Low cost bench-top 5/6 axis general purpose articulated robot arm

Description

R17 (Deucaleon) is a low cost entry to robotics, fast, accurate and reliable and easy to program. It has a long reach and therefore a larger and much more useful workspace than comparable machines. Originally designed by a Russian engineer in our Cambridge location, the mechanics are simple and phenomenally reliable. There are R17 Mk1s in service which have been running 3 shifts a day for ten years without failure; in fact we give a 2 year warranty. The R17 is a complete self-contained five axis vertically articulated robot arm system designed as a cost effective solution for processes requiring long reach or difficult access. Applications include product testing, sample handling, parts handling, machine feeding, welding, spraying, sound measurement and many more. It is easy to apply and program yet is capable of the most intricate tasks.

The Mk5 uses new light weight, high speed, high efficiency hybrid stepping motors with intelligent micro-stepping for both power and speed and for low speed precision when required. Each motion of the robot is monitored by the encoders that stop all motion in the event of a collision or other problem. The Mk5 package includes the new Mk5 controller that again is simple and reliable using a partnership of CPU and DSP micro-processors and compact MOSFET drives. ROBOFORTH II embedded software gets you started easily yet permits the most complex motions, interfaces and peripherals to be programmed, assisted by ROBWIN project manager that brings everything together on one Windows screen. Everyone who uses this system agrees it is the most flexible robot software on the planet. You'll find it a joy to use.

The 6th axis is a unique way to make 6 axes optional, being an add-on module with a miniature stepping motor driving through a Swiss anti-backlash gearbox.

Features

Long reach 5-axis articulated format, optional 6th axis (not available on HPL variant)

Easy mounting of tools, grippers, sensors etc

Fully enclosed; pneumatics and wiring go through the arm, not strapped to the outside.

Free simple intuitive teach pad

User friendly software, English language commands

Input/output interfacing

Non-volatile memory

Complete with controller, software, on-screen manuals, cables, etc. Ready to go

Incremental encoder watchdogs

R17 is supplied ready to run -- robot, controller, all cables, Windows GUI project manager, teach pendant

On-screen manuals

Optional linear track, I/O expansion, bluetooth teach console, TCP/IP

Optional pneumatic or electric grippers, vacuum pickup, tool changers, collision detection.

Specifications

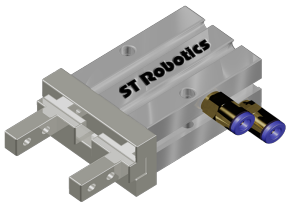
Drives:	High power micro-stepped hybrid stepping motors, optional encoder watchdogs HS variant: high power digital servos.
Reach:	750mm/30ins in any direction; 360 degree waist rotation
Repeatability:	0.1mm (see note)
Payload:	Standard: nominal 1kg, max 3Kg (6.7lbs) at flange HPL variant: nominal 5Kg max 10Kg. HS: nominal 1kg, max 2Kg (repeatability and speed degrade with increasing payload and reach).
Compliance:droop at 250mm at nominal payload:	1.0mm
droop at max reach with max payload:	6mm
Maximum speed Standard:	Waist 150 deg/sec, Shoulder 90 deg/sec, Elbow 130deg/sec, hand 320deg/sec, wrist roll 330 deg/sec.
High speed version (HS):	Waist 300 deg/sec, Shoulder 180 deg/sec, Elbow 360deg/sec, hand 600deg/sec, wrist roll 330 deg/sec.
Max torque for pitch or roll:	5 Nm (repeatability figures degrade with increasing torque).
Weight	Robot 22.5Kg/28lbs Controller 11kg/25lbs
Power:	110/240v ac 420VA (standard controller)
Environment:	IP 54A, 0 - 40C (wider range optional)
MTBF:	20,000 hours (typically over a million cycles)
Safety:	Class 2 stop circuit, stall detect, risk assessment guide. Optional high intensity red LEDs along the arm serve as awareness barrier.
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.

Options

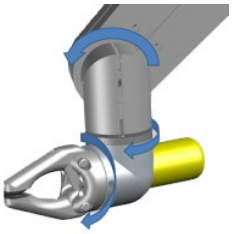
Grippers

As standard the robot terminates in a mounting flange to which can be mounted an 'end effector'. End effectors currently include: electric gripper, SMC 10mm pneumatic gripper, vacuum pickups.



Sixth Axis

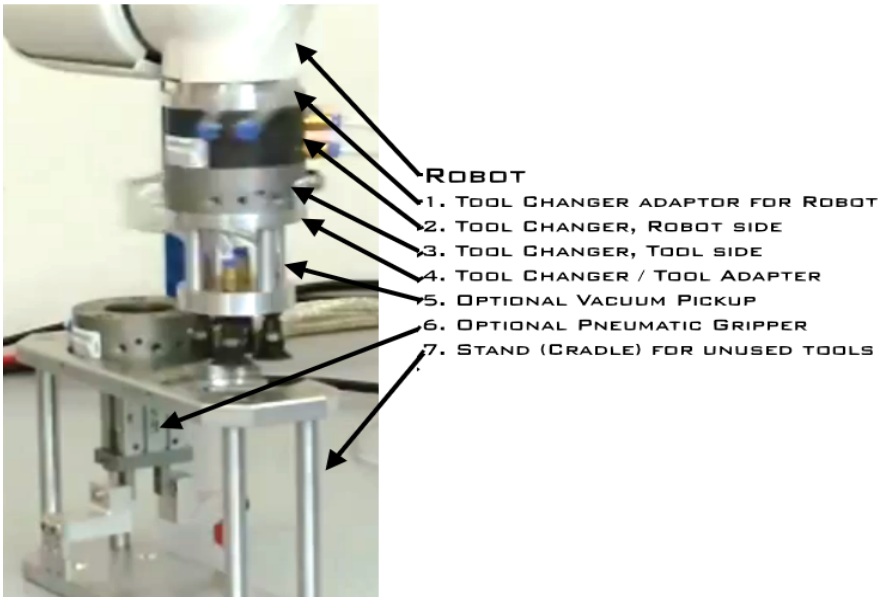
This is a simple solution that makes the 6th axis entirely optional as opposed to being an integral part of the design. Using a small motor and gearbox it is accurate and tough. Programming is an extension to the Cartesian functions of RoboForth. In this way the system can ensure the end effector points in the same direction (same orientation to X Y Z axes) as the robot moves around, or indeed in any direction you choose. The 6th axis is not available on the HPL (High Payload) variant.

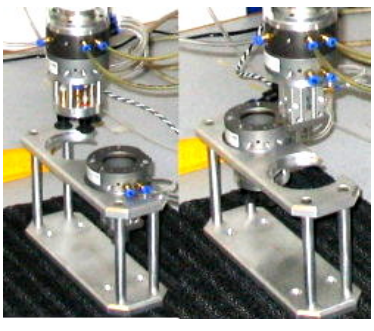


Linear Track

Made to order up to 3m length, using a powerful motor and two recirculating crossed roller bearings.

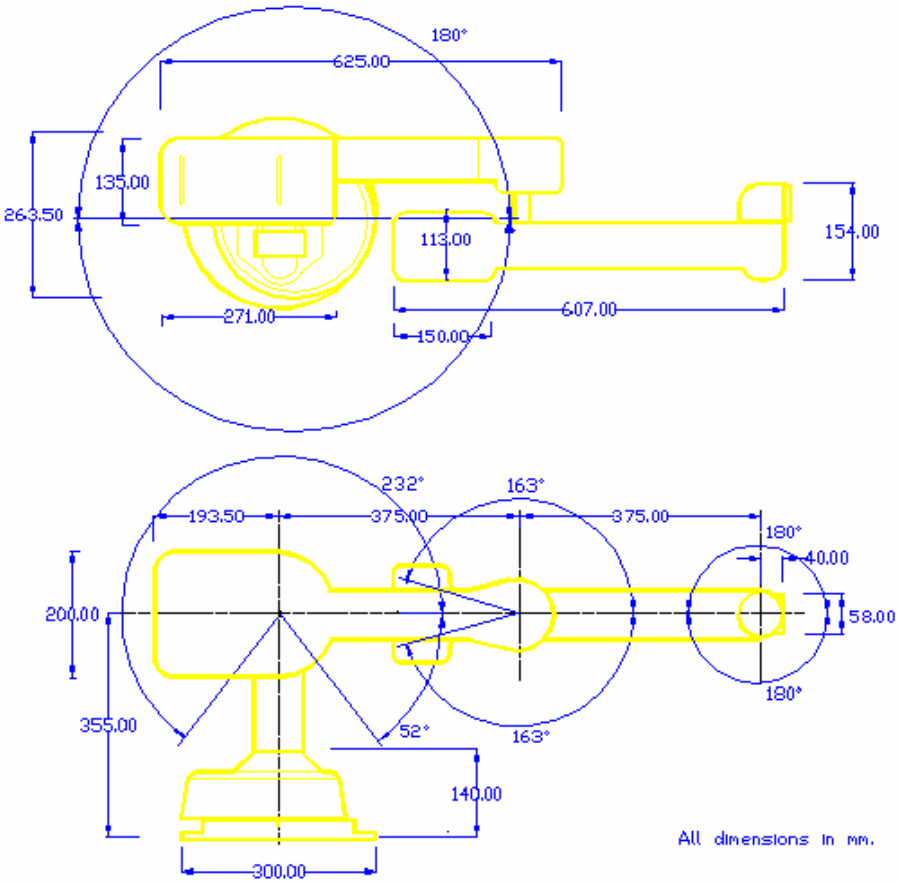
Tool Changers



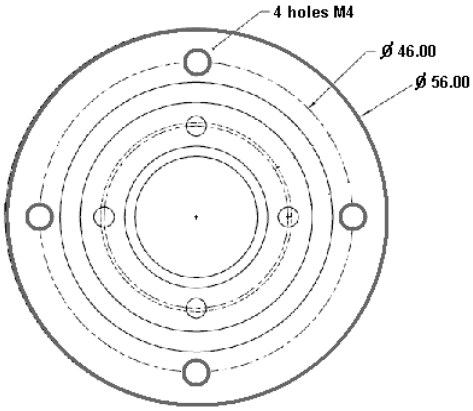


Workspace

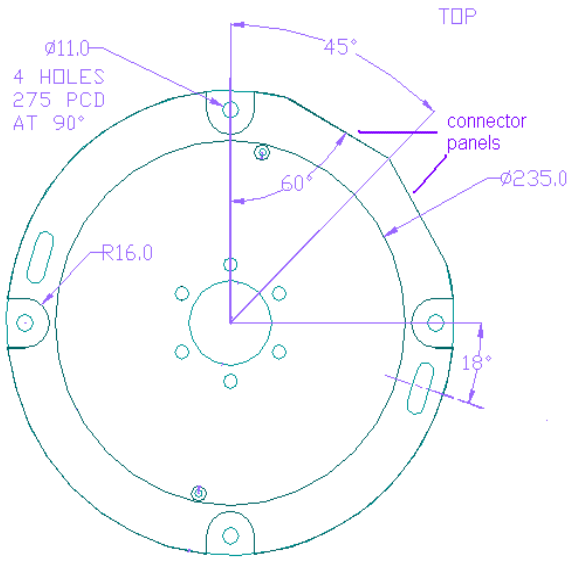
Workspace is a sphere approx 1500mm (60ins) in diameter not including the hand.



Wrist flange (not to scale)



Base fixings to bench



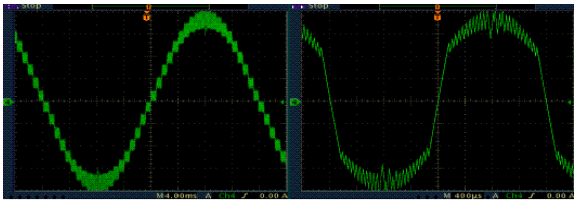
The robot controller

Main Features

Multi-processor
High voltage micro-step drives
Extensive Input-Output - control everything else as well
Millisecond and microsecond timers and interrupts
External emergency stop circuit
Flash memory
Brown-out protection
Free teach pad
Connect via RS232, USB, Bluetooth or TCP/IP

Axis Drives

Axis drives are intelligent MOSFET chopper drives that energize the motors with PWM (pulse width modulated) constant current which recirculates at rest to prevent heating. Microprocessors automatically compensate for low and mid-range resonance. At low and medium speeds they vary phase current sinusoidally in a manner called micro-stepping. As speeds increase they 'morph' from micro-step to full step so that the motors maximum current rating is achieved. See the diagrams below - fig1 shows low speed sinusoidal control of position. You can see the PWM chopping. Fig2 shows the change to full step in progress.



Free Teach Pendant

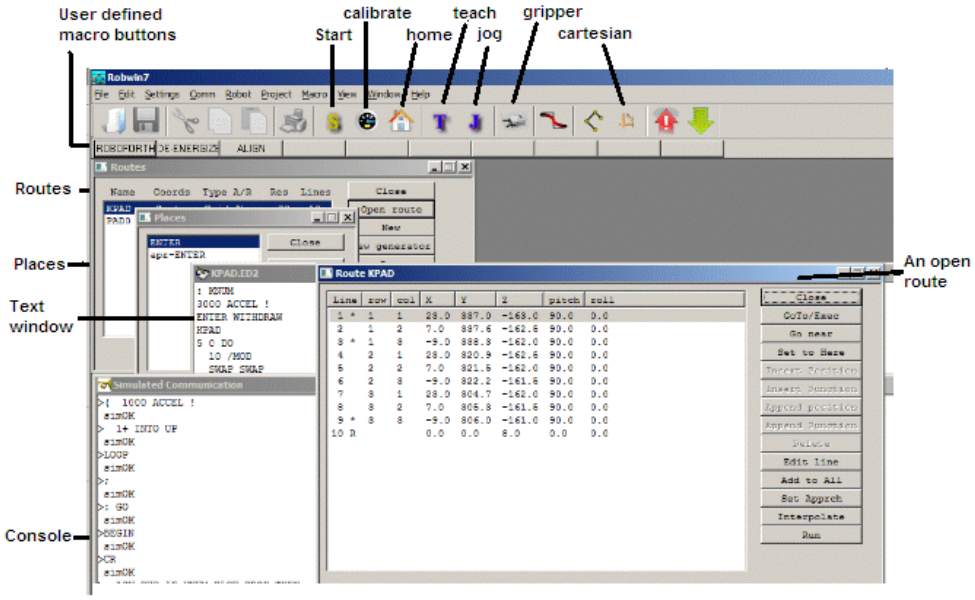
Although the majority of functions are invoked from the computer a simple teachpad is provided for fine positioning of the robot. The teachpad provides the means to select and move any joint or operate the gripper or any peripheral. Movement speed can be slowed right down for fine positioning of the robot.
Alternatively in Cartesian mode the teach pad allows 'jogging' in any X Y or Z direction in increments from 25mm at a time down to 0.1mm for accurate positioning, or to change the angle of pitch yaw or roll in increments from 0.1 deg to 25 deg. A desired robot pose can then be learned by pressing the tick key. A programmable function key is also provided. The stop key is linked in to the safety circuit.

Bluetooth Teach Console

The optional 7-inch tablet teach console with Android software allows the user to position the robot wirelessly using a touch screen. The Android pad connects to the controller via bluetooth. Features include the ability to jog the robot in X Y Z in increments from 0.1 to 100mm, and the hand pitch yaw and roll in increments from 0.1 to 10deg.
The current Cartesian position is constantly updated on screen.
Increase/decrease increments,
Tool/World coordinates,
Grip/ungrip,
Add or delete positions in a route,
Operate peripherals,
Switch to PC and back to access higher levels,
Stop button (always live through 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.



Teaching the robot
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. Functions such as gripper operation, delays, speed changes, spray/glue on/off etc. can be embedded in the route to take effect in the required sequence.
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, the corners of the matrix learned 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.
Finally all these learned and named entities are used in the procedure file 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
TRAY INTO
GRIP
UP
JIG
UNGRIP
WITHDRAW
;
```

Industrial users and 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 I/O 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

ST Robotics are at:
Orwell House, Cowley Road, Cambridge, CB4 0PP, UK. Tel +44 1223 420288
103 Carnegie Center, suite 300, Princeton, NJ 08540, USA, Tel +1 609 584 7522