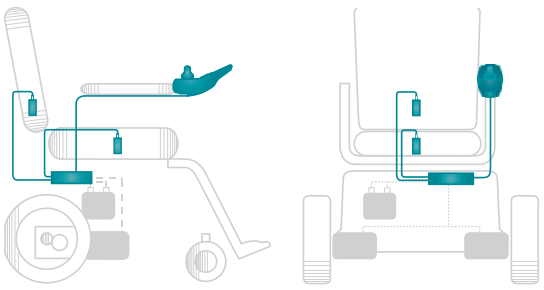
basic actuator module

THE ULTIMATE POWERCHAIR CONTROL SOLUTION



dynamic™

DX2-ACT2/ACT4 **INSTALLATION MANUAL**

About this Manual

This manual can help you understand and install the DYNAMIC DX2 Basic Actuator 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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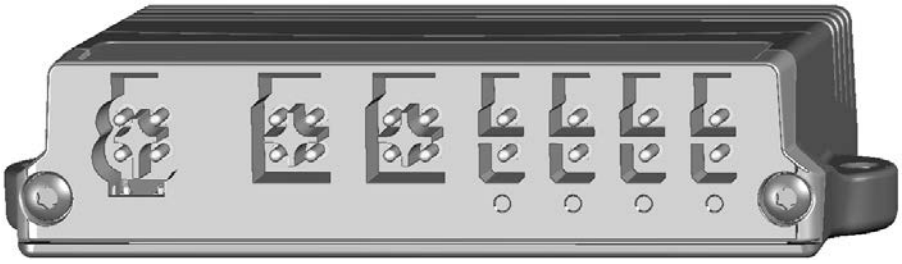
Contents

1 Introduction to the DX2-ACT Module

The DX2-ACT is the frontrunner of a new generation DX Actuator Modules that sets a new standard for DYNAMIC and the powerchair industry.



The DX2-ACT is backwards compatible with existing DX Systems. Features include:

- 2-actuator and 4-actuator modules available. These varieties provide a cost effective scalability to the application requirements
- Up to 4 modules with a total of 12 actuators can be used in a DX System
- Separate actuator connectors with individual status LEDs for easy installation and diagnostics
- All actuator power provided through the DX BUS – no need for a separate battery connection
- Actuator auto-detect - checks which actuator channels are physically connected at power up and displays the appropriate pre-configured functions in the user menu
- Easy identifying and swapping of modules with external module ID connector
- Continuous proportional control of actuator outputs: the user decides how fast or slow an actuator moves by deflecting the joystick further or less
- Simultaneous control of multiple actuators in the same or opposite directions
- Programmable speed control for forward and reverse direction separately
- Individual current control of Actuator Channels
- Two inputs separately programmable as
  - o analogue speed pot or speed limit
  - o 6-stage switch input for Local Limit and Global Inhibit Functions

Notes:

1. *The DX2-ACT is part of the DX System. Read the DX System manual before reading this manual. When this manual refers to sections in the DX System manual, it does so in the format 'see **DSM** section ...'*
2. *It is not possible to use the DX2-ACT together with a DX-CLAM or a DX-TAM in one DX System.*

Safety and protection features

- Thermal rollback monitoring
- Autonomous watchdog timer
- Power supply voltages, actuator motor voltage, and actuator motor current monitored by software
- Reverse battery protection circuitry on the DX BUS power supply.
- Hardware overload detection provides a rapid shut-down in the event of a sudden load short circuit
- A PCB track fuse (> 30A) on the DX BUS power supply signals DXB+ and DXB- to current limit the actuator outputs in the event of a short circuit due to component failure
- The DX BUS connections are able to withstand short-circuiting when connected to a DX/DX2 Power Module, because these Power Modules contain PTC fuses on the power supply
- The software measures CANH and CANL voltage levels for fault testing of the CAN Bus and recognition of a CAN Kill signal
- Software disables the Actuator operation as a response to a CAN Kill signal

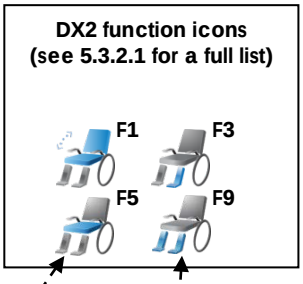
2 DX2-ACT Concept

With the DX-CLAM the DX Master Remote selects and operates actuator channels directly. The DX2 Actuator Modules have a more flexible approach.

With DX2, the Master Remote selects and operates a **function** instead of a channel. Each DX2 Actuator Module has several Actuator Profiles (5.3.2) that can respond to these functions. Each actuator profile can operate up to four actuator channels simultaneously.

Function		Channel assignment			
#	Action	Ch1	Ch2	Ch3	Ch4
1	Seat tilt				✓
3	Left leg rest	✓			
4	Right leg rest		✓		
5	Seat Raise			✓	
6	Tilt + leg rests	✓	✓		✓
9	Both leg rests	✓	✓		

Example actuator function list



Actuator Profiles						
	Profile A	Profile B	Profile C	Profile D	Profile E	Profile F
Input Function Number	1	3	4	5	6	9
Operating Mode	Switched	Switched	Switched	Switched	Switched	Switched
Output Channel 1 Select	Not Used	Normal	Not Used	Not Used	Normal	Normal
Output Channel 2 Select	Not Used	Not Used	Normal	Not Used	Normal	Normal
Output Channel 3 Select	Not Used	Not Used	Not Used	Normal	Not Used	Not Used
Output Channel 4 Select	Normal	Not Used	Not Used	Not Used	Normal	Not Used

Possible Wizard settings for the above actuator function list

If two different Actuator Modules have an Actuator Profile with the same Input Function Number (5.3.2.1), the function with this number will activate those Actuator Profiles in both modules simultaneously, operating together all the actuators that are selected in those Actuator Profiles.

See section 5.4 for several practical examples on how to set up and program a chair with the DX2-ACT Actuator Module.

2.1 Actuator Auto-detect

The actuator auto-detect programmable feature checks which actuator channels are physically connected at power up and displays the appropriate pre-configured functions in the user menu on the Master Remote. This means that seating functions not connected to an actuator channel will not display in the menu. The advantage of this is; a common Wizard program can be used for a family of wheelchairs, which differ only in the number of actuators fitted, rather than having individual programs for each variant.

To enable this feature the **Display Missing Actuators** parameter (5.3.1.3) should be set to **No**. Once enabled, connected actuators are automatically detected when the system powers up. If a function requires an actuator that is not present then that function is automatically removed from the Master Remote and remains unavailable for the duration of the power on session.

If a missing actuator is plugged in then after the next power cycle any functions in the program that use that actuator will automatically be available on the Master Remote menu. Conversely, if an actuator is unplugged it will disappear from the menu when the system is next power cycled.

Notes:

*To take full advantage of auto-detect, standardise on actuator channel assignments. For example, always assign **Tilt** to DX2-ACT4 Channel 1.*

For example, a family of chairs may be programmed with the following functions:

No.	Function	DX2 Icon
F2	Back Rest Angle	
F3	Left Leg Rest	
F4	Right Leg Rest	
F9	Both Leg Rests	
F28	Recline	

A chair fitted with 3 actuators, one for the Back Rest Angle, one for the Left Leg Rest, and one for the Right Leg Rest would have all of the functions, described in the table above, available on the Master Remote. Another chair, using the same program but with no leg rest actuators fitted, would only have the Back Rest Angle (F2) function available since the missing leg rest actuators would cause the other functions to be automatically removed (see table on following page).

Example of actuators fitted and available functions

Actuators Fitted	Available Functions*
Back Rest Angle Left Leg Rest Right Leg Rest	 F2 F3 F4 F9 F28
Left Leg Rest Right Leg Rest	 F3 F4 F9
Back Rest Angle	 F2
Back Rest Angle* Left Leg Rest	 F2 F3

* Both the **Recline** and **Both Leg Rests** functions are unavailable as these functions require both leg rest actuators to be fitted.

Note:

*The **Display Missing Actuators** feature only affects functions local to an actuator module. If an actuator function is programmed to control actuators on more than one DX2-ACT module and one of the required actuators is missing then the function will still appear on the Master Remote.*

This is due to only one actuator module reporting the missing actuator and although it removes any affected functions from its control set the second actuator module, being unaware of the missing actuator, still makes available its contribution to the function and a corresponding icon will be displayed on the Master Remote menu.

3 Specifications

3.1 Electrical Specifications

Parameter	Min	Nominal	Max	Units
DX BUS				
Battery Voltage (powered-on)	12			V
Battery Voltage (operating)	18 V	24	32	V
Battery Voltage (powered-off)	0		45	V
Reverse Supply Voltage	-40			V
Maximum Transient Battery Voltage	-90		+90	V
Quiescent Current (Actuators Idle)		35	100	mA
Powered Down Current		0.25	0.4	mA
Actuator Outputs (powered by DX BUS, no separate battery connection)				
Maximum Output Voltage	18	24	32	V
Continuous Current*		4		A
Output Current 60 seconds* Condition: 10% operational duty cycle. (use for 1 minute, cool off 9 minutes)		15		A
Peak Start-up Current* (up to 2 seconds)			18	A
Actuator Control Inputs (two channels)				
Output Current (enabled)	6.8	7.6	8.6	mA
Working Input Resistance	0		600	Ohm
Maximum Input Voltage			32	V

* All selected outputs combined.

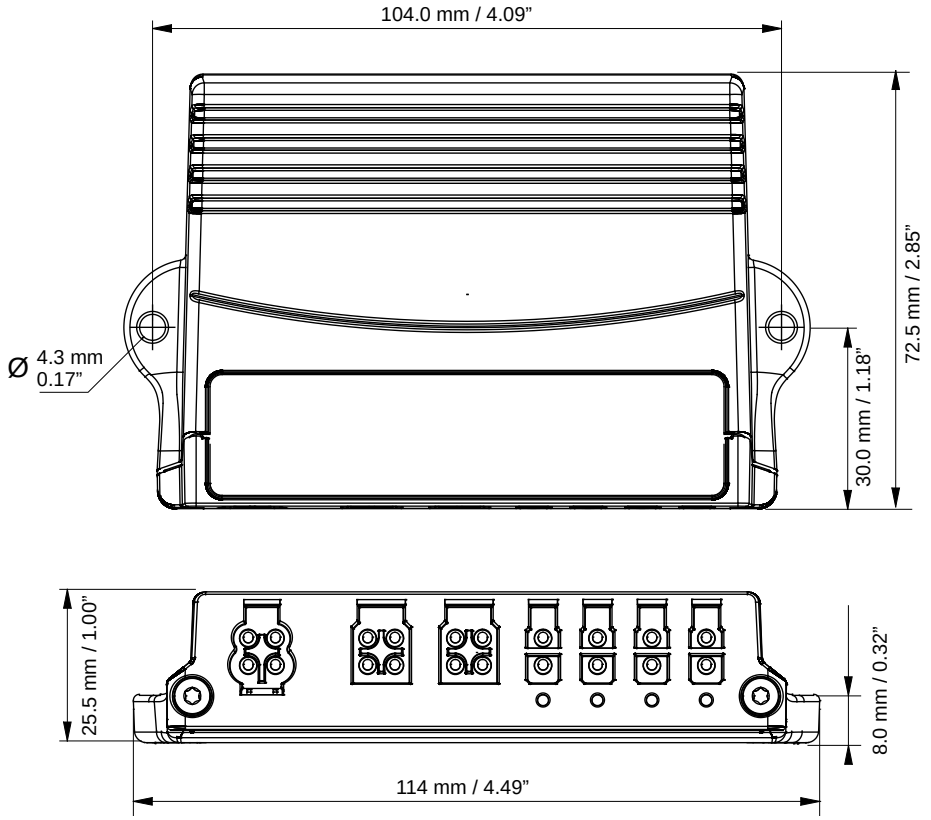
The polarity of the individual actuator outputs can be selected with the **Channel Select** parameters (see 5.3.2.3). The polarity is controlled by software.

Actuator outputs are electrically short-circuited together when not selected to drive.

The power of the actuator outputs is Pulse Width Modulated under software control.

When multiple actuator outputs are selected simultaneously, the outputs share the available current (15A for 60sec, 4A continuous), depending on their load resistances.

3.2 Mechanical Specifications



Warning:

To achieve the specified IPx4 rating, do not mount the DX2 Actuator Module with the connectors facing upward. If necessary, add a cover to protect the Actuator Module and the connectors from splashing and water entry.

3.3 Environmental specifications

Parameter		Value			
Material		Technylstar S60G1-V30			
Protection Rating		IPx4 (if connectors are not facing upward)			
Shipping Weight		300 g			
		Min	**Nominal**	**Max**	**Units**
Mounting Torque (M4 screws)		0.5	1	2	Nm
Operating Temperature Range		-25 (-13)		50 (122)	°C (°F)
Storage Temperature Range		-40 (-40)		65 (149)	°C (°F)
Operating Humidity Range		0		90	%RH

4 Installation

Warning:

Any Wizard setting in this manual is provided as a guideline only.
It is the responsibility of the powerchair manufacturer and installer to determine the suitable settings for each individual chair design.

4.1 Installation procedure

Designing and installing a DX2 Actuator system usually follows the procedure below:

- Determine the **moving functions** that the chair must have and design the **mechanical structure** needed to support these functions.
- Determine the **number of actuators** that are needed to achieve these functions and their **mechanical positions** on the chair.
- Consider the **risks** of the moving parts of the chair.
  Does the chair need **limit switches** to prevent parts of the chair from crashing into each other? If so, **where and how many**?
- Determine the **number of Actuator Modules** that are needed. This depends on the number of actuators and the number of limit switches in the system. Each Actuator Module provides two (DX2-ACT2) or four (DX2-ACT4) actuator channels, and connections for four input switches or two analogue inputs.

Note:

*If in one function multiple actuators that use very different amounts of current are used simultaneously, it can be useful to divide this function over two or more Actuator Modules, because each Actuator Module has its own **Trip Current** setting (5.3.2.8). A light actuator may not produce a stalling current that is high enough to trigger the trip current of a heavier actuator. If you use two or more Actuator Modules in this case, you can set a lower **Trip Current** for the lighter actuator so it does not burn out if it gets stuck.*

- Mount the Actuator Modules (3.2), set the appropriate Module ID for each module (4.3.1), and connect the modules to the DX System (4.3.2). Do not connect the actuators to the module yet.
- Program each function into an Actuator Profile of one of the Actuator Modules (5.3.2). Each Module comes with its own set of Actuator Profiles. ACT2 Modules have 4 Actuator Profiles, ACT4 Modules have 6 Actuator Profiles.
  - Choose an **Input Function Number** (5.3.2.1). This number corresponds with the actuator icon number on the DX2 Advanced Joystick Remote. If two separate modules must react to the same function, choose the same **Input Function Number** in an Actuator Profile on both modules.
  - Choose the **actuator channels,** their moving direction and their trip current that this Profile will use (5.3.2.3). Each Actuator Profile can control any number of active actuator channels of its own Actuator Module.

- Determine the **limit switch settings.** Program the settings into the Actuator Control Input (ACI)**.** Each switch can be set to slow down or stop the chair, or stop actuators from moving in one or both directions. See section 4.3.4 for possible schematics and detailed settings.

- Connect the limit switches to the ACI terminals and the actuators to the actuator outputs.

Precaution:

Cover unused connector sockets with the appropriate connector covers.

DX BUS: *GME64909*
Actuators: *GME65337*
ACI: *GME65325*

- Test the system.

Warning:

For each individual end user, check and make sure that the setup of the actuators, the limit switches and the trip current is such that the user is not crushed by the actuator movement of the chair at any time. Take particular care with users who have limited sensation because they are not able to feel if they are being crushed.

4.2 Mounting

For a drawing see the Mechanical Specifications (section 3.2)

The position and orientation should give maximum mechanical protection to the DX2-ACT Module.

Warning:

To achieve the specified IPx4 rating, do not mount the DX2 Actuator Module with the connectors facing upward. If necessary, add a cover to protect the Actuator Module and the connectors from splashing and water entry.

Regardless of mounting orientation, protect powerchair wiring and connectors from the risk of damage, water splashes and/or water entry, and route the cabling so that water cannot run down into the connector system.

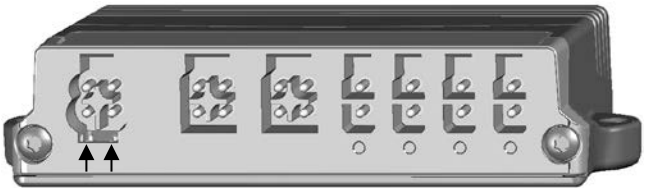
4.3 Wiring

Warning:

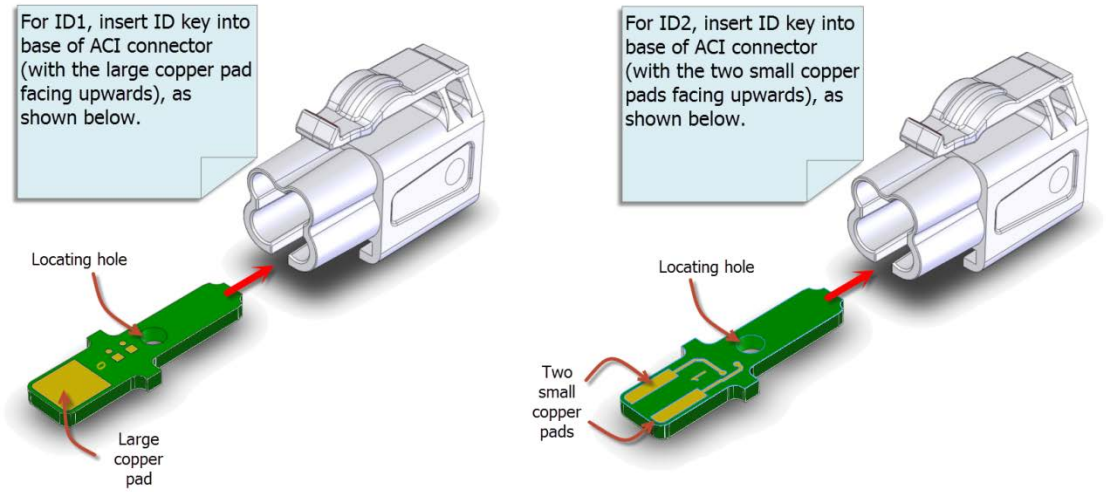
Read the General Wiring Recommendations in the DX System Manual before you read this chapter.

4.3.1 The Module ID

It is possible to connect a maximum of four DX2-ACT Modules in a DX System. With two DX2-ACT4 Modules, and two DX2-ACT2 Modules installed, a DX2 Actuator System can have a total maximum of 4+4+2+2=12 actuator channels.



Each Actuator Module of the same type must have its own specific identification number (ID). The ID can be set with a small ID key (Dynamic Controls' part no: GPC65329A) that is inserted in the Actuator Control Input (ACI) connector (GME65347) (see 4.3.4). The ID key connects to the bottom two pins of the ACI socket.



The external ID key makes it easy to replace and/or identify Actuator Modules within one DX system, because it is not necessary to reprogram them. Just connect the same ACI connector to the new module and the ID will be set automatically.

A module's ID is set by the insertion and orientation of the ID key in the ACI connector. If no key is inserted, the module's ID is set to 1. If an ID key is inserted, then the module's ID will be set to 1 or 2, depending on the orientation of the key. For ID1, insert the ID key into the base of the ACI connector with the large copper pad facing upwards, as shown above. For ID2, insert the ID key into the base of the ACI connector with the two small copper pads facing upwards.

To remove the ID key, lift the ACI connector's tab away from the ID key's locating hole, and then pull the key away from the connector.

The Module ID is only shared between DX2-ACT Modules of the same type. A DX2-ACT4 and a DX2-ACT2 Module can therefore have the same ID within one DX System.

If a system is programmed with the Wizard to have only one DX2-ACT Module of a specific type, that module must have ID1, otherwise the module will not work.

If a system is programmed to have two modules of the same type, the module with ID1 responds to the Actuator Profiles in the ACTx—1 section of the Wizard, and the module with ID2 responds to the Actuator Profiles in the ACTx—2 section of the Wizard.
If one of the two modules is not present, the other module still operates normally.

Programmed Configuration	ID Module 1	ID Module 2	ID Module 3	ID Module 4
ACT2	ID1			
ACT2 + ACT2	ID1	ID2		
ACT4	ID1			
ACT4 + ACT2	ACT4: ID1	ACT2: ID1		
ACT4 + ACT2 + ACT2	ACT4: ID1	ACT2-1: ID1	ACT2-2: ID2	
ACT4 + ACT4	ID1	ID2		
ACT4 + ACT4 + ACT2	ACT4-1: ID1	ACT4-2: ID2	ACT2: ID1	
ACT4 + ACT4 + ACT2 + ACT2	ACT4-1: ID1	ACT4-2: ID2	ACT2-1: ID1	ACT2-2: ID2

Currently, keys with the value ID1 and ID2 are available. If no key is inserted in the ACI connector, the module will have ID1.

The ACI connector may be shipped with a plastic dummy key (GME65326) inserted. With the dummy key inserted, the module will have ID1. If ID2 is required, replace the dummy key with the real ID key (GPC65329A) inserting it as described previously.

4.3.2 Connection with the DX System

The DX2-ACT module has two DX BUS sockets. You can connect the DX BUS cable to either socket.

Precaution:

Connect the Actuator Module as close as possible to the Power Module, because the Actuator Module is a high current module. The DX Bus cable used for this connection should be as short as is practically possible.

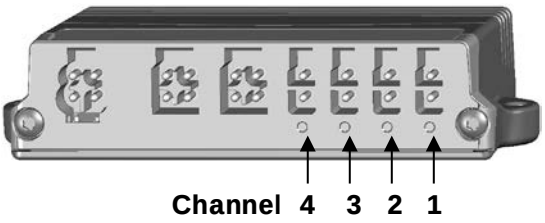
Although it is possible to daisy-chain one DX2-ACT to another with the second DX Bus socket, it is recommended that modules supporting high current actuators should be wired directly to the DX Power Module.

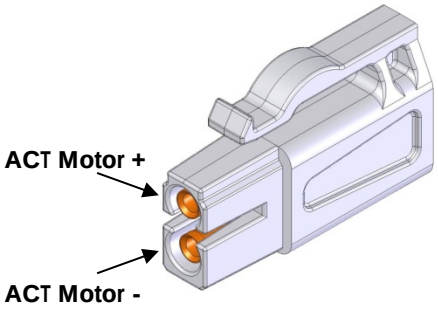
For more information on a possible module connection layout see the DX BUS chapter of the DX System Manual.

If the second DX BUS connector is not used, cover it with a GME64909 DX BUS Connector Cover. This also complies with ISO 7176-14 requirements.

4.3.3 Connection with actuators

Each actuator has its own connector. This makes it easy to add or service a single actuator, because it is not necessary to adjust or rewire a multi-pin connector.





Actuator current rating (A)	Minimum wire size (mm^2)	Minimum wire size (AWG)
3	0.5	20
5	0.75	18
10	1.0	17
15	1.5	15

Recommended wire sizes

Precautions:

For best electrical performance, the wire size must be as large as possible.

For low-current signals, do not use wire sizes smaller than 0.5mm^2/AWG20, because smaller wires are physically not strong enough for this application.

See also the notes and precautions in section *7.1 DX2-ACT Loom Kit.*

Each actuator connector socket has its own status LED. The LEDs flash when the corresponding actuator is operated. The LED that belongs to channel 1 also serves as a Module Status LED, see Module Flash Codes section 6.1.

Precautions:

Label the individual actuator connectors when the chair is assembled. This makes it easier to later determine which connector belongs to which actuator.

The actuator outputs are electrically isolated from each other and from the rest of the system. Make sure that the actuator wiring maintains this isolation.

If more than one actuator is connected to an actuator socket, make sure that the total load on that socket is not higher than 15 A, and that the total load of all channels that will be operated simultaneously is not higher than 15 A.

Cover unused actuator sockets with a GME65337 Actuator Connector Cover. This also complies with ISO 7176 requirements.

4.3.4 Actuator Control Input (ACI)

The ACI socket connects two inputs: ACI-1 and ACI-2.

These can be used for:

- Position limit switches that prevent actuators from moving in one or both directions to make sure that
  - o one part of the chair does not crush another part of the chair
  - o the chair does not become mechanically unstable
- An attendant switch that prevents a user from operating the actuators
- An extra external speed pot or speed limit pot
- Seat position switches or potentiometers that can gradually slow down or stop the chair when the seat is in a position that makes the chair not stable enough to drive.

Both ACI inputs can be individually set to 4 different modes.

Mode	Operation
Fail Safe	Six different input resistor bands are recognised. This allows the use of two input switches in a fail safe way. All values can be obtained using 150 Ω resistors only.
Simple	Five different input resistor bands are recognised. All values can be obtained using 150 Ω resistors only, or alternatively 120 Ω and 330 Ω resistors (DYNAMIC Shark compatible).
Speed Pot	Analogue input that scales down the speed of the powerchair, depending on the resistance between the ACI terminals. Either a 500 Ω linear potentiometer or discrete resistors can be used.
Speed Limit	Analogue input that limits the speed of the powerchair, depending on the resistance between the ACI terminals. Either a 500 Ω linear potentiometer or discrete resistors can be used.

Select the ACI Mode of the two ACI inputs with the
ACI 1 Mode and **ACI 2 Mode** parameter (see 5.3.3.1)

Precaution:

If the ACI socket is not used, cover it with a GME65325 DX2 ID/ACI Connector Cover. This also complies with ISO 7176-14 requirements.

ACI Signals

In Fail Safe or Simple mode, each input band can generate a signal. which may modify the behaviour of either chair driving, actuator operation, or both.

For some applications when chair driving is either slowed down or stopped by such an ACI signal, it is desirable to restrict this behaviour so that such signals are ignored while the chair is actually being driven. For this purpose each ACI can be programmed to ignore certain signals by setting ACI Monitoring to Latched (see 4.3.4.4).

Signal	Meaning
None	• No action necessary: this band is either safe or not used.
Local1 Local2 Local3 Local4 Local5 Local6 Local7 Local8	• Local signals are local to the Actuator Module of a particular ACI input. Local signals do not have an effect on other DX2 Actuator Modules in the system. • Local signals can be used directly to stop a local actuator from running in one or both directions, or they can be used as an input to one of the two ACI Local OR signals (actions that depend on the occurrence of two or three separate signals).
Global1 Global2 Global3 Global4 Global5 Global6 Global7 Global8	• Global signals are shared with all other DX2 Actuator Modules in the system. • A global signal can stop an Actuator Profile of any Actuator Module in the system from running in one or both directions, if it is assigned as an **Act. Profile Inhibit Cause** or an **Extend/Retract Inhibit Cause** in that Actuator Profile. • A global signal can be used as an input to one of the two "Local OR" signals of any DX2 Actuator Module in the system.
Flash Code 2	• Generates a Flash Code 2 (DX Accessory Fault) on the Master Remote as a warning to the user; for example, to indicate that an actuator is almost at its end of travel. This signal does not inhibit drive; however it may be programmed to inhibit an actuator. • This signal can stop an actuator of the Actuator Module from running in one or both directions, if it is assigned as an **Act. Profile Inhibit Cause** or an **Extend/Retract Inhibit Cause** in its Actuator Profile. • This is a local signal and only affects actuators attached to the module being programmed.
Stop	• Inhibits driving. • Generates a Flash Code 2 (DX Accessory Fault). • In addition to drive inhibit this signal can stop an actuator of the Actuator Module from running in one or both directions, if it is assigned as an **Act. Profile Inhibit Cause** or an **Extend/Retract Inhibit Cause** in its Actuator Profile. • This is a local signal and only affects actuators attached to the module being programmed.

Signal	Meaning
System Slowdown	• Activates a System Slowdown. The speed during a System Slowdown is set with the **System Slowdown** parameter. • Generates a Flash Code 2 (DX Accessory Fault). • This signal may be programmed to inhibit an actuator. • This signal can stop an actuator of the Actuator Module from running in one or both directions, if it is assigned as an **Act. Profile Inhibit Cause** or an **Extend/Retract Inhibit Cause** in its Actuator Profile. • This is a local signal and only affects actuators attached to the module being programmed.
Local-Slow1 Local-Slow2	• Slows down the speed of the powerchair with a Speed Pot and a Speed Limit function, each of which can be used independently or together. • The Speed Pot and Speed Limit values must be set with the **Local-Slow1 Pot**, **Local-Slow2 Pot**, **Local-Slow1 Limit** and **Local-Slow2 Limit** parameters. If any of these four functions is not needed, leave the value of its parameter at 100%. • Each Actuator Module has its own Slow1 and Slow2 settings. • Local-Slow1 and Local-Slow2 are **local signals** that can be used to stop a local Actuator Profile from running in one or both directions, if they are assigned as an **Act. Profile Inhibit Cause** or an **Extend/Retract Inhibit Cause** in that Actuator Profile. Local-Slow1 and Local-Slow2 do not have an effect on other DX2 Actuator Modules in the system. • **Does not** generate Flash Code 2 (DX Accessory Fault) on the DX Master Remote. **This behaviour is different from the DX-CLAM.** The Slow/Stop input of the DX-CLAM generates Flash Code 2 when it is activated. • This is a local signal and only affects actuators attached to the module being programmed.

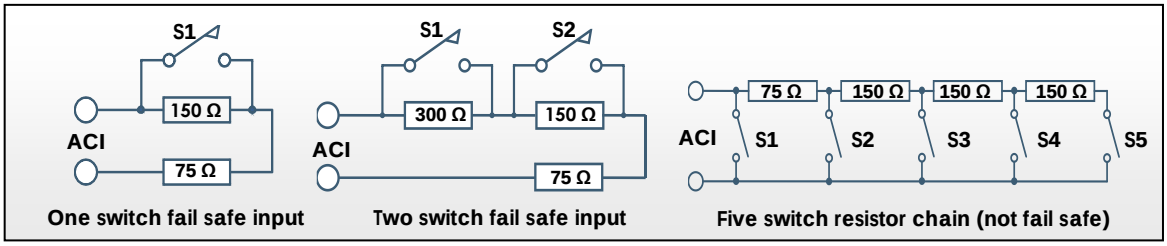
Select the desired signal for each input with the **ACI Resistor Band Setup** parameter (see 5.3.3.3).

4.3.4.1 Fail Safe Mode

Six different input resistor bands are recognised.

Band	Range (Ω)
Open circuit	> 582
B4 - 525 Ω	480 – 582
B3 - 375 Ω	341 – 419
B2 - 225 Ω	204 – 256
B1 - 75 Ω	67 – 93
Short circuit	All other

⚠ Max. Resistor tolerance 1%



Possible schematics - all resistor values can be obtained using 150 Ω resistors only.

The circuit is called fail safe because it can detect open circuit and short circuit occurrences in most situations. For the best "fail safe" operation:

- route the wires in pairs, not in loops
- use resistors with a tolerance of 1% or better
- use single resistors and mount the resistors as close to the switches as possible
- mount the termination resistor close to the switch at the GND-side of the circuit.

Possible Wizard settings for the schematics shown above

One switch fail safe configuration					
Short/Fault	**B1 (S1 closed)**	**B2 (S1 open)**	**B3 (not used)**	**B4 (not used)**	**Open**
Stop*	Any signal	Any signal	Stop*	Stop*	Fault**

Two switch fail safe configuration					
Short/Fault	**B1 (both closed)**	**B2 (S1 closed)**	**B3 (S2 closed)**	**B4 (both open)**	**Open**
Stop*	Any signal	Any signal	Any signal	Any signal	Fault**

Five switch configuration***					
Short/Fault (S1 closed)	**B1 (S2 closed)**	**B2 (S3 closed)**	**B3 (S4 closed)**	**B4 (S5 closed)**	**(all) Open**
Any signal	Any signal	Any signal	Any signal	Any signal	Any signal

* Short circuit and bands that are not used normally do not occur unless there is a fault in the wiring. A fault in the wiring may be the symptom of a serious error, for example crushed cables. For this reason a complete stop of the chair may be necessary as a safety precaution.

** Open circuit indicates that the circuit is not connected. Depending on the function of the switches that should be connected this may or may not be serious enough to cause a stop, a slow down, just a flash code warning or nothing.

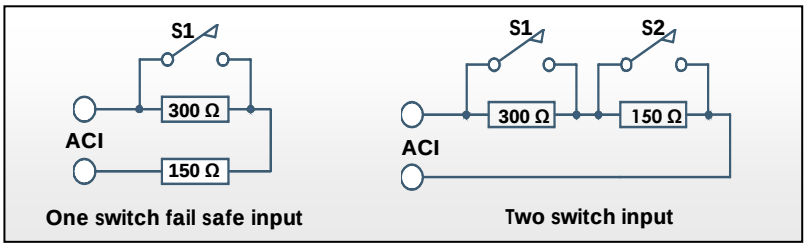
*** Only use this configuration in applications that are not safety critical. Note that when a switch with a lower number is closed, it blocks detection of all the switches with a higher number.

4.3.4.2 Simple Mode

Five different input resistor bands are recognised.
All the resistor values that are needed can be obtained by using 150 Ω resistors,

This mode is similar to the DCI Multi Speed mode of the DYNAMIC Shark system.

Band	Range (Ω)
Short circuit	0 – 74
B2 - 150 (120) Ω	74 – 224
B3 - 300 (330) Ω	224 – 374
B4 - 450 Ω	374 – 500
Open circuit	> 500



Possible schematics - all resistor values can be obtained using 150 Ω resistors only, or alternatively 120 Ω and 330 Ω resistors.

Possible Wizard settings

One switch fail safe configuration					
Short/Fault	**B1 (not used)**	**B2 (S1 closed)**	**B3 (not used)**	**B4 (S1 open)**	**Open**
Stop*	Not settable	Any signal	Stop*	Any signal	Fault**

Two switch configuration – not fail safe					
Short/Fault (both closed)	**B1 (not used)**	**B2 (S1 closed)**	**B3 (S2 closed)**	**B4 (both open)**	**Open (open circuit)**
Any signal	Not settable	Any signal	Any signal	Any signal	Fault**

* Short circuit and bands that are not used normally do not occur unless there is a fault in the wiring. A fault in the wiring may be the symptom of a serious error, for example crushed cables. For this reason a complete stop of the chair may be necessary as a safety precaution.

** Open circuit indicates that the circuit is not connected. Depending on the function of the switches that should be connected this may or may not be serious enough to cause a stop, a slow down, just a flash code warning or nothing.

Precaution:

Simple Mode cannot detect a short circuit between the ACI terminals in a two switch configuration, because the short circuit band is already used for the state when both switches are closed. For this reason it is recommended to use Fail Safe Mode instead of Simple Mode for two switch configurations.

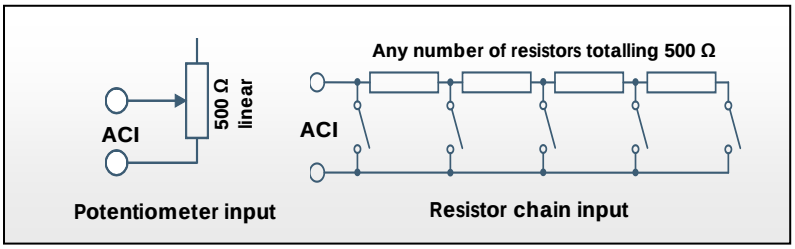
For Fail Safe operation, mount the resistors as close to the switch as possible.

4.3.4.3 Speed Pot Mode / Speed Limit Mode

The ACI acts as an Analogue input that scales down or limits the speed of the powerchair, depending on the resistance between the ACI terminals.
Either a 500 Ω linear potentiometer or discrete resistors can be used.

The Speed Pot/Speed Limit value works in parallel with all other Speed Pots/Speed Limits that are present in the DX System: the one with the lowest momentary value will determine the speed.

Band	Range (Ω)	Speed (%)
short circuit	0 – 50	0
linear range	50 – 450	0 – 100
full speed	450 - 600	100
open circuit	> 600	Fault / Inhibit



Possible Wizard settings

Speed Pot / Speed Limit configuration					
Short/Fault (short circuit)	**B1 (not used)**	**B2 (not used)**	**B3 (not used)**	**B4 (not used)**	**Open (open circuit)**
Not settable	Not settable	Not settable	Not settable	Not settable	Fault*

* Open circuit indicates that the circuit is not connected. Depending on the function of the switches that should be connected this may or may not be serious enough to cause a stop, a slow down, just a flash code warning or nothing.

Note:

*If a **Speed Pot** has the value zero, the maximum speed of the powerchair is <u>not</u> zero, it is equal to the **Forward Speed @ Minimum** parameter for the currently active Drive Profile.*

*If a **Speed Limit** has the value zero, the maximum speed of the powerchair is also zero. If **Speed Limit Mode** is used, an extra series resistor can prevent the chair from entering drive inhibit when the pot is fully turned down.*

For more information about the Speed Pot and Speed Limit functions, see the 'Speed limiting options' section in the DX System Manual.

4.3.4.4 Latched vs Continuous Monitoring of ACI signals

This feature is controlled by the **ACI 1 / 2 Monitoring** parameter and has no effect on actuator operation; it only influences the affect that ACI signals have on driving behaviour.

Note:

If an ACI is programmed to inhibit certain actuator operations then that protection is functional at all times, regardless of the setting of ACI Monitoring.

ACI inputs are typically connected to switches designed to operate as a result of actuator movement. These switches can restrict actuator movement to prevent crushing the chair occupant or to prevent collision between moving chair parts. Alternatively, or additionally, they can be used to inhibit chair driving or reduce speed if normal driving is considered unsafe.

ACI inputs are normally activated by actuator movement; tilt switches, however, may activate as a result of the chair being driven or pushed on to an incline and other switches may accidentally activate due to impact or vibration. For this reason ACI Monitoring can be set to one of two modes:

Continuous ACI Monitoring

- With ACI Monitoring set to **Continuous**, the ACI signals are updated continuously in all modes.
- If an ACI signal is asserted for any reason and is programmed as a **Stop**, **System Slowdown,** or **Local-Slow1/2** then chair driving will be inhibited or speed will be reduced as required.

Latched ACI Monitoring

- With ACI Monitoring set to **Latched**, the ACI input is read continuously in all modes so that any actuator protection remains in place.
- If an ACI signal is asserted due to actuator movement and is programmed as a **Stop**, **System Slowdown** or **Local-Slow1/2** then chair driving will be inhibited or speed will be reduced as required. (It is normally not possible to operate actuators while a chair is being driven unless the chair's configuration includes an actuator remote control (DX-ARC).)
- If an ACI signal is asserted due to any other reason, such as driving on to an incline, or switch vibration when driving on a rough surface, the signal will be ignored and not affect driving.

Note:

For any ACI signal it is important not only to consider its effect on actuator operation and chair driving behaviour but to also consider (especially for tilt switches) all the reasons that signal could be activated.

Latched Monitoring of Stop Signal

A **Stop** signal will only be detected while an actuator is being operated. An active **Stop** signal will prevent driving and must be cleared by adjusting the actuator position to allow driving, a power cycle will not be necessary. Once the **Stop** signal has been cleared, and provided the actuators are not operated again, then any subsequent assertion of the same ACI **Stop** signal (for example due to pushing or driving the chair on to a ramp) will be ignored by the chair drive system.

If a **Stop** signal is activated as a result of driving on to an incline, or as a result of switch vibration when driving on a rough surface, the signal will not affect driving. Even after stopping the chair, it will continue to be ignored until an actuator is operated.

Latched Monitoring of System Slowdown Signal

A **System Slowdown** signal will only be detected while the chair is stationary or while an actuator is being operated. Immediately before chair driving starts, and provided that the actuators are not operated again, then any subsequent changes to the **System Slowdown** signal will be ignored until either the chair comes to a stop or an actuator is operated.

If a **System Slowdown** signal is activated as a result of driving on to an incline or as a result of switch vibration when driving on a rough surface, the signal will not affect driving. However after stopping the chair, if the **System Slowdown** signal is still activate, then subsequent drive speed will be reduced since the signal is detected when the chair is stationary.

Latched Monitoring of Local-Slow1/2 Signal

A **Local-Slow1/2** signal will only be detected while the chair is stationary or while an actuator is being operated. Immediately before chair driving starts, and provided that the actuators are not operated again, then any subsequent changes to the **Local-Slow1/2** signal will be ignored until either the chair comes to a stop or an actuator is operated. The programmed Speed Pot and Speed Limit values corresponding with the latched **Local-Slow1/2** signal will determine the chair drive speed.

If a **Local-Slow1/2** signal is activated as a result of driving on to an incline or as a result of switch vibration when driving on a rough surface, the signal will not affect driving. However after stopping the chair, if the **Local-Slow1/2** signal is still activate, then subsequent drive speed will be reduced since the signal is detected when the chair is stationary.

5 Programming the DX2-ACT module

Warning:

The DX2 Actuator Module is part of the DX System. Read the DX System Manual programming chapter (DSM chapter 7) including all warnings and notes before reading this chapter.
The programming chapter of this DX2 Actuator Module manual only describes Actuator Module specific programming.

Section 5.1 gives the preliminary setup instructions.

Section 5.2 gives a list of all DX2-ACT parameters.

Section 5.3 gives a detailed description of these parameters.

Section 5.4 describes several step-by-step scenarios from design to implementation:

Connecting an external Speed Pot (5.4.1)

Seat raise example (5.4.2)

Full chair example (5.4.3)

Note:

If the configuration or programming of the Actuator Modules changes, it may be necessary to turn the system on and off several times before the modules operate correctly again.

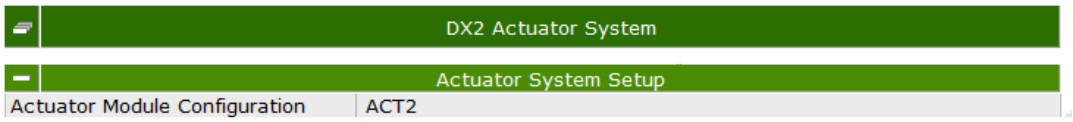
See section 6.3 for details.

5.1 Preliminary Setup Instructions

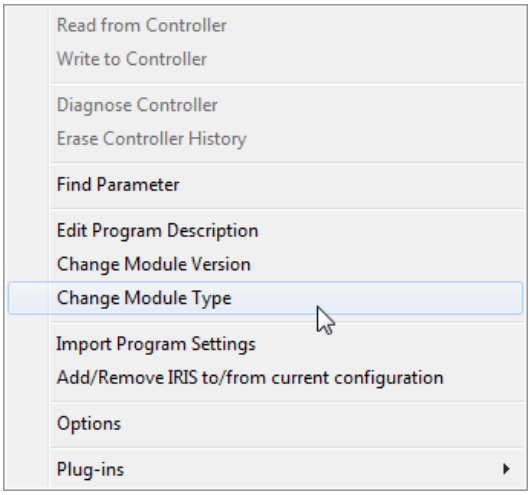
Before setting up the powerchair via the parameters outlined in this section, the Wizard needs to know about the Actuator Modules (number, type, and version) installed in the system (see also **4.3.1 The Module ID**).

5.1.1 Set Actuator Module Configuration

The number and type of Actuator Modules are described in Wizard with the **Actuator Module Configuration** parameter (see image below).



This parameter is not directly editable, as indicated by the parameter's grey background.



To change the parameter's value to reflect the number and type of Actuator Modules in the system, click on the Wizard's **Tools** menu and select **Change Module Type** (as shown left).

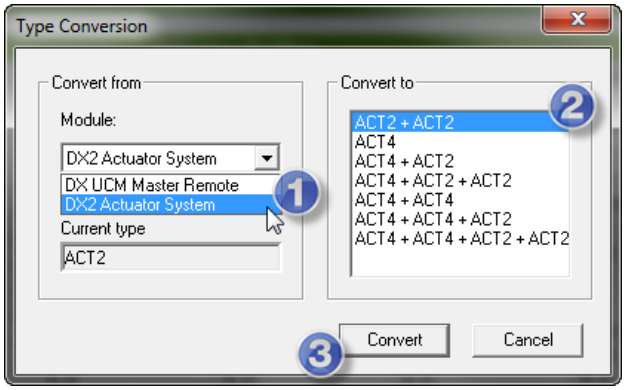
The **Type Conversion** dialogue box will be displayed, as shown below. To change the configuration:

Step 1) From the **Module** drop-down text box, select DX2 Actuator System.

Step 2) If the **Current type** displayed is not correct, then select the Actuator configuration from the **Convert to** text box.

Step 3) Press the **Convert** button.

After selecting the correct configuration, Wizard will update the **Actuator Module Configuration** to reflect your choice. So, for example, if you chose two ACT2 modules in step 2 above, then **Actuator Module Configuration** will display **ACT2 + ACT2**, as shown in the image below.



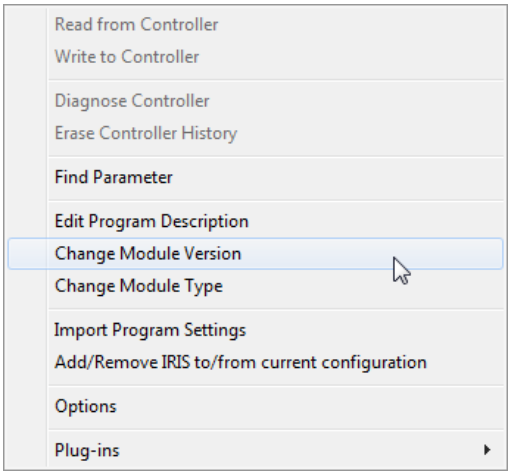
DX2 Actuator System	
Actuator System Setup	
Actuator Module Configuration	ACT2 + ACT2
ACT2-1 Module Missing	Normal
ACT2-2 Module Missing	Normal

Notice also, that when the **Actuator Module Configuration** parameter is updated, so too are the number of **Module Missing** parameters. These parameters can be set to change the behaviour of the system when a module is no longer detected in the system.

5.1.2 Set Actuator Module Version

To maintain backwards compatibility with previous Actuator Module revisions the module version can be set as either **Rev A** or **Rev B**. Some parameters are only available with **Rev B**.

Actuator Modules version V1.09 or newer will accept **Rev A** or **Rev B** programs, while previous versions will only accept **Rev A**.



To change the revision, click on the Wizard's **Tools** menu and select **Change Module Version** (as shown left).

The **Version Conversion** dialogue box will be displayed, as shown below. To change the version:

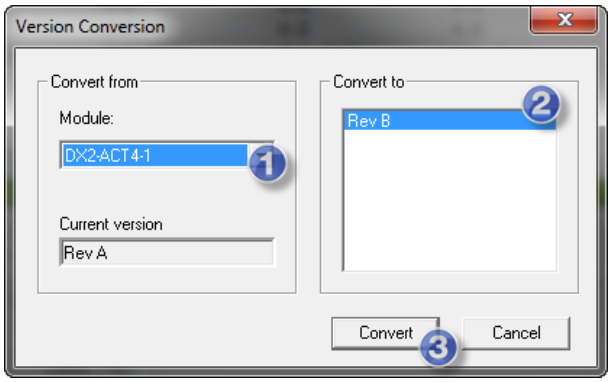
Step 1) From the **Module** drop-down text box, select the module that agrees with the Actuator Module you wish to change.

Step 2) If the **Current version** displayed is not correct, then select the version from the **Convert to** text box.

Step 3) Press the **Convert** button.

After selecting the correct version, Wizard will update the parameters to agree with those available for that revision. (See 5.2 for a list of parameters.)

If there is more than one Actuator Module connected to the system, repeat steps 1 to 3 for each module that requires a version change.



5.2 Parameter list

The parameter list in the Wizard starts with the global Actuator System Setup parameter section. The parameters in the global section are shared by all Actuator Modules in the system.

After the global Actuator System Setup the local parameters are listed.
In Wizard, each installed Actuator Module has its own section with local parameters.

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

👁 Viewable at this level

Parameters and values marked with a [B] are only available in actuator module version **Rev B**.

5.2.1 Global Actuator System Setup

Parameter	Possible Values	Default	HHP	Lite	Std	Adv
Actuator System Setup						
Actuator Module Missing*	Normal Slow1 Slow2 Stop	Normal	-	👁	✓	✓
Actuator Module 2 Missing*	Normal Slow1 Slow2 Stop	Normal	-	👁	✓	✓
Slowdown 1 Speed Pot	0 – 100 %	100 %	-	👁	✓	✓
Slowdown 1 Speed Limit	0 – 100 %	100 %	-	👁	✓	✓
Slowdown 2 Speed Pot	0 – 100 %	100 %	-	👁	✓	✓
Slowdown 2 Speed Limit	0 – 100 %	100 %	-	👁	✓	✓

*Each installed Actuator Module has its own **Actuator Module Missing** parameter.

5.2.2 Local Actuator Module Parameters (per Module)

Parameter	Possible Values	Default	HHP	Lite	Std	Adv
Actuator Profiles						
Input Function Number	0 – 37	0	-	✓	✓	✓
Operating Mode	Switched Toggle Latch Toggle/Latch Y Proportional X Proportional	Switched	-	✓	✓	✓
Output Channel 1 Select	Not Used Normal Reverse	Not Used	-	-	-	✓
Output Channel 2 Select						
Output Channel 3 Select (ACT4)						
Output Channel 4 Select (ACT4)						
Act. Profile Inhibit Cause	None Local-1 … Local-8 Global-1 … Global-8 Local-OR-1 Local-OR-2 Driving Stop Local-Slow1 Local-Slow2 [B] System Slowdown [B] Flash Code 2	None	-	-	-	✓
Soft Start/Stop Time	0 – 1.5 s	0 s	-	✓	✓	✓
[B] Maximum Operating Time	0 – 60 s	0 s	-	✓	✓	✓

Parameter	Possible Values	Default	HHP	Lite	Std	Adv
Actuator Profiles (Continued)						
Extend Speed	0 – 100 %	0 %	-	✓	✓	✓
Extend Start Current	0 – 18 A	0 A	-	-	-	✓
Extend Trip Current	0 – 15 A	0 A	-	-	-	✓
Extend Inhibit Cause	Trip Only Local-1 … Local-8 Global-1 … Global-8 Local-OR-1 Local-OR-2 Driving Stop Local-Slow1 Local-Slow2 [B] System Slowdown [B] Flash Code 2	Trip	-	-	-	✓
Retract Speed	0 – 100 %	0 %	-	✓	✓	✓
Retract Start Current	0 – 18 A	0 A	-	-	-	✓
Retract Trip Current	0 – 15 A	0 A	-	-	-	✓
Retract Inhibit Cause	Trip Only Local-1 … Local-8 Global-1 … Global-8 Local-OR-1 Local-OR-2 Driving Stop Local-Slow1 Local-Slow2 [B] System Slowdown [B] Flash Code 2	Trip	-	-	-	✓

Parameter	Possible Values	Default	HHP	Lite	Std	Adv
Actuator Module Settings						
Maximum Motor Volts (V)	20.0 - 32.0	26.0	-	-	-	✓
[B] Display Missing Actuators	No Yes	Yes	-	-	-	✓
ACI 1 Mode ACI 2 Mode	Off Fail Safe Simple Speed Pot Speed Limit	Off	-	-	-	✓
[B] ACI 1 Monitoring [B] ACI 2 Monitoring	Continuous Latched	Continuous	-	-	-	✓
ACI Resistor Band Setup	None Local-1 … Local-8 Global-1 … Global-8 Flash Code 2 Stop System Slowdown Local-Slow1 Local-Slow2	None	-	-	-	✓
Local OR 1 (Input 1/2/3) Local OR 2 (Input 1/2/3)	None Local-1 … Local-8 Global-1 … Global-8 Driving Stop Local-Slow1 Local-Slow2 [B] System Slowdown [B] Flash Code 2	None	-	-	-	✓
Local-Slow1 Speed Pot Local-Slow1 Speed Limit Local-Slow2 Speed Pot Local-Slow2 Speed Limit	0 – 100 %	0 %	-	-	-	✓

5.3 Parameter descriptions

5.3.1 Actuator System Setup

5.3.1.1 Actuator Module Missing

Parameter	Possible Values	Default	HHP	Lite	Std	Adv
Actuator Module Missing*	Normal Slow1 Slow2 Stop	Normal	-	👁	✓	✓
Slowdown 1 Speed Pot Slowdown 1 Speed Limit Slowdown 2 Speed Pot Slowdown 2 Speed Limit	0 – 100 %	100 %	-	👁	✓	✓

*Each installed Actuator Module has its own **Actuator Module Missing** parameter.

For each Actuator Module, the setting of its **Actuator Module Missing** parameter sets the action that the DX System must take when that Module is not detected in the system.

Normal - If the Actuator Module is missing, the system operates normally. The system does not slow down.
Slow1 - If the Actuator Module is missing, the system slows down with the value of the **Slow1 Speed Pot** and the **Slow1 Speed Limit** parameters.
Slow2 - If the Actuator Module is missing, the system slows down with the value of the **Slow2 Speed Pot** and the **Slow2 Speed Limit** parameters.
Stop - If the Actuator Module is missing, the system inhibits driving.

Slow1 and **Slow2** are two independent and separate functions that can slow down the powerchair. Use the two different functions if one Actuator Module is more critical than another. For example: if the Actuator Module that controls the seat raise is missing, it can be necessary to limit the speed of the powerchair more than when the Module that controls the leg rest is missing, because a raised seat makes the powerchair more mechanically unstable than a raised leg rest.

Each Slow function can act as a Speed Pot as or as a Speed Limit, or as both.
If either the Speed Pot or Speed Limit component of a Slow function is not needed, leave the value of that component at 100%.

Note:

*The Slow1 and Slow2 limit values are only used by the **Module Missing** parameter.*

Slow1 and Slow2 are additional to the Local-Slow1 and Local-Slow2 parameters of each Actuator Module, and also additional to the System Slowdown parameter and all other Speed Pots and Speed Limits in the system.

All slowdown and limiting functions that are present in the DX System work in parallel: the one with the lowest momentary value determines the actual maximum speed.

5.3.1.2 Maximum Motor Volts (V)

Parameter	Possible Values	Default	HHP	Lite	Std	Adv
Maximum Motor Volts (V)	20.0 - 32.0	26.0	-	-	-	✓

Actuator drive speed is independently programmable for the extend and retract directions, using Extend Speed and Retract Speed (5.3.2.7). These values control the voltage applied to the actuator, and are percentages of the programmed Max Motor Volts parameter.

Note:

If the battery voltage is less than Max Motor Volts, then there will be dead-band at the high end of speeds because the module will not be able to output the programmed "speed". However referring the speeds to a fixed voltage, rather than as a percentage of actual battery voltage, has the advantage that lower speeds will be constant regardless of battery voltage.

5.3.1.3 Display Missing Actuators

Parameter	Possible Values	Default	HHP	Lite	Std	Adv
[B] Display Missing Actuators	No Yes	Yes	-	-	-	✓

The Display Missing Actuators parameter controls which functions are available on the Master Remote when an actuator is missing. This parameter is only available in actuator module version **Rev B**.

If an actuator is missing and this parameter is set to **Yes** then any function that depends on that actuator is still available on the Master Remote and any connected actuators will operate as normal when the function is selected.

When Display Missing Actuators is set to **No** and an actuator is missing then any function that depends on that actuator is not displayed on the Master Remote, making them unavailable for selection.

See section **2.1** for further details of this behaviour.

5.3.2 Actuator Profiles (per Module)

5.3.2.1 Input Function Number

Parameter	Possible Values	Default	HHP	Lite	Std	Adv
Input Function Number	0 – 37	0	-	✓	✓	✓

With the DX-CLAM the DX Master Remote would select and operate actuator channels directly. With DX2, the Master Remote selects and operates a **function** instead of a channel. Each DX2 Actuator Module has several Actuator Profiles that can respond to these functions. Each Actuator Profile can operate up to four actuator channels simultaneously

Input Function Number selects the function that this particular Actuator Profile points to. To disable an Actuator Profile, set its **Input Function Number** to zero.

If multiple Actuator Modules have an Actuator Profile with the same **Input Function Number**, the selection of this number by the Remote will activate all those Actuator Profiles simultaneously, operating together all the actuators that are selected in those Actuator Profiles.

Notes:

1. *Assigning the same function number to different Actuator Profiles works only with multiple Actuator Modules, not within one Actuator Module. If two Actuator Profiles in one Actuator Module have the same **Input Function Number,** the lowest Actuator Profile is used, the other Profile with the same Function Number is ignored.*
2. *If you assign the same function number to two Actuator Profiles of different Modules, make sure that these two profiles also have the same **Operating Mode** (5.3.2.2), **Act. Profile Inhibit Cause** (5.3.2.4), **Extend Inhibit Cause** and **Retract Inhibit Cause** (5.3.2.9).*

Warning:

Ensure that the operating current, for all actuators that have been programmed to operate simultaneously, does not collectively exceed the rated DX-Bus current.

The function number can be chosen freely. However, not all Master Remotes support all function numbers.

Older DX Remotes can select only up to five actuator functions.
For this reason only use function number 1-5 for older DX remotes.

The DX2 Advanced Joystick Remote currently supports 16 functions.
The supported DX2 function numbers and their icons are listed on the following page.

Currently supported DX2 function list

No.	Function	DX2 Icon	No.	Function	DX2 Icon
F1	Seat Tilt		F14	Arm Rest Angle	
F2	Back Rest Angle		F26	Head Device	
F3	Left Leg Rest*		F28	Recline	
F4	Right Leg Rest*		F33	Stand-Up	
F5	Seat Lift		F34	Sit Down	
F6	AUX 1 (any custom function)		F35	AUX2 (any custom function)	
F9	Both leg rests*		F36	AUX3 (any custom function)	
F11	Footplate		F37	AUX4 (any custom function)	

*See note

Note:

Some older DX remotes can request functions F3 and F4 (both leg rests) simultaneously. The DX2 Actuator Module can only operate one Actuator Profile simultaneously. For this reason the DX2 Actuator Module translates an F3+F4 request into an F9 request.

If your chair has two leg rests and an older DX Remote that can control channel 3 and 4 simultaneously, make sure to program 3 different Actuator Profiles with

- *F3 to control the left leg rest*
- *F4 to control the right leg rest*
- *F9 to control both leg rests simultaneously*

If F9 is not programmed, F3+F4 requests have no effect.

Note:

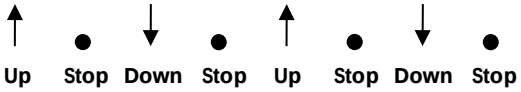
*The actuator auto-detect feature checks which actuator channels are physically connected at power up and displays the appropriate pre-configured functions in the user menu on the Master Remote. This means that if Display Missing Actuators set to **No** any seating functions that are programmed but which do not have the necessary actuator(s) fitted will not display in the menu (see Section 2.1)*

5.3.2.2 Operating Mode

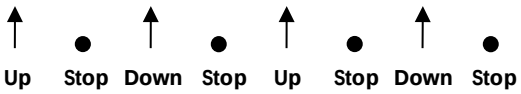
Parameter	Possible Values	Default	HHP	Lite	Std	Adv
Operating Mode	Switched Toggle Latch Toggle/Latch Y Proportional X Proportional	Switched	-	✓	✓	✓

Operating Mode sets how the Actuator Profile reacts to the user interface (the joystick, the buttons and the external switches).

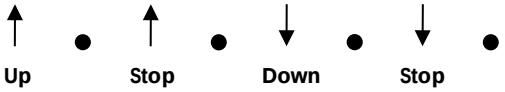
Switched - One actuator button or 'joystick forward' performs up/extend, a second actuator button or 'joystick reverse' performs down/retract. When the joystick is returned to the centre or the button is released, the actuators stop moving.



Toggle - One actuator button or 'joystick forward' toggles between up/extend and down/retract. When the joystick is returned to the centre or the button is released, the actuators stop moving.



Latch - The same as Switched, but when the joystick is returned to the centre or the button is released, the actuators do not stop moving until they reach the end-of-travel. To stop the actuators earlier, deflect the joystick or push the button again.



Warning:

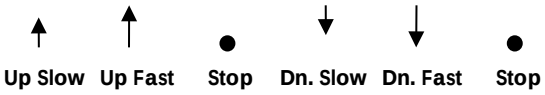
DX2 remotes automatically stop latched actuator movement when another actuator is selected during actuator operation. DX Master Remotes do not have this feature when used with the DX2-ACT.

If the DX2-ACT is used together with a classic DX remote, stop the latched actuator movement before selecting another actuator. Alternatively, turning the system off stops all actuator movement.

If latched actuators are enabled on a DX chair, the manual should notify the end user that turning the system off stops all actuator movement.

Toggle/Latch - Toggle and Latch combined.

Y Proportional - Joystick forward/reverse directly controls the direction and the speed of the actuators. It is not possible to use buttons or external switches to operate the actuators in this mode.



X Proportional - Joystick left/right directly controls the direction and the speed of the actuators. It is not possible to use buttons or external switches to operate the actuators in this mode.

Note:

Proportional Operating Modes cannot be used while driving.

The seating designer must make sure that the selected Proportional joystick axis matches the menu navigation axis of the user interface as appropriate.

5.3.2.3 Channel x Select

Parameter	Possible Values	Default	HHP	Lite	Std	Adv
Output Channel 1 Select	Not Used Normal Reverse	Not Used	-	-	-	✓
Output Channel 2 Select						
Output Channel 3 Select*						
Output Channel 4 Select*						

*Not available for the 2-channel 2ACT Module.

The **Channel Select** parameters select the Actuator Channels that are used in this Actuator Profile. Several Actuator Profiles can use the same actuator channels. For example:

Profile	Function (see 5.3.2.1)	Ch1	Ch2	Ch3	Ch4
A	Left leg rest (F3)	✓			
B	Right leg rest (F4)		✓		
C	Both leg rests (F9)	✓	✓		
D	Seat lift (F5)				✓
E	Back rest (F2)			✓	
F	Recline/lie down (F28)	✓	✓	✓	✓

5.3.2.4 Act. Profile Inhibit Cause

Parameter	Possible Values	Default	HHP	Lite	Std	Adv
Act. Profile Inhibit Cause	None Local-1 … Local-8 Global-1 … Global-8 Local-OR-1 Local-OR-2 Driving Stop Local-Slow1 Local-Slow2 [B] System Slowdown [B] Flash Code 2	None	-	-	-	✓

Act. Profile Inhibit Cause can select several Actuator Control Input (ACI) Signals that will cause the Actuator Profile to stop moving in both directions.

For example: if the back rest may not be adjusted in either direction while the chair is driving, select 'Driving' as the **Act. Profile Inhibit Cause** for the Actuator Profile that controls the back rest.

If more than one condition must prevent an Actuator Profile from moving (for example: driving as well as a certain seat position), select one of the ACI Local OR signals (5.3.3.4) as the **Act. Profile Inhibit Cause.**

If an Actuator Profile must be prevented from moving in only one direction, use the **Extend Inhibit Cause** or the **Retract Inhibit Cause** parameter instead (see 5.3.2.9).

Values marked with a [B] are only available in actuator module version **Rev B**.

5.3.2.5 Soft Start/Stop Time

Parameter	Possible Values	Default	HHP	Lite	Std	Adv
Soft Start/Stop Time	0 – 1.5 s	0 s	-	👁	✓	✓

If an Actuator Profile starts or stops too abruptly, increase the value of the **Soft Start/Stop Time** parameter.

During the Soft Start time and Soft Stop time, the power output to the actuator channels will be reduced. This provides a smoother start and stop of the actuator movement.

The value of the **Start Current** parameter (see 5.3.2.8) will be valid until 300 ms after the **Soft Start/Stop Time** has ended.

5.3.2.6 Maximum Operating Time

Parameter	Possible Values	Default	HHP	Lite	Std	Adv
Maximum Operating Time	0 – 60 s	0 s	-	✓	✓	✓

The Maximum Operating Time parameter sets the maximum time the actuator(s) operate before they automatically stop. This prevents actuators from operating too long and possibly overheating or burning out.

If an actuator function is programmed to operate actuators on more than one DX2-ACT module then all modules should be configured with the same Maximum Operating Time for that function.

A Maximum Operating Time of 0 disables the timeout, allowing the actuators to operate indefinitely.

5.3.2.7 Actuator Speed

Parameter	Possible Values	Default	HHP	Lite	Std	Adv
Extend Speed	0 – 100 %	0 %	-	✓	✓	✓
Retract Speed	0 – 100 %	0 %	-	✓	✓	✓

The Speed parameters set the speed at which the Actuator Profile runs in the selected direction. Both directions can be set individually. This can be useful for Actuator Profiles that have a very different load for the two different directions.

For example: a seat that is being raised has a much higher load than a seat that is being lowered. To make the speed when the seat goes up the same as the speed when the seat goes down, select 100% speed for the up direction and 30% or 50% for the down direction.

These values are percentages of the programmed Max Motor Volts parameter (see 5.3.1.2).

Warning:

Any recommended Wizard setting in this manual is provided as a guideline only. It is the responsibility of the powerchair manufacturer and installer to determine the suitable settings for each individual chair design.

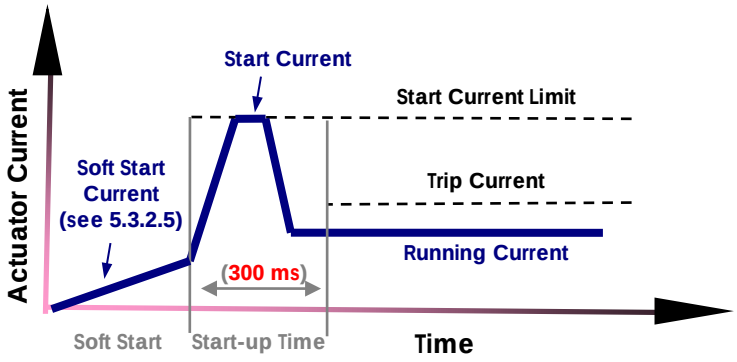
5.3.2.8 Actuator Start Current / Trip Current

Parameter	Possible Values	Default	HHP	Lite	Std	Adv
Extend Start Current	0 – 18A	0A	-	-	-	✓
Extend Trip Current	0 – 15A	0A	-	-	-	✓
Retract Start Current	0 – 18A	0A	-	-	-	✓
Retract Trip Current	0 – 15A	0A	-	-	-	✓

The start-up current of an actuator is usually much higher than the running current.

The **Start Current** parameter sets the maximum current that the Actuator Module provides to the actuators during the start-up time. The Start Current parameter is only valid during the 300ms start-up time period.

The **Trip Current** Parameter sets the running current at which the Actuator Profile will stop moving in the up or down direction. This parameter only takes effect after the start-up time has passed.



It is possible to set a different Trip Current for both actuator directions. For example: if an actuator operates a seat lift, the start current and running current will be much higher when the seat goes up than when the seat goes down. The trip current for the down direction can therefore be much lower than the trip current for the up direction.

Note:

*The value of **Extend Trip Current** and **Retract Trip Current** is for all combined actuators that are active in this Actuator Profile.*

*For example: if an Actuator Profile controls 3 actuators that each have a running current of 2 A in one direction, the **Trip Current** for that direction should be higher than 6 A.*

Precaution:

*If the actuators that have been programmed to operate simultaneously within one Actuator Profile have a very different current rating, make sure that the smallest actuator can handle the trip current of the heavier actuator for a prolonged period of time. If the lighter actuator cannot handle the high trip current, use a second Actuator Module with the same **Input Function Number** to connect the lighter actuator.*

5.3.2.9 Actuator Inhibit Cause

Parameter	Possible Values	Default	HHP	Lite	Std	Adv
Extend Inhibit Cause Retract Inhibit Cause	Trip Only Local-1 … Local-8 Global-1 … Global-8 Local-OR-1 Local-OR-2 Driving Stop Local-Slow1 Local-Slow2 [B] System Slowdown [B] Flash Code 2	Trip Only	-	-	-	✓

The Actuator Profile always stops moving if the running current becomes higher than the value that is specified with the **Trip Current** parameter (5.3.2.8) for the direction that the Actuator Profile is moving in.

In addition to exceeding the maximum trip current, **Inhibit Cause** can select several Actuator Control Input (ACI) Signals that will cause the Actuator Profile to stop moving in the selected direction as well.

For example: if the seat may not be lifted while the chair is driving, select 'Driving' as the **Extend Inhibit Cause** for the Actuator Profile that lifts the seat.

Values marked with a [B] are only available in actuator module version **Rev B**.

Note:

*Selecting an ACI Signal as **Inhibit Cause** does not generate that signal when the trip current is exceeded. Only an ACI input can generate an ACI Signal.*

If an Actuator Profile must be prevented from moving in both directions, use the **Act. Profile Inhibit Cause** parameter instead (see 5.3.2.4).

5.3.3 ACI Settings (per Module)

5.3.3.1 ACI Input Mode Setup

Parameter	Possible Values	Default	HHP	Lite	Std	Adv
ACI 1 Mode ACI 2 Mode	Off Fail Safe Simple Speed Pot Speed Limit	Off	-	👁	✓	✓

Mode	Operation		
Fail Safe	Six different input resistor bands are recognised. All values can be obtained using 150 Ω resistors only.		
	Band	**Range (Ω)**	
	short circuit	< 67	
	75 Ω	67 – 93	
	225 Ω	204 – 256	
	375 Ω	341 – 419	
	525 Ω	480 – 582	
	open circuit	All other	
Simple	Five different input resistor bands are recognised. These values can be obtained using 120 Ω and 330 Ω resistors. This mode is similar to the Multi Speed mode of the Shark system.		
	Band	**Range (Ω)**	
	short circuit	0 – 74	
	225 Ω	74 – 224	
	375 Ω	224 – 374	
	525 Ω	374 – 500	
	open circuit	> 500	
Speed Pot Speed Limit	Analogue input that scales down (Pot) or limits (Limit) the speed of the powerchair, depending on the resistance between the ACI terminals. Either a 500 Ω linear potentiometer or discrete resistors can be used. The Speed Pot and Speed Limit values work in parallel with all other Speed Pots and Speed Limits that are present in the DX System: the one with the lowest momentary value will determine the speed.		
	Band	**Range (Ω)**	**Speed (%)**
	short circuit	0 – 50	0
	linear range	50 – 450	0 – 100
	full speed	450 - 600	100
	open circuit	> 600	Fault / Inhibit

5.3.3.2 ACI 1 / 2 Monitoring

Parameter	Possible Values	Default	HHP	Lite	Std	Adv
[B] ACI 1 Monitoring [B] ACI 2 Monitoring	Continuous Latched	Continuous	-	-	-	✓

Sets the ACI Monitoring mode:

- 'Continuous' mode monitors the ACI constantly while the chair is turned on.
- 'Latching' mode (normally used with tilt switches) does not monitor the ACI while the chair is driving.

See section 4.3.4.4 for an discussion of Latched vs. Continuous monitoring.

This parameter is only available in actuator module version **Rev B**.

5.3.3.3 ACI Resistor Band Setup

Parameter	Possible Values	Default	HHP	Lite	Std	Adv
ACI Resistor Band Setup	None Local-1 ... Local-8 Global-1 ... Global-8 Flash Code 2 Stop System Slowdown Local-Slow1 Local-Slow2	None	-	-	-	✓

Each active band of the chosen ACI Input Mode can generate a signal when the band is triggered (when the input resistance at the ACI terminals is equal to the resistance value of that band).

A signal can

- stop or slow down the powerchair with the Stop, System Slowdown and Local Slow options
- stop the actuators from moving in one or both directions , if the currently active Actuator Profile has the chosen signal selected in its Act. Profile Inhibit Cause, Extend Inhibit Cause or Retract Inhibit Cause parameter.

For each band you can set the desired signal with the **ACI Resistor Band Setup** parameter.

For a detailed description of each signal see ACI Signals, section 4.3.4.

5.3.3.4 ACI Local OR signals

Parameter	Possible Values	Default	HHP	Lite	Std	Adv
Local OR 1 (Input 1/2/3) Local OR 2 (Input 1/2/3)	None Local-1 … Local-8 Global-1 … Global-8 Driving Stop Local-Slow1 Local-Slow2 [B] System Slowdown [B] Flash Code 2	None	-	-	-	✓

The **Act. Profile Inhibit Cause**, **Extend Inhibit Cause** and **Retract Inhibit Cause** parameters (see 5.3.2.4) can be used to stop an Actuator Profile from running in one or both directions. The inputs to these parameters can be one of the ACI Signals (see 4.3.4) that can be selected with the **ACI Resistor Band Setup** parameter (0).

However, in some designs an Actuator Profile must stop moving when not just one, but any one of two or three situations occurs.

For example: the seat cannot be lowered more when either the end-of-travel switch of the actuator is active, or the seat crash switch of the chair seat is active, or the chair is driving.

The Actuator Module provides two Local OR signals that can have up to 3 inputs each, to satisfy this need.

In the above example:

- select the two signals that are generated by the switches as Input 1 and Input 2
- select Driving as Input 3.
- In the affected Actuator Profile, select the applicable Local-OR signal as the **Act. Profile Inhibit Cause**, **Extend Inhibit Cause** or **Retract Inhibit Cause**.

Values marked with a [B] are only available in actuator module version **Rev B**.

5.3.3.5 ACI Local Slow signals

Parameter	Possible Values	Default	HHP	Lite	Std	Adv
Local-Slow1 Speed Pot	0 – 100 %	0 %	-	-	-	✓
Local-Slow1 Speed Limit						
Local-Slow2 Speed Pot						
Local-Slow2 Speed Limit						

Each Actuator Module has two different local slowdown functions.

The slowdown functions are activated if

- a band in the ACI Resistor Band Setup of this Actuator Module has the value Local-Slow1 or Local-Slow2, and
- that band becomes activated: the input resistance at the ACI terminals is equal to the value of that band.

Each slowdown function can slow down the speed of the chair with a separate Speed Pot and Speed Limit component. If one of the two components is not needed, leave its value at 100%.

Note:

Local-Slow1 and Local-Slow2 are additional to the Local-Slow1 and Local-Slow2 parameters of the other Actuator Modules, and also additional to the System Slowdown parameter and all other Speed Pots and Speed Limits in the system.

All slowdown and limiting functions that are present in the DX System work in parallel: the one with the lowest momentary value will determine the actual maximum speed.

5.4 Scenarios

This section provides several simple scenarios from design to implementation.
Each scenario provides standard programming settings for that situation.

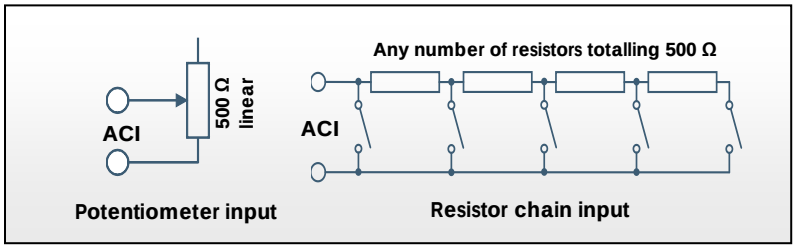
Warning:

Any recommended setting is provided as a guideline only.
It is the responsibility of the powerchair manufacturer and installer to determine the suitable settings for each individual chair design.

5.4.1 Connecting an external Speed Pot

Each Actuator Module has two Actuator Control Input (ACI) connections (see 4.3.4).

If either ACI-1 or ACI-2 has its operating mode set to **Speed Pot Mode** or **Speed Limit Mode** (see 4.3.4.3), it is possible to connect to it a linear 500 Ω potentiometer that acts as an extra Speed Pot or Speed Limit controller.



The Speed Pot/Speed Limit value works in parallel with all other Speed Pots and Speed Limits that are present in the DX System: the one with the lowest momentary value will determine the actual maximum speed.

Possible Wizard settings

Actuator Module Settings						
ACI 1 Mode	Speed Pot					
ACI 2 Mode	Off					
	Short	B1	B2	B3	B4	Open
ACI1 Resistor Band Setup	None	None	None	None	None	Local-Slow1
ACI2 Resistor Band Setup	None	None	None	None	None	None
	Pot (%)	Limit (%)				
Local-Slow1	50	30				
Local-Slow2	100	100				

Local-Slow1 is an optional ACI Signal that is used to slow down the chair when the speed pot circuit is disconnected (for more information on ACI signals see 4.3.4).

Note:

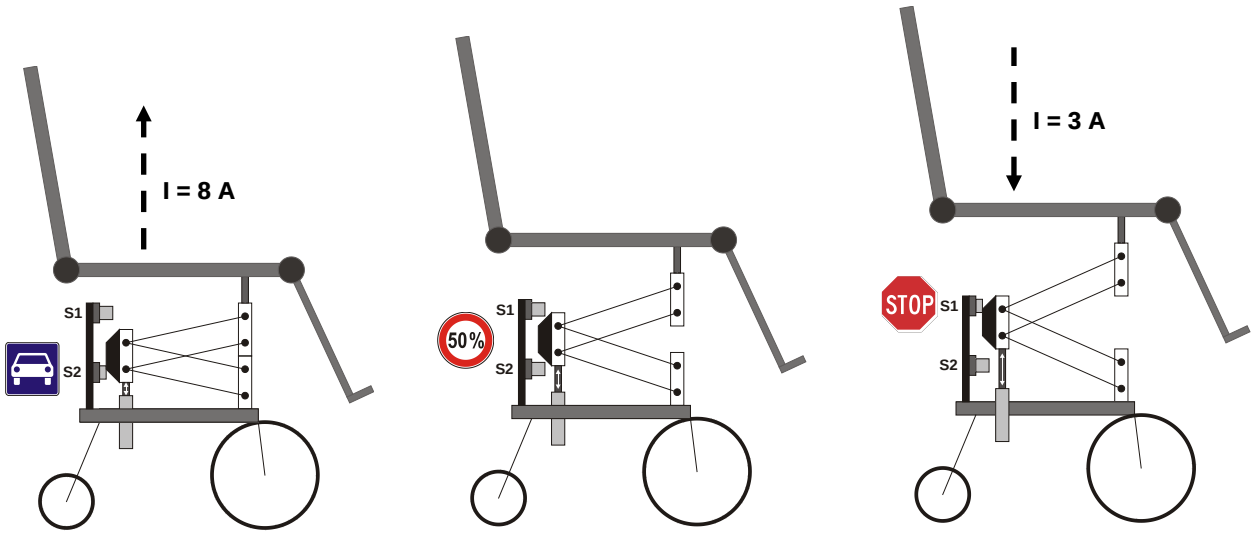
*If a **Speed Pot** has the value zero, the maximum speed of the powerchair is not zero, it is equal to the **Forward Speed @ Minimum** parameter for the currently active Drive Profile.*

*If a **Speed Limit** has the value zero, the maximum speed of the powerchair is also zero. If **Speed Limit Mode** is used, an extra series resistor can prevent the chair from entering drive inhibit when the pot is fully turned down.*

For more information about the Speed Pot and Speed Limit functions, see the 'Speed limiting options' section in the DX System Manual.

5.4.2 Seat raise example

This chair has one actuator to raise the seat. The actuator needs a current of max. 8 A to raise the seat and a current of max. 3 A to lower the seat. Two limit switches reduce the drive speed of the chair when the seat is raised.

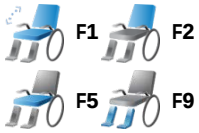


Step-by-step procedure

1. **Decide which actuator will be connected to which channel of the available actuator modules.**
2. **Assign input function numbers to the Actuator Profiles (the DX2 Master Remote selects this function number in the accessory menu).**
3. **Assign the actuator channels to the applicable Actuator Profiles.**

Channel	Actuator Module ① ACT2
1	Seat Lift
2	Unused

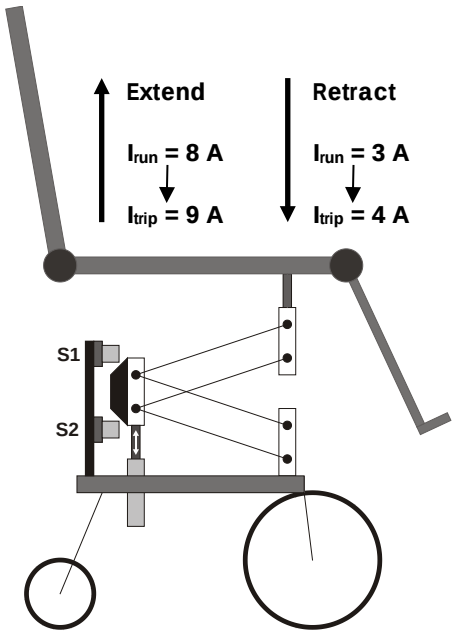
DX2 function icons (see 5.3.2.1)



DX2-ACT2-1

② Actuator Profiles

	Profile A	Profile B	Profile C	Profile D
Input Function Number	5	0	0	0
Operating Mode	Switched	Switched	Switched	Switched
Output Channel 1 Select ③	Normal	Not Used	Not Used	Not Used
Output Channel 2 Select	Not Used	Not Used	Not Used	Not Used



4. Enter the speed at which the actuator moves, for both directions separately.

The actuator runs a lot slower when the seat goes up than when the seat goes down, because in the up direction the actuator must operate against gravity. If you want the seat to go down at the same mechanical speed as that it goes up, decrease the 'Retract Speed' setting until the down-speed is the same as the up-speed.

5. Enter the trip currents (the currents that will stop the actuator movement at the end-of-travel). Always use a trip current that is less than the stall current and higher than the running current in the selected direction. Note: the stall current is dependent on the speed setting and the momentary battery voltage.

In this case the running current in the up direction is much higher than the running current in the down direction, because in the up direction the actuator must operate against gravity.

6. Enter the start-up currents.

Before an actuator starts to move, the current can be much higher than the running current. For the first 300ms after joystick deflection the actuator will not trip, and the current is limited by the 'Start Current' parameter. Choose a value that helps the actuator to start moving but does not damage the actuator when applied for 300ms.

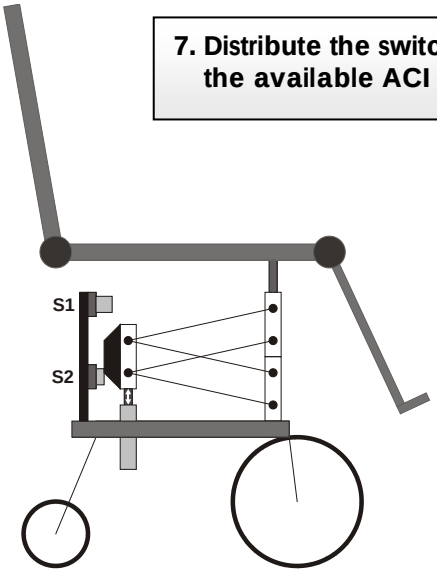
For more information about the start sequence of the actuators see section 5.3.2.8

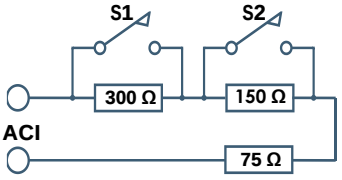
DX2-ACT2-1

Actuator Profiles

	Profile A	Profile B	Profile C	Profile D
Extend Speed (%)	100 (4)	100	100	100
Extend Start Current (A)	15.0 (6)	8.0	8.0	8.0
Extend Trip Current (A)	9.0 (5)	6.0	6.0	6.0
Retract Speed (%)	30 (4)	100	100	100
Retract Start Current (A)	12.0 (6)	8.0	8.0	8.0
Retract Trip Current (A)	4.0 (5)	6.0	6.0	6.0

7. Distribute the switches over the available ACI inputs.

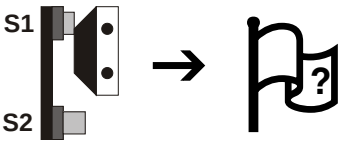




Two switch fail safe ACI input

Band	Cause
Open circuit	fault
B4 - 525 Ω	both open
B3 - 375 Ω	S2 closed
B2 - 225 Ω	S1 closed
B1 - 75 Ω	both closed
Short circuit	fault

		ACT2	
Switch Name	**Activates when**	**ACI1**	**ACI2**
Seat fully up	The seat is completely raised	S1	x
Seat fully down	The seat is completely down (end stop)	S2	x

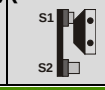


8. Determine the ACI signals that the switches must generate (for more information on ACI signals see section 4.3.4).

It is not mechanically possible that S1 and S2 are both closed. If this situation occurs, the chair probably either has mechanical or electrical problems, which is serious enough to stop the chair from driving.

If S1 is closed, the seat is in a high position which makes the chair mechanically very unstable. To keep the chair safe, it must not be allowed to drive if the seat is in this position. Select Local-Slow1 to slow down the chair. Set the 'Local-Slow1 Limit' to 0% to limit the chair to zero speed (Drive Inhibit).

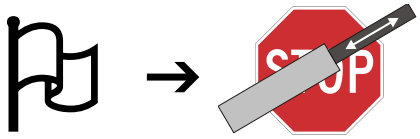
S2 is used as an end-of-travel detection to prevent damage to the actuator. In order to detect the switch it must generate any signal other than 'None'. In this case we use 'Local-1'.

Short (fault)	B1 (both closed)	B2 (S1 closed)	B3 (S2 closed)	B4 (both open)	Open (fault)
X	X				X

Actuator Module Settings						
ACI 1 Mode	Fail Safe					
ACI 2 Mode	Off					
	Short	B1	B2	B3	B4	Open
ACI1 Resistor Band Setup	Stop (Inhibit)	Stop (Inhibit)	Local-Slow1	Local-1	Local-Slow2	Stop (Inhibit)
ACI2 Resistor Band Setup	None	None	None	None	None	None
	Pot (%)	Limit (%)				
Local-Slow1	100	0				
Local-Slow2	100	50				

Short circuit and open circuit should not occur. This might be a sign of crushed wires or a loose connection, which is serious enough to stop the chair from driving.

If both switches are open, the seat is partially raised which makes the chair mechanically unstable. Select Local-Slow2 to slow down the chair. Set the 'Local-Slow2' parameter to 50% to limit the chair to 50% of its maximum speed.



9. Assign the generated signals from the previous step to the applicable Inhibit Causes.

To stop an actuator function from moving in one or both directions, its Actuator Profile must have the chosen signal selected in its **Act. Profile Inhibit Cause**, **Extend Inhibit Cause** or **Retract Inhibit Cause** parameter.

- If the seat is moving down and the actuator runs into its end stop with the full weight of the operator on it, it may become damaged or stuck. To prevent damage to the actuator, S2 is used as an end stop detection to make sure that the actuator stops before it reaches its end-of-travel. To achieve this, the seat must stop moving downward when S2 is closed, which is detected by band B3 from the previous step. Band B3 has the signal **Local-1** assigned to it, therefore select **Local-1** as the **Retract Inhibit Cause**.
- If the seat is moving up, the weight of the operator presses in the opposite direction of the movement of the actuator. For this reason it is not necessary to stop the actuator before it reaches its end-of-travel, because it will not get stuck or damaged. The actuator can keep on moving until it reaches the end-of-travel and trips, therefore select the default **Trip Only** as the **Extend Inhibit Cause**. If you do want to use S1 as end stop detection, select the signal that is generated in band B2 of the previous step: **Local-Slow1**.
- To prevent the seat from being moved while driving, **Driving** is selected as the **Act. Profile Inhibit Cause**.

Actuator Profiles				
	Profile A	Profile B	Profile C	Profile D
Input Function Number	5	0	0	0
Operating Mode	Switched	Switched	Switched	Switched
Output Channel 1 Select	Normal	Not Used	Not Used	Not Used
Output Channel 2 Select	Not Used	Not Used	Not Used	Not Used
Act. Profile Inhibit Cause	**Driving**	None	None	None
Soft Start/Stop Time (s)	0.5	0.5	0.5	0.5
Extend Speed (%)	100	100	100	100
Extend Start Current (A)	15.0	8.0	8.0	8.0
Extend Trip Current (A)	9.0	6.0	6.0	6.0
Extend Inhibit Cause	**Trip Only/Local-Slow1**	Trip Only	Trip Only	Trip Only
Retract Speed (%)	30	100	100	100
Retract Start Current (A)	12.0	8.0	8.0	8.0
Retract Trip Current (A)	4.0	6.0	6.0	6.0
Retract Inhibit Cause	**Local-1**	Trip Only	Trip Only	Trip Only

Actuator Module Settings						
ACI 1 Mode	Fail Safe					
ACI 2 Mode	Off					
	Short	B1	B2	B3	B4	Open
ACI1 Resistor Band Setup	**Stop (Inhibit)**	**Stop (Inhibit)**	**Local-Slow1**	**Local-1**	**Local-Slow2**	**Stop (Inhibit)**
ACI2 Resistor Band Setup	None	None	None	None	None	None
	Pot (%)	Limit (%)				
Local-Slow1	100	**0**				
Local-Slow2	100	**50**				

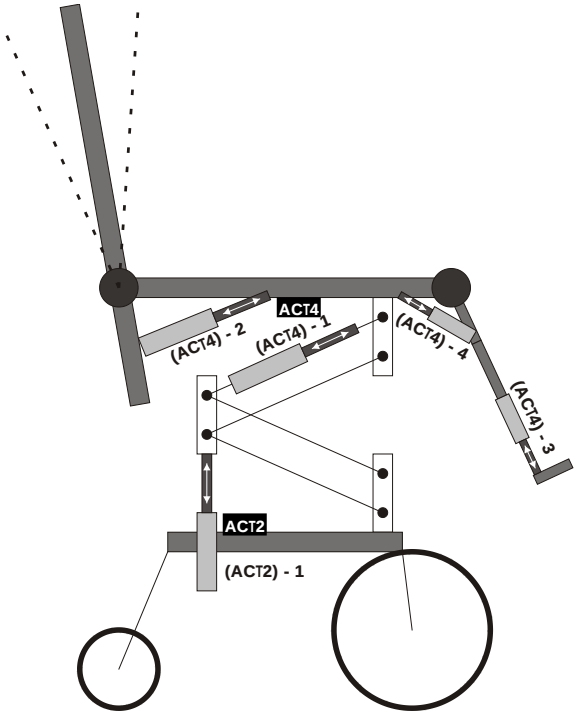
Note:

*The DX2 Actuator Module ignores the **Actuator While Driving** parameter that is used by the DX-CLAM/TAM to prevent the operation of actuators while the wheelchair is driving.*

*To prevent an Actuator Profile from operating while driving, use 'Driving' as an **Act. Profile Inhibit Cause** instead, for every Actuator Profile separately.*

5.4.3 Full chair example

This example uses a chair that has 5 actuators and two Actuator Modules. The example is not based on a real chair, it only explains the principle of setting up and programming a DX2 Actuator Module.



Step-by-step procedure

1. **Decide which actuator will be connected to which channel of the available actuator modules.**

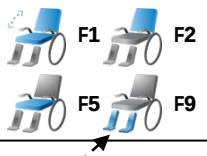
Connect the four actuators on the upper chair assembly to the ACT4 module under the seat. This reduces the wiring requirements between the power base and the upper assembly to a single DX BUS cable.

2. **Assign function numbers to the Actuator Profiles (the DX2 Master Remote selects this function number in the accessory menu).**

3. **Assign the actuator channels to the applicable Actuator Profiles.**

	Actuator Modules	
Channel	**ACT4**	**ACT2**
1	Seat Tilt (F1)	Seat lift (F5)
2	Back rest angle (F2)	Unused
3	Legs extend (F11)	Not available
4	Legs angle (F9)	Not available

DX2 function icons (see 5.3.2.1)



DX2-ACT4-1

Actuator Profiles

	Profile A	Profile B	Profile C	Profile D	Profile E	Profile F
Input Function Number	1	2	11	9	0	0
Operating Mode	Switched	Switched	Switched	Switched	Switched	Switched
Channel 1 Select	Normal	Not Used	Not Used	Not Used	Not Used	Not Used
Channel 2 Select	Not Used	Normal	Not Used	Not Used	Not Used	Not Used
Channel 3 Select	Not Used	Not Used	Normal	Not Used	Not Used	Not Used
Channel 4 Select	Not Used	Not Used	Not Used	Normal	Not Used	Not Used

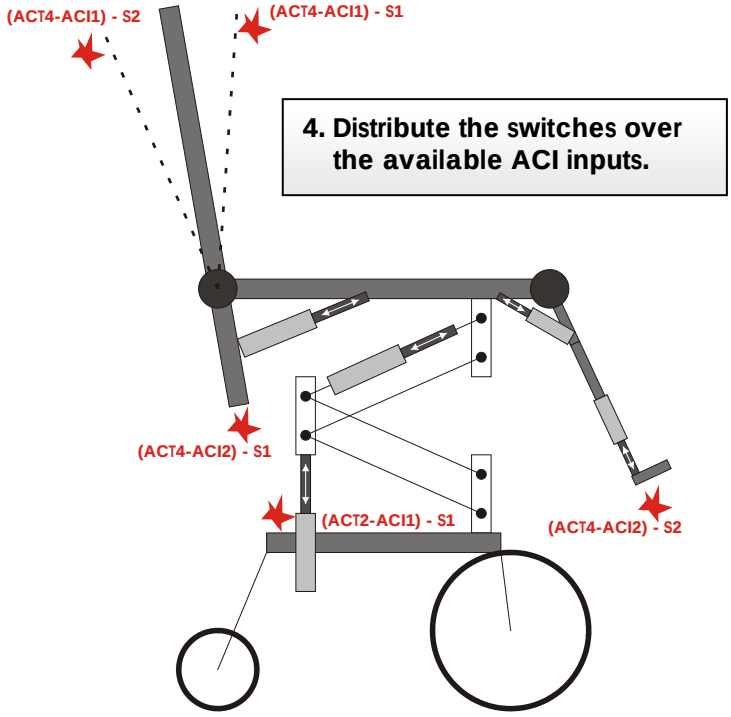
DX2-ACT2-1

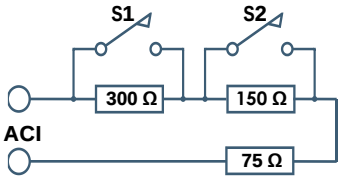
Actuator Profiles

	Profile A	Profile B	Profile C	Profile D
Input Function Number	5	0	0	0
Operating Mode	Switched	Switched	Switched	Switched
Channel 1 Select	Normal	Not Used	Not Used	Not Used
Channel 2 Select	Not Used	Not Used	Not Used	Not Used

Wizard settings for the above configuration

The designer has chosen to use 5 limit switches on this chair (all normally open), connected to the ACI fail-safe inputs. Each Actuator module has 2 ACI inputs (ACI1 and ACI2). Each ACI input can detect 2 switches in fail-safe mode.
For more information on the ACI see section 4.3.4.





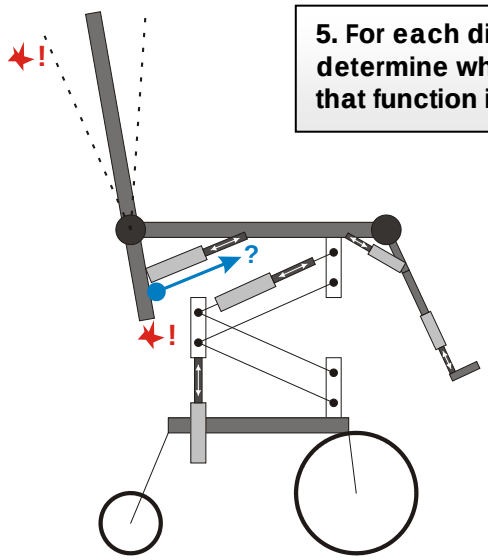
Two switch fail safe ACI input

Band	Cause
Open circuit	fault
B4 - 525 Ω	both open
B3 - 375 Ω	S2 closed
B2 - 225 Ω	S1 closed
B1 - 75 Ω	both closed
Short circuit	fault

		Actuator Modules			
		ACT4		ACT2	
Switch Name	Activates when	ACI1	ACI2	ACI1	ACI2
Tilt fwd	the back rest is tilted forward	S1			
Tilt back	the back rest is tilted backward	S2			
Seat crash	the bottom of the back rest risks crashing into the frame (for example when the back rest is tilted fully backwards and the seat is lowered to its lowest position).		S1		
Leg crash	the bottom or the back of the foot plate touches a surface (for example the front wheels or a sidewalk edge).		S2		
Seat low	the seat is fully lowered			S1	

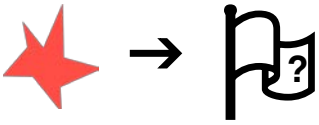
Note:

The location and setup of the switches is not a recommended chair design. These switches were chosen only to explain the principle of setting up and programming a DX2 Actuator Module.



5. For each direction of each actuator function, determine which switch can be pushed when that function is active in that direction.

Function	Module	Extend limit switches	Module	Retract limit switches	Module
Seat Tilt (F1)	ACT4	Tilt Fwd Leg Crash	ACT4 ACT4	Tilt Back Seat Crash	ACT4 ACT4
Back rest angle (F2)	ACT4	Tilt Fwd	ACT4	Tilt back Seat crash	ACT4 ACT4
Legs extend (F6)	ACT4	Leg Crash	ACT4	-	-
Legs angle (F9)	ACT4	-	-	Leg Crash	ACT4
Seat lift (F5)	ACT2	-	-	Seat Low Seat Crash Leg Crash	ACT2 **ACT4** **ACT4**



6. Determine the ACI signals that the switches must generate.

Actuator Module Settings

	Short	B1	B2	B3	B4	Open
ACI1 Resistor Band Setup	Stop (D...	Stop (D...	Local-1	Local-Sl...	None	Stop (D...
ACI2 Resistor Band Setup	Stop (D...	Global-3	Global-1	Global-2	None	Stop (D...

Signals

For more information on ACI signals see section 4.3.4.

Note:

If a switch is only used inside its own Actuator Module, its signal can be local. If a switch must be detected by another Actuator Module, its signal must be global.

In this example, the seat crash and leg crash switch that are connected to the ACI of the ACT4 module should stop the seat lift from moving (see the red text in the table of step 5). The seat lift is a function of the ACT2 module. For this reason the seat crash and leg crash switches must generate a global signal, so the ACT2 module can detect it.

ACT4-ACI1 Resistor Band Setup (fail safe mode) – S1: tilt fwd, S2: tilt back					
Short (fault)	B1 (both closed)	B2 (S1 closed)	B3 (S2 closed)	B4 (both open)	Open (fault)
X ①	 ②	 ③	 ④	 ⑤	X ①
Stop (Inhibit)	Stop (Inhibit)	Local-1	Local-Slow1	None	Stop (Inhibit)

① Short circuit and open circuit should not occur. This might be a sign of crushed wires or a loose connection, which is serious enough to stop the chair from driving.
② The seat cannot be tilted forward and backward at the same time. If this situation occurs it might be a sign of crushed wires also.
③ The Tilt Forward limit switch must stop the movement of the seat tilt and back rest functions (see table of step 5). These functions are both located in ACT4 (the same module as this ACI), so the signal can be local.
④ If the Tilt Back switch is closed, the back rest is extended which makes the chair mechanically unstable. Select Local-Slow1 to slow down the chair. How much the chair must slow down is determined by the Local-Slow1 line in the Wizard (see the Wizard screen shot).
⑤ If both switches are open no action is necessary.

ACT4-ACI2 Resistor Band Setup (fail safe mode) – S1: seat crash, S2: leg crash					
Short (fault)	B1 (both closed)	B2 (S1 closed)	B3 (S2 closed)	B4 (both open)	Open (fault)
X	 ⑧	 ⑥	 ⑦		X
Stop (Inhibit)	Global-1	Global-1	Global-2	None	Stop (Inhibit)

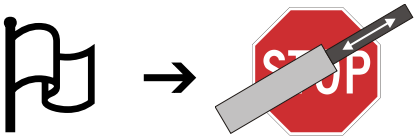
⑥ The seat crash switch should stop the seat tilt, back rest angle and seat lift functions. The seat lift function is located in another module so this signal must be global.
⑦ The leg crash switch should stop the legs extend, legs angle and seat lift functions. The seat lift function is located in another module so this signal must be global.
⑧ The seat crash switch is more important than the leg crash switch, because the seat can damage the electronic components under the chair. For this reason S1+S2 will be detected as seat crash.

ACT2-ACI1 Resistor Band Setup (fail safe mode) – S1: seat low, S2: unused					
Short (fault)	B1 (both closed)	B2 (S1 closed)	B3 (S2 closed)	B4 (both open)	Open (fault)
X	X (9)	 (10)	X (9)	 (11)	X
Stop (Inhibit)	Stop (Inhibit)	Local-1	Stop (Inhibit)	Local-Slow1	Stop (Inhibit)

(9) S2 is not used, so this situation should not occur. If this input resistance is detected, it might be a sign of crushed wires, serious enough to stop the chair from driving.

(10) The seat low switch should stop the seat lift function. This function is located in the same ACT2 module, and it is not used by the ACT4 module, so the signal can be local. Note: this 'Local-1' signal is not related to the 'Local-1' signal of the ACT4 module (assigned to 'tilt fwd', above). The ACT2 cannot detect local signals that belong to other Actuator Modules.

(11) If the 'seat low' switch is not closed, the seat is raised which makes the chair mechanically unstable. Select Local-Slow1 to slow down the chair.



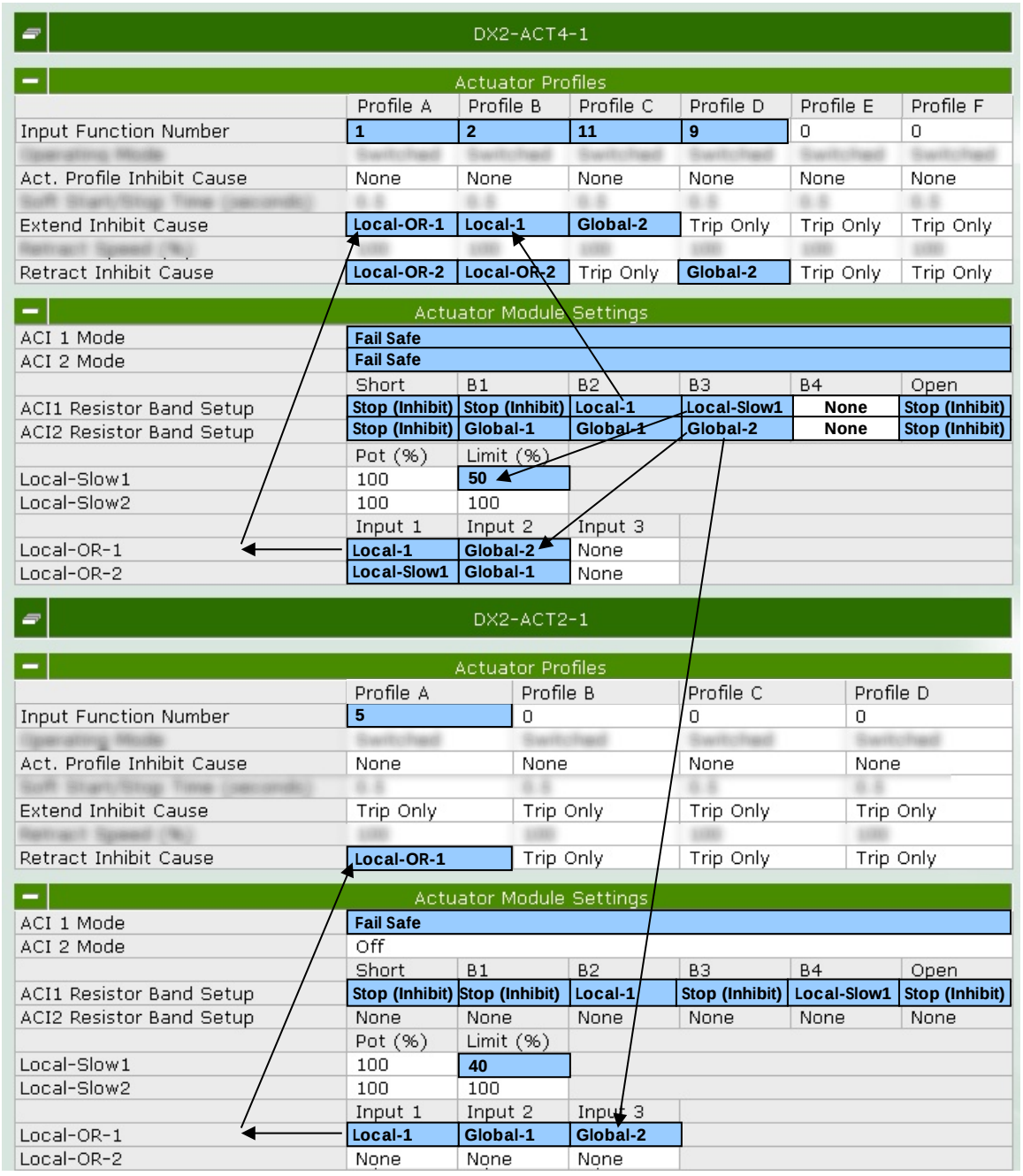
7. Assign the generated signals from step 6 to the applicable Inhibit Cause in the table of step 5.

To stop an actuator function from moving in one or both directions, its Actuator Profile must have the chosen signal selected in its **Act. Profile Inhibit Cause**, **Extend Inhibit Cause** or **Retract Inhibit Cause** parameter.

Function	Extend Inhibit Cause	Signal	Retract Inhibit Cause	Signal	Profile Inhibit Cause
Seat Tilt (F1)	Tilt Fwd Leg Crash	Local-1 Global-2 → Local-OR-1*	Tilt Back Seat Crash	Local-Slow-1 Global-1 → Local-OR-2	
Back rest angle (F2)	Tilt Fwd	Local-1	Tilt Back Seat crash	Local-Slow-1 Global-1 → Local-OR-2	
Legs extend (F6)	Leg Crash	Global-2	-	Trip Only	
Legs angle (F9)	-	Trip Only	Leg Crash	Global-2	
Seat lift (F5)	-	Trip Only	Seat Low Seat Crash Leg Crash	Local-1 Global-1 Global-2 → Local-OR-1**	

* The seat tilt must stop moving when either the Local-1 or the Global-2 signal is active. The two signals are directed into a Local-OR function that creates a new single signal of 3 inputs, see screen shot below.

** The Local-OR functions are only active in their own Actuator Module. This Local-OR-1 function is therefore separate from the Local-OR-1 function of the ACT4 Module (used with seat tilt).



DX2-ACT4-1

Actuator Profiles

	Profile A	Profile B	Profile C	Profile D	Profile E	Profile F
Input Function Number	**1**	**2**	**11**	**9**	0	0
Act. Profile Inhibit Cause	None	None	None	None	None	None
Extend Inhibit Cause	**Local-OR-1**	**Local-1**	**Global-2**	Trip Only	Trip Only	Trip Only
Retract Inhibit Cause	**Local-OR-2**	**Local-OR-2**	Trip Only	**Global-2**	Trip Only	Trip Only

Actuator Module Settings

ACI 1 Mode	**Fail Safe**					
ACI 2 Mode	**Fail Safe**					
	Short	B1	B2	B3	B4	Open
ACI1 Resistor Band Setup	**Stop (Inhibit)**	**Stop (Inhibit)**	**Local-1**	**Local-Slow1**	**None**	**Stop (Inhibit)**
ACI2 Resistor Band Setup	**Stop (Inhibit)**	**Global-1**	**Global-1**	**Global-2**	**None**	**Stop (Inhibit)**
	Pot (%)	Limit (%)				
Local-Slow1	100	**50**				
Local-Slow2	100	100				
	Input 1	Input 2	Input 3			
Local-OR-1	**Local-1**	**Global-2**	None			
Local-OR-2	**Local-Slow1**	**Global-1**	None			

DX2-ACT2-1

Actuator Profiles

	Profile A	Profile B	Profile C	Profile D
Input Function Number	**5**	0	0	0
Act. Profile Inhibit Cause	None	None	None	None
Extend Inhibit Cause	Trip Only	Trip Only	Trip Only	Trip Only
Retract Inhibit Cause	**Local-OR-1**	Trip Only	Trip Only	Trip Only

Actuator Module Settings

ACI 1 Mode	**Fail Safe**					
ACI 2 Mode	Off					
	Short	B1	B2	B3	B4	Open
ACI1 Resistor Band Setup	**Stop (Inhibit)**	**Stop (Inhibit)**	**Local-1**	**Stop (Inhibit)**	**Local-Slow1**	**Stop (Inhibit)**
ACI2 Resistor Band Setup	None	None	None	None	None	None
	Pot (%)	Limit (%)				
Local-Slow1	100	**40**				
Local-Slow2	100	100				
	Input 1	Input 2	Input 3			
Local-OR-1	**Local-1**	**Global-1**	**Global-2**			
Local-OR-2	None	None	None			

Wizard screenshot of the settings for this scenario

6 Diagnostics / Troubleshooting

Note:

*The diagnostics feature in Wizard (**Tools → Diagnose Controller**) can be used to determine and provide more detail on the cause of any fault.*

6.1 The Status LED

Each Actuator Channel has a green LED to indicate the status of the actuator. The LED that belongs to Actuator Channel 1 (called "LED 1") acts as the Module Status LED.

If the system is on and there are no faults present, LED 1 is continuously on, and all other LEDs are off.

When the module is operating one or more actuators, the LEDs of the channels that are operated will flash continuously at 0.5 Hz as long as the channels are operated.

When there is a fault with the Actuator Module, LED 1 displays a Flash Code that indicates the cause of the fault. See section 6.1.1 for a description of the Flash Codes.

If an ACI switch condition or other condition is present that changes the drive characteristics of the chair (normally this is a slow or stop condition), LED 1 shows Flash Code 2. See section 6.1.2 for a list of the possible conditions and the way they are indicated on the Actuator Module and the Master Remote.

If multiple LED-situations occur simultaneously, a fault code has priority over a channel operating indication, which in turn has priority over an ACI-caused Flash Code 2.

6.1.1 DX2-ACT Flash Code List

Note:

These flash codes are the Actuator Module flash codes that are visible on LED 1 of the Actuator Module. They are not the DX System flash codes that are visible on the DX System status LED on the Master Remote.
For DX System flash codes, see the DX System Manual.

Flash Code	Fault source	Sub code (HHP)	Meaning
01	User	00	Wizard programming in progress • Finish programming and then turn the system off and on. • Make sure that you wait 10 seconds after you have turned the system off before you turn it on again.
		01	Power Down in progress • Wait 10 seconds before you turn the system on again.
		02	Joystick source changed to a joystick that is not in the centre position • Release the joystick to the centre
		03	Invalid Actuator Profile (A-F) or direction demand • If this happens often, contact DYNAMIC
02	Slow function	none	See 6.1.2
	Battery	00	Battery Voltage too low or too high • Check the batteries and the cables • Batteries may be empty: charge the batteries • Batteries may be damaged: replace the batteries Batteries may be overcharged: if driving downhill, slow down
03	Actuator	00 01 02 03	Internal current or Voltage fault • Contact DYNAMIC
		04 05	Actuator motor voltage is not what it should be during drive Possible motor short circuit • check the actuator cables for damage • check that the actuator is not faulty • Otherwise internal controller fault, contact DYNAMIC
		06	Failed To Stop
		07	Too Many Fast Current Limit Events
		08	Driving Stopped Due To Trip
		All other	Internal fault • Contact DYNAMIC
06	Configuration	01	Module ID collision • Check that multiple Actuator Modules in the system do not have the same ID (see section 4.3.1)
		02	System check failed
		03	Missing system check
		05	DX System internal fault Actuators will not move when the DX System itself is in a fault state
		All other	Internal DX2-ACT configuration fault • Check DX BUS cables • Turn the system off and on several times. Make sure to wait 10 seconds before you turn the system on again. • If turning the system off and on does not help, contact DYNAMIC

Flash Code	Fault source	Sub code (HHP)	Meaning
9, 10	DX BUS	All	DX BUS hardware fault • Check DX BUS cables • Turn the system off and on several times. Make sure to wait 10 seconds before you turn the system on again. • If all DX BUS connections are OK and turning the system off and on does not help, contact DYNAMIC
12	Actuator	All	Undriveable Actuator Raised when an actuator is detected with no functions that can drive it. Possible causes include an incorrect program or an actuator plugged into the wrong connector.
All other	Internal fault	All	Contact DYNAMIC

6.1.2 System condition indications

Condition	DX2-ACT indication	DX2-REM550 indication (DX2)	DX-REMG90 indication (DX)
DX System Faults			
CLAM is enabled	None, but ACT will not drive actuators	None	None
Master Remote in Fault State	FC6	FC according to fault	FC according to fault
DX2-ACT detects CAN Fault	FC6/9/10, depending on actual fault	FC according to fault detected by Remote	FC according to fault detected by Remote
Actuator System Configuration Faults			
Module ID Collision (2 modules with same ID)	FC6, No DX BUS communication	Actuator system will be "missing"*	None
REM550 Actuator System Missing "Stop Drive"	None	FC2, Drive inhibit*	Not detected
REM550 Actuator System Missing "Slowdown Drive"	None	FC2*	Not detected
ACT Module Missing "Slow1/Slow2"	FC2 on remaining ACT Module	Reduced speed on Speedometer	None
ACT Module Missing "Stop"	FC2 on remaining ACT Module	Drive Inhibit	Drive Inhibit
Actuator Module Local Fault	See 6.1.1	None	None
ACI "Slow" function active (see 4.3.4)			
ACI "Flash Code 2"	FC2	FC2	FC2
ACI "Stop (Drive Inhibit)"	FC2	Drive inhibit	Drive inhibit
ACI "System Slowdown"	FC2	FC2	FC2
ACI "Local Slow"	FC2	Reduced speed on Speedometer	None
ACI in Speed Pot or Speed Limit mode, with outputs less than 100%	FC2	Reduced speed on Speedometer	None

*The REM550 responds to a missing DX2 actuator system if the following parameters are set:

Parameter	Required Value
Actuator System Type	DX2 Actuator System
Actuator System Is Critical	Yes
Actuator System Missing	"Stop Drive" or "Slowdown Drive", as desired.

6.2 Incompatibility with DX (non-DX2) modules

6.2.1 DX2-ACT module + DX Master Remote

6.2.1.1 No safety critical operation possible

The DX CLAM/TAM actuator system and the DX2 actuator system are completely separate. A DX Master Remote does not recognise the DX2 **Actuator System Is Critical** parameter, and the DX2-ACT ignores the **CLAM Is Critical** parameter.

As a result, the DX Master Remote does not detect the absence of an ACT Module, and does not take any action (such as drive inhibit).

Warning:

*Use a **DX2** Master Remote in combination with the DX2-ACT for safety critical applications.*

6.2.1.2 Proportional operating modes not supported

DX Master Remotes do not support the method of proportional actuator control that the DX2-ACT uses.

Do not set the **Operating Mode** parameter (5.3.2.2) to proportional when a DX Master Remote is used. This results in erratic actuator behaviour. Use a DX2 Master Remote for proportional actuator control.

6.2.1.3 Latched movement not stopped

DX2 Master Remotes automatically stop latched actuator movement when another actuator function is selected during actuator operation. Classic DX Master Remotes do not have this feature when they are used with the DX2-ACT.

If the DX2-ACT is used together with a classic DX Master Remote, stop the latched actuator movement before selecting another actuator. Alternatively, turn the system off to stop all actuator movement.

Warning:

If latched actuators are enabled on a DX chair, the manual should notify the end user that turning the system off stops all actuator movement.

6.2.1.4 "Actuator While Driving" parameter is ignored

The **Actuator While Driving** parameter is used to prevent the operation of actuators while the wheelchair is driving. This parameter is only used by the DX-CLAM/TAM.

The DX2-ACT module has a more flexible method to prevent operation of actuator functions while driving: select **Driving** as an **Act. Profile Inhibit Cause** (5.3.2.4) or as an **Actuator Inhibit Cause** (5.3.2.9) for each applicable **Actuator Profile** (5.3.2).

6.2.1.5 Only function number 1-5 supported

DX Master Remotes can select only the first five actuator functions.
For this reason only use **Input Function Number** 1-5 with DX Master Remotes.

6.2.1.6 Two leg rests F3 + F4 translated to F9

Some DX Master Remotes can request functions F3 and F4 (both leg rests) simultaneously. The DX2 Actuator Module can only operate one Actuator Profile simultaneously. For this reason the DX2 Actuator Module translates an F3+F4 request into an F9 request.

If your chair has two leg rests and a DX Master Remote that can control channel 3 and 4 simultaneously, make sure to program 3 different Actuator Profiles with

- F3 to control the left leg rest
- F4 to control the right leg rest
- F9 to control both leg rests simultaneously

If F9 is not programmed, F3 + F4 requests have no effect.

6.2.2 DX2-ACT module + DX accessory modules

6.2.2.1 CLAM Slow/Stop circuit not compatible with ACI

The DX-CLAM Slow/Stop wire loop typically uses input resistances of 10 kΩ or greater. These circuits will be seen as open circuit by the Actuator Control Input (ACI), and can not be used without adapting the resistors to the ACI resistor bands.

For more information about ACI functionality and setup see section 4.3.4.

6.2.2.2 DX-ARC5 only operates function number 1-5

The DX-ARC5 can select and operate only the first five actuator functions.
For this reason only use **Input Function Number** 1-5 with the DX-ARC5 module.

6.2.2.3 DX-ARC5 does not operate in proportional mode

Because the DX-ARC5 is a switched device only, it does not operate actuators in proportional mode on DX2 Actuator Modules.

6.2.2.4 DX-ARC5 cannot select actuators with DX2 Remote

The DX-ARC5 works normally when the DX2 Master Remote is in Drive Mode, but not when it is in Actuator Mode.

In Actuator Mode the actuator selection of the DX2 Master Remote overrides the actuator selection of the DX-ARC5. If the DX2 Remote has selected an actuator function, then only the DX-ARC5 buttons that operate that particular function can be used to operate the actuator.

For example: if the DX2 Master Remote has selected Actuator Function Number 3 (left leg rest), then the DX-ARC5 buttons for actuator 3 extend and retract can be used to operate the left leg rest, but the other buttons on the DX2-ARC5 are ignored.

6.2.2.5 DX-ARC5 + G90

When an ARC switch is pressed while an actuator is operated from the G90, the actuator stops moving and the actuator is deselected. The G90 is still in actuator mode, but no actuator is selected. The joystick must be deflected forward to reselect the actuator before it can be operated again.

6.3 Multiple power cycles after configuration changes

If the configuration of the Actuator Modules changes, it may be necessary to turn the system on and off several times before the modules operate correctly again.

After you have turned the system off, wait a minimum of 10 seconds before you turn it on again to allow the self-test of the Actuator Module to complete (see 6.3.4 below). After you have turned the system on, also wait a minimum of 10 seconds before you turn it off again.

Note:

If you don't wait 10 seconds after turning off the DX System, the Actuator Module will not work and it will show flash code 6 on its Module Status LED.

Turn the system off and on again with the on/off button (waiting 10 seconds) to activate the Actuator Module again.

6.3.1 Re-programming a working Actuator Module

If you re-program an Actuator Module that was working properly, you must turn the system off and on one time to activate the new settings.

6.3.2 Connecting a new module or changing an ID

If you connect a new module to the system, or change the ID of an existing module, you must turn the system on and off two times to activate the new module or ID.

6.3.3 Two modules with the same ID

If two modules have the same ID, they will both refuse to work when the system is turned on. After one module is removed or its ID is changed to a free ID, you must turn the system on and off two times to activate the modules.

6.3.4 Incorrect power down

The Actuator Module performs a self-test when the system is turned off with the on/off button of the Master Remote. If the Actuator Module is turned off in another way (for example: the battery is disconnected, or the DX BUS cable to the Actuator Module is disconnected while the DX System was turned on), it cannot perform the self-test.

The next time the DX System is turned on, the Actuator Module detects that the self-test has failed and as a result it will refuse to work. Turn the system off and on again with the on/off button (waiting 10 seconds) to activate the Actuator Module.

7 Appendices

7.1 DX2-ACT Loom Kit

Part Description	Dynamic Controls Part Number	Qty / Unit
DX2-ACT Loom Kit	DX2LOOM-ACT	1

The DX2-ACT Loom Kit includes the following parts:

Part Description	Dynamic Controls Part Number	Qty / Unit
DX POSITRONIC CONTACT FEMALE LARGE	GCN0793	8
DX POSITRONIC CONTACT FEMALE SMALL	GCN0794	4
CONNECTOR PLUG HOUSING - DX2 ACT	GME65345	4
CONNECTOR PLUG HOUSING - DX2 ID/ACI	GME65347	1
DX2-ACT MODULE ID PCB	GPC65329A	1

Note:

The DX2-ACT Loom Kit, described above, is suitable for both DX2-ACT4 & DX2-ACT2 modules, although a DX2-ACT2 module will not need all the parts listed. It is possible to order the parts separately – please contact DYNAMIC CONTROLS for more information.

Precautions:

With reference to the DX2-ACT Loom Kit above, GCN0793 is rated for 1.5-2.5 mm² (16-14 AWG) wire. For 0.5 mm² (20 AWG) wire, use GCN0794. For 0.75-1.0 mm² wire, GCN0797 is more suitable if it is available.

Do not use wire gauges smaller than 0.5 mm² (20 AWG) because smaller wires are physically not strong enough for this application.

7.2 Intended Use and Regulatory Statement

Intended Use

The DX2-ACT family of Actuator Modules allow drive and control of the Actuators installed in a DX System. The DX2-ACTx is a module of the DX System.

The DX System is a family of modules intended to control powered wheelchairs. The DX System offers flexibility in integrating compatible input and output devices, as configured and connected, and provides extensive adaptability to meet specific user needs through optimal programmability.

The DX System is intended to operate powered wheelchairs utilising 24V motors with integrated park brakes.

The powerchair manufacturers are provided with the integration, set-up, operating environment, test and maintenance information needed to ensure reliable and safe use of the DX System.

Device Classification

Europe

The DX System is a component of a Class I medical device as detailed in the Council Directive 2007/47/EEC concerning Medical Devices.

USA

The DX System is a component of a Class II medical device (Powered Wheelchair) as detailed in 21 CFR § 890.3860.

Wheelchair Components are classified under 21 CFR § 890.3920 as Product Code KNN, Class I (General Controls), 510(k) exempt.

Compliance and Conformance with Standards

In accordance with the device classification, the DX System and all its modules have been designed to enable the powerchair manufacturer to comply with the relevant requirements of the European Medical Device Directive 2007/47/EEC and QSR 21 CFR § 820.

The DX System and all its modules have been designed such that the combination of the wheelchair and the DX System, along with accessories as applicable, complies with the Essential Requirements of the MDD by adopting relevant clauses of harmonised standards EN12184 and EN12182 and the FDA Consensus standard ANSI/RESNA 7176 for performance.

However, final compliance of the complete powerchair system with international and national standards is the responsibility of the powerchair manufacturer or installer.

7.3 Service life

If the product has been installed, used and maintained as recommended, all instructions contained in this manual have been properly followed, and the unit has not been abused, the expected service life period (i.e. serviceable life expectancy) of the product is five (5) years. After this period, DYNAMIC CONTROLS recommends the product

be replaced for safety reasons. DYNAMIC CONTROLS accepts no responsibility or liability for product failure if the product is retained in use beyond the stated service life period.

7.4 Maintenance

1. Keep all DYNAMIC CONTROLS products free of dust, dirt and liquids. To clean the product, use a cloth dampened with warm soapy water. Do not use chemicals, solvents or abrasive cleaners, as this may damage the product.
2. Monthly check all vehicle components for loose, damaged or corroded components, such as connectors, terminals, or cables. Restrain all cables to protect them from damage. Replace damaged components.
3. Once every 6 months, test all switchable functions on the DYNAMIC CONTROLS electronics system to ensure they function correctly.
4. There are no user-serviceable parts in any DYNAMIC CONTROLS electronic product. Do not attempt to open any case or undertake any repairs, else warranty will be voided and the safety of the system may be compromised.
5. Where any doubt exists, consult your nearest service centre or agent.

Warning:

It is the responsibility of the end user to maintain the product in a state of good repair at all times. If any 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.

7.5 Warranty

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

This warranty is subject to the provisions that the equipment:

- has been correctly installed
- has been thoroughly checked upon completion of installation, and all programmable options (if any) have been correctly adjusted for safe operation prior to use
- has been used solely in accordance with this manual and all other manuals of the DYNAMIC CONTROLS products that are used on the mobility vehicle
- 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 unauthorised personnel
- has not been connected to non-specified third party devices without the specific approval of DYNAMIC CONTROLS
- has been used solely for the driving of electrically powered mobility vehicles in accordance with the intended use and the recommendations of the vehicle manufacturer

7.6 Safety and Misuse Warnings

The DX2 Actuator 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 Actuator 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.

- In the case of an emergency while the vehicle is driving, press the On/Off button to perform an emergency stop and turn the system off.
- If operators of the vehicle are left with limited or no mobility because the vehicle loses electric power or breaks down, it is important that they can still call for assistance from wherever they may be.
- Operators of the vehicle must make sure that the proper Drive Profile or Actuator Mode is selected before they try to operate an Actuator Profile or drive the chair. If an operator deflects the joystick in the wrong mode the powerchair will not behave as expected (for example: instead of adjusting the seat position, the chair starts to drive), which can cause damage to the equipment or injury to the operator or bystanders.
- Do not store or operate the DX2 Actuator Module at a temperature that is outside the temperature ranges specified in this manual.

Service and Configuration Warnings

The following warnings are applicable to the installer and therapist only.

- Make sure that all cables and connectors are still securely connected, and that the operator can still reach all operating controls when all actuators are fully extended.
- For each individual end user, check to make sure that the setup of the actuators, the limit switches and the trip current is such that the user is not crushed by the actuator movement under normal conditions of operation. Users with limited sensation are particularly at risk from crushing injuries.
- It is the responsibility of the OEM or installer/therapist to consider whether or not certain actuator movement should be allowed while driving and to program the affected Actuator Profiles accordingly. If actuator movement while driving is allowed, make sure that the operator is instructed on the risks of operating the actuators while driving.
- It is the responsibility of the OEM and installer to make sure that the maximum driving speed of the chair is limited as appropriate when the chair is in a mechanically unstable position, for example when the seat is raised.
- It is the responsibility of the therapist/ installer to minimize any risk of use error, including those arising from ergonomic features and/or the environment in which the device is intended to be used.
- The chair set up and configuration process should take into consideration the

- technical knowledge, experience and education, and
- medical and physical condition, including the level of disability and capability

of each individual user.

- Prior to handing over the vehicle, make sure that users are fully able to operate the product by providing them appropriate training on functionality and safety features, and having them test-drive the vehicle in a safe area in the presence of their agent.

- After maintenance or service of the chair, check the functional operation of each actuator.

7.7 Electromagnetic Compatibility (EMC)

DYNAMIC CONTROLS Electronic controllers and accessories have been tested on typical vehicles to confirm compliance with the following appropriate EMC standards:

USA: ANSI/RESNA WC/Vol:2 - 1998 Sec 21

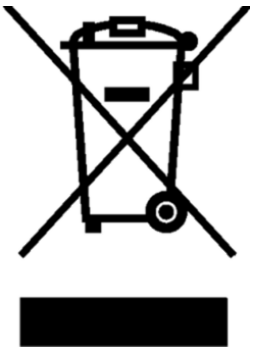
Europe: EN12184: 1999 Sec 9.8.1-3 / ISO7176-21

National and international directives require confirmation of compliance on particular vehicles. Since EMC is dependent on a particular installation, each variation must be tested.

Minimising emissions

To minimise emissions and to maximise the immunity to radiated fields and ESD, follow the general wiring recommendations in section 2.1.1 of the DX System Manual.

7.8 Environmental statement



This product has been supplied from an environmentally aware manufacturer.

Please be environmentally responsible and recycle this product at the end of its life through your local recycling facility.

This product may contain substances that could be harmful to the environment if disposed of into a landfill.

Do not dispose of this product in fire.

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Dynamic Controls is the world's leading manufacturer of electronic controls for power wheelchairs and scooters.
DYNAMIC was established in 1972 and is headquartered in New Zealand.
Regional centres are located in Europe, United States, Asia, and Australasia.

ISO 13485 certified –
DYNAMIC goes above and beyond industry standard expectations to ensure customers receive the best products possible.

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