ADVANCED ROBOTICS

TOSHIBA MACHINE

TM ROBOTICS

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Official Toshiba Machine Robot Partner

TOSHIBA MACHINE

introduction

TM Robotics and Toshiba Machine - in partnership

TM Robotics (Europe) Ltd handles all sales, marketing and support for Toshiba Machine's Industrial Robots throughout Europe. The relationship between the two companies is a guarantee of quality that cannot be matched by any other European SCARA supplier.

Toshiba Machine was established in 1938 and employs almost 3000 people worldwide. As a member of the Toshiba group of companies its origin can be traced back as far as the establishment of the Shibaura Engineering Works Co. in 1875. The expertise gathered over almost thirteen decades has contributed to the refinement of the Toshiba Machine robots.

TM Robotics has an established and extensive network of distributors and integrators in all major European countries. These companies focus on TM Robotics' core markets of food, plastics, pharmaceuticals, packaging, automotive components and electronics. The network of partner companies offers comprehensive levels of training, service and support. This extends from the initial specifications and selection of the right robot for the application, through commissioning and into post-sales support. TM Robotics' strength comes from this base of expertise, innovative products and commitment to service. Indeed, the company constantly strives to apply the advanced technology and versatility provided by Toshiba Machine in new and innovative ways.

The Toshiba Machine Numazu Plant in Japan

A huge wealth of successful installations offers evidence of the success of TM Robotics, its network and the reliability of the Toshiba Machine range of robots. Toshiba Machine robots can be found pouring gold for Johnson Matthey, and on plastics moulding lines belonging to Marshall Tuflex. They can be found manufacturing everything from fasteners and fittings to mobile phones and foodstuffs. To find out more about some of these applications, and others, turn to pages 13 and 14. Available in a variety of sizes our SCARA robots are easily integrated into Toshiba Machine machine tools, injection moulding machines, printing presses and die casting machines.

"In order to progress, European manufacturing must constantly take advantage of the most advanced automation technology. SCARA robots allow us to increase productivity and offer significant cost benefits compared with their five and six axis counterparts".

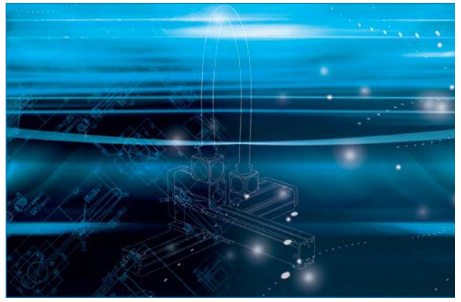
Nigel Smith, managing director, TM Robotics.

an overview

An answer to every industrial automation question

Toshiba Machine's range of SCARA industrial robots is among the largest in the industry and in the world. The smallest robots in the range offer stunning precision and repeatability, sufficient even for electronics manufacture. At the upper end of the range, payload capacity is great enough for heavy handling and palletising applications. The company also offers a range of Cartesian linear actuators that can be constructed in over 500 configurations. This provides an unprecedented range of options for design engineers and integrators.

By combining its SCARA and Cartesian ranges, TM Robotics can provide the right robot for assembly, materials handling, pick and place, sealing, palletising and positioning applications. Toshiba Machine manufacture a range of machine tools, injection moulding machines and printing presses, many of which have a Toshiba Machine SCARA and / or Cartesian robot integrated inside



SCARA precision and SCARA strength

The most significant development in Toshiba Machine's robot range in the last decade is the replacement of the SR series of robots with the new, highly innovative, TH range. The new range includes a like for like substitution for every robot in the SR series, but offers significantly improved payloads and speeds.

The introduction of the TH range began with the development of the TH250 and TH350, which are so precise that they are used to good effect in the electronics industry. In early 2004, the TH650 was introduced to rave reviews from the media – including specialist magazines for the food, pharmaceuticals, packaging and plastics industries. Joining these three machines are the TH450, TH550, TH850 and TH1050, meaning there is now a SCARA available to suit almost any requirement.

The complete range

This new catalogue marks the evolution of the SCARA robot range from Toshiba Machine. From the small and effective TH250 to the powerful TH1050, the widest range of SCARA robots in industry now packs even more power in its punch.

Also available is the SR-HZ series of palletising SCARA robots is suitable for carrying large-sized, heavy work pieces of up to 70kg payloads. The robot also has an unusually wide working envelope.

Cartesian versatility

The Toshiba Machine Cartesian robot uses a modular building block design, allowing single or multiple axis configurations to be built from the same standard components. This system allows for over 500 configurations whilst the compact design minimises space requirements. The robot's very simplicity represents a significant step forward in automation technology.

Control at your fingertips

All of Toshiba Machine's controllers use absolute encoder feedback rather than incremental signals. This removes the need to implement a zero return on start up and as a result leads to significant time savings. They feature inbuilt PLC's to enhance the control functionality. This provides greater flexibility when connecting to external devices and gives parallel processing of robot motion and input, output communication. Like all Toshiba Machine products, the controllers integrate easily with other industrial automation equipment having Profibus, Devicenet or Ethernet optional connectivity.

TH SERIES
compact SCARA Robot series

TH250

Arm length	250mm (125+125)
Z-axis stroke	120mm
Max. payload	3Kg
Repeatability X, Y	±0.01mm
Repeatability Z	±0.01mm

TS1000

No. of axis	Maximum five
Storage capacity	6400 points
I/O	16 inputs/16 outputs
Controls	TH250/TH350

TH350

Arm length	350mm (225+125)
Z-axis stroke	120mm
Max. payload	3Kg
Repeatability X, Y	±0.01mm
Repeatability Z	±0.01mm

SCARA ROBOTS
horizontal multi-joint robots

TH450

Arm length	450mm
Z-axis stroke	150mm(300)
Max. payload	5Kg
Repeatability X, Y	±0.015mm
Repeatability Z	±0.01mm

TH550

Arm length	550mm
Z-axis stroke	250mm (300mm)
Max. payload	5Kg
Repeatability X, Y	±0.015mm
Repeatability Z	±0.01mm

TH650

Arm length	650mm
Z-axis stroke	300mm (350mm)
Max. payload	10Kg
Repeatability X, Y	±0.015mm
Repeatability Z	±0.01mm

TS2000/2100

No. of axis	Maximum five
Storage capacity	6400 points
I/O	38 inputs/32 outputs
TS2000 controls	HSP, HZ, TH450, TH550
TS2100 controls	TH650, TH850, TH1050

TH850

Arm length	850mm
Z-axis stroke	500mm (350mm)
Max. payload	20Kg
Repeatability X, Y	±0.03mm
Repeatability Z	±0.02mm

TH1050

Arm length	1050mm
Z-axis stroke	550mm (500mm)
Max. payload	20Kg
Repeatability X, Y	±0.03mm
Repeatability Z	±0.02mm

SR-1504HZ

Arm length	1500mm (1950mm)
Z-axis stroke	600mm (1200mm)
Max. payload	70Kg (40Kg)
Repeatability X, Y	±0.2mm
Repeatability Z	±0.2mm

SCARA ROBOTS technical specifications

SCARA ROBOTS technical specifications

Model		TH250	TH350	TH450	TH550	TH650	TH850	TH1050	SR-1504HZ
Horizontal multi-joint robot									
Arm Length	Full length	250mm (125+125)	350mm (225+125)	450mm (200+250)	550mm (300+250)	300mm (300+350)	850mm (350+500)	1050mm (550+500)	1500mm (1950mm)
	Axis 1	125mm	225mm	200mm	250mm	350mm	500mm	550mm	850mm
	Axis 2	125mm	125mm	250mm	300mm	300mm	350mm	500mm	650mm
Working Envelope	Axis 1	±115°	±115°	±120°	±120°	±160°	±160°	±160°	±110°
	Axis 2	±140°	±145°	±145°	±145°	±143°	±145°	±145°	±150°
	Axis 3 (Z-axis)	120mm	120mm	150mm (300mm)	150mm (300mm)	200mm (400mm)	200mm (400mm)	200mm (400mm)	600mm (1200mm)
	Axis 4 (Z-axis rotation)	±360°	±360°	±360°	±360°	±360°	±360°	±360°	±360°
Maximum speed	Axis 1	480°/sec	300°/sec	375°/sec	375°/sec	337.5°/sec	300°/sec	281°/sec	130°/sec
	Axis 2	480°/sec	480°/sec	600°/sec	600°/sec	600°/sec	411°/sec	411°/sec	160°/sec
	Axis 3 (Z-axis)	1067mm/sec	1067mm/sec	2000mm/sec	2000mm/sec	2000mm/sec	2000mm/sec	2000mm/sec	1000mm/sec
	Axis 4 (Z-axis rotation)	1143°/sec	1143°/sec	2000°/sec	2000°/sec	1700°/sec	1147°/sec	1147°/sec	300°/sec
	Composite	3.14m/s	2.88m/s	7.33m/sec	6.21m/sec	7.49m/sec	8.03m/sec	8.73m/sec	5.22m/sec
Load	Maximum payload mass	3kg	3kg	5kg	5kg	10kg	20kg	20kg	70kg (arm length 1950:40kg)
	Allowable moment of inertia at end	0.017kgm² (With limited acceleration)	0.017kgm² (With limited acceleration)	0.05kgm²	0.05kgm²	0.1kgm²	0.2kgm²	0.12kgm²	3.5kgm²
Positioning repeatability	X, Y (Plane)	±0.01mm	±0.01mm	±0.015mm	±0.015mm	±0.015mm	±0.03mm	±0.03mm	±0.2mm
	Z-axis (Vertical)	±0.01mm	±0.01mm	±0.01mm	±0.01mm	±0.01mm	±0.02mm	±0.02mm	±0.2mm
	Axis 4 (Z-axis rotation)	±0.03°	±0.03°	±0.015°	±0.15°	±0.015°	±0.03°	±0.03°	±0.05°
Input/output signals for hand		5 inputs, 4 outputs	5 inputs, 4 outputs	5 inputs, 4 outputs	5 inputs, 4 outputs	5 inputs, 4 outputs	5 inputs, 4 outputs	5 inputs, 4 outputs	5 inputs, 4 outputs
Air piping for hand		ϕ4x4 pcs.	ϕ4x4 pcs.	ϕ4x4 pcs.	ϕ4x4 pcs.	ϕ6x4 pcs.	ϕ6x4 pcs.	ϕ6x4 pcs.	ϕ12x2 pcs.
Position detecting system		Absolute system	Absolute system	Absolute system	Absolute system	Absolute system	Absolute system	Absolute system	Absolute system
Mass of the robot		15kg	15kg	27kg	29kg	55kg	72kg	75kg	550kg
Controller		TS1000	TS1000	TS2000	TS2000	TS2100	TS2100	TS2100	TS2100
External view		see www.tmrobotics.ch	see www.tmrobotics.ch	see www.tmrobotics.ch	see www.tmrobotics.ch	see www.tmrobotics.ch	see www.tmrobotics.ch	see www.tmrobotics.ch	see www.tmrobotics.ch

Note: An item in parentheses is an option

Z-axis long stroke

- TH450/TH550 Z-axis stroke can be extended up to 300mm
- TH650/TH850/TH1050 Z-axis stroke can be extended up to 400mm
- Larger margin for upward or downward movement
- Vital in long workplaces

Applicable models: TH450, TH550, TH650, TH850, TH1050

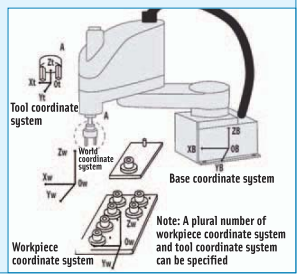
Ceiling type

- Can be suspended from the top of the work area
- Makes the best possible use of the available area

Applicable models: All SCARA robots except for the TH250

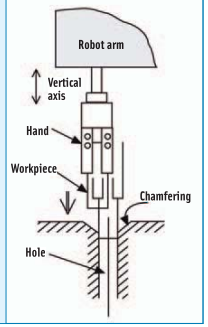
Coordinate system

- Four coordinate systems - world, base, tool and workpiece
- No modification of entire position data after position or tool change



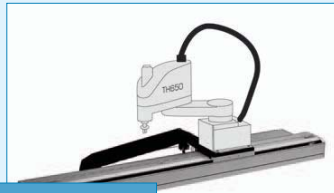
Torque control

- Allows robot movement while controlling each axis motor torque
- Applicable in workpiece insertion
- Protects the robot hand and the workpiece
- Features Torque on/off option, allowing unrestricted movement
- Torque limit allows any limit value to be specified for any axis torque



Addition of traverse axis

- Utilises the maximum five axis control option
- Allows the robot itself to move between workstations
- Dramatically improves flexibility



Applicable models: All SCARA robots

Z-axis bellows

- Ideal when using the robot in a hostile environment so as to protect splashing from liquid and abrasive material
- In case of Z-axis 400mm, the height of the robot tool flange is located 10mm lower than the standard type and Z-axis stoke becomes 390mm

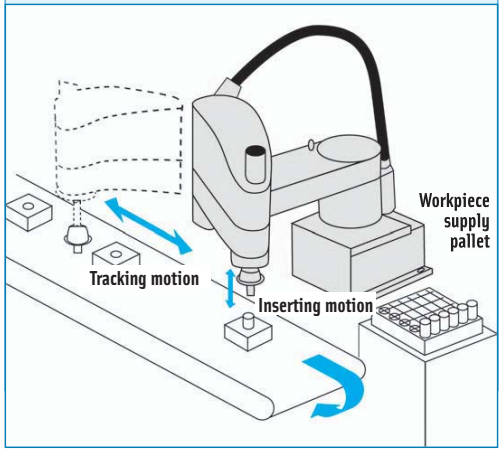
Applicable models: All SCARA robots

Synchronisation with a conveyor

- The robot traces the conveyor's movement
- Allows continuous handling of workpieces
- Allows supply of workpieces to a moving pallet
- Rotational synchronisation available

Compatability with vision system

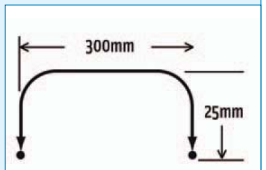
- Guide robot based on machine vision feedback
- Precise timing = high speed accuracy
- Increased flexability, consistant throughput
- Improved return on investment



Cycle time

High-speed arch motion is possible:

TH250: 0.35 seconds with 1Kg load
TH350: 0.37 seconds with 1Kg load
TH450: 0.33 seconds with 2Kg load
TH550: 0.33 seconds with 2Kg load
TH650: 0.33 seconds with 2Kg load
TH850: 0.49 seconds with 2Kg load
TH1050: 0.48 seconds with 2Kg load



Clean room specifications

- Applications such as semi-conductor & pharmaceuticals
- TH-CR series extends to clean room class 10 (0.3µm)
- Operating speeds of Axis 2 and 3 are restricted to 80%

Applicable models: All SCARA robots

Operation mode

Operation modes include PTP, CP, short cut motion and arch command:

PTP (Point to Point control)

- Moves robot fast to target position, irrespective of path
- All axes are synchronized

CP (Continuous path control)

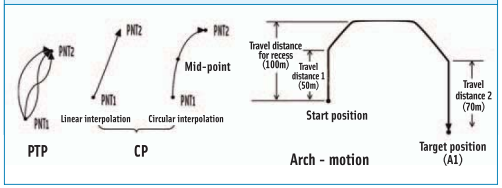
- Moves robot fast to target position, irrespective of path
- Offers linear or circular interpolation
- Three dimensional interpolation can be performed at high speed

Short cut motion

- Robot doesn't stop at taught positions but passes nearby before arriving at its target position
- Avoids an obstruction and shortens the cycle time

Arch motion

- Performs pick and place functions quickly
- The robot moves on an arch shaped path to a target position
- Any travel distance can be specified



CONTROLLER specifications

TS1000

- Built in PLC
- Enhanced monitoring facilities
- Complete system control
- Handles the TH250 and TH350 robots
- Optional fieldbus connectivity (Profibus, Ethernet, Devicenet and CC-link)
- Easy interface to peripheral products
- Maximum five-axis simultaneous control
- 16 inputs and 16 outputs

CONTROLLER	TS1000
No. of axis	Standard 4-axis simultaneous control (max five-axis)
Operation mode	PTP, CP (linear, circular), shortcut
Position detection	Absolute encoders system
Storage capacity	Total: 6400 Points + 12800 Steps One Programme: 2000 Points + 3000 Steps
Number of Programmes	Maximum 256 (247 User files & 9 System files)
Programming Language	SCOL (proprietary, similar to basic)
Teaching Unit	Teach Pendant TP1000 (programmes can be written on PC)
External inputs/outputs	16 inputs/16 outputs (8/8 can be switchable with system)(Expandable) (I/O selectable between plus-common and minus-common)
End-effector control systems	5 inputs/4 outputs
External operation signals	Inputs: Cycle operation modes, start, stop, program reset, etc Outputs: Servo-On, emergency stop, malfunction, etc
Serial communication	RS-232C: 2 ports
Other functions	Torque control, Interruptive functions, self-diagnosis, I/O control & communications during motion, Coordinate calculations, Constant-speed control, Built-in PLC, etc
Options	I/O extension, I/O cables, Field network (Devicenet, Profibus, Ethernet & CC link) Position data latch function, PC software for programming (TSPC), Seperation of operational panel, cable length
Power supply & capacity	Single-phase: AC240V -200V 50/60 Hz(+/-10%) 1.1kVA
Dimensions & Mass	170W x 290H x 270D(mm), Approx. 10kg

TS2100

TS2000:
- Equivalent controller available for **TH450** and **TH550** robots
- Single phase power: AC180/2.7KVA

Dimensions - 290Wx230Hx280D(mm) 12kg

- Suitable for TH650, TH850 and TH1050
- Built in PLC
- Increased servo drive capacity
- Constant speed control
- Optional fieldbus connectivity (Profibus, Ethernet, Devicenet and CC-link)
- Easy interface to peripheral products
- 38 inputs and 32 outputs

CONTROLLER	TS2100
No. of axis	Maximum five-axis simultaneous control
Operation mode	PTP, CP (linear, circular), shortcut
Position detection	Absolute encoders system
Storage capacity	Total: 6400 Points + 12800 Steps One Programme: 2000 Points + 3000 Steps
Number of Programmes	Maximum 256 (247 User files & 9 System files)
Programming Language	SCOL (proprietary, similar to basic)
Teaching Unit	Teach Pendant TP1000 (programmes can be written on PC)
External inputs/outputs	31+7 inputs / 22+10 outputs (7/10 can be switchable with system) (I/O are supplyable between plus-common and minus-common)
Hand control signals	5 inputs/4 outputs
External operation signals	Inputs: Cycle operation modes, start, stop, program reset, etc (6 dedicated Inputs + 7 Inputs shared with general) Outputs: Servo-On, emergency stop, malfunction, alarm, etc. (2 dedicated Outputs + 10 Outputs shared with general)
Serial communication	RS-232C: 2 ports
Other functions	Torque control, Interruptive functions, self-diagnosis, I/O control & communications during motion, Coordinate calculations, Constant-speed control, Built-in PLC, etc
Options	I/O extension, I/O cables, Field network (Devicenet, Profibus, Ethernet & CC link) Conveyor synchronization, Position data latch function, PC software for programming (TSPC), Seperation of operational panel, cable length
Power supply & power capacity	Three phase: AC190/250V (+/-10%) 50/60Hz (+/-10%) 4.4KVA (varies based on the robot arm type)
Dimensions & Mass	420W x 230H x 300D(mm) 16kg

TEACH PENDANT & software

Using the teach pendant couldn't be simpler

The TP1000 teach pendant makes multiple robot control simple and effective. Robot commands can be entered using either the built in keyboard or the digital menu. There is a three-point deadman's switch to enable manual movement when required. In such situations the robot can be controlled using simple, intuitive guide keys. An emergency stop button is provided to make manual robot shut down completely safe and immediate.

Teach pendant features

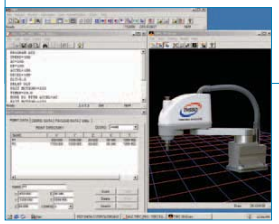
- Allows robot to be moved to taught position
- Position teaching and position data editing
- File operation
- Program creation and editing
- Test operation
- Setting of conditions for automatic operation
- Robot language can be executed directly
- Monitoring of input/output signals and current position
- Display of current error status and error history

Software makes programming simple

Toshiba Machine's TSPC software from TM Robotics makes system integration work simple thanks to its wide range of functions. These include a program editor; grammar check and communications as well as program selection, position teaching and 3D display to check robot motion. As a result, development of the robot programme is far quicker and much simpler. The software also allows variable values to be used on the robot program and I/O status to be checked in real time. This radically improves the debugging process.

Software features

- Cycle time testing, accurate to a fraction of a second, allows verification of all robot programmes in advance
- Grammar check verifies that correct file names are used in programming
- Program execution is displayed in real time
- Allows the use of personal computer instead of an FDD unit
- Simple program storage
- Allows editing, storage and syntax checking via PC
- Communication is performed through a PC



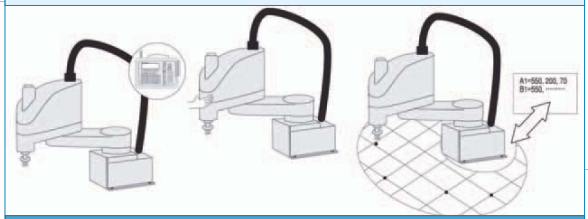
Teaching methods

- Programs are easy to enter via teach pendant
- Uses SCOL robot programming language
- Position data is easy to teach - remote, servo free or MDI coordinate value

Remote
- The arm moves to target position using the teach pendant
- In inching mode, the arm moves a small distance for each keystroke
- In jog mode, the arm moves as long as the key is pressed

Servo free
- The arm can be manually moved into target position when off

MDI: Coordinate value
- Target position can be input by coordinate value
- Useful for entering target position after calculating it from a drawing

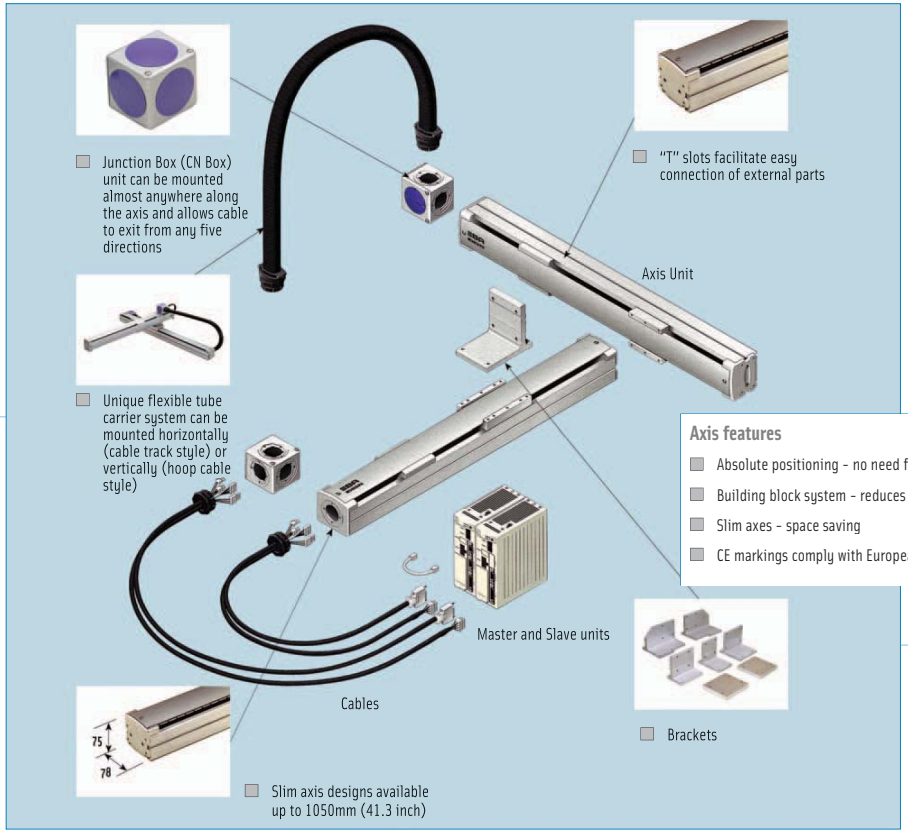


Remote	Servo free	MDI: Coordinate value

Modular construction makes design simple

The BA series Cartesian linear actuator, more commonly known as the ROIbot, uses a modular building block design, allowing single or multiple axis configuration to be built from the same standard components. Manufactured by Shibaura Mechatronics, a wholly owned subsidiary of Toshiba Corporation, this system allows for over 500 configurations whilst the compact design minimises space requirements. With a payload capacity of up to 150Kg per axis and an arm length of between 50mm and 2.5m, the BA series is perfect for even the most demanding applications.

Each axis can handle up to 150kg and features AC servomotors, precision ground ball screws and high rigidity linear guides. Motors can be mounted on either side of the axis, or underneath, to reduce its overall length. The junction box unit can be mounted almost anywhere along the axis and allows cable to exit from any of five directions. The ROIbot is supplied with a unique flexible tube carrier system, which can be mounted horizontally or vertically.



Axis features

- Absolute positioning - no need for home return
- Building block system - reduces part count
- Slim axes - space saving
- CE markings comply with European directives

CARTESIAN linear actuators

The controller

The controllers are similar in size to a stand-alone AC servo driver and fit easily into a control panel. Built in I/O can eliminate the need for external PLC or sequencer controls and provides standard support for basic pick and place and palletising routines. Up to four controllers can be connected together in a multitasking system and each one can accept a pulse train input for movement commands, allowing an external motion control system to be easily integrated.

Controller features

- Compact size - fits easily into a control panel
- Easy to use programming language
- Built in I/O - eliminates external PLC or sequencer controls
- WINDOWS based programming tools
- Multitasking capability - up to four controllers can work together
- World wide power supply - AC 100/120/200/240V
- Pulse train input - external motion control can be easily fitted
- Flexible tube system - mount horizontally or vertically
- Cartesian robot compatable with cost effective TS1000 controller

The belt axis ROIbot - long stroke, high speed

Available in a range of sizes, the new belt axis actuators can handle up to 40kg at speeds of up to 2000mm/s. Both factors depend on motor size, which can be up to 200W, whilst speed is also relative to payload capacity. The stroke range can be up to a maximum of 2500mm on the largest model. Repeatability across the range is ±0.05mm.

Further options

- TPH-2A teach pendant - allows manual control
- Host computer software - edit, execute and save programs from a PC
- Communications cable - connect to a PC
- Clean room - for use in pharmaceutical and laboratory applications
- Dust resistant - for use in dirty environments
- Regenerative discharge units

The BA05 and BA07

Compact ball screw actuators for use in high rigidity applications

BA05/BA07 features

- High rigidity and slim frame
- Can be constructed in two-axes or three-axes (orthogonal) combinations
- Easy to use controller is standard for entire BA series
- Maximum effective stroke for the total axis length saves space
- Absolute-encoder eliminates home return
- Encoder backup by commercially available batteries
- Quiet and accurate precision ground ball screw
- Precision Z-phase detection for home positioning (sensor-less)
- Easy maintenance using replaceable components
- Arm length 50mm - 600mm
- Accurate to 0.02mm
- Payload 30kg

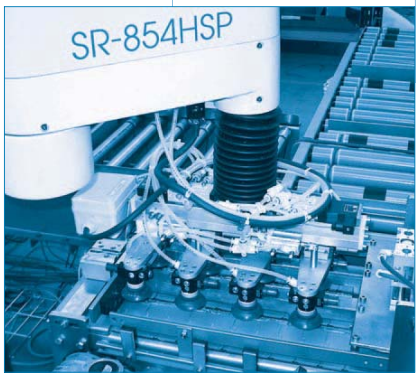
CASE STUDIES

The inevitable tide of industrial automation

Toshiba Machine SCARA robots are in use across Europe in countless applications, from the highly regulated pharmaceutical clean room to handling and logistics applications in packaging. Every year, more and more companies are turning to industrial robots to cut costs, improve productivity and increase output.

For instance, three Toshiba Machine TH350 ceiling mounted robots at a pet food factory in Bremen, northern Germany.

In order to maintain the manufacturer's range and improve its productivity, the company has made substantial investment in factory automation. Toshiba Machine robots now package birdseed sticks at a rate of ninety per minute. Where once there were seven people working on the application across three shifts, now three Toshiba Machine TH350 robots achieve the same results. The people have now been re-deployed across the plant.



The SCARA robots are part of a production line that manufactures birdseed sticks that are analogous to a fat based lollypop, embedded with nuts. The birdseed sticks are fed down three conveyors, each with a ceiling-mounted SCARA robot at its end. As this happens, the boxes are fed down another conveyor. A robot gripper then picks up the seed sticks and transfers them into boxes on a moving conveyor.

Ceiling mounted SCARA robots make the best use of the available work area. They are perfect for use at the junction of convening conveyors or other areas where space is at a premium. Ceiling Mount makes the best possible use of the robot's working envelope and also saves real estate, which, in turn, saves money. As a result, payback times become quicker and the factory becomes leaner.

Another significant factor in the application was cycle time. In order to match the production rates of the manual version of the line, TM Robotics worked with the pet food manufacturer to specify one of Toshiba Machine's fastest robots.

Another example of manufacturing excellence can be found in Spain, where TM Robotics in conjunction with its key Spanish integrator Maser Robotica SA, has helped Dinalot, a manufacturer of automotive parts, develop a Cartesian robot cell to improve production. The robot has reduced component rejection on a high-speed line that manufactures metal disks for use in vehicle fuel injection systems.

The Cartesian robot works in conjunction with a machine vision system in a quality assurance role. There are five versions of the metal disks, which incorporate six tapped and countersunk holes. Before the process was automated, an operator checked the diameters of the holes and their positions relative to a central notch. This time-consuming process involved selective sampling and, as a result, allowed some non-compliant parts to pass through. "Any process where only a portion of a batch is checked inevitably produces errors," explained Nigel Smith of TM Robotics. "By checking component parts with an automated vision system, the user can drastically reduce such errors."

The new system uses two vision sensors mounted on the robot arm and a rack mounted PC. The computer controls the sensors and robot, and displays the inspection images and measurement results.

The entire operation at Dinalot now takes just nine seconds, allowing every part produced to be inspected. The data generated by this system has allowed Dinalot to refine other areas of its machining processes, resulting in long-term benefits as well as short-term payback.

Perhaps the most unusual application TM Robotics has been involved in recently can be found in the UK, where robots are applied to test the strength of pipes. Here TM Robotics teamed up with impact testing specialist Imatek Limited to deliver a robot system to handle the task safely for pipes used by a South Korean steel company.

The application uses Toshiba Machine SCARA robots to test large diameter line pipes that will ultimately be used for carrying fluids at high pressure. Preparation for the DWTT (Drop Weight Tear Test) process involves cutting a segment from the pipe, flattening it and putting a notch on one side as a crack initiator. The segment of pipe is then immersed in liquid nitrogen, to cool it to as low as -160°. Placing the pipe in this cooling bath causes embrittlement before the specimen is then positioned on an anvil in a drop-weight testing machine and broken into two pieces.

The tricky bit is moving the pipe specimen from bath to machine and breaking it within the ten seconds allowed by the test method. "This poses a safety problem as an operator cannot be expected to put their hands inside unless the mass is fully supported," explained Richard Sparks, who handles technical sales at Imatek. "However, to achieve the test cycle time required by the standard, the mass instead has to be suspended, ready to drop. As a result we needed an automated solution, where the robot provided sufficient speed to transfer the pipe into position within the drop-weight tester within the required cycle time."

With the specimen in position, a three-tonne weight is dropped from a height of 3.5 metres onto the pipe, striking the opposite side of the segment to the notch. This creates up to 100,000J of impact energy – as mentioned already about the same as firing 170, 0.45 calibre handguns at a single spot, or an average man weighing about 140lbs falling 180 metres! In order to ensure that the force is being applied in exactly the right place on the steel pipe, the robot needed to provide positioning accuracy of ±0.5mm – another reason for choosing the highly precise Toshiba Machine SCARAs.

Usually the operator visually inspects the broken specimen in order to determine mode of failure. This drop-testing machine is fully instrumented ensuring a very repeatable test method. The initial velocity is measured using a proprietary laser system and force is measured during specimen failure to provide the user with force and displacement data from which the quality of the steel can be determined and how well it will operate under pressure. The end result allows the product to meet the demanding quality standards of the American Petroleum Institute.

"We selected the TM Robotics and Toshiba Machine SCARA for a number of reasons," explained Sparks. "Firstly, the robot only had to move in two planes, which is well within the capabilities of the SCARA. In addition, because SCARAs are so compact, the robot fits easily within the available space. We looked at pneumatic alternatives but the solutions on the market couldn't achieve the positioning or repeatability we were looking for. We also looked at servo motion systems as an alternative but the price and performance of the robot solution was way ahead."

"Apart from the technical advantages provided by the product, TM Robotics was also able to help with the application itself thanks to the company's technical knowledge," continued Sparks. "TM's engineers came up with the right robot, trained us in its use and were able to ship at quite short notice. At Imatek we specialise in instrumented drop-weight testers - this includes a lot of work in the automotive and steel industries. However, this is physically the largest project we have done so far, even in this demanding field, so it was important to be able to rely on TM's level of support."

The efficiencies resulting from Imatek's applications, as well the other two, raise the question of what could possibly stop the inevitable tide of robot automation? Perhaps these three case studies suggest that, at least globally, industry is committed to world-class performance? The increased production, higher profitability and improved levels of safety experienced by the companies in question certainly suggest that this is the case.