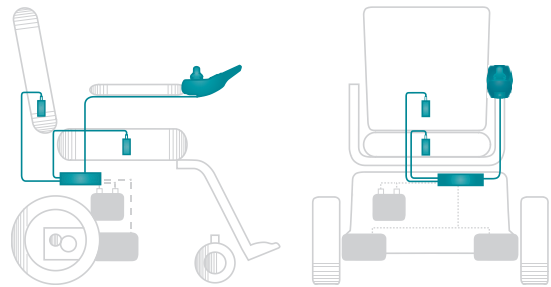




DX2-GYRO DX2-PMA90LG

 THE
ULTIMATE
POWERCHAIR
CONTROL
SOLUTION



About this Manual Addendum

This manual can help you understand and install the DYNAMIC DX2-PMA90LG Power Module. It describes the general principles, but it gives no guidelines for specific applications. If there is a specific requirement for your application, please contact Dynamic Controls or one of the sales and service agents to assist you.

The product is part of the DX System. This manual must be read together with the DX System Manual and all other relevant DX and DX2 component manuals.

In this manual, a few symbols will help you identify the purpose of the paragraph that follows:



Notes & Precautions:

Notes provide supporting information in order to install, configure, and use the product. Not following the instructions given in notes or precautions can lead to equipment failure.



Warnings:

Warnings provide important information that **must** be followed in order to install, configure, and use the product safely and efficiently. Not following the instructions given in a warning can potentially lead to equipment failure, damage to surrounding property, injury or death.

The term '**programming**' used in this manual refers to adjusting parameters and configuring options to suit an application. 'Programming' does not change or alter any software within the controller and is performed using a controlled programming tool available only to authorised personnel.

The term '**accessory**' used in this manual refers to equipment that is ancillary to the main functioning of the DX System. It does not refer to an accessory of the powerchair. The DX System is a component of the powerchair.

The DX System is not user serviceable. Specialised tools are necessary for the repair of any component.

Do not install, maintain or operate this equipment without reading, understanding and following this manual – including the Safety and Misuse Warnings – otherwise injury or damage may result. This manual contains integration, set-up, operating environment, test and maintenance information needed in order to ensure reliable and safe use of the product.

Due to continuous product improvement, DYNAMIC reserves the right to update this manual. This manual supersedes all previous issues, which must no longer be used.

DYNAMIC reserves the right to change the product without notification.

Any attempt to gain access to or in any way abuse the electronic components and associated assemblies that make up the powerchair system renders the manufacturer's warranty void and the manufacturer free from liability.

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1 Introduction to the DX2-PMA90LG

The DX2-PMA90LG is a DX2-PMA Power Module variant that can connect to a DX2-GYRO Module.

The Gyro module can help to keep the chair straight on challenging terrain by measuring the physical movement of the chair. If the chair does not go in the intended direction, the Gyro power module makes small corrections until the chair does go in the intended direction.



Warning:

Gyro Control cannot be used inside moving vehicles such as buses or trains. If a chair with Gyro Control is used on a bus or a train, make sure that either the DX System is powered off or that a non-Gyro stabilised Drive Profile is selected before the vehicle starts moving.

The Gyro module is not operational as long as the joystick is in the neutral position.



Note:

The Gyro control is designed to operate correctly during tyre slip. However, if extreme tyre slip occurs, the Gyro may not be able to correct the direction of the chair anymore. In this case, a Gyro fault may occur and the chair may come to a sudden stop. To reset the Gyro fault, turn the power off and on.



Note:

The DX2-PMA90LG is a variant of the DX2-PMA Power Module family.

This document is an addendum to the DX2-PMA power Module installation manual. Read the DX2-PMA Power Module installation manual before reading this addendum.

All warnings and configurations presented in the DX2-PMA installation manual are also applicable to the DX2-PMA90LG, except where specifically stated differently in this addendum.

2 Specifications

2.1 Electrical Specifications

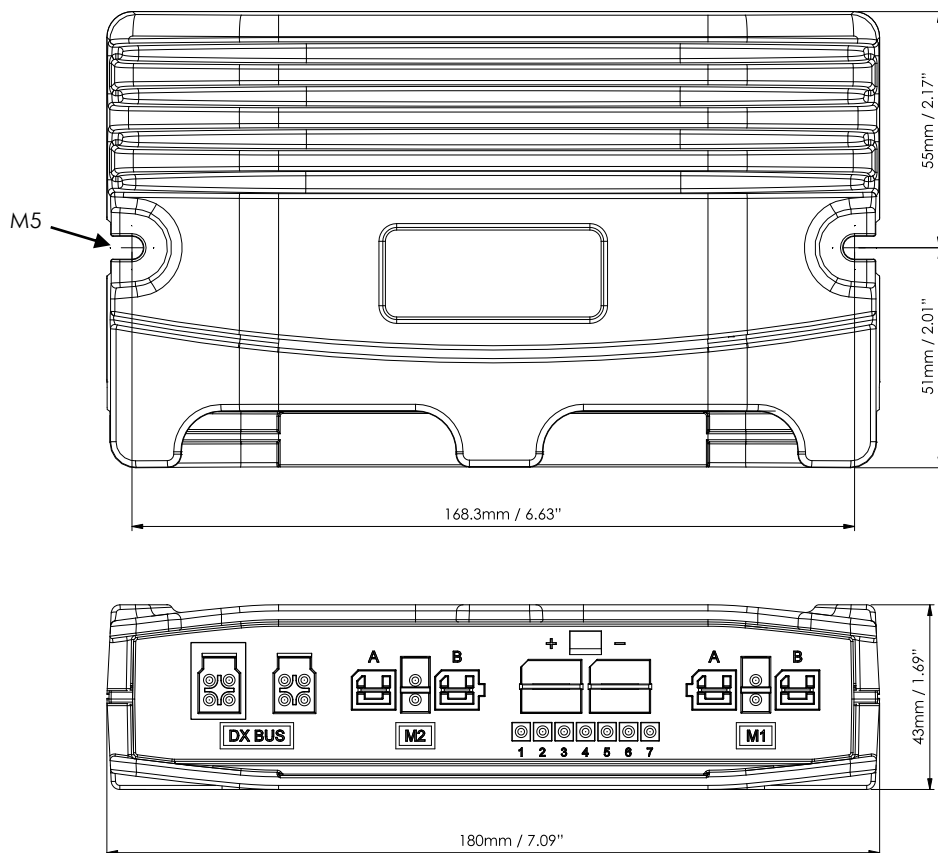
Parameter	Min	Nom	Max	Units
Battery Voltage	18	24	32	V
Battery Saver				
High threshold		21		
Low threshold		18		
Quiescent Power (relay de-energised)		2	5	W
Standby Power		15	20	mW
Thermal limit		70		°C
DX BUS				
CANH and CANL tolerated Voltage	0		38	V
DX BUS supply current @ 40°C	12	14.9		A
Motor Outputs				
Motor Type		24V		DC
Maximum output voltage	23.5			V
Continuous motor current (@ 20°C ambient temperature)		30		A
Peak motor current *15 min @ 20°C initial case temperature **30 sec @ 20°C initial case temperature ***0.1 - 1.5 sec (programmable boost time)	35*	90**	120***	A
PWM frequency	16	19.6	20	kHz
Stall timer (programmable)	2	15	60	s
Park brake outputs				
Output voltage	$V_{bat} - 1.1$		V_{bat}	V
Output current	0.6	1		A
Configuration: single/dual				
Lighting outputs				
Supply Voltage	18	24	32	V
Output power (per output)			50	W
Output current (per output)			2	A
On Board Charger supply				
Voltage		24		V
Current			15	A
Inhibit	via DCI input (see 3.2.6.3 of DX2-PMA installation manual)			



Warning:

Make sure that the total power consumption of all modules in the DX System does not exceed the rated DX BUS current at any time.

2.2 Mechanical Specifications



All dimensions ± 0.5 mm.

Parameter	Min	Nom	Max	Units
Installed depth including connectors		140 5.51		mm inch
Mounting torque (M5 bolts)	2		4.5	Nm
Weight		1040		g
Operating Temperature Range	-25 (-13)		50 (122)	$^{\circ}$ C ($^{\circ}$ F)
Storage Temperature Range	-40 (-40)		65 (149)	$^{\circ}$ C ($^{\circ}$ F)
Operating Humidity Range	0		90	%RH
Battery Connector Cycles			10	cycles
Motor Connector Cycles			100	cycles
Material	pressure die cast aluminium alloy			
Protection rating	IPx4			



Warning:

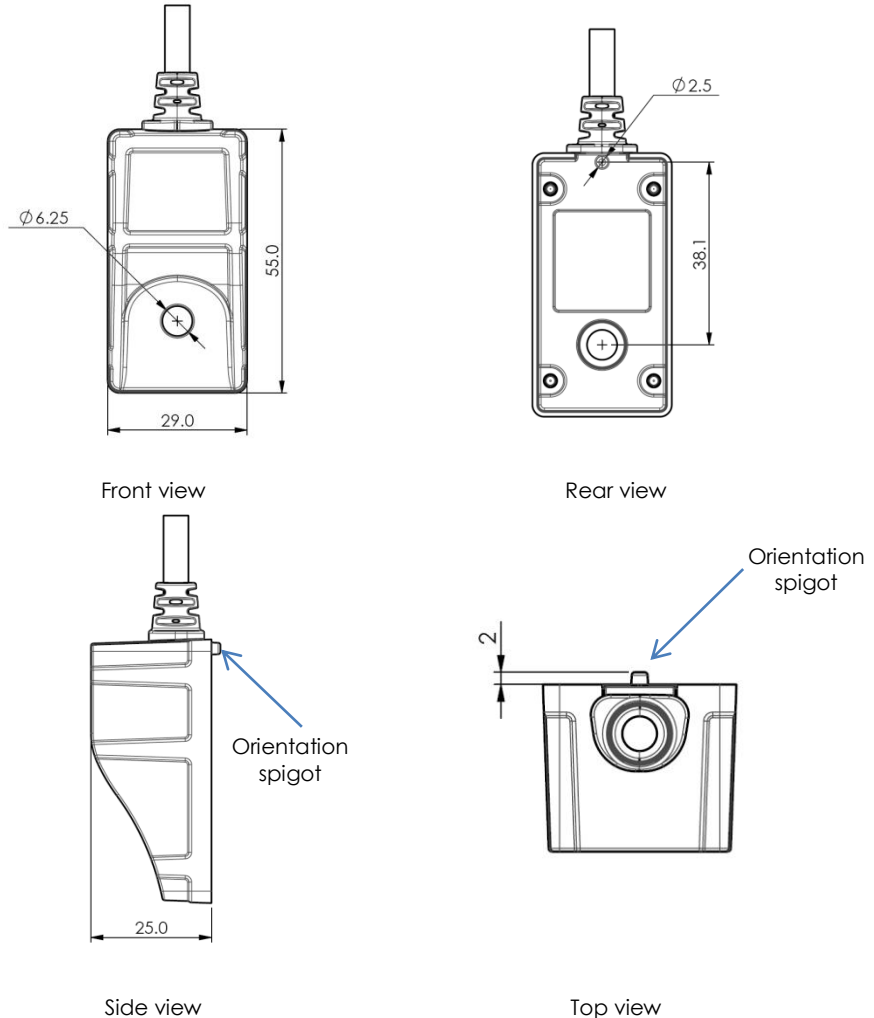
To achieve the specified IPx4 rating, do not mount the DX2 Power Module with the connectors facing upward. In addition, add a water shielding cover if necessary to protect the Power Module from water entry as appropriate to the environment that the chair will be used in.

2.3 The DX2-GYRO Module





Ensure that the DX2-Gyro module is mounted in a true vertical axis (exactly 90 degrees to the horizontal ground level). Two mounting holes are required: one for the M6 mounting bolt, the second for the orientation spigot.

The orientation spigot, located towards the top of the module (see diagrams below), ensures that the Gyro module cannot rotate out of position once it has been secured to the wheelchair frame.



The cable length is 600 mm. For connector information see section 3.2.

	<p>Note:</p> <p>Mount the DX2-GYRO module so that the cable is located on the top side of the unit, with the cable rising vertically upwards. The module will not function in any other position.</p>
	<p>Warning:</p> <p>Mount the Gyro module in a position where the user cannot touch it.</p>

3 Installation

3.1 Connect to the DX System

In contrast to all other DX2-PMA variants, the DX2-PMA90LG module only has **one** DX BUS socket. The socket that the other variants use as a second DX BUS connection is used for the DX2-GYRO module.



To connect multiple DX Modules to the Power Module, either use a DX BUS Y-cable (GCB65231) or a straight cable to a 4-way DX BUS socket (DX-SKT-X4).



Precautions:

Connect high current modules such as an Actuator Module as close as possible to the Power Module (see DSM section 3.2).

3.2 Connect to the DX2-GYRO module

The leftmost socket on the DX2-PMA90LG connects to the DX2-GYRO module.



To avoid confusion with the DX BUS socket, the GYRO socket is clearly marked with a white rectangle. The DX2-GYRO module has a cable with a white connector that can help to recognise the correct connection: the white connector goes into the socket with the white rectangle.



Precaution:

The DX2-GYRO connector is physically identical to the DX BUS connector. If both cables are swapped, no damage will occur to either the Gyro module or the power module. However, the DX System will not start up if the connectors are swapped. It is therefore important to make sure that the connectors are inserted in the correct socket.

3.3 Setup procedure for the Gyro

3.3.1 Preparation

The Gyro module gives the most comfortable results on a chair that has already been set up to provide optimal performance and steering stability without the Gyro control. If the chair has not been set up for steering stability, the Gyro will still correct the direction of the chair and keep the chair straight, but it has to make bigger corrections which results in jerky and uncomfortable driving. Please set up the following parameters first, before activating the Gyro control.

- **Load Compensation**
- **Acceleration**
- **Speed @ Maximum**
- **Deceleration**

See the DX System Manual on how to set up these parameters with Wizard.



Note:

Ensure your Wizard is updated to the latest available version (version 5.6.6 or later), which contains the Gyro Tuning Plug-in, and three new system builder templates for Gyro. You can create a new Gyro programme using the templates, or you can convert an existing DX2-PMA90L programme into a DX2-PMALG version. Under "Tools", click on "Change Module Version" and select the Power Module and change this to the DX2-PMA90LG Version. Repeat this for "Change Module Type". You need to change both Version and Type for the conversion to work properly.

Parameters that can help to keep the chair straight on Front Wheel Drive chairs:

- **Non-Linear Turn** decreases the sensitivity of the joystick for small sideways joystick deflections. This makes it easier to keep the chair straight when unintended small joystick movements occur.
- A reduced **Turning @ Full Speed** decreases the sideways sensitivity of the joystick when the joystick is fully deflected forward. This makes it easier to keep the chair straight at full speed.

After setting up the above parameters, check that the chair is already reasonably driveable without the Gyro control. If this is the case, proceed to set up the Gyro.

3.3.2 Gyro set-up procedure

The DX2 Gyro works by combining input demand from a joystick or switch source with digital gyroscopic information about the direction that the wheelchair is tracking. When the system detects that the wheelchair is deviating from the intended course of direction it automatically corrects the path of travel. The system has four key parameters that must be specifically tuned to each wheelchair design configuration:

- The **Angular Speed Scalar** calibrates the Gyro to a particular wheelchair configuration. This is the most critical value and must be set up before any other Gyro values are adjusted. A calibration tool is included for this in the latest Wizard PC tool.

- **Proportional (Kp) gain** affects the rate at which the Gyro will respond to fast changes in wheelchair direction to provide angular velocity stability.
- **Integral (Ki) gain** processes Gyro information over a longer period of time and this value influences the straight tracking of a wheelchair to provide directional stability.
- **Filtered Response (Kfr) gain** is an optional setting that dampens the sensitivity of joystick signals relative to the Gyro response. Tuning this parameter can provide benefits for users with tremor or inaccurate movements, as well as enabling the integral Ki gain to be set to a higher value to provide better straight line drive performance.

The procedure is as follows:

1. Assign a Gyro Profile to a Drive profile using **Gyro Profile Select**.
2. Check that:
 - **Gyro Kp Gain** is set to zero,
 - **Gyro Ki Gain** is set to zero,
 - **Gyro Kfr Gain** is set to 255.
3. Drive the chair to a flat surface where the chair can turn freely without wheel slip.
4. Set **Gyro Angular Speed Scalar** to the correct value using the **Gyro Tuning Plug-in** (see section 3.4 next).
5. Select the drive profile that has the Gyro module enabled.
6. Slowly drive down a ramp and stop. Increase the value of **Gyro Kp Gain** until the chair starts to vibrate during stopping on the ramp. The vibration means that the parameter is set too high. Decrease the value until the vibrating stops.
7. Drive in a straight line at full speed. Increase **Gyro Ki Gain** until the chair starts to make slow jerks or starts to swerve. This makes the chair feel uncomfortable and shaky even though the direction is kept constant. Decrease **Gyro Ki Gain** until the chair feels comfortable again. Usually **Gyro Ki Gain** has a much lower value than **Gyro Kp Gain**. There are exceptions, therefore always test to make sure that the chair drives comfortably.
8. If the chair reacts too responsively to unintended small joystick movements, decrease **Gyro Kfr Gain**. Please note that decreasing this parameter can introduce steering delays.
9. Set **Gyro Fault Speed Limit** to a value that keeps the chair safe when the Gyro module loses connection or is faulty.



Warning:

The Gyro cannot be used on moving vehicles, such as buses or trains. For this reason, there should always be at least one drive profile that does not have the Gyro control enabled.

To achieve this, do not activate the Gyro on Drive Profile 1. Program this profile so that the chair is always safe and stable to drive without Gyro assistance, for example by limiting the maximum speed.

3.4 Gyro Tuning Plug-in

The Wizard '**Gyro Tuning Plug-in**' provides a convenient tool for OEMs to determine the best value for the **Gyro Angular Speed Scalar** parameter (4.2.2.5).

The **Gyro Angular Speed Scalar** parameter determines the way that the signals coming from the Gyro module are interpreted, and as such affects all other Gyro operational parameters.

Set up this parameter first, before tuning any of the other Gyro parameters.

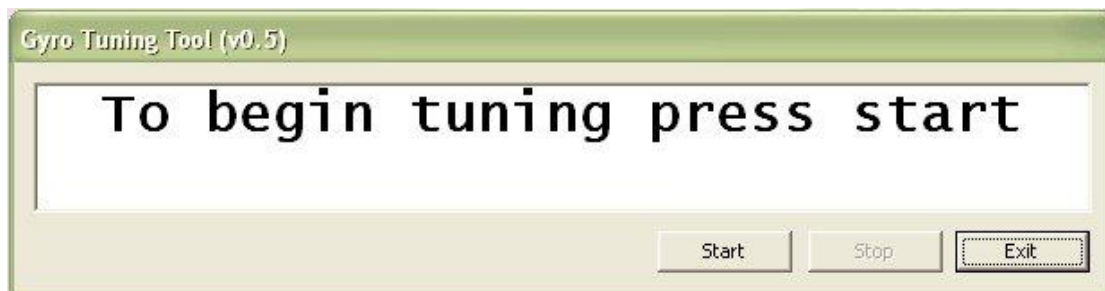


Note:

1) Before you start the plug-in, drive the chair to a place where it can turn freely. Once the plug-in is started, the chair will not drive forward or reverse, it will only drive in circles.

2) The plug-in may require the COM port for Wizard to be set to a COM port number of 9 or less. To change the COM port in Wizard, go to **Tools** → **Options** and then change the COM port number with the **Communications Port** drop-down box.

To start the plug-in, click on **Tools** → **Plug-ins** → **Gyro Tuning Tool**



- Click **Start**. [Note: You may need to increase the Max Turning Speed of the chair to get it to spin fast enough for a good calibration reading.]
- Follow the instructions: spin in one direction until you see "Tuning Successfully Completed".
- Click **Start** again.
- Spin in the other direction until you see "Tuning Successfully Completed".
- Use the average of the two values as the value for **Gyro Angular Speed Scalar**.



Warning:

It is critical that the wheels do not slip at all during the use of the plug-in. If the wheels slip during the turning procedure, the measured value for **Gyro Angular Speed Scalar** will be wrong. If this value is used, the Gyro module will not operate correctly, which can make the wheelchair unsafe.

4 Programming

	<p>Warning:</p> <p>Read the programming chapter of the DX2-PMA installation manual, and the DX System Manual programming chapter (DSM chapter 7) including all its warnings and notes before reading this chapter.</p> <p>The programming chapter of this manual only describes Gyro specific programming.</p>
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4.1 Parameter List

This manual addendum only describes the Gyro parameters.
For all other parameters, see the DX2-PMA installation manual.



Key: ✓ Editable at this level (see section 7.1.2.1 of the DX System manual)
 👁 Viewable at this level

Parameter	Possible Values	Default	HHP	Lite	Std	Adv
Gyro Configuration (4.2.1)						
Gyro Profile Select	Gyro Off Profile G1 Profile G2 Profile G3 Profile G4	Gyro Off	-	👁	👁	✓
Gyro Profiles (4.2.2)						
Gyro Profile Name	any name		-	👁	👁	✓
Gyro Kp Gain	0 - 255	0	-	👁	👁	✓
Gyro Ki Gain	0 - 255	0	-	👁	👁	✓
Gyro Kfr Gain	0 - 255	255	-	👁	👁	✓
Gyro Angular Speed Scalar	10 - 255	35	-	👁	👁	✓
Gyro Fault Speed Limit	0 - 100 %	10 %	-	👁	👁	✓

4.2 Parameter descriptions

4.2.1 Gyro Configuration

4.2.1.1 Gyro Profile Select

Parameter	Possible Values	Default	HHP	Lite	Std	Adv
Gyro Profile Select	Gyro Off Profile G1 Profile G2 Profile G3 Profile G4	Gyro Off	-			✓

This parameter is only used in the DX2-PMA90LG Power Module in combination with a DX2-GYRO stabilisation module. Gyro stabilisation will only occur when a DX2-GYRO module is connected to the Power Module.

The Power Module has 4 Gyro Profiles (G1 - G4) that can be used to adapt the Gyro behaviour to different circumstances, for example smooth or rough terrain.

The **Gyro Profile Select** parameter assigns a specific Gyro Profile to a Drive Profile, to provide Gyro stabilised drive performance in that Drive Profile. Each Drive Profile can have its own Gyro Profile.

To disable Gyro use in a Drive Profile (for example, a Drive Profile for use on buses or trains), set **Gyro Profile Select** for that Drive Profile to '**Gyro Off**'. In this case the standard drive parameters are used and no Gyro stabilisation occurs.



Notes:

1. It is not possible to switch between a non-Gyro Drive Profile and a Gyro Drive Profile while driving. If a switch is made during driving, the chair will stop and an OONAPU condition will occur. The joystick must be released to the centre before the chair will drive again.
2. If the Gyro module is not connected and a Gyro-stabilised Drive Profile is selected, the Gyro Profile limits the maximum speed of the chair to the value of the **Gyro Fault Speed Limit** parameter (4.2.2.6). This makes sure that the chair remains stable in the absence of Gyro stabilisation.



Warning:



Gyro Control cannot be used inside moving vehicles such as buses or trains. If a chair with Gyro Control is used on a bus or a train, make sure that either the DX System is turned off or that a non-Gyro stabilised drive profile is selected, before the vehicle starts moving. To achieve this, the user must be able to select a Drive Profile where the Gyro Profile is set to 'Gyro Off'.
The Gyro module is not operational as long as the joystick is in the neutral position.

4.2.2 Gyro Profiles

The Power Module has 4 Gyro Profiles that can be used to adapt the Gyro behaviour to different circumstances, for example smooth or rough terrain.

Each of the parameters below can be set for each Gyro Profile separately.



4.2.2.1 Gyro Profile Name

Parameter	Possible Values	Default	HHP	Lite	Std	Adv
Gyro Profile Name	any name		-			✓

Gyro Profile Name offers installers/OEMs the possibility to give a name to a Gyro Profile. For example, a name that identifies specific chair models or drive and usage situations.

The name field is 8 characters long.

4.2.2.2 Gyro Kp Gain (Proportional Gain)

Parameter	Possible Values	Default	HHP	Lite	Std	Adv
Gyro Kp Gain	0 - 255	0	-			✓

Gyro Kp Gain determines how much the Gyro reacts to fast changes in direction.

When this parameter is set correctly, the wheelchair will feel responsive, and turn largely as directed by the joystick with minimal tyre slip.


When this parameter is set too low, the Gyro effect will be less and it will be difficult to maintain a straight line course at any significant speed, additionally a user may experience gross tyre slip and rapid rotational acceleration when attempting to exit a turn.

When this parameter is set too high, the chair feels harsh and vibrates, especially when accelerating/decelerating or descending a hill.



Warning:
Excessively large values of **Gyro Kp Gain** can be dangerous. Values of Kp in excess of that required to meet a specified performance objective should be avoided.

4.2.2.3 Gyro Ki Gain (Integral Gain)


Parameter	Possible Values	Default	HHP	Lite	Std	Adv
Gyro Ki Gain	0 - 255	0	-			✓

Gyro Ki Gain determines how much the Gyro reacts to slow changes in direction.

When this parameter is set correctly, the wheelchair will drive in a straight line over significant distances and it will not veer when it drives on sloping terrain.



When this parameter is set too low, the Gyro effect will be less and the benefits described above are reduced.

When this parameter is set too high, the chair may start to swerve slightly from left to right when driving in a straight line, and when turning, the chair may keep on turning a bit more after the user already has stopped turning.



Warning:
Excessively large values of **Gyro Ki Gain** can be dangerous. Values of Ki in excess of that required to meet a specified performance objective should be avoided.

4.2.2.4 Gyro Kfr Gain (Filtered Response Gain)

Parameter	Possible Values	Default	HHP	Lite	Std	Adv
Gyro Kfr Gain	0 - 255	255	-			✓

The Power Module compares the actual movement of the chair with the joystick input (the intended direction). If the user has a tremor, the joystick input does not always accurately represent the intended direction of the chair.

To compensate for this, the joystick input is filtered before it is compared with the actual movement of the chair. **Gyro Kfr Gain** determines how much the joystick input is filtered.

- 0** - Maximum filtering is applied
- 255** - The joystick input is not filtered at all

For normal use, no filtering is needed - set this parameter between 200 -255. Set this parameter to lower values if the Gyro module overcompensates due to sudden unintended joystick movements.


If this parameter is set too low, the chair response may feel delayed.

4.2.2.5 Gyro Angular Speed Scalar

Parameter	Possible Values	Default	HHP	Lite	Std	Adv
Gyro Angular Speed Scalar	10 - 255	35	-			✓

Gyro Angular Speed Scalar calibrates the Gyro Control for the width of the wheelchair, and the type of motors and gearbox.

When this parameter is set correctly, the wheelchair will turn at the same speed with and without Gyro control enabled.



Note:

***Gyro Angular Speed Scalar** affects the operation of **Gyro Kp Gain (Proportional Gain)** and **Gyro Ki Gain (Integral Gain)**. For this reason, set **Gyro Angular Speed Scalar** to the correct value before tuning any of these parameters.*


The Wizard has a plug-in that can determine the appropriate value for this parameter automatically. See **Gyro Tuning Plug-in (3.4)** for details.

4.2.2.6 Gyro Fault Speed Limit

Parameter	Possible Values	Default	HHP	Lite	Std	Adv
Gyro Fault Speed Limit	0 - 100 %	10 %	-			✓

If a Drive Profile is selected that is configured for Gyro operation, and the DX2-GYRO module is not connected or gives faulty signals, the maximum speed of the chair is limited to **Gyro Fault Speed Limit**.

The speed limit makes sure that the chair remains stable in the absence of Gyro stabilisation.



Warning:

Do not set this parameter too high, otherwise the stability of the chair may be compromised during a Gyro fault.

5 Troubleshooting

5.1 OONAPU conditions

While driving, it is not possible to

- switch between a non-Gyro Drive Profile and a Gyro Drive Profile, or
- switch between Drive Profiles that have Different Gyro Profiles selected in their **Gyro Profile Select** field (4.2.1.1), for example G1 and G2.

If a switch is made during driving, the chair will stop and an OONAPU condition will occur. The joystick must be released to the centre before the chair will drive again.

Out Of Neutral At Power Up is a feature that prevents sudden and unexpected powerchair movements if the joystick is out of the centre when the controller is turned on or an inhibit condition is removed. For information on how an OONAPU condition is shown, see the installation manual of the Master Remote used. For more information on OONAPU in general, see section 9.3 of the DX System Manual.

5.2 Gyro Faults

If a Drive Profile is selected that is configured for Gyro operation, and the DX2-GYRO module is not connected or gives faulty signals,

- Gyro operation is disabled, and
- The maximum speed of the chair is limited to the **Gyro Fault Speed Limit** (4.2.2.6) that belongs to the currently selected Gyro Profile, and
- The remote shows Flash Code 2 to indicate that there is a Gyro fault.

If the chair is driving at the time that the fault occurs, the chair decelerates to the speed that is set with the **Gyro Fault Speed Limit** parameter.

If a Gyro fault occurs in a Drive Profile that is not configured for Gyro operation, the chair will continue to drive normally and no fault code will be shown. For this reason it is preferable to switch to a non-Gyro drive profile if a Gyro fault is present, because the non-Gyro drive profile will drive normally and will not limit the speed to **Gyro Fault Speed Limit**. This will probably perform better than continuing to drive with a Gyro-enabled Drive Profile.

Gyro faults are reset with a power cycle only.



Warning:

Chairs that are tuned to operate with a Gyro may become unstable when the Gyro control system is not in operation. Typically the Gyro system allows much faster speeds than in non-Gyro operation.

*To make sure that the chair does not become unstable without the assistance of the Gyro control system, set the **Gyro Fault Speed Limit** parameter to a value that prevents the chair from operating at speeds that can make the chair unstable.*

6 Appendices

The DX2-PMA90LG is a variant of the DX2-PMA family. Please see the appendices of the DX2-PMA installation manual for all DX2-PMA information, which also applies to the DX2-PMA90LG.

In the appendices below, only DX2-PMA90LG-specific information is shown.

6.1 *Intended Use and Regulatory Statement*

Intended Use

The DX2-PMA90LG variant of the DX2 Power Module family is intended to allow the DX2-Gyro module interact with the DX2 System, to improve directional control of wheelchairs - particularly front wheel drive chairs - under both normal driving and adverse traction conditions.

For a description of the DX System and the corresponding device classification, please refer to the DX2-PMA installation manual.

6.2 *Safety and Misuse Warnings*

The DX2 Power Module is part of the DX System and therefore all safety and misuse warnings that appear in the DX System Manual apply to the DX2 Power Module as well. See DSM section 10.4.

Additional warnings to be included in the User Manual

The following warnings must be passed on to the operator of the vehicle before use of the product.

- Gyro Control cannot be used inside moving vehicles such as buses or trains. If you use a chair with Gyro Control on a bus or a train, make sure that either the chair is turned off or that a non-Gyro stabilised drive profile is selected, before the vehicle starts moving.

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