. The status will be restored when Commando is turned back on. This is appropriate if the system has a TÜV compliant lighting module.

"Attendant (ACU)" Options

An extra Response profile is available that collectively defines the drive characteristics of the chair when controlled by the Attendant Control Unit (ACU).

ACU Joystick Swap Left/Right

Set to **'Yes'** to reverse the left/right sense of the Attendant Control Unit (ACU) joystick. Useful if the ACU is mounted upside down in order to maintain normal joystick sense (e.g., for chin or tray applications).

9 Specifications

This chapter gives the electrical, mechanical, and environmental specifications of the Commando series of powerchair controllers.

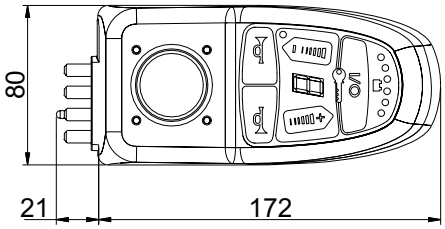
Electrical Specifications

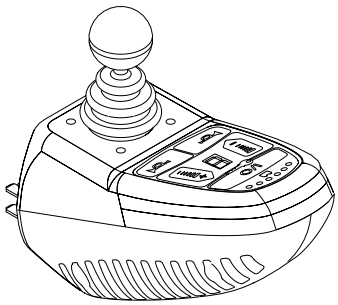
ELECTRICAL SPECIFICATIONS				
PARAMETER				
Compatible Battery Supply	24V supply, 2 x 12V in series, circuit breaker protected, gel cell type of recommended minimum capacity 20 Amp hours. Refer Section 2.			
Compatible Motor	24V DC permanent magnet type, typically rated 100-200 watts.			
Compatible Park Brake	Either 2 x 12V connected in series, or 2 x 24V connected in parallel. Refer chapter 2.			
	Minimum	**Nominal**	**Maximum**	**Units**
Commando Operating Voltage	18	24	32	Volts
Reverse Supply Voltage	-32			Volts
Current Rating				
- Peak (<25 seconds @ 20°C initial)	46	50	52	Amps
- 15 minute (@ 20°C initial)	16	18		Amps
- Continuous (@ 20°C ambient)	11	12		Amps
Maximum Motor Voltage	V_{batt} - 0.5		V_{batt}	Volts
Commando Park Brake Output				
- Voltage	V_{batt} - 0.9		V_{batt}	Volts
- Current	0.6	0.7		Amps
- Open cct Threshold Resistance	1.5		2.2	kOhms
Quiescent Current (idle)		120	150	mAmps
Actuator				
- Voltage	V_{batt} - 0.5		V_{batt}	Volts
- Current			12	Amps
Horn Frequency	900	1000	1100	Hz
Drive Control Input				
- Output Current	8		8.4	mAmps
- Working Input Resistance	0		560	Ohms
- Maximum Input Voltage Range	0		50	Volts
DX Bus				
- CANH, CANL Voltage Range	0		38	Volts
- Maximum Output Current (DXB+)			8	Amps
Battery Charger Maximum Current			16	Amps

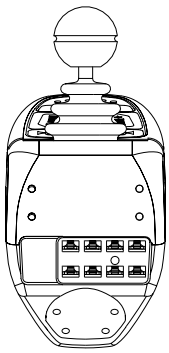
Mechanical Specifications

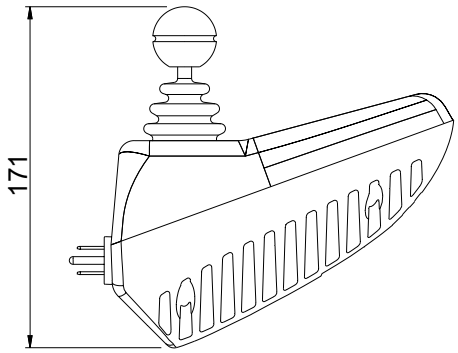
MECHANICAL SPECIFICATIONS	
PARAMETER	
Material	Die cast Aluminium
Finish	Powder coated "Rolling Thunder" (Charcoal/Silver)
Protection Rating	to IP54

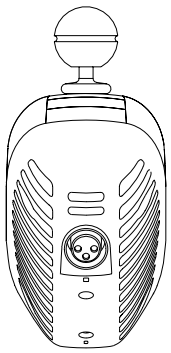
	Minimum	Nominal	Maximum	Units
Shipping Weight		1.1		Kg
Operating Temperature Range	-25		50	°C
Storage Temperature Range	-40		65	°C
Operating Humidity Range	0		90	%RH











Commando

Commando S

Commando Plus

Commando dx

This chapter contains Dynamic part numbers for Commando Accessories, warnings, maintenance information, contact details, and important Electromagnetic Compatibility information.

Commando Accessories

There are a number of Commando accessories available from Dynamic sales centres.

COMMANDO ACCESSORIES	
	DYNAMIC PART # / DESCRIPTION
Commando Handrest	GME38046
Commando Top Mounting Plate	GME38048 - Rectangular with 4 x mounting screws
Commando Bottom Mounting Plate	GME38047 - Round with 4 x mounting screws
Dynamic Beau Complete, Straight	GSP38066 - GCN38040 x1 - Dynamic Beau Cover, Straight - GCN0592 x1 - 9-pin Female Beau Socket - GCN0338 x2 - Beau Screw #6-32 x 17/64 - GCH0024 x1 - Cable Clamp 'O' Clip
Dynamic Beau Complete, Angled	GSP38064 - GCN38041 x1 - Dynamic Beau Cover, Angled -Top - GCN38052 x1 - Dynamic Beau Cover, Angled - Bottom - GSC0172 x2 - M3x16 Pan Pozi, Black - GCN0592 x1 - 9-pin Female Beau socket - GCN0338 x2 - Beau Screw #6-32 x 17/64
Commando DCI Lead, 2 metre	GSM38235
Commando DCI & Actuator Lead, 2 metre	GSM38236
DX BUS Cable	GSM630xx - Last two numbers signify cable length Example: GSM63005 = 0.5 metre GSM63020 = 2.0 metre

Product Disclaimer

Dynamic Controls Ltd. products built today allow our customers' vehicles to conform to national and international requirements. In particular to:

EN12184	Electrically Powered Wheelchairs and Scooters - Requirements and Test Methods
ISO7176 - 9	Climatic Tests for Electric Wheelchairs
ISO7176 - 14	Power and Control Systems for Electric Wheelchairs
ISO7176 - 21	Requirements and Test Methods for Electromagnetic Compatibility of Electric Powered Wheelchairs and Scooters

The performance of controllers fitted to wheelchairs and scooters is very dependant on the design of the wheelchair or scooter. Final compliance must be obtained by the vehicle manufacturer for their particular vehicle. No component certificate issued by Dynamic Controls Ltd. relieves a wheelchair or scooter manufacturer from compliance testing their particular vehicle.

If Dynamic Controls Ltd. controllers are fitted to vehicles or applications other than wheelchairs and scooters, testing to appropriate standards for the particular application must be completed as ISO7176 may be inappropriate.

Electromagnetic Compatibility (EMC)

Dynamic Controls Ltd. products have been tested on typical vehicles to confirm compliance with the appropriate EMC standards.

National and international directives require confirmation of compliance on particular vehicles. Since EMC is dependant on a particular installation, each variation must be tested. The guidelines in this section are written to assist with meeting EMC requirements.

Minimising Emissions

Motors :

Motor brushes generate electromagnetic emissions. It may be necessary to fit capacitors between the brush holders and motor case. Ensure the leads are kept as short as possible.
A suitable capacitor is 4n7, 250V Ceramic.

Wiring :

Keep wire lengths as short as practical for a tidy layout.
Minimise any wire loops, particularly loops of single wires as opposed to wire pairs.
Endeavour to run wires in pairs or bunches.
Where practical, tie cables to wheelchair frame.

Immunity to Radiated Fields

Follow the wiring recommendations for minimising emissions.

Immunity to ESD

Follow the wiring recommendations for minimising emissions.
Ensure all vehicle sub-frames are electrically connected.
Ensure the controller and speed setting potentiometers are electrically connected to the vehicle frame.
Do not leave connections unnecessarily exposed.

Maintenance

1. All vehicle components should be regularly checked for loose, damaged or corroded connectors, terminals, or cabling. All cables should be restrained to protect them from damage. Damaged components should be replaced.

2. All switchable functions on the Dynamic Electronics System should be regularly tested to ensure they function correctly.

3. All Dynamic Electronic Components should be kept free of dust, dirt and liquids. If necessary wipe with a cloth dampened with warm water or alcohol. **Do not** use solvents or abrasive cleaners.

4. Where any doubt exists, consult your nearest Service Centre or Agent.

5. There are no user-serviceable parts in any Dynamic Electronic Component - do not attempt to open any case, or undertake any repairs as warranty claims will be affected.

Warning:
If any Dynamic Electronic Component is damaged in any way, or if internal damage may have occurred (for example by being dropped), have it checked by qualified personnel before operating.

Safety and Misuse Warnings

Warnings to be included in the User Manual

The following warnings are applicable to both the installer and the user, and must be passed on to the end user before use of the product.

- Do not install, maintain or operate this equipment without reading, understanding and following the proper instructions and manuals, otherwise injury or damage may result.

- A warning must be conveyed to the operator that they have the responsibility to ensure that the vehicle is kept in a good safe operating condition, and ensure that components, such as cables, are protected from damage by securing them in optimum positions.

- Users and suppliers of Assistive Mobility products should give consideration to the possibility of a failure to operate, or an incorrect operation, by the product. Should an operator be left with limited or no mobility due to an equipment failure, they should still be able to summon assistance from where ever they may be.

- A warning must be conveyed to the operator that the controller could cause the chair to come to a sudden stop. In situations where this may affect the safety of the operator, this will require the fitting and wearing of a seat belt.

- Performance adjustments should only be made by professionals of the health care field or persons fully conversant with this process and the operators' capabilities. Incorrect settings could cause injury to the operator or bystanders, or damage to the vehicle or surrounding property.

- Incorrect or inappropriate programming can put the wheelchair into a dangerous state. Dynamic Controls accepts no responsibility or liability for accidents caused by incorrect programming. This Programming section and the Dynamic Wizard Installation Sheet / Online Help must be read and understood before attempting to program the controller.

- If a wheelchair is programmed with settings other than default, under some very rare fault conditions default settings could be automatically restored, thereby changing driving characteristics. This in turn could lead to a chair moving in a direction or speed that is not intended. Programmers should consider this risk when programming settings other than default.

- When the controller is replaced it will be loaded with default parameters. This may result in incorrect and dangerous programming for a particular wheelchair system if the wheelchair program installed in the Commando is not suitable for that wheelchair system.

- Do not attempt to drive or test the controller before the correct and suitable wheelchair program has been installed using the Wizard.

- The user should turn the system off while getting in and out of the wheelchair.

- Ensure the vehicle is turned off when not in use.

- Do not operate the vehicle if it behaves erratically, or shows abnormal response, heating, smoke or arcing. Turn the system off at once and consult your Service Agent.

- Do not operate the vehicle if the battery is nearly flat as a dangerous situation may result due to loss of power in an inopportune place.

- The controller should not be operated when the temperature is below -25°C or above 50°C.

- The wheelchair must not be driven when the manual park brake release is operated.

- The manual park brake release should not be operated on a slope.

- If the wheelchair drives without user input, press the On/Off switch to disable.

- No connector pins should be touched, as contamination or damage due to electrostatic discharge may result.

- Most electronic equipment is influenced by Radio Frequency Interference (RFI). Caution should be exercised with regard to the use of portable communications equipment in the area around such equipment. While Dynamic Controls Ltd. has made every effort to ensure that RFI does not cause problems, very strong signals could still cause a problem. If RFI causes erratic behaviour, turn the vehicle off immediately. Leave off while transmission is in progress. Turn your wheelchair or scooter off before using your cell phone or portable communications devices.

- In the event of a fault indicator flashing while driving (battery gauge and/or Status LED), the operator must ensure that the system is behaving normally. If not, the system must be turned off and a service agent contacted.

- Report any malfunctions immediately to your Service Agent.

Service and Configuration Warnings

The following warnings are applicable to the installation technician only.

- Ensure that the programmed wheelchair complies with all prevailing regulatory requirements for your country and application.

- The completed installation must be thoroughly checked, and all programmable options correctly adjusted for safe operation prior to use.

- After the vehicle has been configured, check to make sure the vehicle performs to the specifications entered in the programming procedure. If the vehicle does not perform to specifications, turn the vehicle off immediately and re-program. Repeat this procedure until the vehicle performs to specifications.

Warranty

All equipment supplied by Dynamic Controls Ltd is warranted by the company to be free from faulty materials or workmanship. If any defect is found within the warranty period, the company will repair the equipment, or at its discretion, replace the equipment without charge for materials and labour.

The Warranty is subject to the provisions that the equipment:

- Has been correctly installed.
- Has been used solely in accordance with this manual.
- Has been properly connected to a suitable power supply in accordance with this manual.
- Has not been subjected to misuse or accident, or been modified or repaired by any person other than someone authorised by Dynamic Controls Ltd.
- Has been used solely for the driving of electrically powered vehicles in accordance with the vehicle manufacturer's recommendations.

Sales and Service Information

New Zealand/Asia

Head Office

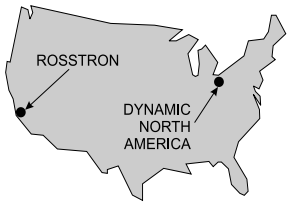
Dynamic Controls Limited
Print Place
Christchurch
New Zealand
Telephone: Int. +64 3 338 0016
Fax: Int. +64 3 339 1234
Web site: http://www.dynamicmobility.co.nz
Email: sales@dynamic-controls.co.nz

Europe

Sales and Service

Dynamic Europe Ltd.
Lisle Avenue
Kidderminster
DY11 7DL
United Kingdom
Telephone: Int. +44 1562 820 055
Fax: Int. +44 1562 742 720
Email: sales@dynamic.eu.com

North America



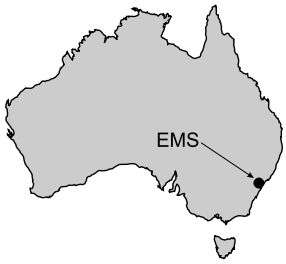
Sales and Service

Dynamic Controls, North America Office
Dynamic North America
31335 Industrial Parkway, Suite 2
North Olmsted, Ohio 44070
USA
Tel: Int. +1 440 979 0657
Fax: Int. +1 440 979 1028
Email: sales@dynamic-controls.com

Service Agent

Rosstron Inc.
1521 W. 259th St
Harbor City, CA 90710
USA
Telephone: Int. +1 310 539 6293
Fax: Int. +1 310 539 4078
Email: rosstron@earthlink.net

Australia



Service Agent

Electronic Mobile Service
46 Berripa Close
North Ryde, Sydney
NSW Australia 2113
Tel - 24 hour: Int. +61 2 9887 2824
Pager: Int. +61 2 9963 1778
Fax: Int. +61 2 9887 2114
Email: fredems@ozemail.com.au

Note:

The controller should be labelled with the manufacturer's service agent's telephone number.

Index

Index

Symbols

A

B

C

D

E

F

G

H

I

J

K

L

M

O

P

R

S

T

U

V

W