

IRC5 hardware to deliver coordinated multi-robot control

ABB's newly-launched fifth generation robot controller, the modular IRC5, represents one of the largest steps changes made in robot control technology. It is not only the capability to control up to four fully coordinated robots with the new MultiMove functionality that makes the leap forward, but also the IRC5's innovative modular design with a logical split of functions and minimum dependency between modules. Added to this are the comprehensive communications, minimum maintenance and high reliability (80,000 hour MTBF) plus the new innovative, open systems, portable interface unit, the FlexPendant.

The Modules

One control module and one drive module make up an IRC5 controller (the Flexible Controller), with the option of an added process module to house custom equipment and interfaces for such as spot welding, arc welding and gluing. The Flexible Controller with one control and one drive module plus a process module if required has all the capability to operate one 6-axis robot plus servo drive work positioners and the like. To increase the number of robots needs only the addition of a drive module and possibly a process module for each extra robot up to a maximum of four, which then may be driven in MultiMove mode. Nor is there a problem to connect the modules as only two cables are required between each, one carrying the safety signals and the other an Ethernet link for inter-module communication.

Each module of whatever type is housed in a common design and identical size cabinet with a 700 x 700mm footprint and 625mm height. The common footprint and straight-side design, together with the simple two-cable link, gives total flexibility in how the modules are arranged. They may be stacked vertically, which minimises floor area, or placed side by side, or distributed up to 75m apart. The latter allows each module to be placed in the optimum operational position; for example the control cabinet could be placed in a central area with the drive, and process, cabinet positioned close to the robot cell. Also, there is minimum dependency between the modules, each having its own computer, power supplies and standard Ethernet communications, so that each may be replaced, exchanged, upgraded or repackaged with minimal interference to the others.

The control module is the heart of the IRC5. It houses the main computer, which has the power to perform the advanced control algorithms and MultiMove path calculations for up to 36 servo axes, and direct four drive modules. It uses an open system architecture with an industrial PC based on a commercial Intel motherboard and processor, and PCI bus. This use of standard components eliminates any future obsolescence by facilitating ready upgrades as computer processing technology advances.

A unique feature of the IRC5 is the comprehensive communications capability. Cards for virtually any of the common types of fieldbus may be fitted into one of the expansion slots on the PCI bus. These include single channel 500kBaud DeviceNet, which is ODVA compliant to allow use of a large number of third party units, two channel Profibus DP supporting up to 12Mbps and two channel Interbus, for which copper wire and fibre optic interfaces are available.

Another slot will take a three channel Ethernet card, one of which may be used for Ethernet IP fieldbus, which ABB is offering as a standard option. The other two channels provide connections to the drive module and to the operator panel on the front of the module. The latter provides the means to plug in an external PC (lap top) for such as system configuration and program editing and down loading, for instance, which can be more efficient than the FlexPendant. A further slot is available for a serial connection card.

Each module has its own internal 24vDC power supply which, in the control module, is backed up by a UPS to provide 20 seconds for a safe shut down. This UPS is a no-battery system and one of the many “zero maintenance” features of the IRC5. It is a proprietary, capacitor-based system, called Ultracap that will last for the lifetime of the controller. ABB is unique in using this system in robotics.

Another panel in the control module cabinet is the interface to safety devices such as the emergency stop. This leaves a large volume of space, particularly in the Flexible Controller, for auxiliary power, I/Os, process equipment and other custom devices, all of which may be mounted on a separate plate for ease of assembly and exchange. This also allows late customisation and helps lower internal logistics costs.

A key design aim of the IRC5 is ease of use and ease of installation, the simple two-cable link between modules being an example of the latter. Another is the ‘single entry’ connectivity through the control module for up to four robots with all connections easily accessible at the front of the cabinet. Those for the field bus and the factory network Ethernet are at the base of the cabinet, while the service channel for the PC lap top and the USB port for mass memory are on the operator panel on the LHS. The mains on/off switch, the mode selector and the emergency stop button are also mounted on this panel, and these may be removed and placed remotely, for instance in close proximity to the cell area.

Up to four drive modules, each containing an axis computer and servo drive cards, may be connected to one control module. The axis computer is able to calculate the position and speed of up to nine servo axes (compared to seven axes for the S4Cplus) and to undertake the position measurement of up to 14 axes. There is the capacity for nine servo drive cards, which are available in a 6-pack bundle (for a 6-axis robot) to minimise connections, components and PCBs, and in single-packs for additional axes.

Rather than have separate cabinets for the control and drive modules, there is the option of a combined cabinet, the Compact Controller, which has the identical 700 x 700mm footprint but a height of 900mm, over 25% less volume than the S4Cplus ‘all-in-one’

cabinet. It has the same hardware and performance as the discrete module Flexible Controller, but has less space for custom I/O boards and the like. Also, it is still 'stackable' with a process module, for example. The Compact unit could be the logical choice for a single robot installation, but is still expandable by the addition of drive modules for multi-robot and MultiMove applications.

From the very start of the IRC5's development the customer has been the centre-focus with a designed-in high reliability and simple maintenance. Reduced part count is one of the methods adopted to increase reliability using measures such as the 6-pack servo drive that has 54% less connectors, 7% fewer components and a 42% reduction in the number of PCB's compared to S4Cplus. There are fewer cooling fans, seven as opposed to nine for the SC4plus, and there is no fan on the main computer CPU. Nor with the fully sealed cabinet is there need for air filters. Other methods for longevity include the no-battery UPS, speed control of the drive module fans and an auto spin-down function for the hard drive unit to extend bearing life time as well as the use of industrially robust processors and components.

Maintenance is facilitated by easy access to most parts through the front hinged door, which is sealed to prevent dust intrusion and gives the cabinet an IP-54 rating. All units within the cabinet are accessible without disconnecting cables. Only the transformer and the cooling fans need to be accessed at the rear of the cabinet through a hatch. And, the fan module has a snap-in holder that is easy to replace.

The overall result of these measures is an MTBF of 80,000 hours (over nine years of 24 hour-7 day operation), unrivalled by any of ABB's competitors in the robotics industry. High reliability and minimal maintenance are "givens" for users who, therefore, may concentrate their energies and resources on achieving optimum production performance from their ABB robot cells.

FlexPendant

The synchronous control of four robots is potentially a complex task but its implementation and fulfilment have been greatly simplified with the new operator interface or teach unit, the FlexPendant. There are two elements in making the unit "customer comfortable", its physical design and layout and its use of familiar menu-driven Windows 'point-and-click' pages on a touch screen display.

The unit weighs less than 1.3kg and is ergonomically designed to fit naturally into either hand for left or right hand use whether the operator has large or small hands. Also, the 7.7inch (640 x 480 pixel) graphical colour touch screen indexes through 180 degrees for left and right hand use so is always viewed the correct way round. The use of a touch screen has minimised the number of buttons, only eight being needed for fast-access, four of which are fixed and four assignable. The only other appendages are the unique ABB 3-way joystick, for intuitive jogging of the robot, and an emergency stop. The result is a very clear and simple-to-use layout. Also, the unit is extremely tough with protection to IP54 and the screen is robust and easy to clean and, for instance, will resist arc weld spatter from 1m or more away.

Only one FlexPendant is required per control module whether controlling one or four robots. Connection is via a single cable so helping to minimise cable clutter to a cell. The connection is also "hot plug" so that once programs have been loaded into the controller,

the unit may be removed. This can be beneficial in avoiding tampering and unauthorised use. It also makes possible the sharing of a FlexPendant between several IRC5 cells, helping further reduce customer investment and increase leanness.

The FlexPendant has been designed as a stand alone unit and not merely a display for the controller computer, and therefore, does not degrade the latter's performance. It has its own computing power with an open system PC architecture and software developed in alliance with Microsoft using the Windows .NET operating system. It is the world's first open robot interface unit and ABB is the first industrial automation and robotics company and probably the first in the manufacturing sector to exploit Windows .NET. This operating system is extremely robust and designed for 24-hour, 7-day safe operation with a high level of virus immunity.

Custom applications are readily built for FlexPendant using standard development tools from Microsoft, including the C# language and support for Asian language characters including Chinese, Japanese and Korean, making IRC5 more attractive to Far East markets. Full use may be made of graphics and icons to create pages in the familiar Windows layout with toolbars, status menus and soft buttons, which are activated or 'clicked' on the touch screen with the finger rather than a mouse button.

Windows may be built with the optimum of information and just the number of soft buttons needed for its particular use, avoiding cluttering the screen with redundant information and making for much clearer and easier use. Applying familiar icons and graphics to pages further improves FlexPendant's 'friendliness' and makes possible the creation of pages that the user can follow intuitively without having to undergo intensive training.

Applications that run on FlexPendant are used in all aspects of the operation of the robot cell including set-up, program loading, process development, fine tuning, cell operation, reporting and servicing. User authentication systems may be built-in to allow different access levels for the various user groups ranging from programmers and process engineers through cell supervisors and production operators to service personnel.

While programs may be edited on the FlexPendant, the more efficient way is to use a PC with its greater computing power and wider range of software tools. The control module has been designed for ready connection of a PC without any complex setting up or protocol problems. Connection may be direct via a plug on the module's operator panel to the USB port or indirectly via the factory network. To support the use of a PC to edit programs and configure systems, ABB has developed RobotStudio Online (RSOL), which

is supplied free with every IRC5 system. There is a total transparency between using the FlexPendant and a PC running RSOL.

The modules and FlexPendant of IRC5 and RSOL provide the ideal vehicles for the rapid implementation of multi-robot operation whether in individual or MultiMove coordinated mode. Each system can be configured to meet the user's exact needs and deliver the highest performance with maximum lifetime profitability.



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For more information about IRC5: www.abb.com/robotcontroller