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3p6 M2 CONTROL ELECTRONICS

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CHANGE RECORD

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1. INTRODUCTION

Since ever the 3.6 telescope f/8 secondary unit has suffered from severe mechanical instabilities. This together with the inability to introduce online corrections to the decentring comma has severely limited the optical performance of the telescope. Considering that the new generation of instruments (e.g. HARPS) need to exploit the maximum possible optical image quality attainable with the telescope, a new mechanical design based on the NTT secondary unit concept was designed and built. The new unit is equipped with VLT complaint computer controlled servo drives for the focus, X and Y motions of the secondary mirror unit.

1.1. PURPOSE AND SCOPE

This document is intended to serve as a design document, construction guide and service manual for the 3p6 M2 control electronics.

Starting from a general description and block diagram it goes all the way down to the schematic diagrams, function tables, connection tables and references to the part list.

1.2. REFERENCE DOCUMENTS

- [RE1] 3.6m Telescope f/8 Top-end Overhaul User Requirements 3p6-SPE-ESO-36022-0001 Issue 1.3 M. Sterzik December 12, 2001.
- [RE2] Configuration of VLT Standard VME Boards VLT-MAN-ESO-17210-1358 Issue 1.4 B. Gustafsson 5-October-2001

1.3. APPLICABLE DOCUMENTS

- [AP1] ESO VME4SA-X1 4-Channel DC Servo Amplifier Technical Manual VLT-MAN-ESO-17130-0273 Issue 3.0
- [AP2] ESO VME4SA BACKPLANE Technical Manual VLT-MAN-ESO-17130-0274 Issue 3.0
- [AP3] VLT Electronic Cabinet Cooling System User Manual VLT-MAN-ESO-17130-1603 Issue 1.0 F. Biancat Marchet April 27, 1998
- [AP4] USER-Manual MACCONTROLLER MAC4-INC Version 4.2
- [AP5] Harmonic Drive Operations Manual AC-Servo Amplifier SC-500/510.
- [AP6] VLT-SPE-ESO-10000-0015 VLT Electronic Design Specification Issue 4.0 09/12/96.

1.4. ACRONYMS & ABBREVIATIONS

DC	Direct Current
VME	Versa Module Europe
TBD	To Be Defined
TBM	To Be Measured
VLT	Very Large Telescope
LCU	Local Control Unit
NTT	New Technology Telescope
PCB	Printed Circuit Board
RAM	Random Access Memory
TTL	Transistor Transistor Logic
PPR	Pulse Per Revolution
ZD	Zenith Distance

2. M2 MOTION CONTROL

2.1. Motion Control Concept

The concept developed for the motion control of the 3p6 M2 unit is based on the standard motion control components used by ESO to build instruments. This approach brings various advantages like: reduced development and manufacturing costs, past proven experience, standardised components and shared spare parts.

The standard VME4SA is used as usually done with the MACC-INC companion. The difference with the more typical implementations is that here the VME4SA does not act as the drive motor power amplifier but as a signal driver for a specialized, high power, AC servo amplifier. However the limit and init switches interface capabilities of the VME4SA are still fully used. The advantage of this approach is that the specialized AC servo amplifier is absolutely transparent to the VLT software.

2.2. Motion Control Components

The motion control electronic components used for the M2 are:

- MACC4/INC [AP4] and VME-4SA [AP1] VLT standard modules.
- Harmonic Drive AC-Servo Amplifier SC500/510 [AP5]

Three Harmonic Drive Systems servo actuators type FHA-25B-3015E-E150 are used for rotating the focus, X and Y driving screws. These actuators integrate a brushless AC motor together with a harmonic reduction gear and an incremental 1500 PPR optical shaft encoder coupled to the motor axis. Each linear drive is complemented by end of stroke high precision limit/init switches together with coarse catastrophic-limit switches.

Every actuator is accompanied by three screw terminals group. All the connections from the actuator and limit/init switches are routed through these terminals to the control LCU-power amplifiers cabinet. The signal groups correspond to; AC motor drive, incremental encoder and limit/init switches.

The control electronics is mounted on top of the M2 unit inside a hermetically sealed Knürr cabinet equipped with an active heat exchanger unit. The cabinet houses a VME LCU, three AC servo amplifiers and support circuitry.

Externally the control cabinet receives; the mains 220VAC supply, the Ethernet connection, one inlet and one outlet coolant hoses. By opening the rear door an external PC could be connected via RS232 to each AC servo amplifier and the LCU console port. This is for setup and engineering monitoring of the servo amplifiers and VME CPU configuration.

From the control cabinet three identical groups of signals are routed to its close neighbour the M2 drive.

2.3. Motion Control Functions

The motion control function of the M2 comprises three identical AC servo drives amplifier combinations with built in digital velocity loop. These units provide incremental encoder pulses to the outside world as balanced differential signals and receives an analogue voltage in the range of +/-10V as the external velocity command. On top of the velocity loop a position loop inside the control LCU utilizes the encoder signals as feedback and delivers the required +/-10V velocity control signal.

Normal operation init/limit functions are implemented by six BAUMER type “My-Com g” precision switches. These switches report both to the AC servo amplifier and the VME4SA via dedicated signal conditioning circuits mounted over small PCBs.

A hardware interlocking function, called the catastrophic limit, is implemented by six rugged limit switches mounted at the end of stroke for the focus, X and Y mechanisms. The six switches are serially connected and act over the mains power relay coil, see **Figure 1** below.

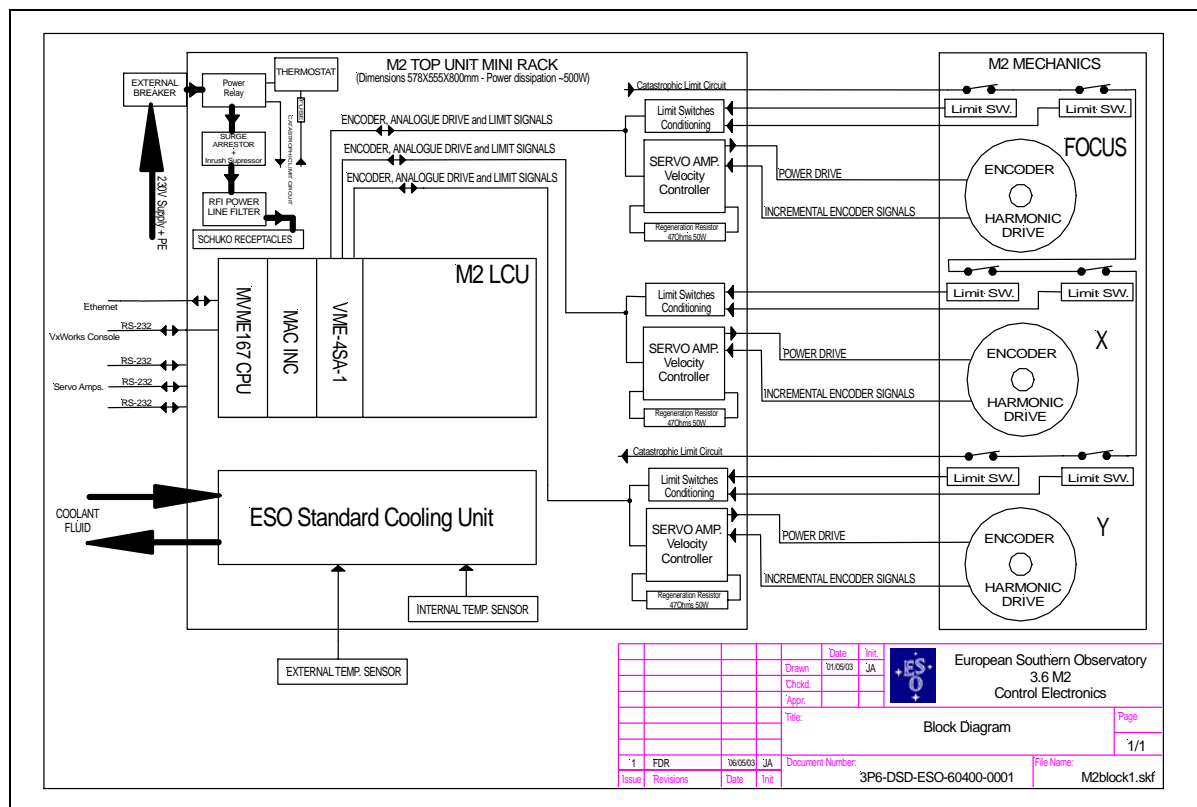


Figure 1: M2 Control Electronics Block Diagram

2.4. Focus, X and Y Position and velocity control loops

The rotation and angular positioning of the M2 drive screws is performed by means of nested position and velocity control loops.

The main loop is the position control loop starting with an incremental encoder to sense the relative angular position of the motor. A dedicated VME motion controller MAC4/INC [AP4] compares the sensed position with the position command value calculated by the main instrument control software and generates a corrective action (+/-10VDC range) to the AC servo amplifier [AP5]. The configuration software sets the position controller parameters like integration gain, maximum speed, software limits, initialization point, etc.

The second loop is the velocity control loop. The corrective output signal ($\pm 10V$) generated by the position control loop is sent to the AC servo amplifier through the VME driver-amplifier VME4SA [AP1], this is to have all the limit and init switches signals compatible with the VLT software. The AC motor velocity is measured by means of the same incremental encoder coupled to the motor axis used to measure the screw angular position. The velocity value is compared with the commanded velocity value coming from the MAC4/INC output and the error signal is filtered by a digital PID inside the servo amplifier. The PID filter parameters are defined by the aid of a MS Windows program talking via RS232 to the amplifier during configuration. The parameters are kept in a flash memory inside the amplifier.

Each function, focus, X and Y is equipped with limit/init and catastrophic limit switches mounted at the end of stroke of each function. The mechanical configuration is such that during normal operation the limit/init switches are only actuated but in case of malfunction the carriage will continue moving actuating the catastrophic limit switch as well.

3. M2 DRIVES ELECTROMECHANICAL COMPONENTS

3.1. Focus, X and Y Drive Components

All three axis use identical electromechanical components.

Rated Output Power	W	160
Rated Output Torque	Nm	51
Maximum Output Torque	Nm	157
Max. Continuous Stall Torque	Nm	71
Rated Output Speed	Rpm	30
Maximum Output Speed	Rpm	40
Rated Current	Arms	1.4
Maximum Current	Arms	3.2
Ratio	-	100
Torque Constant	Nm/A	60
Voltage Constant	V/Rpm	6.4
Mechanical Time Constant	mS	6.8
Electrical Time Constant	mS	1.4
Moment of Inertia (output)	Kgm ²	2.3
Power Supply for control Unit	VAC	230
Rated Motor Speed	Rpm	3000
Maximum Motor Speed	Rpm	4000
Resistance	Ω	3.7
Inductance	mH	5
Weight	Kg	4.7
Encoder Resolution	Ppr	1500
Encoder Output Signals	-	A,A\,B,B\C,C\,U,U\,V,V\W,W\ 5V Line Driver

Table 1: FHA-25B-3015E-E150 Harmonic Drive

- The init-limit switches are BAUMER type “My-Com g”.
- The catastrophic limit switches are Omron type D4D-1532N.
- The driving screws are of the zero backlash type equipped with roller screw nuts. The pitch is 1 millimetre.

Focus	mm	+/- 20
X	mm	+/- 6.2
Y	mm	+/- 6.5

Table 2 : Absolute Maximum Mechanical Travel

- The focus limit switches adjustment is set to +/-16mm for the normal limit and +/-16.5mm for the focus catastrophic limit.

- The X and Y limit switches adjustment is set to +/-5mm for the normal limit and +/-5.5mm for the X and Y catastrophic limit.

3.2. Focus Linear Encoder

Originally the three axes focus, X and Y were equipped with rotary encoders inside the AC servo drive actuators. These actuators drive the mechanism screw directly and assume that the screw-nut combination is backlash free. From these encoders the velocity and position feedback for the control system is derived.

During the preliminary tests we found that the focus screw-nut combination has a backlash greater than 100um. It was decided to keep the rotary encoder for the velocity feedback and add a linear 45mm stroke 1um resolution, 2um precision Mitutoyo encoder, measuring directly over the focus carriage, for the focus position feedback. Refer to 7.12 for the connection details.

4. Electronics Cabinet

The control electronics is mounted on top of the M2 unit inside a hermetically sealed Knürr cabinet equipped with an active heat exchanger unit. The cabinet houses a VME LCU, three AC servo amplifiers and support circuitry.

4.1. VME LCU

The VME LCU is integrated by the following components:

- ESO standard VME RACK (with minimized depth)
- 10 Slots VMEBUS with Active Termination and Auto Daisy Chain
- MVME 712M Transition Module for the CPU I/O
- MVME 2604 Power PC 604 32-bit microprocessor 32MB RAM memory
- MAC4/INC MACCON Motion Controller Module [AP4]
- VME4SA-I ESO DC Servo Amplifier type 1 (2 Amps capacity) [AP1]
- 2X KNIEL 15V 1.6A DC Power Supply.
- VME Power Supply KNIEL FPM 300W.

Refer to 7.2 7.3 7.4 drawings for a schematic view of the VME LCU.

4.2. AC Servo Amplifiers

Three AC Servo Amplifiers type SC-510 are mounted inside the cabinet as shown on 7.5. Refer to [AP5] for a detail description of the SC-510.

4.3. VME4SA Component Adapter Configuration

For each channel the VME4SA has an eight pin dual in line socket for plug in a small component carrier whose components are dependent on the application, refer to [AP1] page 8 for a detailed explanation.

In this application the configuration for channels 1, 2 and 3 is identical and as shown in the table below:

Pin # row 1	Pin # row 2	Component
1	8	Open
2	7	360K

3	6	Wire jumper
4	5	Open

Table 3 : Component Adapter Configuration

4.4. Cabinet Cooling Unit

The cabinet cooling unit used is the ESO standard “VLT Electronic Cabinet Cooling System” [AP3]. The unit is mounted on the bottom of the cabinet with adequate clearance around it for the proper air circulation. Two PT100 elements, one mounted over a heat-sink in the outer wall of the cabinet and the other in contact with the inner wall of the cabinet, are used by the cooling system for keeping the internal temperature the same as the exterior and thus avoiding thermal gradients. The heat is removed from the unit by means of circulating water.

Note that the cooling unit fans are used for blowing air directly over the VME chassis, due to space limitations no supplemental fan tray is used in the application.

4.5. Mains Power Distribution

AC power enters the cabinet via a double pole circuit breaker. The control knob of this breaker is located externally over the side wall of the cabinet. Internally the AC supply goes to a double contact power relay. The coil of the relay is energized with the mains supply and serially connected with the catastrophic limit switches chain a thermostat and a protection fuse. Finally the mains supply goes through an inrush suppressor an over-voltage protector and a power line filter. The power distribution after the conditioning is as follows:

- Direct connection to the three AC servo amplifiers.
- Three Schucko outlets for powering the VME, cooling unit and spare.

Refer to 7.6 for the schematic diagram.

5. CABLING

5.1. Focus, X an Y drive units

Near each harmonic drive unit a group of three numbered screw terminal strips named TSU1_n, TSU2_n and TSU3_n, where n is F,X,Y, to identify the particular group, serve both as test points and junction for the connections coming from the LCU cabinet to each harmonic drive unit and limit-init switches.

5.2. Cabinet

The cabinet wiring is as shown on 7.6. For sake of simplicity only one channel is shown.

5.2.1. Cable Feed-trough

The cables feed-trough is a custom built piece which allows passing every cable and hose to the cabinet interior keeping adequate seal to prevent the internally circulating air of leaking to the outside environment.

5.3. Inside the LCU

The LCU wiring is done as shown on 7.3 and 7.4.

5.4. Wiring Tables

Signal VME4SA	Pin # VME4SA	Pairs Colour	Term # TSC1_F	ACSA_F X3	LSWC_F J1
M+	E8	Red		1	
M-	E5	Black		2	
Shield #1				3**	
Shield #2			1		
Phase +A	A8	Pink	2		
Phase -A	A6	Grey	3		
Phase +B	B7	Yellow	4		
Phase -B	B5	Green	5		
Phase +Z	A4	White	6		
Phase -Z	A2	Brown	7		
Upp. Lim	C3	Violet			3
Low. Lim	D3	Black			7
GND	C6	Blue		7	10
Vx(+15V)	D2	Red		9	9

Table 4 : Cable #1_F* (Channel #1 VME4SA to TSC1_F, ACSA_F, LSWC_F)

*See “Cable #1 VME4SA to Servo Amplifier and Conditioning PCB” Schematic.
Label: “Cable #1_F”.

**Shield #1 connected to terminal #3 in series with a 51ohm resistor and 10nF capacitor (see “Cabling Layout” Schematic).

Signal VME4SA	Pin # VME4SA	Pairs Colour	Term # TSC1_X	ACSA_X X3	LSWC_X J1
M+	E8	Red		1	
M-	E5	Black		2	
Shield #1				3**	
Shield #2			1		
Phase +A	A8	Pink	2		
Phase -A	A6	Grey	3		
Phase +B	B7	Yellow	4		
Phase -B	B5	Green	5		
Phase +Z	A4	White	6		
Phase -Z	A2	Brown	7		
Upp. Lim	C3	Violet			3
Low. Lim	D3	Black			7
GND	C6	Blue		7	10
Vx(+15V)	D2	Red		9	9

Table 5 : Cable #1_X* (Channel #2 VME4SA to TSC1_X, ACSA_X, LSWC_X)

*See “Cable #1 VME4SA to Servo Amplifier and Conditioning PCB” Schematic.
Label: “Cable #1_X”.

**Shield #1 connected to terminal #3 in series with a 51ohm resistor and 10nF capacitor (see “Cabling Layout” Schematic).

Signal VME4SA	Pin # VME4SA	Pairs Colour	Term # TSC1_Y	ACSA_Y X3	LSWC_Y J1
M+	E8	Red		1	
M-	E5	Black		2	
Shield #1				3**	
Shield #2			1		
Phase +A	A8	Pink	2		
Phase -A	A6	Grey	3		
Phase +B	B7	Yellow	4		
Phase -B	B5	Green	5		
Phase +Z	A4	White	6		
Phase -Z	A2	Brown	7		
Upp. Lim	C3	Violet			3
Low. Lim	D3	Black			7
GND	C6	Blue		7	10
Vx(+15V)	D2	Red		9	9

Table 6 : Cable #1_Y* (Channel #3 VME4SA to TSC1_Y, ACSA_Y, LSWC_Y)

*See “Cable #1 VME4SA to Servo Amplifier and Conditioning PCB” Schematic.
Label: “Cable #1_Y”.

**Shield #1 connected to terminal #3 in series with a 51ohm resistor and 10nF capacitor (see “Cabling Layout” Schematic).

Signal Name	Term # TSC1_F	Pairs Colour	ACSA_F X7
Shield	1		9
Phase +A	2	Pink	1
Phase -A	3	Grey	6
Phase +B	4	Yellow	2
Phase -B	5	Green	7
Phase +Z	6	White	3
Phase -Z	7	Brown	8

Table 7 : Cable #2_F*(TSC1_F to ACSA_F)

*See “Cable #2 Terminal Strip to Servo Amplifier” Schematic.
Label: “Cable #2_F”.

Signal Name	Term # TSC1_X	Pairs Colour	ACSA_X X7
Shield	1		9
Phase +A	2	Pink	1
Phase -A	3	Grey	6
Phase +B	4	Yellow	2
Phase -B	5	Green	7
Phase +Z	6	White	3
Phase -Z	7	Brown	8

Table 8 : Cable #2_X*(TSC1_X to ACSA_X)

*See “Cable #2 Terminal Strip to Servo Amplifier” Schematic.
Label: “Cable #2_X”.

Signal Name	Term # TSC1_Y	Pairs Colour	ACSA_Y X7
Shield	1		9
Phase +A	2	Pink	1
Phase -A	3	Grey	6
Phase +B	4	Yellow	2
Phase -B	5	Green	7
Phase +Z	6	White	3
Phase -Z	7	Brown	8

Table 9 : Cable #2_Y*(TSC1_Y to ACSA_Y)

*See “Cable #2 Terminal Strip to Servo Amplifier” Schematic.
Label: “Cable #2_Y”.

Signal Name	ACSA_F X3	Pair Colour	LSWC_F J1
CCWL	11	Violet	4
CWL	10	Black	8

Table 10 : Cable #3_F*(ACSA_F to LSWC_F)

*Label: "Cable #3_F".

Signal Name	ACSA_X X3	Pair Colour	LSWC_X J1
CCWL	11	Violet	4
CWL	10	Black	8

Table 11 : Cable #3_X*(ACSA_X to LSWC_X)

*Label: "Cable #3_X".

Signal Name	ACSA_Y X3	Pair Colour	LSWC_Y J1
CCWL	11	Violet	4
CWL	10	Black	8

Table 12 : Cable #3_Y*(ACSA_Y to LSWC_Y)

*Label: "Cable #3_Y".

Signal Name	ACSA_F X9	Pairs Colour	Term # TSU1_F
CHA	1	Pink	1
CHA/	6	Grey	2
CHB	2	Yellow	3
CHB/	7	Green	4
CHC	3	White	5
CHC/	8	Brown	6
SYNC_U	4	Violet	7
SYNC_U/	5	Black	8
SYNC_V	10	White/green	9
SYNC_V/	15	Brown/green	10
SYNC_W	9	Red/blue	11
SYNC_W/	14	Grey/pink	12
+5V(Enc)	11	Red	13
DGND	13	Blue	14
Shield	D-Sub Housing		15

Table 13 : Cable #4_F*(ACSA_F to TSU1_F)

*See “Cable #4 Encoder Input Signals to AC-Servo Amplifier” Schematic.
Label: “Cable #4_F”.

Signal Name	ACSA_X X9	Pairs Colour	Term # TSU1_X
CHA	1	Pink	1
CHA/	6	Grey	2
CHB	2	Yellow	3
CHB/	7	Green	4
CHC	3	White	5
CHC/	8	Brown	6
SYNC_U	4	Violet	7
SYNC_U/	5	Black	8
SYNC_V	10	White/green	9
SYNC_V/	15	Brown/green	10
SYNC_W	9	Red/blue	11
SYNC_W/	14	Grey/pink	12
+5V(Enc)	11	Red	13
DGND	13	Blue	14
Shield	D-Sub Housing		15

Table 14 : Cable #4_X*(ACSA_X to TSU1_X)

*See “Cable #4 Encoder Input Signals to AC-Servo Amplifier” Schematic.
Label: “Cable #4_X”.

Signal Name	ACSA_Y X9	Pairs Colour	Term # TSU1_Y
CHA	1	Pink	1
CHA/	6	Grey	2
CHB	2	Yellow	3
CHB/	7	Green	4
CHC	3	White	5
CHC/	8	Brown	6
SYNC_U	4	Violet	7
SYNC_U/	5	Black	8
SYNC_V	10	White/green	9
SYNC_V/	15	Brown/green	10
SYNC_W	9	Red/blue	11
SYNC_W/	14	Grey/pink	12
+5V(Enc)	11	Red	13
DGND	13	Blue	14
Shield	D-Sub Housing		15

Table 15 : Cable #4_Y*(ACSA_Y to TSU1_Y)

*See “Cable #4 Encoder Input Signals to AC-Servo Amplifier” Schematic.
Label: “Cable #4_Y”.

Signal Name	ACSA_F X1	TERM # TSC2_F	Cables Colour	Term # TSU2_F
Brk1		1	Brown	1
Brk2		2	White	2
U	U		Yellow	3
V	V		Grey	4
W	W		Pink	5
PE	PE		Green	6
PE	PE		Shield	7

Table 16 : Cable #5_F*(ACSA_F & TSC2_F to TSU2_F)

*Label: “Cable #5_F”.

Signal Name	ACSA_X X1	TERM # TSC2_X	Cables Colour	Term # TSU2_X
Brk1		1	Brown	1
Brk2		2	White	2
U	U		Yellow	3
V	V		Grey	4
W	W		Pink	5
PE	PE		Green	6
PE	PE		Shield	7

Table 17 : Cable #5_X*(ACSA_X & TSC2_X to TSU2_X)

*Label: "Cable #5_X".

Signal Name	ACSA_Y X1	TERM # TSC2_Y	Cables Colour	Term # TSU2_Y
Brk1		1	Brown	1
Brk2		2	White	2
U	U		Yellow	3
V	V		Grey	4
W	W		Pink	5
PE	PE		Green	6
PE	PE		Shield	7

Table 18 : Cable #5_Y*(ACSA_Y & TSC2_Y to TSU2_Y)

*Label: "Cable #5_Y".

Signal Name	LSWC_F J1	Pairs Colour	TERM # TSU3_F
Shield	Earth		Earth
SWC3A	1	White	1
SWC3B	2	Yellow	2
SWD3A	5	Brown	3
SWD3B	6	Green	4

Table 19 : Cable #6_F*(LSWC_F to TSU3_F)

*Label: "Cable #6_F".

Signal Name	LSWC_X J1	Pairs Colour	TERM # TSU3_X
Shield	Earth		Earth
SWC3A	1	White	1
SWC3B	2	Yellow	2
SWD3A	5	Brown	3
SWD3B	6	Green	4

Table 20 : Cable #6_X*(LSWC_X to TSU3_X)

*Label: "Cable #6_X".

Signal Name	LSWC_Y J1	Pairs Colour	TERM # TSU3_Y
Shield	Earth		Earth
SWC3A	1	White	1
SWC3B	2	Yellow	2
SWD3A	5	Brown	3
SWD3B	6	Green	4

Table 21 : Cable #6_Y*(LSWC_Y to TSU3_Y)

*Label: "Cable #6_Y".

Signal Name	TERM # TSC1	Cables Colour	TERM # TSU1
Neutral	1	White	1
F20	2	Black	2

Table 22 : Cable #7*(TSC1 to TSU1)

*Label: "Cable #7".

Signal Name	TERM # TSU1_F	Pairs Colour
CHA	1	Green
CHA/	2	Green/white
CHB	3	Grey
CHB/	4	Grey/white
CHC	5	Yellow
CHC/	6	Yellow/white
SYNC_U	7	Brown
SYNC_U/	8	Brown/white
SYNC_V	9	Blue
SYNC_V/	10	Blue/white
SYNC_W	11	Orange
SYNC_W/	12	Orange/white
+5V(Enc)	13	Red
DGND	14	Black
Shield	15	

Table 23 : Cable #8_F*(TSU1_F to HD_F)

*Label: "Cable #8_F".

Signal Name	TERM # TSU1_X	Pairs Colour
CHA	1	Green
CHA/	2	Green/white
CHB	3	Grey
CHB/	4	Grey/white
CHC	5	Yellow
CHC/	6	Yellow/white
SYNC_U	7	Brown
SYNC_U/	8	Brown/white
SYNC_V	9	Blue
SYNC_V/	10	Blue/white
SYNC_W	11	Orange
SYNC_W/	12	Orange/white
+5V(Enc)	13	Red
DGND	14	Black
Shield	15	

Table 24 : Cable #8_X*(TSU1_X to HD_X)

*Label: "Cable #8_X".

Signal Name	TERM # TSU1_Y	Pairs Colour
CHA	1	Green
CHA/	2	Green/white
CHB	3	Grey
CHB/	4	Grey/white
CHC	5	Yellow
CHC/	6	Yellow/white
SYNC_U	7	Brown
SYNC_U/	8	Brown/white
SYNC_V	9	Blue
SYNC_V/	10	Blue/white
SYNC_W	11	Orange
SYNC_W/	12	Orange/white
+5V(Enc)	13	Red
DGND	14	Black
Shield	15	

Table 25 : Cable #8_Y*(TSU1_Y to HD_Y)

*Label: "Cable #8_Y".

Signal Name	TERM # TSU2_F	Cables Colour
Brk1	1	Blue
Brk2	2	Yellow
U	3	Red
V	4	Black
W	5	White
PE	6	Green
Shield	7	Shield

Table 26 : Cable #9_F*(TSU2_F to HD_F)

*Label: "Cable #9_F".

Signal Name	TERM # TSU2_X	Cables Colour
Brk1	1	Blue
Brk2	2	Yellow
U	3	Red
V	4	Black
W	5	White
PE	6	Green
Shield	7	Shield

Table 27 : Cable #9_X*(TSU2_X to HD_X)

*Label: "Cable #9_X".

Signal Name	TERM # TSU2_Y	Cables Colour
Brk1	1	Blue
Brk2	2	Yellow
U	3	Red
V	4	Black
W	5	White
PE	6	N/A
Shield	7	Shield

Table 28 : Cable #9_Y*(TSU2_Y to HD_Y)

*Label: "Cable #9_Y".

Signal Name	TERM # TSU3_F	Pair Colour
SWC3A	1	Black
SWC3B	2	Blue

Table 29 : Cable #10_F*(TSU3_F to UL_F)

*Label: "Cable #10_F".

Signal Name	TERM # TSU3_X	Pair Colour
SWC3A	1	Black
SWC3B	2	Blue

Table 30 : Cable #10_X*(TSU3_X to UL_X)

*Label: "Cable #10_X".

Signal Name	TERM # TSU3_Y	Pair Colour
SWC3A	1	Black
SWC3B	2	Blue

Table 31 : Cable #10_Y*(TSU3_Y to UL_Y)

*Label: "Cable #10_Y".

Signal Name	TERM # TSU3_F	Pair Colour
SWD3A	3	Black
SWD3B	4	Blue

Table 32 : Cable #11_F*(TSU3_F to LL_F)

*Label: "Cable #11_F".

Signal Name	TERM # TSU3_X	Pair Colour
SWD3A	3	Black
SWD3B	4	Blue

Table 33 : Cable #11_X*(TSU3_X to LL_X)

*Label: "Cable #11_X".

Signal Name	TERM # TSU3_Y	Pair Colour
SWD3A	3	Black
SWD3B	4	Blue

Table 34 : Cable #11_Y*(TSU3_Y to LL_Y)

*Label: "Cable #11_Y".

Signal Name	TERM # TSU1	Pair Colour
Neutral	1	Black
F20	2	Black

Table 35 : Cable #12*(TSU1 to Catastrophic Limit Switches Chain)

*Label: "Cable #12".

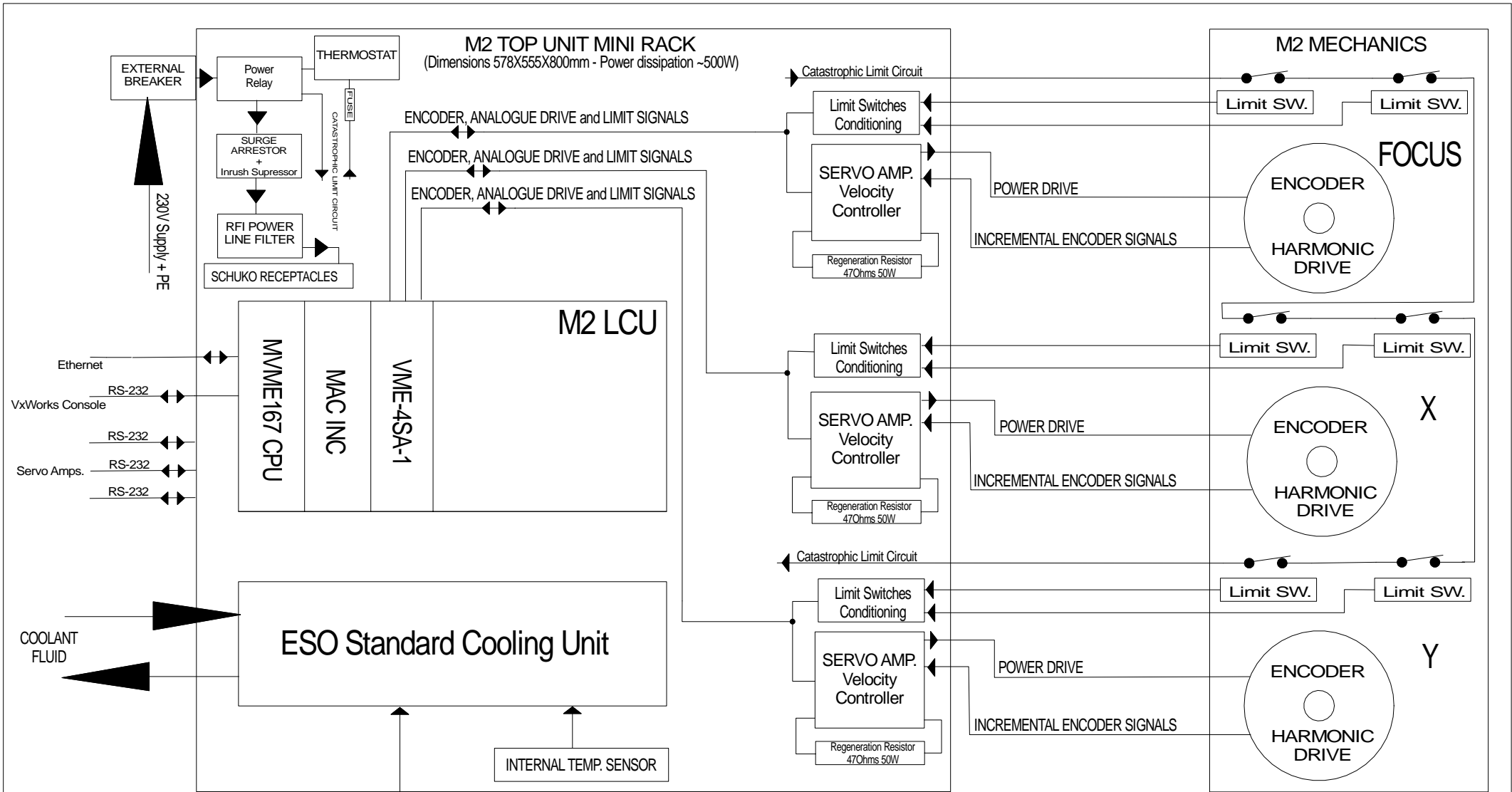
6. SPARE PARTS LIST


Item	Description	Qty
1	Harmonic Drive Servo Amplifier SC-510	1
2	MVME712 VME CPU transition module	1
3	KNIEL TYP> CP 15.1,6 power supply	1
4	AC Servo Armonic Drive Actuator FHA-25B (with brake)	1
5	Line Filter Schaffner FN350-8-29	2
6	3.6 M2 Limit Switches Signal Conditioner Module	1

7. DRAWING and SCHEMATIC DIAGRAM APPENDIX

The drawings and circuit schematic diagrams are listed below and annexed to this document as eleven A4 format sheets.

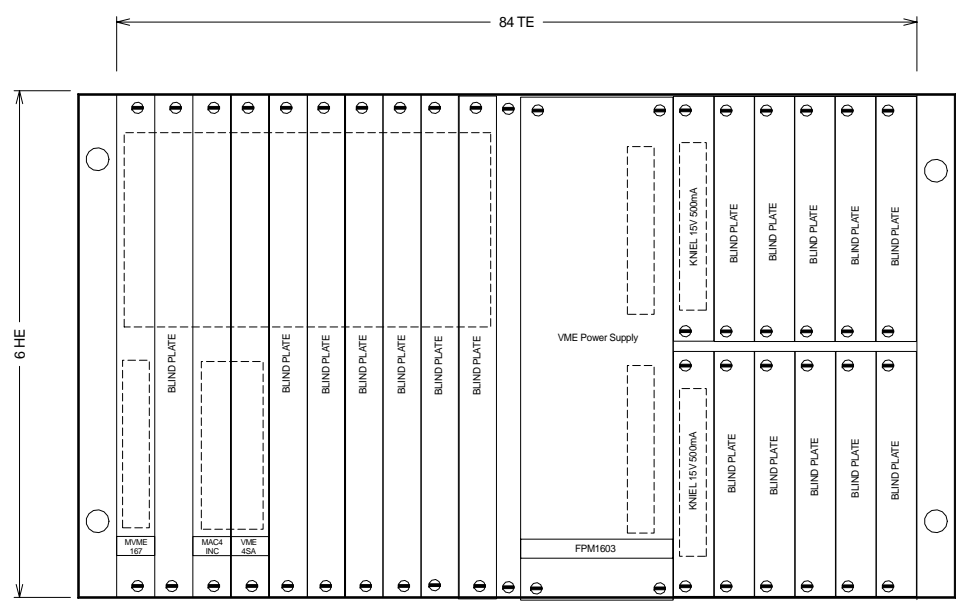
- 7.1. *Block Diagram***
- 7.2. *M2-LCU Chassis Layout***
- 7.3. *M2-LCU Internal Wiring Diagram (Part 1)***
- 7.4. *M2-LCU Internal Wiring Diagram (Part 2)***
- 7.5. *M2 Rack Layout Rear View***
- 7.6. *Cabling Layout***
- 7.7. *Cable #1 VME4SA to Servo Amplifier and Conditioning PCB***
- 7.8. *Cable #2 Terminal Strip to Servo Amplifier***
- 7.9. *Cable #4 Encoder Input Signals to AC-Servo Amplifier***
- 7.10. *Limit Switches Signal Conditioning Circuit***
- 7.11. *Limit Switches Signal Conditioning PCB***
- 7.12. *Focus Mitutoyo Linear Encoder Connection***



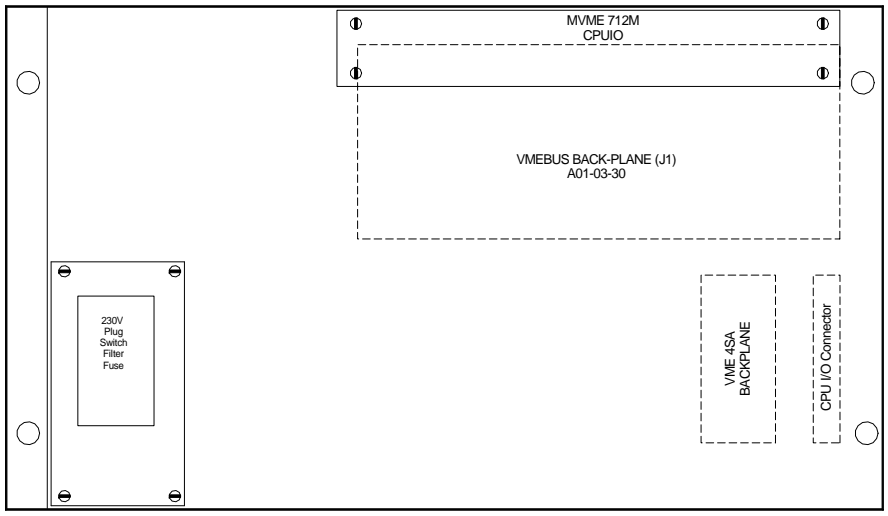
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	Appr.							
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								1/1
1	FDR	06/05/03	JA	Document Number: 3P6-DSD-ESO-60400-0001			File Name: M2block1.skf	
Issue	Revisions	Date	Init					

M2-LCU

FRONT SIDE VIEW




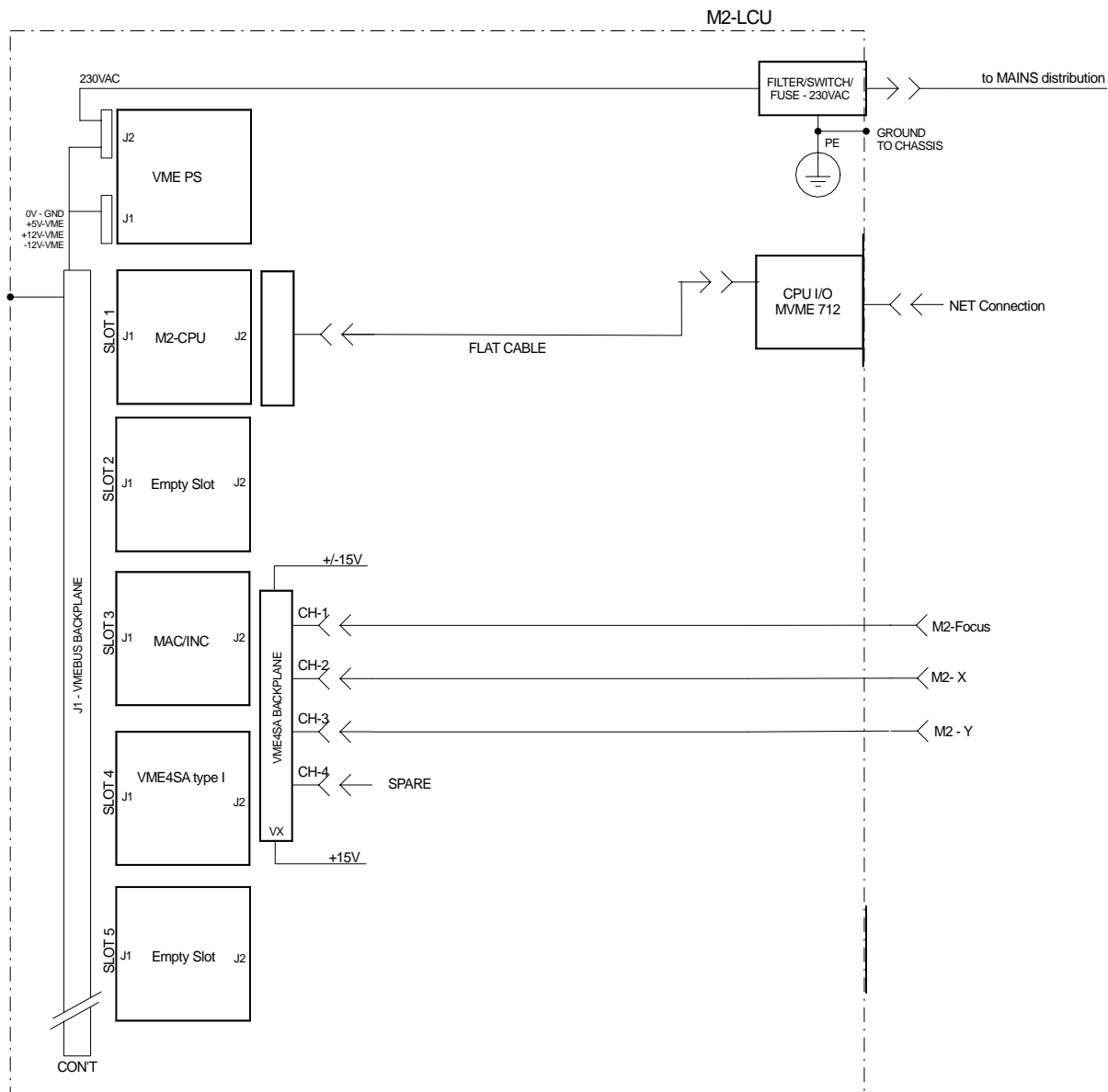
REAR SIDE VIEW




LEGENDE:

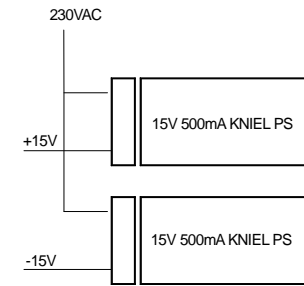
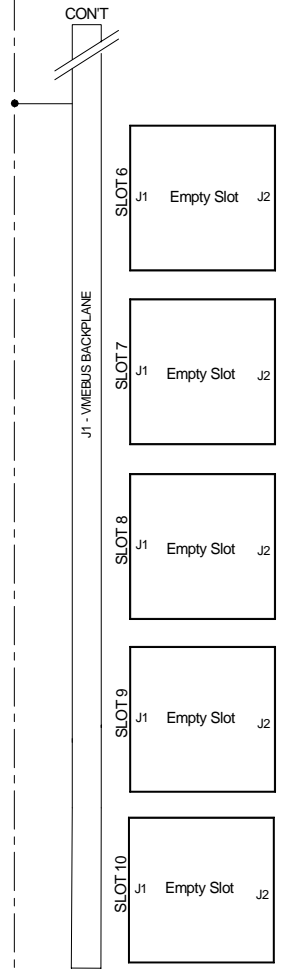
- RACK: ESO Standard (minimize depth)
- VMEBUS: 10 SLOTS - ACTIVE TERMINATION - AUTO DAISY CHAIN
- CPUIO: TRANSITION MODULE MVME 712M
- CPU:MOTOROLA - MVME167
- MAC4/INC: MACCON - MOTION CONTROLLER
- VME4SA: ESO - DC SERVO-AMPLIFIER TYPE 1 (2Amps)
- 2X KNIEL 15V 1.6A Power Supply
- VME PS: KNIEL FPM 300W FOR VME BUS SUPPLY


				Date	Init.	 European Southern Observatory 3.6 M2 Control Electronics		
			Drawn	20/04/03	JA			
			Chckd.					
			Appr.					
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								1/1
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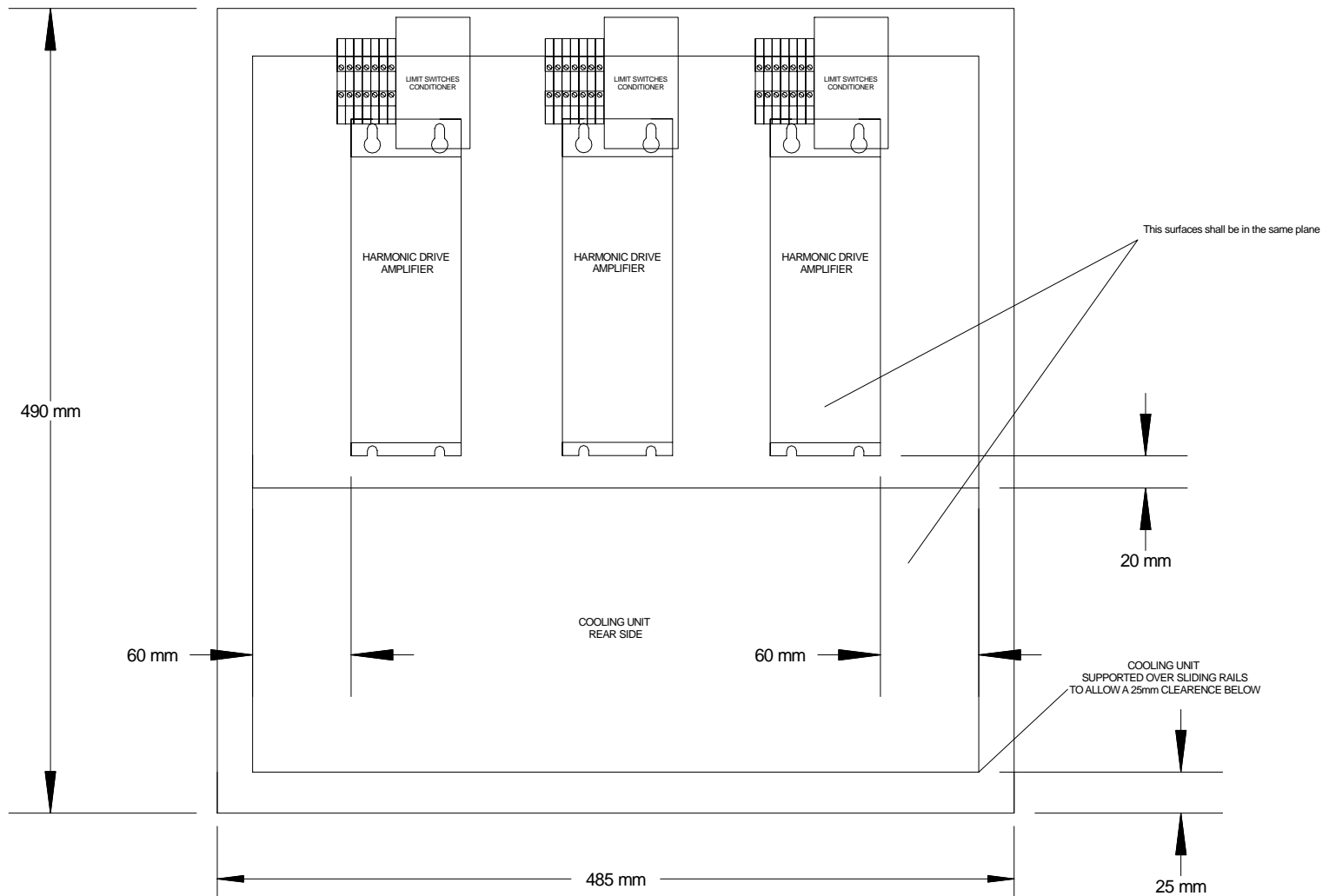



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1	FDR	06/05/03	JA	Document Number:	3P6-DSD-ESO-60400-0001		Page 1/1	
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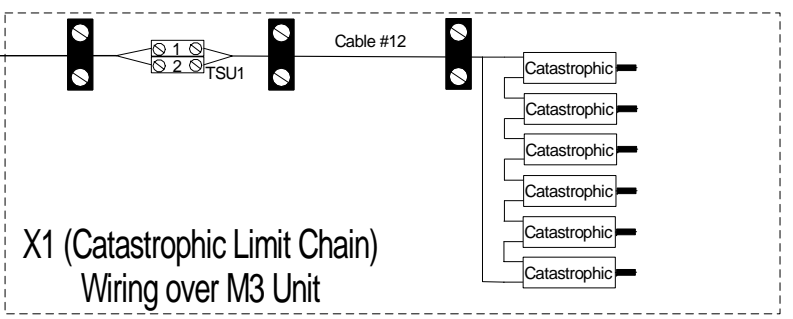
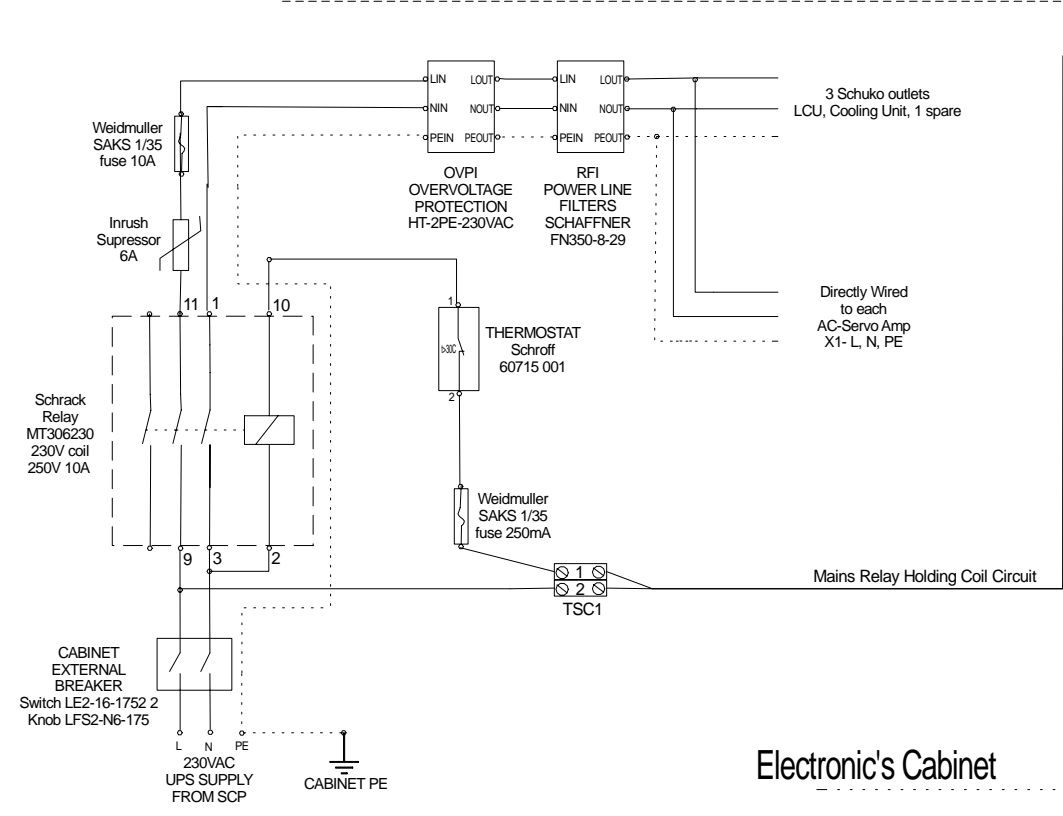
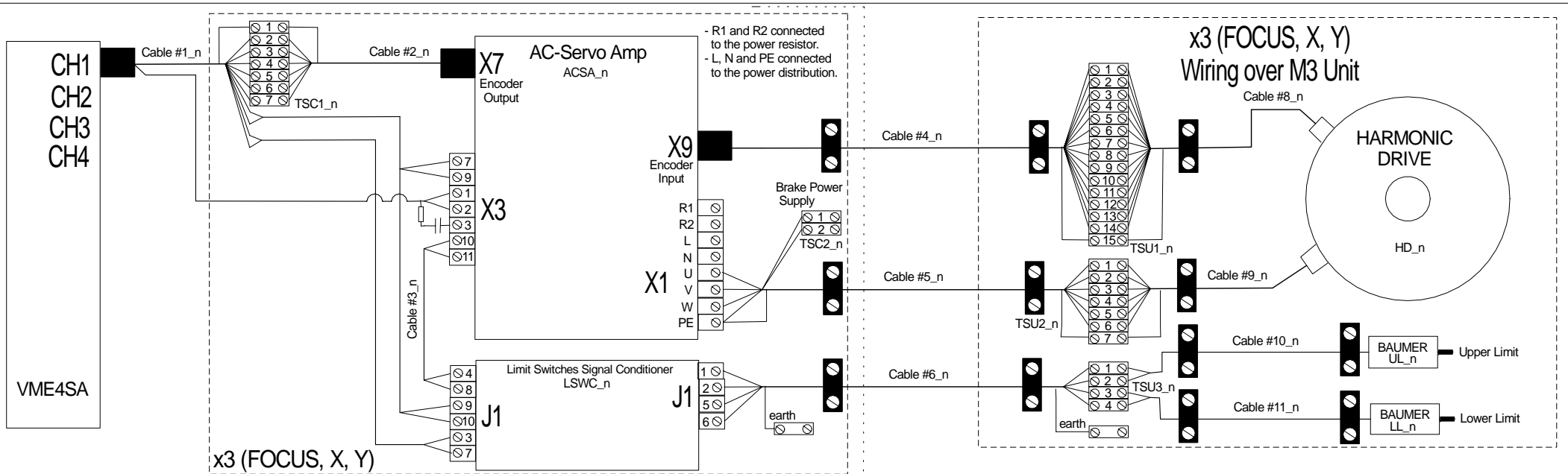
M2-LCU



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			Appr.					
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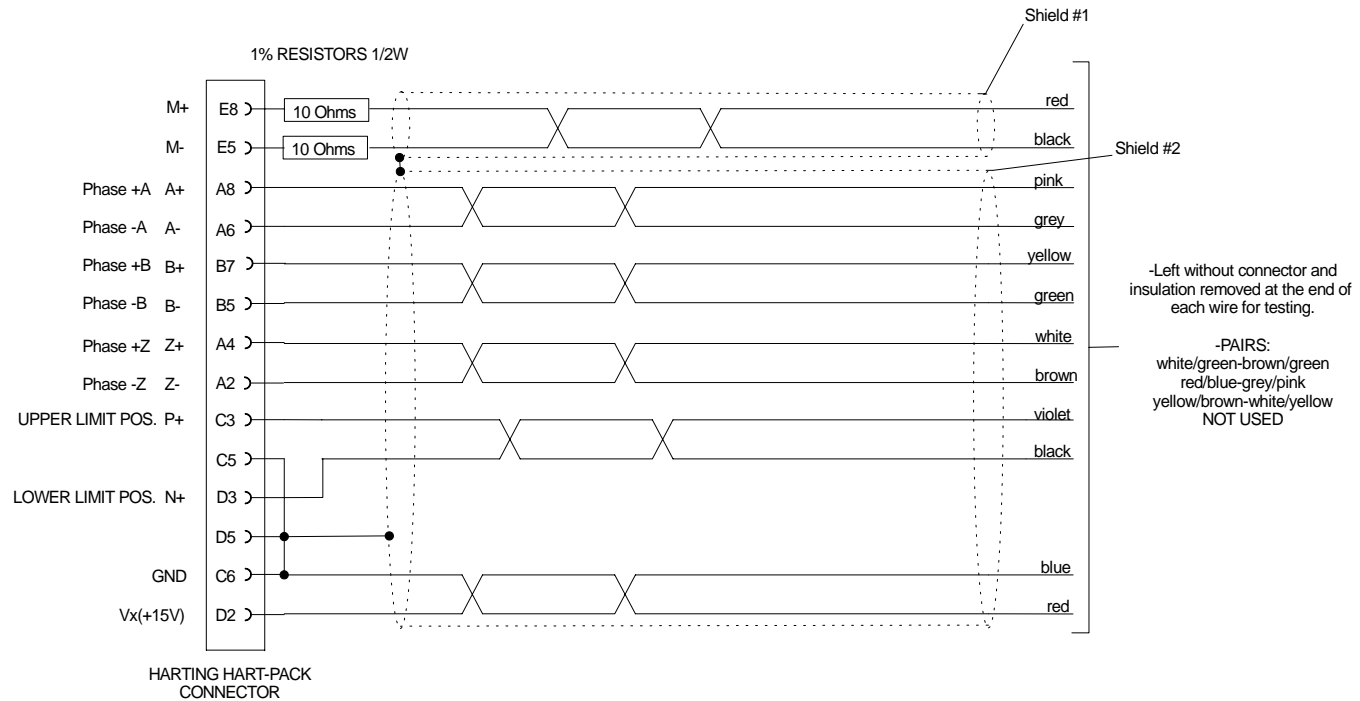
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							1/1
1	FDR	06/05/03	JA	Document Number:			File Name:
Issue	Revisions	Date	Init	3P6-DSD-ESO-60400-0001			rack.skf



= Cable Strain Relief


Electronic's Cabinet

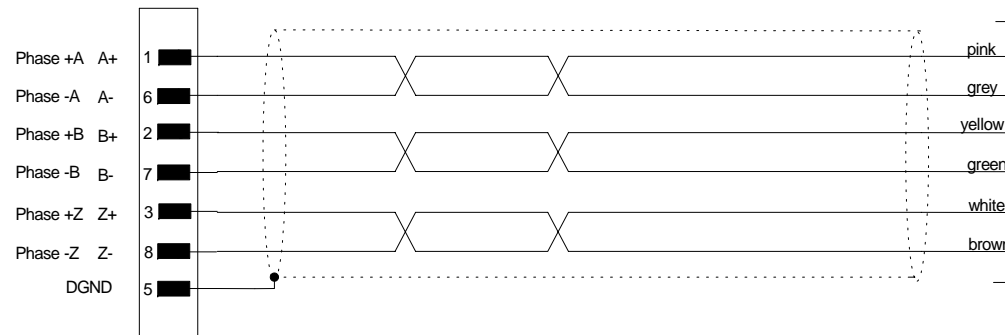
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						1/1	
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Issue	Revisions	Date	Init	3P6-DSD-ESO-60400-0001		Layout1.SKF	



NOTES:

- Length 1.5m
- Quantity 3 units
- Complete double electrical test, pin to end and check for shorts between lines.
- At the Harting connector side the cables must point downward when plugged in the VME4SA backplane.
- The 10 Ohm resistors shall be inside the Harting connector cover properly insulated.
- Use heat shrinkable tube at the Harting side to fix the cables firmly to the cover and have EFFECTIVE strain relief.

				Date	Init.	 European Southern Observatory 3.6 M2 Control Electronics	
			Drawn	17/06/03	JA		
			Chckd.				
			Appr.				
Title:						Cable #1 VME4SA to Servo Amplifier and Conditioning PCB.	Page
							1/1
1	A	17/06/03	JA	Document Number:		File Name:	
Issue	Revisions	Date	Init	3P6-DSD-ESO-60400-0001		Cable1.SKF	




-Left without connector and insulation removed at the end of each wire for testing.

-PAIRS:
violet-black
blue-red
white/green-brown/green
red/blue-grey/pink
yellow/brown-white/yellow
NOT USED

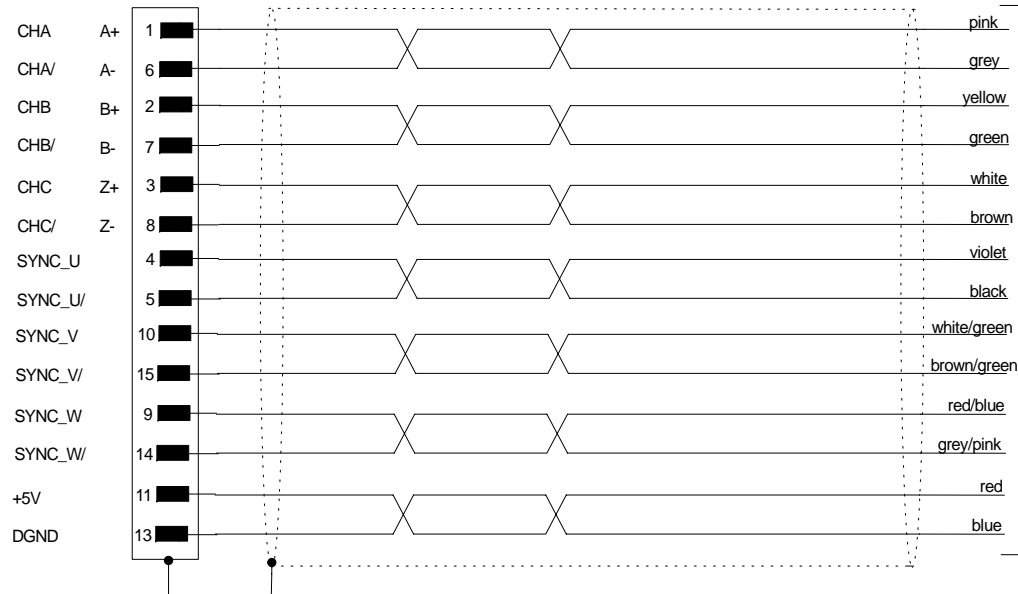
Cannon Dsub 9 pins male
Cover with fixation screws

NOTES:

- Length 1 m
- Quantity 3 units
- Complete double electrical test, pin to end and check for shorts between lines.
- Fix the cable firmly to the cover to have EFFECTIVE strain relief.

				Date	Init.	 European Southern Observatory 3.6 M2 Control Electronics	
			Drawn	17/06/03	JA		
			Chkd.				
			Appr.				
Title:						Cable #2 Terminal Strip to Servo Amplifier.	Page
							1/1
1	A	17/06/03	JA	Document Number:		File Name:	
Issue	Revisions	Date	Init	3P6-DSD-ESO-60400-0001		Cable2.SKF	

Cannon Dsub 15 pins male high density
Cover with fixation screws




-Left without connector and insulation removed at the end of each wire for testing.

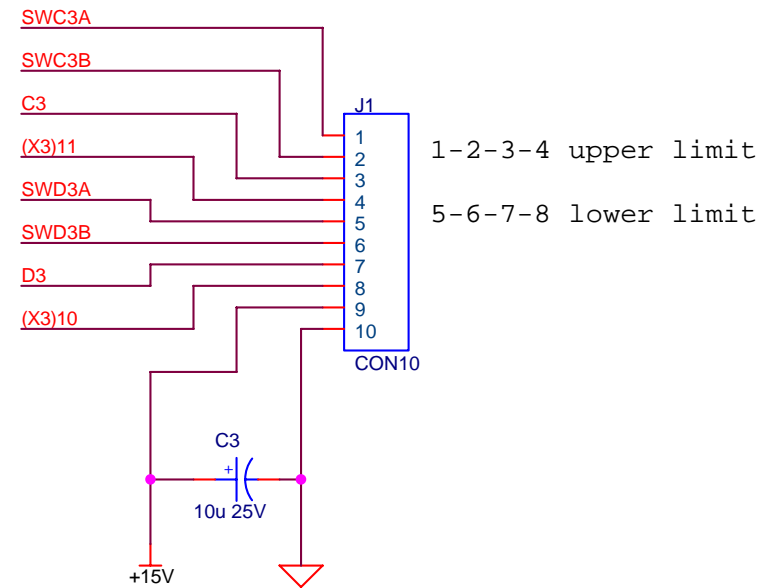
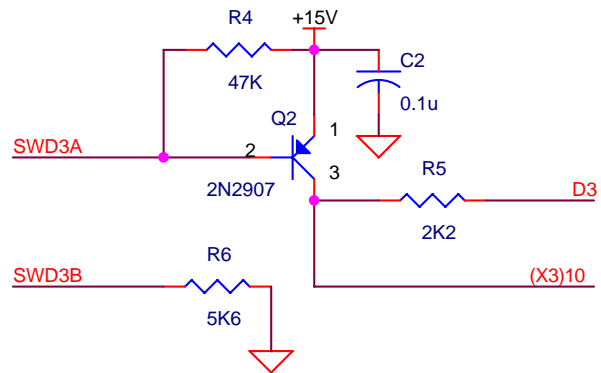
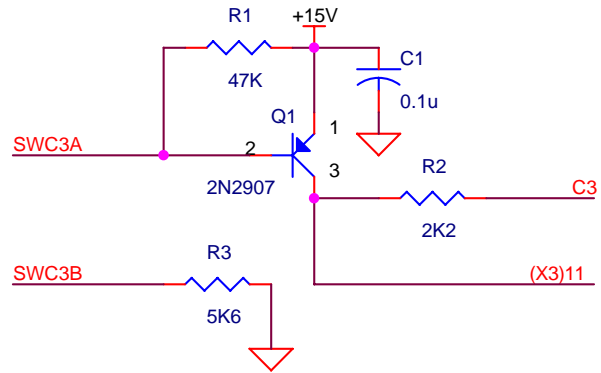
-PAIR:
yellow/brown-white/yellow
NOT USED

NOTES:

- Length TBD m
- Quantity 3 units
- D-Sub Housing connected to shield
- Complete double electrical test, pin to end and check for shorts between lines.
- Fix the cable firmly to the cover to have EFFECTIVE strain relief.

					Date	Init.		European Southern Observatory 3.6 M2 Control Electronics
				Drawn	17/06/03	JA		
				Chckd.				
				Appr.				
				Title:				Page
				Cable #4 Encoder Input Signals to AC-Servo Amplifier.				1/1
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Issue	Revisions	Date	Init	3P6-DSD-ESO-60400-0001			Cable4.SKF	

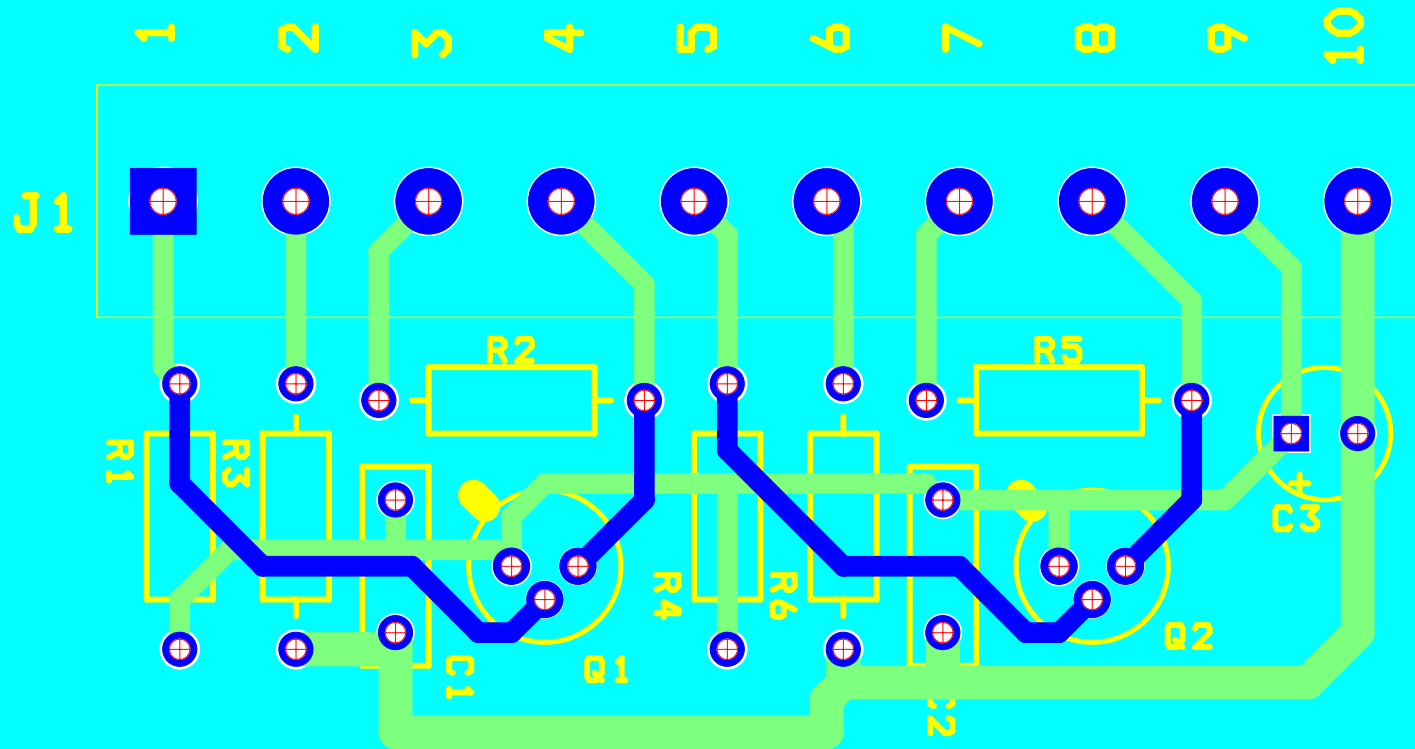
DIN rail mounted circuit. One per axis (Focus, X, Y)



European Southern Observatory La Silla			
Title Limit Switches Signal Conditioning Circuit			
Size A	Document Number 001	J. Alonso File: LMSW1.OPJ	Rev A
Date:	Sunday, June 15, 2003	Sheet	1 of 1

Limit Switches Signal Conditioning PCB

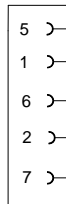
LED 2003



3.6 M2 Limit Switches Signal Conditioner

Cannon Dsub 9 pins female
Cover with nut fixations

Cable #2_FOCUS DSUB 9
Connected to this connector



RED

Connected to the LCU +5V across a 1A fuse.

BLACK

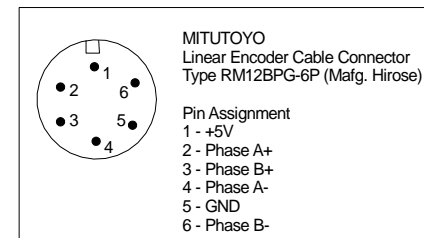
Each cable is fitted with female pins and shrinking tube for insulation. The connection to the Mitutoyo cable connector is done inserting pin by pin. We are buying the special connector for the final version.


yellow Phase +B
grey Phase -B
green Phase +A
brown Phase -A
pink +5V
white GND

To MITUTOYO
linear encoder connector

NOTES:

- Length 2.5 m
- Quantity 1 unit
- Complete double electrical test, pin to end and check for shorts between lines.
- Fix the cable firmly to the cover to have EFFECTIVE strain relief.



					Date	Init.		European Southern Observatory 3.6 M2 Control Electronics
				Drawn	24/01/05	JA		
				Chckd.				
				Appr.				
					Title: Focus Mitutoyo Linear Encoder Connection.			Page
								1/1
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