

**Atacama
Large
Millimeter
Array**

Interface Control Document

Between:

Cryostat

And:

Monitoring & Control Unit


FEND-40.03.00.00-40.04.03.00-A-ICD

Version: A

Status: Released

2004-09-30

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Change Record

| Version | Date | Affected Section(s) | Change Request # | Reason/Initiation/Remarks |
|---------|------------|---------------------|------------------|---------------------------|
| A | 2004-09-30 | All | -- | First release |
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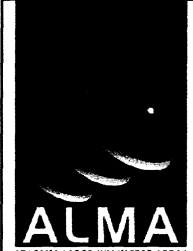

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1 Description

1.1 Purpose

The purpose of this document is to provide a detailed description of the interface between the Front End Monitoring and Control system and the Cryostat, both electrical and logical.

Functionally, this specifies electronic control for the following components:

- Backing pump (ALMA Prod No.: 40.03.03.01)
- High vacuum pump (ALMA Prod No.: 40.03.03.02)
- Gate valve (ALMA Prod No.: 40.03.01.05)

(These components are controlled via the hardware Interlock [AD7])

And the monitoring of the following parameters:

- Dewar vacuum
- Temperature of all 3 stages near the cold head
- Temperature of 2 radiation shields at two places. Exact places to be defined and agreed.
- Temperature of the 4K plate at two places. Exact places to be defined and agreed.
- Status of the turbo pump and the gate valve.

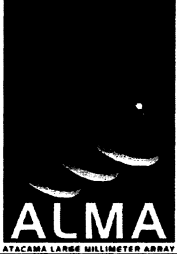
This ICD does not cover:

- Cryo cooler start/stop
- Cryo cooler drive indication
- Compressor over temperature alarm signal according to manufacturers recommendation
- Compressor He line pressure alarm signal according to manufacturers recommendation

The control for those items is located outside the receiver cabin and is covered in [AD6].

1.2 Scope

The scope of this document is limited to only what is necessary to clearly specify the interface between these subsystems. For detailed descriptions, specifications, circuit and wiring diagrams, etc. of the cryogenic system or the front end M&C please refer to the appropriate documents, listed below.

| | | |
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2 Related Documents and Drawings

2.1 Applicable Documents

The following documents are part of this document to the extent specified herein. If not explicitly stated differently, the latest issue of the document is valid.

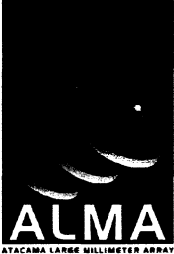
| <i>Reference</i> | <i>Document title</i> | <i>Document ID</i> |
|------------------|---|--|
| [AD1] | ALMA System: Electromagnetic Compatibility (EMC) Requirements | ALMA-80.05.01.00-001-B-SPE |
| [AD2] | ALMA System Electrical Design Requirements | ALMA-80.05.00.00-005-C-SPE |
| [AD3] | ALMA cryostat Technical Specifications | FEND-40.03.00.00-002-B-SPE |
| [AD4] | ALMA Front End M&C Technical Specifications and Requirements | FEND-40.04.03.00-001-A-SPE (in preparation) |
| [AD5] | Front End Sub-system Technical specification | FEND-40.00.00.00-001-A-SPE |
| [AD6] | ICD between Indoor Control Unit and Cryostat monitoring & Control module | FEND-40.03.02.03-40.04.05.00-A-ICD |
| [AD7] | ALMA Front End Cryostat Valve Interlock and Fail-Safe Requirements | FEND-40.03.03.00-001-A-SPE |
| [AD9] | Manual Leybold TURBOVAC TW70H 63 ISO-K | |
| [AD10] | Manual Leybold Center One single channel vacuum gauge controller | GA 09.033/2.02 |
| [AD11] | ALMA Cryostat Operating Manual | FEND-40.03.00.00-019-A-MAN |

In the event of a conflict between one of the before mentioned applicable documents and the contents of this document, the contents of the applicable document shall be considered as a superseding requirement.

2.2 References

The following documents contain additional information and are referenced in this document.

| <i>Reference</i> | <i>Document title</i> | <i>Document ID</i> |
|------------------|---------------------------------|----------------------------|
| [RD1] | ALMA Acronyms and Abbreviations | ALMA-80.00.00.00-004-A-LIS |
| [RD2] | ALMA Project Book | |
| [RD3] | ALMA Product Tree | ALMA-80.03.00.00-001M-LIS |

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2.3 Abbreviations and Acronyms

A limited set of basic acronyms used in this document is given below. A complete set of acronyms used in the ALMA project can be found in reference [RD1].

| | |
|----------------|--|
| ALMA | <u>A</u> tacama <u>L</u> arge <u>M</u> illimetre <u>A</u> rray |
| ICD | <u>I</u> nterface <u>C</u> ontrol <u>D</u> ocument |
| ICU | <u>I</u> ndoor <u>C</u> ontrol <u>U</u> nit |
| I/O | <u>I</u> nput / <u>O</u> utput |
| M&C | <u>M</u> onitoring <u>a</u> nd <u>C</u> ontrol |

3 Interface Requirements

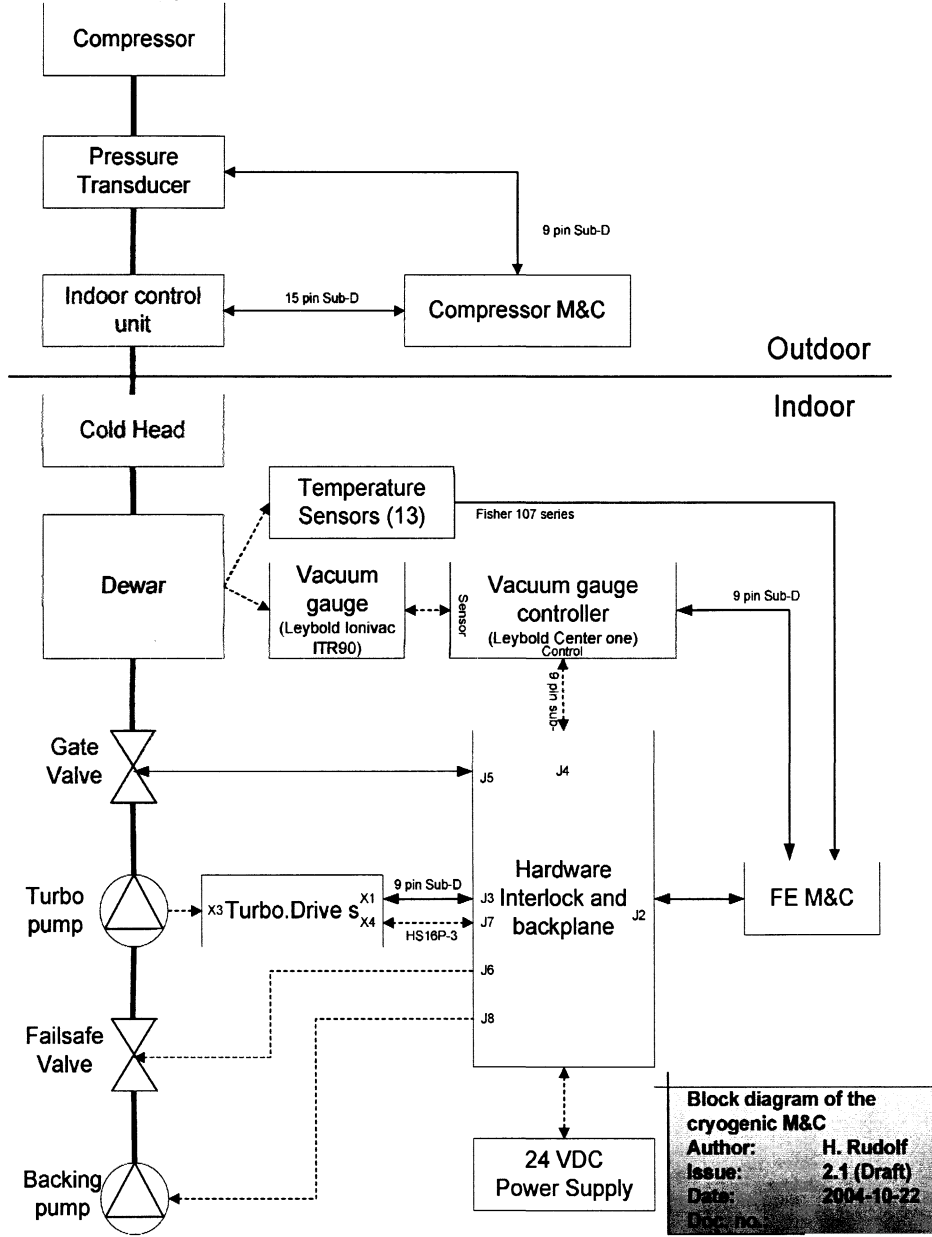
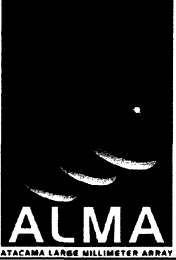


Figure 1: Block diagram of the Cryogenic M&C

| | | |
|---|---|---|
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3.1 Electronic Interface Requirements

As shown in figure 1 the FE M&C interfaces with the cryostat at several points.

3.1.1 List of connectors

3.1.1.1 Vacuum gauge

The vacuum gauge is controlled via a single channel vacuum gauge controller (Leybold Center One). The vacuum gauge controller is connected via an analogue interface to the FE M&C. At the vacuum gauge controller is a 9 pin sub-D male connector.

| Pin No. | Signal | |
|---------|---------------------------------------|-------------------------|
| 1 | Analog output | |
| 2 | Switching function off (n.c. contact) | |
| 3 | Switching function (common) | |
| 4 | Switching function off (n.c. contact) | |
| 5 | Control input HV_H | On = +24 V Off = 0 V |
| 6 | + 24 V | |
| 7 | Chassis | |
| 8 | Error (n.o. contact) | |
| 9 | Error (common) | |

In [AD10] is given a detailed explanation of the signals.

As a minimum, the following functions shall be implemented:

| Function | Name | Intervall |
|-----------------|------------------|----------------|
| Vacuum Pressure | Measurement data | 60 sec. |
| Gauge Status | Error Status | 60 sec. |
| Gauge Reset | Reset | When necessary |


It shall not be possible to set the threshold values via software. They shall be set during the integration of the cryostat and stored in the EEPROM.

3.1.1.2 Hardware interlock

The command to the hardware interlock shall activate the pump-out procedure. It shall be only given when the 4 K stage has reached a temperature of maximum 20K. For further details please refer to [AD7].

Through the Hardware Interlock shall be also given the error information of the Turbo.Drive S and the status of the gate valve.

The connection between the Hardware Interlock and the FE M&C is implemented via a backplane. This backplane is also described in [AD7].

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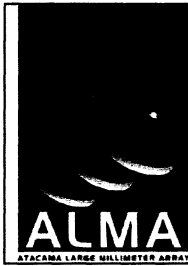
| Control | Function | Intervall | |
|---------------|------------------|----------------|---|
| Pumps | Pump out | When necessary | |
| Turbo.Drive S | Status | 60 sec. | No Error present: contact closed Error: contact open |
| Gate Valve | Position: open | 60 sec. | During the transition from open to close, no signal is present. |
| Gate Valve | Position: closed | 60 sec. | During the transition from close to open, no signal is present. |

3.1.1.3 Temperature sensors

The 13 temperature sensors are bias via 4 wires per sensor. The sensor type is described in the following table. The excitation current for the PRT sensors is 1 mA and 10 μ A for the TVO sensors [AD11]. The connector is a Fisher 107 series.

All temperature sensors shall be read every 60 seconds.

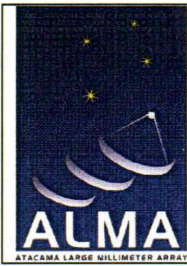
| Pin | Internal wire type | Sensor | Component | Pin | location | |
|-----|--------------------------------|--------|-----------|-----|----------------------|--------------|
| 1 | Manganin Twisted pair (42 swg) | 1 | PRT | I+ | 90K plate near link | Twisted Pair |
| 2 | Manganin Twisted pair (42 swg) | | | I- | | |
| 3 | Manganin Twisted pair (42 swg) | | | V+ | | Twisted Pair |
| 4 | Manganin Twisted pair (42 swg) | | | V- | | |
| 5 | Manganin Twisted pair (42 swg) | 2 | PRT | I+ | 90K plate far side | Twisted Pair |
| 6 | Manganin Twisted pair (42 swg) | | | I- | | |
| 7 | Manganin Twisted pair (42 swg) | | | V+ | | Twisted Pair |
| 8 | Manganin Twisted pair (42 swg) | | | V- | | |
| 9 | Manganin Twisted pair (42 swg) | 3 | TVO | I+ | 12K plate near link | Twisted Pair |
| 10 | Manganin Twisted pair (42 swg) | | | I- | | |
| 11 | Manganin Twisted pair (42 swg) | | | V+ | | Twisted Pair |
| 12 | Manganin Twisted pair (42 swg) | | | V- | | |
| 13 | Manganin Twisted pair (42 swg) | 4 | TVO | I+ | 12K plate far side | Twisted Pair |
| 14 | Manganin Twisted pair (42 swg) | | | I- | | |
| 15 | Manganin Twisted pair (42 swg) | | | V+ | | Twisted Pair |
| 16 | Manganin Twisted pair (42 swg) | | | V- | | |
| 17 | Manganin Twisted pair (42 swg) | 5 | TVO | I+ | 4K Cryocooler stage | Twisted Pair |
| 18 | Manganin Twisted pair (42 swg) | | | I- | | |
| 19 | Manganin Twisted pair (42 swg) | | | V+ | | Twisted Pair |
| 20 | Manganin Twisted pair (42 swg) | | | V- | | |
| 21 | Manganin Twisted pair (42 swg) | 6 | TVO | I+ | 12K Cryocooler stage | Twisted Pair |
| 22 | Manganin Twisted pair (42 swg) | | | I- | | |
| 23 | Manganin Twisted pair (42 swg) | | | V+ | | Twisted Pair |
| 24 | Manganin Twisted pair (42 swg) | | | V- | | |
| 25 | Manganin Twisted pair (42 swg) | 7 | TVO | I+ | 4K plate near link | Twisted |



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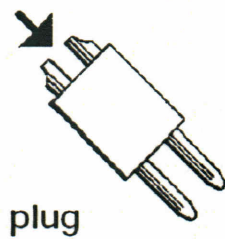
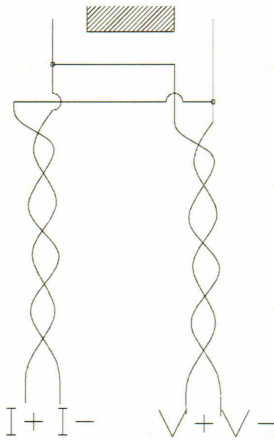
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| | | | | | | |
|----|--------------------------------|----|-----|----|----------------------|---------|
| 26 | Manganin Twisted pair (42 swg) | | | I- | | Pair |
| 27 | Manganin Twisted pair (42 swg) | | | V+ | | Twisted |
| 28 | Manganin Twisted pair (42 swg) | | | V- | | Pair |
| 29 | Manganin Twisted pair (42 swg) | 8 | TVO | I+ | 4K plate near link | Twisted |
| 30 | Manganin Twisted pair (42 swg) | | | I- | | Pair |
| 31 | Manganin Twisted pair (42 swg) | | | V+ | | Twisted |
| 32 | Manganin Twisted pair (42 swg) | | | V- | | Pair |
| 33 | Manganin Twisted pair (42 swg) | 9 | TVO | I+ | 4K plate far side | Twisted |
| 34 | Manganin Twisted pair (42 swg) | | | I- | | Pair |
| 35 | Manganin Twisted pair (42 swg) | | | V+ | | Twisted |
| 36 | Manganin Twisted pair (42 swg) | | | V- | | Pair |
| 37 | Manganin Twisted pair (42 swg) | 10 | TVO | I+ | 4K plate far side | Twisted |
| 38 | Manganin Twisted pair (42 swg) | | | I- | | Pair |
| 39 | Manganin Twisted pair (42 swg) | | | V+ | | Twisted |
| 40 | Manganin Twisted pair (42 swg) | | | V- | | Pair |
| 41 | Manganin Twisted pair (42 swg) | 11 | PRT | I+ | 90K Cryocooler stage | Twisted |
| 42 | Manganin Twisted pair (42 swg) | | | I- | | Pair |
| 43 | Manganin Twisted pair (42 swg) | | | V+ | | Twisted |
| 44 | Manganin Twisted pair (42 swg) | | | V- | | Pair |
| 45 | Manganin Twisted pair (42 swg) | 12 | TVO | I+ | 12K shield top | Twisted |
| 46 | Manganin Twisted pair (42 swg) | | | I- | | Pair |
| 47 | Manganin Twisted pair (42 swg) | | | V+ | | Twisted |
| 48 | Manganin Twisted pair (42 swg) | | | V- | | Pair |
| 49 | Manganin Twisted pair (42 swg) | 13 | PRT | I+ | 90K shield top | Twisted |
| 50 | Manganin Twisted pair (42 swg) | | | I- | | Pair |
| 51 | Manganin Twisted pair (42 swg) | | | V+ | | Twisted |
| 52 | Manganin Twisted pair (42 swg) | | | V- | | Pair |
| 53 | N/C | | | | | |
| 54 | N/C | | | | | |
| 55 | N/C | | | | | |

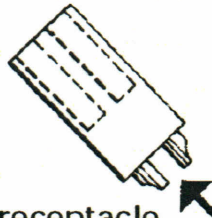


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plug



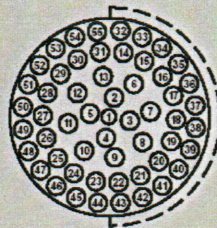
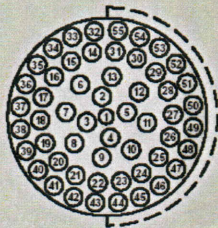
receptacle

SERIES

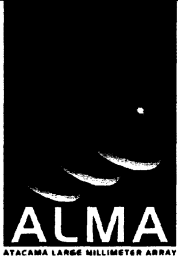
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Type «A»

REFERENCE
 NUMBER



107 A023
107 Z023
solder

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3.2 Software/Control Function Interface Requirements

3.2.1 Software/Control Function

Calibration tables for the temperature sensors are provided.

An excel spreadsheet contains for the PRT sensors a single (generic) lookup table and one for each of the TVO sensors. The TVO sensor table contains a look-up table as well as a Chebychev interpolation polynomial.

3.2.2 Summary of Monitor Points

| Name | Suggested Interval (secs) |
|----------------------------------|----------------------------------|
| Temperature 90K plate near link | 60 |
| Temperature 90K plate far side | 60 |
| Temperature 12K plate near link | 60 |
| Temperature 12K plate far side | 60 |
| Temperature 4K Cryocooler stage | 60 |
| Temperature 12K Cryocooler stage | 60 |
| Temperature 4K plate near link | 60 |
| Temperature 4K plate near link | 60 |
| Temperature 4K plate far side | 60 |
| Temperature 4K plate far side | 60 |
| Temperature 90K Cryocooler stage | 60 |
| Temperature 12K shield top | 60 |
| Temperature 90K shield top | 60 |
| Vacuum pressure | 60 |
| Dewar valve state | 60 |
| Vacuum Pressure | 60 |
| Gauge Status | 60 |
| Turbo.Drive Status | 60 |
| Gate Valve position open | 60 |
| Gate Valve position closed | 60 |

3.2.3 Summary of Control Points

| Name | Suggested Interval |
|-------------|---------------------------|
| Gauge Reset | <i>When necessary</i> |
| Pump out | <i>When necessary</i> |

3.3 Safety Interface Requirements

The Hardware Interlock [AD7] assures that no action of the monitor and control system shall cause incorrect or dangerous conditions in the front end cryostat subsystem.