VERY LARGE TELESCOPE

ESO VME4SA
BACKPLANE

TECHNICAL MANUAL

VLT-MAN-ESO-17130-0274
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Issue	Date	Part affected	Remark
1	01-09-92	All	First issue
2	25-1-94	All	
3	23-11-1994	4.1, 4.1.2, 4.1.3, 4.3, 4.3.6, 4.5	New encoder connection VX voltage rule

Table of contents

1. INTRODUCTION.

1.1. Purpose.

This document describes the ESO VME4SA backplane. It shall also be used as a reference for ESO standardised field wiring for instrument control applications.

1.2 Reference documents.

(1) : VLT-MAN-ESO-17130-0373 "ESO VME4SA-X1 4-channel DC-servo amplifier"
(2) : Technical description - MACCONTROLLER. Fa. Maccon.

2. OVERVIEW

2.1 System

The VME4SA backplane is a part of a (ESO defined and standardised) VME-based DC motor motion control system consisting of :

* MAC4/INC or MAC4/SSI 4-axes DC-motor motion controller board,
* ESO VME4SA-X1 4-axes DC-motor amplifier board and
* ESO VME4SA backplane.

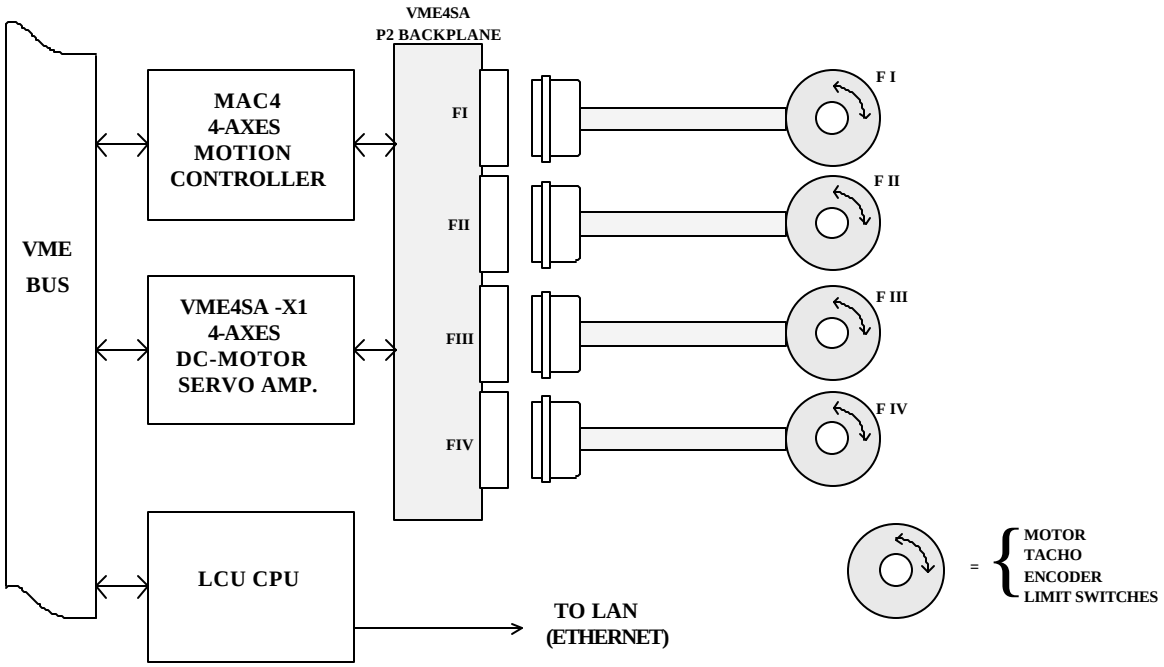


Fig 2.1.1. General description.

These three units form a compact, high performance versatile DC servo motor motion control system. Its prime use is for VLT instrument control system.
As illustrated in fig. 2.1.1, the backplane interconnects the MAC4 motion controller and the VME4SA servo power amplifier at VME P2 level. The four controlled functions (mechanical functions with a motor coupled to tacho and encoder as well as status switches) are connected to the back side of the VME4SA backplane through four identical connectors (one connector for each function).
Each one of these connectors provides access to all signals related to one function, including motor, limit, tacho and encoder signals, thus simplifying cabling significantly. See also fig. 2.1.2., where the basic signals of one function are illustrated.

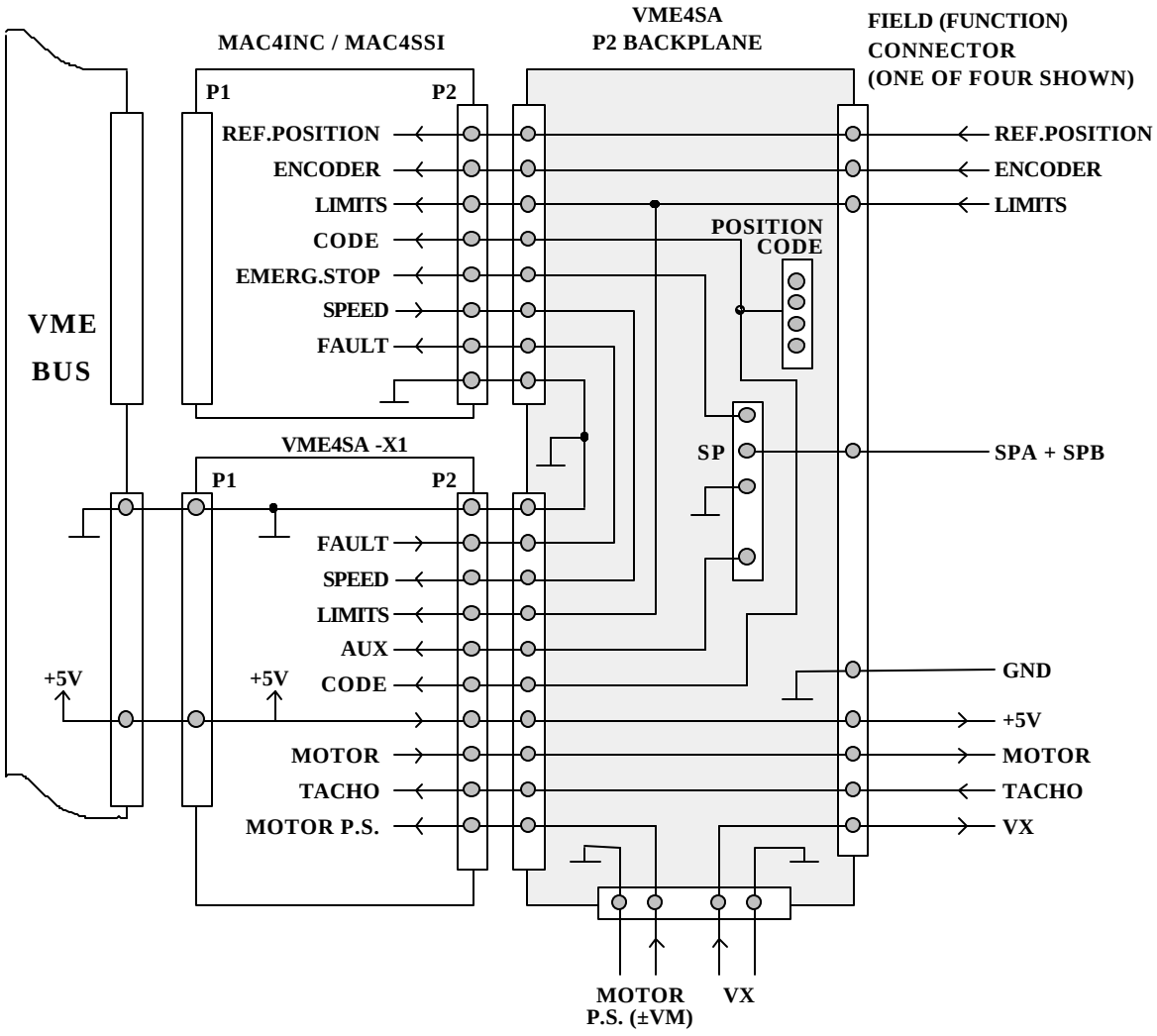
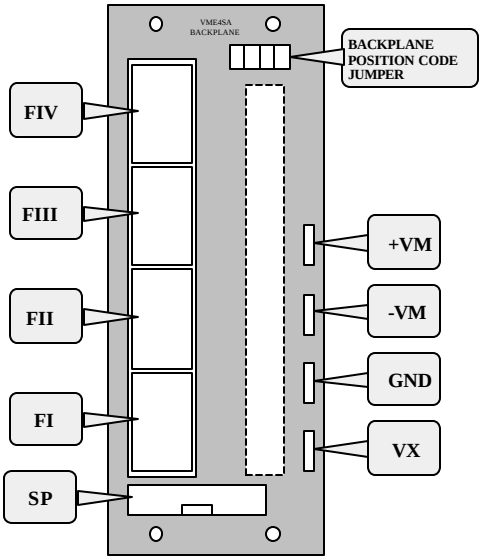


Fig 2.1.2. Signal overview. Figure shows logical connections.

Each function also has access to signal ground, +5V supply, a user provided voltage supply and two unallocated signals (user disposable). Note that in fig. 2.1.2. all signals are indicated as logical rather than physical connections. For a more detailed description of the connections, see section 4.

3. BACKPLANE LAYOUT



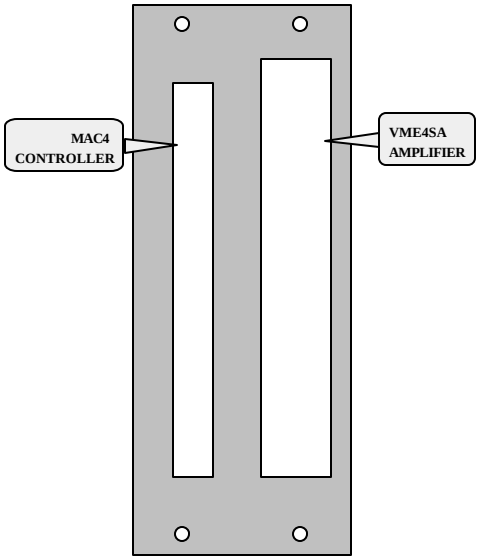


Fig 3.1. Connector (chassis rear) side. *Fig 3.2. VME-slot side.*

Figure 3.1. shows the backplane seen from the VME-chassis rear, or function (process) connector side. From this side the user has access to the four function connectors FI-FIV, the SP connector, the backplane address code jumpers and connectors for motor power supply (±VM). In figure 3.2. (seen from VME-chassis front side) the P2 connectors for MAC4 and VME4SA-X1 power amplifier are shown.

4. CONNECTIONS

4.1 MAC4 connector

The MAC4 motion controller is connected to the backplane from the VME-slot side to a (VME P2 connector) DIN 96-pole female connector, see fig 4.1. Only rows A and C are used.

C	B	A	
o		o	1
o		o GND	2
o AIN1		o GND	3
o AIN2		o AIN3	4
o A1+/CL1+		o AIN4	5
o A1-/CL1-		o B1+/DATA1+	6
o Z1+		o B1-/DATA1-	7
o Z1-		o A2+/CL2+	8
o B2+/DATA2+		o A2-/CL2-	9
o B2-/DATA2-		o Z2+	10
o A3+/CL3+		o Z2-	11
o A3-/CL3-		o B3+/DATA3+	12
o Z3+		o B3-/DATA3-	13
o Z3-		o A4+/CL4+	14
o B4+/DATA4+		o A4-/CL4-	15
o B4-/DATA4-		o Z4+	16
o		o Z4-	17
o		o	18
o		o	19
o		o	20
o -DF1		o	21
o -DF2		o -DF3	22
o PC0		o -DF4	23
o PC1		o PC2	24
o		o	25
o GND		o -STOP	26
o -SN1		o -SP1	27
o -RS1		o -SP2	28
o -RS2		o -SN2	29
o -SP3		o -SN3	30
o -SP4		o -RS3	31
o -SN4		o -RS4	32

NOTE : PINS WITH TWO ASSIGNEMENTS SEPARATED BY A "/" SIGN REFERS TO MAC4/INC OR MAC4/SSI, RESP.

Fig 4.1. Pin allocation of MAC4 connector on VME4SA backplane(VME chassis rear view).

4.1.1 AIN1-AIN4

Motor speed reference signal. Output from MAC4 to power amplifier. Signals are routed from MAC4 connector to VME4SA power amplifier connector. Analogue signal, range -10 to +10 V.

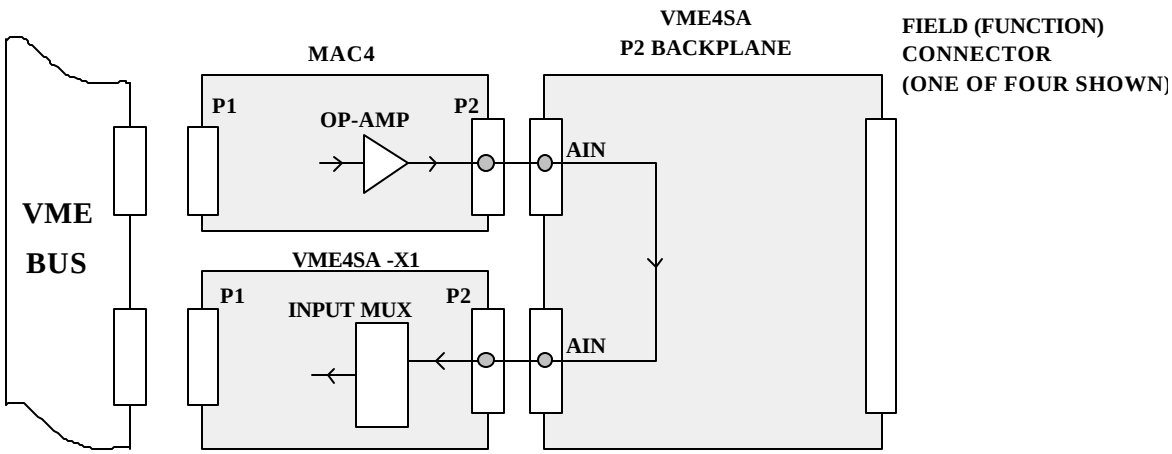


Fig 4.1.1. AIN signal connection.

4.1.2 A,B,Z

Incremental encoder signals. Input to MAC4, TTL-level differential signals. Signals are routed from function connectors FI-FIV to MAC4. Signal names are abbreviated as follows : Z1+ means Zero pulse F1 differential positive, Z1- means Zero pulse F1 differential negative.

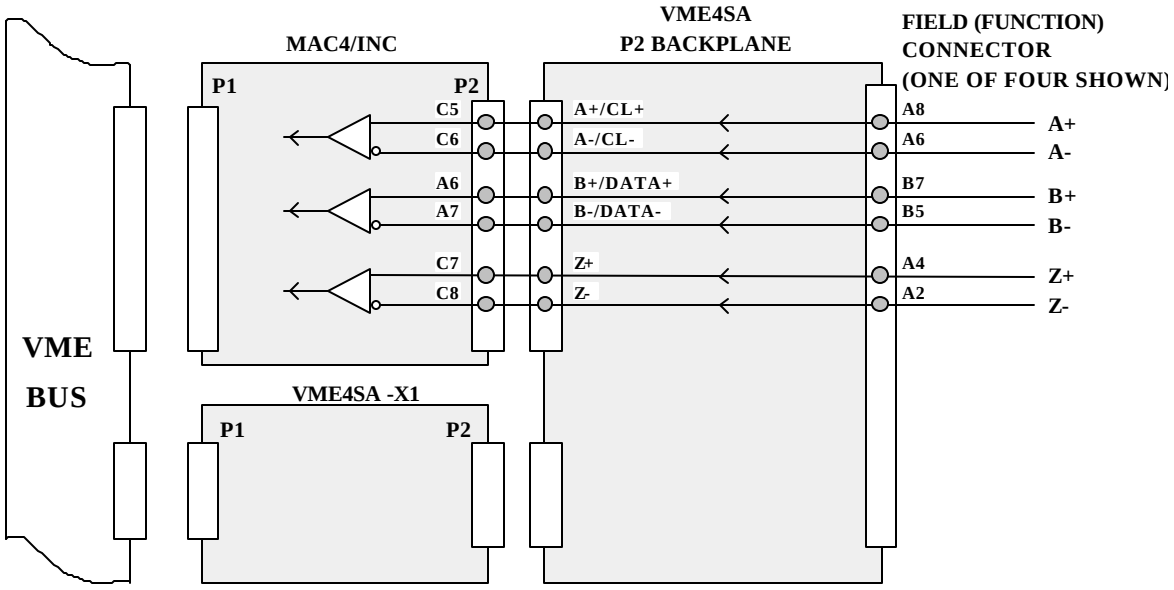


Fig 4.1.2. Incremental encoder signal connection. Only axis 1 (FI) connections shown.

4.1.3 CL,DATA

Serial absolute encoder (SSI) signals. Output (clock) and input (data) to MAC4, TTL-level differential signals. Signals are routed from function connectors FI-FIV to MAC4/SSI. Signal names are abbreviated as follows : CL1+ means clock F1 differential positive, CL1- means clock F1 differential negative.

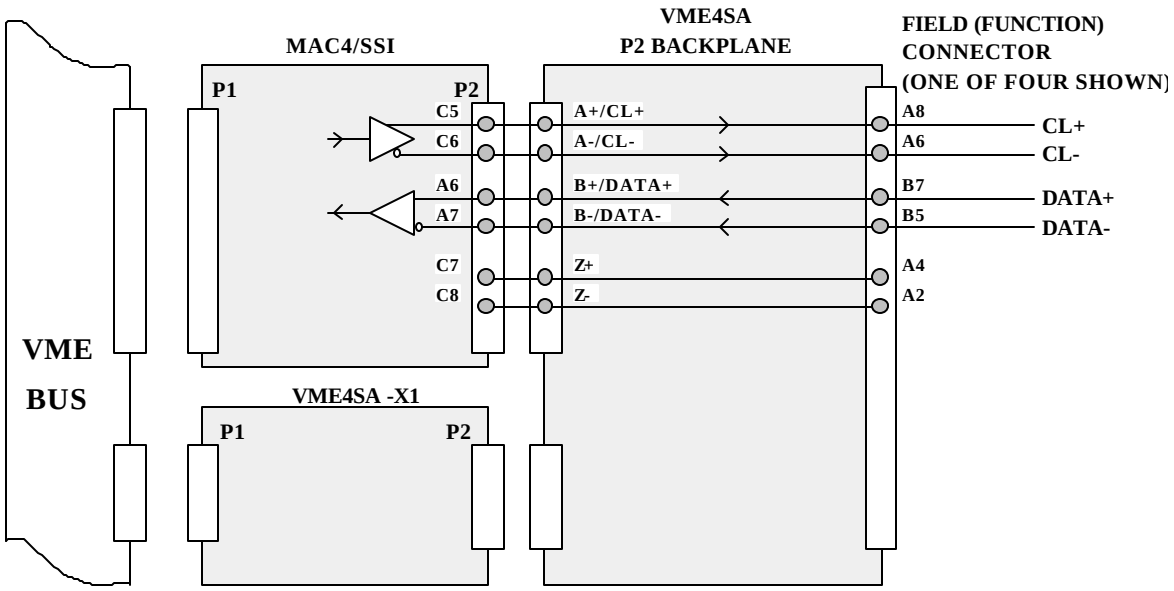


Fig 4.1.3. Absolute serial (SSI) encoder signal connection. Only axis 1 (FI) connections shown.

4.1.4 -DF1 to -DF4

Drive fault channel I to IV. Input to MAC4 from VME4SA amplifier (via optocouplers on backplane). A high level on this signal to MAC4 indicates that the power amplifier is OK.
Note that whenever the VME4SA servo amplifier is not inserted into its VME slot, the drive fault inputs of the MAC4 unit are low, thus indicating drive fault.

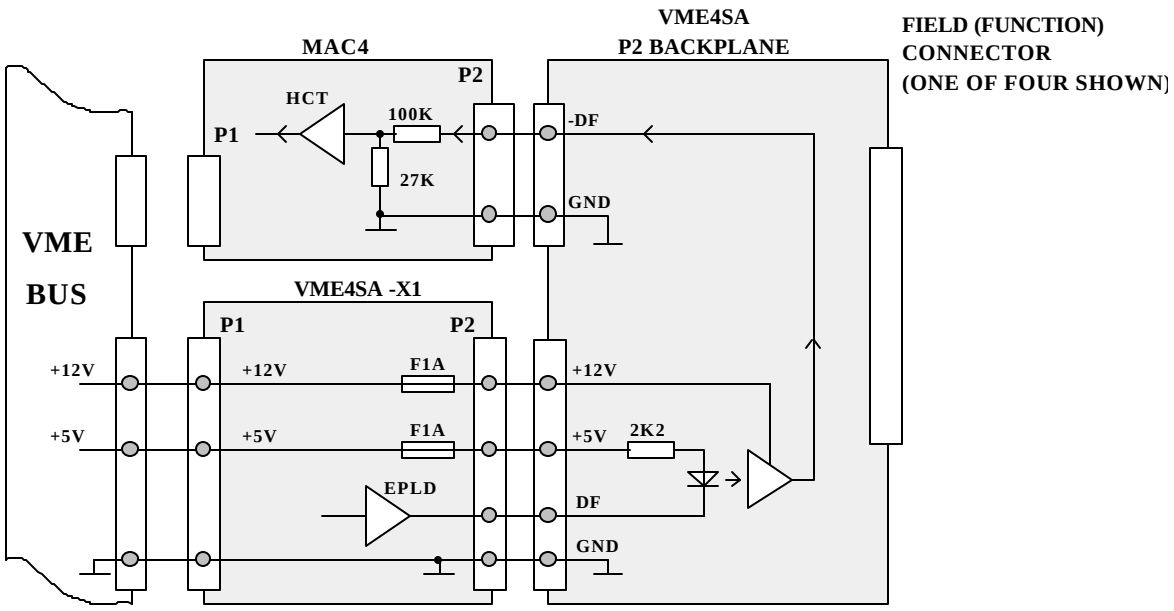


Fig 4.1.4. Drive fault (-DF) signal connection.

4.1.5 PC0-PC3

Position Code bit 0-3. Input to MAC4 motion controller (and VME4SA-X1 amplifier) from position code jumper BR1 on backplane. See also fig. 3.1.
The purpose of the position coding is to provide to the CPU a VME-slot identification mechanism if several sub-sets of motion control systems exist within the same VME LCU.

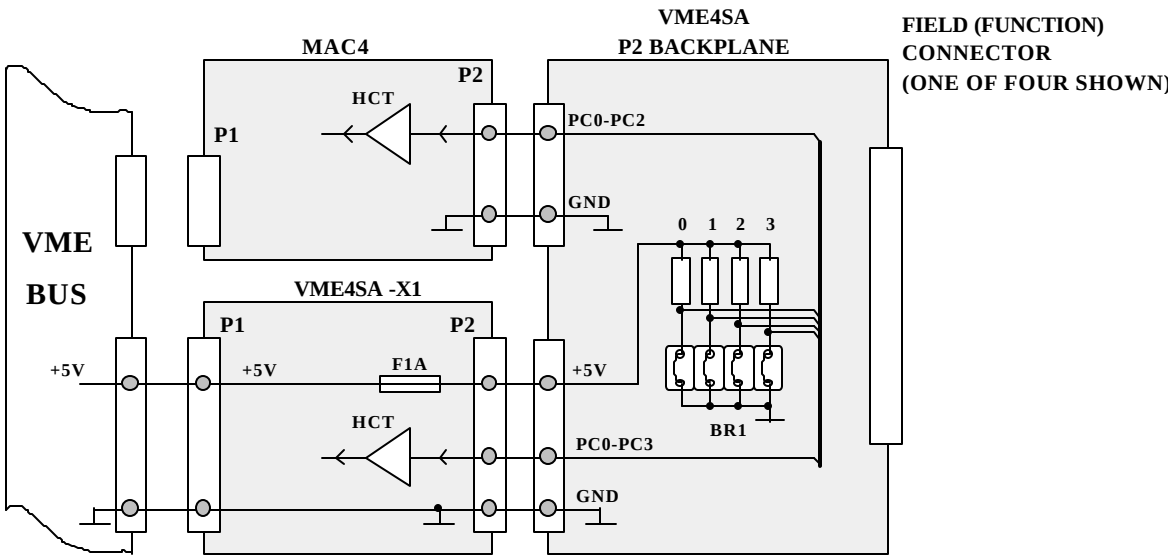


Fig 4.1.5. Position code (PC0-PC3) signal connection (see also sect. 5).

Note 1 : In the MAC4 manual these pins are named "FC0-FC2".
Note 2 : When the VME4SA servo amplifier is not present, the position code inputs PC0-PC3 of the MAC4 unit will all be low (0) because the pull-up resistors are supplied with +5V from the VME4SA board.
Note 3 : Only three bits (PC0-PC2) are connected to the MAC4. The VME4SA servo amplifier is connected to all four bits PC0-PC3.
Note 4 : An inserted jumper corresponds to a logical 0 (zero).

4.1.6 -STOP

This is an emergency stop signal input to the MAC4 board. The signal is available for the user at the SP connector (see sect. 4.4) where it can be connected to external circuitry (potential free contacts).
Note that the pull-up resistor is connected to +12V supply from the VME4SA servo amplifier, meaning that the MAC4 will always indicate "stop" when the power amplifier is disconnected from the backplane.
If the signal is left unconnected (switch open in fig. 4.1.6.) MAC4 will operate normally. If the -STOP pin is connected to GND (switch closed in fig. 4.1.6.) then MAC4 will immediately stop motion on all four axes.

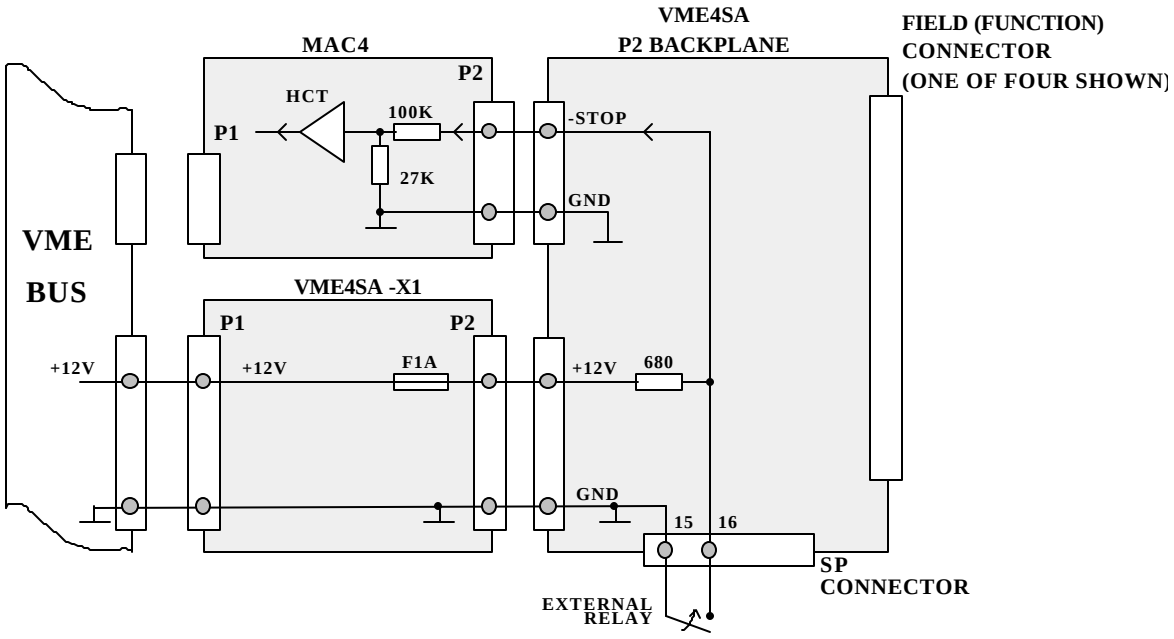


Fig 4.1.6. Emergency stop (-STOP) signal connection.

4.1.7 -RS1 to -RS4

Reference signal I-IV. This signal is used for initialising encoder position in some applications. For detailed description of how to use these signals, see MAC4 manual. Signals are routed from function connectors FI-FIV to MAC4 motion controller. If the -RS pin is left unconnected or connected to GND in the function connector (FI-FIV) the MAC4 reads ON reference position. If a current of 2-30 mA is supplied it will be interpreted as OFF reference position.

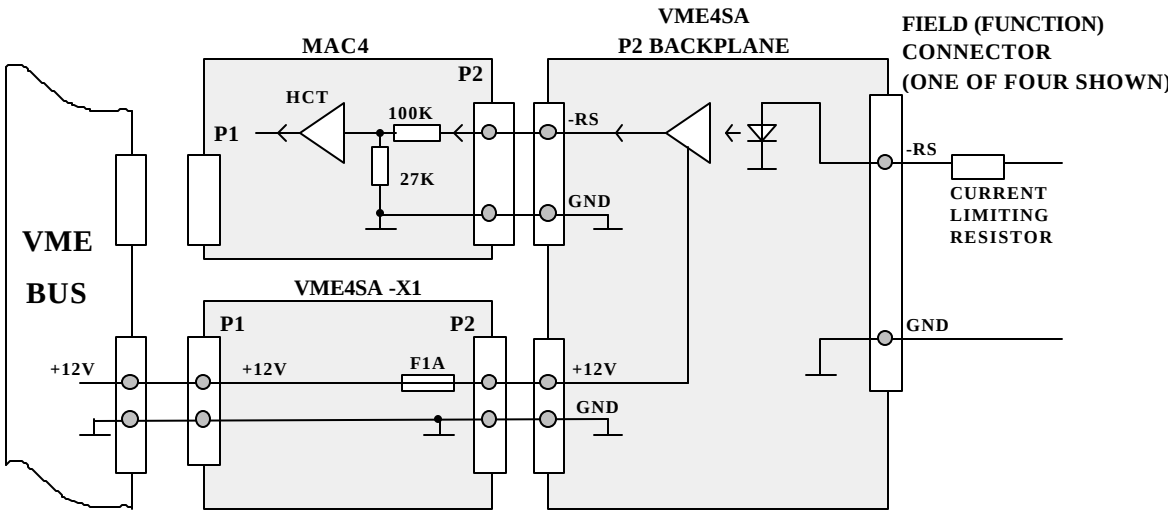


Fig 4.1.7. Reference switch (-RS) signal connection.

Note 1 : The user must connect the external (field) input via a current limiting resistor that limits the optocoupler current to within 2-30 mA.

Note 2 : When the VME4SA servo amplifier is not seated in its slot, the reference position inputs -RS1 to -RS4 of the MAC4 unit will all be low because the optocouplers are supplied from the VME4SA board.

4.1.8 -SP1 to -SP4

Upper (positive) limit switch input to MAC4. Signals are routed from function connectors FI-FIV to MAC4 via optocouplers. No current through the opto-couplers means ON limit, a current of 2-30 mA means OFF limit.

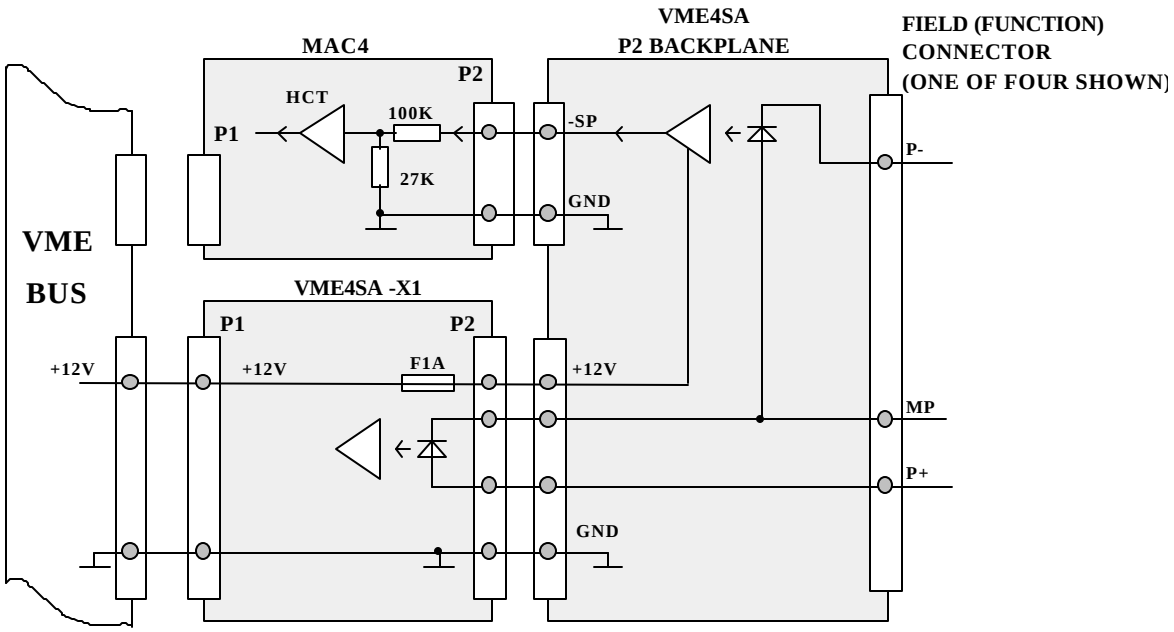


Fig 4.1.8. Upper (positive) limit signal (-SP) signal connection.

For further information about the connection of external devices like limit switches etc., see figure 4.3.2. (sample set-up) and section 4.3.4 (limit switch connection).

Note 1 : The user must connect the external (field) input via a current limiting resistor that limits the current through the optocouplers to within 2-30 mA.

Note 2 : When the VME4SA servo amplifier is not seated in its slot, the limit switch inputs -SP and -SN of the MAC4 unit will all be low (on limit) because the optocouplers are supplied from the VME4SA board.

4.1.9 -SN1 to -SN4

Lower (negative) limit switch input to MAC4. Signals are routed from function connectors FI-FIV to MAC4 via optocouplers. No current through the opto-couplers means ON limit, a current of 2-30 mA means OFF limit.

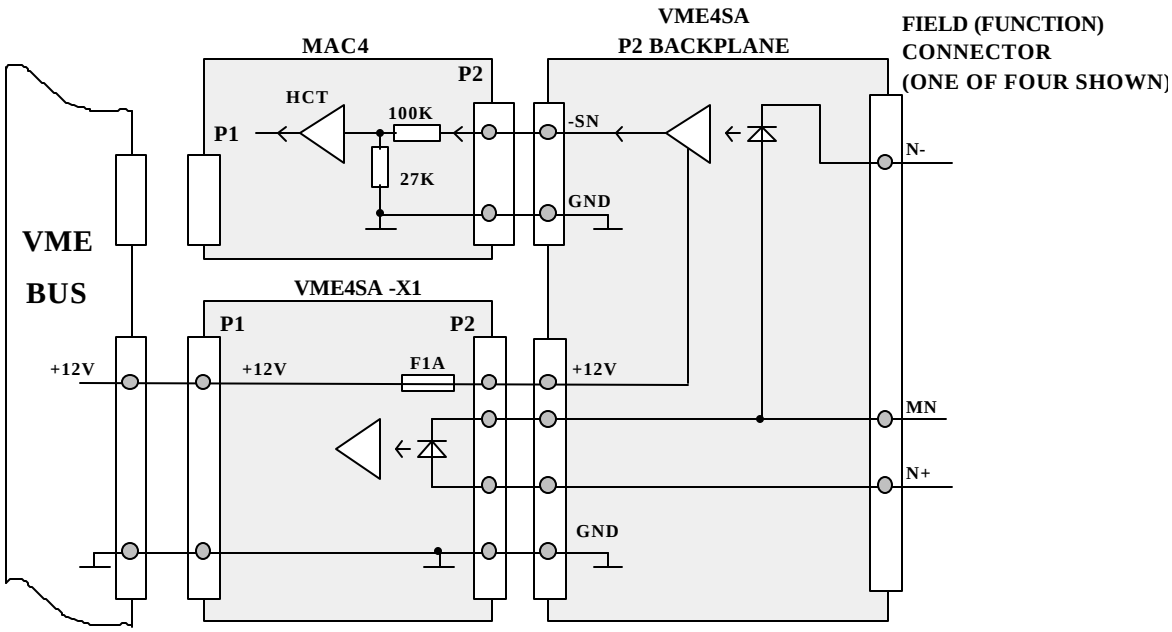


Fig 4.1.9. Lower (negative) limit signal (-SN) signal connection.

For further information about the connection of external devices like limit switches etc., see figure 4.3.2. (sample set-up) and section 4.3.4 (limit switch connection).

Note 1 : The user must connect the external (field) input via a current limiting resistor that limits the optocoupler current to within 2-30 mA.

Note 2 : When the VME4SA servo amplifier is not present, the limit switch inputs -SP and -SN of the MAC4 unit will all be low (on limit) because the optocouplers are supplied from the VME4SA board.

4.2 VME4SA-X1 connector

The VME4SA-X1 DC motor servo amplifier is connected to the backplane from the VME-slot side to a Harting Har-Pak 148-pole male connector. For further information about signals, see also VME4SA-X1 manual.

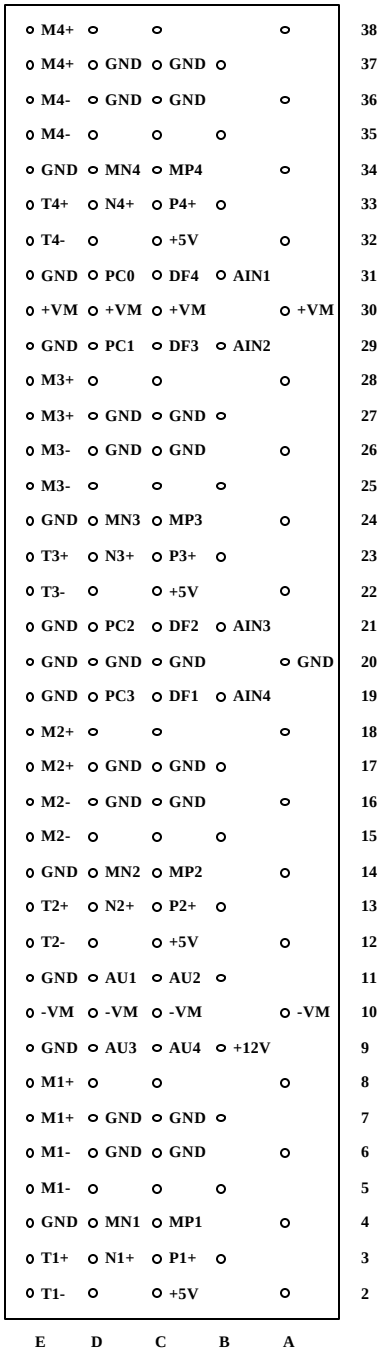


Fig 4.2. Pin allocation of VME4SA-X1 connector (VME chassis rear view).

4.2.1 M1-M4

Motor drive output channel I-IV. See also appendix 1 regarding motor/tacho polarity and rotation direction. The use of a separate shielded twisted pair cable between field connector and motor is strongly recommended.

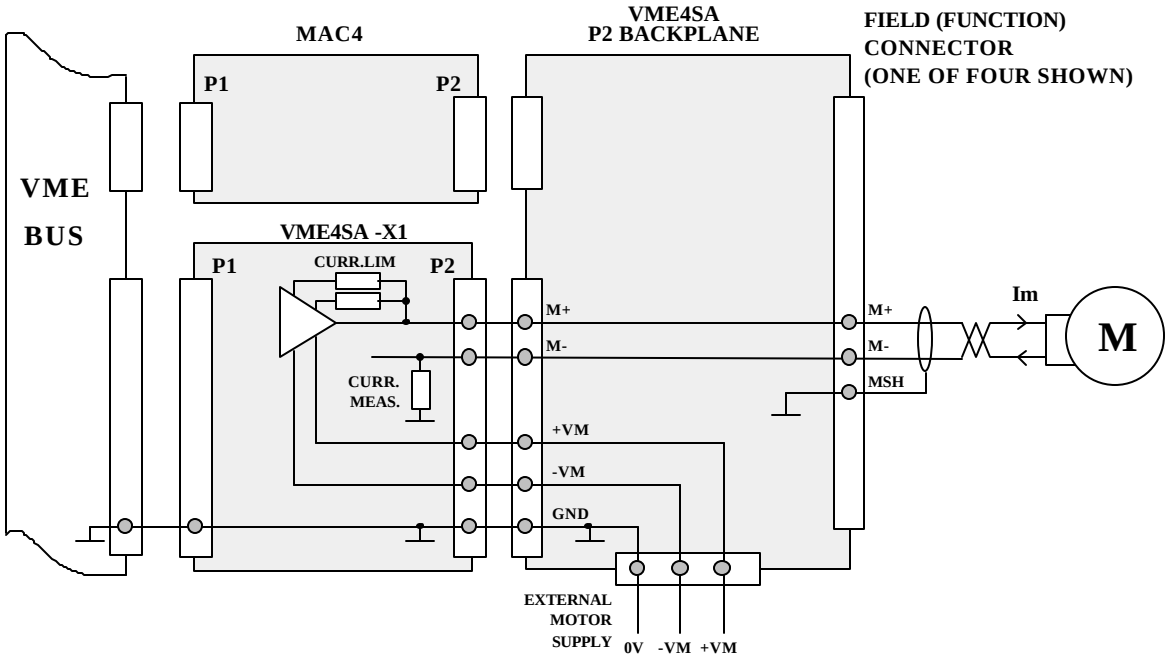


Fig 4.2.1. DC motor output.

4.2.2 T1-T4

Tacho input channel I-IV. See also appendix 1 regarding motor/tacho polarity and rotation direction. The use of a separate shielded twisted pair cable between field connector and tacho is strongly recommended.

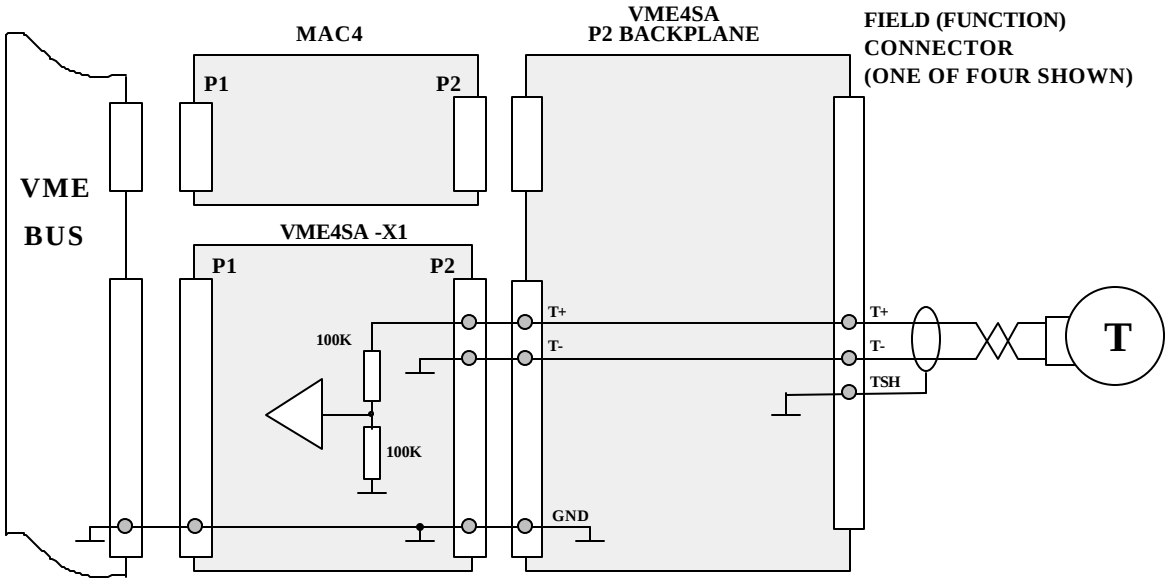


Fig 4.2.2. DC tacho input.

4.2.3 +12V

Voltage supply from VME4SA-X1 amplifier to backplane for backplane internal use (optocoupler supply). Fused 1 amp on VME4SA-X1 amplifier.

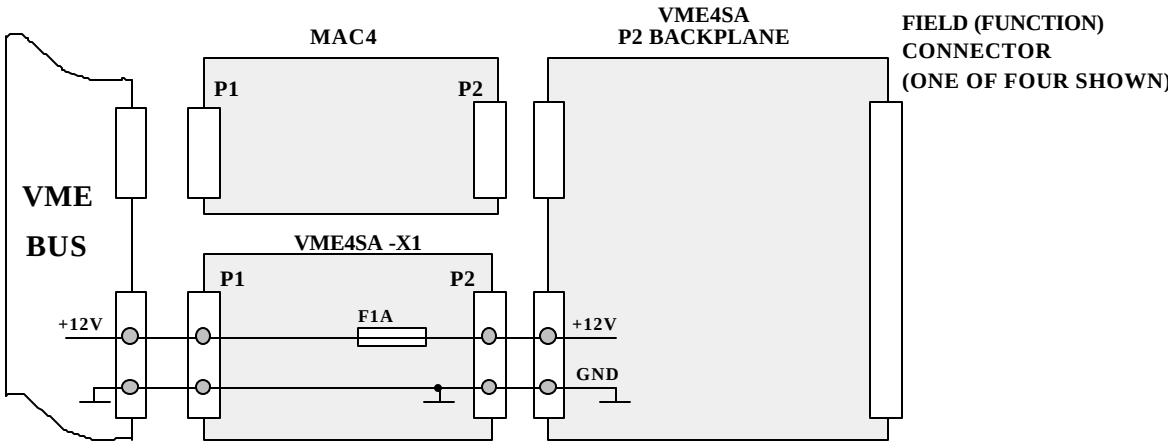


Fig 4.2.3. +12V supply.

4.2.4 +5V

Voltage supply from VME4SA amplifier to function I-IV. Note that the usage of this pin is application dependent. The user can decide whether to use this pin (for example to supply an encoder) or not. If the pin is used, please note the following:

Note 1 : Be sure not to overload the VME power supply.
Note 2 : This is the VME supply, and thus a galvanic connection between the VME-bus power supply and the field wiring will be established.
Note 3 : The supply is fused (1 amp.) on the VME4SA amplifier board. This fuse is common for all four field connectors FI-FIV. If the fuse is blown, (or if the VME4SA amplifier is pulled out from the VME-crate) the supply for all four field connectors will be interrupted. If higher current is required, it must be supplied externally.

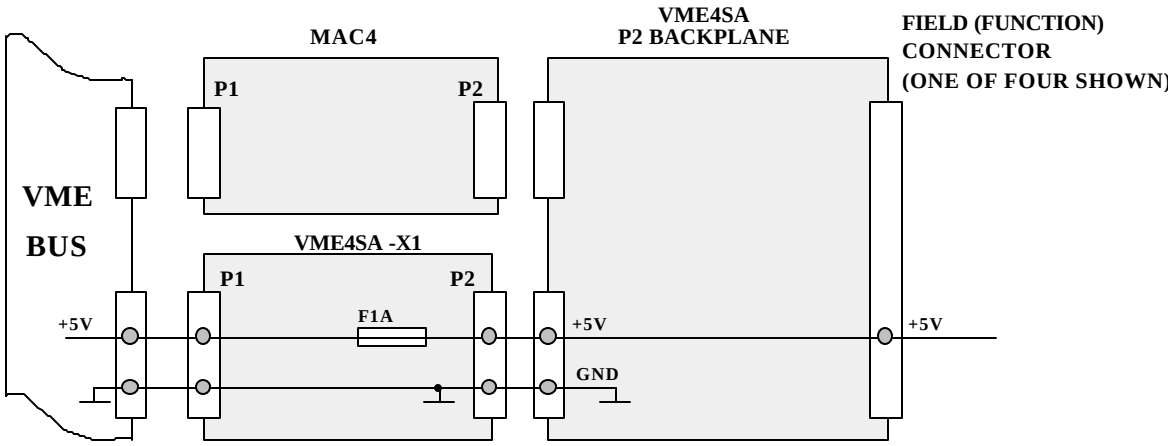


Fig 4.2.4. +5V supply.

4.2.5 ±VM

Motor drive supply voltage. Connects to three terminals (+VM, -VM, GND) on the VME4SA backplane, see fig. 3.1 and fig. 4.2.1.

Note 1 : The motor supply ground is common with VME GND, see sect 4.2.6.

4.2.6 GND

Common reference for supplies and signals. Ground is common for VME and motor power supply. The VME power supply ground shall be connected only to the GND terminals on the VME backplane, and motor power supply ground shall only be connected to the VME4SA GND terminal. The only common ground point will be the VME4SA backplane.
Motor and tacho have dedicated ground connection pins, and shall not be connected to any other point.
The MAC4 has an isolation barrier (opto-coupled) and is connected to VME ground on the logic side and VME4SA backplane ground on the process side.

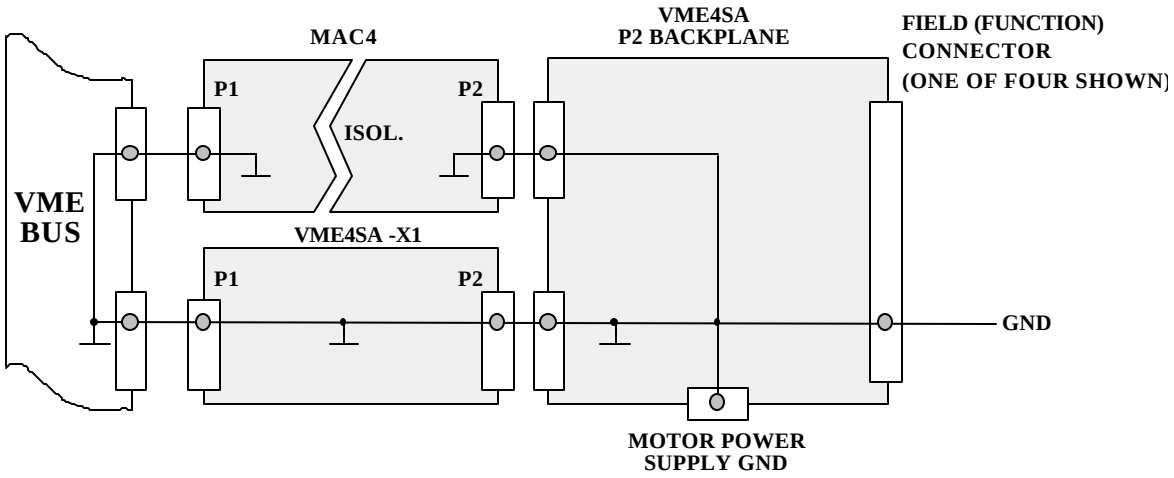


Fig 4.2.6. Grounding.

4.2.7 DF1-DF4

Drive fault channel I to IV. Output from VME4SA amplifier to MAC4. See sect. 4.1.4.

4.2.8 PC0-PC3

Slot position code bit 0-3. Input to VME4SA amplifier and MAC4 from jumper BR1. See sect 4.1.5.

4.2.9 AIN1-AIN4

Speed reference input to VME4SA servo amplifier. See also sect 4.1.1.

4.2.10 AU1-AU4

Auxiliary speed reference input to VME4SA amplifier channel I-IV. See also VME4SA-X1 amplifier technical manual.

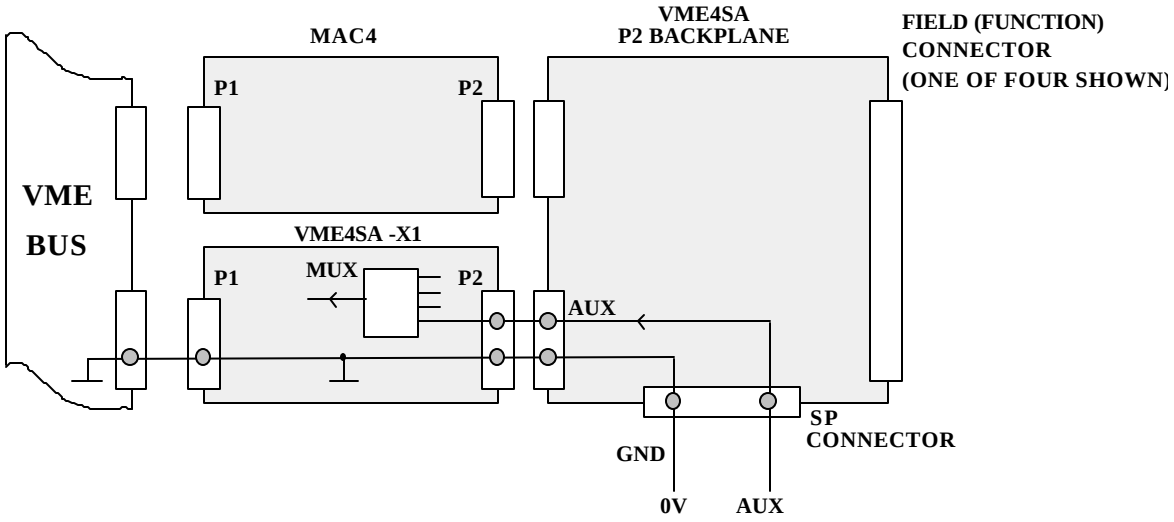


Fig 4.2.10. Amplifier auxiliary input.

4.2.11 MN1 - MN4

Lower limit (LLIM) switch optocoupler LED (cathode) input to VME4SA servo amplifier. See also sect 4.1.9.

4.2.12 N1+ to N4+

Lower limit (LLIM) switch optocoupler LED (anode) input to VME4SA servo amplifier. See also sect 4.1.9.

4.2.13 MP1 - MP4

Upper limit (ULIM) switch optocoupler LED (cathode) input to VME4SA servo amplifier. See also sect 4.1.8.

4.2.14 P1+ to P4+

Upper limit (ULIM) switch optocoupler LED (anode) input to VME4SA servo amplifier. See also sect 4.1.8.

4.3 Function connectors I-IV

The four functions I-IV are directly connected to the backplane with individual 41-pole female connectors of type HARTING "har-pak", order number 07 51 104 0000. The wires are connected with crimp contacts.
The four function (field) connectors FI-FIV have the same electrical pinout and can be interchanged. For security reasons, however, it is possible to use a mechanical coding system (see HARTING "har-pak" technical documentation) to prevent accidental mix-up of connectors.
It is strongly recommended to use separately shielded twisted pair cables for tacho and (if possible) motor signals.

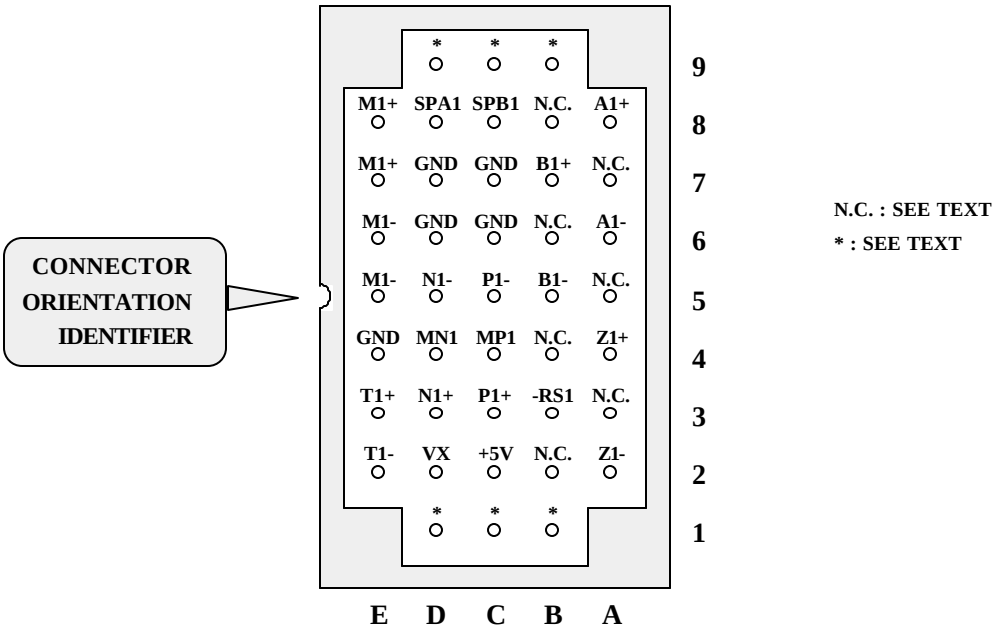


Fig. 4.3.1. Function connector, connection side view.

Note: Pins marked with "*" in fig 4.3.1 are used internally and may NOT be connected. Pins marked with "N.C." are not connected.

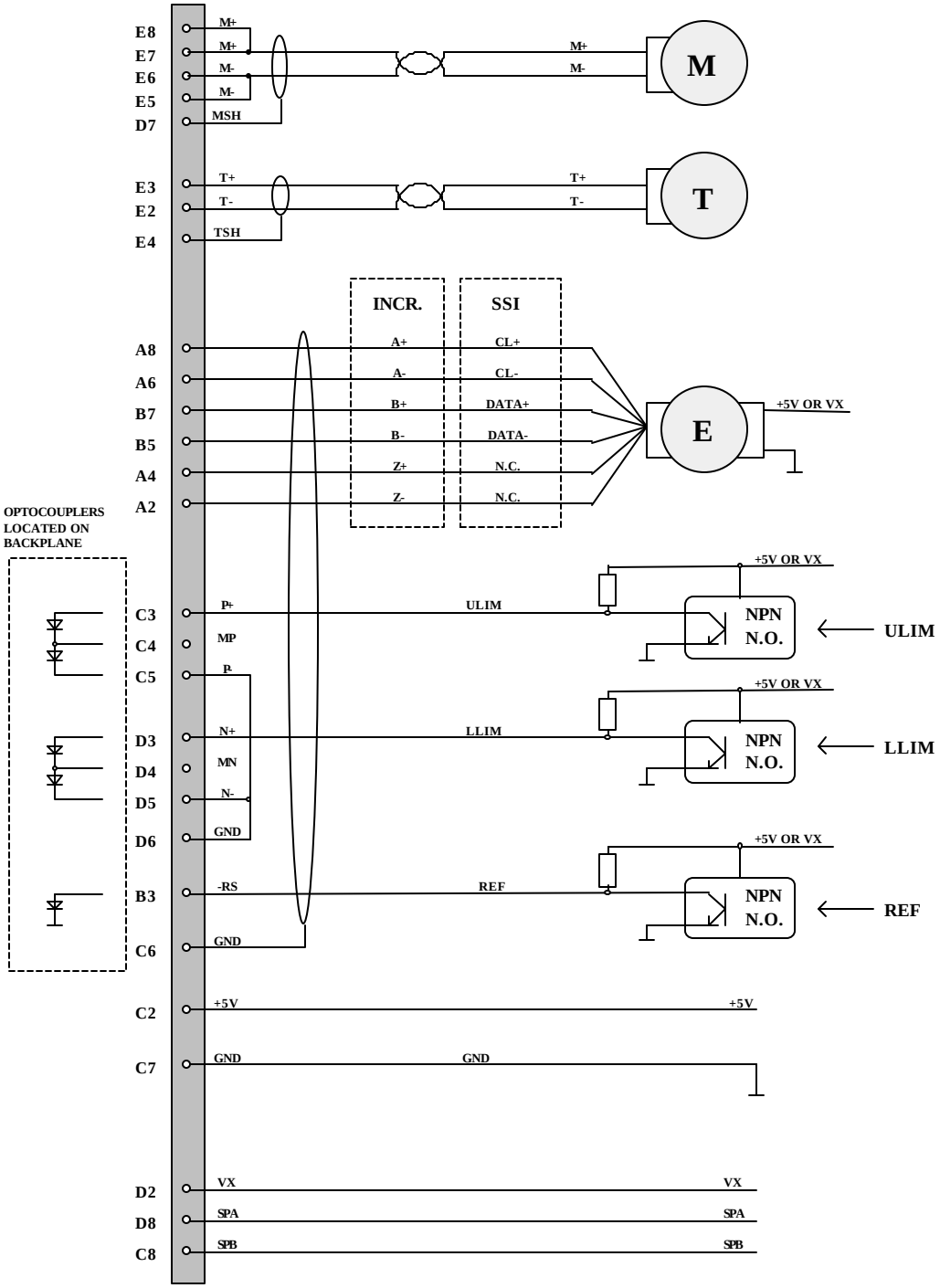


Fig. 4.3.2. Cabling example.

If the backplane is used with incremental encoders together with the MAC4/INC unit, connect the encoder signals as indicated in fig 4.3.2. with signals A,B,Z. If absolute serial (SSI) encoders are used together with the MAC4/SSI unit, connect signals CL (clock) and ENC (encoder data) as shown in the same figure. See also section 4.3.3. Note that A-/CL- and A+/CL+ pins are signal inputs on the MAC4/INC board, and signal sources on the MAC4/SSI board !

4.3.1 Motor.

The DC motor shall be connected to M+ and M- pins as shown in fig 4.3.2. The motor must under no circumstance be connected to ground. If the motor current does not exceed 2 amp. it is allowed to connect only one of the two paralleled M+ and M- pins.
See also sect. 4.2.1.

4.3.2 Tacho.

The DC tacho signal shall be connected to T+ and T- pins as shown in fig 4.3.2. The tacho must under no circumstance be connected to ground. It is very important to use a shielded twisted pair cable for the tacho signal to reduce noise to a minimum.
See also sect. 4.2.2.

4.3.3 Encoder.

The encoder signals are routed from the encoder via function connectors FI-FIV to the MAC4 unit. If incremental encoders are used (MAC4/INC only), connect the six signal lines A+,A-,B+,B- and Z+,Z- as illustrated in fig. 4.3.2. (one axis shown only). If absolute serial encoders are used (MAC4/SSI only), connect the four signal lines CL+,CL- (clock) and ENC+,ENC- (data) as shown in fig 4.3.2, and leave pins "Z+" and "Z-" unconnected. The encoder should operate with differential signals. If not, special measures must be taken to ensure proper operation. See also sect. 4.1.2, 4.1.3, and MAC4 manual.

4.3.4 Limit switches.

The limit switch inputs are opto-isolated with two optocouplers, see fig 4.1.8. and 4.1.9. The first optocoupler controls the limit inputs of the VME4SA-X1 power amplifier, and the second optocoupler controls the limit input of the MAC4 motion controller. The two opto-LED's are connected serially as shown in fig 4.1.8. and 4.1.9.

In the standard configuration (fig 4.3.4.1) only the + and - inputs are used, and the M pin is left unconnected. Therefore the limit inputs for both MAC4 and VME4SA-X1 are activated simultaneously from one single source.
The current through the opto-LED's must be externally limited to 2-30 mA with resistor R in fig. 4.3.4.1. This resistor must be mounted physically close to the limit switch thus ensuring that "on limit" condition will be indicated in case of cable failure or unplugged field (function) connector. The voltage drop for one opto-LED is approximately 1.1 V.
If inductive proximity (or similar) switches are used, these must be of NPN, N.O. (normally open) type. It is also possible to use electro-mechanical switches such as micro-switches or relay contacts.

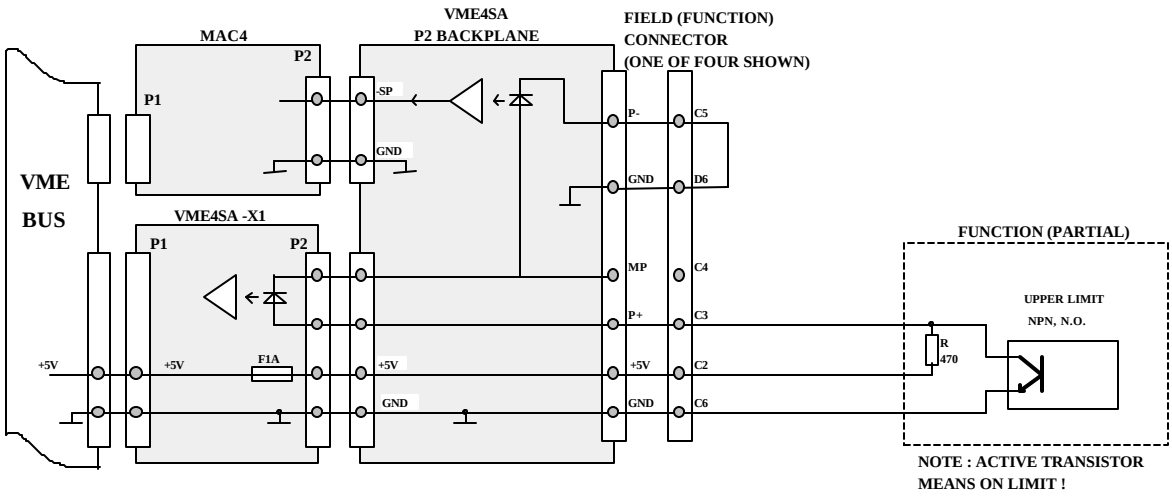


Fig 4.3.4.1. Limit switch input, normal operation.

When a current of 2-30 mA is flowing through the opto-LED's, this indicates an OFF limit (normal) condition. Consequentially, if no current is flowing through the opto-LED's it means ON limit.
In special applications, the limit signals to the MAC4 motion controller and the VME4SA amplifier can be operated independently by using the M pin. This is illustrated in fig 4.3.4.2. In the case where the MAC4 limit input (early limit) shall be activated before the VME4SA limit input (late limit), the connection shall be made as shown in fig 4.3.4.2.

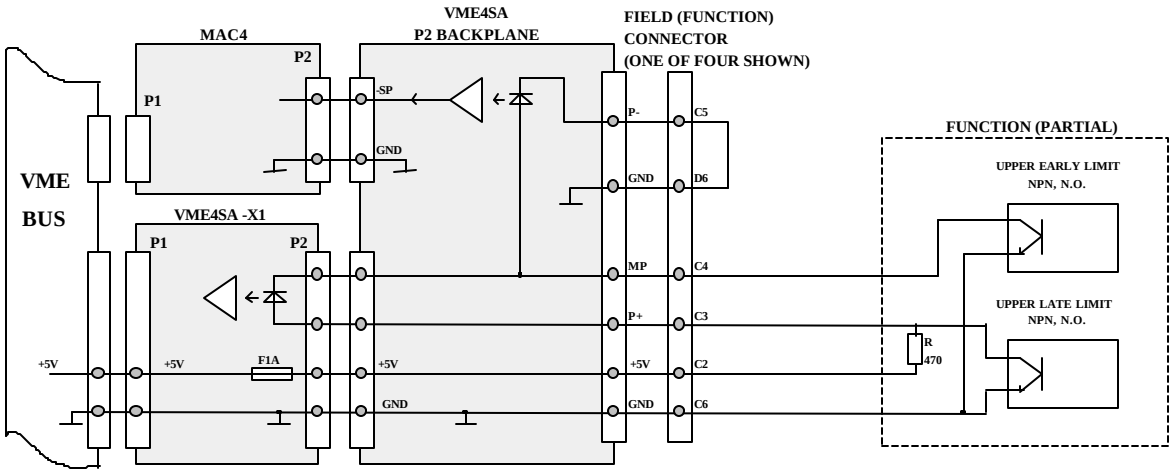


Fig 4.3.4.2. Limit switch input, special operation (early and late limit).

Note 1: This special configuration requires two NO (normally open) NPN-type switches.

Note 2: When using this special configuration, always mount resistor R in fig 4.3.4.2 at the physical function. This ensures that whenever the cable between VME-crate and function is disconnected, limit condition is true (for safety reasons).

4.3.5 Reference position switch

This signal is routed to the corresponding pin on the MAC4 motion controller. See sect 4.1.7 and MAC4 manual for further details.
If inductive proximity switches are used, these must be of NPN, N.O. (normally open) type. It is also possible to use electro-mechanical switches such as micro-switches or relay contacts.

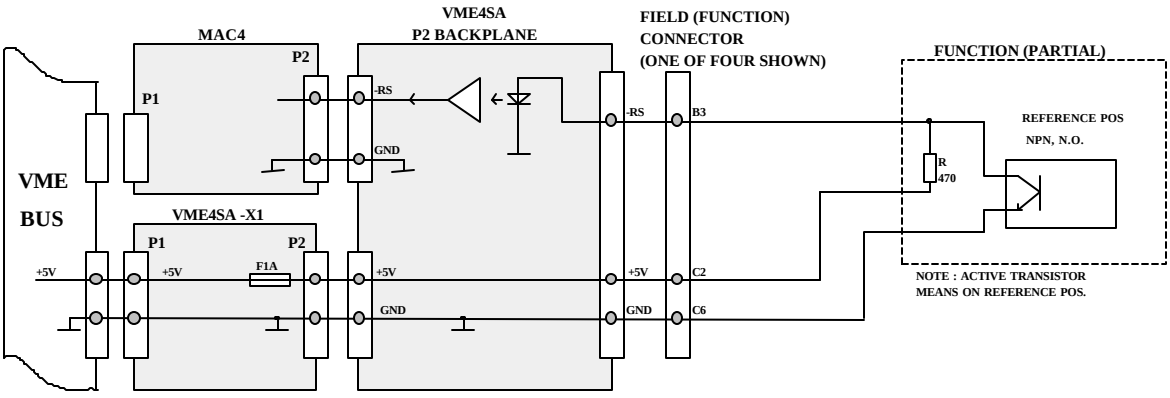


Fig 4.3.5. Reference switch input.

4.3.6 VX

Voltage supply from VX terminal (see fig 3.1) to function connectors I-IV. User defined auxiliary power supply. Routed from VX terminal to all four field connectors FI-FIV. See also sect 4.4.

Rule : To avoid damage to externally connected devices (encoders, limit switches etc.) supplied from VX, the VX voltage shall be within the range +12 - +24 VDC.

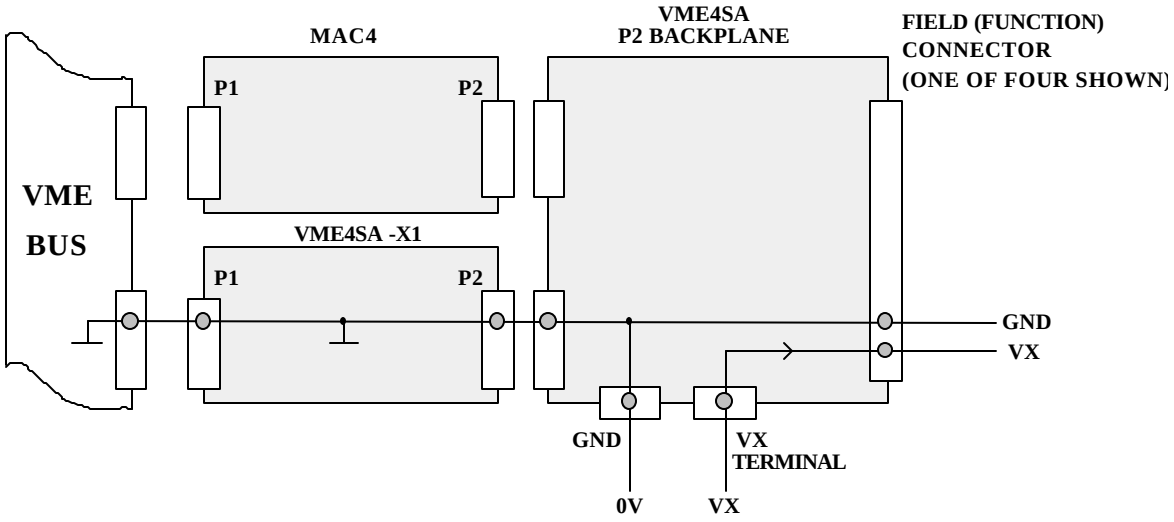


Fig 4.3.6. VX supply.

4.3.7 +5V

All functions FI-FIV have access to +5V supply. The supply comes from the VME-bus supply via the VME4SA-X1 power amplifier. See also sect. 4.2.4.

Note 1 : The supply is fused F1A on the VME4SA-X1 board.

Note 2 : Be sure not to overload the VME-bus supply.

Note 3 : The supply is only available when the VME4SA-X1 is plugged in.

4.3.8 SPA-SPB

Spare (disposable) signals.

User defined signals for auxiliary status signals etc. See also sect. 4.4. for more details on the SP connector.

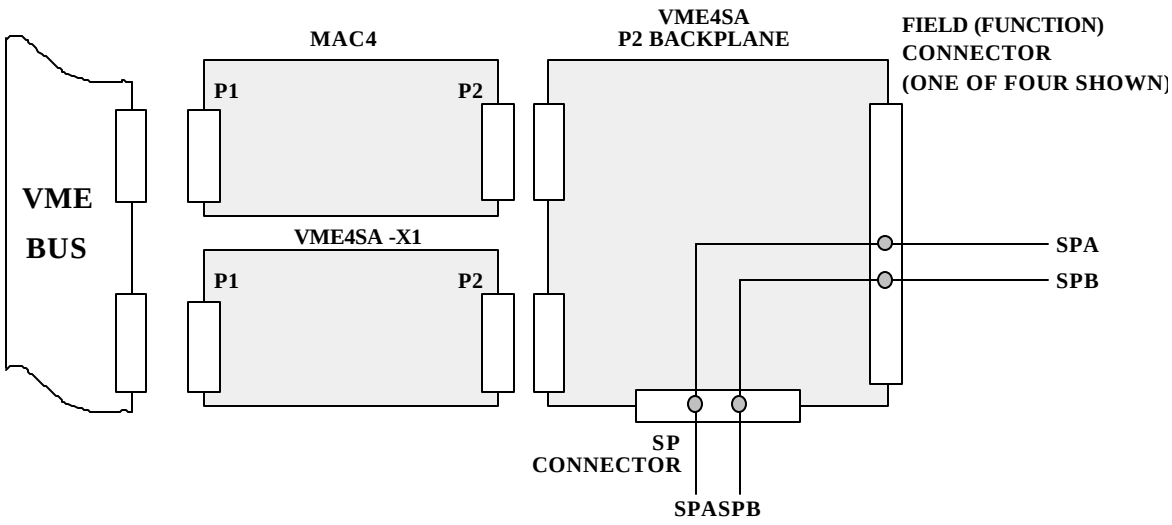


Fig 4.3.8. Spare (SPA and SPB) signals connection.

4.4 SP connector

Each function FI to FIV has two unassigned pins SPA and SPB (see fig 4.3.1. and 4.3.2.) that can be used freely. The SPA-SPB signals (two for each function) are routed to a 16-pin connector at the lower end of the connector side (see fig 3.1) of the backplane. Two ground pins are also available in this connector. For pin assignment, see fig 4.4. This connector also provides access to the auxiliary speed reference input AU1-AU4, see sect. 4.2.10. These inputs, one for each channel I-IV, are the speed reference inputs when the corresponding channel on the VME4SA amplifier is in the auxiliary mode. Further, the emergency stop input (-STOP) is accessible on the SP connector, see also sect. 4.1.6.

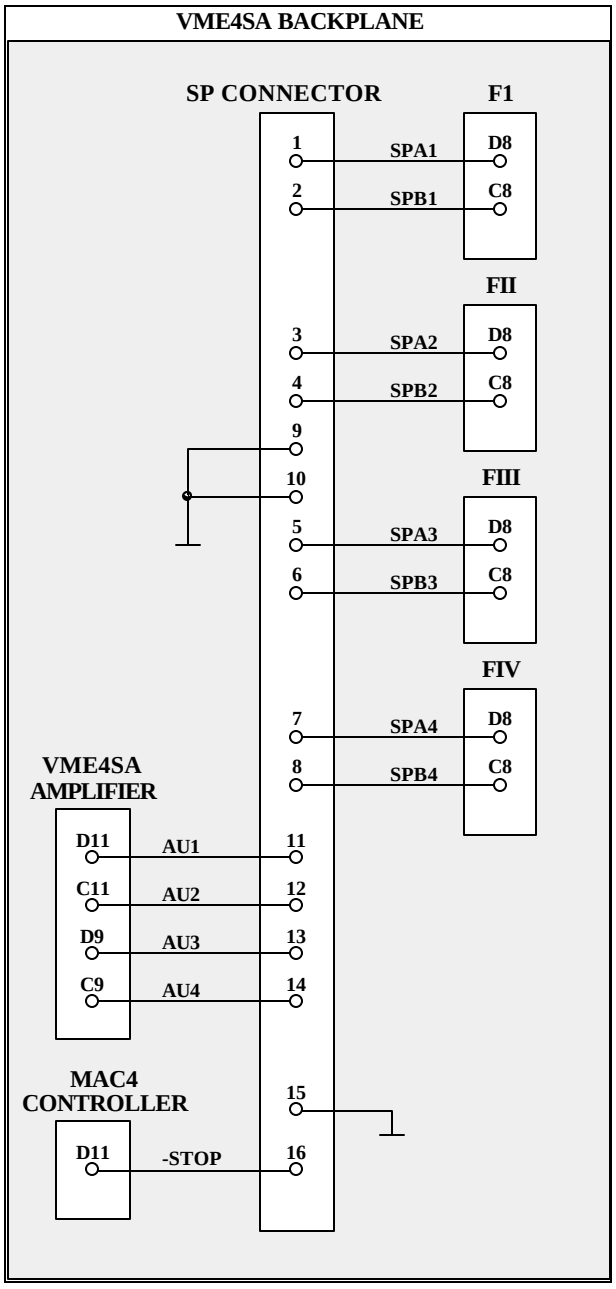


Fig 4.4. SP connector.

4.5 Power supply connection

The motor power supply ±VM shall be connected to the three terminals +VM, GND and -VM (see fig 3.1. and fig 4.2.1.). The connectors are of 6.3 mm flat shoe type.
The VX supply is distributed to all four functions FI-FIV (see also sect 4.3.6.). This supply is user disposable for power supply of encoders, limit switches etc.

Note 1 : See sect. 4.3.6. for limitations on VX supply !

Note 2 : The supply voltage inputs are NOT polarity protected. Be careful when applying voltage to the terminals VM+ and VM-.

5. BACKPLANE ADDRESS CODING

On the function connector (VME-chassis rear) side of the backplane (see fig. 3.1.) there are four jumpers BR1. These jumpers can be set to a four-bit code, that can be read back from the VME-bus over both VME4SA power amplifier and MAC4 motion controller. When this address is correctly set, it gives the software the possibility to check whether the correct boards are inserted into the right slot.
This coding is also essential to identify (from software) individual boards when in a VME-system multiple sets of VME4SA-X1 and MAC4/SSI co-exist.
An inserted jumper will be read back as a zero, and a missing jumper will be read back as a logical one.
See also fig 4.1.5.

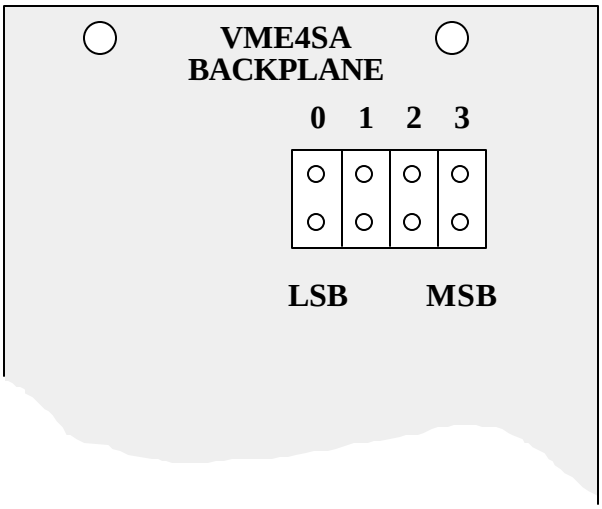


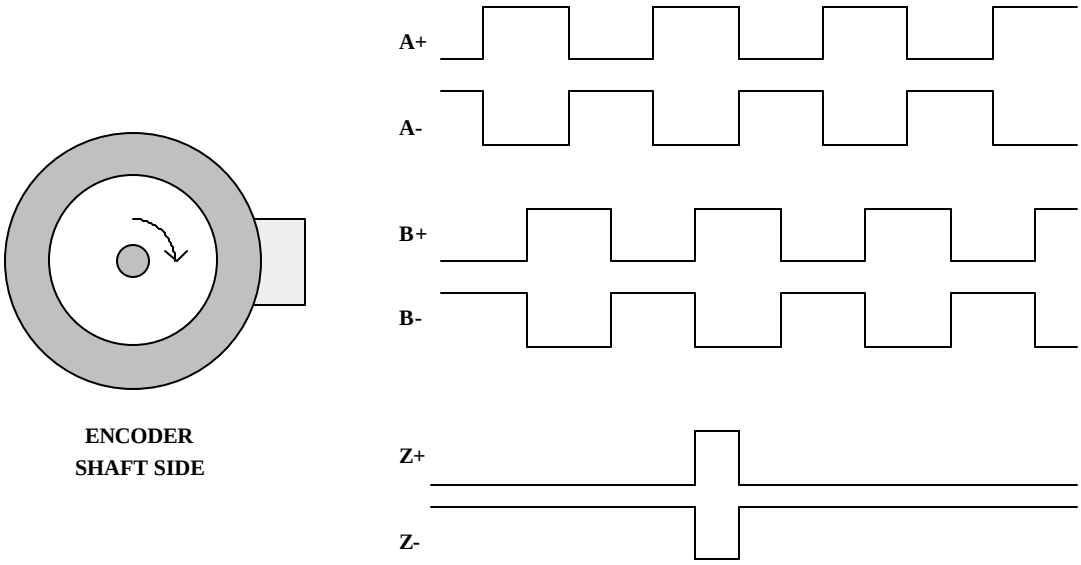
Fig 5. Backplane address coding jumpers.

Note : The MAC4 can only read back the three least significant bits, while the VME4SA reads back all four bits.

6. MECHANICAL INSTALLATION

When installing the backplane it is very important to align the horizontal position of the backplane to the VME slots to allow the VME4SA amplifier connector to mate with the VME4SA power amplifier board. Due to the high pincount, it will be very difficult to insert or extract the power amplifier board unless the alignment is carefully made.
It is recommended to use a plastic insulating strip between the backplane board and the VME-chassis profile.

Appendix 1 : Incremental encoder signals



Definitions :

A move in *positive direction* (ex. from position 10 to 20) means :

1. Encoder shaft shall rotate *clockwise* (CW).
2. *Output pulse* train from encoder shall be as defined in figure above.
3. Position counter in hardware (e.g. MAC4) shall count *upwards*.

Motor drive voltage shall be applied in such a way that when the MAC4/INC unit is performing a move in positive direction, the encoder shaft rotates clockwise (seen from shaft side) as indicated in figure above.

Set-up procedure :

1. Verify that the encoder signals are correct (as above) by rotating the encoder shaft clockwise (CW).

2. Try to move the function forward (encoder shaft rotates CW) with the handset (right arrow on handset) or MAC4 move command. Notice motor behaviour (motor speed and encoder direction of rotation).

Result :	Motor speed uncontrolled, encoder shaft rotates CCW	Motor speed controlled, encoder shaft rotates CCW	Motor speed uncontrolled, encoder shaft rotates CW	Motor speed controlled, encoder shaft rotates CW

Action	Reverse motor polarity	Reverse motor and tacho polarity	Reverse tacho polarity	Correct connection