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RECOMMENDED GUIDELINE FOR ROBOT INJECTION MOLDING MACHINE ELECTRICAL INTERFACE • PHASE II

SPI PUBLICATION NO. AN146 • MARCH 2006

RECOMMENDED GUIDELINE FOR ROBOT/HANDLING DEVICE
INJECTION MOLDING MACHINE
ELECTRICAL INTERFACE

1. Purpose

The purpose of this work is to provide electrical interface guidelines for the installation of robots/handling devices with horizontal injection molding machines.

2. Objective

The objective of the committee is to standardize the electrical interface between the horizontal injection molding machine and the robot/handling device as well as to specify the electrical connection for this standard interface.

3. Scope

The guideline applies to the electrical interface between robots/handling devices and horizontal injection molding machines. It does not include any interface for the transfer of data since solutions to this problem are covered by the SPI communications protocol.

The risk assessment for the movements of the robot/handling device require redundancy which is achieved by the two channels of emergency stop for both the injection molding machine and the robot/handling device and two channels for the injection molding machine mold areas guards.

SPI AN-116 shall only be used for replacement purposes on existing equipment. See Annex A for adapters from AN-146 to AN-116 for both the HIMM and Robot/Handling device.

4. Definitions

- 4.1. Robot/Handling Device** - A multi-functional manipulator designed to move material, parts, tools or specialized devices through variable programmed motions for the performance of a variety of tasks. The term "Robot/Handling Device" is meant to include programmable manipulators and non-programmable manipulators such as "pickers". This term does not include automatic mold changers or conveyors.
- 4.2. Injection Molding Machines (I.M.M.)** - For purposes of this guideline, injection molding machine shall mean all horizontal or vertical injection molding machines that melt plastic materials, either thermoplastic or thermoset, and rubber, and inject said material into a mold held closed by a clamp.
- 4.3. Optional Multi Stations Signals (MSS)**
These signals are used for I.M.M. with shuttle table (figure 3) or rotary table (figure 4) or Indexing unit (figure 5) as needed.

5. Electrical Interface

5.1. Descriptions

A 50 pin interface connection (DIN #43652) 10A 250VAC double lever base (figure 2) and hood plug (figure 1) connection acts as the physical link between

the robot/handling device and the horizontal injection molding machine. Two sets of inserts are required for each plug of the interface. There are 25 contact pins (male) and 25 contact socket (female) in each connector insert.

The signals in both the I.M.M. and robot/handling device are given by contacts, e.g. contacts of relays or switches, semiconductors, etc. The contact making is either potential-free or related to reference potential supplied to a contact of the plug mounted on the I.M.M. or the robot/handling device. Table 1 and 2 shows contact assignments and functions. There are unassigned contacts to meet special requirements or to accommodate further developments. All contact assignments are required unless otherwise noted as “optional”.

5.2. Contact Specification

5.2.1. Emergency stop, Movable Gates & Guards Closed Signals & Mold Area Free

The signals must be within the following requirements:

- The Voltage must not exceed 50 VDC or 250 VAC.
- A current of at least 6mA must be maintained during signaling.
- The maximum current is 6 A.

5.2.2. Logical Signals

The logical signal current shall not exceed 100 mA.

5.2.3. Reference Potential (Table 1 ZA9, ZC9 and Table 2 A9, C9)

- Voltage: 18- 36 VDC
- Overlay ripple: 2.5 Vpp
- Overvoltage withstanding 60 V minimum for 10 ms
- Current 2 A maximum

5.3. Plug Contact Assignment

- Unless otherwise noted, the switch contacts are switching the reference potential (table 1 ZA9 for the I.M.M. signal and table 2 A9 for the robot/handling device signal).
- All signals are continuous signals unless otherwise noted.
- The signals are conducted from the signal source to the respective pin.
- When the robot/handling device is switched off (signal table 2-B2 is high), signals from the robot/handling device can assume any status except “Emergency Stop-Channel 1” (table 2-A1/C1), “Emergency Stop-Channel 2” (table 2-A2/C2), “Enable Clamp Motion” (table 2-A3/C3), “Permit Clamp Close” (table 2-A6/A9).
- When the robot is switched off (signal table 2-B2 is high), signals from the I.M.M. can assume any status except “Emergency Stop-Channel 1” (table 1-ZA1/ZC1), “Emergency Stop-Channel 2” (table 1-ZA2/ZC2), “Movable Gates & Guards Closed-Channel 1” (table 1-ZA3/ZC3), “Movable Gates & Guards Closed-Channel 2” (ZA4/ZC4).
- Core pull 1 or pull 2 may be used for single core pull or group of core pulls.
- Safety signals transmitted via two channels shall have a maximum delay <0.5 second between channel 1 signal and channel 2 signal. This is to be applied to “Emergency stop of machine”, “Movable gates & guards closed of the machine” and “Emergency stop of the robot/handling device”.

5.3.1. Plug on the I.M.M. – Figure 2 (male)

Table 1-Signals from Injection Molding Machine to Robot/Handling Device

Contact Number Pin-Fig. 2	Function
ZA1/ZC1	EMERGENCY STOP (I.M.M.) – Channel 1 The switch contact must be open when the injection moulding machine emergency stop device is being actuated. Opening the switch contact causes emergency stop of the robot/handling device.
ZA2/ZC2	EMERGENCY STOP (I.M.M.) – Channel 2 The switch contact must be open when the injection moulding machine emergency stop device is being actuated. Opening the switch contact causes emergency stop of the robot/handling device.
ZA3/ZC3	MOVABLE GATES & GUARDS CLOSED (I.M.M.) –Channel 1 The switch contact is closed when safety devices (e.g. movable gates and guards etc.) on the I.M.M. are operative to prevent access to dangerous movements of the robot/handling device. The signal is active in any mode of operation of the I.M.M. The signal must be the result of the mold area safety devices' limit switch contacts in series according to ANSI B151.1.
ZA4/ZC4	MOVABLE GATES & GUARDS CLOSED (I.M.M.) –Channel 2 The switch contact is closed when safety devices (e.g. movable gates and guards etc.) on the I.M.M. are operative to prevent access to dangerous movements of the robot/handling device. The signal is active in any mode of operation of the I.M.M. The signal must be the result of the mold area safety devices' limit switch contacts in series according to ANSI B151.1.
ZA5/ZA9	(OPTIONAL) REJECT PART (I.M.M.) This signal is high when the molded part is not acceptable. This signal must be given on/or before the mold fully open signal and remain high at least until “Permit clamp close” and removed with the start of mold closing. It is recommended to have the signal high prior to the start of mold opening.
ZA6/ZA9	MOLD FULLY CLOSED (I.M.M.) HIGH signal when the mould closing is completed. Note: The signal "Enable mould closure" is then no longer required (see table 2: handling device / robot signals contact No A6)
	(OPTIONAL MSS) START HANDLING DEVICE/ROBOT AT POSITION 2 (E) HIGH signal when a mould half is positioned at station 2 (E) (reference figure 4)
ZA7/ZA9	MOLD FULLY OPEN (I.M.M.) HIGH signal when mould opening position is equal to or more than required position. Inadvertent alteration to mould opening stroke smaller than that required for the handling device / robot to approach must be impossible. The signal must remain HIGH as long as the mould is open and must not be interrupted by a change of operation mode or safety guard opening.
	(OPTIONAL MSS) TABLE IN POSITION GENERAL Enable start handling device/robot. HIGH signal when the rotary or shuttle table is in one of the positions for loading or unloading. This signal is maintained whenever the rotary or shuttle table is in these positions.
ZA8/ZA9	(OPTIONAL) INTERMEDIATE MOLD OPEN POSITION (I.M.M.) HIGH signal when mould opening reaches a set position smaller than mould opening position (see table 1: injection moulding machine signals contact No ZA7). The signal remains HIGH to the end of mould opening position. Two sequences are possible with this signal: Mould opening stops on intermediate position and gives start signal to handling device / robot. Mould opening restarts with the signal "Enable full mould opening" (see table 2: handling device / robot signals contact No A7). Mould opening does not stop on intermediate position, however gives the signal to handling device / robot. At this sequence the signals “ Enable full mould opening” (see table 2: A7) and “Mould area free” (table2: A3/C3) are not in use. LOW signal when intermediate mould opening position is not in use.
	(OPTIONAL MSS) START HANDLING DEVICE/ROBOT AT POSITION 3 (F) HIGH signal when a mould half is positioned at station 3 (F) (reference figure 4)

Contact Number Pin-Fig. 2	Function
ZA9	HANDLING DEVICE/ROBOT REFERENCE POTENTIAL 24 VDC (Reference potential)
ZB2/ZA9	ENABLE OPERATION WITH HANDLING DEVICE/ROBOT (I.M.M.) HIGH signal when the injection moulding machine is able to be operated with handling device / robot. This signal shall not be used to start the handling device / robot. If the signal turns LOW during the operation mode of the handling device / robot "operation with injection moulding machine", it is recommended that the handling device / robot continues its automatic cycle until the end position.
ZB3/ZA9	EJECTOR FULLY RETRACTED (I.M.M.) HIGH signal when the ejector has been finally (e.g. after the number of its set cycles) retracted regardless of the moving platen position. The signal is the acknowledgement for the "Enable ejector retraction" signal (see table 2: handling device / robot signals contact No B3), when the ejector sequence is selected. It is recommended to have HIGH signal when the ejector sequence is not in use.
ZB4/ZA9	EJECTOR FULLY FORWARD (I.M.M.) HIGH signal when the ejector has been advanced. The signal is the acknowledgement signal for the "Enable ejector advance,,(see table 2: handling device / robot signals contact No B4). It is recommended to have HIGH signal when the ejector sequence is not in use.
ZB5/ZA9	(OPTIONAL) CORE #1 FULLY SET (IN POSITION 1) CORE #1 FREE FOR HANDLING DEVICE/ROBOT TO APPROACH (I.M.M.) HIGH signal when the core pull 1 is in position 1 (see table 2: handling device / robot signals contact No B5). It is recommended to have LOW signal when the core pull sequence is not in use.
ZB6/ZA9	(OPTIONAL) CORE #1 FULLY PULLED (IN POSITION 2) CORE #1 IN POSITION TO REMOVE PART (I.M.M.) HIGH signal when the core pull 1 is in position 2 (see table 2: handling device / robot signals contact No B6). It is recommended to have LOW signal when the core pull sequence is not in use.
ZB7/ZA9	(OPTIONAL) CORE #2 FULLY SET (IN POSITION 1) CORE #2 FREE FOR HANDLING DEVICE/ROBOT TO APPROACH (I.M.M.) HIGH signal when the core pull 2 is in position 1 (see table 2: handling device / robot signals contact No B7). It is recommended to have LOW signal when the core pull sequence is not in use.
ZB8/ZA9	(OPTIONAL) CORE #2 FULLY PULLED (IN POSITION 2) CORE #2 IN POSITION TO REMOVE PART (I.M.M.) HIGH signal when the core pull 2 is in position 2 (see table 2: handling device / robot signals contact No B8). It is recommended to have LOW signal when the core pull sequence is not in use.
ZC5/ZA9	RESERVED FOR FUTURE USE BY SPI (I.M.M.) (REQUIRED MSS) END OF ORDER HIGH signal when the quantity is complete. <i>Example: the robot must remove the finished part but not pick a new insert.</i>
ZC6/ZA9	RESERVED FOR FUTURE USE BY SPI (I.M.M.) (REQUIRED MSS) INSERT PART(S) IN MOLD HIGH signal when insert part(s) have been positioned in mould half.
ZC7	RESERVED FOR FUTURE USE BY SPI (I.M.M.) (REQUIRED MSS) PART AVAILABLE HIGH signal if moulded part is available. The signal shall be set with " Table in position, general " (ZA7); it shall change to LOW when C7 changes to HIGH (see Explanation).
ZC8	NOT ASSIGNED BY SPI. MANUFACTURER DEPENDENT
ZC9	HANDLING DEVICE/ROBOT REFERENCE POTENTIAL 0 V (Reference potential)

5.3.2. Plug on the I.M.M. – Figure 2 (female)

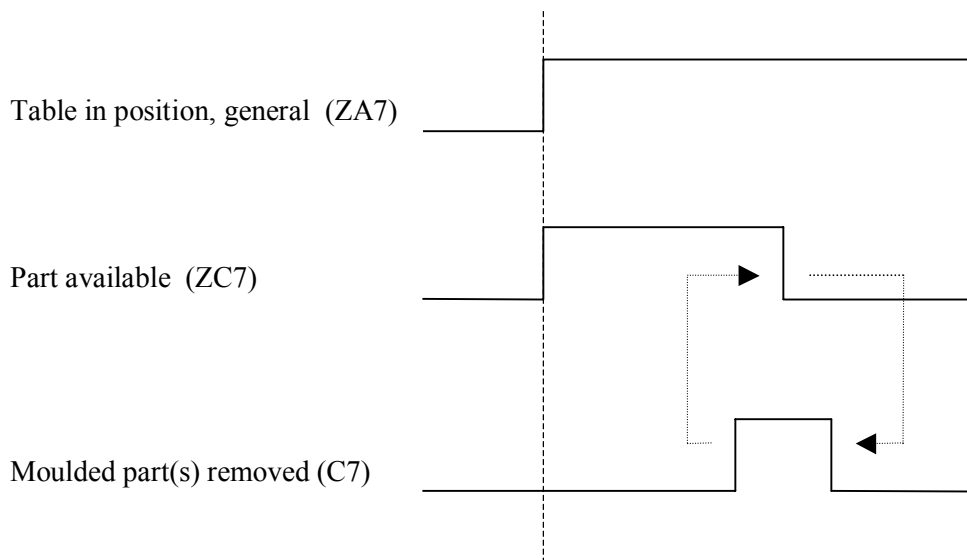
Table2-Signals from Robot/Handling Device to Injection Molding Machine

Contact Number Socket- Fig. 2	Function
A1/C1	<p>EMERGENCY STOP (ROBOT/HANDLING DEVICE) – CHANNEL 1 The switch contact must be open when the handling device / robot emergency stop is being actuated. The switch contact opening causes emergency stop of the injection moulding machine. The switch contact must be operative if the handling device / robot is switched off. It is recommended that the switch contact is operative when the handling device / robot is unselected.</p>
A2/C2	<p>EMERGENCY STOP (ROBOT/HANDLING DEVICE) – CHANNEL 2 The switch contact must be open when the handling device / robot emergency stop is being actuated. The switch contact opening causes emergency stop of the injection moulding machine. The switch contact must be operative if the handling device / robot is switched off. It is recommended that the switch contact is operative when the handling device / robot is unselected.</p>
A3/C3	<p>MOULD AREA FREE The switch contact is closed when the handling device / robot is outside the mould area and does not interfere with mould opening and closing movements. The switch contact must be opened when the handling device / robot leaves its start position. If the switch contact is open neither opening nor closing of the mould may occur. However the injection moulding machine may ignore this signal when mould opening is carried out after e.g. an intermediate stop (see table 1: injection moulding machine signals contact No ZA8), if the optional sequence is selected on the injection moulding machine. The signal must have the described effect even when the handling device / robot is switched off. It is recommended to close the switch contact when the handling device / robot is unselected.</p>
	<p>(REQUIRED MSS) TABLE AREA FREE The switch contact is closed when the handling device / robot is outside the table area or outside the area of the moving mould halves. Table motion must be interrupted whenever this signal is not present.</p>
A4/C4	<p>RESERVED FOR FUTURE USE BY SPI (I.M.M.)</p>
A5	<p>NOT ASSIGNED BY SPI. MANUFACTURER DEPENDENT</p>
A6/A9	<p>ENABLE MOLD CLOSE HIGH signal when the handling device/robot is retracted enough for start of mould closure. The signal must remain HIGH at least until "Mould closed" (see table 1: injection moulding machine signals contact No ZA6) is available. If the signal is LOW as a result of a fault, mould closing must be interrupted. The signal "Enable mould closure" must not be a logical "or" with other signals, e.g. "Close safety guard" or a push button in any operation mode. The signal must be HIGH if the handling device/robot is switched off. It is recommended to have HIGH signal when the handling device/robot is unselected.</p>
	<p>(REQUIRED MSS) ENABLE TABLE MOTION HIGH signal to indicate that the robot is in a predetermined safe position and enables the rotary or shuttle table to move. Table motion must be interrupted whenever this signal is not present. This signal is no longer required once the table is in position (see ZA7).</p>
A7/A9	<p>(OPTIONAL) ENABLE MOLD FULL OPEN HIGH signal when the handling device / robot has taken the part and allows to continue mould opening. The signal must remain HIGH until "Mould open" signal is given by the injection moulding machine (see table 1: injection moulding machine signals contact No ZA7).</p>
	<p>(OPTIONAL MSS) RESERVED FOR FUTURE USE BY SPI</p>

Contact Number Socket- Fig.2	Function
A8/A9	RESERVED FOR FUTURE USE BY SPI (I.M.M.)
A9	SUPPLY FROM THE I.M.M. 24 VDC /2 A (Reference potential)
B2/A9	HANDLING DEVICE/ROBOT OPERATION MODE (OPERATION WITH HANDLING DEVICE/ROBOT) LOW signal when the handling device / robot mode switch is "Operation with injection moulding machine". HIGH signal when the handling device / robot mode switch is "No operation with injection moulding machine". HIGH signal when the handling device / robot is switched off.
B3/A9	ENABLE EJECTOR RETRACT HIGH signal when the handling device / robot enables the movement for ejector back. The signal must remain HIGH at least until "Ejector back" signal is given by injection moulding machine (see table 1: injection moulding machine signals contact No ZB3).
B4/A9	ENABLE EJECTOR FORWARD HIGH signal when the handling device / robot enables the movement for ejector forward. The signal must remain HIGH at least until "Ejector forward" signal is given by the injection moulding machine (see table 1: injection moulding machine signals contact No ZB4).
B5/A9	(OPTIONAL) ENABLE MOVEMENT OF CORE #1 TO POSITION #1 (ENABLE MOVEMENT FOR HANDLING DEVICE/ROBOT TO APPROACH FREELY) HIGH signal when the handling device / robot is in position to enable the movement of the core pullers 1 to position 1. It is recommended that the signal remains HIGH at least until "Core pullers 1 in position 1" signal is given by injection moulding machine (see table 1: injection moulding machine signals contact No ZB5). The signal shall remain at least until position 2 has been left. (see table 1: injection moulding machine signals contact No ZB6).
B6/A9	(OPTIONAL) ENABLE MOVEMENT OF CORE #1 TO POSITION #2 (ENABLE CORE #1 TO REMOVE THE PART) HIGH signal when the handling device / robot is in position to enable the movement of the core pullers 1 to position 2. It is recommended that the signal remains HIGH at least until "Core pullers 1 in position 2" signal is given by injection moulding machine (see table 1: injection moulding machine signals contact No ZB6). The signal shall remain at least until position 1 has been left. (see table 1: injection moulding machine signals contact No ZB5).
B7/A9	(OPTIONAL) ENABLE MOVEMENT OF CORE #2 TO POSITION #1 (ENABLE MOVEMENT FOR HANDLING DEVICE/ROBOT TO APPROACH FREELY) HIGH signal when the handling device / robot is in position to enable the movement of the core pullers 2 to position 1. It is recommended that the signal remains HIGH at least until "Core pullers 2 in position 1" signal is given by injection moulding machine (see table 1: injection moulding machine signals contact No ZB7). The signal shall remain at least until position 2 has been left. (see table 1: injection moulding machine signals contact No ZB8).
B8/A9	(OPTIONAL) ENABLE MOVEMENT OF CORE #2 TO POSITION #2 (ENABLE CORE #2 TO REMOVE THE PART) HIGH signal when the handling device / robot is in position to enable the movement of the core pullers 2 to position 2. It is recommended that the signal remains HIGH at least until "Core pullers 2 in position 2" signal is given by injection moulding machine (see table 1: injection moulding machine signals contact No ZB8). The signal shall remain at least until position 1 has been left. (see table 1: injection moulding machine signals contact No ZB7).
C5	NOT ASSIGNED BY SPI. MANUFACTURER DEPENDENT

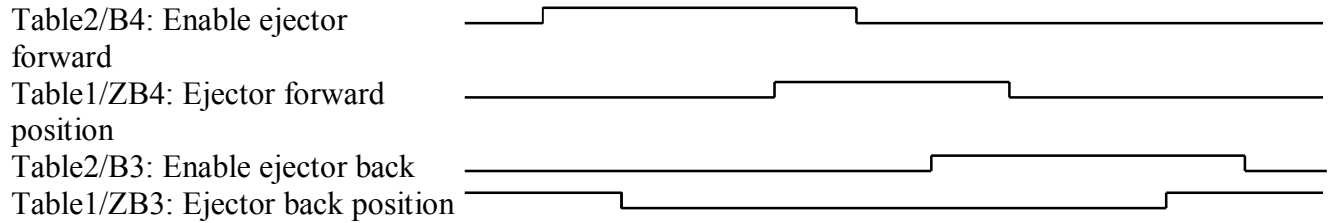
Contact Number Socket- Fig.2	Function
C6/A9	RESERVED FOR FUTURE USE BY SPI (I.M.M.)
	(REQUIRED MSS) INSERT PART(S) INSERTED HIGH signal when the handling device/robot has inserted the insert part(s). The signal shall remain HIGH until ZC6 is HIGH.
C7/A9	RESERVED FOR FUTURE USE BY SPI (I.M.M.)
	(REQUIRED MSS) MOLDED PARTS REMOVED HIGH signal when the handling device/robot has removed the moulded part(s). The signal shall change to LOW when ZC7 changes from HIGH to LOW (see Explanation).
C8	NOT ASSIGNED BY SPI. MANUFACTURER DEPENDENT
C9	SUPPLY FROM THE I.M.M. 0 V (Reference potential)

Explanation of Signals ZC7 and C7:



6. Ejector sequences (Example)

The following sequence as shown in the time diagram is used

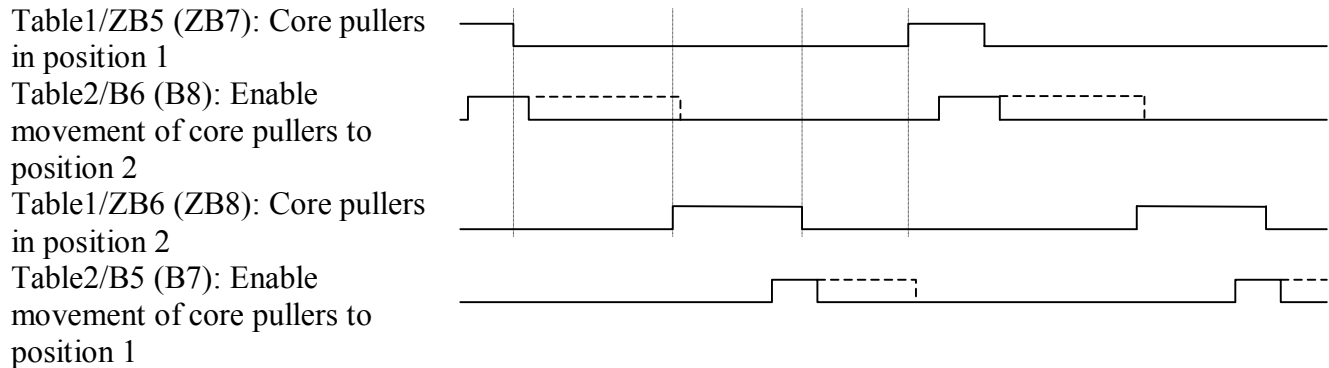


7. Core Pull sequences (Example)

In general positions 1 and 2 are used for synchronization between the injection moulding machine and the handling device / robot, where position 1 is preferable the position for free movement of the handling device / robot through the mould area. Positions 1 and 2 are used alternating.

7.1 Core Pull 1 (or core pull 2) moving in two directions

Position 1 is equivalent to ejector back, position 2 is equivalent to ejector forward.

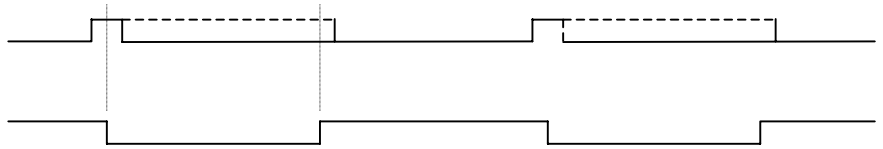


7.2 Core pull 1 (or core pull 2) moving in one direction

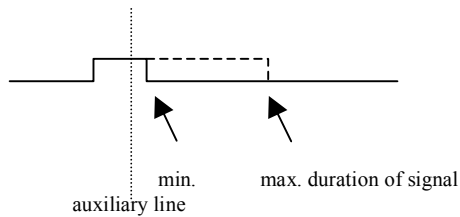
Example: Unscrewing gear box

Table2/B6 (B8): Enable movement of core pullers to position 1

Table1/ZB5 (ZB7): Core pullers in position 1



Explanation:



8. Related Documents

- ANSI/SPI B151.1 - Safety Requirements for Horizontal Injection Molding Machines
- ANSI/SPI B151.29- Safety Requirements for Vertical Injection Molding Machines
- ANSI/B151.27 – Robot Used with Horizontal and Vertical Injection Molding Machines-Safety Requirements for the Integration, Care and Use.

9. Source of connector

Supplier	HARTING	TYCO/AMP/HTS	WIELAND	MENCOM/ILME
Plug Type	Han 50 D	HD 50	Revos HD	CH 50
Pin Insert	09 21 025 3001	2-1103108-3	73.700.2553.0	CDM 25
Pin Insert "Z"	09 21 025 3011	0-1103108-1	73.700.2553.3	CDM 25 X
Socket Insert	09 21 025 3101	2-1103109-3	73.710.2553.0	CDF
Socket Insert "Z"	09 21 025 3111	0-1103109-1	73.710.2553.3	CDF 25 Z
Address	HARTING Inc. 1370 Bowes Road Elgin, Illinois 60123	Tyco/AMP Harrisburg, PA Phone: 800-522-6752	Wieland 49 International Rd Burgaw, NC 28425 Phone: 910-259-5050	MENCOM Corp. 2330 Centennial Dr. Gainesville, GA 30504 Phone: 770-535-4585

The plugs from these suppliers are interchangeable and additional suppliers are invited to be listed.

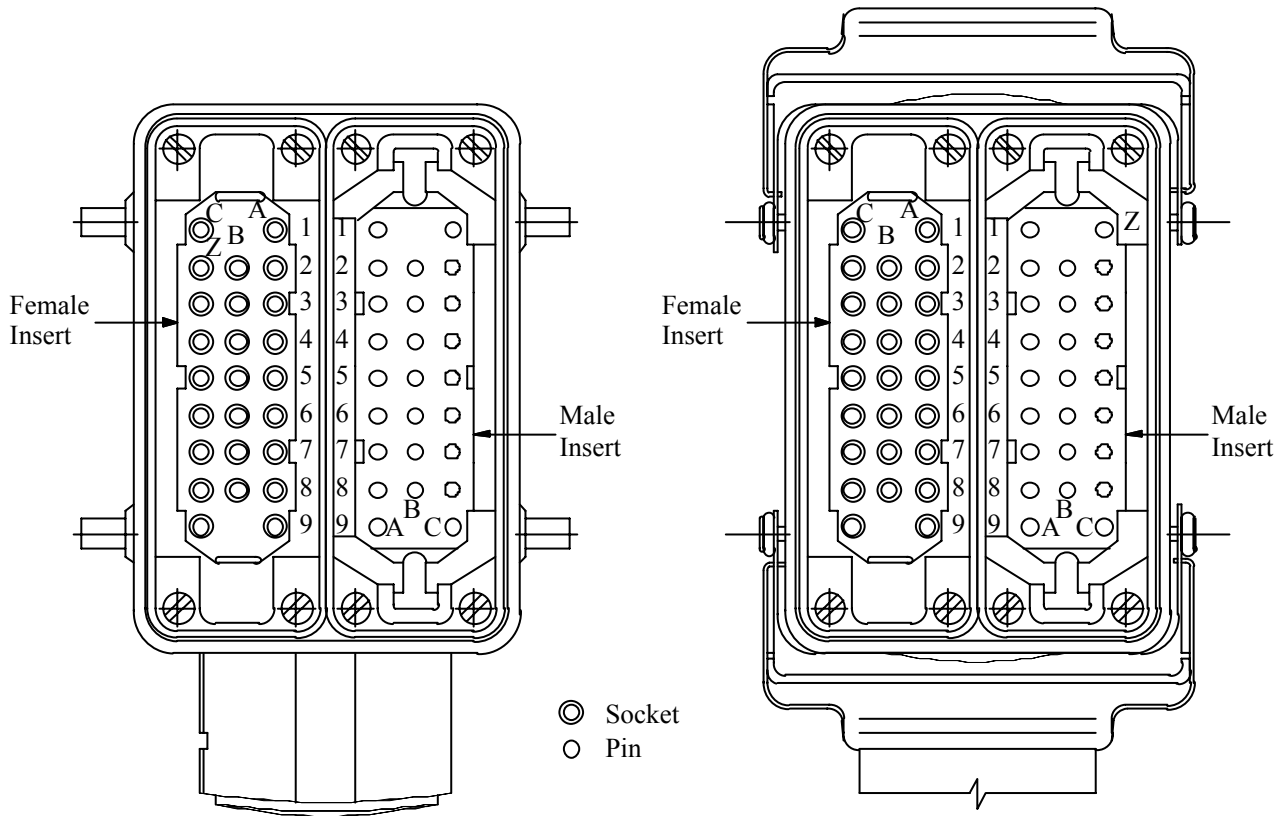


Figure 1
Plug on the robot device

Figure 2
Plug on the Horizontal Injection Molding

Arrangements of pins and sockets viewed from the mating side (opposite the wiring side)

Figure 3– Shuttle Table Machine

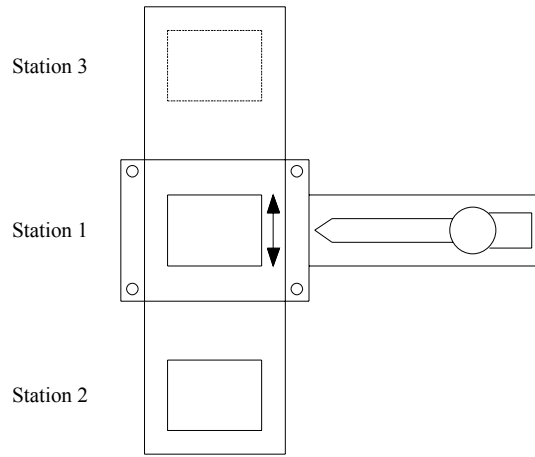


Figure 4– Rotary Table Machine

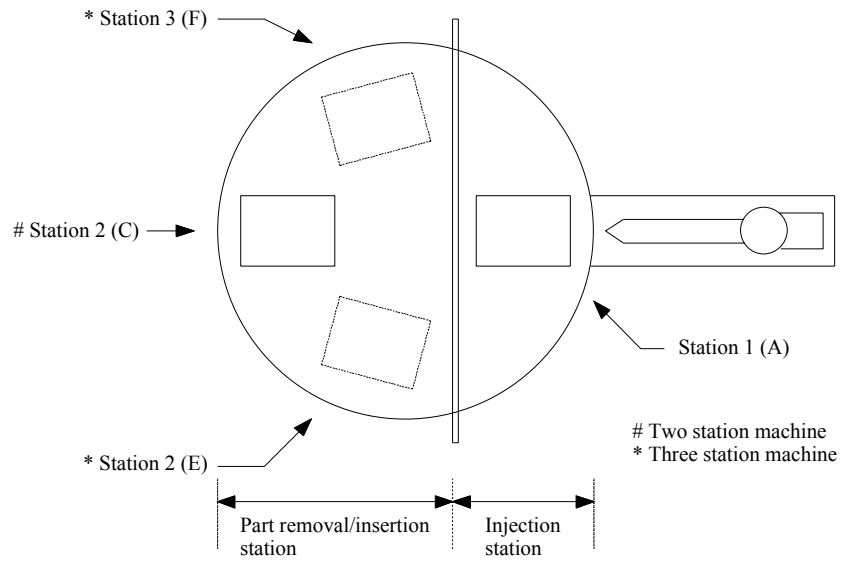
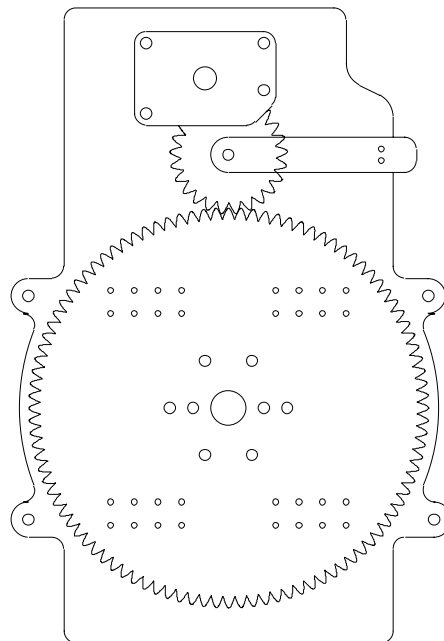


Figure 5– Indexing Unit



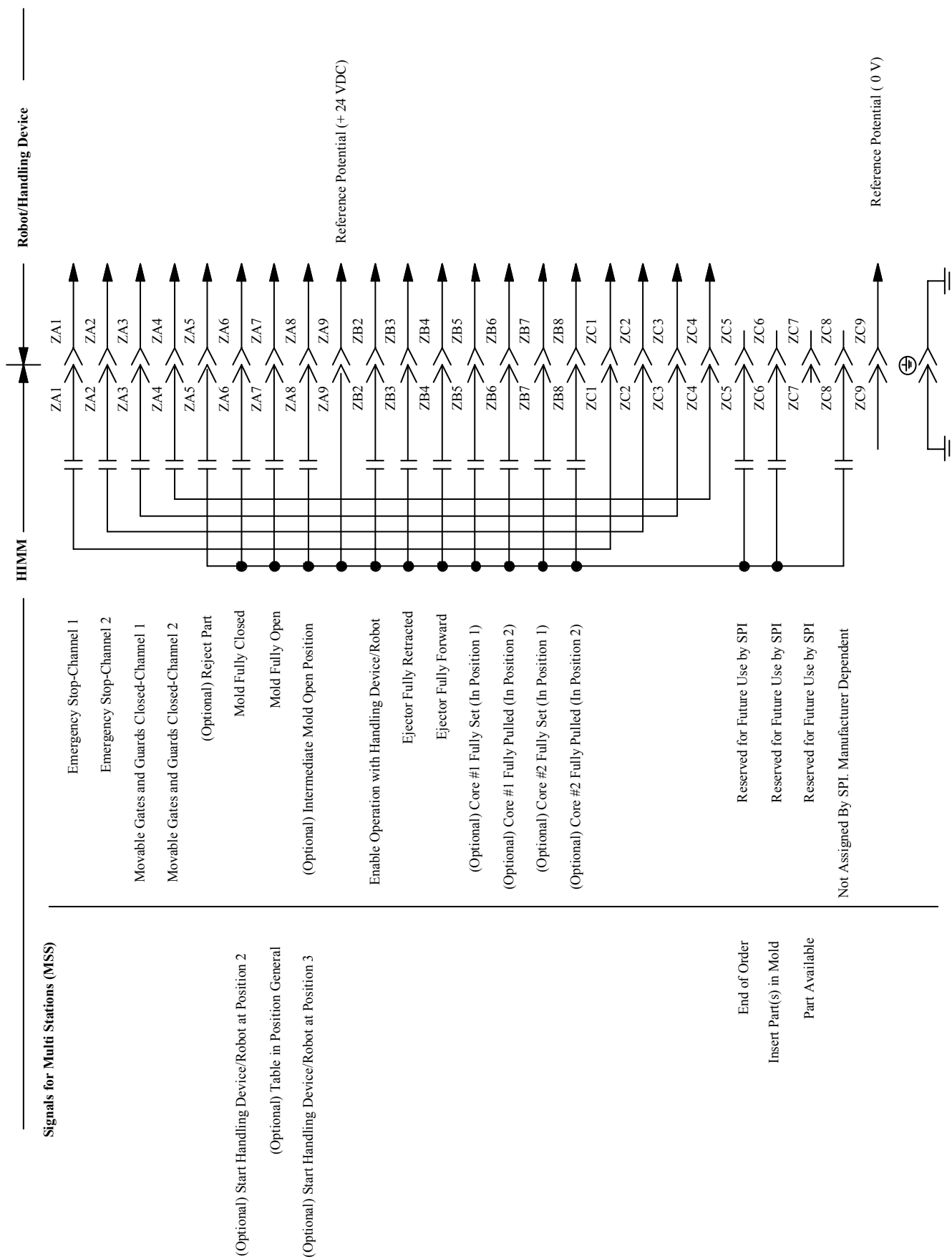


Figure 6 - Plug (male insert) Connection Diagram

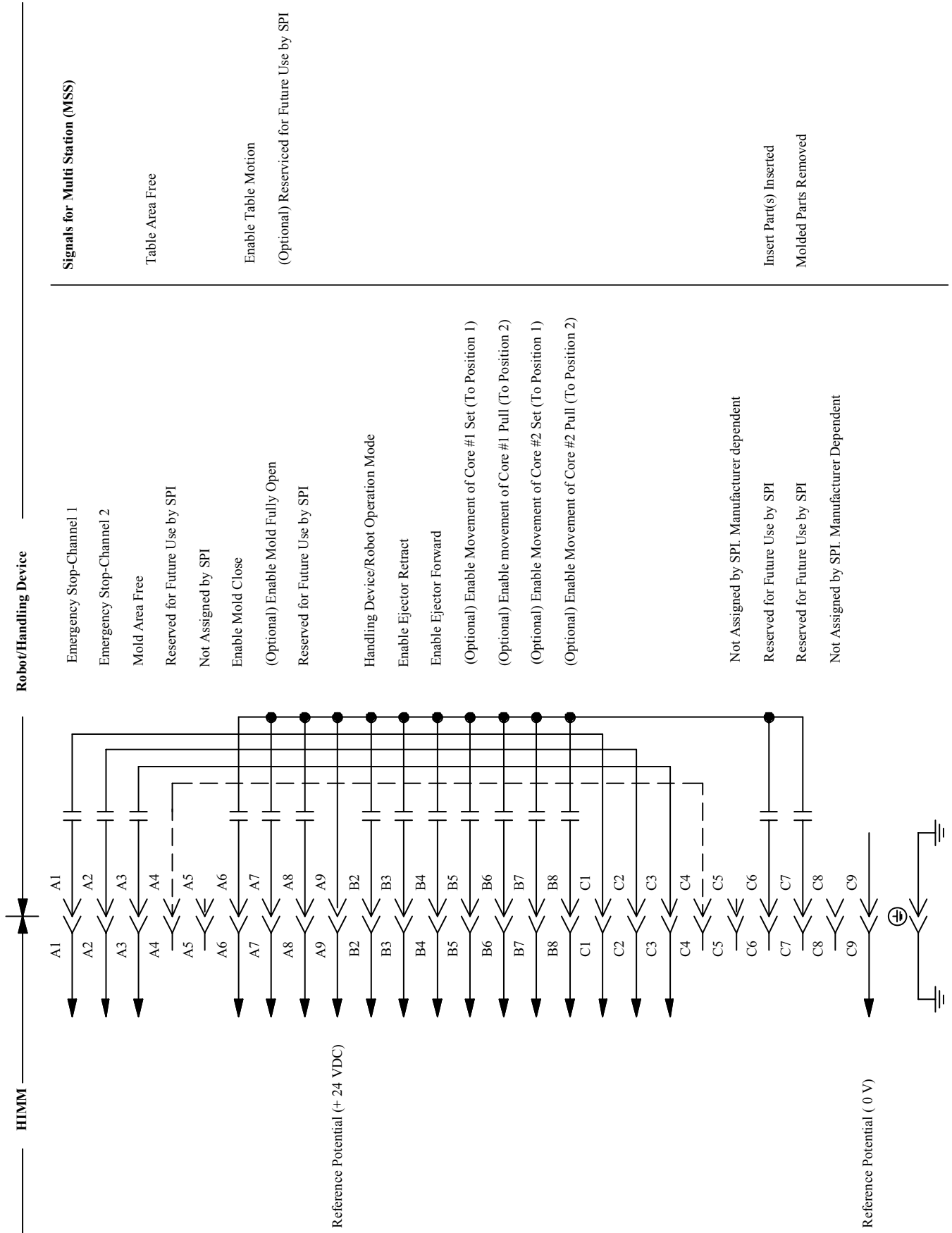


Figure 7 - Plug (female insert) Connection Diagram

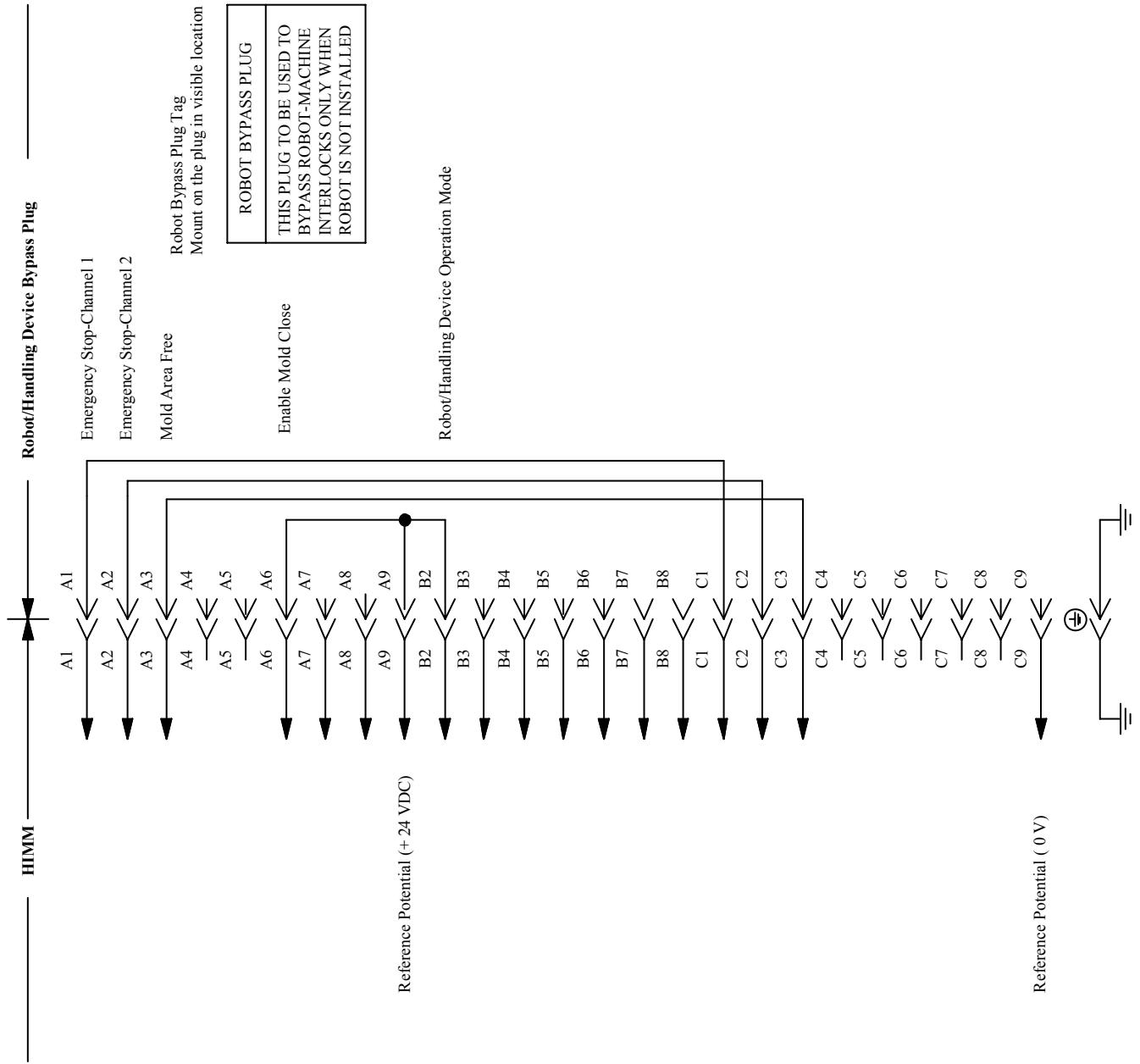


Figure 8 - Robot not Installed Bypass Plug

Annex A - Informative

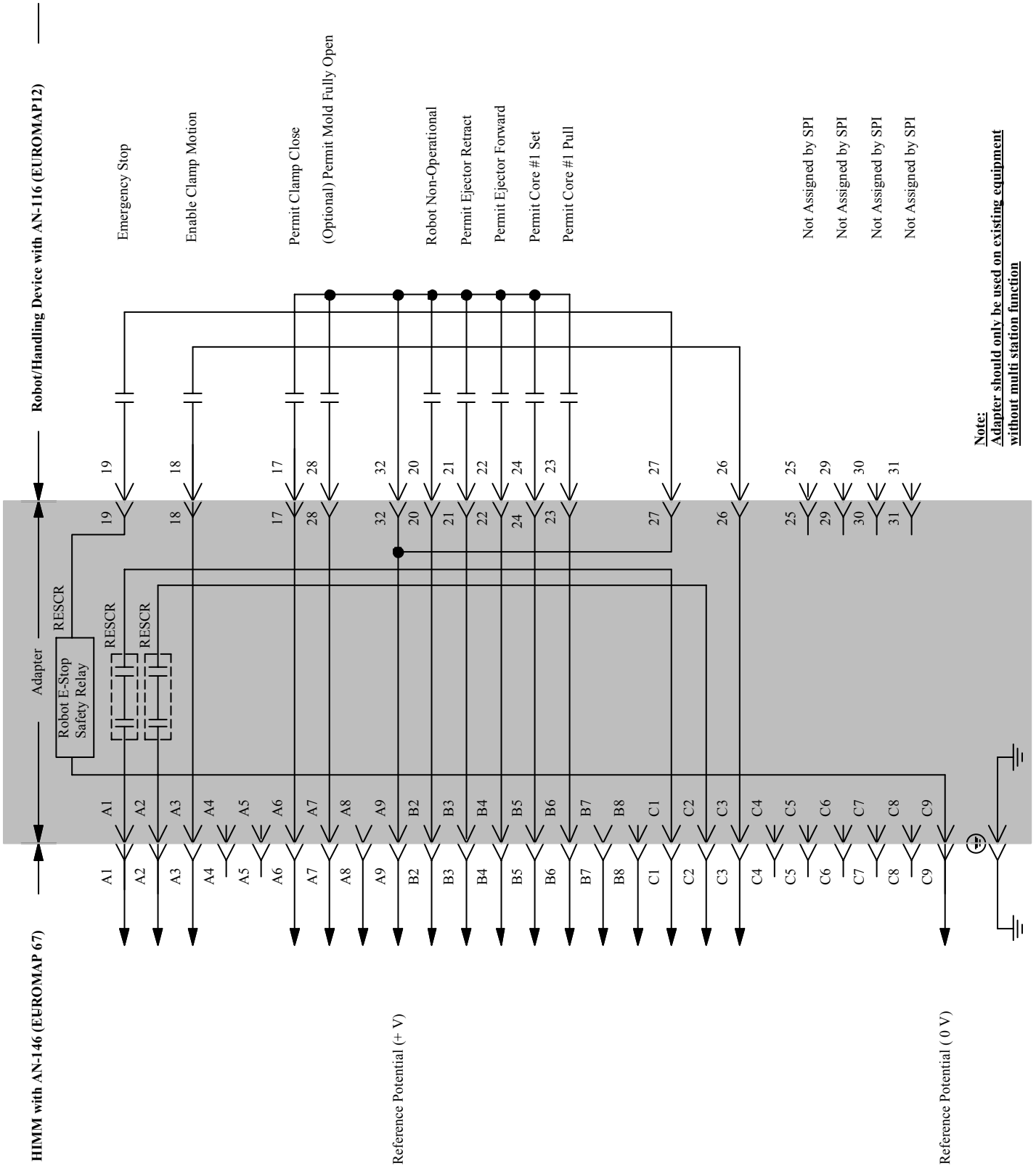


Figure 9 - Adapter (female insert) Machine AN-146 to Robot AN-116

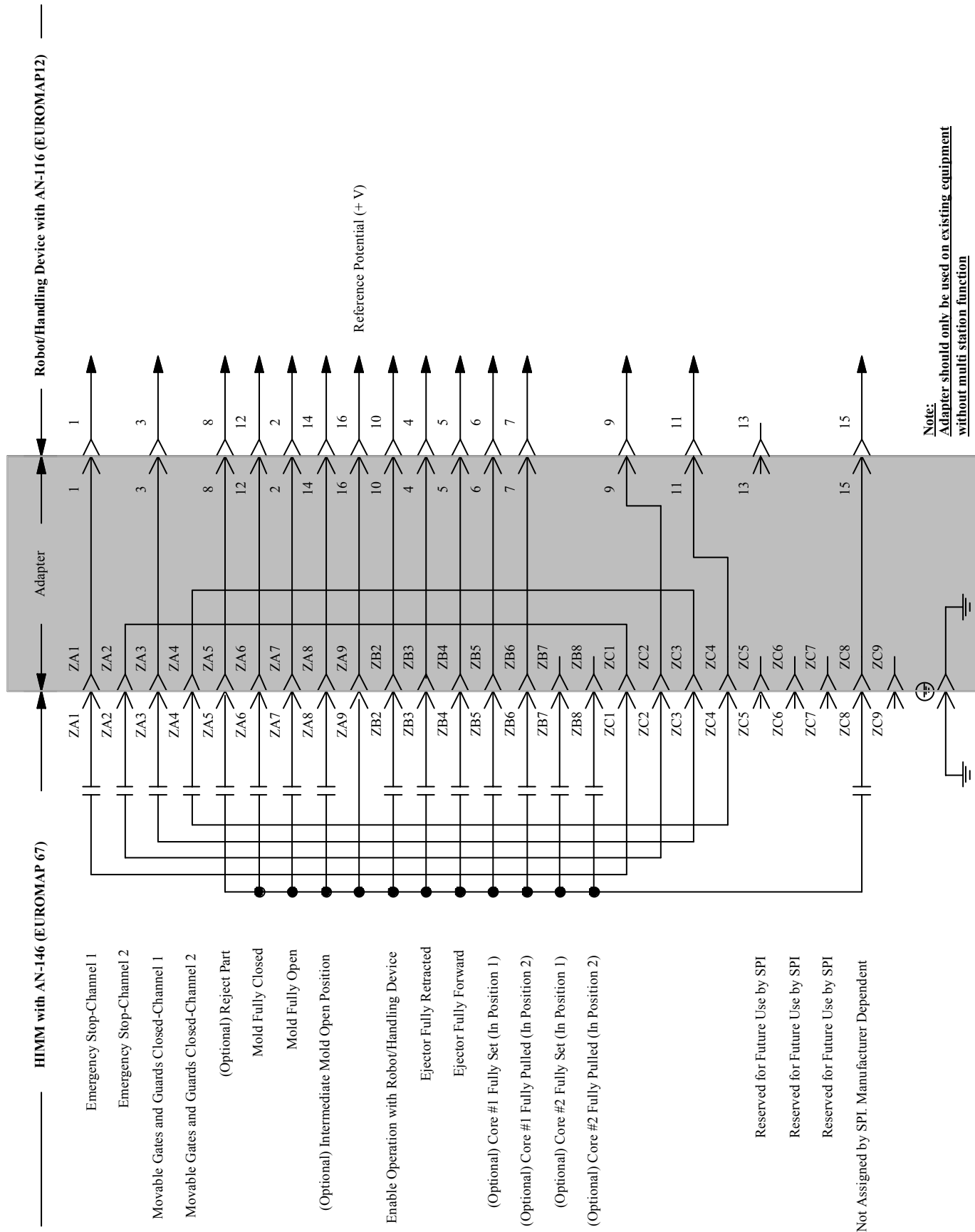
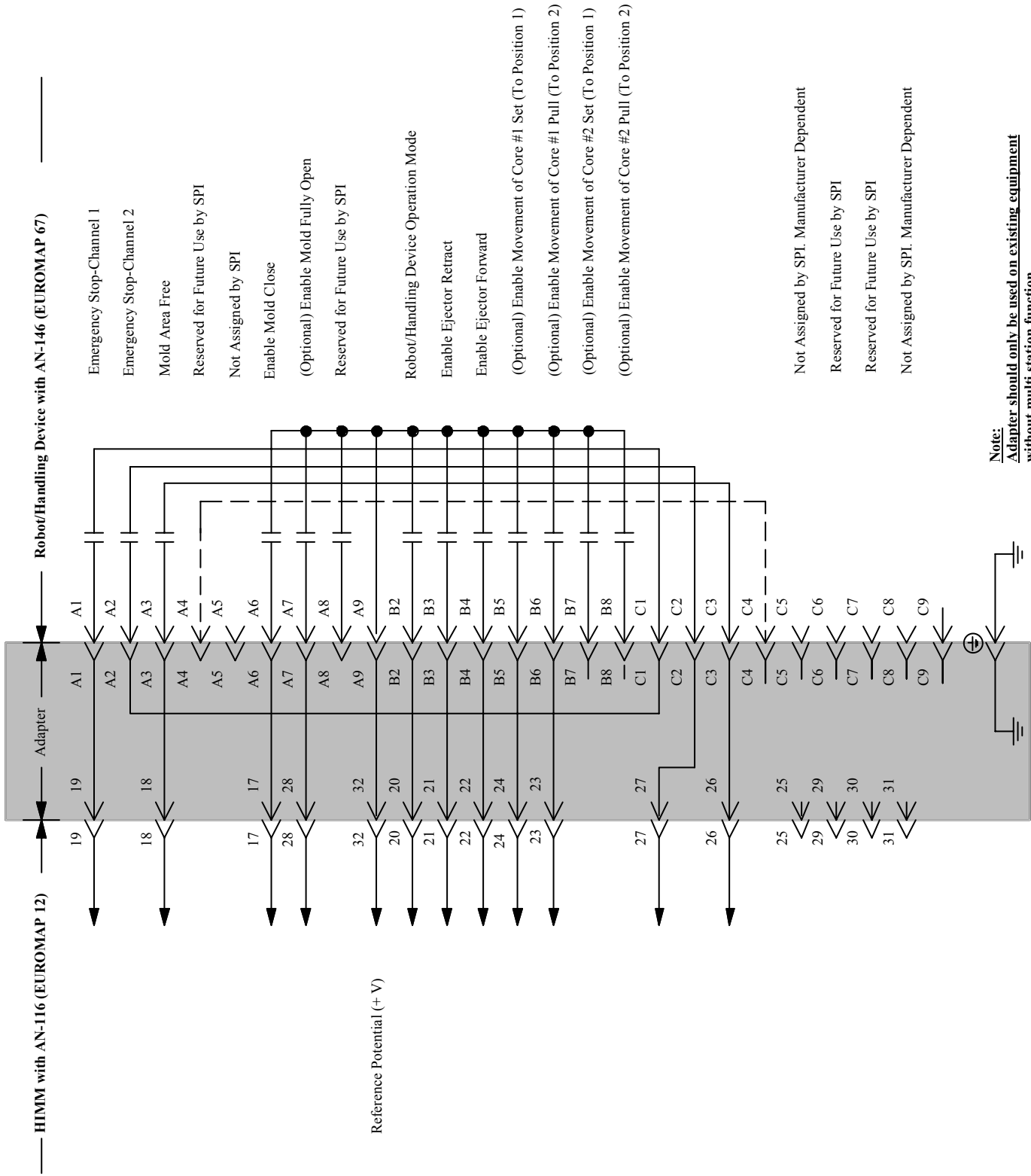
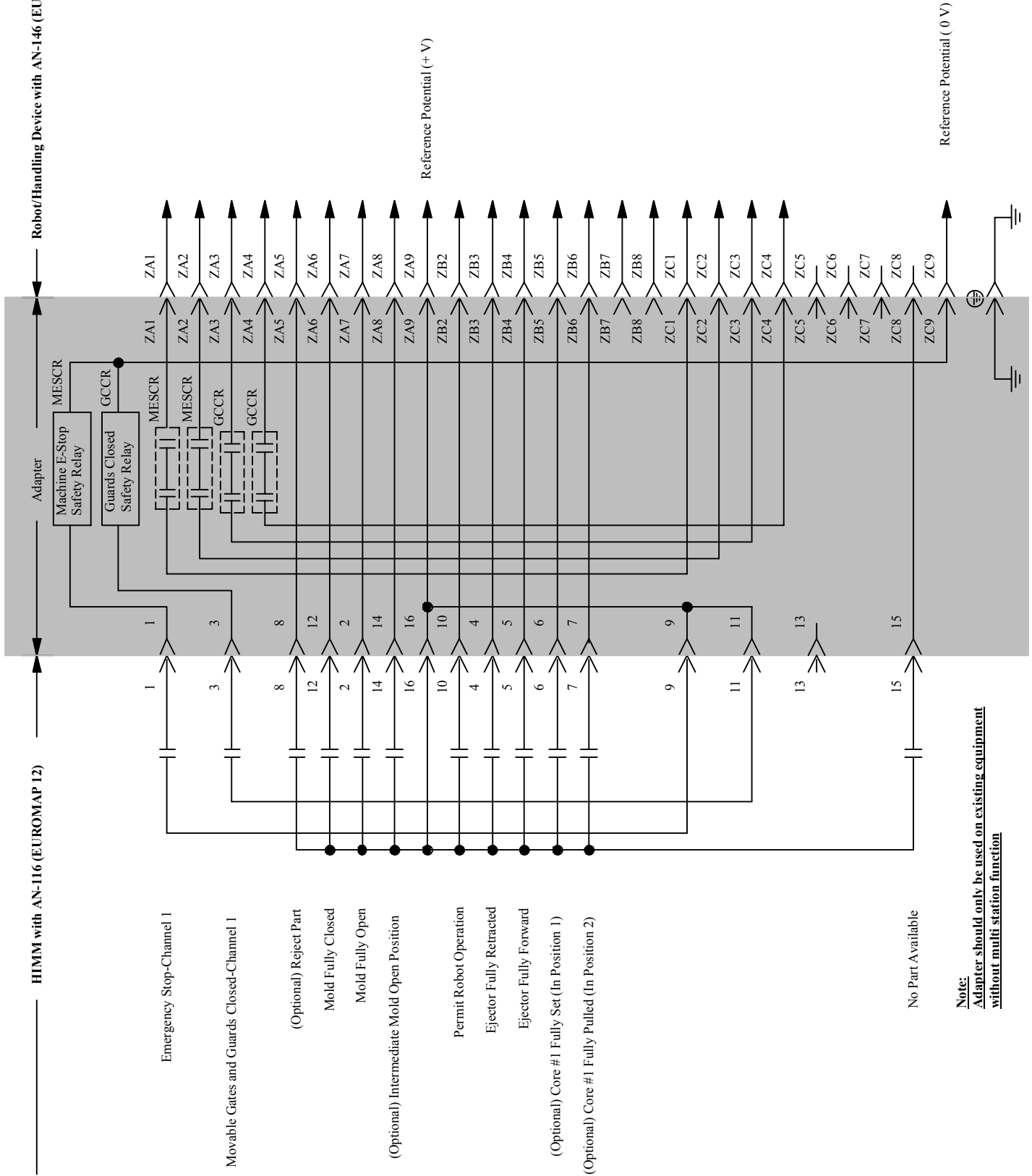


Figure 10 - Adapter (male insert) Machine AN-146 to Robot AN-116



Note:
 Adapter should only be used on existing equipment
 without multi station function

Figure 11 - Adapter (female insert) Machine AN-116 to Robot AN-146



Note:
Adapter should only be used on existing equipment
without multi station function

Figure 12 - Adapter (male insert) Machine AN-116 to Robot AN-146