Keep Control: PULPO 2

ESO's new housekeeping unit

Christoph Geimer, Claudio Cumani, Nicolas Haddad, Javier Reyes, Javier Valenzuela, Bernhard Lopez

European Southern Observatory ESO (www.eso.org)

Karl Schwarzschildstr. 2, 85748 Garching near Munich

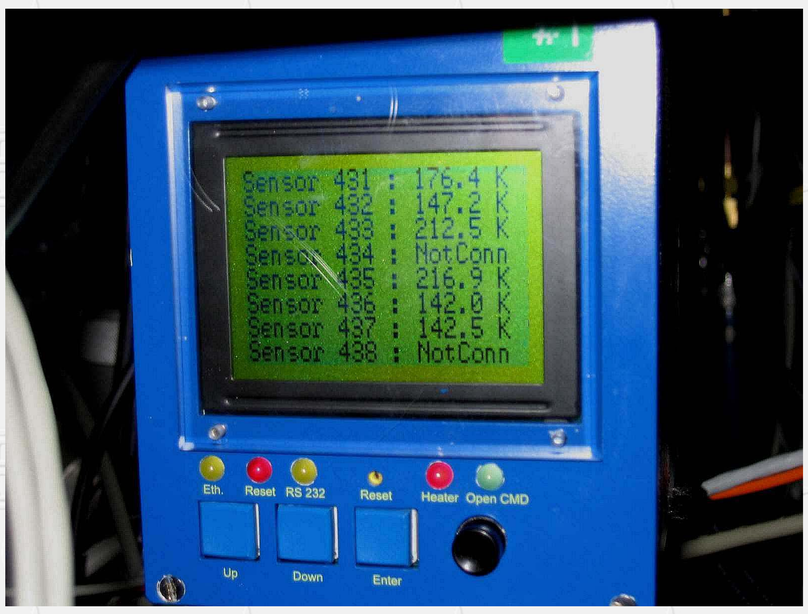


Figure 1: PULPO 2 front panel

"Rule with your heart and live with your conscience" - QUEEN

Summary:

Wide field imagers put tough requirements on temperature control and housekeeping functions. So far ESO has used PULPO 1 (designed by N. Haddad) for this purpose, but today's mosaics like ESO's OmegaCAM (cf. paper by O.Iwert et al.) with 36 CCD's in the focal plane require a new approach.

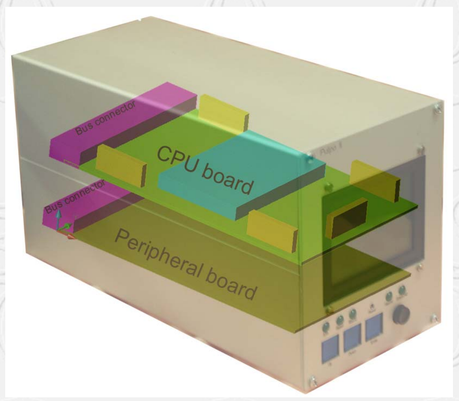
This poster introduces ESO's new housekeeping unit PULPO 2.
Key features are:
•Monitoring of 29 PT100 sensors (4 wire system) by default and up to 125 with external multiplexer board.
•Temperature control of the focal plane with up to 8 independent heaters.
•Monitoring of the vacuum in the cryostat (by means of Balzers or Edwards vacuum gauges).
•Separate alarm outputs for temperature and vacuum.
•Shutter control with measurement of open and close delays.
•Internal logging of numerous system parameters over time (up to 65000 records), thereby making PULPO 2 a valuable trouble shooting and optimizing tool.
•Backwards compatibility with PULPO I.

The PULPO 2 control software exploits all capabilities of the hardware to implement further functionality for system monitoring and recovery to a safe state in case of failure.

Figure 2: PULPO 2 back panel

"In the quiet of the night, let our candle always burn..." - QUEEN

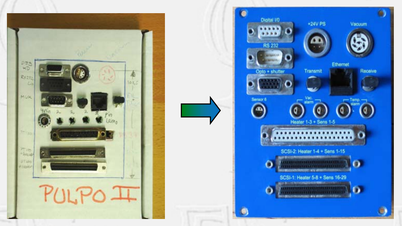
1. Description



PULPO 2 is a compact unit (230x105x 120mm) containing two Eurocard size (160x100mm) boards.
The CPU-Board contains an embedded PC running the PULPO 2 control software under Linux and provides power to the rest of the unit.
The peripheral board contains all circuitry needed to fulfill the required housekeeping functions - PT100 inputs, amplifiers and 16bit ADC, shutter interface, alarm output, vacuum monitoring, and temperature regulation.
The communication between the two boards follows the ISA bus standard.

Figure 3: FIERA PULPO 2

From the first draft ..... to the real thing



"Buddy you're a boy make a big noise playing in the streets gonna be a big man someday..." - QUEEN

Figure 4: Use your illusion !

2. The Hardware

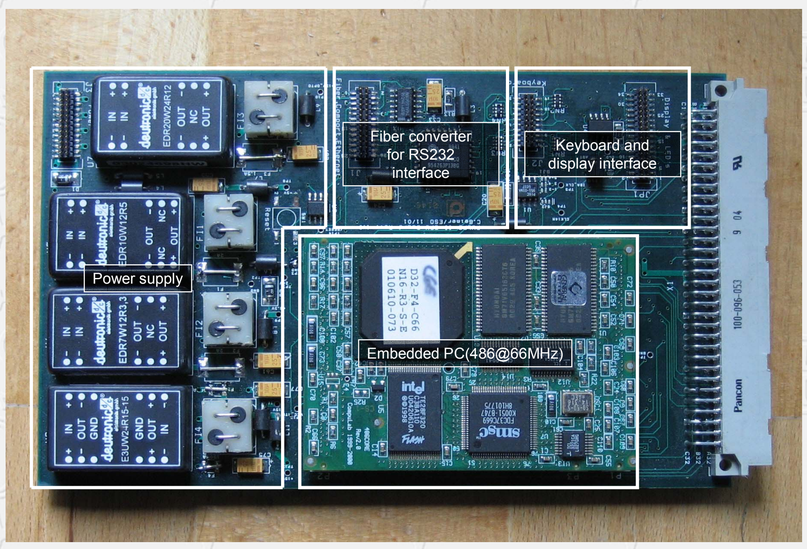


Figure 5: The PULPO 2 CPU board

The PULPO 2 CPU board is a eurocard size board.The core component is a credit card size embedded PC module from Compulab. It hosts a complete PC with 486 processor, integrated 16 MB flash disk, 32 MB of RAM, Ethernet controller and all standard PC peripherals (serials, parallel port, IDE controller, etc).
PULPO 2 is supplied with +24V from the FIERA linear power supply. All internal voltages (+5V, +3.3V,+-15V and +12V) are generated on the CPU board by means of DC/DC converters. Each voltage has auto resetting SMD fuses. Standard bypassing plus additional PI Filters are used to smoothen the supply voltages. A voltage supervisor, MAX 814, on the 5V supply is used to generate a reset on power-up and in case of a power failure. The MAX814 also provides the option of a manual reset via a button on the front panel. A 3V lithium battery is used to keep the RTC (real time clock) on the 486Core running in case of a power failure.

The RS232-to-fiber interface is built around a ML4624 chip. It drives an Agilent HFBR 1414 transmitter and receives commands via a HFBR 2416 receiver. The fiber can be up to 1500m.
The display on the front panel is a Varitronix MGLS 12864T.

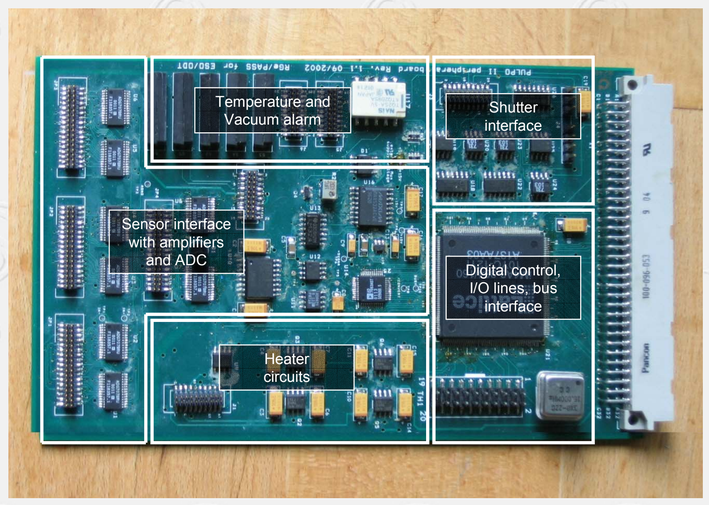


Figure 6: The PULPO 2 Peripheral board

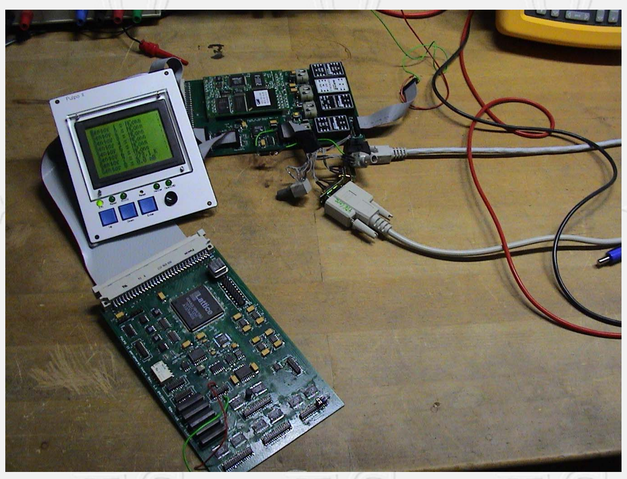
The PULPO 2 Peripheral Board contains all interfaces to the cryostat and the shutter. The core component here is a PLD, that controls all the interfaces on the board and takes care of the communication to the CPU board.

The sensor interface contains a multiplexer group with 32 inputs. One channel is used for monitoring the vacuum in the cryostat (Balzers or Edwards gauges - "just" software), another one for the onboard sensing of the heater current and for an internal calibration resistor. The other 29 channels can be used to connect external PT100 sensors (4 wire system). The output of the multiplexers goes via a two stage amplifier with programmable gain into a 16-bit ADC. Low gain (G=8) is used for heater current and vacuum sensing. High gain (G=72) is used for PT100 input.

PULPO 2 uses PWM (Pulse Width Modulation) for the heater control. The power dissipation inside the unit is therefore very small (~30mΩ per heater). A total of 8 independent - or jointly used - heaters is available. The heaters are operated with the linear +24V supply in order to avoid switching noise (from the DC/DC converters) in the focal plane. The maximum heater current is 3A giving a maximum heating power of up to 72W.

PULPO 2 also features a set of alarm outputs for temperature and vacuum. Four independent alarm outputs are available (2 for temperature and 2 for vacuum problems). The alarm values for temperature and vacuum can be configured by software.

Optical detectors require a shutter.
PULPO 2 offers 1 output (Open command) and 4 inputs (Open status, Close status, Remote and Fail). All of them are opto isolated in order to avoid ground loops. Exposure time counting and the measurement of the open and close delays are handled by the PLD. The logic for the I/O lines is programmable via the software enabling PULPO 2 to interface with almost any type of shutter.



"A new life is born.
Somehow I have to make this final breakthru' …. NOW!" - QUEEN

Figure 7: We have first light

3. The Software

Most of the features offered by PULPO 2 are implemented via the control software on the CPU-Board.
The communication between the SLCU and PULPO 2 goes through a simple serial link (RS232).
The protocol consists of a two character command followed by several parameters (e.g.: SP,1,153 -> set temperature control for heater 1 to 153K). Currently there are 60 commands available. Several status bytes can be retrieved via the serial to get information about the current status of the device.

The software controls the peripherals via a set of registers that are implemented in the PLD. The PID tuner that is required for accurate temperature control is also implemented in Software. The accuracy of the temperature regulation is typically +-0.1K for the control sensor assigned to a heater.

Other valuable software features are:

• Data Logging
The 486Core runs embedded Linux. Therefore only 60% of the flash disk is used for the OS, leaving approximately 9MB free to store the data from the connected sensors. The logging interval is adjustable. The number of records than be stored on the flash disk is currently 65000. In the case of OmegaCAM this is sufficient to log all 101 sensors for almost 7 days if the log interval is set to 15 minutes.
The logfile is cyclic, which means that the first entries will be overwritten as soon as the number of 65000 records is reached.

• Self recovery:
The self recovery feature ensures that the CCD's are protected in case of an alarm condition. One of the sensors connected to PULPO 2 can be selected to trigger the self recovery. As soon as the alarm from this sensor is triggered PULPO 2 will start to heat the CCD's in order to ensure that the CCD's are always warmer than the rest of the cryostat. This will avoid contamination.

Close the loop !

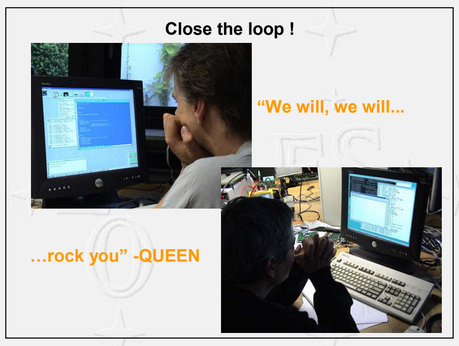
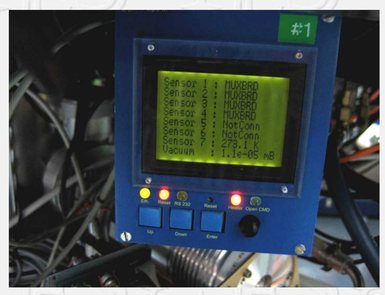


Figure 8: It just needs mixing ...



"HERE WE ARE, born to be kings.
We're the princes of the universe" - QUEEN

Figure 9: … and there it is !

"*If you can't beat them …*

@eso.org

… join them!" - QUEEN