MOBILE HARBOUR CRANES
General description and system architecture

The following figure illustrates the architecture of the control system for mobile cranes. The crane management system has a master-slave architecture; the master unit is the DCU-C, a high performance automotive grade controller designed to be used as main control unit for industrial vehicles; the DCU-C, combined with an external VGA touch-screen display, is also used as Man Machine Interface.

All the slave units are connected to the master through the CAN-bus and the communication is based on the CANopen protocol, allowing an easy integration of further external devices. The SIOC slave units are equipped with an appropriate standard control software and they are all identical and interchangeable: the identification over the CAN network is defined by the wiring through two digital inputs made for this purpose. The same principle is applied to the DCU-S slave units, too. This architecture makes the software maintenance extremely easy and fast for further future upgrades.
Crane operator's cabin and engine room

As shown in the figure, you can see:

1. **12.1" color TFT sunlight-readable display** with anti-glare surface, resistive touchscreen and integrated virtual keyboard; it is directly connected to the master unit of the control system.
2. Right joystick for winch movements, vehicle translation and tools control + 6 function buttons.
3. Left joystick for boom movements and slewing movements control + 6 function buttons.
4. Pedal for slewing/vehicle translation proportional braking (analog potentiometer).
5. Box, suitable to the original model, containing the engine ignition key, the emergency pushbutton and the joystick for the stabilizers movements driving. The box contains the **DCU-C** master unit and the **DCU-S** slave unit for the management of the I/O resources of the cabin, too.
6. GSM/GPRS antenna.
7. LAN cable for the remote display connection to a personal computer.
8. **SIOC** slave controllers.
9. Personal computer for technical support and diagnostic of the system.
Remote management and assistance

Remote display technology allows the whole interaction between the Innoval technicians and the crane control system all over the world, simply connecting a Windows personal computer with an internet connection to the master unit via USB.

The control system also provides a LAN connection inside the electrical panel: using the same technology, maintenance technicians can directly monitor and control all the crane functionalities. This feature is very useful during vehicle startup and maintenance, because you can have on site all the diagnostic tools provided by the control system (real-time display of the status of all the I/O resources, possibility to force the status of the outputs, etc.). The LAN connection is password protected for safety.

Radio remote control

Almost all the movements of the crane can be controlled by the optional radio remote control, too.

For safety reasons, the simultaneous control of the crane by many control places is not allowed: if a control place is enabled, all others are disabled. For this purpose, there is a proper key-selector located near the electrical panel.

When the crane is radio-controlled, the maximum speed of the proportional movements can be reduced by appropriate setting of a system parameter.
Graphical User Interface

The figure above shows the main window of the graphical user interface, where you can see, from the top to the bottom:

- the indicator and warning lamps;
- the alarms button/bar, where the active alarms are cyclically shown; the list of all active alarms can be displayed simply by touching the button/bar;
- the monitoring dialog, which shows all the system monitoring variables; this dialog is organized as a property-sheet, so the operator can browse around all the forms quickly and intuitively, by selecting the corresponding tab;
- the warnings button/bar (same operating mode of the alarms button/bar);
- the virtual keyboard, which performs the same functionality of a physical keyboard with back-lit keys allowing an easy customization.

The indicator and warning lamps, the alarm and the warnings button/bars and the virtual keyboard are always visible.

In addition to the standard and safety functions of the crane, the system can control:

- automatic stabilization and leveling
- mechanical grab
- spreader
- timber grab
- electric motor
- automatic greasing system
- double (redundant) boom angle inclinometer and load cell
- slewing encoder with working area limitation functionality
- winch encoder
Other monitoring dialog windows

Inputs/Outputs status dialog:

Outputs test dialog:

Alarm black-box contents dialog:
### Working hours:

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</table>

### Calibrations and parameters:

**Calibrations**

**Parameters**

### System diagnostic menu:

**Test I/O**

- Set debug flags
- Show working variables
- Test outputs
- View I/O status

**Alarms black-box**

- View black-box
- Erase black-box
- Export black-box

**Weightings recording**

- View black-box
- Erase black-box
- Export black-box
The **DCU-C** is a fully programmable automotive grade unit designed to be used as high performance master controller and Man-Machine-Interface, together with a VGA display, in industrial vehicles. Its construction features allow it to operate in harsh environments (high temperature ranges, water, dust, vibration).

Main technical features:
- Windows CE operating system with real time response
- Color VGA display and touch-screen management
- Audio and external cameras handling
- High speed GSM and GPRS data management module
- I-Button interface (for operator identification and login)
- Operating temperature range: -40 °C .. +75 °C
- Max. humidity level: 95%
- Protection grade: IP68

The **SIOC** control unit (**S**ecure **I**O **C**ontroller) is a programmable controller designed to operate as slave unit in "automotive" environment with a high degree of reliability and safety. It offers the possibility to realize, together with the DCU-C master unit, a master/slave control system with PL-d (EN ISO 13849) safety level without the need of certifying the DCU-C application software. This goal is reached because the SIOC units handle all the security critical parts of the system by themselves: the logic that defines the safety-relevant part of the system is programmed using a very simple (and easy to analyze) Instruction List (IL) language (simplified IEC1131 IL) and the communication over the CAN-bus is based on the CANOpen EN50325-5:2010 security protocol.

Main technical features:
- Operating temperature range: -40 .. +70 °C
- Max. humidity level: 95%
- Protection grade: IP68C

The **DCU-S** unit is a slave controller managed via CANOpen protocol. It handles all the I/O resources of the cabin.

Main technical features:
- Operating temperature range: -40 .. +70 °C
- Max. humidity level: 95%
- Protection grade: IP68
The MCT display is designed to be used in harsh environments; is based on a 12.1” color TFT sunlight-readable panel with anti-glare surface and resistive touchscreen. The rugged frame in painted aluminum alloy has VESA standard mounts (75 mm).

Main technical features:
- Display type: transflective TFT LCD, anti-glare surface
- LDC size: 12.1”
- Aspect ratio: 4:3
- Resolution: 640 x 480
- Brightness: 1000 cd/m²
- Contrast: 700:1
- Viewing angle: horizontal 80°, vertical 80°
- VESA compliant mounting holes (75 mm)
- Operating temperature range: 30 .. +80 °C
- Max humidity level: 80% operating, 90% storage (without condensation)
- Protection grade: IP67 (front)
- Vibration: IEC68-2-6

The INNOVAL application software is 100% compatible with the GEA existing systems and it completely replicates all the functionalities and the safety issues.

INNOVAL also provides an extensive and detailed technical manual of over 270 pages.