

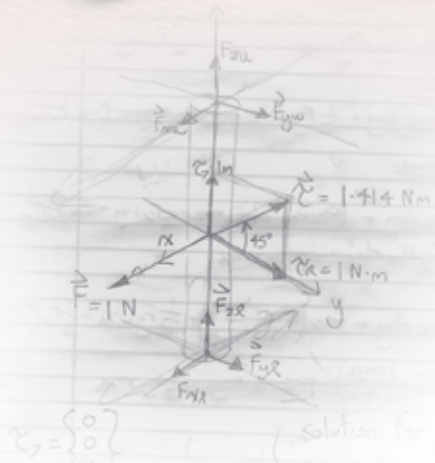
# OPEN ARCHITECTURE ROBOTICS PLATFORMS

## More Control and Simplicity for Robotics Research

Quanser technology allows advanced research and teaching in robotics by creating an open architecture platform based on popular industrial and commercial robots.

More than 20 years of experience in the field of mechatronics and controls enables Quanser to design and implement innovative platforms for research in Robotics and Haptics. These open architecture devices are customized for advanced engineering research. The diverse range of modern applications for the Robotics Collection includes:

- Robot-assisted Surgery
- Force Feedback Teleoperation
- Space and Undersea Expeditions
- Human Rehabilitation Systems



# TAKE MORE CONTROL OF YOUR KUKA ROBOT

The KUKA Open Architecture Kit from Quanser joins leading Quanser technology with KUKA industrial-grade robots to create a true open architecture platform for robotics research and teaching.

This integrated, turn-key and flexible solution is designed for research applications that include teleoperation and articulated robot manipulation. In addition, it can be used for a wide range of teaching topics and experiments such as dynamics modeling, kinematics, joint level control and workspace level trajectory planning. As a result, you can look forward to more control and simplicity as you maximize your resources and effectiveness.

## THE KUKA OPEN ARCHITECTURE KIT

The Kit is available only from Quanser and consists of:

- QUARC control software
- 3D visualization
- KUKA Robot Blockset
- Onsite commissioning service

The Kit is designed to integrate with the following hardware and software that you may already own or can purchase separately from KUKA or other suppliers:

- KUKA Robot R650 or R850
- KUKA Robot Sensor Interface (RSI)
- KUKA C2sr Controller
- A dedicated PC
- MATLAB®/Simulink® software

Bringing all these elements together enables you to perform rapid prototyping that accelerates control design and implementation. Ultimately, you will be able to implement your own research projects and get accurate test results quickly.

## HOW IT WORKS

QUARC is a powerful rapid control prototyping tool that significantly accelerates control design and implementation. QUARC seamlessly integrates with Simulink® for rapid controls prototyping and hardware-in-the-loop implementation. It is fully integrated with Real Time Workshop.

You can draw a controller in Simulink®, generate code and run it in real-time. Working together, KUKA and QUARC eliminate any tedious hand coding and cumbersome hardware integration.

Using the KUKA Robot Blockset provided by QUARC, you can control any KUKA Robot equipped with a Robot Sensor Interface (RSI) through the interactive Simulink® environment.

The KUKA Robot RSI software module is the standard sensor interface allowing real-time communication and path correction of the KUKA Robot. This is done by streaming data via an ethernet interface to the external computer in real-time at a rate of 83 Hz.

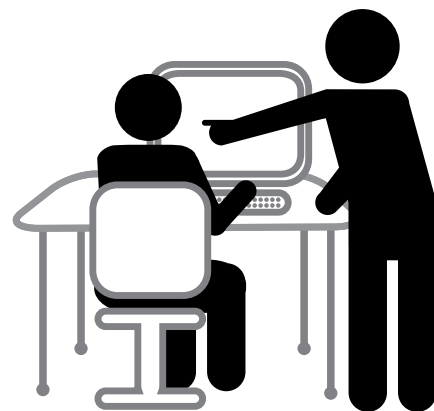
The QUARC KUKA Blockset supports two KUKA Robot models: the KR 5 SIXX R850 and KR 5 SIXX R650.



*QUARC seamlessly integrates with Simulink® for rapid controls prototyping and hardware-in-the-loop implementation.*

## The KUKA Open Architecture Kit

*The Kit is an integrated combination of essential Quanser software components and commissioning expertise, designed to work with specific KUKA Robots and PC-based hardware and software.*



*Onsite commissioning is offered by Quanser. This involves installing and running the KUKA Robot Open Architecture system, as well as training your staff in its use.*

**CAPTIVATE. MOTIVATE. GRADUATE.**



### KUKA Robot

Two KUKA Robot models are supported by this Open Architecture Kit: the KR 5 SIXX R850 and the KR 5 SIXX R650. Robots must be purchased separately.



### KUKA C2sr Controller

The KUKA C2sr Controller interfaces with QUARC software to control and measure the robot's movements. KUKA Controller must be purchased separately.



### Dedicated PC

The KUKA Robot Open Architecture Kit requires a PC equipped with QUARC and MATLAB®/Simulink® software. Dedicated PC must be purchased separately.

## HARDWARE REQUIREMENTS

- A dedicated computer is required to control the KUKA Robot. The computer needs to be equipped with:
  - A working serial port to dedicate to interfacing with the KUKA Robot and a null-modem cable
  - A working Ethernet port (10Mbit/s or 100Mbit/s compatible in full duplex mode) to dedicate to interfacing with the KUKA Robot and a regular Ethernet cable
  - VxWin Network card. The 3COM 3C905CX-TX-M 10/100 PCI network interface card is recommended. May be obtained from KUKA Manufacturer
- KR C2sr Controller, which is paired with the robot from manufacturer
- KUKA Robot Sensor Interface (RSI) version 2.2 [or later], installed with RealTime (RT) ethernet support on the robot controller

## QUARC BLOCKSET CAPABILITIES

- Command either Cartesian or joint velocity set points
- Measure the Cartesian positions, joint angles and joint torque commands
- Set either Cartesian or the joint minimum and maximum velocity limits
- KUKA built-in safety checks are still enabled for safe operation
- 3D visualization of KUKA Robot is provided

For more information about QUARC software, or to request a 30 day trial version, please visit [www.quanser.com/quarc](http://www.quanser.com/quarc).

## SOFTWARE REQUIREMENTS

- QUARC (provided by Quanser)
- KUKA QUARC Blockset (provided by Quanser)
- MATLAB®/Simulink® (purchased separately)
- Real-time Workshop Toolbox
- Windows® XP, Vista or 7

Onsite commissioning and/or training may be arranged on request. Please contact [sales@quanser.com](mailto:sales@quanser.com) for more information on the availability and price.

**PLEASE NOTE:** All required components need to be directly purchased through KUKA, except where otherwise stated.

## TECHNICAL SPECIFICATIONS KUKA ROBOT

	KR 5 SIXX R850	KR 5 SIXX R650
Payload	5 kg	5 kg
Number of axes	6	6
Max. reach	850 mm	650 mm
Repeatability	<±0.03 mm	<±0.02 mm
Weight	29 kg	28 kg
Mounting positions	Floor, ceiling	Floor, ceiling
Controller	KR C2sr	KR C2sr
Max. speed	7.6 m/s	8.2 m/s

For more information on KUKA Robots, please visit [www.kuka-robotics.com](http://www.kuka-robotics.com).



# TAKE MORE CONTROL OF YOUR DENSO ROBOT

The DENSO Open Architecture Robot from Quanser gives researchers and instructors the precision, flexibility and speed they require for effective robotics research and teaching.

The compact DENSO 6-Axis Articulated Robot is a valuable tool for a number of reasons. It has a small footprint which saves costly facility space. It is also widely employed in industry, so experience gained using it will be of great benefit to researchers and students alike.

QUARC control design software and the Quanser custom-designed controller box integrate with this robot to create a unique robotic test bed that can be controlled through Simulink®. This advanced yet user-friendly platform significantly accelerates real-time programming of Denso manipulator.

The DENSO 6-Axis Open Architecture Robot has a wide and growing range of applications. This includes, but is not limited to, teleoperation, robot-assisted surgery, rehabilitation, nursing assistance, welding and pick-and-place activity.

## DENSO OPEN ARCHITECTURE ROBOT WORKSTATION

The workstation is available only from Quanser and it includes the following hardware and software:

- DENSO 6-Axis Articulated Robot
- QUARC control software
- 3D visualization
- DENSO Robot Blockset
- A Pre-Configured PC
- DENSO Controller (custom-designed by Quanser)
- MATLAB®/Simulink® (purchased separately)
- Optional Force/Torque Sensor

Bringing all these elements together enables you to do rapid prototyping that accelerates control design and implementation. You will be able to implement your own research projects and get accurate test results quickly.

## HOW IT WORKS

The DENSO 6-Axis Articulated Robot is able to position and orient the end-effector within a large workspace. Its action resembles a human arm that can access any position and orientation within its reach.

The custom-designed controller box contains six amplifiers and built-in FF+PID (feedforward, proportional, integral, derivative) controllers. The controllers are commanding the motors and measuring the encoders at a rate of 4kHz.

All the gains in the built-in controller are accessible from QUARC Blockset through 1kHz cross-cable communication. These blocksets also have direct access to the amplifier's current commands in the module. Users can both tune the built-in controller gains in the QUARC interface or design their own controller in the Simulink® environment, and command the amplifier currents directly in a fully open architecture scenario. In the fully open architecture mode, user-defined currents are sent directly to the motors and the operator is responsible for implementing a stable feedback system.



### VP-6 DENSO Robot

*DENSO Robots are one of the world's most commonly-used industrial robot arms. The VP 6-Axis Articulated Robot combines high speed and repeatability with powerful load-handling capability.*

## IDEAL FOR TELEOPERATION SYSTEM

Quanser technology allows the DENSO Robot to be bundled with any haptic device supported by QUARC, including the Quanser HD<sup>2</sup> High Definition Haptic Device (see below), to create a high fidelity bilateral teleoperation setup where the forces and torques at the tip of the robot are measured and applied back to the operator through the haptic device.

The DENSO Open Architecture Robot Workstation supports the VP-6 Axis model.



*Quanser's HD<sup>2</sup> high definition haptic device and the Denso Robot create a bilateral teleoperation system suitable for research in such areas as force-feedback systems, telesurgery and remote manipulation.*

**CAPTIVATE. MOTIVATE. GRADUATE.**



#### DENSO Controller

The DENSO 6-Axis Robot is supplied with an exclusive, Quanser, custom-designed open architecture controller which offers all the capabilities of an industrial system and interfaces with QUARC.



Using QUARC and the DENSO Robot Blockset, you can control the DENSO-VP6 Robot through the interactive Simulink® environment.



#### Pre-Configured PC

The DENSO Robot is operated from a pre-configured PC included in the workstation. The PC contains QUARC®, the DENSO Robot Blockset, a trial version of MATLAB®/ Simulink®, and a pre-designed controller. The Pre-Configured PC enables you to set up and run the workstation quickly and with minimal effort.\*

\*Monitor, keyboard and mouse sold separately.

### HARDWARE REQUIREMENTS

- Denso 6-Axis Articulated Robot
- Quanser Open Architecture Controller
- Pre-configured PC with custom ethernet card
- Optional Force/Torque Sensor (sold separately)

### DENSO ROBOT KIT CAPABILITIES

- Command either Cartesian or joint velocity set points
- Tune the DENSO built-in controller gains or design your own controller
- Measure the Cartesian positions, joint angles and joint torque commands
- Programmable through MATLAB®/Simulink® using QUARC software
- Set either Cartesian or the joint minimum and maximum velocity limits
- DENSO built-in safety checks are still enabled for safe operation
- 3D visualization for DENSO Robot is provided

For more information about QUARC software or to request a 30 day trial version, please visit [www.quanser.com/quarc](http://www.quanser.com/quarc).

### SOFTWARE REQUIREMENTS

- QUARC (provided by Quanser)
- DENSO QUARC Blockset (provided by Quanser)
- MATLAB®/Simulink® (purchased separately)
- Real-time Workshop Toolbox
- Windows® XP, Vista or 7

### TECHNICAL SPECIFICATIONS DENSO ROBOT

Overall arm length	210 (first arm) + 210 (second arm) = 420 m
Payload	2 kg
Number of axes	6
Position repeatability	In each of X, Y and Z directions: ±0.02 mm
Position detection	Absolute encoder
DENSO Robot Weight	Approx. 14 kg
Mounting positions	Floor, ceiling
Controller	Quanser Custom Ethernet-based Controller Box
Max. composite speed	3900 mm/s (at the center of an end-effector mounting face)

For more information on DENSO Robots, please visit <http://www.densorobotics.com/>.

# TAKE MORE CONTROL OF YOUR THERMO CATALYST-5 OPEN

Advanced robotics researchers require articulated robots that are used in industry.

The Thermo CataLyst-5 Open Architecture Articulated Robot is widely used by industry and, as an articulated robot, is ideal for applications that require complex movements, such as dispensing, machine loading and unloading, material application, material handling, assembly and product testing.

The Thermo CataLyst-5 Open Architecture Articulated Robot offers five degrees of freedom and is well-suited to applications that require flexible movement without sacrificing speed or reliability. It also offers a linear track option for tending multiple machines.

## THE THERMO CATALYST-5 ARTICULATED OPEN ARCHITECTURE ROBOT WORKSTATION

The workstation is available only from Quanser and it includes the following hardware and software:

- Thermo CataLyst-5 DOF Articulated Robot
- C500C Controller
- Thermo Robot Blockset
- QUARC software
- A Pre-Configured PC
- MATLAB®/Simulink® (purchased separately)
- Optional Force/Torque Sensor
- Optional Linear Track
- Optional Gripper

This integration enables you to use the full features of the Thermo industrial controller for task planning experiments or switch to the open architecture solution to examine complex dynamic and kinematic control issues.

Bringing all these elements together enables you to do rapid prototyping that accelerates control design and implementation. Ultimately, you will be able to implement your own research projects and get accurate test results quickly.

## HOW IT WORKS

The Thermo CataLyst-5 Robot is supplied with a custom-designed open architecture controller which offers all the capabilities of an industrial system and is interfaced to QUARC through a Quanser Data Acquisition Board.

You have direct access to the amplifier's current commands in the C500C Controller and encoder values of every single joint on the robot arm.

You can design your own closed-loop controllers in the Simulink® environment and command the amplifier currents directly in a fully open architecture scenario. Using Quanser's state-of-the-art, real-time data acquisition system, you will be able to execute your control algorithms in real-time deterministically.



### Thermo CataLyst-5 Robot

*The Thermo CataLyst-5 Robot automates manipulation for a wide variety of instruments and devices while dramatically increasing walk-away time and reducing human error.*

*NOTE: system shown with optional 6 DOF Force-Torque Sensor, C500C Open Architecture controller included in base system, Linear Track [sixth axis] is optional (not shown here)*



*Quanser's 5 DOF Haptic Wand and the Thermo Robot create a bilateral teleoperation system suitable for research in such areas as force-feedback systems, telesurgery and remote manipulation.*

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# ARCHITECTURE ROBOT



## C500C Controller

The Thermo CatalySt-5 Robot is supplied with a custom designed open architecture controller which offers all the capabilities of an industrial system.



Using QUARC and the Thermo Robot Blockset, you can control the Thermo CatalySt-5 Robot through the interactive Simulink® environment.



## Pre-Configured PC

The Thermo CatalySt-5 Robot is operated from a pre-configured PC\* included in the workstation. The PC contains QUARC®, the Thermo Robot Blockset, a trial version of MATLAB®/ Simulink®, and a pre-designed controller. The Pre-Configured PC enables you to setup and run the workstation with minimal effort and time.

\*Monitor, keyboard and mouse sold separately.

## HARDWARE REQUIREMENTS

- Thermo CatalySt-5 Articulated Robot
- C500C Controller
- Pre-Configured PC
- E-stop chain
- Optional Force/Torque Sensor (sold separately)
- Optional Linear Tracker (sold separately)

## THERMO CATALYST-5 ROBOT CAPABILITIES

- Automatic homing enables the CatalySt-5 to start moving plates on power-up
- True random access capabilities: load and unload plates from the front, top, or side of an instrument
- Programmable through MATLAB®/Simulink® using QUARC software
- End-of-arm connector allows you connect bar code readers and other devices
- Articulated wrist permits full control over plate orientation
- Invert mountable and track mountable

For more information about QUARC software, or to request a 30 day trial version, please visit [www.quanser.com/quarc](http://www.quanser.com/quarc)

## SOFTWARE REQUIREMENTS

- QUARC (provided by Quanser)
- QUARC Thermo CatalySt-5 Blockset (provided by Quanser)
- MATLAB®/Simulink® (purchased separately)
- Real-time Workshop Toolbox
- Windows® XP, Vista or 7

## TECHNICAL SPECIFICATIONS THERMO ROBOT

Payload	1 kg
Number of axes	5
Reach (std. gripper)	660 mm
Repeatability	<±0.05 mm
Weight	19 kg
Mounting positions	Floor, ceiling
Controller	C500C
Max. speed	210° /sec per joint

For more information on the Thermo CatalySt-5 Articulated Robot, please visit [www.thermoscientific.com](http://www.thermoscientific.com).



QUANSER  
INNOVATE. EDUCATE.

## YOU CAN RELY ON QUANSER TO ADVANCE CONTROL EDUCATION

For over two decades Quanser has focused solely on the development of solutions for advanced control education and research. Today, over 2,500 universities, colleges and research institutions around the world rely on a growing portfolio of Quanser control systems.

Our Robotics solutions offer quality, convenience, ease of use, ongoing technical support and affordability. They are part of a wider range of Quanser control lab solutions designed to enhance students' academic experience. You can count on Quanser solutions to captivate undergraduate and graduate students, motivate them to study further and encourage them to innovate.

Engineering educators worldwide agree that Quanser solutions are reliable and robust. Choose from a variety of mechatronics experiments and control design tools appropriate for teaching at all levels as well as advanced research. Take advantage of engineering expertise that includes mechatronics, electronics, software development and control system design. Leverage the accompanying ABET-aligned course materials which have been developed to the highest academic standards. Last but not least, rely on Quanser's engineers for ongoing technical support as your teaching or research requirements evolve over time.



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