R12 5 Axis Robotis Arm

DATA SHEET

Introducing the R12

The R12-500 is a complete self-contained five (optional sixth) axis vertically articulated robot arm system designed as a cost effective solution for bench top automation. Applications include testing, sample handling, machine feeding. The hand terminates in a mounting plate to which can be mounted one of our low cost grippers, vacuum pickups or your own device.

Easy to program, the R12 offers speed, accuracy and reliability yet is capable of the most complex tasks. It has a useful 500mm reach. A development of our existing R17 technology, the R12 it is a breakthrough in bench top robotics. Like the R17, it is a 5 axis articulated robot arm but with a 500mm reach. It is lighter, faster and quieter, using high efficiency digital motors driving through steel reinforced polyurethane timing belts. Optional incremental optical encoders provide exceptional integrity as well as safety.

The R12 is a professional tool made to industrial standards. Machined from solid alloy and finished with aesthetic acrylic covers, the system is supplied complete with controller, cables, connectors, software and manuals - ready to use immediately. The K11 controller is reliable and simple to use offering a partnership of CPU and DSP micro-processors and compact micro-stepping drives. The **ROBOFORTH II** software ensures easy start up and use allowing for the most complex motions, interfaces and peripherals to be programmed.

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Features

- 5-axis articulated format (optional 6th axis available)
- Easy mounting of tools eg: grippers, sensors, pipettes
- Fully enclosed system (pneumatics and wiring routed through the arm, not exposed outside).
- Easy to use intuitive teach pad
- User friendly software with English language commands
- Input/output interfacing
- Non-volatile memory
- Supplied complete with controller, software, on-screen manuals and cables
- Optional incremental encoder watchdogs
- Ready to Operate - Windows GUI project manager and teach pendant

Features

Drives:	High power micro-stepped hybrid stepping motors, optional encoder watchdogs
Reach:	500mm/ 20ins in any direction; 360 degree waist rotation
Repeatability:	0.1mm (see note)
Payload:	nominal 500g, max 1Kg (2.2lbs) at flange (repeatability and speed degrade with increasing payload and reach).
Compliance at nominal payload:	0.4mm
droop at max reach /max payload:	2.3mm
Maximum speed:	Waist 220 deg/sec, Shoulder 200 deg/sec, Elbow 500deg/sec, hand 600deg/sec, wrist roll 600 deg/sec. Max linear speed approx 800mm/s. Standard Cycle 2s
Max torque for pitch/roll:	1 Nm (repeatability figures degrade with increasing torque).
Weight:	Robot 12.8Kg/28lbs Controller 11kg/25lbs
Power:	110/240v ac 420VA (standard controller)
Environment:	IP 54A, 0 - 40C (wider range optional)
MTBF:	15,000 hours (typically over a million cycles)
Safety:	Class 2 stop circuit, stall detect, LED awareness barrier, optional IR workspace monitor.
Noise:	Approx 40-50dB at 1m.

Note: repeatability measured as a standard deviation of all 3 dimensions at 100% speed and zero payload over 24 hours after a 1 hour warming up period. Figures for ISO 9283 available on request.

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The role of the encoder in the R12 is that of watchdog (timer). Here, the loop is closed after the completion of each individual motion which is different to a conventional servo control. The R12 encoder option comprises miniature optical incremental encoders fitted to each axis.

Without encoders, the R12 will run accurately and indefinitely in an open loop without error thanks to micro-stepping drives and accurate transmission. However, should the robot suffer a collision, the controller will not know and the robot will need to be recalibrated. Such collisions usually occur accidentally during programming and rarely during normal running. It is simply necessary to run the calibrate routine after each such event. With the encoder option, the controller notices the discrepancy immediately, stops the robot and announces the error.

Optional Sixth Axis

A simple solution, the sixth (6th) axis is optional as opposed to being a permanent part of the design. Using a small motor and gearbox it is highly accurate and tough. Programming is an extension to the Cartesian functions of RoboForth. In this way the system can ensure the end effector points in the same direction (same orientation to X Y Z axes) as the robot moves around, or indeed in any direction you choose.

LED Awareness Barrier

Red LEDs shining from inside the covers catch your attention as the robot moves about and serve as an additional safety measure.

Grippers

As standard the robot terminates in a mounting flange to which can be mounted an 'end effector'. Available end effectors:

V12 Vacuum Pickup	EG12 Parallel Action Electric Gripper	P12 Pneumatic Gripper

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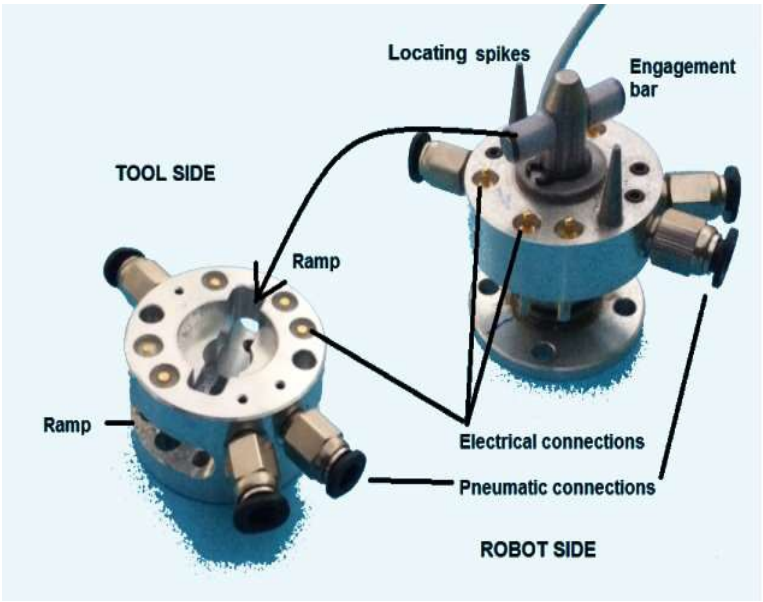
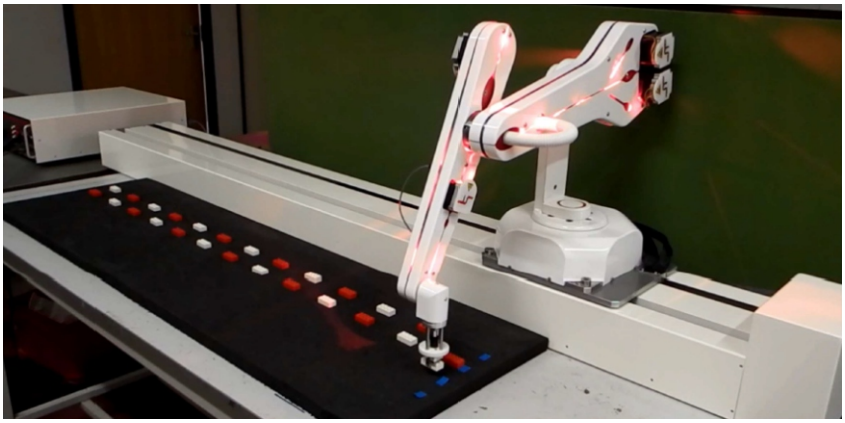
Passive Tool Changer

If you have a range of tools possibly including your own the robot can change from one to another using our innovative tool changer.

The tool changer comprises 2 parts: robot side and tool side. There has to be 1 tool side for every tool. Spare tools are located on a tool stand.

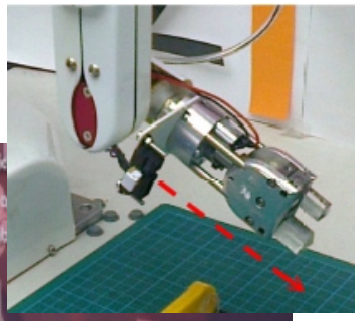
To connect to the tool the robot engages a locking bar then rotates the roll axis 90 degrees to lock in place. Spikes on the tool stand restrain the tool side during rotation. To unlock the procedure is reversed and the robot withdraws.





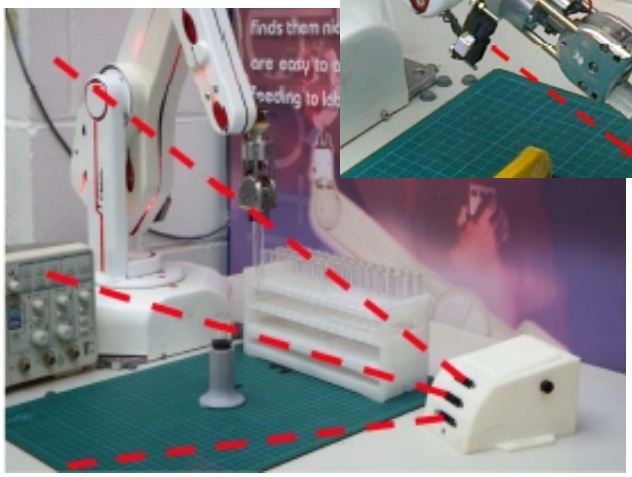
Linear Track

Made to order up to 3m length, using a powerful motor and two recirculating crossed roller bearings. A non-magnetic version is also available.



Sentry Workspace Safety

Sentry works by having 3 IR beams across the work area. Should a person or object enter the workspace a stop signal is sent to the robot causing it to stop at maximum deceleration. This is a superior to methods involving collision detection as the robot never makes contact with the user. Alternatively, a single sensor can be mounted directly on the robot to detect if the user interferes with the direction of travel.



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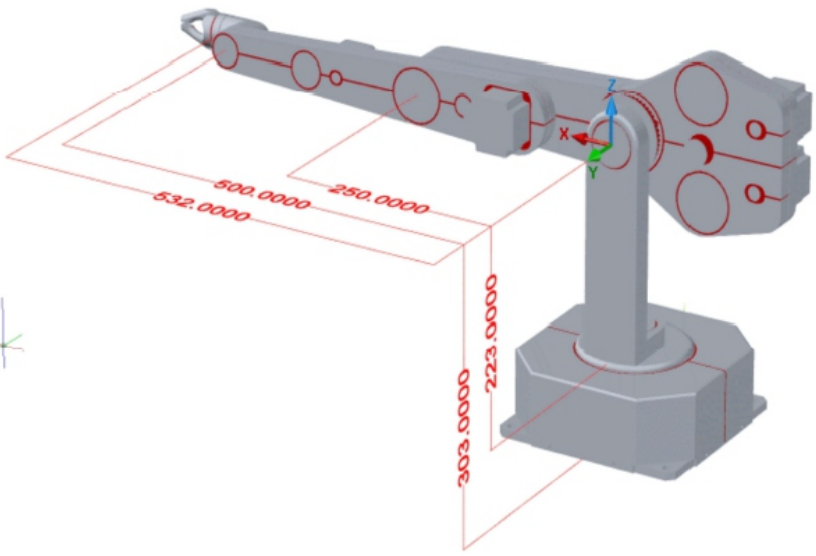
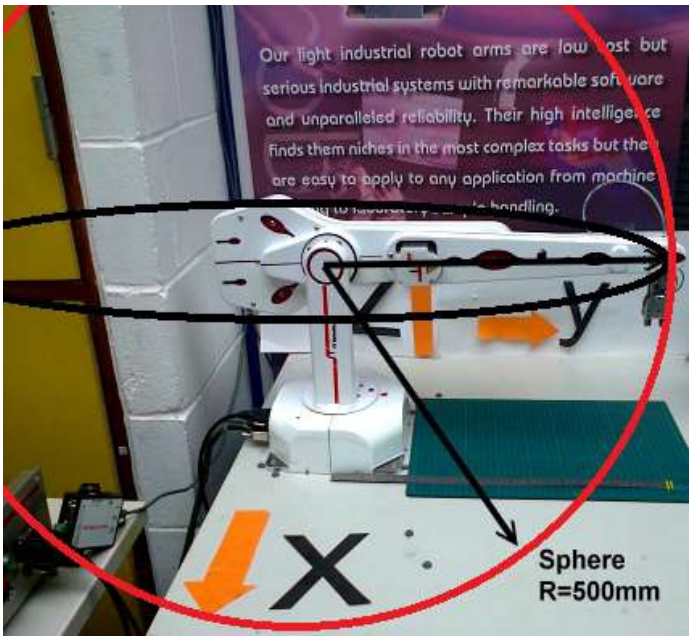
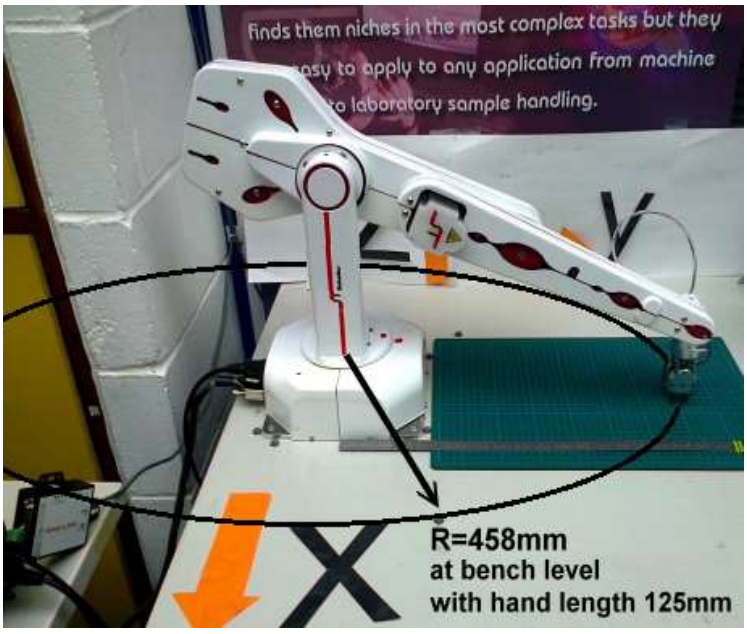
Workspace

Arm comprises 2 limbs 250mm each plus 360 degrees base rotation.

Therefore the workspace is a sphere 1000mm (40ins) in diameter. This is measured from the center of rotation of the shoulder to the centre of rotation of the hand. The hand will add to the total reach.







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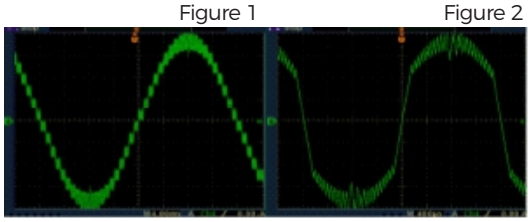
Controller Features

- Multi-processor
- High voltage micro-step drives
- Extensive Input-Output control
- Millisecond and microsecond timers and interrupts
- External emergency stop circuit
- Flash Memory
- Brown-out protection
- Teach pad
- Connect via Rs232, USB, Bluetooth or TCP/IP

Axis Drives

Axis drives are intelligent MOSFET chopper drives that energise the motors with PWM (pulse width modulated) constant current which recirculates at rest to prevent heating. Micro processes automatically compensate for low and mid range residence. At low and medium speeds they very phase current sinus solidly in a manner called micro stepping. Speeds increase they morph from micro step to full step so that the Motors maximum current rating is achieve. See the diagram below Figure 1 shows low speed sinusoidal control of position. You can see the PWM chopping. Figure 2 shows the change of full step in progress.

Figure 1 Figure 2



Free Teach Pendant

Although the majority of functions are involved from the computer, a simple teach pad is provided to find position of the robot. The teach pad provides a means to select and move any joint or operate the gripper or any peripheral. Movement speed can be slowed right down for fine tuning position of the robot.

Alternatively in Cartesian mode the teach pad allows 'jogging' in any XY or Z direction in increments from 25 mm at a time down to 0.1 mm for accurate positioning or to change the angle of pitch your or role in increments from 0.1˚ to 25˚. A designed robot pose can then be learned by pressing the tick key. A programmable function key is also provided. The stop key is linked into the safety circuit.

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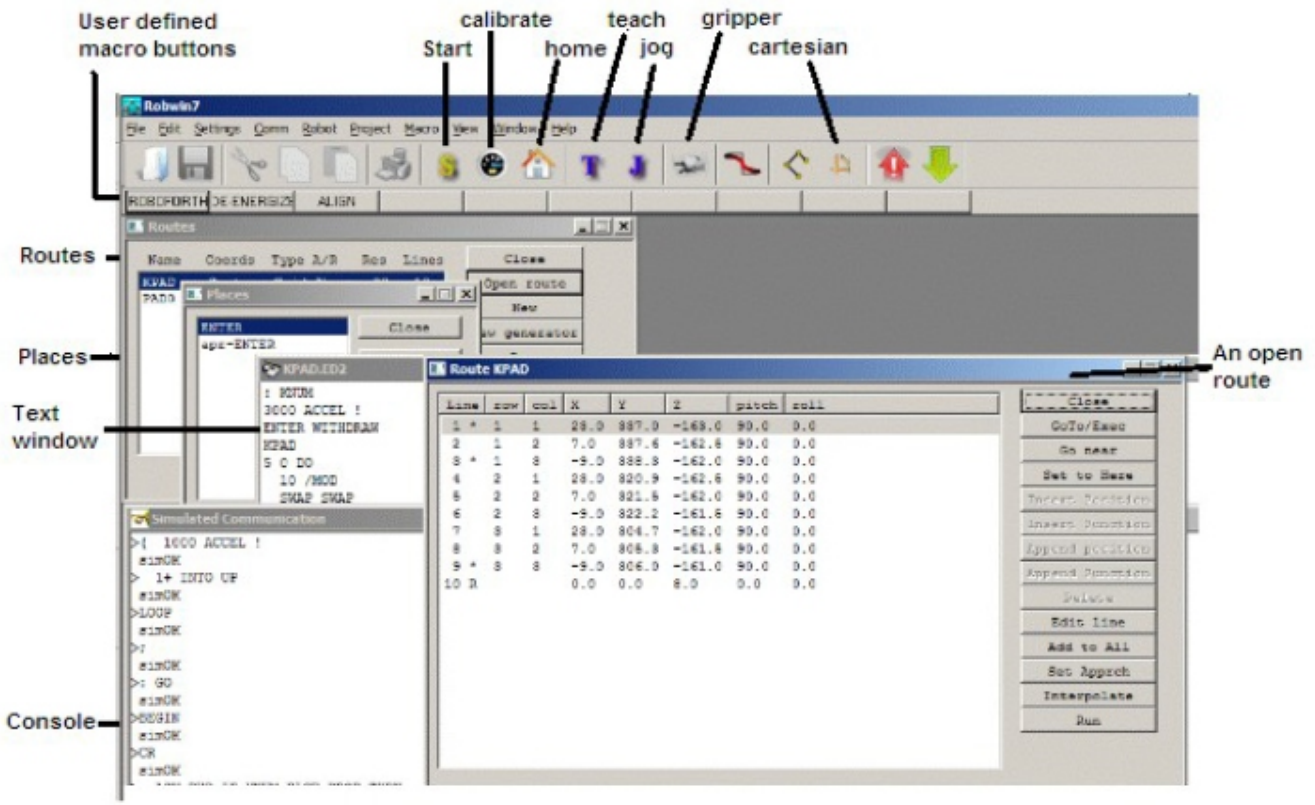
Axis Drives

The optional 7 inch tablet teach console with android software allows the user to position the robot wirelessly using a touchscreen. The android pad connects to the controller via Bluetooth, Features include the ability to jog the robot in X, Y and Z increments from 0.1mm to 100mm and the hand pitch your and roll in increments from 0.1 to 10˚.

The current cartesian position is constantly updated on screen and includes increase/decrease increments, tool/world coordinates, grip/ungrip, add or delete position in a routine, operate peripherals, switch to PC and back to access higher levels, stop button (always live via Bluetooth).

Software

Our software is called **RoboForth II** and **RobWin7**. RoboForth is embedded in the controller flash memory. RobWin is a project manager that runs in your PC.



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Teaching the Robot

(in brief) may be achieved by choosing one of two 'entities':

1. A Route: This is a list of spatial coordinates each of which is a row of numbers representing motors counts away from the zero (HOME) position or absolute Cartesian coordinates. The route is created by the user with his/her given name e.g. ROUTE I66. RobWin makes this simple with a dialog box that creates the entry in the controller as well as on disk. Coordinates are then added to the list by clicking 'insert position' or using the tick key on the teach pad. The robot moves from point to point with the command RUN, moving through them at optimum speed or at constant velocity. Associated commands provide editing and the ability to run parts of a route, or to retrace. A route is also used as a reference for discrete positions, for palletizing for example. Editing is achieved using dialog windows or with ROBOFORTH commands such as REPLACE which also permit self learning features, for example the robot can modify its own positions according to the programmed procedure.

A grid (matrix) is also a list, organized in 2 dimensions and a row is one-dimensional. The number of rows and columns are specified in dialog boxes. Learn the corners of the matrix and the system computes the rest of the positions and downloads them to the controller. This is useful accessing trays of items etc.

2. A Place:

This is a single named coordinate. It is self learning and self executing. It is created by the user with his/her given name using a dialog box or with a native command e.g. PLACE JIG.

To return the robot to this position later simply use the word JIG or include it in a list of other positions and actions possibly including input/output.

Finally all these learned and named entities are used in the procedure window to create new definitions or 'words' which determine how the positions are used, i.e. in what order, in what circumstances etc.
For example a word might be defined using a place named **JIG** and a matrix route named **TRAY:**

- GETPART
- SWITCH 1 WAIT
- TRAY INTO
- GRIP UP
- JIG
- UNGRIP
- WITHDRAW
- PUMP ON
- 1000 MSECS
- PUMP OFF

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Industrial & Educational Users Love Our Software!

RoboForth and **RobWin** are acclaimed as being the easiest and quickest to learn robot software in the world. See these testimonials:

'The language is easy to use, especially after working on a*** or a***. [major robot manufacturers names deleted]" - **Eli Lilly Pharmaceuticals, USA**

"We were all very impressed with how quickly we could get going with the robot system (especially Robwin and ROBOFORTH)"- **The Technology Partnership (Cambridge, UK)**

"This thing is awesome! ... 16 second video clip attached (was amazed at how easy it was to get program wrote for it). We used the added 1/0 to interface it with a PLC and have them working together beautifully. The documentation that you send with the robot made everything really easy to do."- **Halifax CC, NC.**

"We just finished the first course using the robot and everything worked great!
Students liked the robot a lot and found the programming interface easy to use and very intuitive."- Indiana Tech. "This has been one of the best investments we have made, it does a great job for us."- **Mesa Labs, USA**

"I finally understand why you made RoboForth as is. It is extremely lean. When I worked with the big name robots, their robots require a ton of memory on windows to run their API... RoboForth is so lean and the performance on Linux is insanely good. There aren't any other industrial grade robots that have this kind of performance." **Waterloo University, Canada**

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