

X4 Rugged Terrain Rover kits

Assembly and Technical Data

DS-X4
DS-X4L

Features

- **Excellent teaching aid for ICT studies.**
- **Powerful 4x servo motor drive for exceptional steep incline and rugged terrain capability.**
- **NiMH battery pack and re-charger supplied with DS-X4**
- **Aluminium chassis provides tough base for flexible microcontroller and peripheral expansion.**
- **Kit includes all necessary hardware and electronics to construct an ‘out of the box’ autonomous rover.**
- **Micro-sized controller with infrared sensors, speed controlled wheel drive and external serial control.**
- **Ideal platform for OOPic[®], BASIC Stamp[®] etc.**
- **Simple screw together construction requiring only a few tools.**
- **Multi-level base expansion kit and solar recharging module available.**

Description

The Designer Systems DS-X4 and DS-X4L are rugged terrain rover kits with 4 wheel drive and knobby tyres capable of traversing steep inclines and rough terrain with ease.

Based on a tough aluminium chassis the X4 can be assembled ‘out of the box’ to produce a simple ‘bump-reverse-turn’ autonomous rover. However, with the addition of a microcontroller system such as the Savage Innovations OOPic[®], BASIC Stamp[®], BX24[®] etc. the rover can be increasingly expanded to feature Ultrasonic range finding, GPS positioning, wireless communication, cameras etc.

The controller supplied with the X4 kit is a simple module that will provide ‘bump-reverse-turn’ control with infrared, left and right front, bump sensing and control the four drive servos.

A serial control line is also provided to allow the X4’s movement



DS-X4 shown

to be externally instructed by sending simple commands to the controller. The connected microcontroller is able to control direction, with speed control, and also enable/disable rover features.

Applications

The DS-X4 kits are an ideal introduction to the world of robots, being the perfect teaching aid for ICT based studies. Their ‘expandability’ allows a wide range of sensors and control techniques to be studied.

Selection Guide

Description	Part Number
X4 Rugged Terrain Rover (kit) (7.2V NiMH battery pack + recharger + X4 controller board)	DS-X4
X4 Rugged Terrain Rover Lite (kit) (AA battery holder + X4 controller board)	DS-X4L
Base expansion Kit (Multi-level)	DS-X4BK
Solar Recharging Module (DS-X4 only)	DS-SRM
X4 Controller board	DS-X4C

Kit contents

The DS-X4 kit consists of the following items (quantity):

- X4 Aluminium Base Plate (1off)
- X4 Aluminium servo bracket (4off)
- HS311 Sport modified servo (4off)
- 7.2V 1500mAh (1.5Ah) NiMH battery pack (1off)
- 220-240V input battery charger unit (1off)
- Mains adaptor (EUR only) (1off)
- X4 controller board (1off)
- Wheel with spiked air cushioned tyre (4off)
- 200mm black cable tie (2off)
- 80mm black cable tie (5off)
- M3 x 25mm top threaded metal spacer (4off)
- M3 x 8mm top threaded metal spacer (4off)
- M3 x 6mm pan-head screw (100off)
- M3 x 10mm pan-head screw (16off)
- M3 full nut (100off)
- M3 lock washer (100off)
- M4 lock washer (4off)
- No. 4 x 3/4" self tapping screw (4off)
- 150mm length of tie wire (4off)

The DS-X4L kit consists of the following items (quantity):

- X4 Aluminium Base Plate (1off)
- X4 Aluminium servo bracket (4off)
- HS311 Sport modified servo (4off)
- AA battery holder (1off)
- Battery holder lead (1off)
- X4 controller board (1off)
- Wheel with spiked air cushioned tyre (4off)
- 20mm Velcro hook & loop coins (2off)
- 80mm black cable tie (5off)
- M3 x 25mm top threaded metal spacer (4off)
- M3 x 8mm top threaded metal spacer (4off)
- M3 x 6mm pan-head screw (100off)
- M3 x 10mm pan-head screw (16off)
- M3 full nut (100off)
- M3 lock washer (100off)
- M4 lock washer (4off)
- No. 4 x 3/4" self tapping screw (4off)
- 150mm length of tie wire (4off)

If any of the above items are missing please contact your distributor immediately.

NOTE: An additional base kit (DS-X4BK) to expand the X4 is available from your stockist.

Tools required

The following tools are required to build the X4 kit:

- Medium sized 'Pozi-drive' or 'Philips' screw driver.
- Pair of sharp scissors or side cutters.
- Small pair of pliers.
- M3 spanner / socket (optional).

Preparing the wheels

The wheels should be attached to the servo horns' with reference to photo 1.0 on page 5 as follows:

1. While holding the circular 'horn' ❶ of the servo unscrew the centre screw and pull off the horn.
2. Take a piece of the supplied tie wire and bend in the centre to form a 'U' shape. Pass the two ends of the 'U' wire through two of the outermost holes ❷ in the rear of 'horn'.
3. Take a wheel and pass the ends of the wire 'U' each side of one of the spokes, around each side of the hub and back down and through two of the outermost holes ❸ on the other side of the 'horn', pulling, twisting and cutting off the excess.

Preparing the X4 base plate

The X4 aluminium base plate is able to accommodate a number of different microcontroller platforms as well the supplied X4 controller board:

- OOPic¹, OOPic II¹ and OOPic-R¹
- OOPic-C¹, BASIC Stamp² (24pin version), BASICX³, BX24³ in conjunction with the DS-RCB board.
- Microchip 28pin DIL PIC range (e.g. PIC16F73, PIC16F876 etc.) in conjunction with the DS-RCB board.

¹ Trademark of Savage Innovations Inc.

² Trade mark of Parallax International Inc.

³ Trademark of Netmedia Inc

Figure 1.0 on page 5 shows two sample base plate layouts for the OOPic, OOPic II, DS-RCB etc. and the OOPic-R, the black dots denoting the holes to use for the spacers. Both microcontroller boards and peripherals can be mounted either at the front or rear of the base, we recommend the front for the microcontroller and rear for peripherals (e.g. DS-WCM, DS-GPM etc.)

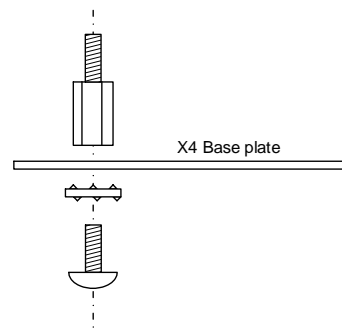
The kit is supplied with two lengths of spacers:

25mm: For fixing OOPic-R board due to serial port restrictions.

NB: OOPic-R fixing holes require enlarging.

8mm: For fixing OOPic, OOPic II and DS-RCB boards. X4 controller uses front two (2) spacers for mounting.

Both sets are secured with M3 x 6mm pan-head screws and M3 lock washers as illustrated in the following drawing:



Attaching the servos

The servo motors must be attached to the aluminium 'L' shaped servo brackets before being attached to the base plate as photo 3.0 on page 5. This is accomplished by passing the servo lead through the large hole in the bracket, seating the servo into the bracket and securing the servo to the bracket with 4x M3 x 10mm pan-head screws, M3 lock washers and M3 full nuts.

Each of the four bracket & servo assemblies must then be secured to the X4 base plate with 4x M3 x 6mm pan-head screws, M3 lock washers and M3 full nuts.

Attaching the wheels

Using a No.4 self-tapping screw and a M4 lock washer secure each of the prepared wheels to a servo while holding the wheel firmly as illustrated in photo 2.0 on page 5.

The finished assembly should be as illustrated in figure 2.0 on page 6.

Attaching the battery pack

There are two different battery pack types as follows:

DS-X4: The 7.2V NiMH battery pack is attached to the underside of the base with two (2) 200mm black cable ties as illustrated in figure 3.0 on page 7 (Photo 3.0 page 5), the black dots denoting the cable tie holes to use.

Take two (2) 200mm black cable ties and pass each through and over the top of the base, back through the base, through the end of the tie and pull until secure. The ties should then lie where denoted by the dotted lines on figure 3.0.

DS-X4L: The AA battery holder should be fixed to the top of the base

using the supplied Velcro hook and loop coins. The supplied battery lead should then be snapped onto the holder.

TIP: Fix the Velcro coins to the holder NOT the batteries.

Use 6x AA(R6) (R6P, LR6) sized NiMH re-chargeable batteries. Do not use alkaline batteries as the higher voltage may damage servos.

X4 Controller connection

All servo and battery pack wiring should be passed up through the large hole at the front of the X4 base. 5x 80mm cable ties are provided to allow excess servo lead to be tied up to produce a neat solution.

The X4 controller is connected as in Photo 4.0 page 6 (looking from the rear) as follows:

1. Locate the leads from the two servos on the right hand side of the X4 and insert their connectors onto the header marked 'RH SVs'.

Note: The yellow wire from the servo should be aligned with header pin marked 'YEL'

2. Locate the leads from the two servos on the left hand side of the X4 and insert their connectors onto the header marked 'LH SVs'.

Note: The yellow wire from the servo should be aligned with header pin marked 'YEL'

Other controller connection

It is beyond the scope of these instructions to examine the connection and operation requirements for all available controller systems. However, taking the OOPic-R as an example the two sets of servo leads (left and right drive) should be connected to the servo pin headers (IO) available on this board and the OOPic-R's on-board 5V servo regulator should be enabled.

Drive is controlled by providing a servo position, to both servos on each side, either positive or negative of the centre position for forward and backward or disabling the servo drive to stop.

It should be noted that servo damage may result if servos on the same side are driven in opposite directions.

Charging the battery pack

The X4 (not X4L) is supplied with a mains charger unit to allow the NiMH battery pack to be charged.

The charger is also supplied with multiple adaptor leads that allow the charging of standard racing battery packs etc.

Six (6) charge current settings are available on the charger 50, 80, 120, 180, 240 & 300 mA. The supplied X4 battery pack is rated at 1500mAh (1.5Ah), so for a standard 10-12hour charge the selector switch should be set to 180 to ensure that the pack is fully charged in this time.

Note: The battery pack is supplied un-charged and must be charged for at least 24 hours at the 180 rate before being used.

Charger connection...

To connect the pack to the charger first select the charging adaptor lead featuring the small two (2) pin header and insert this into the end of the charger lead (you may need to remove the round power connector adaptor to do this).

Insert the charger into a free mains socket (adaptor supplied for EURO use), switch ON and the 'Power' indicator will illuminate. Connect the battery pack to the charger lead and leave for 10-12 hours.

Note: The charger can be left charging the pack without damage, however this is not recommended.

X4 Operation

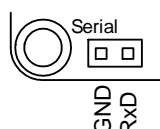
Insert the battery pack lead onto the connector marked 'POWER IN' on the X4 controller ('Power' on the OOPic-R).

X4 Controller: After 5 seconds the X4 will move away forward until it meets an obstacle (*obstacles non-infrared reflective will not be detected*), whereupon it will stop, reverse (2 seconds), turn in the opposite direction (1 second) and carry on forward once more. This process will continue until the battery pack is disconnected.

Other controller: Dependant on program written.

X4 Controller serial control

The X4 Controller is fitted with a two pin connector marked 'Serial', which is pinned as follows:



This interface can be used to control the servo drive outputs and enable /disable a number of features from a connected controller board such as the OOPic, OOPic II, OOPic-R, BASIC Stamp, BX24 etc. or any other controller board with an IO line capable of inverted TTL (normally low 0V with high 5V data bits) serial output and configured for the following protocol:

9600 baud (bps)
8 Data bits
1 Stop Bit
No Parity
No handshaking (if configurable)

Once connected the X4 controller will enter control mode one (1) second after the battery has been connected.

TIP: Most controller boards have support for serial LCD output, which is an ideal method of driving the X4 controller.

A simple human readable command language is used to control the X4, which consists of a control character followed by a decimal value of zero (0) to 9.

The following commands are supported:

Fn	Forward at n speed
Bn	Backward at n speed
Rn	Turn Right at n speed
Ln	Turn Left at n speed
S0	Stop
C0	Turn off bump sensors
C1	Turn on bump sensors
Tx	Turn time after bump
Px	Backward time after bump

n = 1 to 9 speed i.e. F5 would move forward at speed 5. A value of 9 is maximum speed.

x = 1 to 9 seconds i.e. T2 would setup a 2 second turn on bump. Default settings are T1 and P2.

All commands must be in upper-case, lower case will be ignored.

C0/C1: The bump sensor default value is 'C1' or turned ON, which means that if an obstacle is detected the X4 will stop-reverse-turn at the current speed value, stop and await a new direction command.

A value of 'C0' or turned OFF requires that a separate means of bump detection must be employed, as the X4 will crash into any obstacle in its way.

X4 Controller Electrical Characteristics (T_A = 25°C Typical)

Parameter	Minimum	Maximum	Units	Notes
Battery Supply Voltage (BSV)	6.0	8.0	V	
Battery Supply Current	5	550	mA	1
Servo output voltage	As BSV	As BSV		
Servo output pulse duration	1000	2000	uS	
Servo output pulse repetition	200	20	mS	
Servo output pulse resolution	-	1	uS	
'Serial' interface input level	-0.3	5.0	V	
'Serial' interface speed	-	9600	bps	

X4 Controller Absolute Maximum Ratings

Parameter	Minimum	Maximum	Units	Notes
Battery Supply Voltage	-	10	V	2

X4 Environmental

Parameter	Minimum	Maximum	Units
Operating Temperature	-5	70	°C
Storage Temperature	-10	80	°C
Humidity	0	80	%
Dimensions (built)	185mm (L) x 160mm (W) x 80mm (H)		
Weight (DS-X4 built)	600g		
Immunity & emissions	EMC compliance to 89/336/EEC		

Notes:

1. Maximum value given is during servo operation without drive load.
2. Value given is maximum voltage for X4 controller; normal servos will not tolerate a supply voltage this high.

Servos

Type	HS311 Standard Super Sport (modified)
Control system	Pulse Width Control 1500uS neutral
Operating voltage range	4.8 to 7.2V
Operating temperature	-20 to +60oC
Operating speed	0.19sec/60o @ 4.8V 0.15sec/60o @ 6.0V
Stall torque	3kg.cm @ 4.8V 3.7kg.cm @ 6.0V
Current drain	8mA IDLE, 150mA RUNNING (no load)
Size	41 x 20 x 36.5mm
Connection	3pin 2.54mm pitch non-polarised SIL socket

Battery pack & charger (DS-X4 only)

Battery Type	4 cell Nickel Metal Hydride (NiMH)
Output voltage	7.2V nominal
Capacity	C = 1500mAh (1.5Ah)
Maximum discharge rate	2 x C
Size	100 x 43 x 14mm
Connection	2pin 2.54mm pitch polarised Molex socket
Charger Type	NiCd / NiMH constant current
Output currents	50, 80, 120, 180, 240 & 300 mA
Output voltage	1.2 to 12V auto-sensing
Input Voltage	230VAC nominal (other voltages available)
Protection	Short circuit, over temperature, polarity reversal
Connections	2pin 2.54mm pitch polarised Molex header 2pin Tamiya racing pack socket 2.5mm power connector (reversible polarity)

Miscellaneous

Wheel type	5 spoke wheel 75mm diameter, 28mm wide spiked tyre
Base type	185 x 92 x 1.5mm aluminium satin black finish
Servo bracket type	L bracket in 1.5mm aluminium satin black finish

The X4 design and specification are subject to change without notice.

Photo 1.0 (Servo horn wiring)



Photo 2.0 (Wheel securing)



Photo 3.0 (DS-X4(L) servo bracket mounting and DS-X4 battery pack mounting)

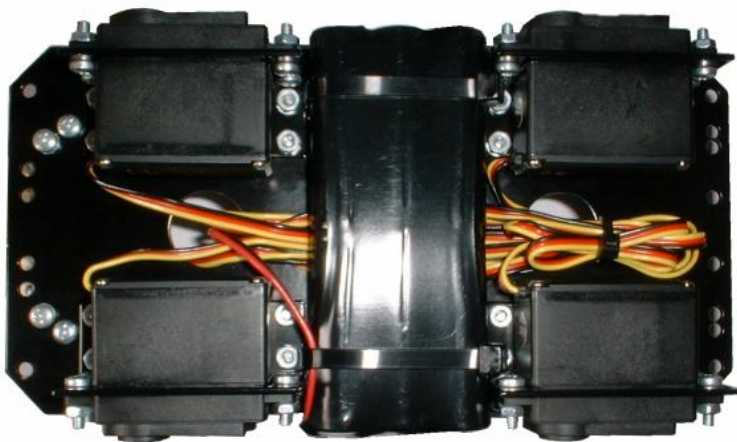
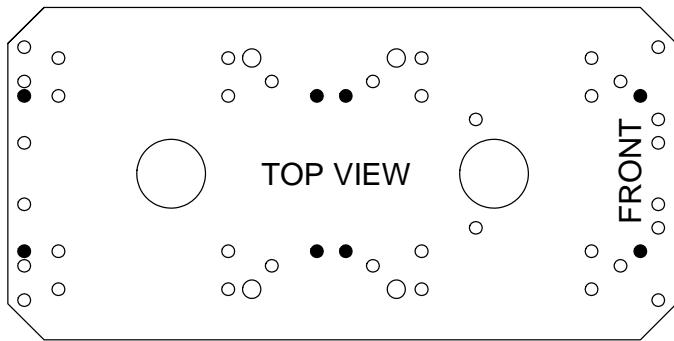


Figure 1.0 (Base plate microcontroller fixings)

OOPic, OOPic II, DS-RCB etc.



OOPic-R

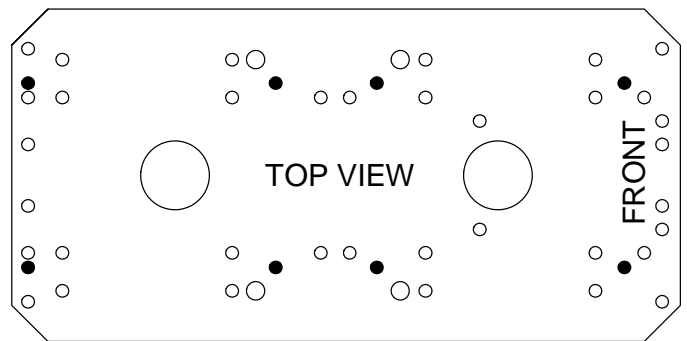


Figure 2.0 (Servo and wheel positions)

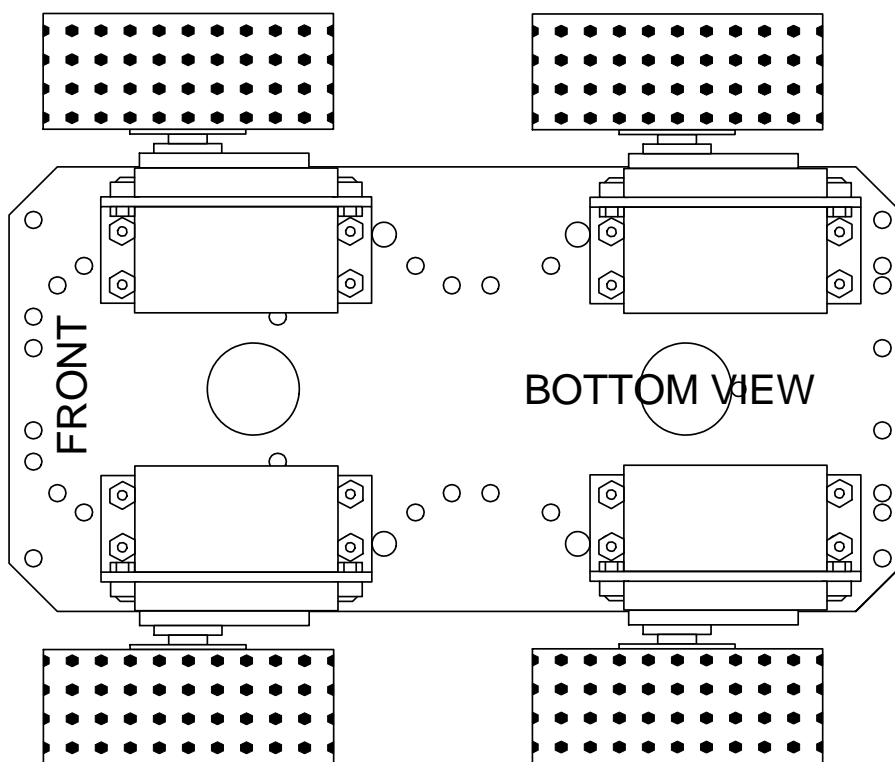


Photo 4.0 (X4 Controller servo connections)

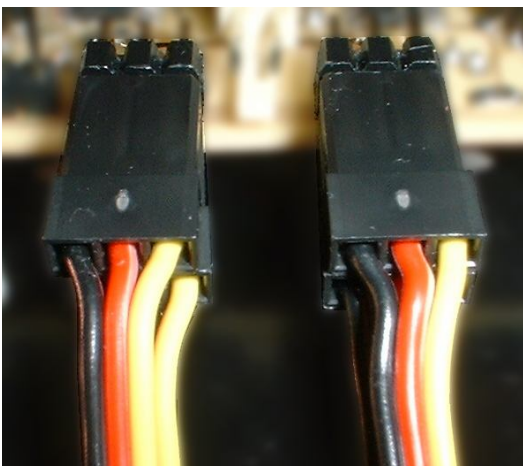
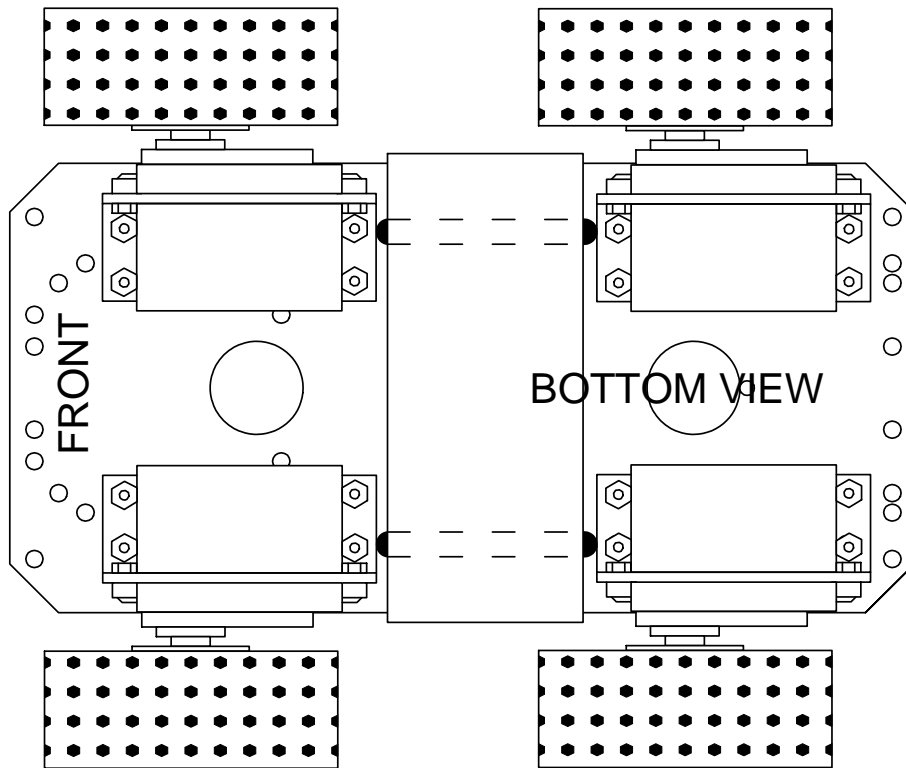


Figure 3.0 (DS-X4 battery pack mounting)



IMPORTANT

Battery care

The DS-X4 NiMH battery pack supplied with your DS-X4 will give you hours of service when used correctly.

To optimise the life of your battery pack

- Disconnect the battery pack from the X4 controller, microcontroller platform, when not in use.
- Do not leave the battery in a discharged state.
- Recharge the battery regularly to prevent deep discharge.
- Store the battery pack at room temperature.
- Use only the DS-X4 charger. Any other charger may damage the battery pack.

Battery pack replacement

With proper care, your battery pack should give approx. 800-1000 charge/discharge cycles.

If you ever need to replace the battery pack please contact your local Designer Systems product distributor.



Battery Recycling

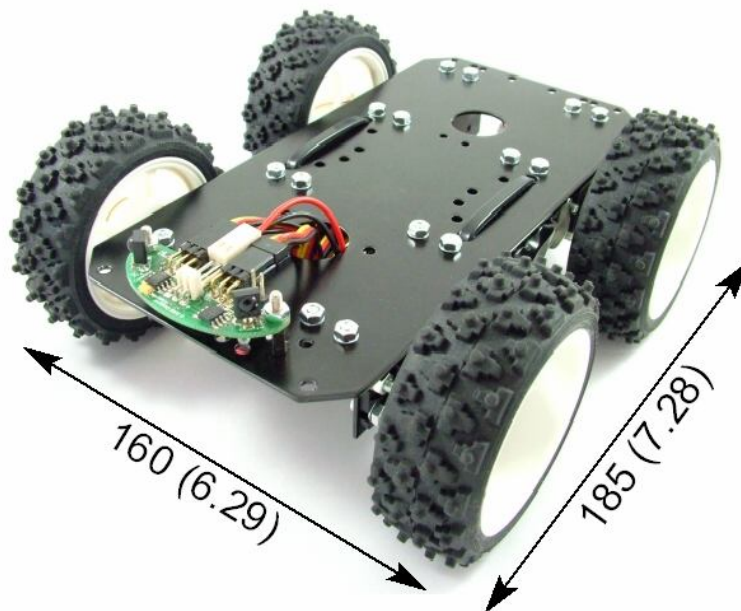
The DS-X4 battery pack is a Nickel Metal Hydride rechargeable battery that must be recycled. Before recycling ensure that the battery has none, or little, remaining charge.

To preserve natural resources, please recycle the battery properly. Do not throw your battery into ordinary household waste. International law prohibits the disposal of rechargeable batteries in this way.

Consult your local waste disposal company for information regarding available recycling options.

Mechanical Specifications – Units millimetres (inches)

Design subject to change without notice



WEEE Consumer Notice

This product is subject to Directive 2002/96/EC of the European Parliament and the Council of the European Union on Waste of Electrical and Electronic Equipment (WEEE) and, in jurisdictions adopting that Directive, is marked as being put on the market after August 13, 2005, and should not be disposed of as unsorted municipal/public waste. Please utilise your local WEEE collection facilities in the disposition and otherwise observe all applicable requirements. For further information on the requirements regarding the disposition of this product in other languages please visit www.designersystems.co.uk



RoHS Compliance

This product complies with Directive 2002/95/EC of the European Parliament and the Council of the European Union on the Restriction of Hazardous Substances (RoHS) which prohibits the use of various heavy metals (lead, mercury, cadmium, and hexavalent chromium), polybrominated biphenyls (PBB) and polybrominated diphenyl ethers (PBDE).

Other accessories

DS-X4 shown with DS-X4BK base expansion kit and DS-SRM solar recharging module



Declaration of Conformity

Apparatus name / model number DS-X4C

Conformity via Generic Standard EN50081-1
Generic Standard EN50082-1

Conformity criteria For use only within commercial, residential and light industrial applications

We certify that the apparatus identified above conforms to the requirements of Council Directive 89/336/EEC & 73/23/EEC

Signed.

Date 1/6/02

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Manufacturer Designer Systems, 15 Andrew Place, Truro, Cornwall
TR1 3HZ, United Kingdom

Description of apparatus X4 controller board

Having made this declaration the CE mark is affixed to this product, its packaging, manual or warranty.

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