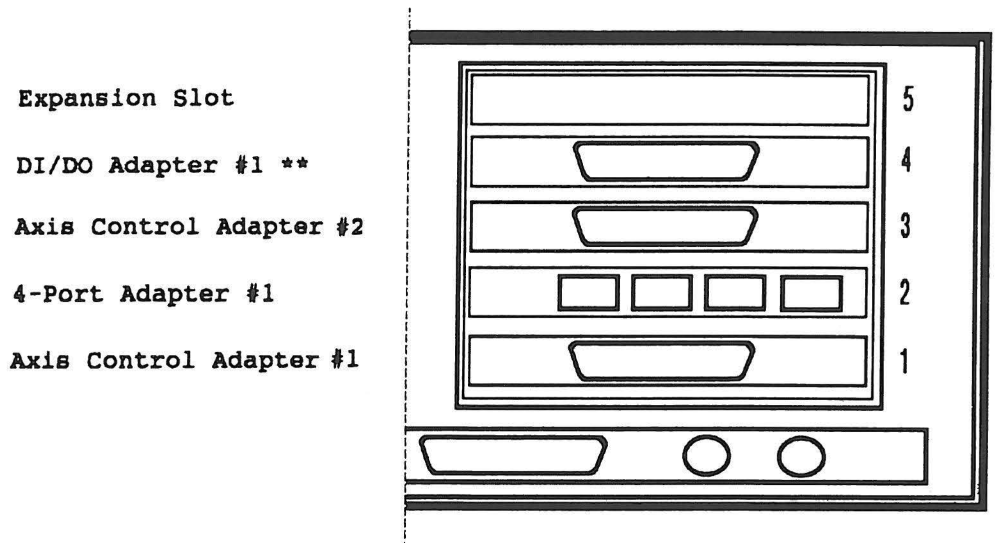
Chapter 9. Wiring Diagrams

Note: The wiring diagrams are in order by wiring diagram number. They are referred to throughout the manual as "COxx", "SPxx", or "WDxx", where "xx" signifies the appropriate number.

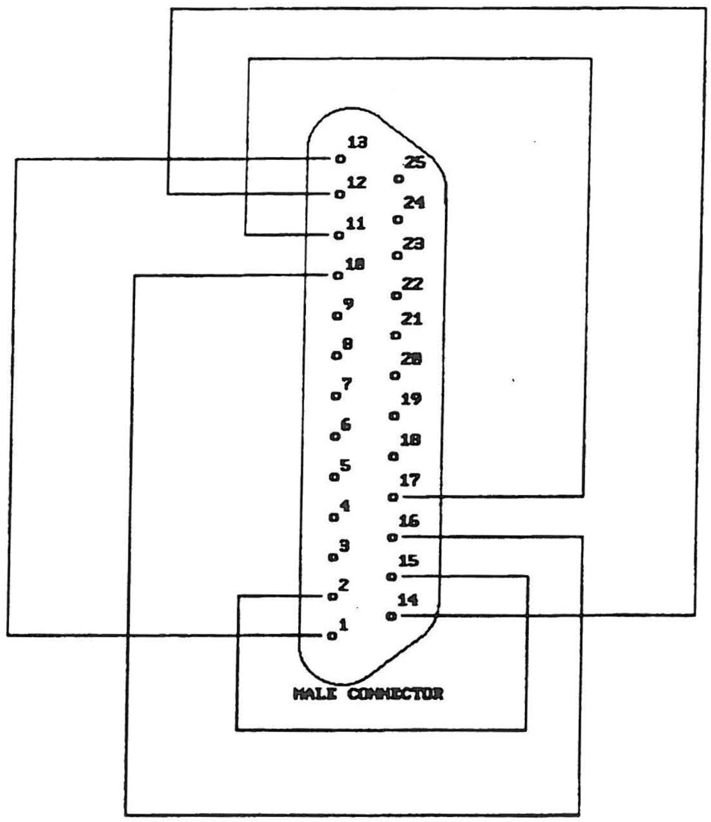
Contents

CO02 Standard Feature Card Assignments and Connectors



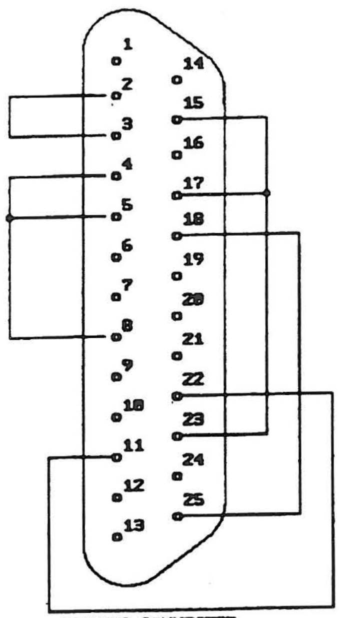
** Note: Your DI/DO Adapter may have a different connector than shown

CO10 Parallel Wrap Plug (P/N 6421777)



PIN	SIGNAL
1 to 13	-Strobe to SLCT
2 to 15	Data Bit 0 to -Error
10 to 16	-ACK to -INIT
11 to 17	-BUSY to -SLCT IN
12 to 14	PE to -AUTO FEED XT

CO13 Serial Wrap Plug (P/N 6421776)

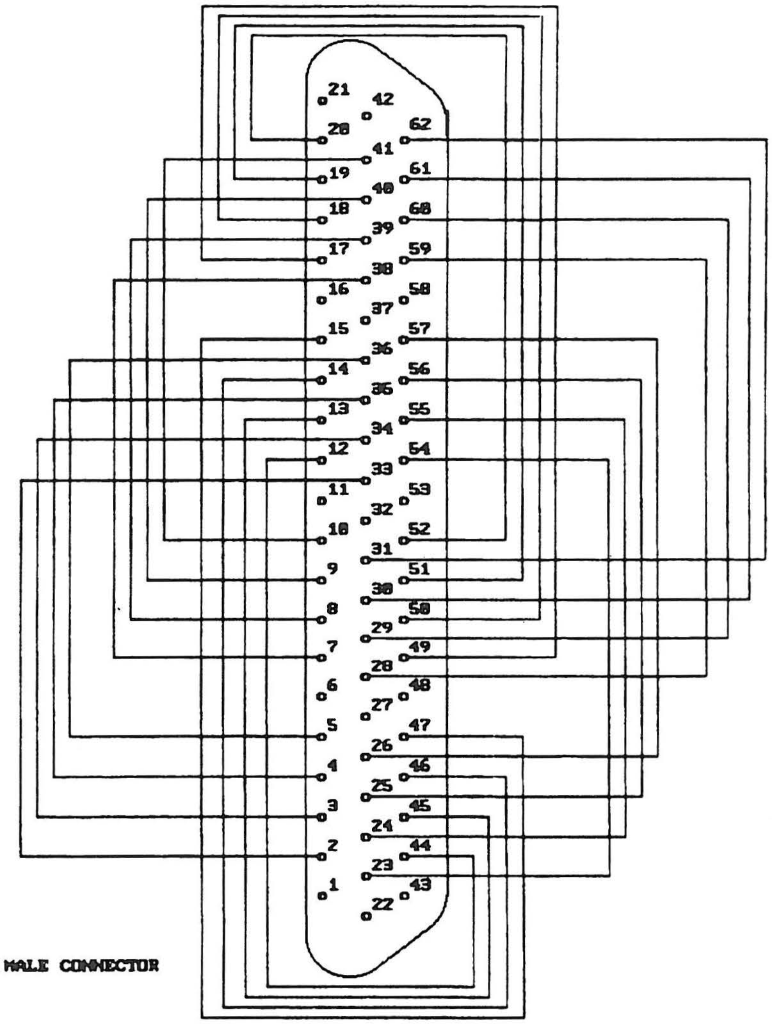


FEMALE CONNECTOR

PIN	SIGNAL
2 to 3	TX to RX
8 to 4 to 5	CD to RTS to CTS
11 to 22	SS to RI
15 to 17 to 23	TSET to RSET to DSRS
18 to 25	TEST(OUT) to TEST(IN)

CO15 IBM 48-Point DI/DO Card Wrap Plug (P/N 04G2143)

Also identified as P/N 67X1349.

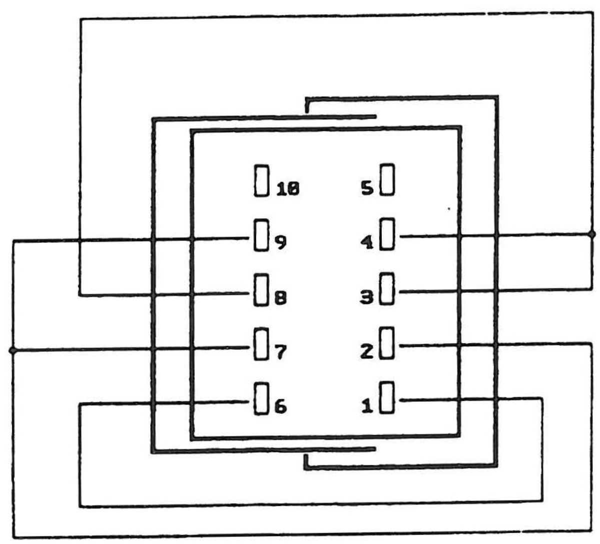


MALE CONNECTOR

PIN
2 to 33
3 to 34
4 to 35
5 to 36
7 to 38
8 to 39
9 to 40
10 to 41
12 to 44
13 to 45
14 to 46
15 to 47
17 to 49
18 to 50
19 to 51
20 to 52
23 to 54
24 to 55
25 to 56
26 to 57
28 to 59
29 to 60
30 to 61
31 to 62

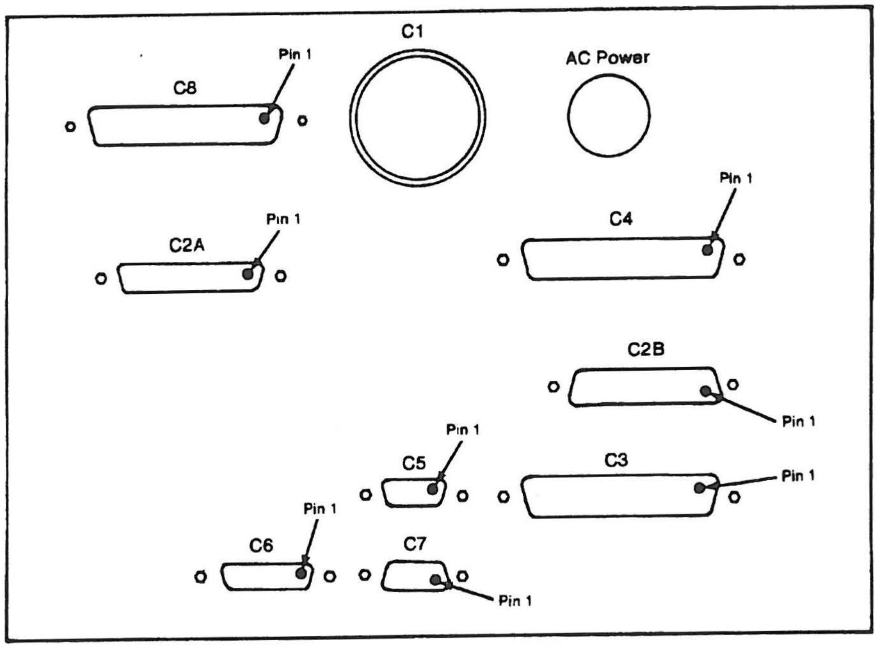
CO16 4-Port RS-232 Card Wrap Plug (P/N 04G2123)

Also identified as P/N 6298966.



PIN
1 to 6
2 to 7 and 9
3 to 4 and 8

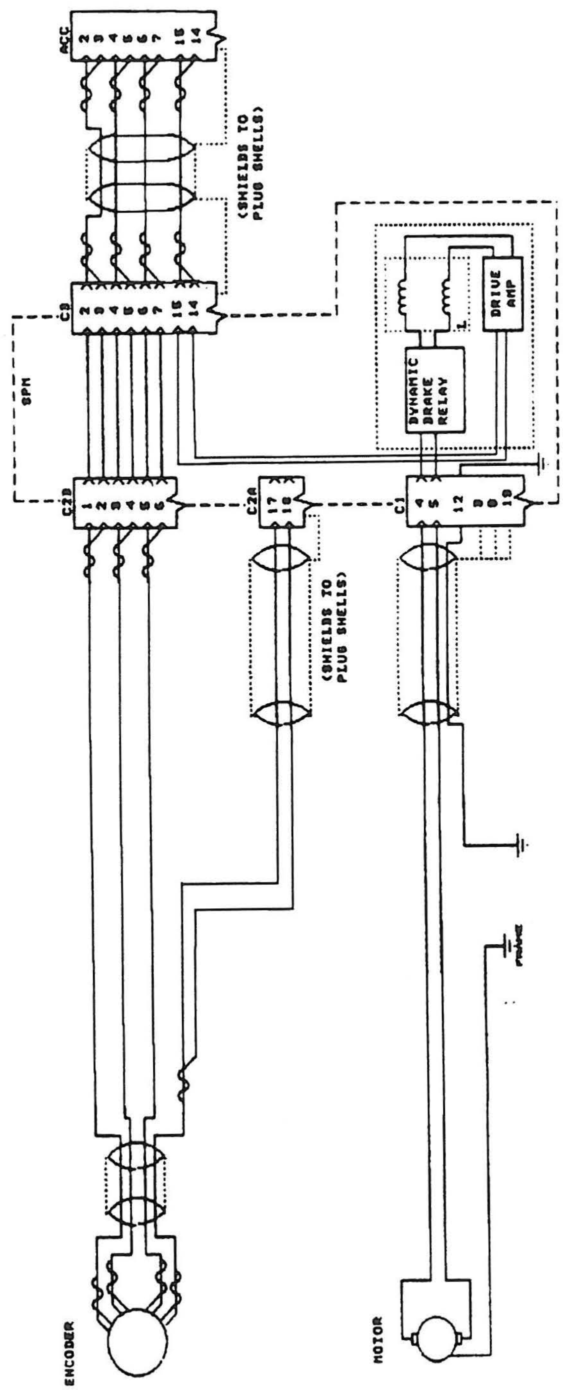
SP02 Typical Servo Power Module Cable Connectors



Cabling chart

C1	Manipulator
C2A	Manipulator
C2B	Manipulator
C3	Axis Control Card 1 (card slot 1)
C4	Axis Control Card 2 (card slot 3)
C5	External safety circuit
C6	Remote "Stop" switch/Pendant
C7	Pendant Serial Port (System Unit Serial Port or 4-Port, Port 1)
C8	Remote Operator Panel

WD10 Typical Control Circuit



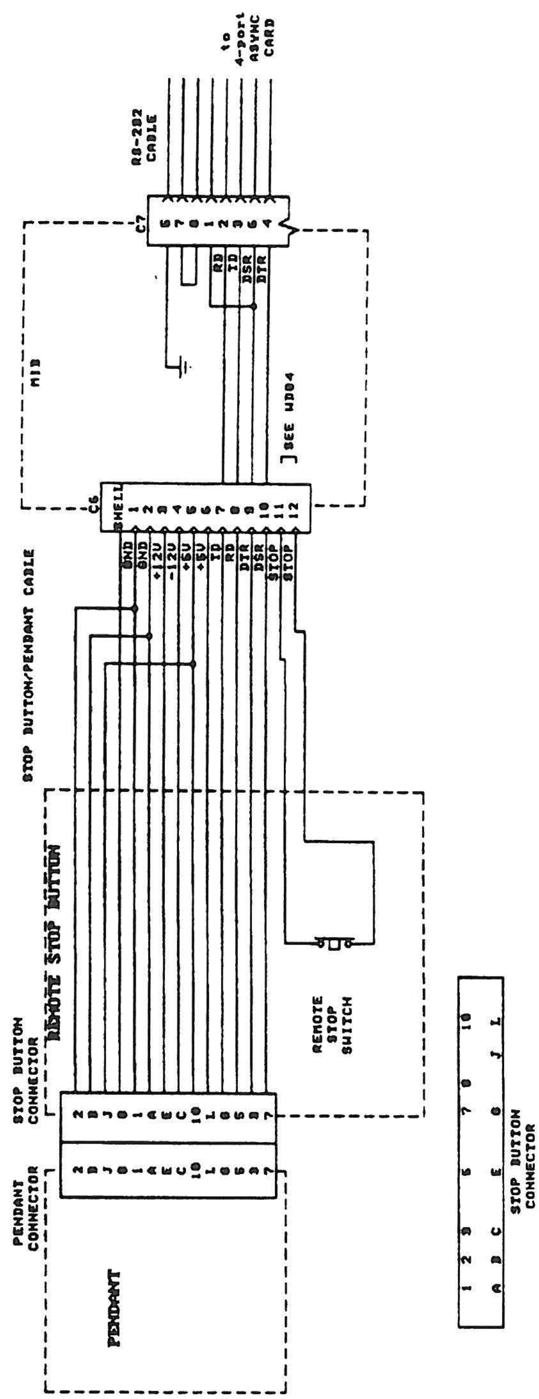
WD11 Axis Control Card Signals

These signals are provided to the Servo Power Module from the Axis Control Adapter Cable. The pin numbers refer to the pins on the output end (50 Pin D Shell Connector) of the cable.

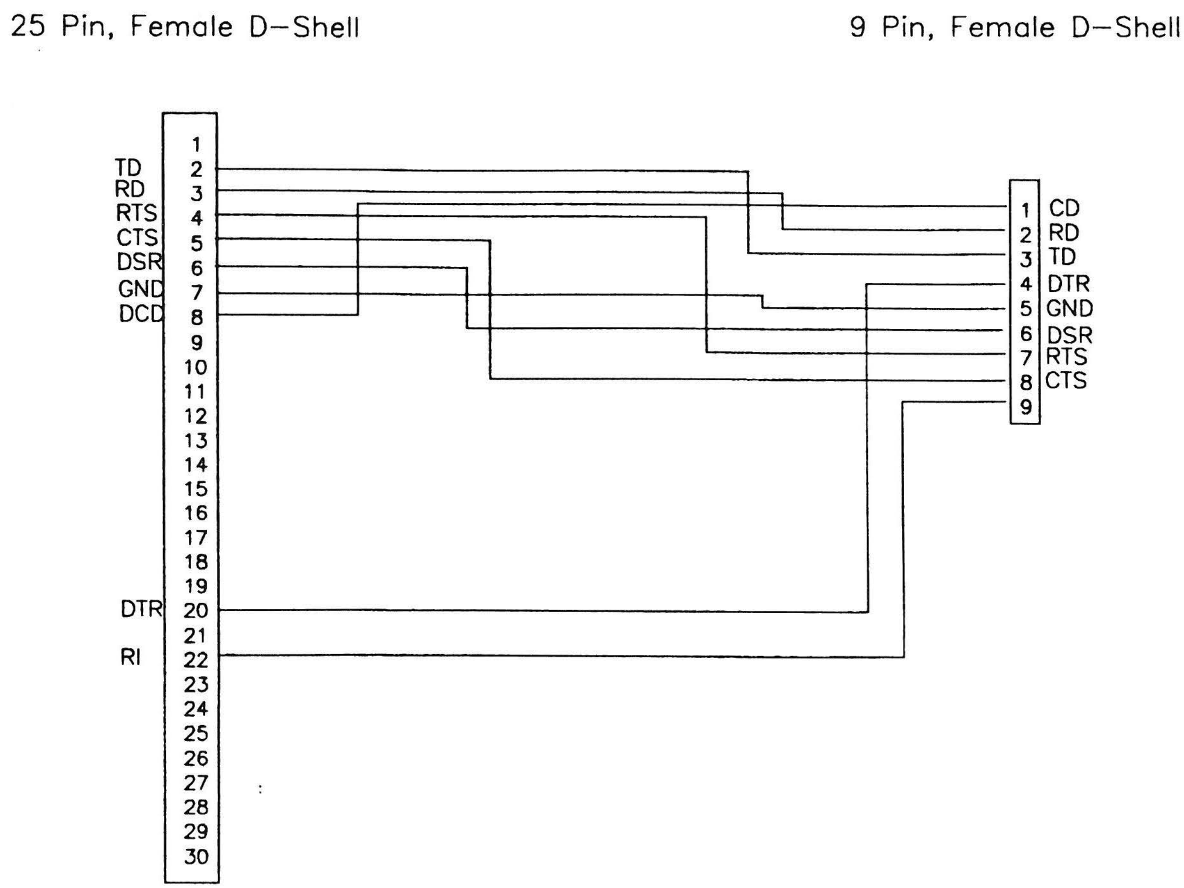
PIN #	ACC #1 Function	ACC #2 Function
01	+12 VDC (supplied)	+12 VDC (supplied)
02	Axis 1 Encoder A	Axis 3 Encoder A
03	Axis 1 Encoder NOT A	Axis 3 Encoder NOT A
04	Axis 1 Encoder B	Axis 3 Encoder B
05	Axis 1 Encoder NOT B	Axis 3 Encoder NOT B
06	Axis 1 Encoder INDEX	Axis 3 Encoder INDEX
07	Axis 1 Encoder NOT INDEX	Axis 3 Encoder NOT INDEX
08	Axis 2 Encoder A	Axis 4 Encoder A
09	Axis 2 Encoder NOT A	Axis 4 Encoder NOT A
10	Axis 2 Encoder B	Axis 4 Encoder B
11	Axis 2 Encoder NOT B	Axis 4 Encoder NOT B
12	Axis 2 Encoder INDEX	Axis 4 Encoder INDEX
13	Axis 2 Encoder NOT INDEX	Axis 4 Encoder NOT INDEX
14	Axis 1 DAC return	Axis 3 DAC return
15	Axis 1 DAC output	Axis 3 DAC output
16	Axis 2 DAC return	Axis 4 DAC return
17	Axis 2 DAC output	Axis 4 DAC output
18	+15 VDC (source)	+15 VDC (source)
19	-15 VDC (source)	-15 VDC (source)
20	Ground (-15 VDC)	Ground (-15 VDC)
21	DI - Fatal Fault Axis 1	DI - Fatal Fault Axis 3
22	DI - Fatal Fault Axis 2	DI - Fatal Fault Axis 4
23	DI - Over-Run	DI - Cable Keying Check
24	DI - Start Button	DI - SPM Power Good
25	DI - Global Enable	DI - Pause Button
26	DI - Load Button	DI - End Button
27	DI - Home Button	DI - Select Button
28	DI - Resume Button	DI - Key Switch Position
29	Ground (DI common)	Ground (DI common)
30	+24 VDC (source)	+24 VDC (source)
31	Ground (+24 VDC)	Ground (+24 VDC)
32	DO (WD) - Global Enable	DO (WD) - No Connection
33-36	-- Not Used --	-- Not Used --
37	DO - Start Button Indicator	DO - End Button Indicator
38	DO - Load Button Indicator	DO - Pause Button Indicator
39	DO - Home Button Indicator	DO - Home Position Select

PIN #	ACC #1 Function	ACC #2 Function
40	DO - Error Indicator	DO - Resume Button Indicator
41	DO - Manip Power Indicator	DO - 7 Seg Display Bit 0
42	DO - Manip Z brake	DO - 7 Seg Display Bit 1
43	DO - Manip Air Solenoid	DO - 7 Seg Display Bit 2
44	DO - No Connection	DO - No Connection
45	DO (WD) - Axis 1 Servo Enable	DO (WD) - Axis 3 Servo Enable
46	DO (WD) - Axis 2 Servo Enable	DO (WD) - Axis 4 Servo Enable
47	Ground (+15 VDC)	Ground (+15 VDC)
48	DI - Axis 1 Home Switch	DI - Axis 3 Home Switch
49	DI - Axis 2 Home Switch	DI - Axis 4 Home Switch
50	-12 VDC (supplied)	-12 VDC (supplied)
51-62	-- Not Used --	-- Not Used --

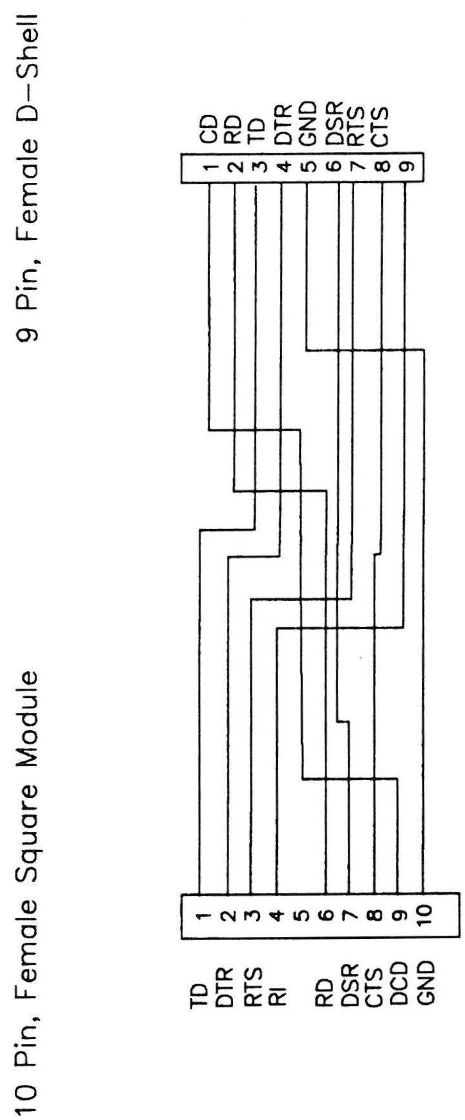
WD32 Pendant



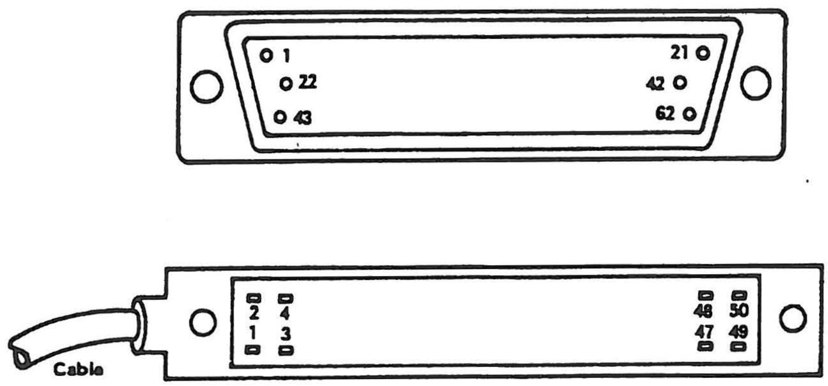
WD33 Pendant Cable to COM1



WD34 Pendant Cable to 4-Port Adapter



WD35 Digital Input/Output Cable



Appendix A. Glossary

Accuracy — is a measure of a manipulator's ability to move to a commanded position that has been theoretically computed. It is the difference between the commanded position and the actual achieved position. Errors from commanded positions that were obtained by teaching points is measured by the term "Repeatability".

Cartesian — is the X-Y coordinate space that the manufacturing system uses for designating point locations. This is also called the "world coordinate system". Also, manipulators with two linear axes mounted perpendicular to each other are referred to as Cartesian Coordinate machines.

Inertial Load — is the first mass moment of inertia of an object. In this context it refers to the moment of inertia the payload reflects on a specific axis, such as a roll or pitch axis.

Maximum Speed — is the speed maintained by a joint after acceleration and prior to deceleration at the end of the move. Speed at the end of the arm may be greater than the specified maximum speed when multiple joints are used on a single move.

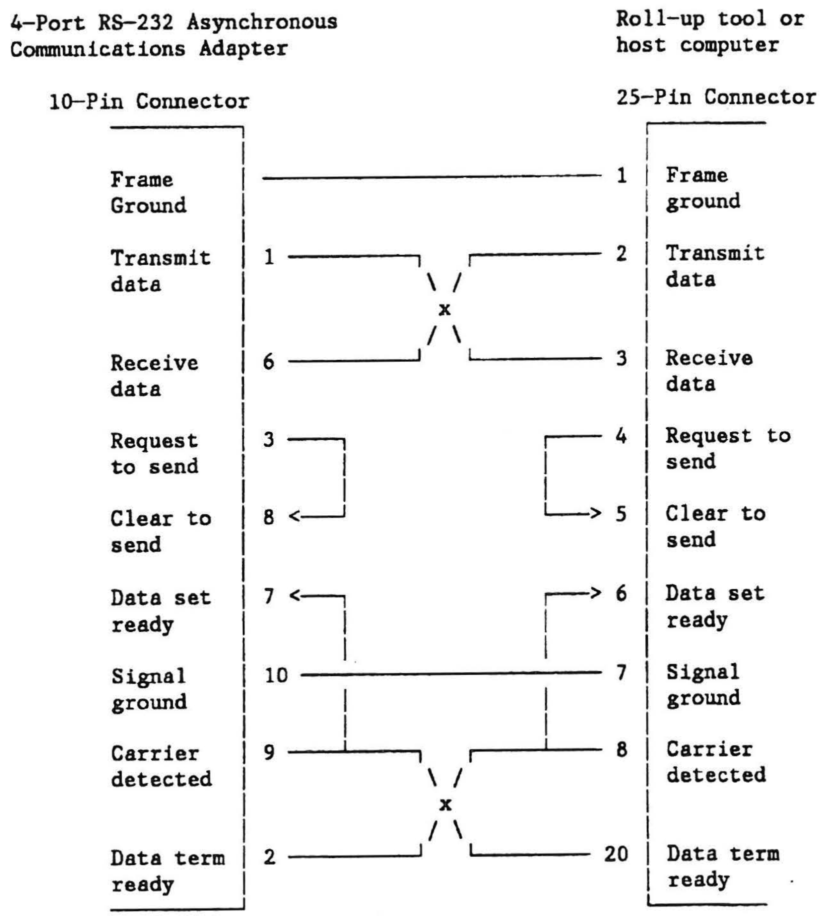
Payload — is the maximum weight the manipulator is designed to carry. (Ability to firmly grip such a payload is affected by choice of fingernails or end-of-arm effector, coefficient of friction, and so on).

Repeatability — is the variation in returning to a given point and is expressed as a distance from the mean within which at least 99.5% of all measurements fall. This is based on fixed temperature, speed, payload, and direction within the operating range.

Settling time — is the time required to settle all axes to their final destinations within the repeatability range.

Appendix B. 4-Port RS-232-C Asynchronous Communications Adapter Cable Wiring

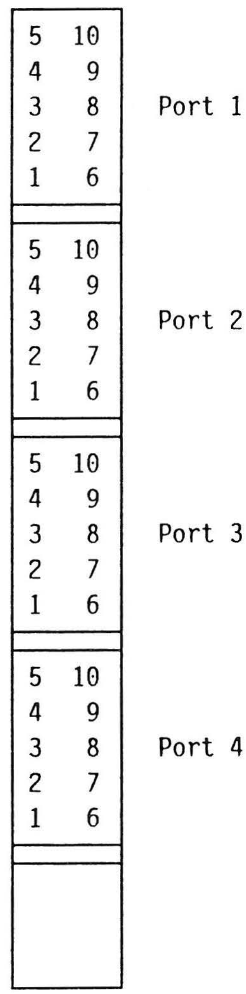
The following figure describes the connections for the cable that allows the attachment of a host computer, roll-up tool, or other RS-232-C data line to the controller (7537 Industrial Computer / Motion Controller) via the 4-Port RS-232 Asynchronous Communications Adapter.



Local RS-232-C Cable Wiring

```
┌──────┐
|5   10|
|4    9|
|3    8|
|2    7|
|1    6|
└──────┘
```

4-Port Card Connector
(as viewed from rear)



4-Port Asynchronous Communications Adapter
(as viewed from rear of 7537)

Appendix C. Checking DI/DO Points With The Pendant

Contents

Displaying DI/DO Points

To display DI/DO points:

1. Turn the Auto/Teach keyswitch to the Teach position.
2. Press the Inputs or Outputs button on the pendant.
3. One of the following displays will appear:
   - If no DI or DO points are available (never configured), the pendant will display either 'NO INPUT POINTS' or 'NO OUTPUT POINTS', whichever is appropriate.
   - If DI or DO points are available (have been configured), the pendant will display the *first* 24 DI or DO points in the following manner:

```
1st point--> 0000 0000 0000
             0000 0000 0000 <--24th point

where:  0 indicates an inactive state (off), and
        1 indicates an active state (on)
```

   Note: The displayed points will be the *first* 24 DI or DO points that have been configured; they need not be consecutive points. For example, the displayed points may be 1 through 8, 25 through 32, and 57 through 64.

4. Scrolling forward — If more than 24 DI or DO points have been configured, move the cursor with the cursor forward (↓→) pendant button to the 24th DI or DO point that is displayed. Then press the cursor forward (↓→) button again to scroll to the next eight DI or DO points on the pendant display.
5. Scrolling Backward — If you wish to display previous points, use the cursor back (←↑) button to move the cursor to the first point displayed. Then press the cursor back (←↑) button again and the pendant will scroll to the previous eight DI or DO points on the pendant display.

Turning DI/DO Points On or Off

The state of DI points cannot be changed with the cursor; however DO points may be turned on or off with the pendant as follows:

1. Use the cursor forward (↓→) or the cursor back (←↑) button on the pendant to select a DO point to change.
2. Press the No (0) button to turn a DO point off, or press the Yes (1) button to turn a DO point on.

This procedure is very helpful in analyzing outbound DO problems.

CAUTION:
When turning a DO point on or off, be aware that unexpected movement or noises in fixtures or feeders may result.

Appendix D. Useful AML/2 Information

Contents

AML/2 Configuration Utility

The AML/2 Configuration Utility presents information on configuring the AML/2 software. It includes the following topics:

- Entering the factory specified offsets for the axes that require them — These offsets are shipped with each manipulator. They are in a small plastic bag attached to the machine.
- Selecting left or right home position for certian SCARA models — Left or right is as viewed from the base of the manipulator, not from the Z axis.
- Specifying DI and DO points — There are 48 DI/DO points per card for the IBM adapter. The points for each card must be specified in six groups with eight points per group.
- Specifying the communications ports — This includes the 4-Port card(s) and any optional Serial/Parallel and Multiport Model 1 adapter cards that are in the system.

Application software must be programmed correctly. If it is not, the resulting symptom could resemble a hardware malfunction. For example, incorrect programming could cause the following:

- The arm moves to the wrong home position.
- A specific DI or DO point does not work.
- A specific communications port does not work.

After the configuration utility is loaded, follow the prompts on the pendant. The values entered previously will be displayed, with an option to change that value. An incorrect response made earlier can easily be detected and corrected.

Do not alter any code in this utility without fully understanding the impact on the next IPL sequence.

To run the Configuration Utility, refer to Chapter 2, "Configuring the AML/2 Manufacturing Control System" in *AML/2 Manufacturing Control System User's Guide*.

APPLNAME.AML File

The purpose of the APPLNAME.AML file, which is found on the "Diagnostics" diskette, is to state the actual names of the programs that will reside in program levels 1 through 7 in the 7537 Motion Controller. Note that application levels 1 through 5 may have any names, but that application levels 6 and 7 must have specific names to run diagnostic programs.

The default name listing of the APPLNAME.AML file follows:

```
APPLNAME.AML:

1 APPL1     Can have any name.
2 APPL2     Can have any name.
3 APPL3     Can have any name.
4 APPL4     Can have any name.
5 APPL5     Can have any name.
6 APPL6     Must have this name to run the HOME program (see Note 1).
7 VERIFY    Must have this name to run the VERIFY program (see Note 2).

/*  END OF FILE
```

Notes:

1. The HOME program is contained on the "Diagnostics" diskette.
2. The VERIFY program is contained on the "AML/2 Manufacturing Control System" diskette.
3. For any AML/2 application program to be loaded from diskette on the controller, the file APPLNAME.AML must also reside on that diskette.

HWDEF.CFG File

The HWDEF.CFG file is one of the most critical files in the AML/2 software system; it should *never* be written into directly. Only the software installation procedure, the configuration utility, and the OFFSET program have access to alter data in this file. Thus, each "AML/2 Manufacturing Control System" diskette must be associated only with its own specific manufacturing system. (It is a good practice to identify the associated manufacturing system on each primary and backup diskette's label.)

The HWDEF.CFG file is created from one of the HW*.CFG files at the time the software installation procedure is executed. Therefore, the original machine .CFG file is always intact in the software library, with default parameters. If the HWDEF.CFG file ever becomes unusable, installation must be done again, using the "Reinstall" option.

Remember, the backup AML/2 diskette must always be updated with a copy of the most recent HWDEF.CFG file whenever the software installation procedure is reinstalled, the OFFSET program is run, or the configuration utility is updated.

Using the Optional Monitor Feature

To display information on your monitor that would normally be presented on the pendant only, delete the line:

"CTTY TERM0"

from the AML/2 Manufacturing Control System AUTOEXEC.BAT file.

Note: Terminal mode on the AML/2 Application Development Environment software will not work unless the removed line ("CTTY TERM0") is replaced in the AUTOEXEC.BAT file.

Appendix E. Controller Digital Input/Digital Output (DI/DO)

Contents

Digital input/digital output (DI/DO) features provides non-isolated TTL level signals that are configurable in groups of eight as either inputs or outputs. A cable is provided to connect the DI/DO card to industry standard 24-point optical isolation boards, such as those made by Opto 22, Potter-Brumfield, or Gordos-Arkansas. These manufacturers offer a variety of modules that plug into each of the 24 positions on the boards to provide input or output capability to ac or dc devices of various voltage ratings.

The user must supply a 5-volt dc power source to the two optical isolation boards. The 5-volt dc supply should meet international requirements for safety isolation transformers and provide safety extra-low voltages (SELV). All modules on the optical isolation boards must be designed for operation using the 5-volt dc voltage supplied by the user.

CAUTION:

Any user wiring attached to the controller other than at the user interface connectors may cause:

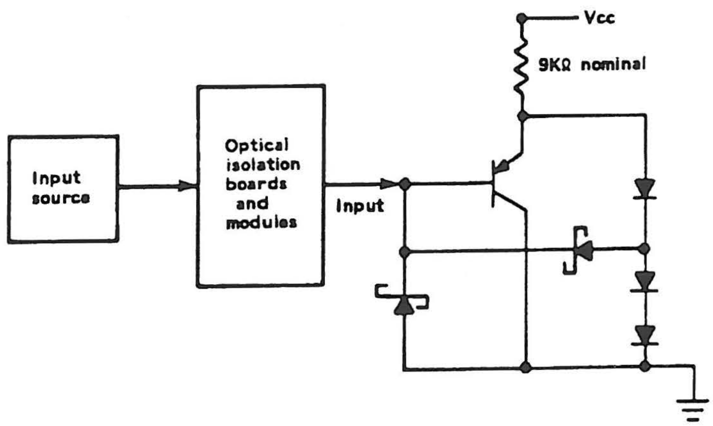
- **a safety hazard**
- **warranty invalidation**
- **system errors**
- **unreliable operation.**

The following tables and diagrams describe the IBM 48 Point DI/DO feature.

Digital Input (DI)

The following figure shows the digital input circuit from a 48-point DI/DO card and a representation of a typical optical isolation circuit interfacing to the input source.

The optical isolation circuit is based on an industry standard 24-point optical isolation board, such as those made by Opto 22, Potter-Brumfield, or Gordos-Arkansas. The user must provide dc voltage to power such a board.



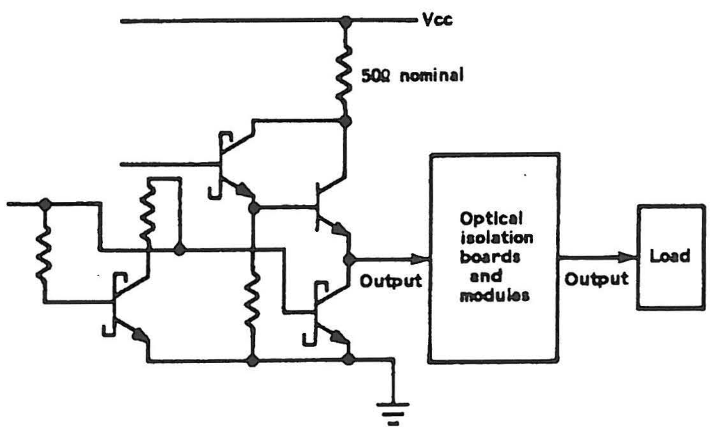
Characteristic	Voltage Sense Description
Circuit type	Solid state, nonisolated TTL
Input form:	
Low	Current sinking, 0.2 ma at 0.8 V maximum
High	20 μa at 2.0 V minimum
Voltage limits:	5.5 Vdc maximum, high level input
	0 Vdc minimum, low level input
Input impedance	TTL characteristic
Response time	20 ms

Digital Output (DO)

Output commands from the application program or the pendant energize DO circuits, providing a circuit closure for external devices.

External user devices must provide voltage (5 Vdc) and optical isolation. The following figure shows a digital output circuit from a 48 DI/DO card and a representation of a typical optical isolation circuit interfacing to the load.

The optical isolation circuit is based on an industry standard 24-point optical isolation board, such as those made by Opto 22, Potter-Brumfield, or Gordos-Arkansas.

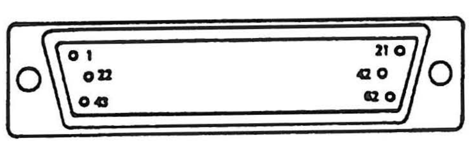


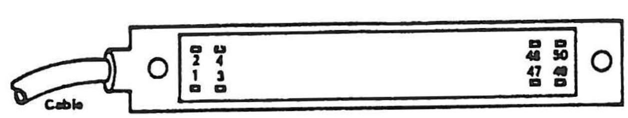
Characteristic	Circuit Description
Circuit type	Solid state, nonisolated TTL 3-state outputs
Output form:	
High	(Source current) 15 ma at 2.0 V
Low	(Sink current) 24 ma at 0.5 V
Off-state	200 µa
Duration of output	Application controlled
Response time	20 ms

IBM 48-Point DI/DO Card User Cable Layout

Cable 1-24		
62-pin conn.	Conn. 1-24	Signal name
1	50	--
2	48	Data 1
3	46	Data 2
4	44	Data 3
5	42	Data 4
6	49	Gnd
7	40	Data 5
8	38	Data 6
9	36	Data 7
10	34	Data 8
11	1	Gnd
12	32	Data 9
13	30	Data 10
14	28	Data 11
15	26	Data 12
16	13	Gnd
17	24	Data 13
18	22	Data 14
19	20	Data 15
20	18	Data 16
21	25	Gnd
22	NA	Not used
23	16	Data 17
24	14	Data 18
25	12	Data 19
26	10	Data 20
27	37	Gnd
28	8	Data 21
29	6	Data 22
30	4	Data 23
31	2	Data 24

Cable 25-48		
62-pin conn.	Conn. 25-48	Signal name
32	na	Not used
33	48	Data 25
34	46	Data 26
35	44	Data 27
36	42	Data 28
37	49	Gnd
38	40	Data 29
39	38	Data 30
40	36	Data 31
41	34	Data 32
42	1	Gnd
43	50	--
44	32	Data 33
45	30	Data 34
46	28	Data 35
47	26	Data 36
48	13	Gnd
49	24	Data 37
50	22	Data 38
51	20	Data 39
52	18	Data 40
53	25	Gnd
54	16	Data 41
55	14	Data 42
56	12	Data 43
57	10	Data 44
58	37	Gnd
59	8	Data 45
60	6	Data 46
61	4	Data 47
62	2	Data 48





Cable Routing

Interference between DI/DO cables and typical sources of electrical noise will more likely occur with long, parallel runs. A good rule to follow is to keep all DI/DO cables at least 0.3 m (1 ft) away from any power line or other ac source.

In addition to the electrical noise sources listed in -- Heading 'NOISE' unknown --, the following sources should be avoided when cabling DI/DO.

- Fluorescent and neon lighting fixtures.
- Power distribution systems, including wiring, transformers, generators, and alternators.
- Signal generators, intercommunications systems, and security signal systems.
- Ultrasonic cleaning equipment.
- Electromagnetic equipment, such as degaussers, magnetic chucks, etc.
- Control equipment (relays, contactors, etc.) for machinery and other switching devices that carry or switch relatively large amounts of currents.

Some Good Rules To Follow

- Comply with all local, state, and national safety and electrical codes.
- Enclose overhead cables in a grounded trough.
- Keep cable lengths as short as possible.
- When several cables are coming from the same signal source, lay them along the same route.
- Store excess cable in an "S" shape — not coiled up.

Note: All unused wires in multi-conductor cables must be grounded *at the optical isolation board end only.*

Signal Cable Selection

Three general categories of wiring and cabling are suggested for designing cabling to the system DI/DO points. The following three categories are listed in order of preference:

1. *Shielded twisted pair.* This is an individually-shielded wire-pair instrumentation cable. It is available with either a braided shield or conductive foil-wrapped shield and drain wire. Twinaxial cable may be used to get controlled high-frequency characteristics. The shielded twisted-pair types of cable substantially reduce crosstalk.

2. *Unshielded twisted-pair.* This is a general purpose cabling of stranded wire. It is available with or without a protective jacket. Crosstalk is the most serious application problem encountered with this type of cable. If this type of cable is used to carry unbalanced signals, the signals must be of similar amplitude and speed.

3. *Coaxial cable.* This is a single-conductor cable with a braided and insulated shield. This has high-frequency controlled losses and a constant characteristic impedance. It may also be used as low-frequency shielded cable in a noisy environment.

The following general information should be considered when selecting cables:

- Shielded twisted-pair is generally considered the best type of cable.
- Shielded cable is preferred for high-speed digital signal applications and for use in industrial or noisy environments. The shield should be grounded according to the specific recommendations for the attaching device.
- Stranded conductor cable is easier to install and is less susceptible to conductor breakage than single strand conductor.
- The external protective jacket of the cable must withstand the environment in which it is installed. Temperature range, humidity range, and the possibility of chemical contamination must all be considered.