

## **ABB takes the lead in multi-robot synchronous control**

ABB has launched its fifth generation robot controller, the IRC5. It sets new standards with its modular concept, a completely new ergonomically-designed Windows interface unit, and fully coordinated multiple (up to four) robot control through the MultiMove function.

The new controller is focussed directly at the customer with greatly simplified application planning, set-up, operation and serviceability of single and multiple robot cells. A key element in this superior 'customer friendliness' is the new class-leading portable interface unit, the FlexPendant, with its familiar Windows layout and touch-screen operation. The modular concept also means every system is a cost-efficient investment, designed to match the exact needs of the user, and yet is readily expandable to meet future demands. It is a true lean solution that will lead to increased customer life-time profitability.

The IRC5 inherits all the tried and tested software of the existing S4CPlus controller plus a number of significant advancements, including the new MultiMove. Like its predecessor, the IRC5 is PC based with all control functions executed in software, but is completely new in concept and physical realisation.

### **Modular Design**

The modularity of the IRC5 is a major step forward in robot control with a logical split of functions into control, axis drives and process. Each module can be housed in its own cabinet with identical footprints so they may be stacked for minimal floor occupancy or distributed depending on the user's need. There is minimum dependency between the modules, each having its own computer power and supervision and standard Ethernet communications. This flexibility makes it easy to lay-out the modules, to repackage them in different forms and to upgrade or replace one with minimal interference to the others.

The hub of the IRC5 is the control module that uses a standard industrial PC. Here are performed all the control functions and path calculations for up to four 6-axis robots plus additional axes such as work positioners, a total maximum of 36 axes. Early versions of IRC5 will be delivered with a 566MHz Intel Celeron processor (upgradeable to 1.2MHz) but others will be readily applicable as future more powerful chip sets are developed. Also contained in the module are connections to process equipment, networks, field busses and safety devices. There is also a large amount of space for custom I/O boards that may be added at a late stage.

The drive module houses the axis computer (a 250MHz Motorola PowerPC), which controls the position and speed of up to 9 servo axes, and the servo drive cards. The main servo drive is in a 6-pack bundle (for a 6-axis robot) to minimise connections, components and PCBs, with additional axes supplied in single-packs. Up to four drive modules can be linked to the main control module and thereby drive up to four robots and additional axes, and this is the basis for MultiMove applications. And, with just two cable connections - safety and Ethernet – between the control module and each

drive module, installation is simple. In the same way it is easy, as well as low in cost, to expand the cell should a customer decide to add robots after the first installation.

There is the option to mount the control and one drive module in a single, taller cabinet with the same footprint, termed the Compact Controller, which is ideal for a single robot cell. It has exactly the same functionality as the separated module arrangement (termed the Flexible Controller), including the facility to add further drive modules for multiple robot cells. The compact cabinet just has less space for customised interfaces and lacks the ability to have a physical split of the control and drive functions.

The process module is a cabinet of the same standard format ready to receive the application package such as for spot welding, arc welding, gluing and others. It has the same communications and interface arrangements as the control module, and an identical footprint, and therefore is linked in the same way to the control module, whether in Flexible or Compact Controller form.

A major customer benefit of the modular concept with the standardised footprint and two-cable communications links is a total flexibility in the lay-out. For example in a single robot cell, all three modules may be stacked one above the other – a process module can also be stacked above a Compact Controller cabinet – or they may be placed side-by-side. They can also be distributed up to 75m apart (the drive module must be within 50m of the robot arm).

Similarly, for a multiple robot cell, modules may be stacked and placed side-by-side in an array, for instance, a control-drive-process stack alongside one or more drive-process stacks. There again, all may be separated and distributed up to the 75m limit. An advantage of the distributability is being able to place each module in its ideal position. For example, the control module may be located remote from the robot cell, such as in a central control area for easy access and not interfering with the cell itself. One feature supporting the latter is the ability to remove from the controller the operator panel (on-off, mode selector, start and emergency stop switches) and place it in an optimum position such as adjacent to the physical cell.

### **Open system interface unit**

The second major advance in ABB's new controller, and central to the ease-of-use philosophy, is the FlexPendant interface unit. It represents a significant breakthrough in both concept and technology. Physically the unit is lightweight at under 1.3kg and is extremely tough with protection to IP54, fits naturally into either hand leaving the other free, and has an ergonomic design that suits large and small, left and right handed operators alike. It is simple in layout with a 7.7inch (640 x 480 pixel) full colour touch screen that indexes 180 degrees for left and right hand use so it is always viewed the correct way round. The screen is easy to clean and safe from arc welding damage at 1m or more. The FlexPendant has only eight 'hard', fast-access buttons, four of which are fixed and four assignable, plus the unique ABB 3-way joystick for intuitive jogging of the robot, and an emergency stop.

The FlexPendant software has been developed in close cooperation with Microsoft using the Windows CE.NET operating system and is the world's first open robot

interface unit. ABB is the first industrial automation and robotics company and probably the first in the manufacturing sector to exploit Windows CE, which is increasingly being used in commercial applications such as new smart mobile phones. It is extremely robust and designed for 24-hour, 7-day safe operation with a high level of virus immunity. Screens for FlexPendant are readily created in this environment using Microsoft's C# language. CE provides all the benefits of an open system and, for example, allows ABB to apply Asian language characters including Chinese, Japanese and Korean, thus making IRC5 products more attractive in Far East markets.

Custom applications are readily built with the minimum of redundant information displayed on each page. This makes it much easier to use, particularly as the layout is identical to any Windows page on a PC. Further improving the FlexPendant's usability is the full colour graphics, with readily recognisable icons 'clickable' by finger on the touch screen.

While loading and start-up of the robot program may be done on the FlexPendant, a more efficient way is to use a PC that has more power, a full keyboard and can call on a wider range of software tools including the new RobotStudio Online that ABB has developed in parallel with the IRC5 and is included at no extra charge. The PC may be connected to the IRC5 control module either locally via its Ethernet service port, or remotely via the factory network.

### **Powerful software tool**

RobotStudio Online (RSOL) simplifies the installation and configuration of the IRC5. Programs may be created and edited using the ABB RAPID robot language or taken from the full RobotStudio planning and simulation software. They are then downloaded to the control module from the PC. Events may be monitored and recorded, I/O signals added and configured and when completed all backed up on the PC. The FlexPendant is then used for fine tuning and running the programs.

There is a seamless cooperation between FlexPendant and RSOL running on the PC and in effect RSOL transforms the PC into a teach pendant. One may be interchanged with the other with no effect on the performance of the controller. To the control module there is a total transparency between the FlexPendant and RSOL and any function or operation performed on one runs on the other and all on-line data is accessible from both.

### **MultiMove**

The third and perhaps most exciting advance of the IRC5 is the MultiMove functionality that enables the coordinated operation of up to four robots in a cell. This gives enormous potential to reduce costs, improve quality, increase productivity and expand robot applications.

MultiMove is totally flexible through the ability to switch between coordinated and independent operation of the robots in the cell. All four robots and additional devices in an IRC5 cell may operate totally independent of each other, or they may be totally coordinated with fully synchronised sequences and movements. But also, the robots

may operate in groups with two or three coordinated and at the same time, the other one or two in the cell work independently.

Even without multi-robot coordinated motion cost savings are made in reduced I/O and communications links because four robots as well as additional axes are controlled from one module. Also, cycle times may be reduced by eliminating the handshaking necessary with separated controllers.

The coordinated operation of the robots and additional devices greatly expands these customer benefits. An example is balanced operation with two or more robots working on the same workpiece, such as simultaneous arc welding, which may eliminate the risk of distortion due to uneven shrinkage on cooling and thereby improve component quality. Multiple robot handling of flimsy workpieces is another potential, as is the ability to lift loads larger than the capacity of a single robot.

Using one robot as the workpiece handler and others to wield process tools, opens up a whole 'new world' of applications and benefits; the part handling robot as a flexible fixture; rapid start as soon as the part is picked up with no waiting for the part to be positioned; higher relative speeds between tooling and workpiece; and full access to all poses of a part allowing a process to be completed in one handling - one-stop processing.

Even though MultiMove is a complex function to implement and requires large processing power particularly in the path planning and the synchronisation of all the drive motors of each robot, its realisation has been made simple. Experience from customers given early exposure to MultiMove has indicated that anyone familiar with programming an ABB robot particularly when coordinated with additional axes such as a work positioner, will have little difficulty in creating MultiMove applications.

A feature unique to ABB is each robot in coordinated operations has its own program that may be written and edited in the RAPID language to which MultiMove functionality is now incorporated. The programs may be viewed and executed from the FlexPendant (or PC running RSOL) totally or partly independent of each other. The same applies to any additional axes, which may now have their own program just like a robot.

During coordinated motion all the devices work with the same moving work object held by one of the robots or positioner, and the other devices operate in synchronism by executing their RAPID move instructions simultaneously.

The ability to jog in the synchronised mode during which the relative positions of all the cooperating devices are maintained is a further MultiMove feature unique to ABB. This is accomplished with the FlexPendant joystick. At any time during this procedure, one or more of the robots may be 'de-synchronised' and its relative position changed using the joystick. This is a big advantage in fine tuning programs involving MultiMove.

A potential 'minefield' during synchronous MultiMove operations is recovery from a production stop. Not only has the robot at 'fault' to avoid work and tooling but also has to communicate with its synchronised 'partners' during the retraction to a safe position as well as the recovery back to the last position. This is achieved through the path recording functionality in the IRC5 controller that is activated for every robot in a MultiMove operation. Knowledge of the path leading to the error point enables the 'fault' robot to retract to the safe point identified in the RAPID error recovery routine. The same path data will similarly be used in returning to the last program position after recovery.

## **RobotWare**

MultiMove, which was made possible by the power and modularity of the new IRC5 controller, adds further to the functionality in ABB's RobotWare software portfolio. RobotWare incorporates many man-years of ABB expertise in motion control technology, the foundation of which is a dynamic model of the robot held in the main control computer. This now applies to all robots controlled by IRC5.

A key RobotWare function exploiting knowledge of the dynamic model is TrueMove, which ensures the motion path followed by the robot is the one programmed irrespective of the speed or load conditions - WYPIWYG (What You Program Is What You Get). This function is even more valuable in multi-robot cells by eliminating the need to calibrate every robot in the cell prior to production start-up, and ensuring a high consistent quality of parts.

QuickMove is another key RobotWare function carried over to IRC5. This unique self-optimising motion control feature keeps cycle times to a minimum by ensuring acceleration is constantly at a maximum, resulting in cycle times up to 25% less than traditional robot controls. Load identification, software collision detection in place of mechanical devices, and Absolute Accuracy are some of the other existing functions ported over to the new generation controller.

The expertise of ABB from over 30 years of developing and installing more than 125,000 robots has been channelled into the IRC5 controller. It therefore represents the biggest advances made by ABB in robot control technology. However, its principles and its realisation in software are identical to that of the previous generation so customers will recognise a strong family link. Users will also find a familiarity in the development of their programs and operation of their ABB robots, and importantly all their existing software for S4 generation controllers will run just as readily on the IRC5.

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For more information about IRC5: [www.abb.com/robotcontroller](http://www.abb.com/robotcontroller)