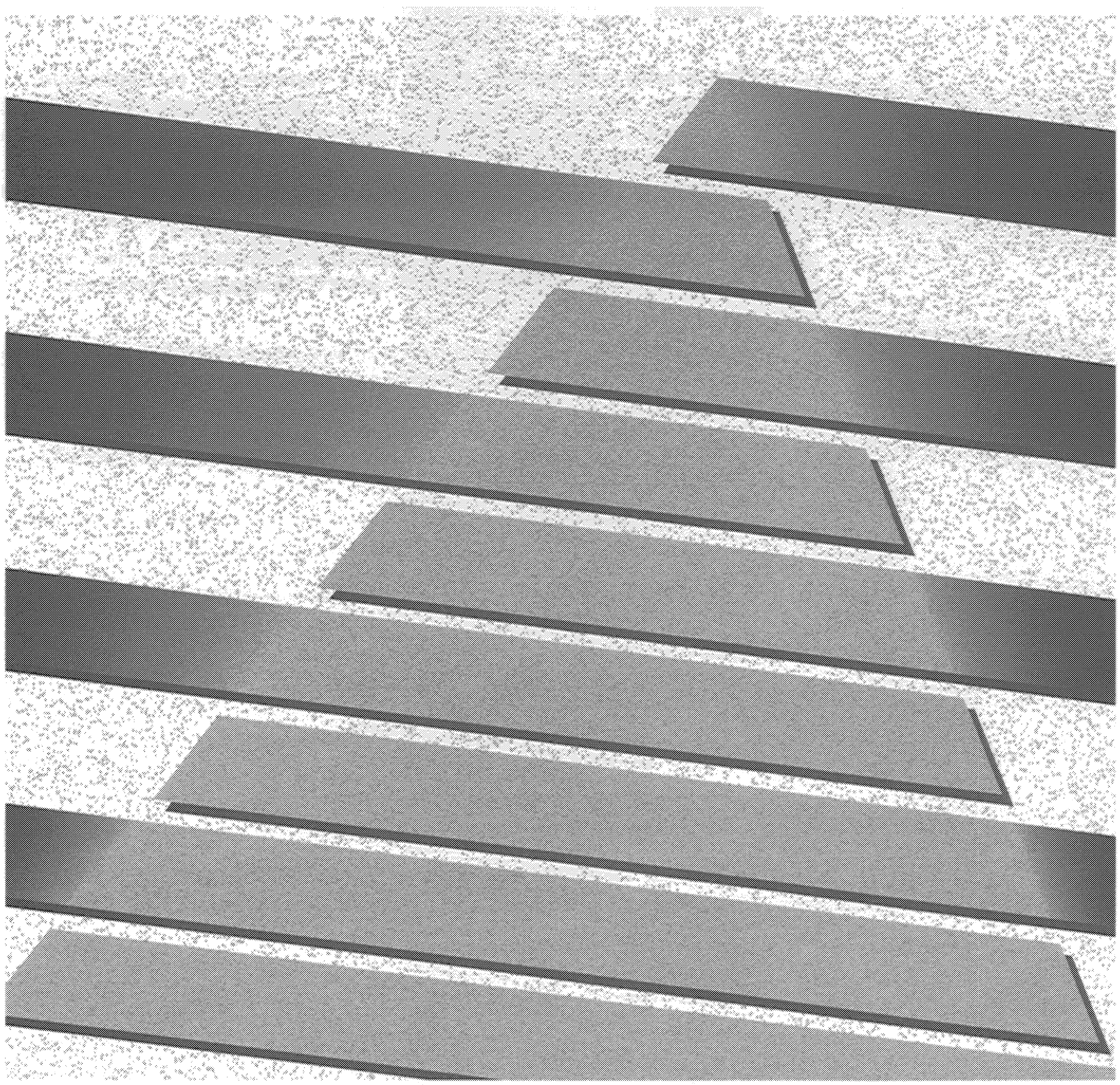
ALLEN-BRADLEY

IMC 120
Motion Control System

Installation Guide



Important User Information

Because of the variety of uses for the products described in this publication, those responsible for the application and use of this control equipment must satisfy themselves that all necessary steps have been taken to assure that each application and use meets all performance and safety requirements, including any applicable laws, regulations, codes and standards.

The illustrations, charts, sample programs and layout examples shown in this guide are intended solely for purposes of example. Since there are many variables and requirements associated with any particular installation, Allen-Bradley does not assume responsibility or liability (to include intellectual property liability) for actual use based upon the examples shown in this publication.

Allen-Bradley publication SGI – 1.1, *Safety Guidelines for the Application, Installation, and Maintenance of Solid State Control* (available from your local Allen-Bradley office), describes some important differences between solid-state equipment and electromechanical devices which should be taken into consideration when applying products such as those described in this publication.

Throughout this manual we make notes to alert you to possible injury to people or damage to equipment under specific circumstances.

WARNING: Tells readers where people may be hurt if procedures are not followed properly.

CAUTION: Tells readers where machinery may be damaged or economic loss can occur if procedures are not followed properly.

Warnings and Cautions:

- identify a possible trouble spot
- tell what causes the trouble
- give the result of improper action
- tell the reader how to avoid trouble

Important: We recommend that you frequently backup your application programs on an appropriate storage medium to avoid possible data loss.

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1.0 Chapter Overview

This chapter introduces you to this manual and gives you the following information:

- who we wrote this manual for
- what this manual contains
- how to use this manual effectively
- where to find more information

1.1 Manual Audience and Purpose

We wrote this manual for those who must perform the following tasks with the IMC 120 motion control system:

- configure the system
- plan panel layout
- unpack and inspect the system
- install the system components into the I/O chassis
- wire user devices (fast inputs and outputs, E-Stop circuitry, drives and feedback devices) to the system
- test the IMC 120 hardware using the handheld pendant

We assume that if you are using this manual, you know or are familiar with:

- reading wire and ladder relay diagrams
- installing drives and feedback devices

1.2 Manual Contents

This manual is designed to install and test your IMC 120 hardware. Where possible, it follows a "step-by-step" approach and gives you the information you need when you need it.

Figure 1.1 shows the "task flow" of this manual and table 1.A gives a brief overview of each chapter.

Figure 1.1
Task Flow Of This Manual

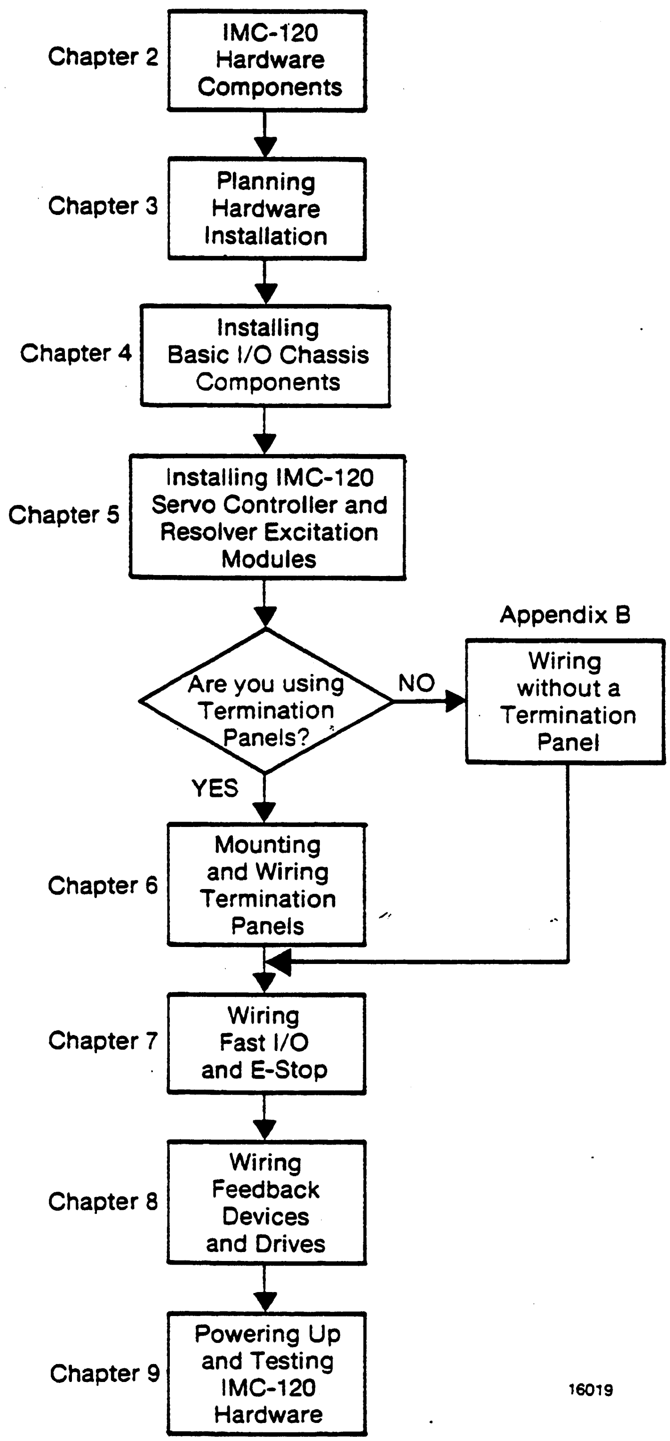


Table 1.A
What This Manual Contains

Chapter	Title	Purpose
2	Hardware Components	Hardware you need, components compatible with the IMC 120 system
3	Planning Installation	Laying out your IMC 120 system, unpacking, inspecting, and storage of system components
4	Installing Basic I/O Chassis Components	Installing your I/O chassis and power supply
5	Installing IMC 120 Servo Controller and Resolver Excitation Modules	Description of IMC 120 servo controller module and its plug-in memory cartridge, how to install the plug-in memory and replace its battery, description of resolver excitation module
6	Mounting and Wiring the Termination Panel	Termination panel features, mounting the termination panel, general wiring practices
7	Wiring Fast I/O and E-Stop Connections	Typical fast I/O connections and their equivalent circuits, wiring hardware over-travels, home limit switches, and trigger touch probes, wiring E-Stop for single, two or three, and four axis systems
8	Wiring Feedback Devices and Drives	Power limitations of encoders, connecting differential encoders, linear scales, resolvers, auxiliary feedback devices, wiring A-B drives
9	Powering Up and Testing IMC 120 Hardware	Testing E-Stop wiring without handheld pendant; Connecting off-line development system to download AMP parameters; plugging in the handheld pendant; testing the E-Stop button and fast I/O; integrating the axes..

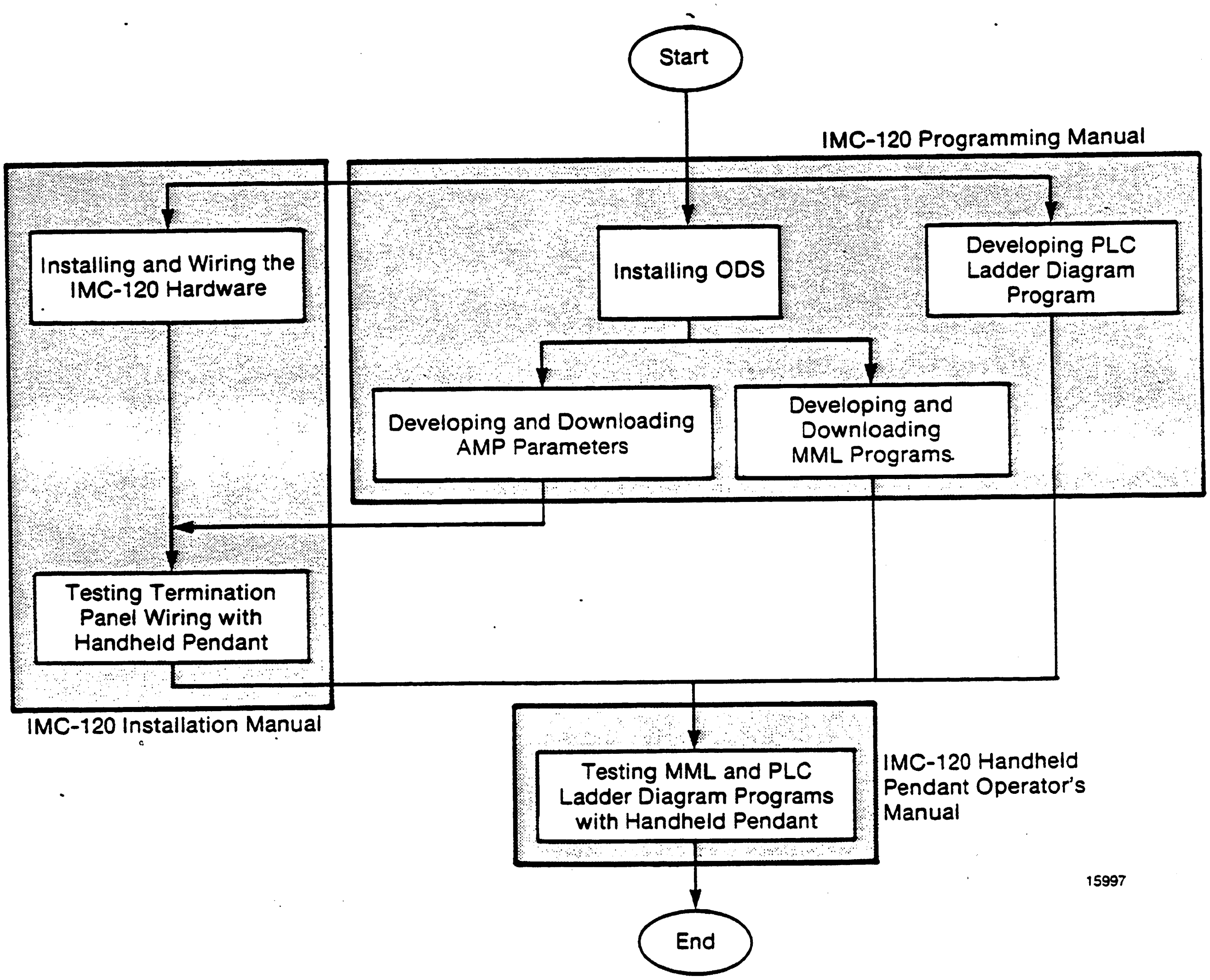
Table 1.A (Continued)
What This Manual Contains

Appendix	Title	Purpose
A	Cable Drawings	Drawings that show each IMC 120 cables wiring diagram, connectors pinouts, and specifications for making the cable
B	Wiring Without a Termination Panel	Pinout Signals for the servo controller and optional resolver excitation modules, maximum distances to user devices, how to use the wiring diagrams in chapters 7 and 8
C	Choosing a Resolver	Factors you should consider when choosing a resolver; resolver transformation ratio, rotor and stator impedence, maximum input current

1.3 Using This Manual

This manual is one of a series of manuals designed to help you install, program, test and operate an IMC 120 motion control system. Figure 1.2 shows you how this manual fits into the way we have provided this information.

Figure 1.2
Where This Manual Fits In



1.3.1 WARNINGs, CAUTIONs, and Important Information.

Information that is especially important to note is identified by three labels:

WARNING: informs you of circumstances or practices that can lead to personal injury as well as to damage to the control, the machine, or other equipment.

CAUTION: informs you of circumstances or practices that can lead to damage to the control, your machine, or other equipment.

Important: provides you with information that is important for successful application of the control.

1.3.2 Terms and Conventions

In this manual, we use the following terms and conventions:

- IMC 120 servo controller module - the servo controller
- <A> - the key marked A on the computer keyboard
- <ENTER> -the key on the computer keyboard marked ENTER, or RETURN.
- AMP - Adjustable Machine Parameters - parameters that specify axis and controller characteristics
- ODS - Offline Development System - application software that lets you use certain personal computers to create AMP and MML files and download them to the IMC 120 servo controller module
- MML - Motion Management Language for programming the motion of the axis the IMC 120 servo controller controls
- PLC - programmable logic controller - a processor that monitors and controls outputs
- E-Stop - emergency stop

1.4 Finding More Information

For more information on the IMC 120 motion control system, please contact your local Allen-Bradley sales office or distributor, or refer to these related publications:

Catalog Number	Title	Publication Number
1771-HS	IMC 120 Motion Control System Installation Manual	1771-6.5.45
1771-PS7	120/220V AC Power Supply With User Power Product Data	1771-2.123
1771-P7	AC (120/220V) 16 A Power Supply Product Data	1771-2.93
1771-HM	IMC 120 Plug In Memory Product Data	1771-2.124
1771-HR	IMC 120 Resolver Excitation Module Product Data	1771-2.125
1771-HT	IMC 120 Termination Panel Product Data	1771-2.126
1771-HD	IMC 120 Handheld Pendant Operator's Manual	1771-6.5.50
8100-HSKAR	IMC 120 Motion Control System Programming Manual	1771-6.5.51
1771-HCDOC	IMC 120 Motion Control System Installation Manual IMC 120 Handheld Pendant Operator's Manual IMC 120 Motion Control System Programming Manual	1771-6.5.45 1771-6.5.50 1771-6.5.51
1784-T50	Industrial Terminal T50 User's Manual	1784-6.5.1
1784-T50	Industrial Terminal T50 User's Manual Update	1784-6.5.1-DU1
1784-T45	Portable Programming Terminal User's Manual	1784-6.5.7
1784-T45	Setting Up Your 1784-T45 Portable Terminal	1784-6.5.7-DU2
1784-T35	T35 Plant Floor Terminal User's Manual	1784-6.5.6

2.0 Chapter Overview

In this chapter we discuss:

- hardware you need
- components compatible with the IMC 120 System

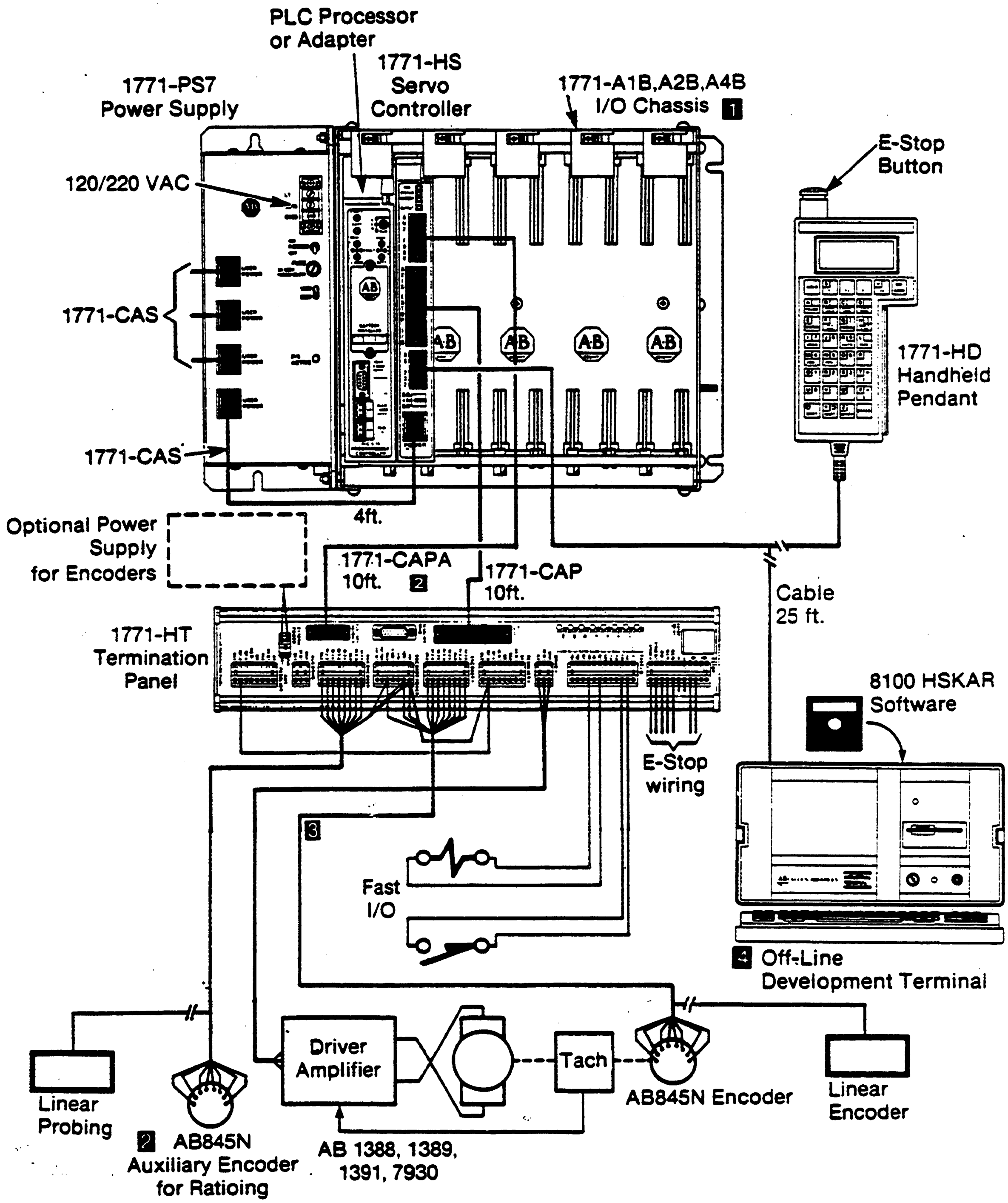
2.1 Hardware You Need

Hardware for the IMC 120 system consists of:

- IMC 120 system components
- components that are compatible with the IMC 120 system
- additional hardware

Figures 2.1 and 2.2 show IMC 120 encoder and resolver servo systems for one axis closed-loop systems. The type and quantity of hardware you need depends on how many axes your application needs. Consult your local Allen-Bradley sales engineer or distributor to help you select the right equipment for your application.

Figure 2.1
IMC 120 Single Axis Encoder System



1 1771-PS7 power supply and 1771-A3B mounting is different (see fig. 3.5)

2 The second encoder and the 1771-CAPA cable are needed only in ratioing and probing applications.

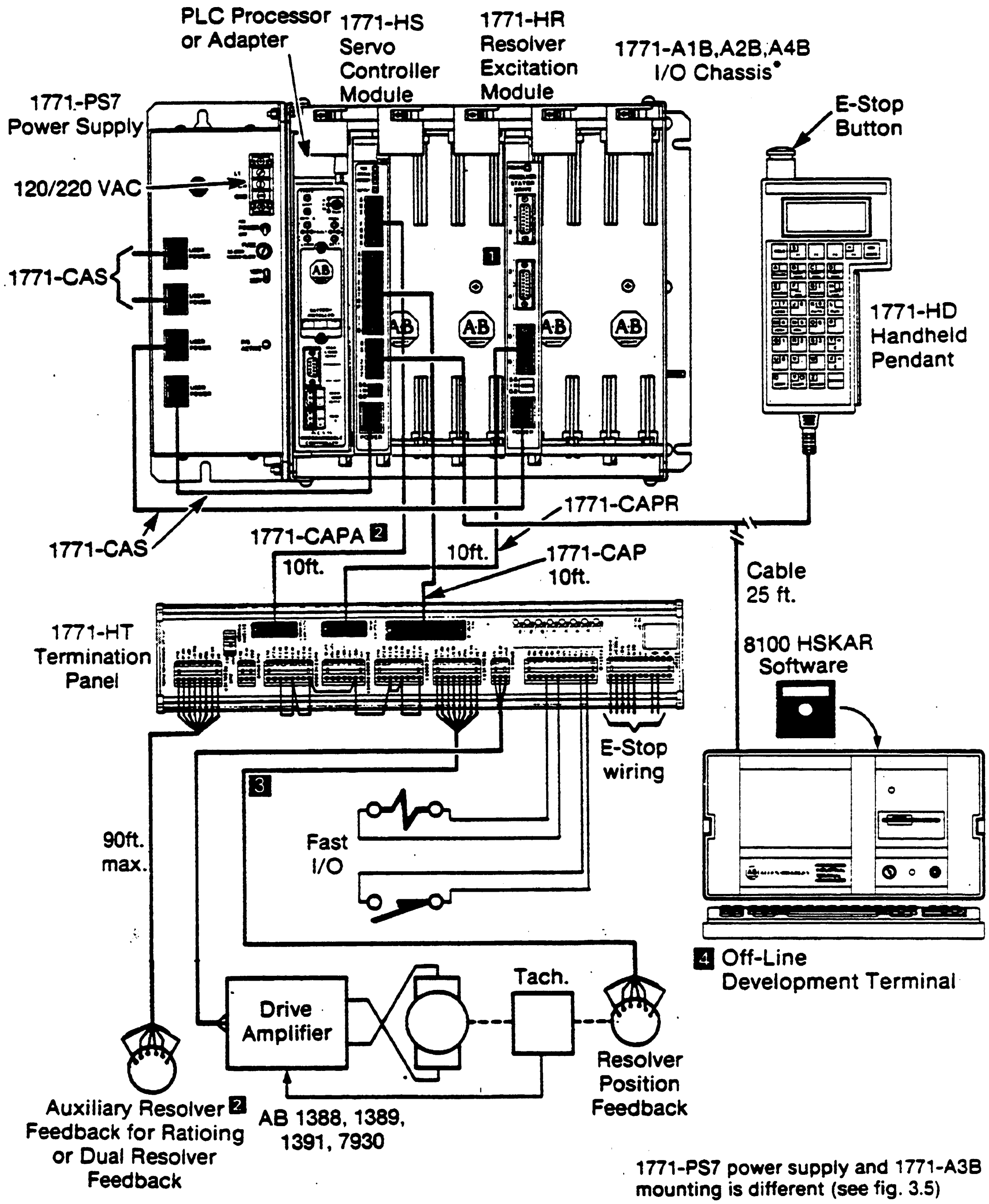
3 For distances over 90ft., contact the company.

4

Off-line Development Terminal:	Use with cable:
1784-T50	1771-CT50
1784-T45	1771-CT45
1784-T35	1771-CT50

15853

Figure 2.2
IMC 120 Single Axis Resolver System



1 Normally installed next to the Servo Controller Module.

2 The second encoder and the 1771-CAPA cable are needed only in ratioing and dual resolver feedback applications.

3 For distances over 90ft., contact the company.

4

Off-line Development Terminal:	Use with cable:
1784-T50	1771-CT50
1784-T45	1771-CT45
1784-T35	1771-CT50

15685

Select your IMC 120 system components from Table 2.A.

Table 2.A
IMC 120 System Components

Catalog Number	Description
IMC 120 Modules	
1771-HS	IMC 120 servo controller module includes a 1771-HM plug-in memory (32K) cartridge, a maximum of three servo controller modules are allowed per I/O chassis if resolvers are used. The number of encoder modules is limited by user side power from the PS7 power supply.
1771-HSA	IMC 120 servo controller module includes a 1771-HMA plug-in memory (96K) cartridge, a maximum of three servo controller modules are allowed per I/O chassis per qualifications stated for the 1771-HS module.
1771-HR	optional IMC 120 resolver excitation module, needed only with resolver feedback devices, one excitation module can serve 3 servo controller modules.
IMC 120 Memory Cartridges	
1771-HM	32K memory cartridge that plugs into the 1771-HS or 1771-HSA servo controller module; AMP parameters and application programs are stored in this memory
1771-HMA	96K memory cartridge that plugs into the 1771-HS or 1771-HSA servo controller module; AMP parameters and application programs are stored in this memory
Power Supply	
1771-PS7	power supply mounts on a I/O chassis and connects directly to 1771-A1B, 1771-A2B, or 1771-A4B I/O chassis; if you use 1771-A3B I/O chassis, 1771-PS7 power supply must be mounted on a backplate no more than 1 cable foot from its I/O chassis and is connected to the I/O chassis with a 1771-CA3B cable Important: The 1771-PS7 has power and current limitations. It is possible to exceed 1771-PS7 capacity with 1771 modules. Therefore, you must add up the current and power drawn by your selection of modules, and verify that they are within the 1771-PS7 capacity. See section 3.1, "Calculating Your Power Needs" for your IMC 120 power requirements and example calculations.
Optional Termination Panel	
1771-HT	one for each servo controller module you use, to wire E-Stop string, E-Stop Reset pushbutton, fast inputs and outputs, drives and feedback devices

Table 2.A (continued)
IMC 120 System Components

Catalog Number	Description
Optional Hand Held Pendant	
1771-HD	to operate and test IMC 120 system; includes cable to RS232 connector of servo controller module
Offline Development Systems	
1784-T50, 1784-T35, or 1784-T45	for programming AMP and MML (machine motion language) programs
Optional Cables	
1771-CAS	connects the 1771-PS7 power supply to a servo controller or resolver excitation module (one required for each servo controller or excitation module used)
1771-CT50	from the RS 232 connector on the servo controller module to 1784-T50 or 1784-T35 offline development systems
1771-CT45	from the RS 232 connector on the servo controller module to 1784-T45 offline development system
1771-CAPR	from the RESOLVER STATOR DRIVE connector of the resolver excitation module to the RESOLVER DRIVE connector on the 1771-HT termination panel
1771-CAP	from the AXIS ESTOP I/O connector on the servo controller module to the AXIS ESTOP I/O connector on the 1771-HT termination panel
1771-CAPA	from the AUX FDBK connector on the servo controller module to AUX. FEEDBACK connector on the 1771-HT termination panel
1771-CAD	spare cable that is used with 1771-HD handheld pendant
1771-CA3B	needed only to connect the backplane power connector of the 1771-PS7 power supply to the backplane connector of 1771-A3B (12 slot) chassis;
Software	
8100-HSKAR	3 1/2" or 5 1/4" floppy disk containing software used on the offline development system for: • entering AMP parameters and downloading them to the servo controller module • writing and editing application programs and downloading them to the servo controller module

2.2 Components Compatible with the IMC 120 System

The following components must be compatible with the IMC 120 system:

- the I/O chassis that houses the servo controller and resolver excitation modules
- the adapter or processor and I/O modules that are located in the same I/O chassis as the servo controller and resolver excitation modules
- drive and feedback (encoder or resolver) devices
- devices connected to fast inputs and outputs

In the following sections we will discuss these components.

2.2.1 Compatible Chassis

Compatible I/O chassis are available in four sizes:

- 1771-A1B (4 slot)
- 1771-A2B (8 slot)
- 1771-A3B (12 slot)
- 1771-A4B (16 slot)

Both servo controller modules and resolver excitation module (if required) are installed in the I/O chassis along with compatible modules.

2.2.2 Compatible Adapter and Processor Modules

The left most slot of each chassis accepts either an adapter module or a processor module. An I/O adapter module provides communication between the I/O modules and a programmable controller/scanner (figure 2.3). A processor module monitors inputs and controls outputs (figure 2.4).

The IMC 120 system is compatible with the following PLC in-rack processors and I/O adapters that support 1/2 slot addressing:

- 1771-ASB Adapter Module Series B Rev. A or later
- PLC 2/16 or PLC 2/17 Processor Module Series C Rev. A or later (compatible with built-in power supply)
- PLC 2/02 Processor Module (compatible with built-in power supply)
- PLC 5/15 Processor Module Series B Rev. A or later
- PLC 5/12 or PLC 5/25 Processor Module

Figure 2.3
1771-ASB Series B Adapter Module Providing Communication Between IMC 120 System and a PLC Scanner

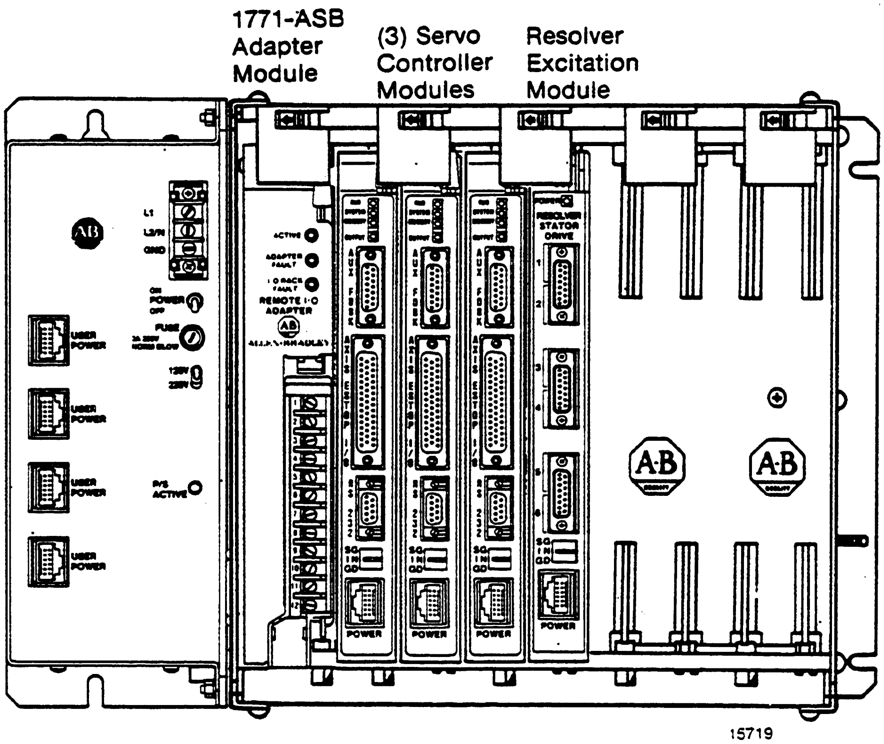
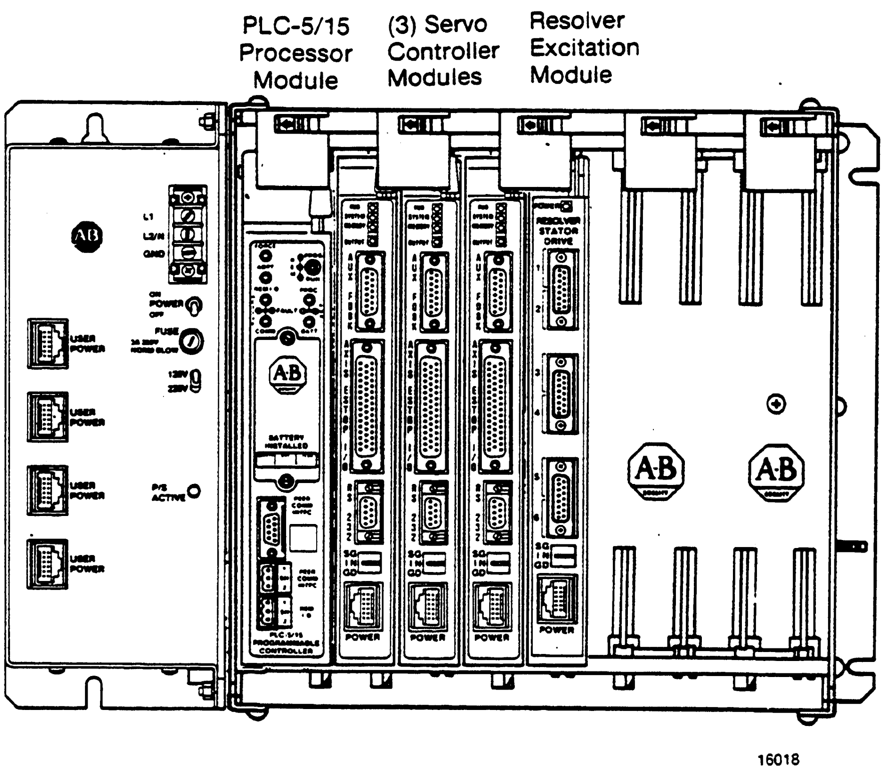


Figure 2.4
PLC 5/15 Series B Rev. A Processor Module Monitoring and Controlling an IMC 120 System



2.2.3
Intelligent I/O Modules Incompatible with IMC 120

Here is a list of modules that **cannot** be placed in the same 1771 chassis with a servo controller module:

- 1771-QC (closed loop positioning module)
- 1771-QA (open loop positioning module)
- 1771-IF (8 single-ended analog inputs) when combined with expander input module, 1771-E1, E2, or E3
- 1771-OF (4 single ended analog outputs) when combined with the expander output module, 1771-E4
- 1771-IX (6 floating differential thermocouple inputs) or 1771-IY (6 floating differential thermocouple input expander)

2.2.4
Compatible A-B Drive Systems

The IMC 120 supports Allen-Bradley Series 1388, 1389, 1391, and 7930 servo drive systems.

Table 2.B lists references that help you select a suitable drive system.

Table 2.B
A-B Drives Selection Guide References

A-B Drive	Publication No.	Title
1388/7930	7900-4.3	Series 7900 DC Servo Drive Selection Guide
1389	1389-2.0	Bulletin 1389 AC Servo Amplifier System Product Data Sheet
1391	1391-2.0	Bulletin 1391 AC PWM Servo Controller Product Data Sheet

The servo controller module provides a ± 10V analog output to one drive amplifier for a velocity command. This analog voltage is 12 bits plus an additional sign bit (13 bits total) and interfaces to drive amplifiers with a 2K-20K ohm range. Table 2.C shows servo drive signal ANALOG OUT specifications.

Table 2.C
Servo Controller Module Drive Reference Signal Specifications

Resolution
- 13 bits or 2.44 mV/bit

Output Voltage Swing
- ± 10V

Load Range
- 2K-20K ohms

Conversion Time
- 28us

Output Step Response (20V swing)

rise time	120us typical
overshoot	5% typical
settling time	60us typical

Differential Linearity
- ± 1 LSB Max.
  (Monotonic over the entire temperature range)

Output Offset Voltage
- 500uV max

Gain Error Drift
- 7 LSB max

2.2.5 Compatible Encoders

The IMC 120 system supports Allen-Bradley AB-845N differential encoders. Other encoders may be compatible if they comply with the specifications listed in Table 2.D.

Table 2.D
IMC 120 Compatible Encoder Specifications

Maximum Channel Frequency:

Incoming quadrature frequency is limited by the following relationship:

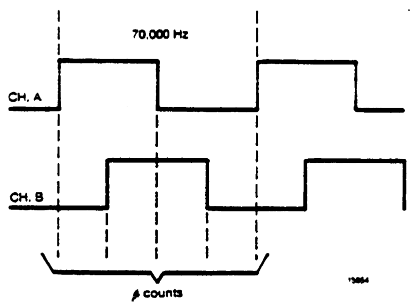
F_{CHAN} (HZ) = 1111.11 (90-E_Q)

where E_Q = quadrature error (degrees,electrical)

Example:

for an AB845N encoder with a 27^0 quadrature error, the maximum frequency is:

F = 1111.11 (90-27^0 quadrature error) = 70,000 Hz



#counts/sec = 4 counts/cycle x 70,000 cycles/sec
= 280,000 counts/sec

Input Signal:

Encoder feedback must be differential with 5V compatible output signals, open-collector outputs are not supported.(i.e. channels A, B, and Z must have source and sink current capability, 8830 line driver outputs or equivalent)

Input Sink current:

7mA maximum

Marker Channel:

Gated or ungated type markers are supported;

Encoder Cable Length:

50 feet limit when using +5V from servo controller module; 100 feet when using +15V from servo controller module; 100 feet limit when using customer supplied power supply.

2.2.6 Compatible Resolvers (2.5K Hz)

Table 2.E lists of resolvers gives a number of resolvers that are potentially compatible with the IMC 120 resolver interface specifications (table 2.F). It is your responsibility to determine which resolvers are best suited in any particular application. Read Appendix C, How to Choose a Resolver.

Table 2.E
List of Resolvers

Harowe

Model #	*Speed*[1]	*Rotor Output*
11BRW-300-F	x1	3.3V RMS
11BRW-300-K	x1	3.4V RMS
11BRCT-300-F	x2	3.4V RMS
11BRCT-300-M	x2	6.9V RMS
11BRCT-300-T	x4	2.8V RMS
11BRCT-300-U	x5	1.6V RMS

Clifton

Model #	*Speed*[1]	*Rotor Output*
11-BHW-0IE	x1	2.7V RMS
11BHM-6F	x4	6.2V RMS
11BHM-4F	x5	4.0V RMS
11BHM-8HV	x10	2.0V RMS
11BHW-29	x1	3.1V RMS

1. Speed =# of electrical cycles per revolution of resolver = # of poles divided by 2

Table 2.E (continued) List of Resolvers

Singer Kearfott

Model #	*Speed*[1]	*Rotor Output*
CR4-1095-004	x1	3.4V RMS
CR4-1095-020	x4	3.3V RMS
CR4-1095-042	x2	7.6V RMS
CR4-1095-043	x2	7.6V RMS
CU9-1095-001	x1	3.4V RMS
CU9-1095-002	x1	3.4V RMS
CU9-1095-201	x2	3.3V RMS
CU9-1095-501	x5	2.8V RMS
CU9-1095-101	x10	1.8V RMS
CU9-1095-103	x10	1.8V RMS
CU9-1095-104	x10	1.8V RMS

Transicoil

Model #	*Speed*[1]	*Rotor Output*
11BRC-U27199	x1	3.4V RMS
11BRC-U217805	x2	3.3V RMS
11BRC-U217886	x5	1.2V RMS

Tamagawa Seiki

Model #	*Speed*[1]	*Rotor Output*
TS530N33E9	x1	3.9V RMS
TS20MN55E1	x5	1.7V RMS

1. Speed = # of electrical cycles per revolution of resolver = # of poles divided by 2

Table 2.F
IMC 120 Compatible Resolver Specifications

Rotor Input Amplitude[1] (line to line)	1VRMS min.
Rotor Input Impedence:	4750 ohms (line to line)
Zero Cross Detection Uncertainty[2]:	$\pm$ 1LSB
Resolution:	4000 counts/electrical cycle or 100 ns/count
Max. RPM:	18,750/P where: P = # of resolver poles = (# of electrical cycles/rev. of the resolver) x 2
Max. Servo Velocity (IPM):	(3.75×10^7/P)x(servo resolution) where: P = # of resolver poles = (# of electrical cycles/rev. of the resolver) x 2 servo resolution = # in./ count

.Example: A 2 pole resolver is connected to a 5 revs/inch ball screw.

What is the servo resolution?

2 pole = 1 electrical cycle/rev

$$\text{servo resolution} = \frac{1 \text{ revolution}}{\text{elec. cycle}} \times \frac{1 \text{ elec. cycle}}{4{,}000 \text{ counts}} \times \frac{1 \text{ inch}}{5 \text{ revolutions}}$$

$$\text{servo resolution} = \frac{.00005 \text{ in}}{\text{count}}$$

What is the maximum allowable resolver RPM[3]?

$$\text{Max. RPM} = \frac{18{,}750}{P} = \frac{18750}{2} = 9{,}375 \text{ RPM}$$

What is the maximum servo velocity?

$$\text{Max. Velocity} = \left(\frac{3.75 \times 10^7}{2}\right) \times (50 \times 10^{-6} \text{ counts}) = 937.5 \text{ in/min}$$

---

1. Rotor input amplitude is specified when connected to the servo controller module. Not open-circuited.

2. Zero cross uncertainty represents position error drift over temperature assuming all other conditions are ideal. Therefore it does not represent the complete system error, but rather just the servo controller module's contribution to that error.

3. Resolver mechanical constraints may limit this to a lower value.

2.2.7
Compatible Fast Inputs and Outputs

The fast I/O (FIN1-FIN4, FOUT1-FOUT4) are 24VDC compatible and are designed to be used in conjunction with the 1771-PS7 power supply. Potential 24VDC I/O devices should be reviewed for compatibility with the electrical specifications in table 2.G.

Table 2.G
Fast Input and Output Electrical Specifications

OUTPUTS (SOURCE DRIVERS)		CONDITIONS
V_{oh} (high level on-state output voltage)	Min 19V Typ 23V Max 26V	I_{oh} = Max
I_{oh} (high level on-state output current for each output)	Max 100MA	
Off-State Output Leakage Current (Output Shorted To Gnd)	Max 200uA	
Total Short Circuit Trip Current For All 4 Fast Outputs	Min 480MA Typ 604MA Max 777MA	Note 1
Over Current Protection Trip Delay	Min 65us Typ 120us Max 200us	Note 1
Output Surge Current (each output)	Max 150MA for 0.5 sec	Note 2
INPUTS		
V_{T+} (Input Low-High Trip Threshold)	Min 7.2V Typ 11.5V Max 16.1V	
V_{T-} (Input High-Low Trip Threshold)	Min 4V Typ 7.4V Max 11.4V	
V_{HYST} (hysteresis)	Min 1.9V Typ 4.1V Max 6.5V	
I_{IN} @ 27V	Max .50MA	
T_{PD+} (Input Low-High Debounce Filter)	Min 0.63MS Typ 1.07MS Max 1.83MS	
T_{PD-} (Input High-Low Debounce Filter)	Min 0.57MS Typ 1.04MS Max 1.78MS	
V_{IN-} (Absolute Max.)	Max $\pm$75V	

Note 1: Servo controller module monitors the total fast output current. During steady state conditions it should not exceed (4 outputs x 100mA/output) or 400mA. If the total output current exceeds the minimum trip value (480 mA), the servo controller interprets this condition as a short circuit and turns off all the outputs after the over-current trip delay time has elapsed. The trip delay serves as a filter to guard against nuisance faults yet protects the outputs if there is a short circuit.

Note 2: This is the surge rating for one output and it assumes that the total current for all 4 fast outputs is below the short circuit detection point.

3.0 Chapter Overview

In this chapter we discuss:

- calculating your power needs
- laying out back panel spacing
- unpacking and inspecting system components

3.1 Calculating Your Power Needs

You must determine the power requirements of IMC 120 and non-IMC 120 modules so that you don't exceed the 1771-PS7's wattage capacity.

To determine power requirements use the following steps:

1. Add up IMC 120 module power requirements
2. Add up non IMC 120 module power requirements
3. Subtract power requirements calculated in steps 1 and 2 from the 1771-PS7 power supply capacity to see if the 1771-PS7 can handle the full system load.
4. If there is not enough power, either split modules into different chassis, or consider using a 1771-PS7 for user side power and a 1771-P7 power supply (refer to Publication No. 1771-2.93) for backplane power. Go back to Step 1 with the proposed new configuration and redo the whole procedure.

3.1.1 Add Up IMC 120 Power Requirements

The 1771-PS7 power supply is limited to a total of 100 watts of power. Each IMC 120 module, however, has two sets of circuits that are electrically isolated: backplane and user side.

To support this electrical isolation, the 1771-PS7 internally is really two isolated power supplies that have their own power limitations; 80 Watts for the backplane side and 65 Watts for the user side.

When adding up IMC 120 power requirements, one must separately add up the backplane and user side power requirements.

IMC 120 Module Power Requirements

Table 3.A lists the power requirements of the backplane and user side of each IMC 120 module.

Table 3.A
IMC 120 Module Power Requirements

	Backplane Power	User side Power
Servo Controller Module (1771-HS)	3.6W	5.1W
Resolver Excitation Module (1771-HR)	.4W	7.8W

These power requirements include the power drawn by each module internally as well as the power drawn by the following external devices:

- Resolvers (up to max loading allowed by resolver module)
- Drive Out (2K max load)
- Fast Inputs (Fins)
- E-Stop String (50ma. max allowed per 1771-HS)
- Handheld Pendant

These external devices were included because they either draw very little power or draw about the same power from installation to installation.

The IMC 120 module power requirements do not include the power requirements for encoders or fast outputs (Fouts). Since fast outputs and encoders can use substantial amounts of power (up to 36.3W max for three servo controller modules), you must calculate the power drawn by these devices and add them to the IMC 120 module requirements.

If you don't use all this power, you can use it on the backplane for other 1771 modules.

To Calculate Encoder Power

Encoder Power = (encoder voltage) x (maximum encoder current). Table 3.B lists encoder power calculation examples for 5V and +15V encoders. Encoder power is added to the user side power requirements, but it has no effect on the backplane side.

Table 3.B
Encoder Power Calculations Examples

Encoder Voltage	Max. Current (Amps)	Total Power (Watts)
+5V	.25 A.	1.25W
+15V	.1 A	1.5 W.

To Calculate Fast Output (Fout) Power

Each Fout is rated at 24V. Thus, fast output power = (24V) x (maximum current drawn for that output). Add up the power on all fast outputs and then add this totaled power to the user side requirements; it has no effect on the backplane side.

Table 3.C lists two examples of fast output calculations for:

- 12 Fouts (using 3 servo controller modules) that draw their maximum of 100 ma. each
- two Fouts that draw 50 ma. max each

Table 3.C
Fast Output Calculations

# of Fouts	Fast Output Voltage	Maximum Current (Amps)	Fast Output Power (Watts)
12 x	(24V) x	(.1A)	= 28.8 W user side.
2 x	(24V) x	(.05A)	= 2.4W user side.

From these examples you can see that you have the opportunity to save a lot of watts by reducing the current or number of Fouts.

To Calculate Total IMC 120 Power Requirements

To calculate the total power required by the IMC 120 subsystem, you merely add up the appropriate watts for each IMC 120 module, and then add in the power needed for the fast outputs and encoders. You must track backplane and user watts separately.

Example 1

3 servo controller modules (1771-HS)
3 encoders 5V @ 250 ma. max
12 Fouts @ 100 ma. max each

	Backplane Watts	User Watts	Total Watts
3 servo modules	(3.6W)(3 units) = 10.8W	(5.1W)(3 units) = 15.3W	26.1W
3 encoders	(0W)(3 units) = 0W	(5V)(.25A)(3 units) = 3.75W	3.75W
12 Fouts	(0W)(12 fouts) = 0W	(24V)(.1A)(12 fouts) = 28.8W	28.8W
Total Watts	10.8W	47.85W	58.65W

Example 2

2 Servo controller modules using 4 encoders 5V @ 250 ma. max.
1 Servo Controller module using 2 resolvers
1 Resolver excitation module
12 Fouts @ 100ma. max each
(Note: This is the most power demanding IMC 120 subsystem possible using 3 controllers or less.)

	Backplane Watts	User Watts	Total Watts
3 servo modules	(3.6W)(3 units) = 10.8W	(5.1W)(3 units) = 15.3W	26.1W
1 resolver module	(.4W)(1 unit) = .4W	(7.8W)(1 unit) = 7.8W	8.2W
4 encoders	(0W)(4 units) = 0W	(5V)(.25A)(4 units) = 5.0W	5.0W
12 Fouts	(0W)(12 fouts) = 0W	(24V)(.1A)(12 fouts) = 28.8W	28.8W
Total Watts	11.2W	56.9W	68.1W

3.1.2
Add Up Non-IMC 120 Module Power Requirements

Non IMC 120 modules draw:

- their backplane power from the 1771-PS7 power supply
- their user power from an external user supplied power supply (if any).

Therefore, only backplane power is considered here.

For both examples 1 and 2, assume the non-IMC 120 modules are:

- one PLC-2/16 (backplane +5V @ 1.25A)
- two IAD double density AC input modules (backplane +5V @ .25A each module)
- two OAD double density AC output modules (backplane +5V @ .7A each module).

Example: Non IMC 120 Power Requirements

	Backplane Watts	1771-PS7 User Watts	Total Watts
PLC-2/16	(5V)(1.25A) = 6.25W	OW	6.25W
2 IAD's	(5V)(.25A)(2 units) = 2.5W	OW	2.5W
2 OAD's	(5V)(.7A)(2 units) = 7.0W	OW	7W
Total non IMC 120 requirements	15.75W	OW	15.75W

3.1.3
Subtract IMC 120 and NON IMC 120 Power Requirements From 1771-PS7 Capacity

The 1771-PS7 power supply can deliver no more than 100 total watts (the sum of backplane and user side watts). In addition, no more than 80W can be drawn on the backplane side, and no more than 65W can be drawn from the user side. These three requirements must always be met.

Example 1 (Continuation of Example 1 From Step 1)

	Backplane Watts	User Watts	Total Watts
1771-PS7 Capacity	80.0W	65.0W	100.0W
IMC 120 requirements (from Step 1)	-10.8W	-47.85W	-58.65W
Non IMC 120 requirements (from step 2)	-15.75W	-0.0W	-15.75W
Left over 1771-PS7 Capacity	+53.45W	+17.15W	+25.60W

Neither the backplane (80W), user side (65W), nor total system (100W) watt capacity is exceeded. This configuration works, and has 25.60W to spare.

3.1.4 *If the 1771-PS7 Capacity Is Exceeded?*

If the 1771-PS7 capacity is exceeded, you can:

- split your cards into several chassis and use two supplies.
- use the 1771-PS7 for the user side only by mounting it nearby the chassis and then mount a 1771-P7 power supply (refer to Publication 1771-2.93) to the chassis to provide backplane power.

Using the 1771-P7 power supply to provide backplane power only gives you 65W maximum on the user side (1771-PS7 maximum limit) and 80W on the backplane side (1771-P7 maximum limit) for a total of 145W maximum.

3.1.5 Current Requirements According to Each 1771-PS7 Output Voltage

Table 3.D lists the current (Amperage) requirements according to each 1771-PS7 output voltage for each IMC 120 module.

Table 3.D
Servo Controller and Resolver Excitation Current Requirement

	Servo Controller Module		Resolver Excitation Module	
	AMPS	WATTS	AMPS	WATTS
+5V backplane	.720	3.6	.065	.4
+5V user	.310	1.6	.340	1.8
+15V user	.070	1.1	.207	3.1
-15V user	.017	.3	.192	2.9
+24V user	.086	2.1	0.000	0.0

Table 3.E lists the 1771-PS7 power supply's regulation current limits for each output voltage.

Table 3.E
1771-PS7 Regulation Current Limits

1771-PS7 Output Voltage	AMPS Allowed
+5V backplane	0 - 16A
+5V user	0 - 8A
+15V user	0 - 2A
-15V user	0 - 2A
+24V user	0 - 2.5A

3.2 Laying Out Your IMC 120 System

A well-planned layout is essential to the proper installation of the IMC 120 system. You should consider the following factors when planning the installation of your system:

- where to locate your IMC 120 system
- how to protect your IMC 120 system

The layout depends on the types and numbers of components that make up your IMC 120 system. The maximum distances between components is limited by cable lengths. The minimum component spacing is limited by environmental and electrical noise interference considerations.

Factors that influence your systems environment are temperature and humidity. Factors that influence electrical noise interference include:

- wire routing
- module placement within the I/O chassis
- noise suppressors
- component grounding

You should plan module placement and raceway layout in conjunction with one another. We, however, will look at them separately.

3.2.1 Environment

Your primary concern in installing your IMC 120 system components should be determining the proper environment in which to install it. IMC 120 system components (excluding the handheld pendant and the 1784-T50, 1784-T45, or 1784-T35 off-line development system) require:

- an operating temperature: 0 to 60° C (32° to 140° F) measured 1" below the chassis
- a storage temperature: -40° to 85° C (-40° to 185° F)
- relative humidity: 5 to 95% (without condensation)

The temperature of the air must not exceed 60°C (140°F) at any point immediately below any I/O chassis or power supply. The failure rate of semiconductor devices may increase significantly if the temperature is raised above 60°C. Furthermore, a significant decrease in the failure rate of the semiconductor devices can be expected for every degree below 60°C that the ambient temperature can be kept.

The temperature is higher toward the top of an enclosure that houses system components. Factors that determine the temperature in the enclosure include:

- the size of the enclosure
- the power dissipation within the enclosure
- the temperature of the air surrounding the enclosure.

Power dissipation includes not only the power dissipated through the power supplies for the I/O chassis backplanes, but also the user supplied power dissipated through the input and output circuits.

To allow necessary air flow for cooling of components, see figure 3.1 and follow these rules:

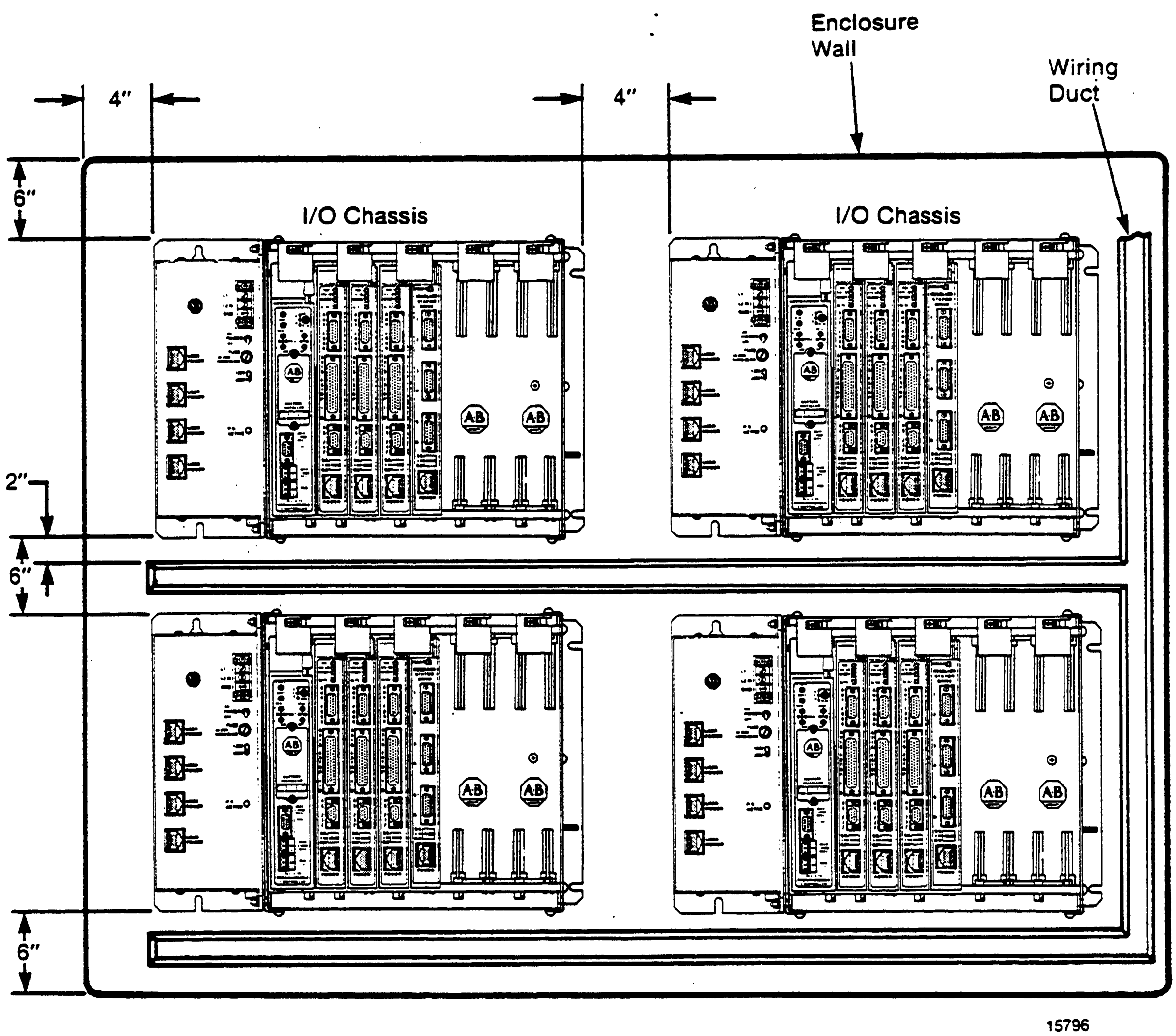
1. Minimum vertical separation between chassis and the top and bottom of the enclosure is 6 inches. (figure 3.1).

2. Minimum horizontal separation between chassis and enclosure sides is 4 inches.

3. Leave any excess space at the top of the enclosure where the temperature is the highest.

4. Wiring ducts and terminal strips should be mounted no closer than 2 inches from any chassis.

Figure 3.1
Minimum Spacing for Cooling Air Flow



Using Fans and Air Conditioning

In cases where a substantial amount of heat is being produced by equipment inside or outside the enclosure, place fans inside the enclosure to:

- assist air circulation
- eliminate "hot spots" near the I/O sub-system components

However, do not bring in unfiltered outside air. It introduces harmful contaminants and dirt.

In extreme cases, air conditioning may be required to guard against excessive internal enclosure temperatures.

3.2.2 Wire Routing

Wire routing of an IMC 120 system is related to where the different types of modules are placed in the I/O chassis. Therefore, you should determine module placement before you layout and install your system. When planning your wire routing, classify all wires and cables connecting your IMC 120 system into the following categories.

Category 1 Conductors

In general, Category 1 conductors are high-power conductors that are more tolerant of electrical noise than category 2 conductors. However, they may also generate more noise.

Category 1 conductors includes:

- **AC power lines**
- **High-power AC I/O lines** -- Connected to AC I/O modules that are rated for high power and high noise immunity.
- **High-power DC I/O lines** -- Connected to DC I/O modules that are rated for high power or have input circuits with long time constant filters for high noise rejection. They typically connect to devices such as:
  - hard-contact switches
  - relays
  - solenoids

Category 2 Conductors

In general, category 2 conductors are low-power conductors that are less tolerant of noise than category 1 conductors. They should also generate less noise. All IMC 120 cables and termination panel wiring are in this category. Category 2 conductors include:

- **Serial communication cables** -- Connected to programming terminals, data terminals, and from the scanner to remote I/O adapter modules, or PLC processors.
- **Low-power DC I/O lines** -- Connected to DC I/O modules that are rated for low power and have input circuits with short time constant filters to detect short pulses. They typically connect to devices such as:
  - proximity switches
  - photo-electric sensors
  - TTL devices
  - encoders and resolvers
  - motion control devices
  - analog devices
- **Low-power AC/DC I/O lines** -- Connected to I/O modules that are rated for low power such as low-power contact-output modules.

Category 3 Conductors

Category 3 conductors interconnect IMC 120 system components within an enclosure. They include I/O chassis power cables, 1771-CAS, that provide backplane power to I/O chassis.

Wire Routing Guidelines

The following are general guidelines for routing wires and cables for your IMC 120 system installation. These guidelines apply to wire and cable routing both inside and outside of the enclosure. Follow these guidelines to guard against coupling noise from one conductor to another.

1. You can route all category 1 conductors with machine power conductors of up to 600V AC (feeding up to 100 hp devices) if this does not violate local codes. Article 300-3 of the National Electrical Code requires that all conductors (AC and/or DC) in the same raceway must be insulated for the highest voltage applied to any one of the conductors in the raceway.

2. Properly shield all category 2 conductors, where applicable, and route them in separate raceways. If category 2 conductors must cross power feed lines, they should do so at a right angle.

3. Route category 2 conductors at least 1 foot from 120V AC power lines, 2 feet from 240V AC power lines, and 3 feet from 480V AC power lines.

4. Route category 2 conductors at least 3 feet from any electric motors, transformers, rectifiers, generators, arc welders, induction furnaces, or sources of microwave radiation.

5. If a category 2 conductor is in a metal raceway or conduit, that raceway or conduit must be well grounded along its entire length.

6. All category 3 conductors should be routed external to all raceways or in a raceway separate from any category 1 or category 2 conductors.

3.2.3 Module Placement

All the IMC 120 system modules should be:

- in adjacent slots within a chassis
- kept as far away as possible from all DC and AC I/O modules

A good strategy is to place the IMC 120 system modules on the left side of the chassis along with other intelligent I/O modules and the processor/adapter. Then place any DC and AC I/O modules on the right side of the chassis, leaving any empty slots between these two groups.

This placement protects the intelligent (CPU based) modules from the heat and electrical noise of the DC and AC I/O modules.

When planning your module placement you must:

- Classify the modules that you are using into their conductor categories and follow the guidelines indicated in section 3.2.4.

  You should divide modules, as much as possible, into the following types:

  - AC
  - high level DC
  - low level digital DC (TTL, encoder, pulse output),
  - analog I/O

  If a complete I/O chassis cannot be reserved for one of these types of modules, one end of an I/O chassis can be reserved for one type of modules, and the other end for another type. If there is to be a blank I/O slot, choose a slot between two groups of different types of modules to further separate them.

- Consider the number of slots each module occupies. .

  Module placement in an I/O chassis is determined by the following guidelines:

  - any single-slot module can be placed into any slot.

  - any 2-slot module must be placed into two slots of an even/odd pair (0/1, 2/3, 4/5, 6/7, 8/9, 10/11, 12/13, 14/15). Never have a module straddle two slot pairs.

  - separate input modules from output modules because output circuits can conduct more current than input circuits.

3.2.4
Suppressing Noise Interference

Special considerations should be given to possible electrical noise interference. Potential noise generators include inductive devices such as:

- relays
- solenoids
- motors
- motor starters

You'll need suppression for electrical noise generators when inductive devices are connected:

- as output devices
- on the same AC power line that powers your processor

Figure 3.2 shows what suppressors you need to reduce electrical noise. Table 3.F lists each suppressor that complements our equipment.

Figure 3.2
Noise Suppression Equipment to Reduce Electrical Noise

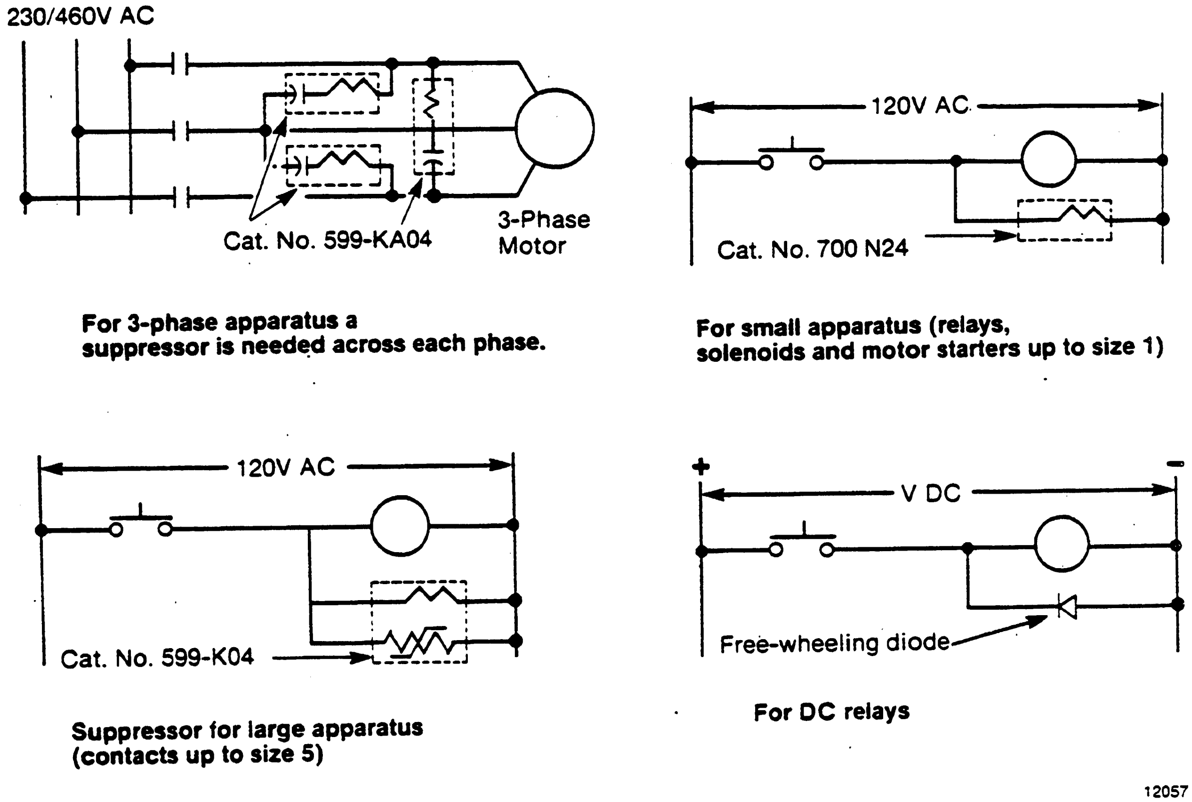


Table 3.F
Allen-Bradley Suppressors

Suppressor Cat. No.	Allen-Bradley Equipment
599-K04[1]	Motor Starter Bulletin 509
1401-N10[1]	Motor Starter Bulletin 709
700-N24[2]	Relay Bulletin 700 Type N or P
700-N24[3]	Miscellaneous

1 For starters with 120V AC coils.
2 Maximum coil voltage 150V AC or DC
3 The 700-N24 is a universal surge suppressor. You can use it on electromagnetic devices with the limitation of 35 VA (sealed), 150 V.

3.2.5 Grounding

Grounding is important for safety in electrical installations. With solid-state controls, proper grounding (including elimination of ground loops) has an added value of reducing the effects of electrostatic and electromagnetic interference. Providing a low-impedance path to earth-ground potential reduces the chances of EMI causing your IMC 120 system to malfunction.

An authoritative source for grounding requirements is the National Electrical Code. Article 250 of the code provides such information as the size and types of conductors and methods of grounding electrical components.

As defined in the code, a grounding path must be permanent and continuous, and must be able to safely conduct ground-fault current that may occur in the system to ground with minimum impedance. Also, the connections to a grounding conductor must be of a permanent nature. Local codes and ordinances dictate which grounding method is permissible.

3.2.6 Space Requirements

Pick an enclosure that will house I/O chassis, PLCs, power supplies, and termination panels that you need for your application. There also needs to be space for transformers, fusing, a disconnect switch, a master control relay, and terminal strips.

19 Inch Rack Mounting

IMC 120 system components are usually mounted on a backpanel, which in turn is mounted in the enclosure. However, the mounting brackets on a 12-slot I/O chassis can be removed from the back edge of the chassis and re-assembled onto the front edge of the chassis to mount it in a 19-inch rack.

For I/O chassis, 1771-PS7 power supply, and termination panel spacing and dimensions see figures 3.3 through 3.6. Refer to your processor installation manual for your PLC dimensions.

Figure 3.3
Mounting Dimensions of 1771-PS7 Power Supply

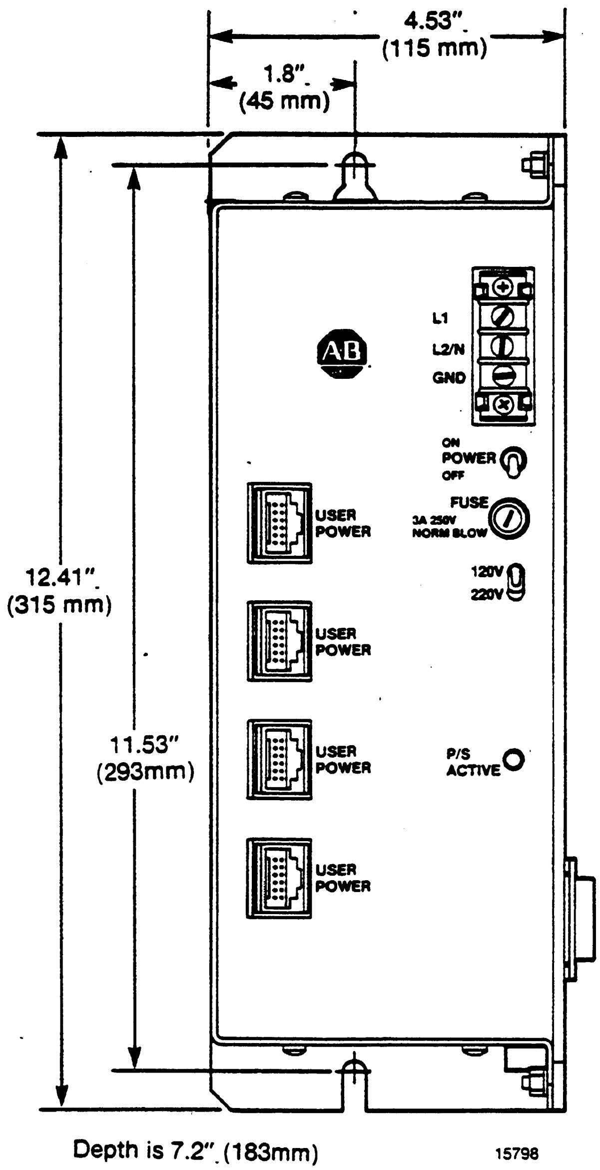


Figure 3.4
Mounting Dimensions of 4-slot, 8-slot, and 16-slot Series B I/O Chassis with 1771-PS7 Power Supply

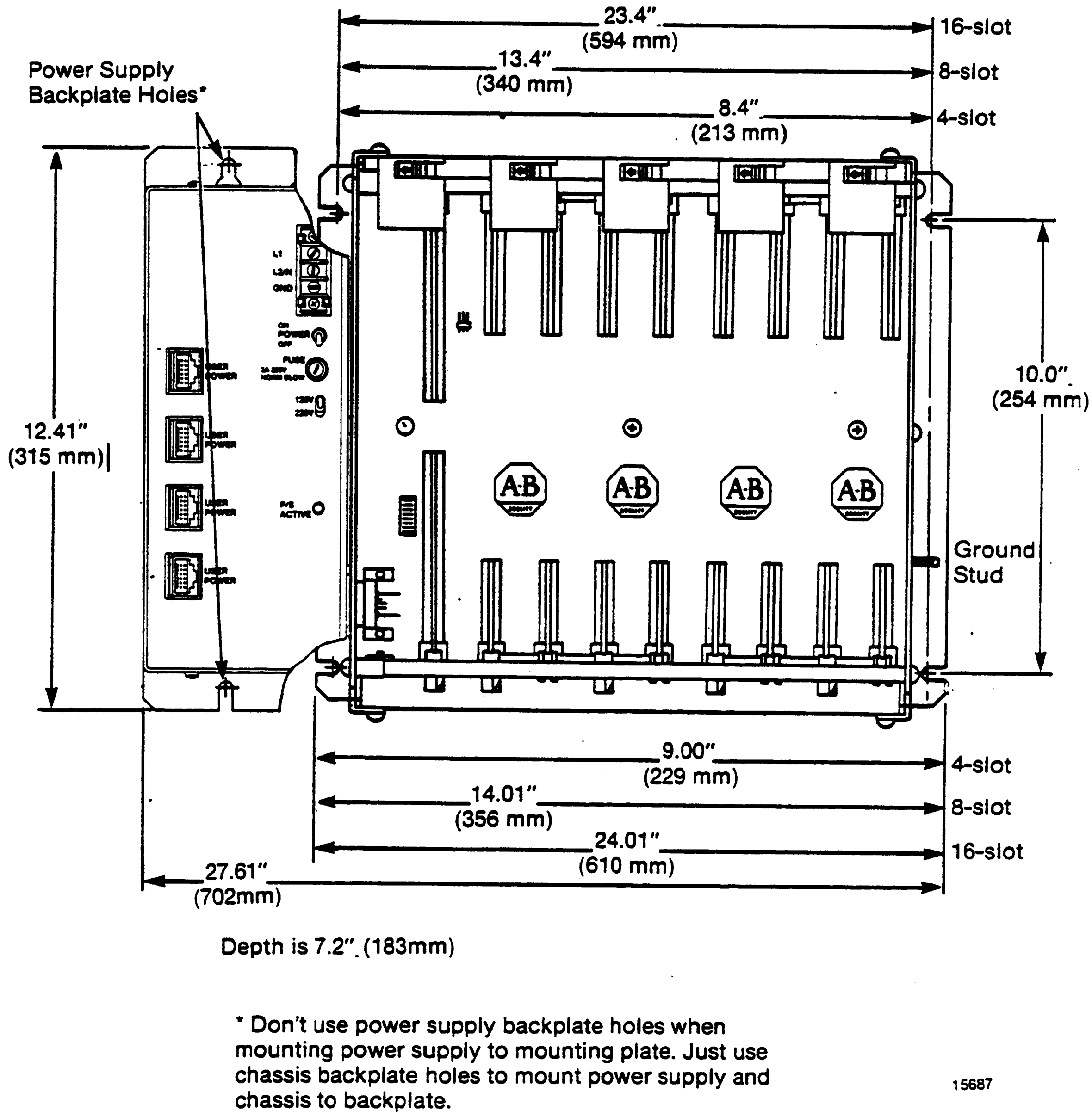


Figure 3.5
Mounting Dimensions of 12-slot Series B I/O Chassis with the 1771-PS7 Power Supply

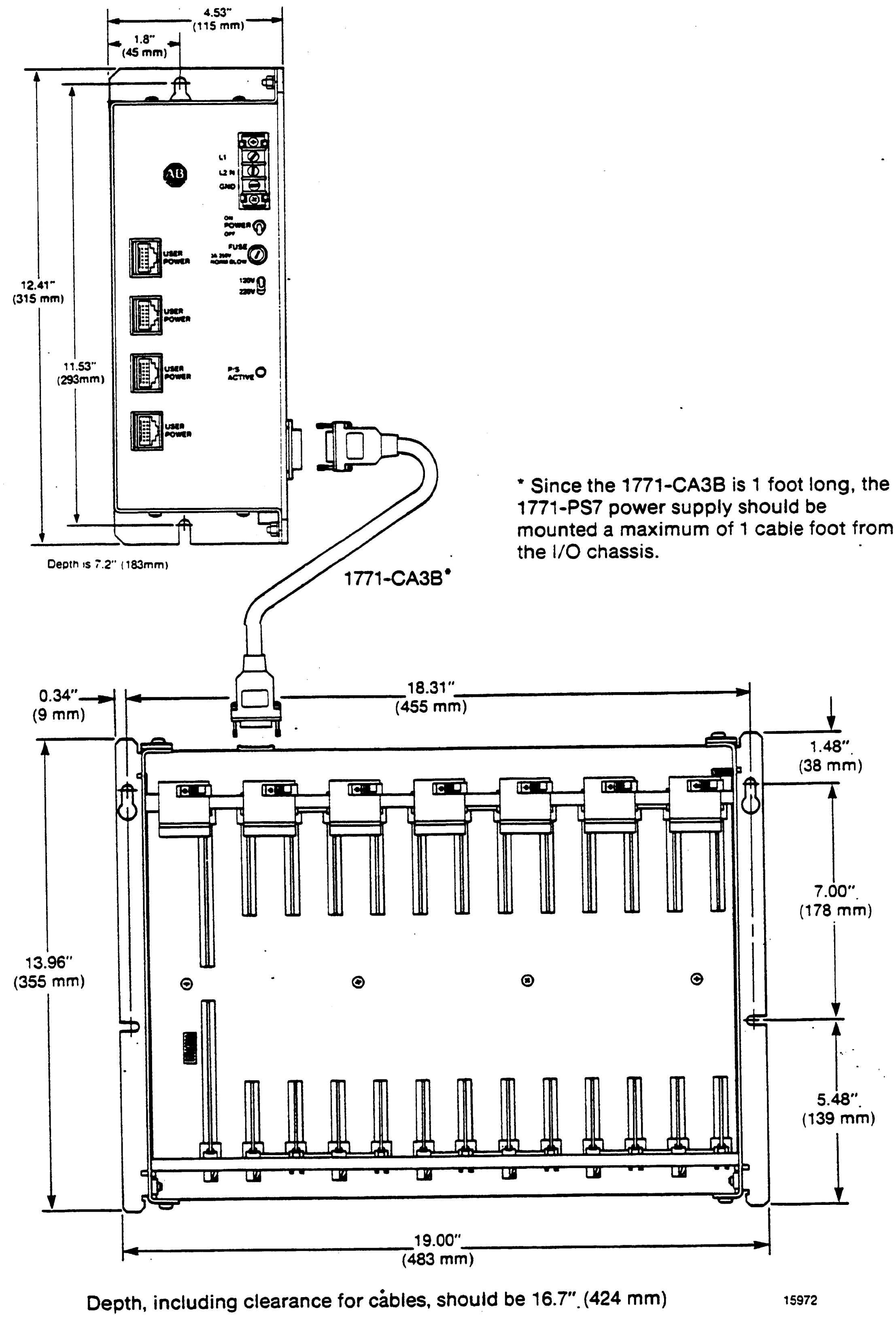
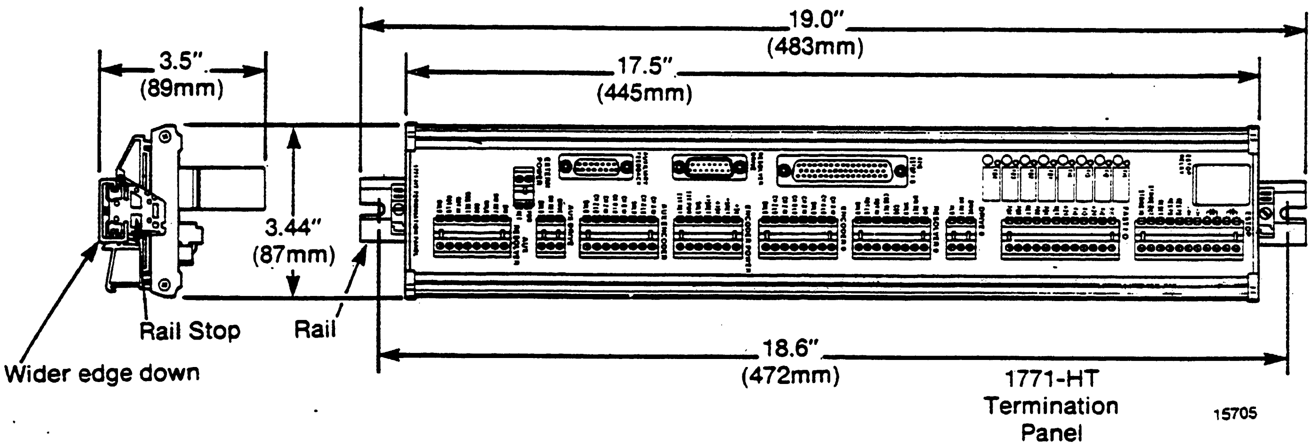


Figure 3.6
Mounting Dimensions of the 1771-HT Termination Panel



3.6 Unpacking and Inspecting the IMC 120 System

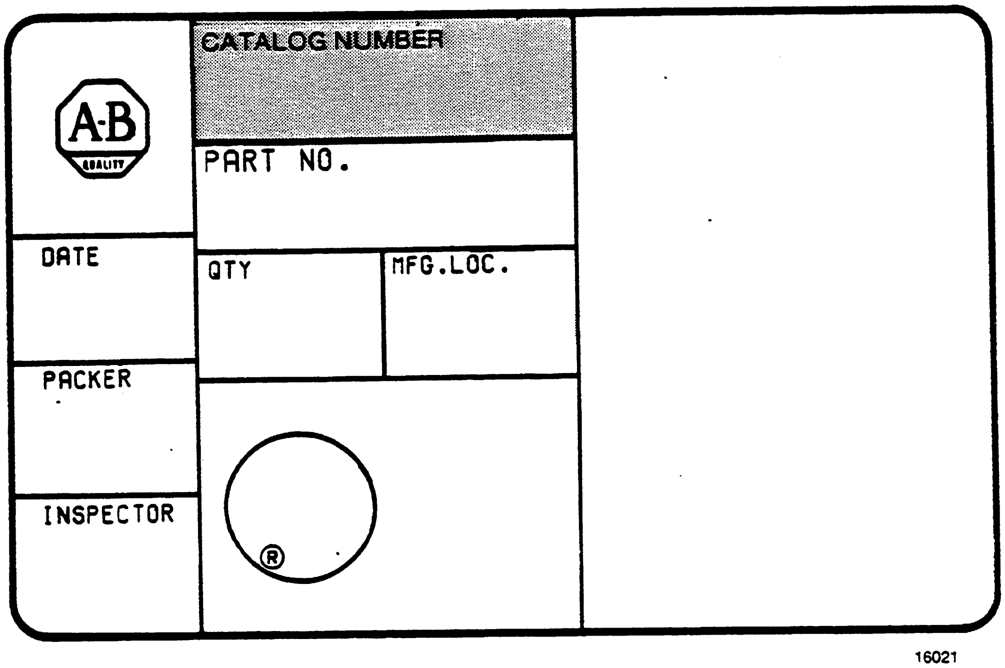
CAUTION: Electrostatic discharge can degrade performance or damage the module. Observe the following precautions to guard against such damage:

- Touch a grounded object to eliminate static charge from your body before handling the module. It is also recommended practice to wear a wrist strap (such as cat. no. 8000-XESD) that provides a high resistance path to ground.
- Do not touch the backplane connector or connector pins.
- Do not touch other circuit components when you are setting switches or jumpers. If available, use a static-safe work station.
- Keep the module in its static-shield bag when not in use.

For more information about electrostatic discharge and how to guard against it, refer to publication 8000-4.5.2, Guarding Against Electrostatic Damage -- Using the ESD Kit.

To make sure that you receive what you ordered, first check the label on each shipping carton with your order. Figure 3.7 shows you the label and where the catalog number is located.

Figure 3.7
Shipping Label



Remove the contents from the shipping carton. Check the items received against the bill of lading to assure that the equipment nameplate description matches the material ordered.

Important: All claims for breakage and damage, whether concealed or obvious, must be made to the carrier by the buyer as soon as possible after receipt of the shipment. Allen-Bradley will be glad to render the buyer reasonable assistance in the securing of adjustment for such damage claims.

4.0 Chapter Overview

This chapter discusses how to:

- install your I/O chassis
- install the 1771-PS7 power supply to the I/O chassis
- install the processor or I/O adapter module

4.1 Installing the I/O Chassis

Installing the I/O chassis consists of:

- mounting and grounding the I/O chassis
- setting the backplane switches
- setting the power supply configuration plug
- installing keying bands
- labeling

Before you install the I/O chassis, you should be familiar with the chassis components and specifications.

4.1.1 I/O Chassis Components

Figure 4.1 shows the hardware components of 8 slot series B chassis. The hardware components of 4 and 16 slot series B chassis are in the same location as those shown for 16 slot series B chassis.

Figure 4.2 shows the hardware components of 12 slot series B chassis

Figure 4.1
Hardware Components of 4, 8, and 16 Slot Series B I/O Chassis

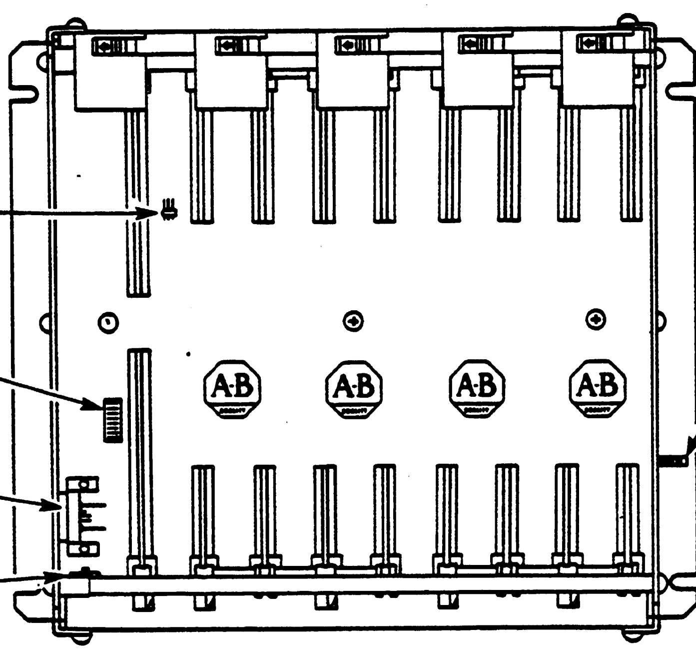
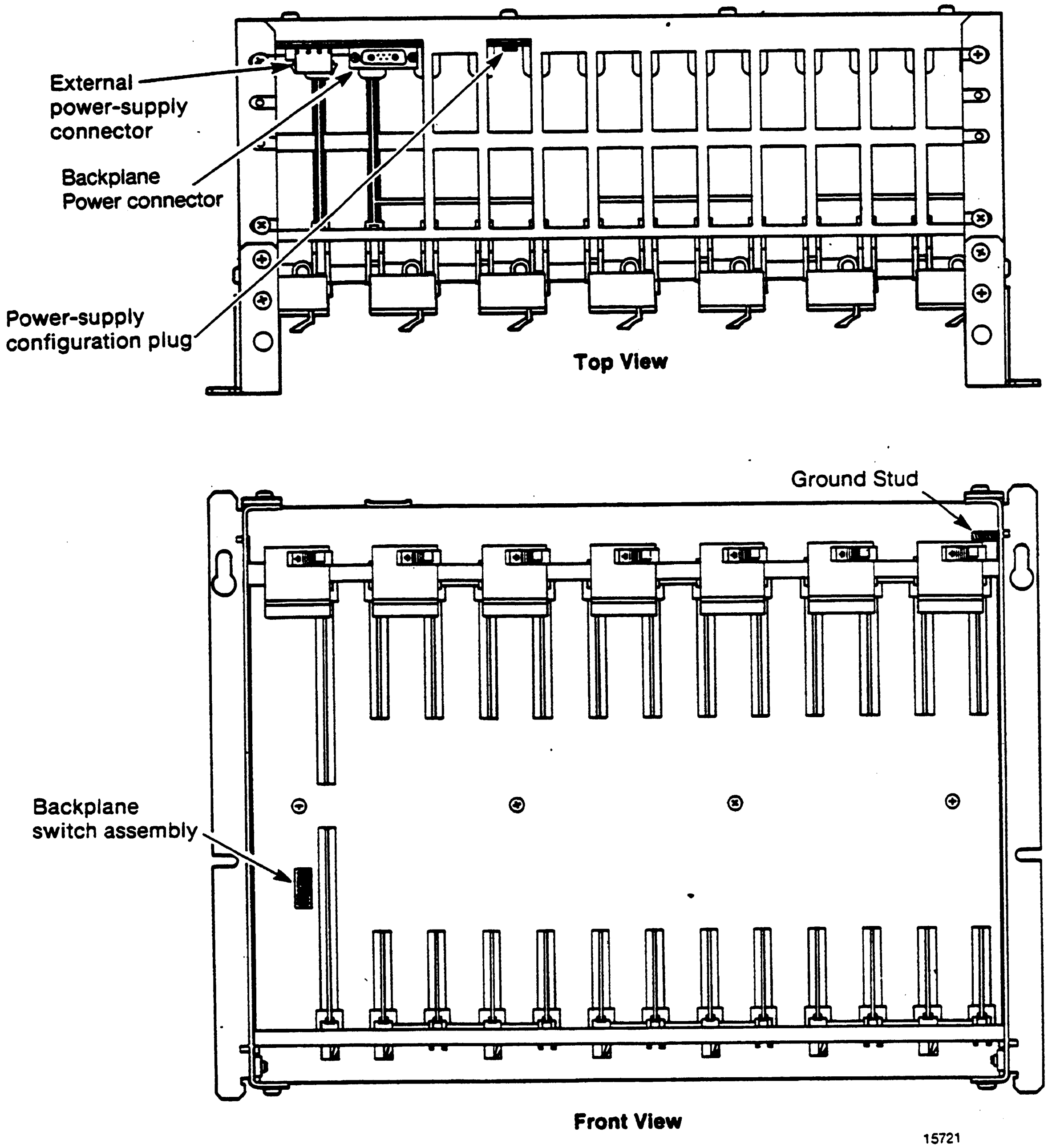


Figure 4.2
Hardware Components of 12 Slot Series B I/O Chassis



4.1.2 Specifications for Series B 1771 I/O Chassis

Maximum Backplane Current

- 16 A

I/O Module Slots

- 4 (1771-A1B)
- 8 (1771-A2B)
- 12 (1771-A3B)
- 16 (1771-A4B)

***Dimensions** (W x H x D)*

4 Slot			8 Slot			16 Slot		
9.0	12.5	7.0 in	14.0	12.5	7.0 in	24.0	12.5	7.0 in
228	318	178 mm	356	318	178 mm	610	318	178 mm

12 Slot (without flanges and panel mounted)

- 17.5 in 13.9 in 8.5 in
- 443 mm 355 mm 216 mm

12 Slot (with flanges and rack mounted)

- 19.0 in 14.0 in 8.7 in
- 483 mm 357 mm 221 mm

***Weight** (with no modules)*

4 Slot	8 Slot	12 Slot	16 Slot
9 lbs (4.1 kg)	11 lbs (5 kg)	17 lbs (7.6 kg)	13 lbs (5.8 kg)

4.1.3
Mounting and Grounding the I/O Chassis

After you've established all layouts (section 3.2) , you can begin mounting and grounding the I/O chassis. Consult publication 1770-4.1, Allen-Bradley Programmable Controller Wiring and Grounding Guidelines, for:

- mounting assembly details
- ground bus connections
- enclosure wall ground connections

Also consult National Electrical Code, published by the National Fire Protection Association of Boston, Massachusetts

4.1.4
Setting the Backplane Switches

The 8 switches in this switch assembly are located on the left side of the chassis backplane (figures 4.1 and 4.2).

Set these switches before you install the processor or I/O adapter module. Use a ball-point pen to set each switch. **Do not** use a pencil because the tip can break off and jam or short the switch.

Last State Switch

In all cases, the last state switch should be set to the OFF position. This way, if the PLC processor or I/O adapter fails, the servo controller modules go into E-Stop and stop their axes. If the last state switch is set to the ON position, no such protection exists.

Addressing Switches

In all cases, you must select 1/2 slot addressing. The servo controller module communicates correctly with the PLC processor or I/O adapter only in 1/2 slot addressing mode.

Use the following figures to set the I/O chassis backplane switches:

- Figure 4.3, when installing a PLC-5/12, PLC-5/15, or PLC-5/25 processor module
- Figure 4.4, when installing a 1771-ASB remote I/O adapter module
- Figure 4.5, when installing either a PLC-2/02, PLC-2/16, or a PLC-2/17 processor module

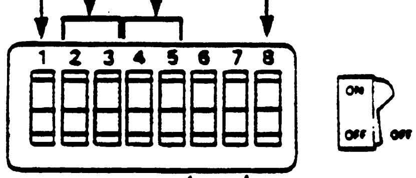
Figure 4.3
I/O Chassis Backplane Switch Assembly Settings for PLC-5/12, PLC-5/15, and PLC-5/25 Processor Modules

Switches 4	Switches 5	
OFF	ON	You select 1/2-slot addressing

Last State Switch set of **OFF** position [1]

Switches 2	Switches 3	
OFF	OFF	Switches 2 and 3 are not used; set these switches to **OFF** position.

Switch 8:
When **OFF**, RAM memory protect is disabled.
When **ON**, RAM memory protect is enabled.[2]



Switches 6	Switches 7	
OFF	OFF	EEPROM memory transfers to CMOS RAM at power-up. If there is no EEPROM module, the processor FAULT LED blinks and bit 9 in the major fault status word is set.
ON	ON	EEPROM memory transfers to CMOS RAM if CMOS RAM is not valid.
ON	OFF	EEPROM memory does not transfer to CMOS RAM; if CMOS RAM is not valid, a processor fault occurs.

[1] Regardless of this switch setting, outputs are reset when the processor detects a run-time error or an I/O backplane fault or you select program mode. Set to OFF position for consistency.
[2] You cannot clear memory when this switch is ON.

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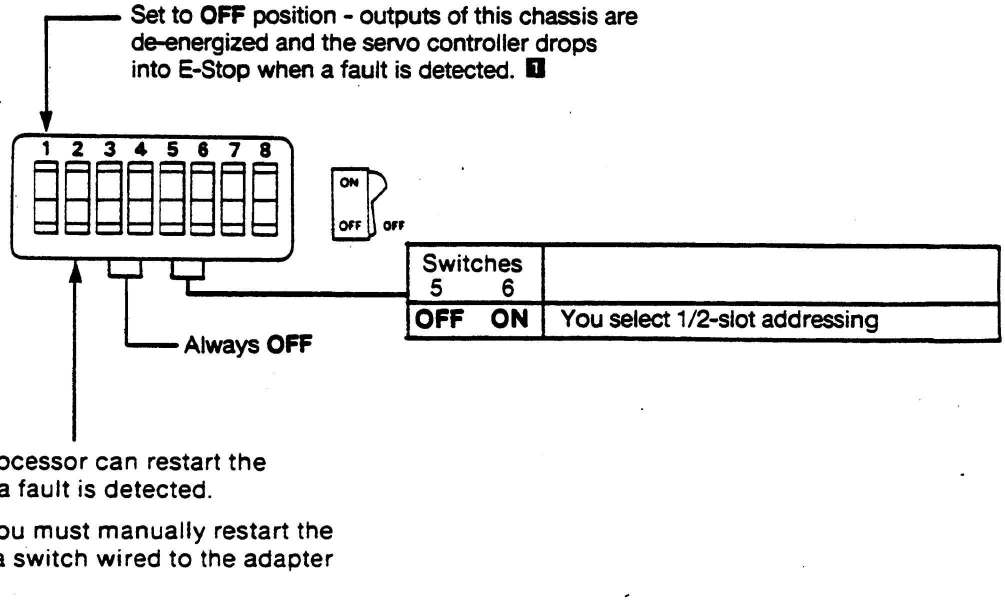
Figure 4.4
I/O Chassis Backplane Switch Assembly Settings for a 1771-ASB Remote I/O Adapter Module



1 **CAUTION:** If you set switch 1 to the **ON** position, outputs connected to this chassis remain in their last state when a fault is detected and machine motion can continue after fault detection. We recommend that you set switch 1 to the **OFF** position to de-energize outputs wired to this chassis when a fault is detected.

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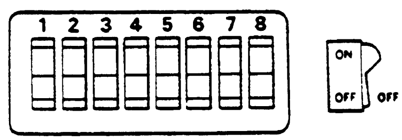
Figure 4.5
I/O Chassis Backplane Switch Assembly Settings for either a PLC-2/02, PLC-2/16, or a PLC-2/17 Processor Module



Caution: Set switch 1 to the **OFF** position to de-energize outputs wired to this chassis when a fault is detected.

If you want:	Then set:	And
Outputs to de-energize when a fault (red LED is ON) is detected 1	Switch 1 OFF	—
1/2 slot addressing 2	Switch 4 ON	Switch 5 ON
RAM memory protect disabled	Switch 8 OFF	—
RAM memory protect enabled 3	Switch 8 ON	—

1 Last state switach only on PLC-2/16 and PLC-2/17 Series C, and PLC-2/02 Series A.

2 When using 1/2 slot addressing and 32 point I/O modules: a 16 slot chassis equals four racks which equals 512 I/O.

3 When memory protect is enabled, you can only change the status and value of the bits in the first 128 words (word address up to 177 octal) of the data table.

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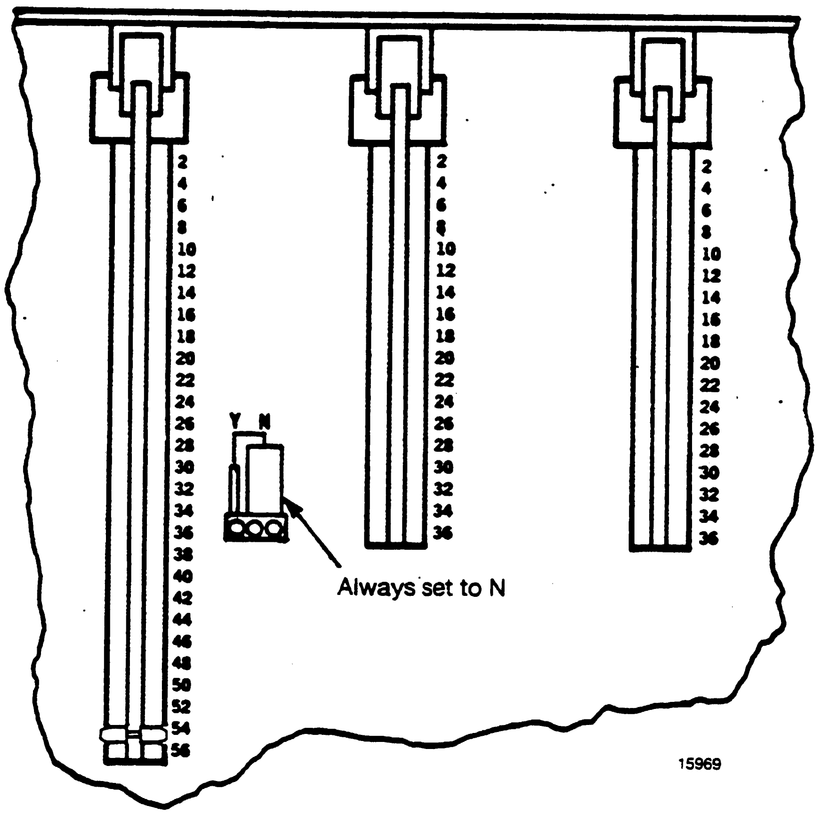
4.1.5 Setting the Power Supply Configuration Plug

Since the 1771-PS7 power supply cannot be inserted into a I/O chassis slot, it is considered an external power supply. Therefore, set the configuration plug to the right position. See figure 4.6.

Figure 4.6
Power Supply Configuration Plug Settings



4.1.6 Installing Keying Bands

Each module is slotted in two places at the rear edge. These slots are intended to mate with the yellow plastic keys we supply with each I/O chassis. If you position the keys in the backplane connector to correspond with the slots in a particular module, you guard against inserting the wrong module into a slot. The keys also help align the module with the backplane connector.

Insert or remove keys with your fingers. If you use a tool, you can damage the backplane connector.

Use the numbers to the right of the backplane socket shown in figure 4.7 as a guide when positioning the keying bands. For other modules keying positions, refer to their individual product data.

CAUTION: A module inserted into a wrong slot could be damaged by improper voltages. Use keying bands to prevent insertion of modules into the wrong slot.

Do not place any I/O modules in the leftmost slot of the I/O chassis. The processor module or remote I/O adapter module goes there.

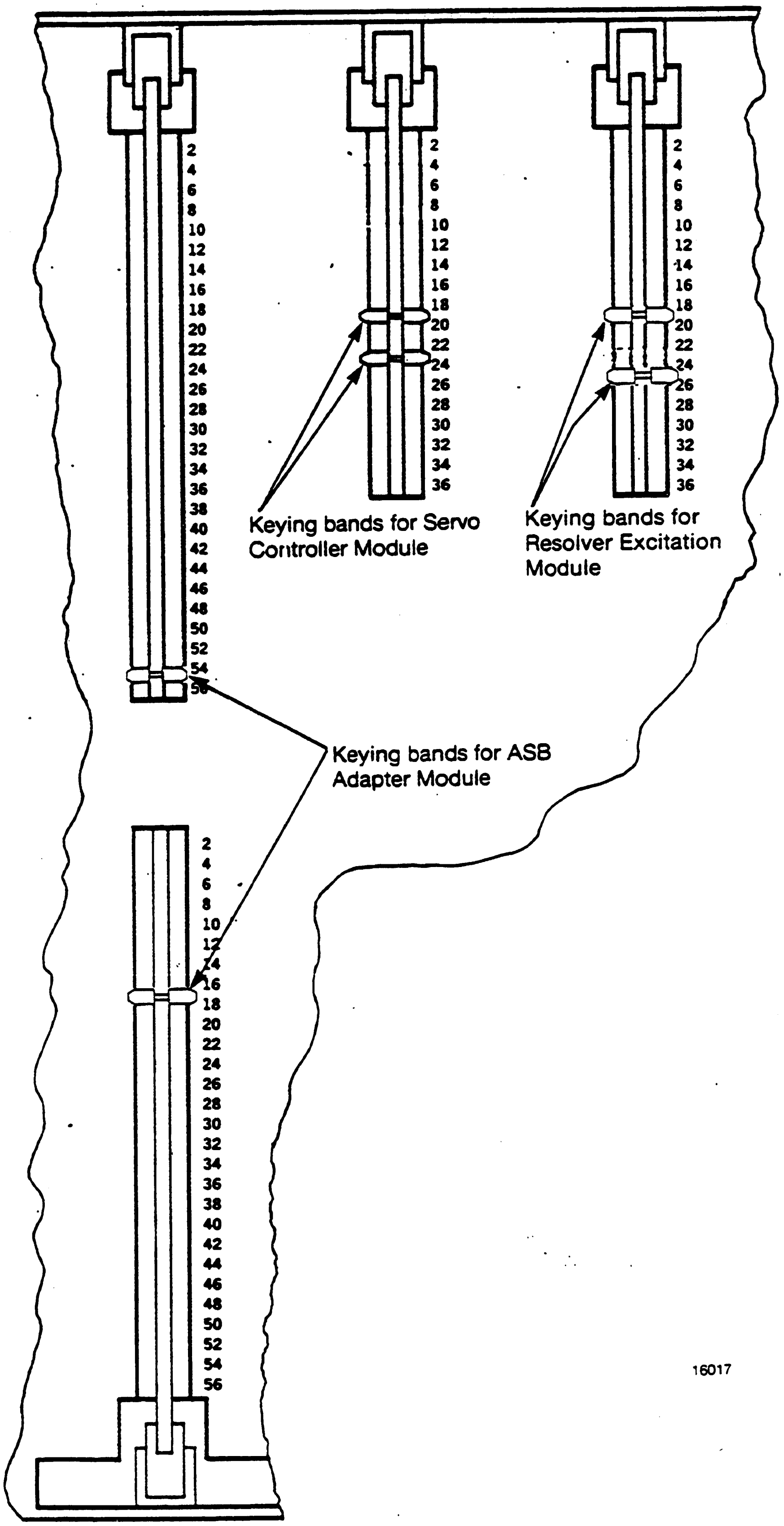
Table 4.A lists the two keying bands for:

- the IMC 120 system compatible processor and I/O adapter modules.
- the IMC 120 servo controller and resolver excitation modules.

Table 4.A
Keying Bands Positions for Processor and I/O Adapter Modules

Module	Keying Bands
PLC 5/15 Processor	40 and 42 54 and 56
PLC 2/16 and 2/17 Processor	40 and 42 54 and 56
1771-ASB I/O Adapter	54 and 56 upper backplane 16 and 18 lower backplane
Servo Controller Module	18-20 22-24
Resolver Excitation Module	18-20 24-26

Figure 4.7
Keying Band Positions



4.1.7 Labeling Your I/O Modules

Apply a label to each module locking latch. Write in the terminal numbering for each module, rack number, and I/O group number.

4.2 Installing the 1771-PS7 Power Supply

the 1771-PS7 power supply supplies

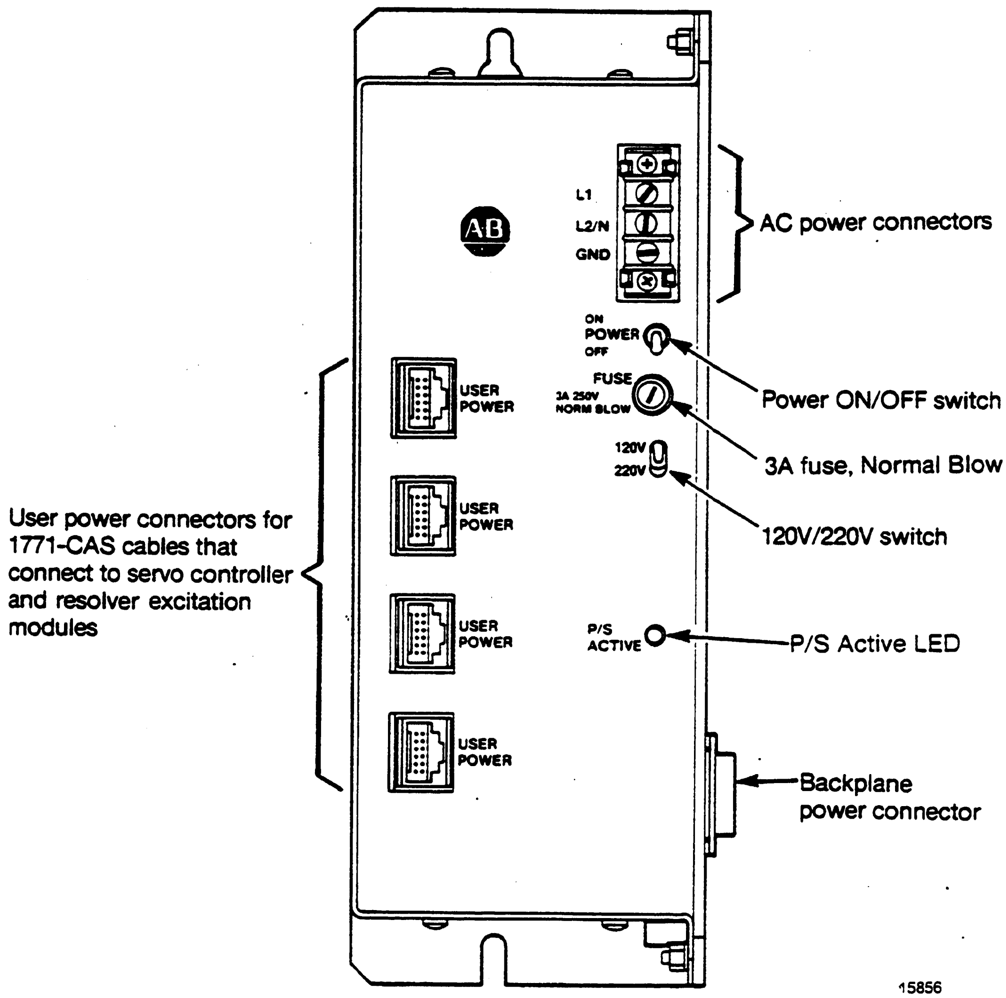
- +5V DC at 16A maximum to backplane (backplane power) for all modules in the I/O chassis
- 5V, ±15V and 24V DC through external connections to servo controller and resolver excitation (user side) for encoder, resolver, servo drive, fast input and output, and E-STOP devices.

This power supply can accept a power source of 120V AC or 220V AC.

User side power is isolated from backplane power. This isolated power eliminates the need for the user to purchase and mount a separate power supply, and it provides electrical isolation between encoders, resolvers, drives, fast I/O, E-stop circuits and the 1771 backplane.

Figure 4.8 shows the features of the 1771-PS7 power supply.

Figure 4.8
1771-PS7 Power Supply



4.2.1 P/S ACTIVE LED

A green P/S ACTIVE LED provides status indication during power supply operation. If the LED does not illuminate during powered operation it may be due to one or more of the following reasons.

- Backplane overcurrent
- User power overcurrent
- Total output power greater than 100W
- Total user power greater than 65W or total +5V user power greater than 40W
- Input voltage level not within specified range
- Power supply is inoperative

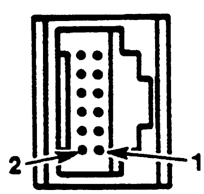
4.2.2 USER POWER Connectors

The 1771-PS7 uses 4 connectors to distribute user side power to 3 servo controller modules and 1 resolver excitation module within a I/O chassis. The connector is a 12 pin latch and lock shielded type.

The 1771-CAS cables connect the 1771-PS7 to the servo controller and resolver excitation modules. When connecting these cables to the user power connectors, route these cables away from AC input power and other cables.

The pinout of the four 12 pin latch and lock connectors is:

Pin#	Description
1	user +24VDC
2	user 24VDC COM
3	user +24VDC
4	user 24VDC COM
5	user +15VDC
6	user COM
7	user -15VDC
8	user COM
9	user +5VDC
10	user COM
11	user +5VDC
12	user COM
S	chassis gnd (Shield)



Power Connector

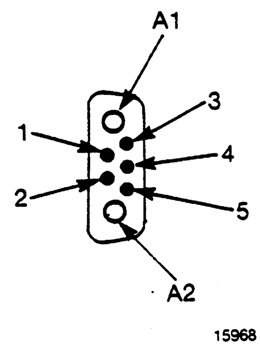
15727

4.2.3 Backplane Power Connector

A D-sub power connector provides power to I/O chassis backplane. This connector is located on the right side of the 1771-PS7 near the bottom back wall. This connector may be directly connected to the -A1B, -A2B or -A4B series I/O chassis when used with the 1771-PS7 power supply mounting plate. This connector may also be connected by a 1771-CA3B I/O power cable if an -A3B series I/O chassis is used.

The D-sub power connector provides the following connections:

Pin #	Description
A1	backplane common
A2	backplane +5VDC
1	no connection
2	backplane processor enable
3	backplane +5VDC sense
4	backplane signal ground sense
5	no connection



4.2.4 Specifications of 1771-PS7 Power Supply

Dimensions
- 4.5" W x 6.75" D x 12" H

Operating Temperature
- 0° to 60° C

Weight
- 6.5 lbs

Input Power

120VAC @ 2.0A
220VAC @ 1.0A

Total Output Power

- 100W System
- 65W User Side
- 80W Backplane

Isolation

- Input line to output isolation is 1.5KV RMS.
- Input line to chassis isolation is 1.5KV RMS.
- 1771-CAS user power cable isolation is 707V RMS

Efficiency

- Minimum of 60% at full load output over entire input range

Output Capability-System Side (1771 backplane)
- +5VDC @ 16A

Output Capability-User Side

Output	Set-Point	Regulation Limits	Current ** Limit	Ripple *** P-P
User +5VDC	5.20	5.00V to 5.30V, 0-8A	8.00A	100mV @ 5A
User +15VDC	15.00	14.43V to 15.57V, 0-2.0A	4.33A	100mV @ 1A
User -15VDC	-15.0*	-14.10V to -15.90V, 0-2.0A	4.33A	100mV @ 1A
User 24VDC	24.0*	21.12V to 26.88V, 0-2.5A	2.71A	400mV @ 2A

* Setpoints for -15V and 24V user outputs will depend upon output loading.

** Current limits are shown for reference only and are minimum current limits for the respective outputs based upon a maximum user side power capability of 65W or a maximum +5VDC user side power capability of 40W.

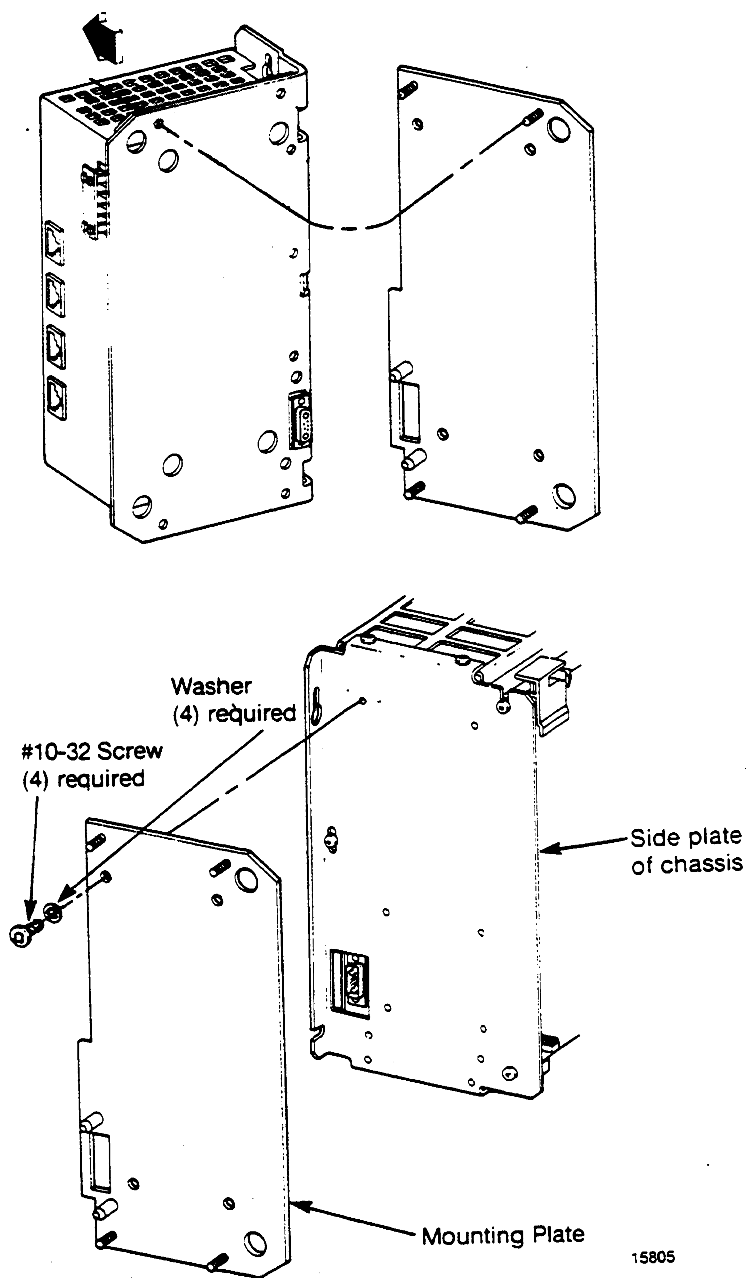
*** AC component measured at P/S output connector from 5Hz to 20MHz.

4.2.5 Mounting Your 1771-PS7 Power Supply

The 1771-PS7 power supply mounts on the left-side plate of 4, 8, or 16 slot series B I/O chassis. The power connector plugs directly into the backplane connector of the I/O chassis. First mount the Series B I/O chassis to the backplate. Then mount the 1771-PS7 power supply to the Series B I/O chassis with the 4 #10-32 nuts (see steps in figure 4.9).

If you have a 12 slot series B I/O chassis, mount the 1771-PS7 power supply up to 1 cable-foot from the I/O chassis. A 1771-CA3B I/O power cable is required to connect to this chassis. Follow the steps in figure 4.10.

Figure 4.9
Attaching the 1771-PS7 to 4, 8, or 16 slot Series B I/O Chassis

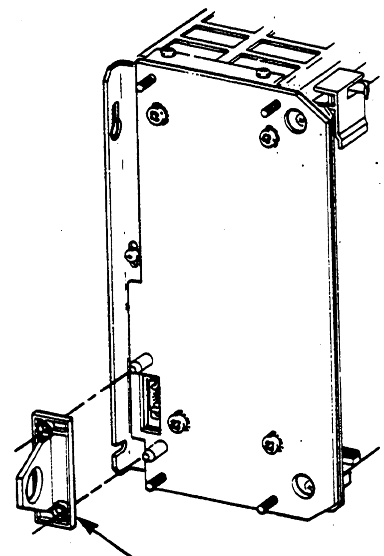


1. 1771-PS7 power supply comes with it's mounting plate attached. Separate the mounting plate from the power supply.

2. Install the mounting plate, with (4) #10-32 screws and washers onto the side plate of the 1771 chassis. Leave the screws loose to enable the mounting plate to move with freedom.

Figure 4.9 (Continued)
Attaching the 1771-PS7 to 4, 8, or 16 slot Series B I/O Chassis

3. Install alignment fixture onto the taper pins of the mounting plate and push until the alignment fixture is fully inserted into the receptacle on the chassis. Now tighten the (4) #10-32 screws. The mounting plate is now permanently attached to the chassis. (The alignment fixture has located the mounting plate into the same position as the receptacle.)
4. Remove the alignment fixture.



5. Install the power supply, by aligning the receiving holes of the power supply over the taper pins on the mounting plate. Push until the plug on the power supply is fully inserted into the receptacle on the chassis.
6. Install (4) #10-32 nuts & washers onto the #10-32 studs now protruding through the power supply mounting holes from the mounting plate.

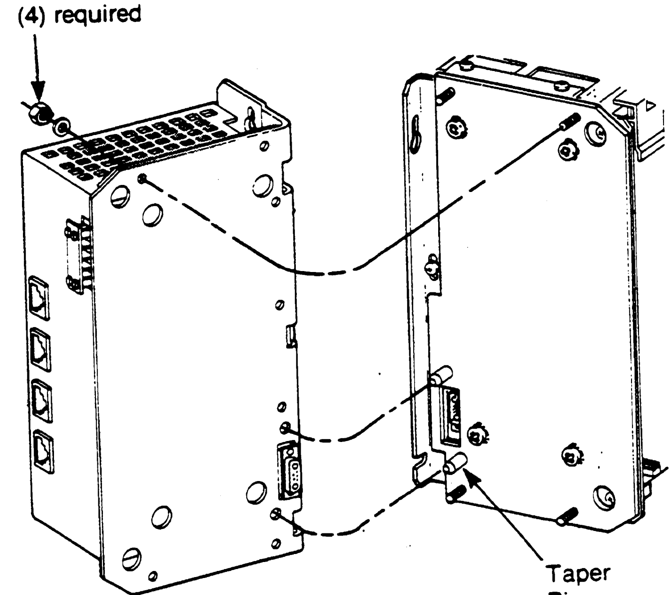
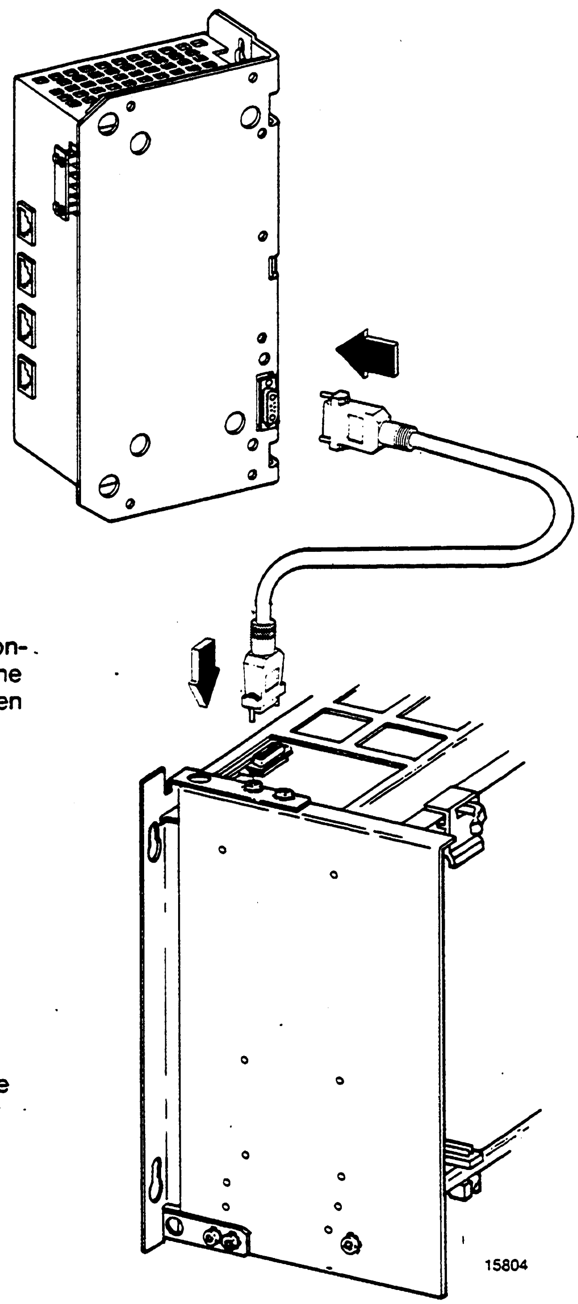


Figure 4.10
Connecting the 1771-PS7 to 12 slot Series B I/O Chassis

1. Mount the 1771-PS7 near and above the Dsub connector located on the top of the chassis (no more than 1 cable foot). Allow for a generous bend of the 1771-CA3B cable to reduce the stress on the connectors mounted on the chassis and the power supply.

2. Connect the 1771-CA3B I/O power cable to the Dsub connector located on the side of the 1771-PS7 power supply. Tighten the connector screws.

3. Connect the other end of the cable to the power Dsub connector located on the top of the chassis. Tighten the connector screws.



4.3 Connecting Power to the 1771-PS7 Power Supply

This power supply requires input from either a 120V AC or 220V AC source. Allen-Bradley initially sets this input voltage selector switch to 220 volts.

1. Place the power switch in the OFF position.

2. Select the input voltage selector switch for 120V or 220V AC as required for the input voltage available at installation.

   This can be accomplished with an 1/8" slotted screwdriver.

CAUTION: Do not place the screwdriver blade more than 1/4" into the switch slot.

The AC input voltage is connected to a 3 terminal barrier strip located on the front top right of the power supply. Connect:

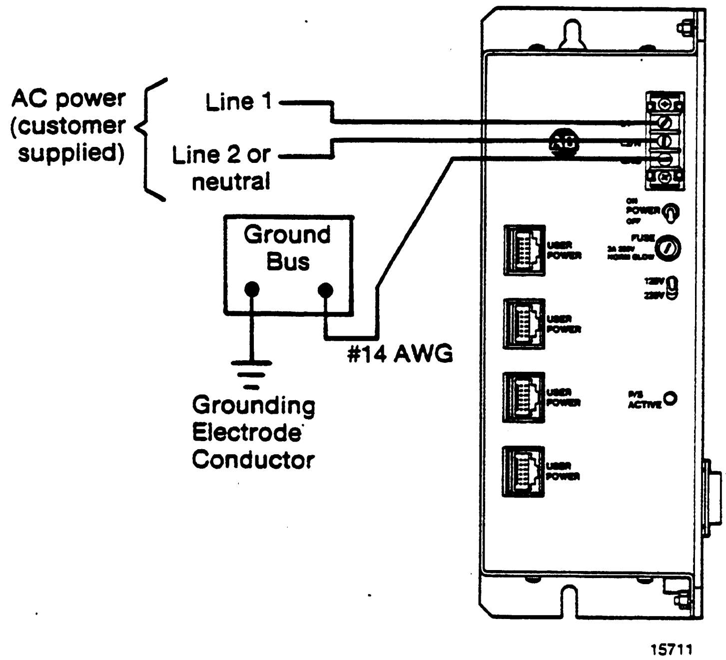
- L1 to the high side of the line power
- L2/N to the low side of the line power
- GND to the central ground bus (earth ground)

We recommend number 14 AWG wire to connect the GND terminal to the ground bus.

A 3A normal blow 250V fuse protects the input line L1 from drawing more than 3 amperes.

To connect wires to each terminal, see figure 4.11.

Figure 4.11
Wiring AC power to the 1771-PS7 Power Supply



4.4 Installing Your Processor or I/O Adapter Module

before installing your in-rack processor or I/O adapter module, you must set backplane switches on the module. Refer to your processor or I/O adapter module manual to make these settings. Table 4.B lists the manual and its publication number for compatible in-rack processor or I/O adapter module.

Table 4.B
Manuals for Installing Compatible In-Rack Processors or Remote I/O Adapter Modules

Processor or Adapter Module	Publication Number	Title
1771-ASB	1771-6.5.37	Remote I/O Adapter Module User's Manual
PLC 5/15	1785-6.6.1	PLC-5/15 Controller Assembly and Installation Manual
PLC 2/16 or PLC 2/17	1772-6.5.8	Mini-PLC-2/16, -2/17 Series C Processor User's Manual

To install your processor or I/O adapter module, slide it into the leftmost slot of the I/O chassis. Refer again to the pertinent installation section of your manual.

5.0 Chapter Overview

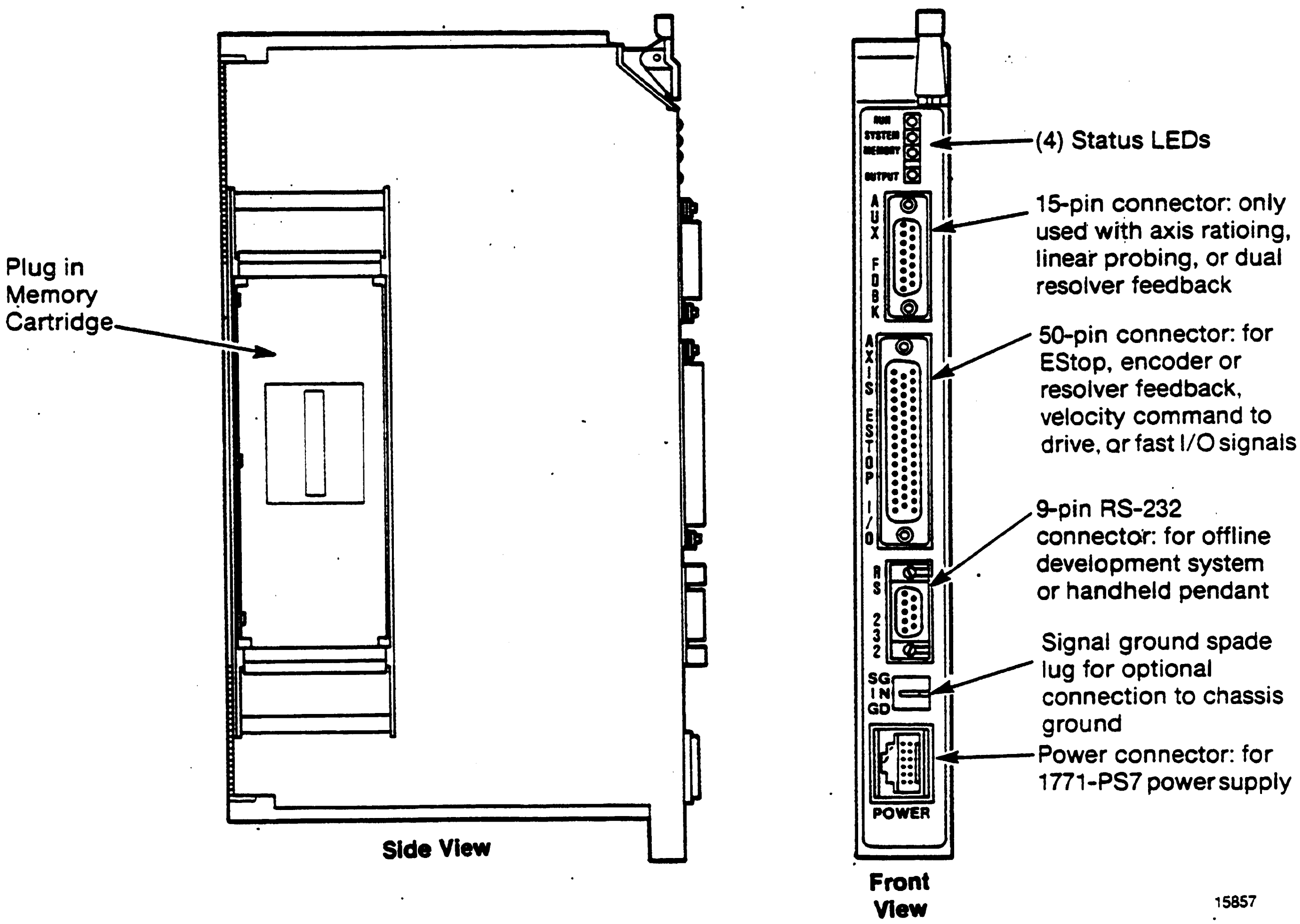
In this chapter we discuss:

- IMC 120 servo controller -- installation features, cabling, electrical specifications, plug-in memory cartridge; how to enable its memory, how to replace and dispose of its battery, and how to insert it into the servo controller module
- IMC 120 resolver excitation module installation features, cabling, and electrical specifications
- installing the servo controller and excitation modules in the I/O chassis
- connecting power to the servo controller and resolver excitation modules

5.1
IMC 120 Servo Controller Module

Figure 5.1 shows the servo controller module with its LED's, connectors, and plug-in memory cartridge.

Figure 5.1
Servo Controller Module



5.1.1
Status LED Indicators

Table 5.A lists four status LED indicators, their colors, and their functions.

Table 5.A
Status LED's

Indicator (Color)	Status	Description
RUN Green	off	at powerup before IMC 120 software initializes and performs quick hardware diagnostics
	on	after software initializes and performs quick hardware diagnostics once on, it turns off only in the event of a module fault that can not be detected by software.
SYSTEM Red	on	indicates module faults detected by software (i.e. PLC communication fault, memory error, broken wire, lithium battery too low, etc.)
	off	normal operation
MEMORY Red	on	if plug-in memory cartridge is not installed.
	off	normal operation
OUTPUT Red	on	if a short circuit exists on one or more of the 4 fast outputs. To clear this fault, you must remove the short circuit condition and cycle power to the servo controller module.
	off	normal operation

5.1.2 Servo Controller Module Connectors

AXIS ESTOP I/O Connector

The 50 pin Axis E-stop I/O connector receives and provides the following signals.

- receives encoder feedback signals
- provides encoder power
- sends velocity command to drives
- receives resolver feedback (rotor signals only)
- receives fast input (FIN 1-4) signals
- provides fast I/O power
- sends fast output (FOUT 1-4) signals
- receives E-Stop status, reset, and E-Stop string signals

AUX FDBK Connector

The 15 pin AUX FDBK connector receives and provides the following signals

- receives auxiliary encoder feedback signals
- provides power to auxiliary encoder
- receives auxiliary resolver rotor return signal

RS 232 Connector

Use the RS-232 connector to:

- download or upload MML programs or AMP parameters to and from the offline development system

- test and debug IMC 120 hardware and the MML program through the handheld pendant

A jumper in the handheld pendant cable informs the servo controller module that the handheld pendant, and not the offline development system, is hooked up. You can locate the offline development system a maximum of 50 feet from the servo controller module. The handheld pendant comes with a 25 foot cable.

User POWER Connector

The user POWER connector receives power from the 1771-PS7 power supply through the 1771-CAS cable and has the identical pinout as the 1771-PS7 USER POWER connector (see section 7.2.2).

5.1.3 Servo Controller Module Cabling

Table 5.B lists the cabling that connects the servo controller to the 1771-PS7 power supply, the termination panel*, and the offline development system:

Table 5.B
Servo Controller Cables

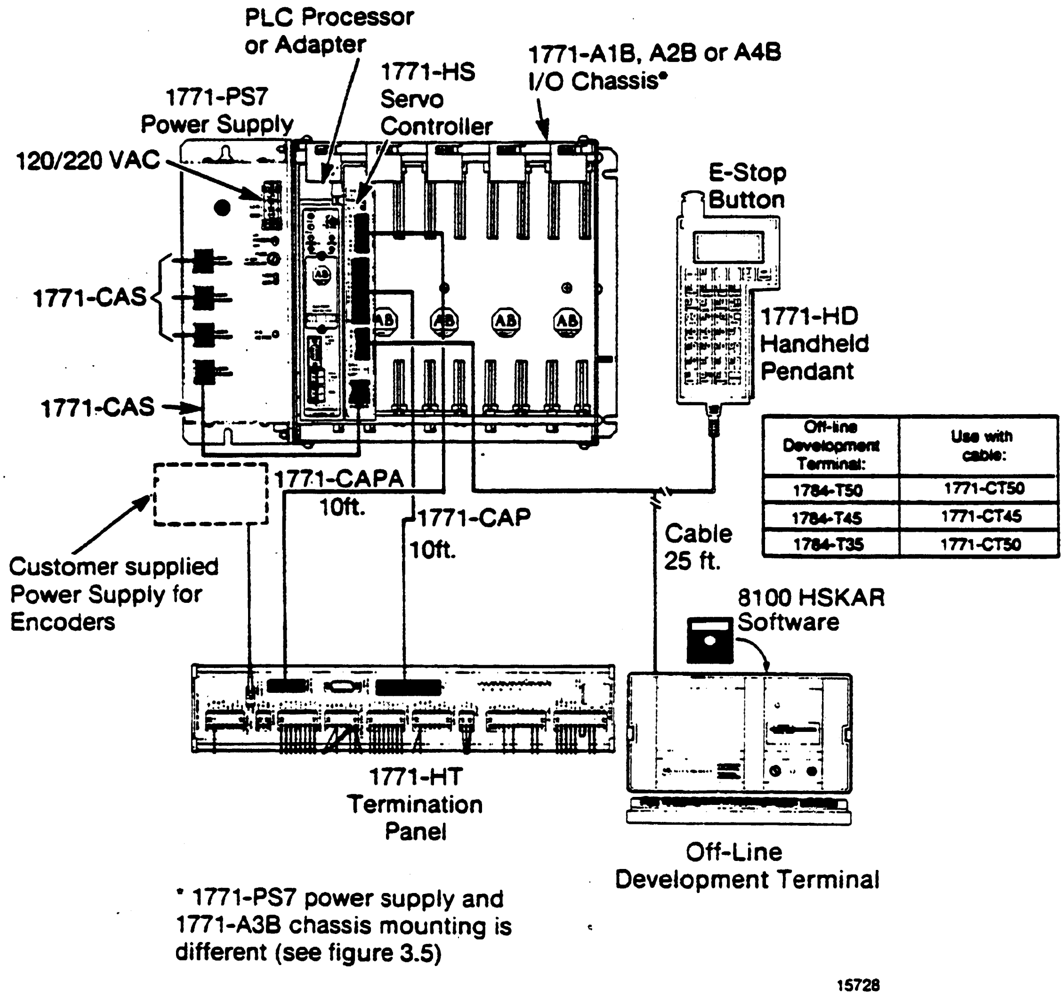
Catalog No.	Description	When Used
1771-CAS	connects user POWER connector of servo controller module to the USER POWER connector of the 1771-PS7 power supply	Always
1771-CAP	connects AXIS ESTOP I/O connector of the servo controller module to the AXIS ESTOP I/O connector of the termination panel	Required if you are using a termination panel to wire drives, feedback devices, fast I/O and E-Stop
1771-CAPA	connects the AUX FDBK connector of the servo controller module to the AUXILIARY FEEDBACK connector of the termination panel	Required if using a termination panel and second feedback device for ratioing, linear touch probing, or absolute positioning
1771-CT50	connects the RS-232 connector of the servo controller module to the connector of the T35 or T50 off-line development system**	Required if uploading or downloading AMP parameters or MML programs
1771-CT45	connects the RS-232 connector of the servo controller module to the connector of the T45 off-line development system**	Required if uploading or downloading AMP parameters or MML programs

* If you are not using a termination panel, refer to Appendix A to make your own cable that connects to the appropriate servo controller connectors.

** The Handheld pendant comes with its own 25 foot cable that connects to the RS-232 connector of the servo controller module

Figure 5.2 shows the cabling between the servo controller module, 1771-PS7 power supply, the termination panel, and the RS-232 device (handheld pendant or offline development system).

Figure 5.2
Servo Controller Cabling



5.2 1771-HM Plug-in Memory Cartridge

The IMC 120 servo controller module comes with the 1771-HM plug-in memory cartridge already installed.

The 1771-HM memory cartridge:

- plugs directly into the servo controller module through the component side cover of the module
- is necessary for the operation of the IMC 120 system since it is the entire system memory.

The plug-in memory cartridge contains:

- a lithium battery for battery backup
- either 8K or 72K CMOS RAM for MML program memory

5.2.1 Enabling the Battery on the Plug-In Memory Cartridge

To enable the battery, set the rocker switch SW1 to BAT ON (see figure 5.3) using a ballpoint pen. This switch is accessible through the cover of the plug-in memory cartridge.

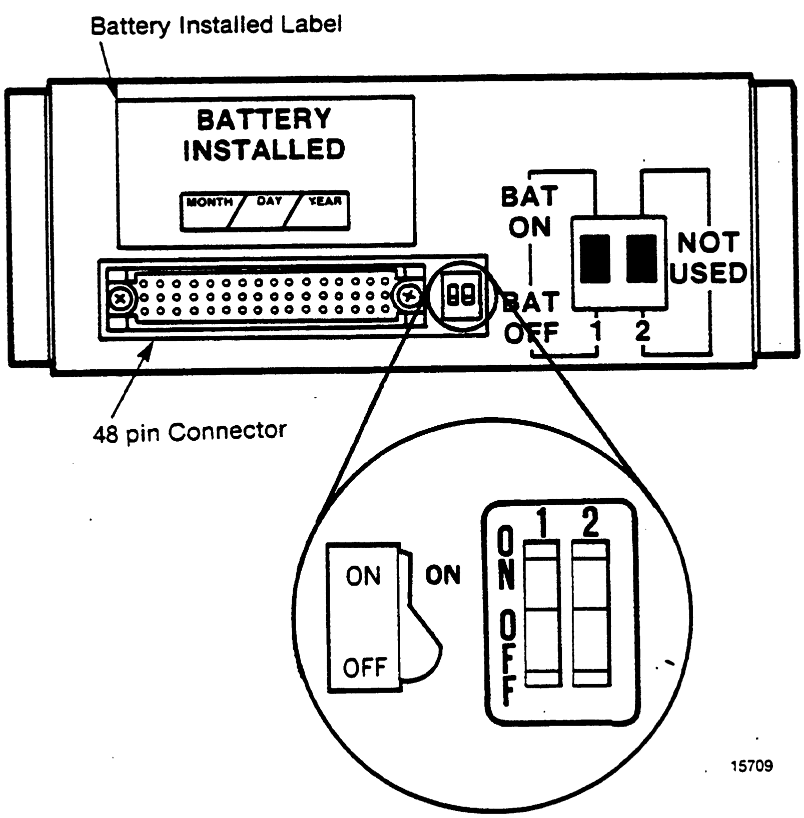
CAUTION: Do not use a pencil because a broken tip could short out circuitry causing failure of the cartridge.

Important: Failure to enable the battery results in:

- the red SYSTEM led on the servo controller module to light
- a battery low signal (bit 15 set in word 5 of block 0) to the PLC

The servo controller module still functions but stored MML programs and AMP parameters are lost when power is removed from the system.

Figure 5.3
Setting the Enable Switch on the Memory Cartridge



5.2.2
Inserting the Memory Cartridge

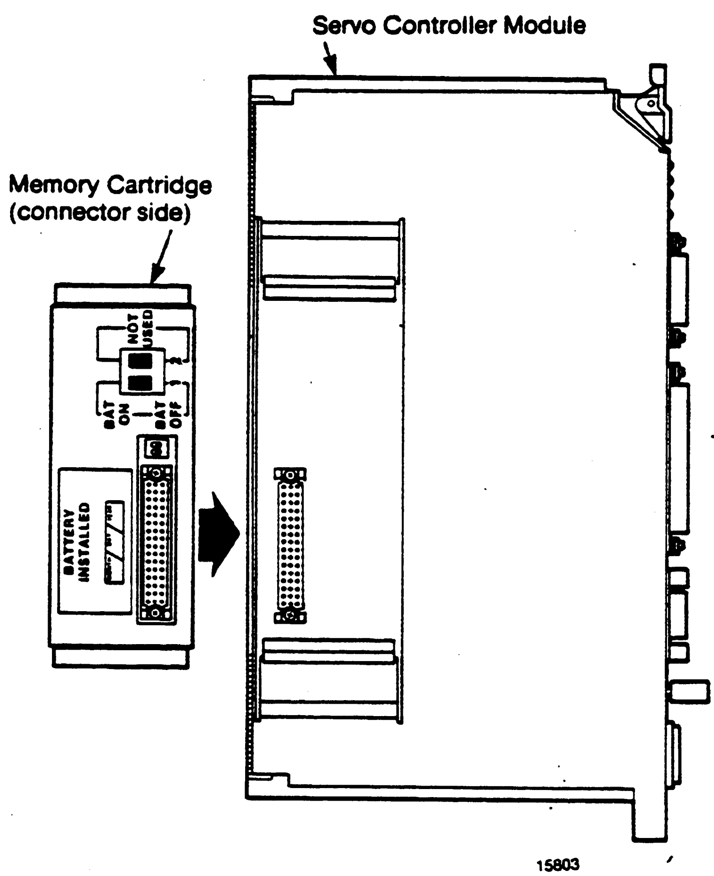
Figure 5.4 shows how the plug-in memory cartridge fits into the servo controller module. Make sure that:

- the edge of the memory cartridge fits snugly into the side cover of the servo controller module
- the male and female parts of the 48 pin connector fit snugly

If you don't install the memory cartridge in the servo controller module, the red MEMORY LED lights on the servo controller when power is supplied to the system.

Important: If the servo controller module doesn't power up, (green RUN LED isn't lit), when power is applied or the red MEMORY LED turns on, you may have bent a pin on the connector while inserting the memory cartridge.

Figure 5.4
How the Memory Cartridge Fits Into the Servo Controller Module



5.2.3 Checking the Lithium Battery

The typical life expectancy of your lithium battery is 3.5 years based upon an average ambient temperature of 40° C measured just below the chassis. Battery life is a strong function of temperature. If your environment approaches worst case (60° C), battery life may be as short as 1.4 years.

If your lithium battery has reached the low trip point, the servo controller module informs you through either:

- its SYSTEM led turning on
- the warning message #64, MEMORY CARD BATTERY LOW, displayed on the IMC 120 handheld pendant
- a battery low signal (bit 15 set in word 5 of block 0) to the PLC

Important: The battery Check low trip point is typically 3.10V DC. Normal battery voltage is between 3.6V DC and 3.66V DC.

If your lithium battery has reached its low point, you should replace it immediately even though the remaining life is typically several weeks. No guarantees can be made as to the remaining life expectancy of the cell.

5.2.4 Replacing the Lithium Battery

You can replace the lithium battery only if the IMC 120 system is powered down and the servo controller module is unplugged from the 1771 chassis to allow access to the plug-in memory cartridge.

Important: Follow these guidelines when you handle plug-in memory cartridges:

- wear an ESD grounding wrist strap
- when the memory module is removed from the servo controller module immediately put it into a static-protective bag
- do not touch the internal connector or any part of the circuit board

You may lose your MML programs and AMP parameters when you swap the old battery for the new one unless you upload your MML programs and AMP parameters to an off-line development system.

If your off-line development system is not available, use the following procedure to replace the battery and maintain MML and AMP files:

1. Power down the host PLC.

2. Remove the servo controller module from the I/O chassis.

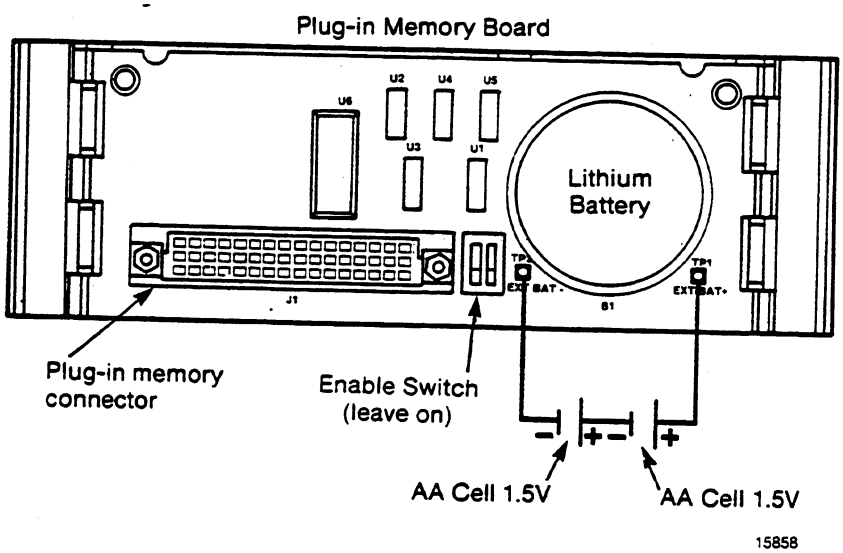
3. Unplug the memory module from the servo controller module. Pry up on the slots to disassemble.

   Important: Do not turn off the battery enable switch during this replacement procedure.

4. Remove the printed circuit board containing the memory from the plastic case.

5. Use two 1.5V AA cells as a power source to backup CMOS memory while you change the battery. Figure 5.5 shows the circuit for this battery and its connections to the memory board.

Figure 5.5
Circuit for Battery



6. Connect external batteries to the supplied test points on the plug-in memory board.

   Important: If you inadvertently connect the batteries in reverse order, the cartridge is not harmed, but the MML program and AMP parameters will be lost.

7. Remove old battery and install new battery.

8. Remove external batteries.

9. Re-assemble memory cartridge.

If you lose memory during this procedure, you must download your MML program (see chapter 16 in the IMC 120 Programming Manual) and AMP parameters (see chapter 11 in the IMC 120 Programming Manual) from the off-line development system.

Publication 1770-2.19 entitled "PLC-3 Lithium Battery Information" provides other information on lithium battery relating to:

- handling
- storage
- transportation
- disposal
- potential hazards
- handling damaged batteries

WARNING: Follow the lithium battery information provided here. If you fail to do so, you risk damaged equipment and personal injury

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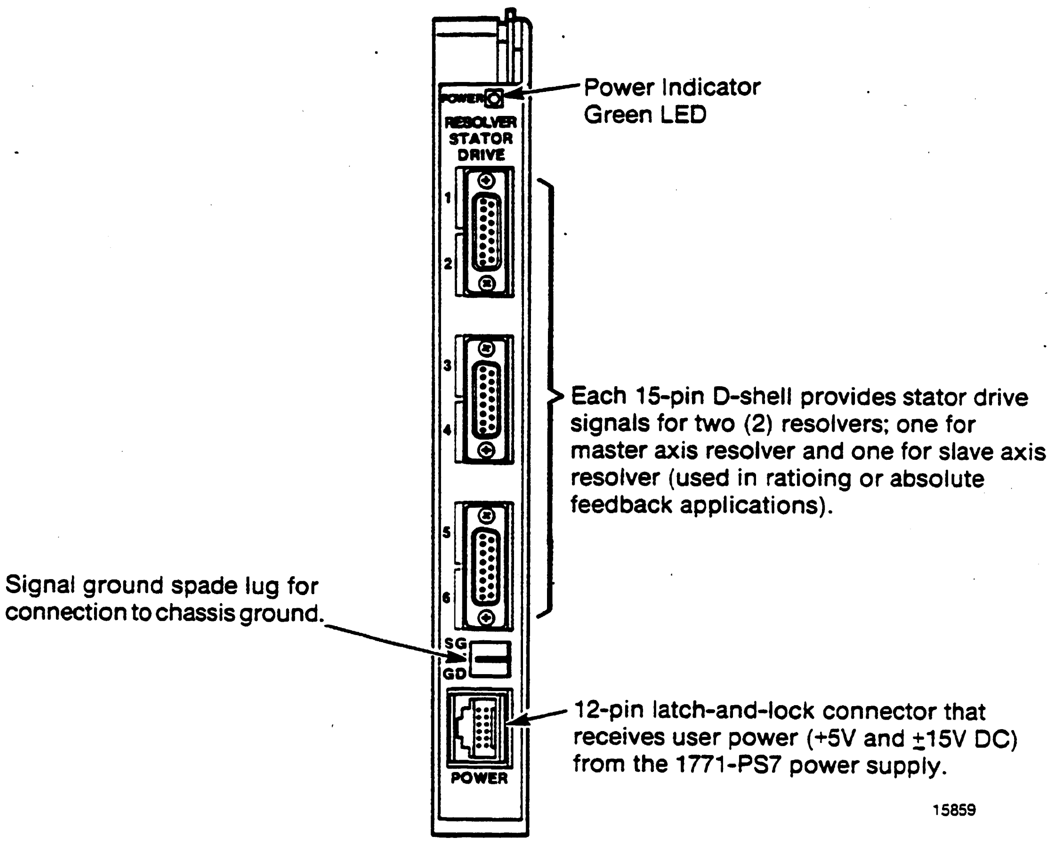
5.3 Resolver Excitation Module

A resolver excitation module is only used when the IMC 120 system uses resolver feedback. The resolver excitation module provides sine and cosine signals that excite the stator of the resolvers. The rotor signal of the resolver provides position feedback to the servo controller module.

Figure 5.6 shows the excitation module's POWER LED and connectors.

Figure 5.6
Resolver Excitation Module



5.3.1 Power Indicator

A single green LED indicates that the user side power (+24VDC, ±15VDC, +5VDC) is present. If this LED is not on, it indicates loss of user side power.

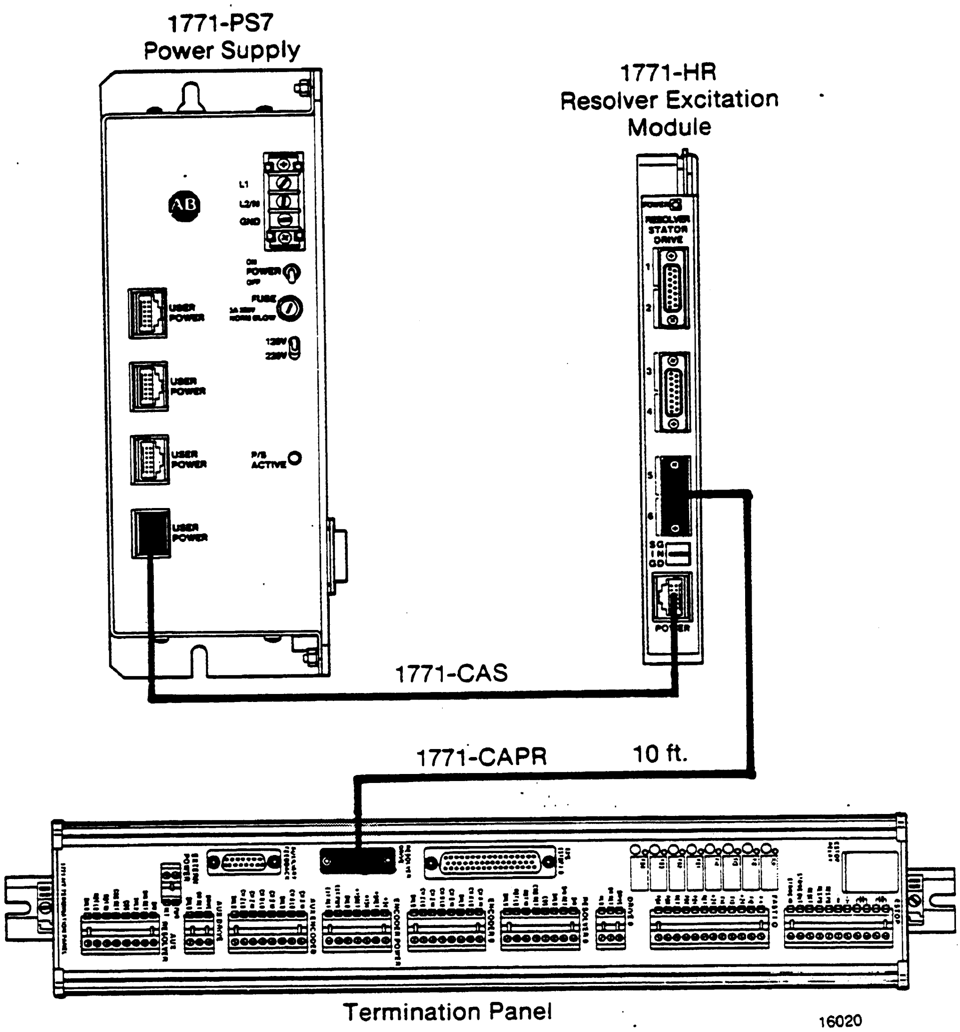
5.3.2 Resolver Excitation Module Connectors

The resolver excitation module has 3 D shell connectors for resolver excitation signals. Each D shell provides connections for 2 resolvers; 1 for master axis resolver and 1 for slave axis resolver (used in ratio, linear touch probe, or absolute positioning applications). Therefore, three D shell connectors enable you to connect up to six resolvers to the excitation module.

The 12 pin latch and lock type POWER connector receives +24VDC, ±15VDC, and +5VDC power from the 1771-PS7 power supply.

Figure 5.7 shows the cabling between the resolver excitation module, termination panel, and power supply.

Figure 5.7
Resolver Excitation Connections



5.3.3
Electrical Characteristics

Nominal Sinusoid Output Characteristics	
output amplitude	6.72 V RMS (min.) 7.07 V RMS (typ.) 7.42 V RMS (max.)
sine to cosine amplitude matching	typ. ± 0.1% max. ± 0.3%
D.C offset voltage	typ. ± 0.005 VDC max. ± 0.01 VDC
signal distortion	typ. 0.05% THD max. 0.1% THD
output frequency	2.5 kHz ± 0.02% max
sine to cosine phase relationship	typ. 90° ± 2.7 Minutes max. 90° ± 5.4 Minutes
sample edge to sine phase offset	min. 0.27° typ. 0.36° max. 0.45° (sine lags sample)
sample edge to sine phase offset drift	± 5.4 Minutes
maximum total output load (minimum load impedance)	max. 80 ohm @ 80 Degree (inductive)
output current limit	min. 0.18A typ. 0.28A max. 0.35A
power-up To Output Stable Delay	max. 2 seconds

5.4 Inserting Servo Controller and Resolver Excitation Modules

WARNING: Remove backplane power from the I/O chassis and disconnect user power cabling before installing or removing a module.

- Failure to remove power from the backplane or to disconnect cabling could cause module damage, degradation of performance, or personal injury.
- Failure to remove power from the backplane could cause injury or equipment damage due to possible unexpected operation.

CAUTION: Do not force a module into a backplane connector. Forcing a module can damage the backplane connector or the module.

To insert a module into an I/O chassis, follow these steps:

1. Remove backplane and user side power from the I/O chassis before inserting or removing a module.
2. Open the module locking latch on the I/O chassis and insert the module into the slot keyed for it.
3. Firmly press to seat the module into its backplane connector.
4. Secure the module in place with the module locking latch.

5.5 Grounding Servo Controller and Resolver Excitation Modules

Figure 5.8 shows a typical grounding and shielding block diagram for an IMC 120 system. All of the shields and signal commons (normally floating) are tied to earth ground at a single point. A signal ground lug has been provided on each IMC 120 module for this purpose. See figure 5.9 for connection details.

The practice of connecting shields to earth ground at both ends should be avoided since it may result in circuit loops that are susceptible to both radiated and coupled noise.

Figure 5.8
Typical Grounding and Shielding Arrangement for an IMC 120 Resolver System

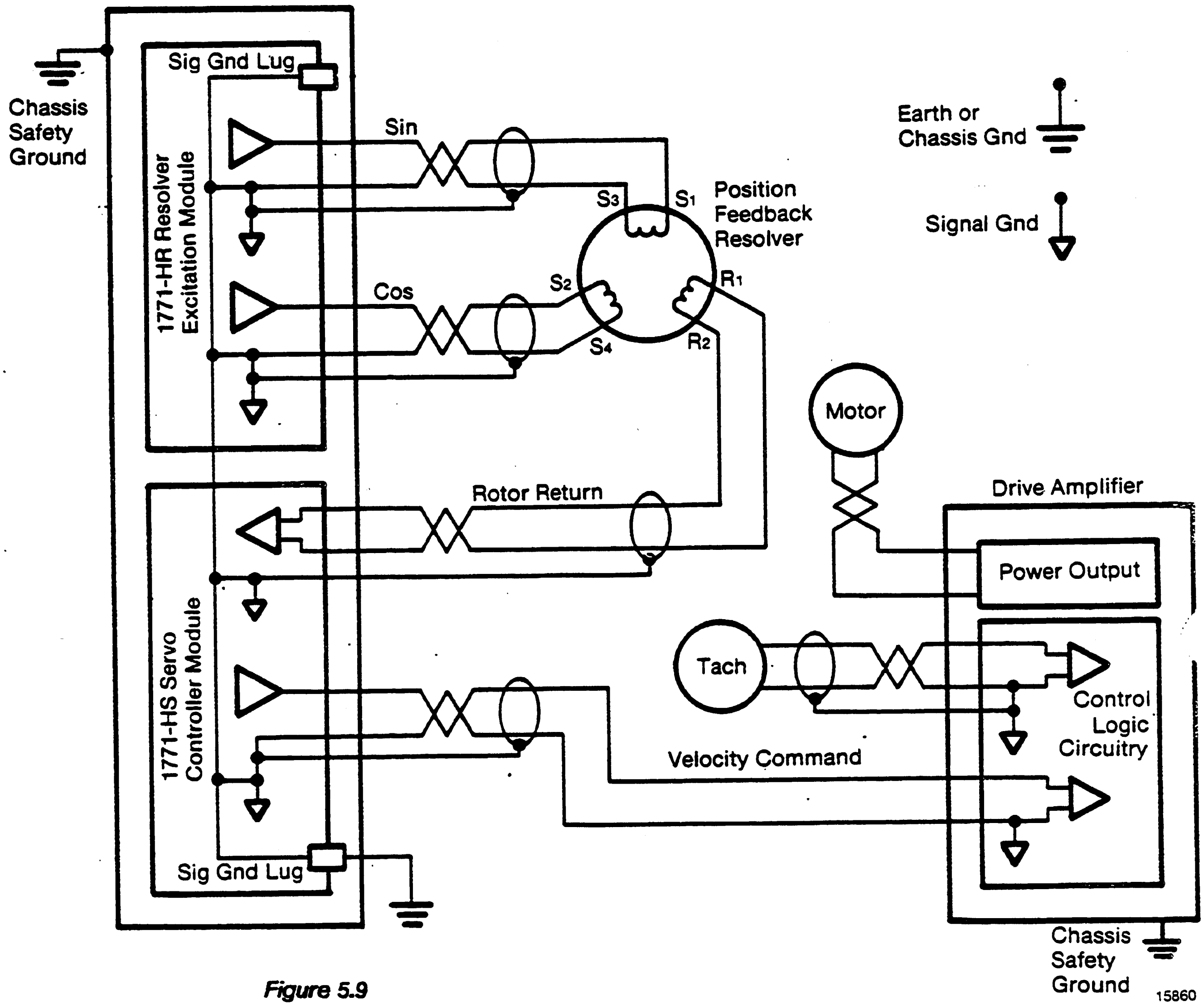
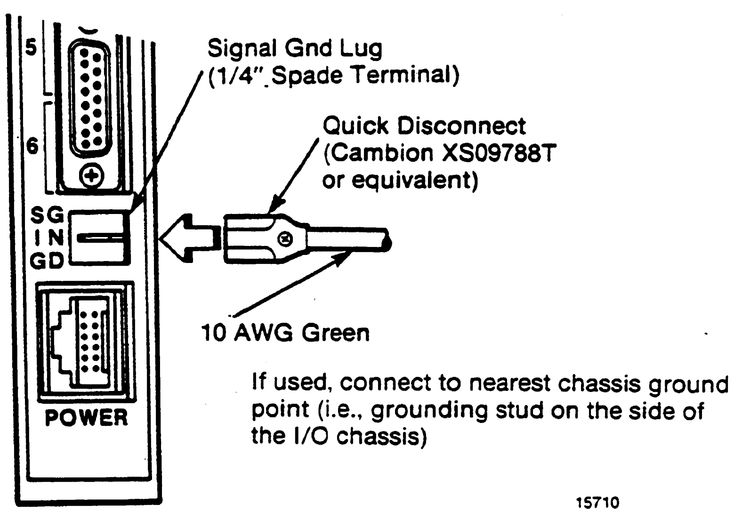


Figure 5.9
Grounding a Resolver Excitation Module



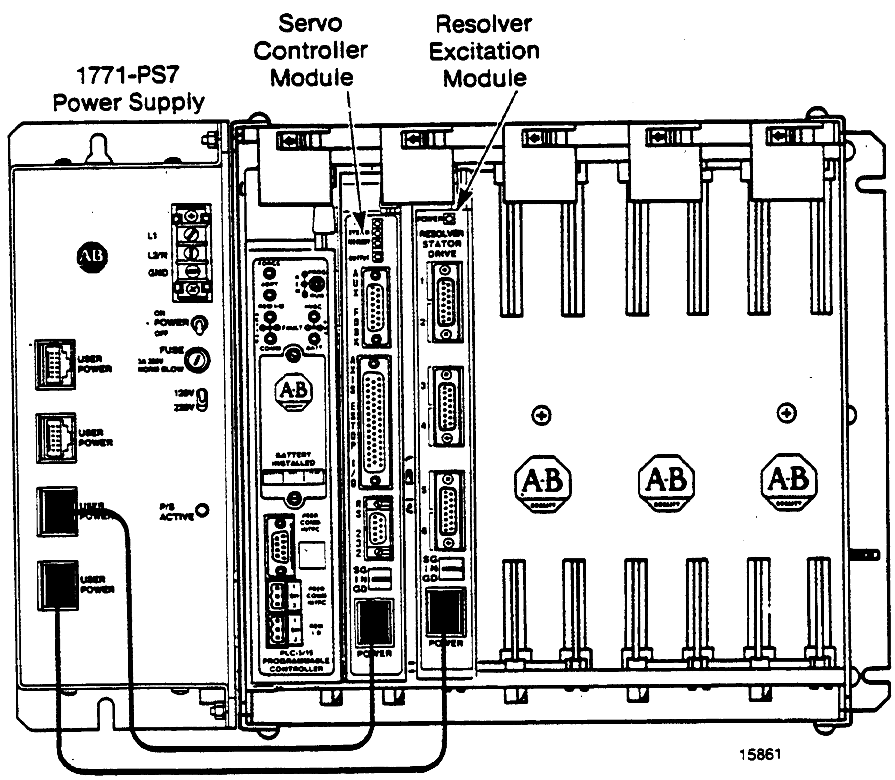
5.6
Replacing A Servo Controller Module

All AMP parameters and MML programs are stored in the memory cartridge on the servo controller module. When you replace a failed servo controller module, you must remove the memory cartridge from the old module and insert it onto the new module. In this way, the AMP parameters and the MML programs can be transferred to the new module without requiring an off-line development system for downloading.

5.7
Connecting Power to the Servo Controller and Resolver Excitation Modules

Figure 5.10 shows you how to connect 1771-CAS cables to the servo controller and resolver excitation modules. Make sure that power has been connected to your 1771-PS7 power supply and that it is turned OFF before you connect the cables (see section 4.3).

Figure 5.10
Connecting Power to Servo Controller and Resolver Excitation Module



6.0 Chapter Overview

This chapter discusses:

- termination panel features
- mounting the termination panel
- general wiring practices

6.1 Termination Panel Features

The termination panel is an option that provides an easy and convenient means for you to connect and troubleshoot your IMC 120 system.

The termination panel (see figure 6.1) features:

- D shell connectors for cables from the servo controller and resolver excitation modules
- pluggable screwtype connectors for wiring to user devices.
- fast I/O LEDs to indicate the status of 4 fast inputs (FI1-FI4) and 4 fast outputs (FO1-FO4)
- a socketed on-board relay for E-Stop functions that provides relay contacts to enable the drives and lets you daisy-chain up to 3 servo controllers onto a single E-Stop string

Separate pluggable connectors are provided for both resolvers and encoders, so you can use the termination panel in either encoder or resolver systems.

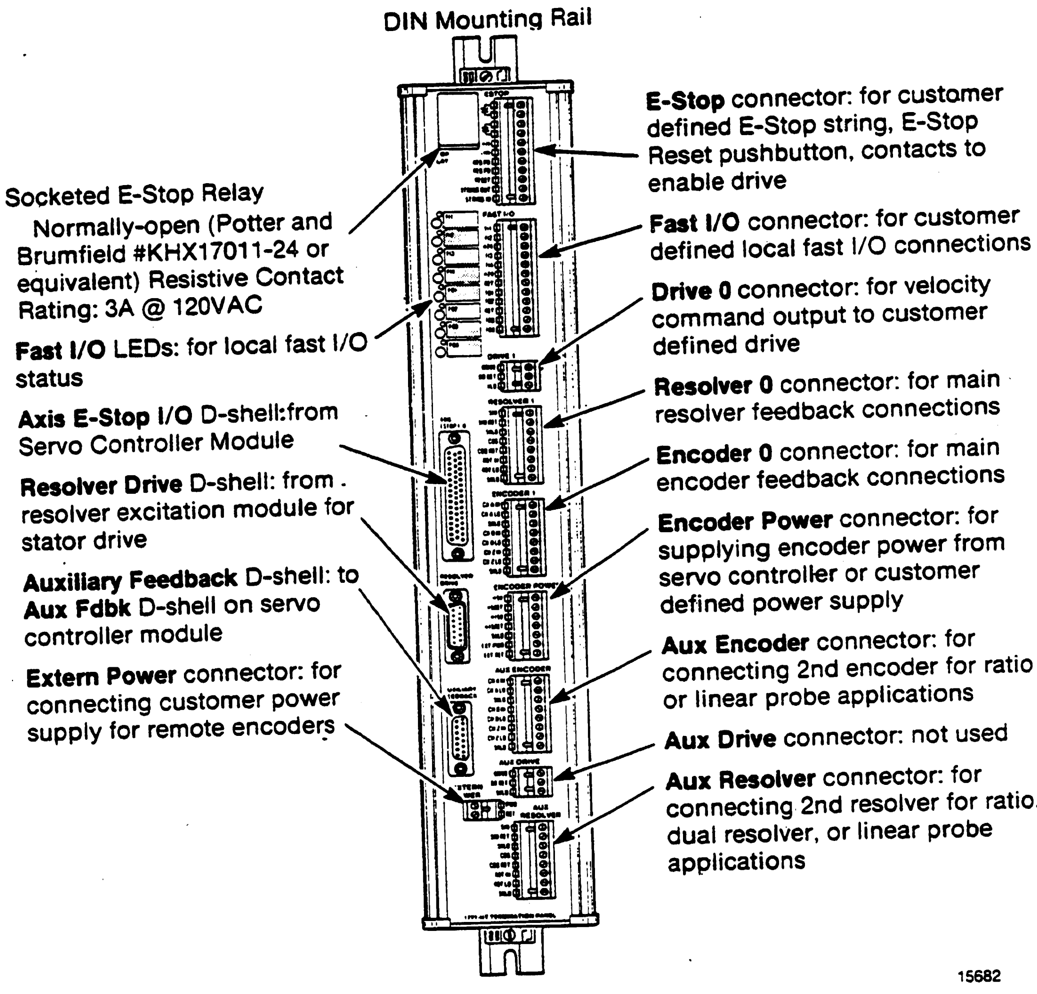
Important: Total cable length from the termination panel to the feedback devices should be no further than:

- 40 cable feet for +5VDC encoders if you don't use an external power supply
- 90 cable feet for +5VDC encoders if you use an external power supply
- 90 cable feet for + 15VDC encoders
- 90 cable feet for resolvers

Add 10 feet if no termination panel is used. Distance is then measured from the servo controller and resolver excitation modules instead of the termination panel.

All user connections with the exception of the RS-232 port and user side power are routed through the termination panel. User side (isolated) voltages of +5VDC and +15VDC for encoder power (chosen by wiring to the appropriate connector pin), and +24VDC for fast I/O is available on-board. All connections are designated on the board (see figure 6.1).

Figure 6.1
Termination Panel



6.2 Mounting the Termination Panel

The termination panel is shipped:

- with the E-STOP Relay and all connectors installed
- mounted to the DIN type # 46277-1 mounting rail

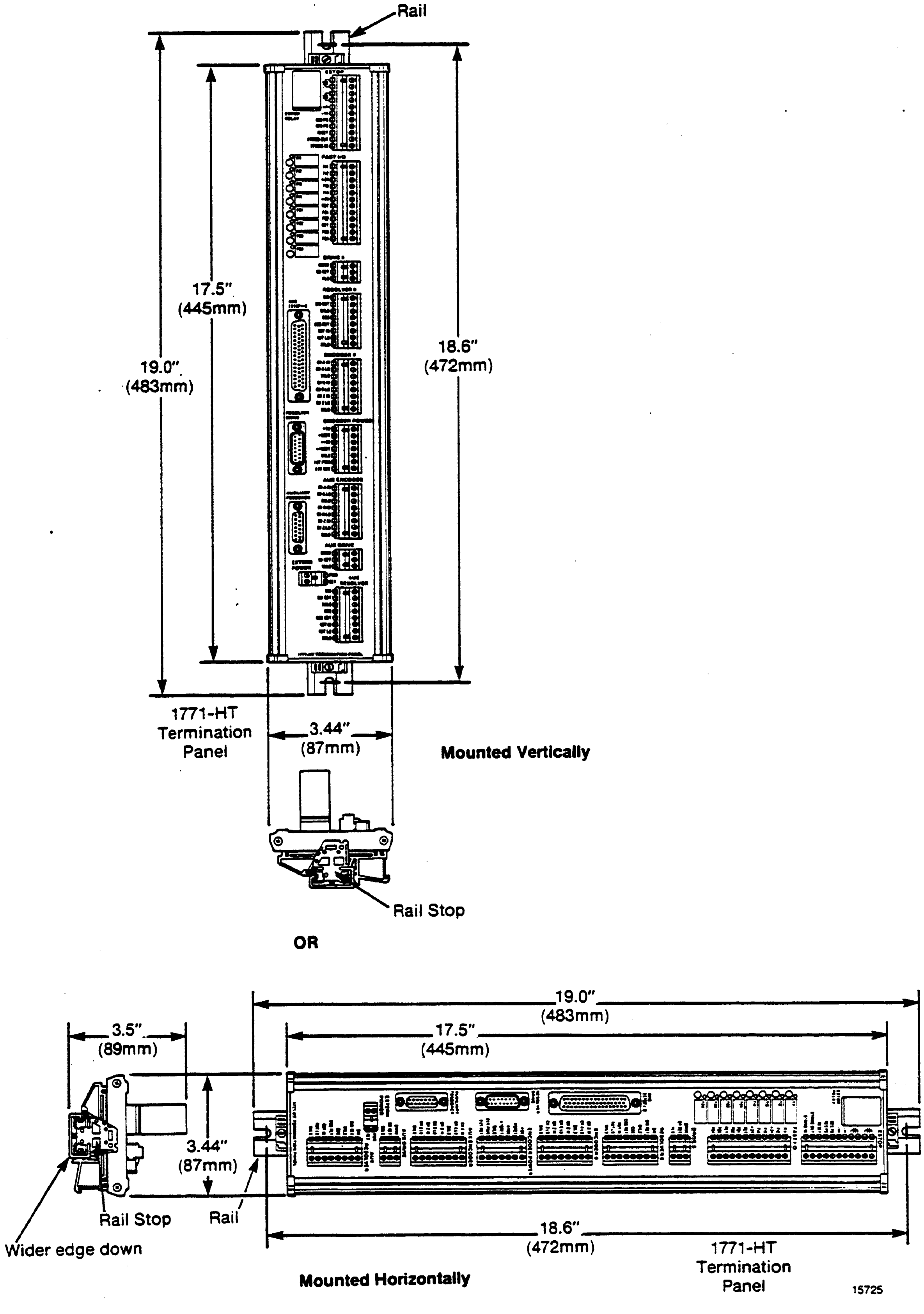
The termination panel can be easily separated from its mounting rail by unsnapping it.

A screwdriver and wire strippers are the only tools required to set up the termination panel.

Fasten the termination panel and its rail either horizontally, one orientation only, or vertically (see figure 6.2) to the enclosure wall with two screws.

Important: If you install the termination panel horizontally, the wider edge of the mounting rail should be down (see figure 6.2).

Figure 6.2
Termination Panel Mounting Considerations



6.3 General Wiring Practices

In this section we discuss:

- connecting different level power conductors to terminals
- using shielded cables

6.3.1 Connecting to Terminals

Keep low-level signal conductors separate from high-level power conductors. This is particularly important for cable connections to encoders and resolvers. Read Chapter 3, "Planning Your Hardware Installation" to learn how you should route conductor category 2 wires and cables connected to IMC 120 modules.

Follow the practices outlined in publication 1770-4.1, entitled "Programmable Controller Wiring and Grounding Guidelines" to learn how to route other conductor categories.

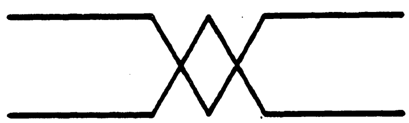
6.3.2 Using Shielded Cables

For many connections, we tell you to use shielded cable. Using shielded cables and properly connecting their shields to ground protects against electromagnetic noise interfering with the signals transmitted through the cables.

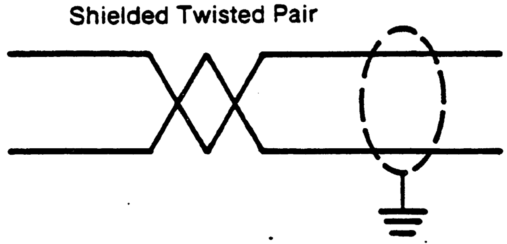
WARNING: Use shielded cable as directed in this manual. If you do not, the axis motion in your motion control system could be unpredictable. This could result in damage to equipment and/or injury to personnel.

Within a cable, pairs of wires are twisted together. Using a twisted pair for a signal and its return path provides further protection against noise.

We show a twisted pair like this:



We show a shielded twisted pair like this:



Shield wires, in general, should connect to ground at one and only one end. The termination panel provides a convenient place to connect all shield wires while providing the necessary ground connection through the servo controller module.

At the other end, cut the shield foil and drain wire short and cover them with tape to protect against their accidentally touching ground. Keep the length of leads extending beyond the shield as short as possible.

In high noise environments, the user may want to connect shield wires at both ends of the cable in an attempt to improve the noise immunity of the system. If this must be done, terminate one end of the shield to ground through a 0.1 uf capacitor to avoid ground loops in the system.

7.0 Chapter Overview

This chapter discusses:

- connecting fast inputs and outputs
- wiring E-stop connections

7.1 Wiring Fast Inputs and Outputs

On the termination panel, the +24VDC fast inputs and outputs of the servo controller are routed from the AXIS ESTOP I/O connector (50 pin D shell) to the FAST I/O connector (12 pin pluggable).

The fast I/O consists of:

- fast inputs FI1-FI4
- fast outputs FO1 - FO4
- +24VDC and +24VDC return signals

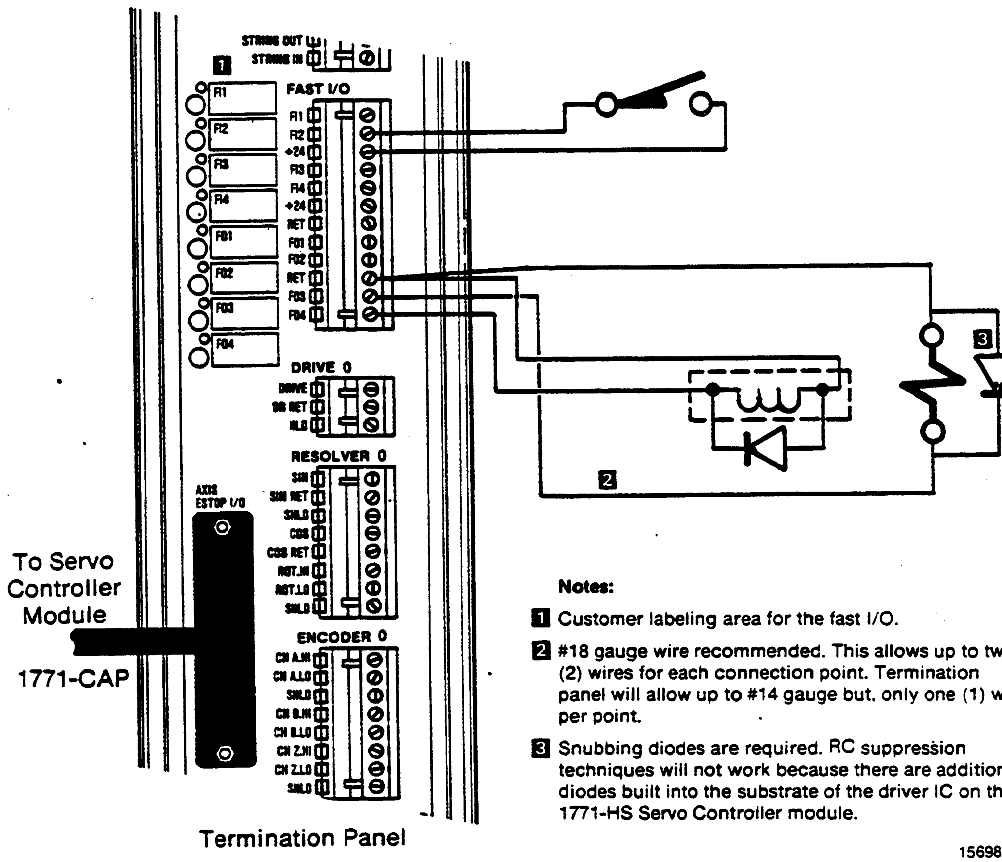
FI1 can be used as a fast input as well as a trigger probe input. See Part 3, Programming AMP for details concerning configuration of the probe input.

We recommend 18 AWG wire for wiring fast I/O. This allows 2 wires for each connection point. The termination panel accepts 14 AWG wire, but this allows only one wire per point.

Figure 7.1 shows a diagram of typical fast I/O connections. Figure 7.2 shows equivalent fast input and fast output circuits.

Important: All fast inputs are +24VDC referenced (i.e. the input device always connects between +24VDC and the appropriate fast input). All fast outputs are GND referenced (i.e. the output load always connects between the fast output and ground).

Figure 7.1
Typical Fast I/O Connections



Notes:

1 Customer labeling area for the fast I/O.

2 #18 gauge wire recommended. This allows up to two (2) wires for each connection point. Termination panel will allow up to #14 gauge but, only one (1) wire per point.

3 Snubbing diodes are required. RC suppression techniques will not work because there are additional diodes built into the substrate of the driver IC on the 1771-HS Servo Controller module.

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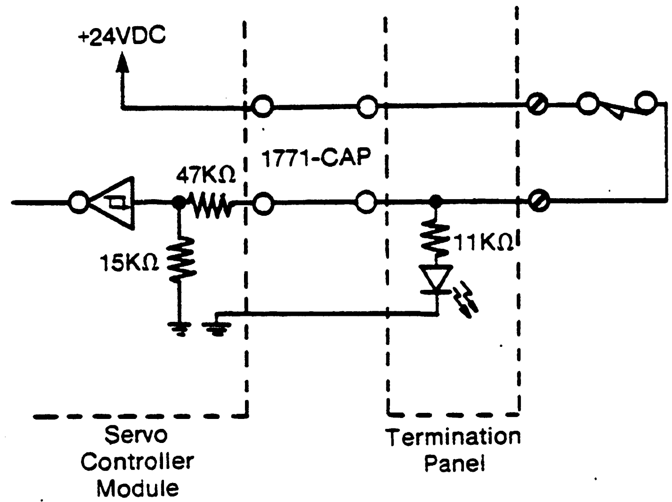
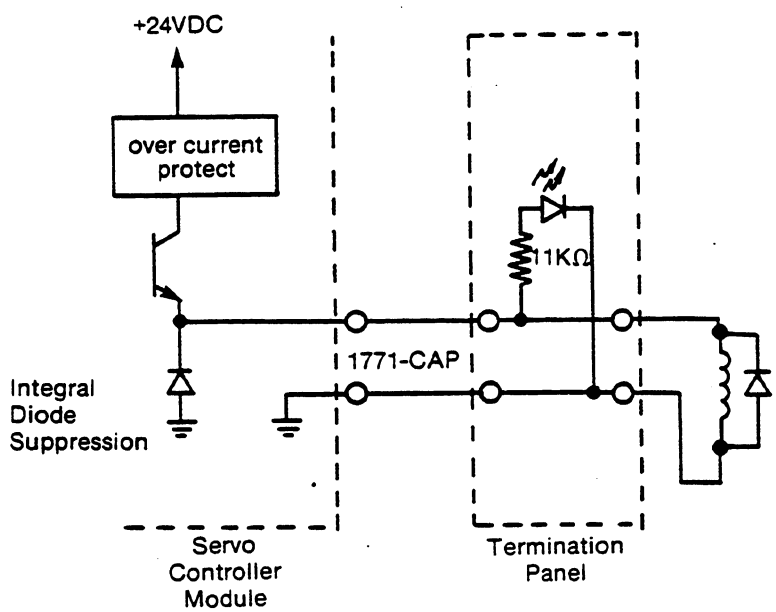
Figure 7.2
Equivalent Fast Input and Output Circuits

Equivalent Fast Input Circuit



Equivalent Fast Output Circuit



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7.1.1
Wiring Hardware Overtravels

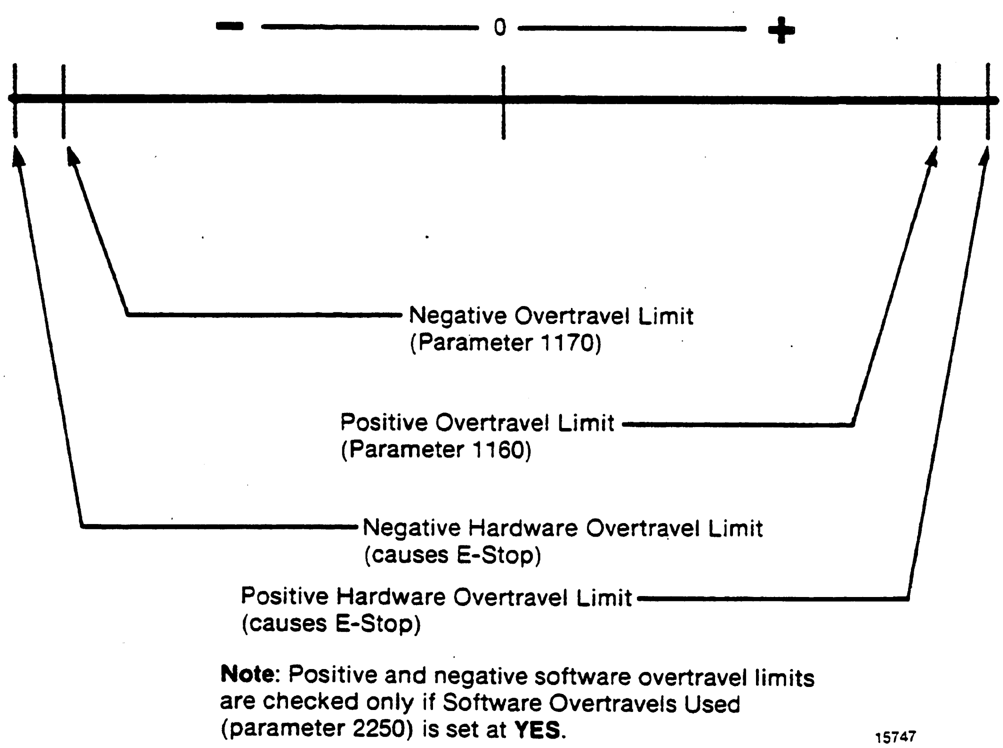
Hardware overtravel limit switches for each axis should be:

- wired into the customer E-Stop string
- positioned outside software overtravels as shown in figure 7.3.

The system should go into E-Stop when a hardware overtravel is tripped.

Refer to AMP parameter 2250 in Chapter 12 of the IMC 120 Motion Control System Programming Manual (Publication 1771-6.5.51) to read more about software overtravels.

Figure 7.3
Overtravel Limits



7.1.2 Connecting Home Limit Switch as a Fast Input

Establish any one of the fast inputs as the home limit switch through AMP parameter 2360, SOURCE OF SWITCH INPUT. Refer to the IMC 120 Motion Control System Programming Manual (Publication 1771-6.5.51) to read more about this AMP parameter.

The exact position of home is not important. It is important that the home position is:

- a repeatable resting place for the axis when it is not in use
- free of obstruction from any other axis that is in motion

To connect a home limit switch, follow these steps:

1. Place the limit switch near the approximate desired home position.
2. Adjust the encoder so that the marker is about 1/2 revolution from the limit switch closure.

   or

   Adjust the resolver so that the null is about 1/2 cycle from the limit switch closure.

   If step 2 is not done, home may occasionally be off by one revolution of the encoder.

7.1.3 Wiring a Trigger Touch Probe

Use fast input #1 (FI1) for a trigger touch probe. To do this, you must enable AMP parameter 2070, TYPE OF TOUCH PROBE USED, using the AMP utility. Refer to the IMC 120 System Programming Manual (Publication 1771-6.5.51) to learn how to use the AMP utility.

The electrical interface specifications are identical to a normal fast input except that there is no debounce filtering present.

The time delay between the servo controller module receiving the touch probe trigger and latching the current axis position is considered negligible. However, you should be aware of any external delays that may introduce position "staleness" in the probing operation, especially at higher probing speeds.

It is a good idea to datum (establish an offset for the distance between the actual location and the location sensed by the probe of a known point) the touch probe at the same velocity that you move the probe. This helps insure that if there are any external delays in the trigger signal, the position staleness shows up as a constant position offset error and is subtracted out of the measurement (assuming any external delay is repeatable).

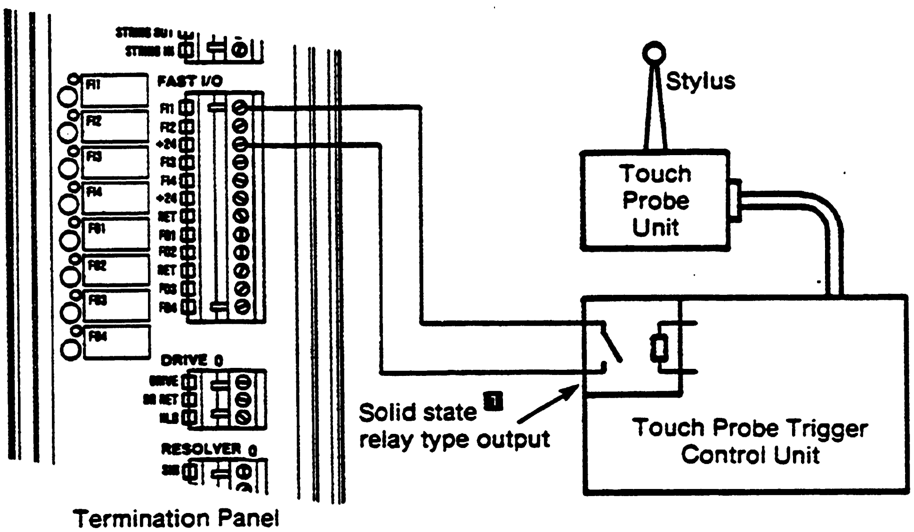
The servo controller touch probe interface is intended for use with control units that offer 24VDC compatible solid state relay outputs. (see figure 7.4). Other configurations can be supported as long as the user operates within the published electrical specifications.

The touch probe circuitry resident on the servo controller module only responds to trigger probe edge changes (edge polarity is programmable through AMP parameter 3080, POLARITY OF PROBE, using the AMP utility). Once the active edge occurs, position data is captured by the module, and additional occurrences of the trigger signal has no effect until the probe is re-enabled under program control (see examples 1 and 2).

Table 7.A
Touch Probe Input (FI1) Electrical Specifications

V_{T+} (Input Low-High Trip Threshold)	Min	7.2VDC
	Typ	11.5VDC
	Max	16.5VDC
V_{T-} (Input High-Low Trip Threshold)	Min	4.0VDC
	Typ	7.4VDC
	Max	11.4VDC
$V_{Hysteresis}$	Min	1.9VDC
	Typ	4.1VDC
	Max	6.5VDC
I_{IN} at 27V	Max	0.50mA
V_{IN} (absolute max.)	Max	± 75VDC

Figure 7.4
Typical Touch Probe Interface Wiring



1 It is preferred, from a safety standpoint, that the solid state relay be closed at rest and open when the touch probe stylus deflects. A broken wire or short circuit to ground will appear to the system as a probe fired and the probing cycle in process will stop commanding motion towards the part. The user should make every effort to insure failsafe operation of the touch probe. Not all vendors' touch probe control units conform to this safety consideration.

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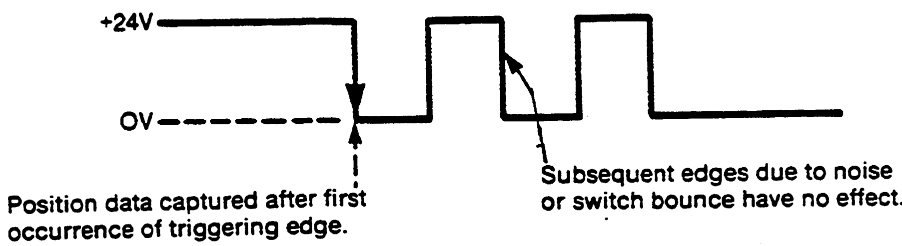
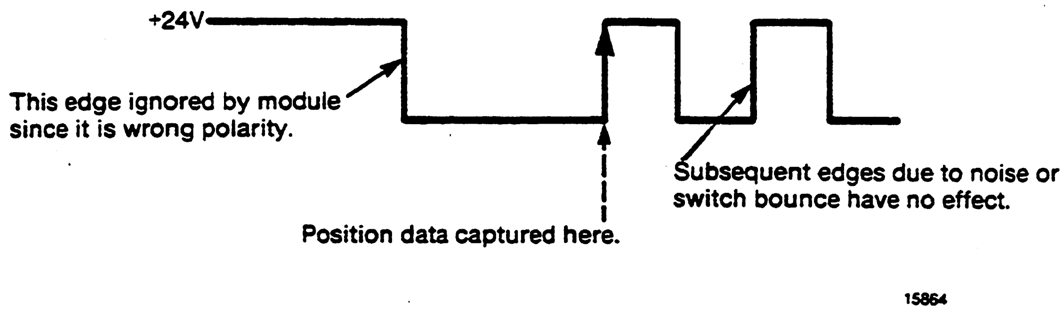
Example 1:

The servo controller module is programmed for high to low touch probe triggering.



Example 2:

The Servo Controller module is programmed for low to high touch probe triggering.



7.2 E-Stop Operation

WARNING: The E-Stop circuitry on this device is intended for use with ONLY a +24 volt DC E-Stop string. The use of voltages other than +24 volts DC can result in damage to the unit and will void the warranty. A sample circuit for 120 volt AC E-Stop string is shown in Figure 7.9. This is intended as a guide. If you have any questions or use other voltages in your E-Stop string, consult your Allen-Bradley representative.

The servo controller module detects and controls E-Stop conditions. Each servo controller module has a separate and independent E-Stop circuit. Refer to customer wiring documentation for recommendations on how to correctly wire your external E-STOP string.

When you connect the handheld pendant (1771-HD) to the servo controller module, the E-Stop pushbutton on the handheld pendant is inserted into the existing E-Stop string.

To unplug the handheld pendant so that the system does not drop into E-Stop, you must hold in the E-Stop Reset pushbutton while simultaneously unplugging the pendant.

Important: The E-Stop Reset Pushbutton should be mounted near the handheld pendant connection point.

The following events cause a hardware E-Stop to occur:

- broken wire in the user power cable (1771-CAS)
- powerfail (signal from 1771 backplane)
- watch-dog time out on servo controller module
- software E-Stop conditions
- a contact in the external E-Stop string or a broken/ missing wire opens the string (someone pushes the E-Stop pushbutton)

Table 7.B shows the specifications for the servo controller E-Stop relay.

Table 7.B
Specifications for the E-Stop Relay on the Servo Controller Module

Max. Contact Voltage Rating	*80VDC max*
Operate time	*500us averaage*
Contact bounce	*less than 200us*
Contact resistance	*150 milliohms average*
Contact rating	*4.0VA @ 0.25A max*

7.2.1 Wiring the E-Stop for One Axis System

WARNING: The E-Stop circuitry on this device is intended for use with ONLY a +24 volt DC E-Stop string. The use of voltages other than +24 volts DC can result in damage to the unit and will void the warranty. A sample circuit for 120 volt AC E-Stop string is shown in Figure 7.9. This is intended as a guide. If you have any questions or use other voltages in your E-Stop string, consult your Allen-Bradley representative.

Wiring the E-Stop for one axis system consists of connecting:

- Drive Enable (+-| |-+)
- E-Stop Reset pushbutton (RES PB, RES PB, and RESET)
- customer E-Stop string (STRING IN and STRING OUT)

WARNING: It is responsibility of the user to develop a failsafe wiring design for his customer E-Stop string.

The elements of the E-Stop string consist of the following connections in series:

- axis hardware overtravels
- remote E-Stop
- motor thermal switch
- transformer thermal switch
- drive fault

Figure 7.5 shows the E-Stop circuitry for a one axis system and its equivalent ladder diagram.

Figure 7.5
E-Stop Circuitry and Equivalent Ladder Diagram for a One Axis System

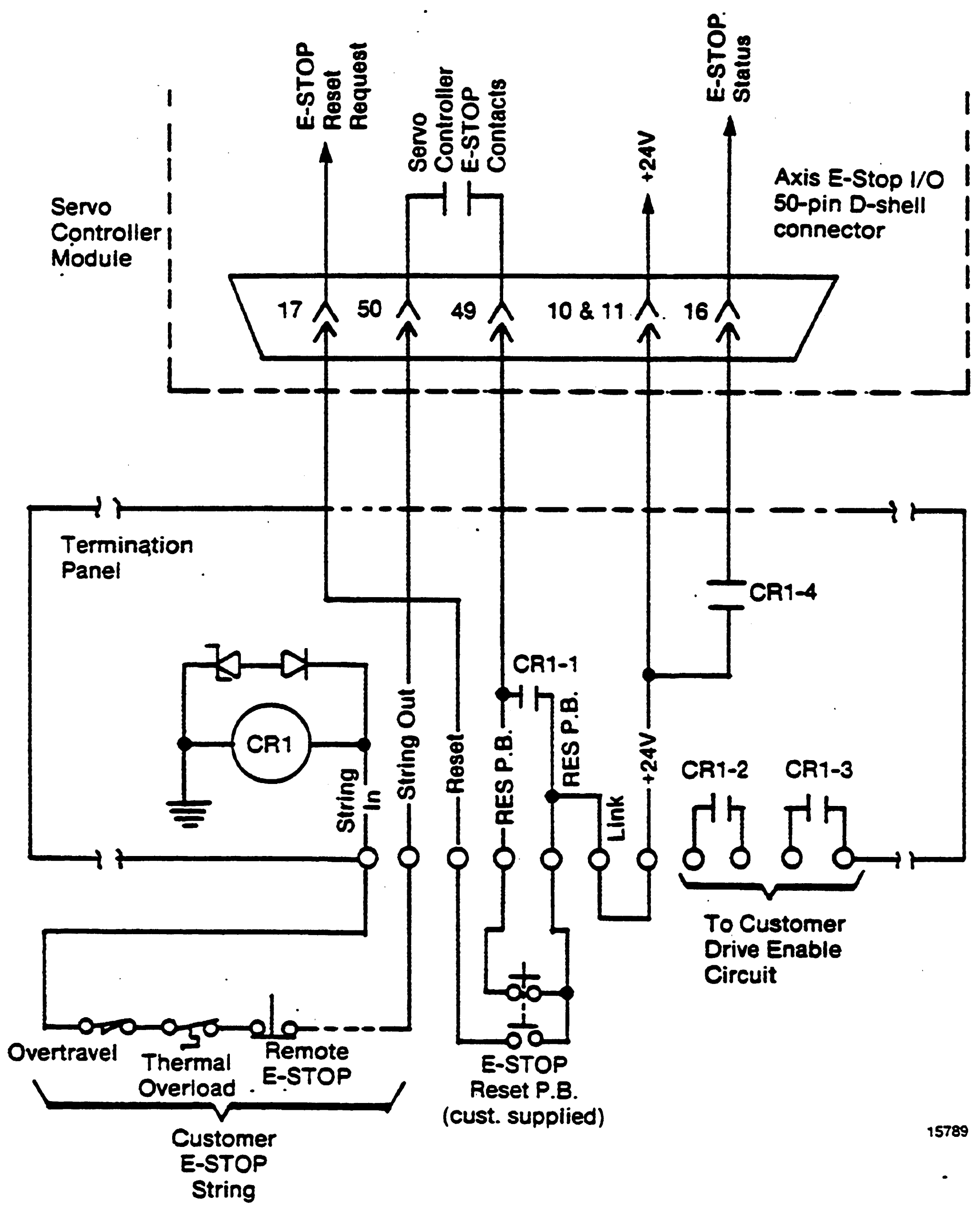
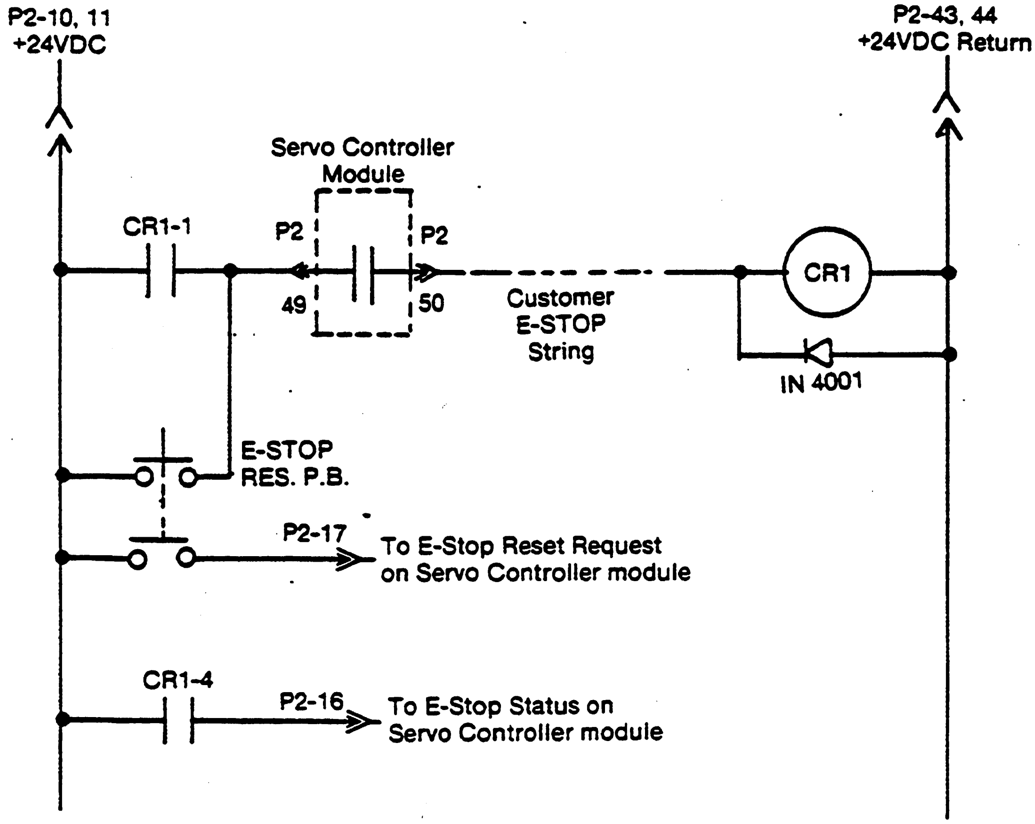


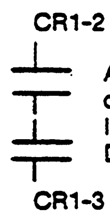
Figure 7.5 (continued)
E-Stop Circuitry and Equivalent Ladder Diagram for a One Axis System

Equivalent E-STOP Circuit
P2=50-pin D-shell connector
on Servo Controller module



Note:

CR1 is Potter & Brumfield #KHX 17D11-24
Coil: 24VDC, 650Ω
Contact: 3A Resistive, 120VAC
Arrangement: 4 form C



Auxiliary Contacts of K1 used in Drive Interface. See Customer DWGS provided for your Drive.

Caution:

If the above relay is not used, be sure that replacement relay has a coil resistance greater than or equal to 650Ω.

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To wire E-Stop connections you must refer to wiring diagrams for the IMC 120 compatible drive you are using. Table 7.C lists the figures that show wiring for four different Allen-Bradley compatible drives.

Table 7.C
Figures Numbers and Wiring Diagrams for Compatible Allen-Bradley Drives

Figure	Wiring Diagram for
8.13	1388 DC PWM Servo Controller
8.15	1389 AC Servo Amplifier
8.14	1391 AC Servo Controller Amplifier
8.16	7930 DC Servo Controller Amplifier

The 1389 servo drives (see figure 8.15) requires a 115 VAC power contactor (K1) to supply main power to the drive amplifier. See the 1389 Servo Amplifier Installation manual for details.

7.2.2 Wiring the E-Stop for Two or Three Axis System

WARNING: The E-Stop circuitry on this device is intended for use ONLY with +24 volt DC E-Stop string. The use of voltages other than +24 volts DC can result in damage to the unit and will void the warranty. A sample circuit for 120 volt AC E-Stop string is shown in Figure 7.9. This is intended as a guide. If you have any questions or use other voltages in your E-Stop string, consult your Allen-Bradley representative.

For a two or three axis system you need a termination panel and a servo controller module for each axis. Refer to figure 7.6 for E-Stop circuitry and equivalent ladder diagrams for two or three axis system that:

- all of the servo controller modules must be up and running before the system comes out of E-Stop
- if any one axis drops into E-Stop, the whole system drops into E-Stop.

Figure 7.6
E-Stop Circuitry and Equivalent Ladder Diagrams for Two or Three Axis System

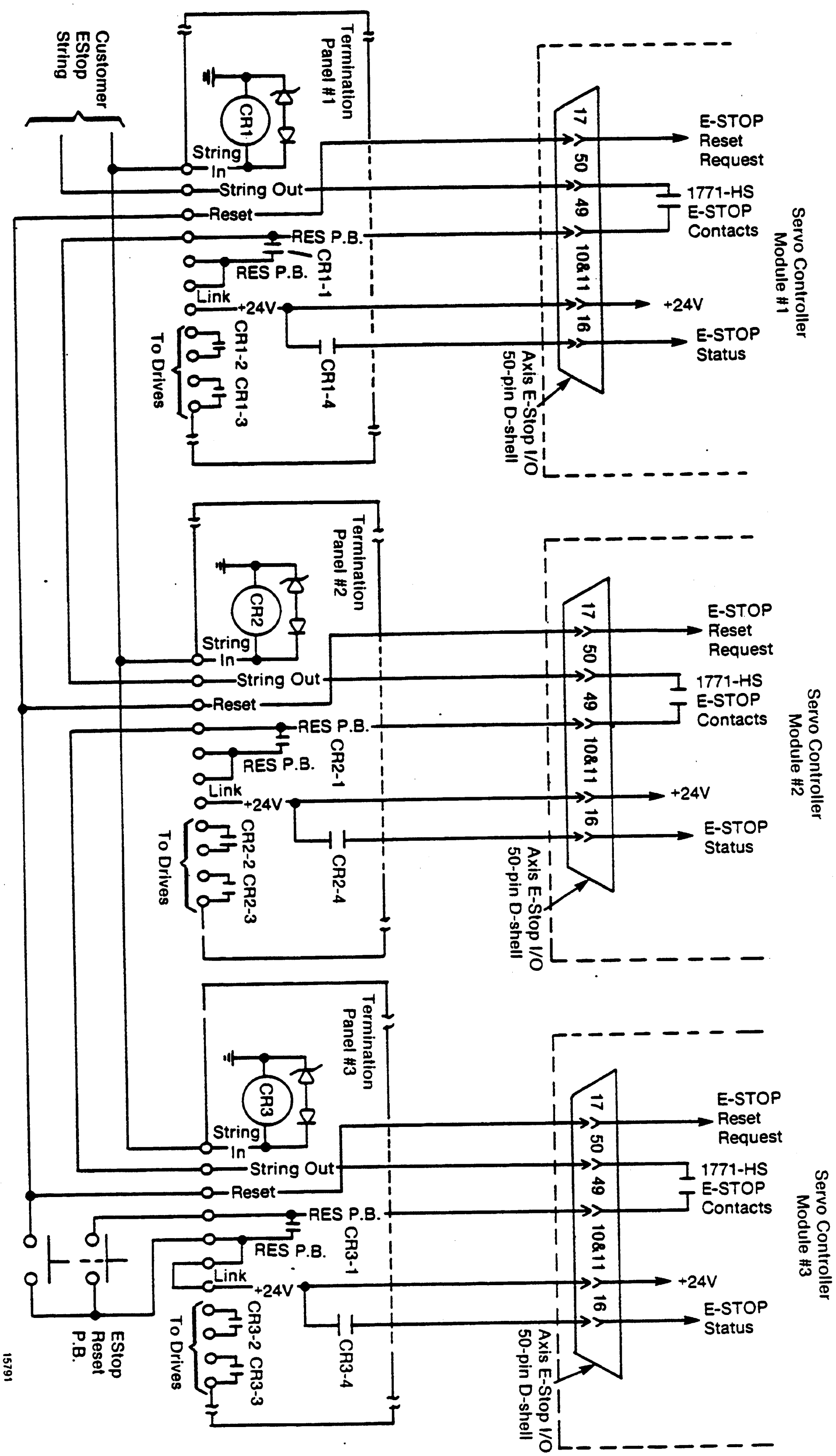
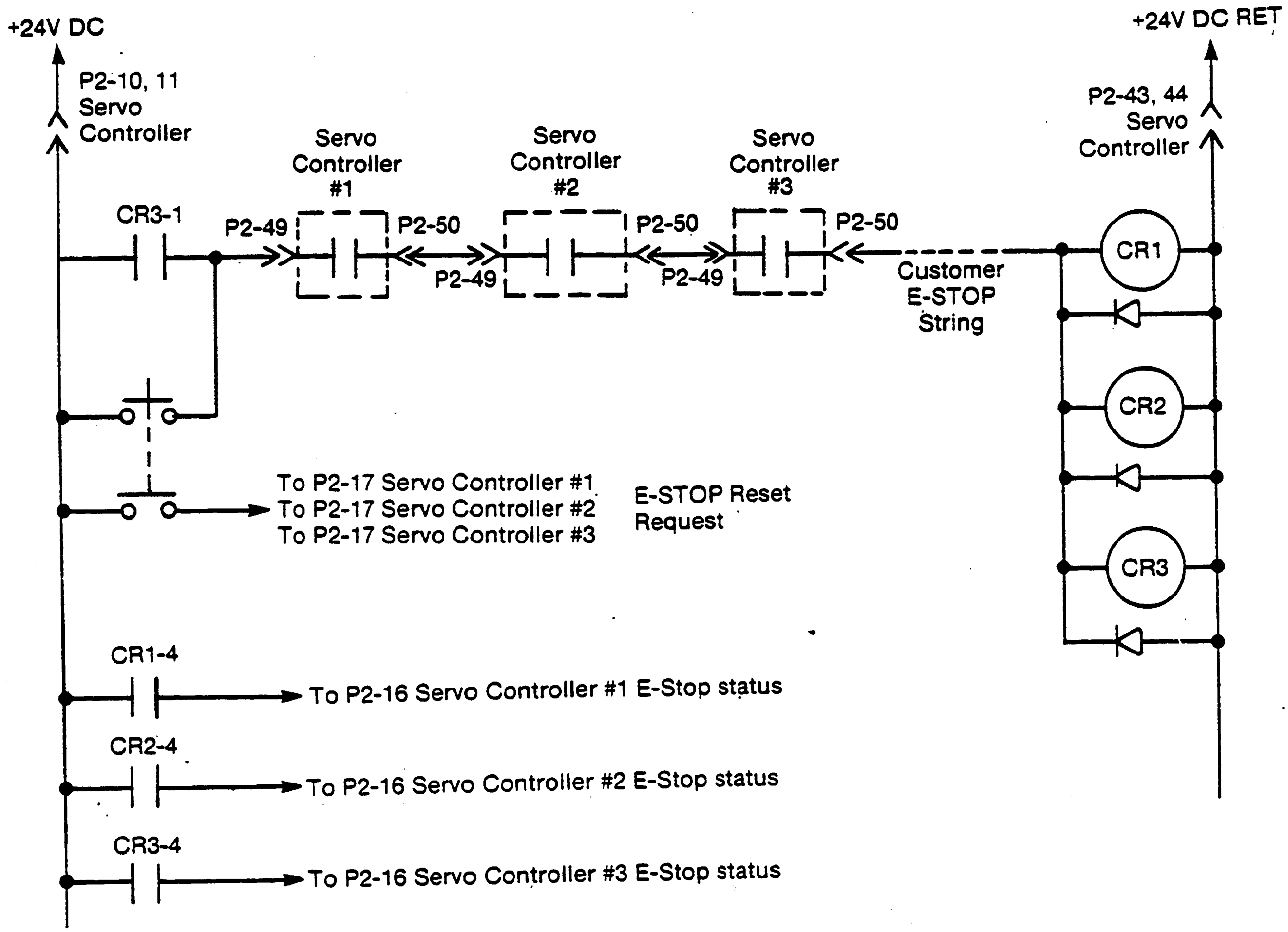


Figure 7.6 (continued)
E-Stop Circuitry and Equivalent Ladder Diagrams for Two or Three Axis System



Notes:

1. P2 is the 50-pin D-shell on the Servo Controller module labelled **Axis E-Stop I/O**.
2. CR1, CR2, and CR3 auxiliary contacts to be used for drive enable of each drive amplifier. CR2 and CR3 may not always be required.
3. CR1 is Potter & Brumfield #KHX 17D11-24
   Coil: 24VDC, 650Ω
   Contact: 3A Resistive, 120VAC
   Arrangement: 4 form C
4. If the above relay is not used, be sure that the replacement relay has a coil resistance greater than or equal to 650Ω.

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7.2.3 Wiring a Four Axis System with the Same E-Stop String

WARNING: The E-Stop circuitry on this device is intended for use ONLY +24 volt DC E-Stop string only. The use of voltages other than +24 volts DC can result in damage to the unit and will void the warranty. A sample circuit for 120 volt AC E-Stop string is shown in Figure 7.9. This is intended as a guide. If you have any questions or use other voltages in your E-Stop string, consult your Allen-Bradley representative.

For a four axis system you need four termination panels and four servo modules (and two resolver excitation modules if all four axes require resolver feedback). Since an I/O chassis can only contain a maximum of 3 servo controller modules and one resolver excitation module, you need an additional I/O chassis.

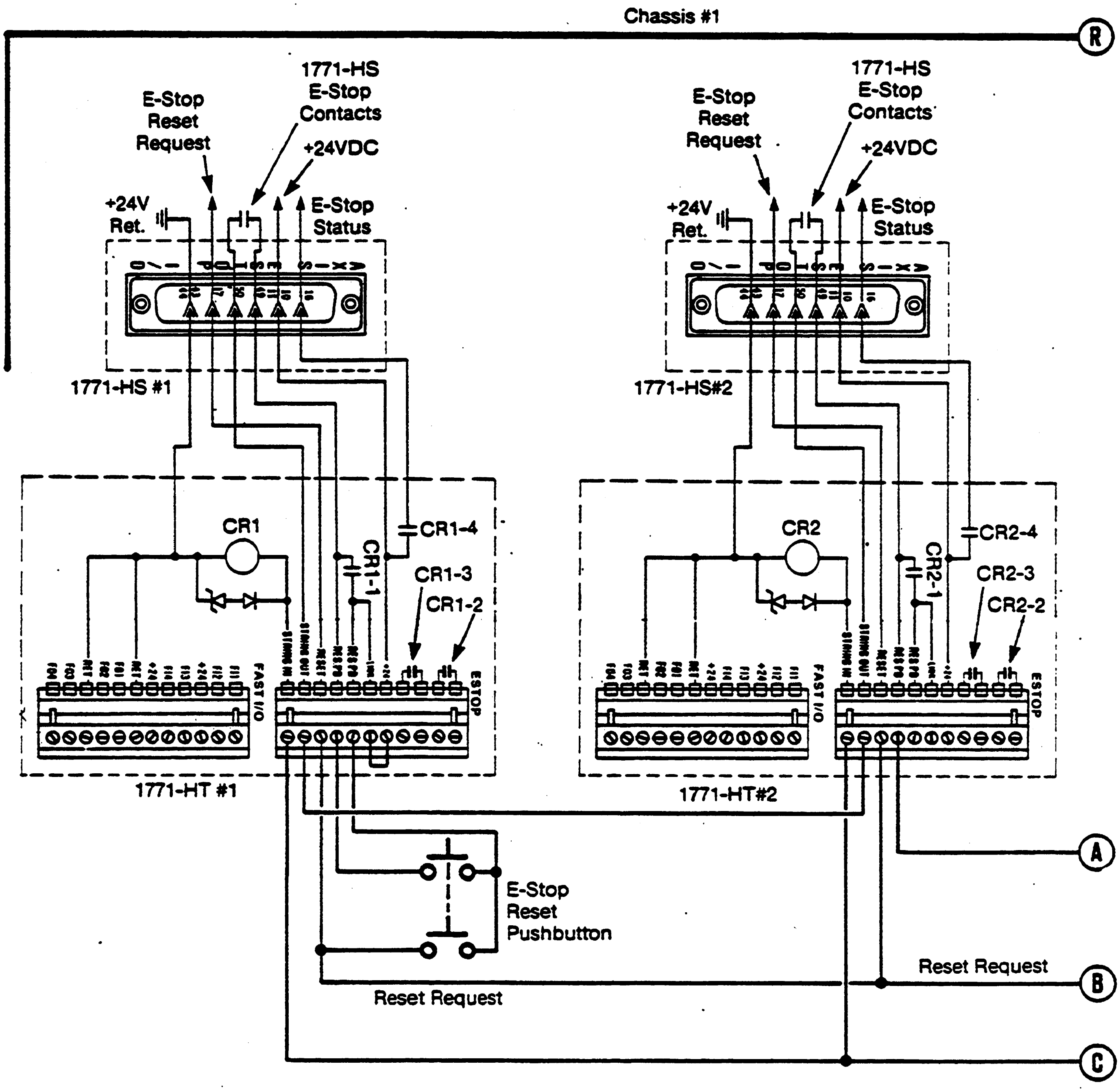
If you require more than 3 servo controller modules in the same E-Stop string, you must be careful not to power more than 3 termination panels (one 650 ohm 24V DC relay in each panel) from the same power supply.

Depending on the drives used, there may be spare contacts available on the termination panel that can be used to implement the E-Stop circuit. Otherwise, you must supply an additional relay.

Refer to figures 7.7 and 7.8 for 2 E-Stop circuits and equivalent ladder diagrams (one using a spare contact and the other using a customer supplied relay) for a four axis system that:

- all of the servo controller modules must be up and running before the system comes out of E-Stop
- if any one axis drops into E-Stop, the whole system drops into E-Stop.

Figure 7.7
E-Stop Circuitry and an Equivalent Ladder Diagram for Four Axis System Using a Spare Contact



Notes:

1. No more than three (3) 650Ω, 24VDC relays are powered from each 1771-PS7 power supply.
2. Since there are two 1771-PS7 power supplies in this configuration, the 24VDC return lines should be connected together.

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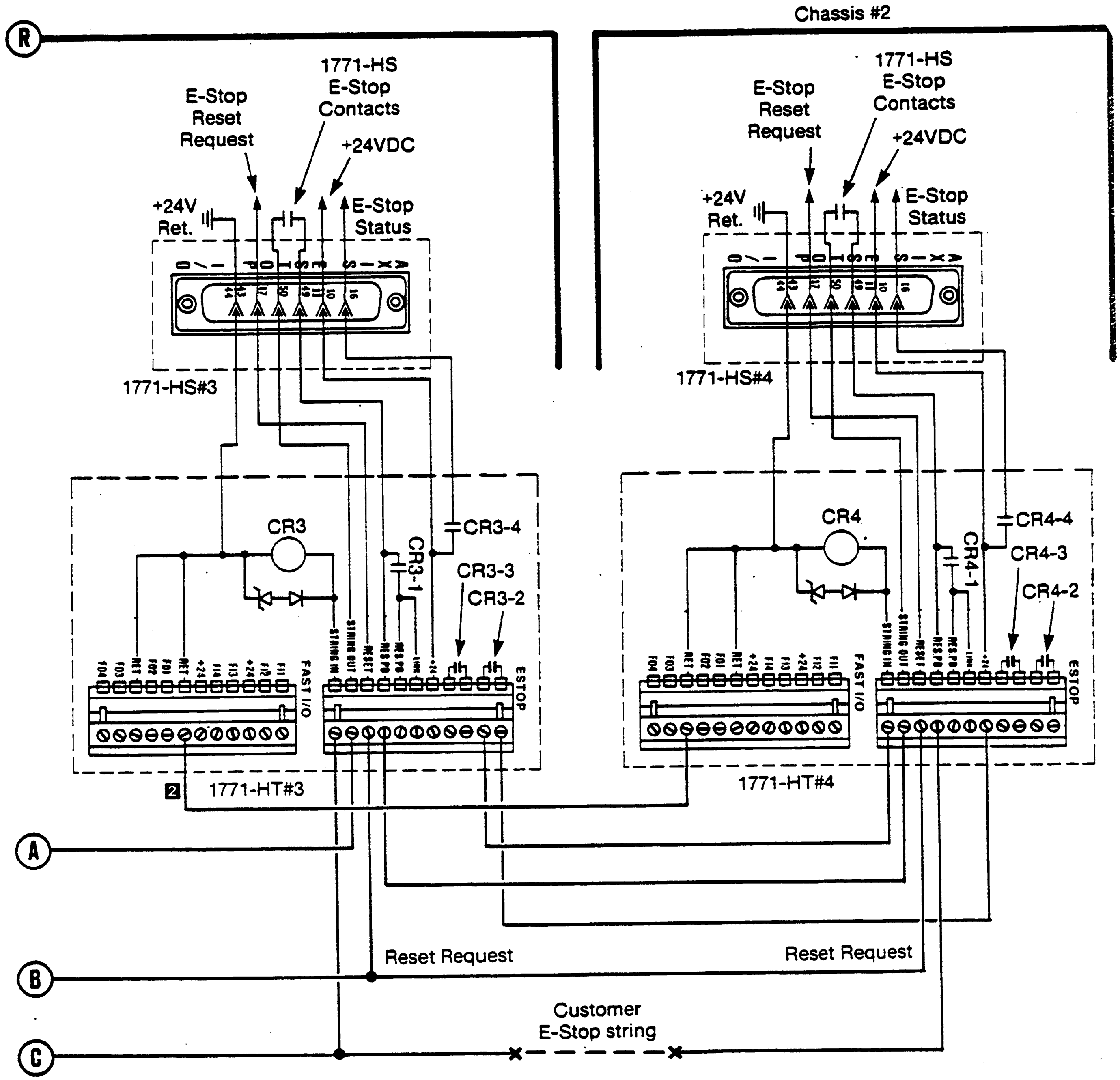
Figure 7.7 (continued)
E-Stop Circuitry and an Equivalent Ladder Diagram for Four Axis System Using a Spare Contact

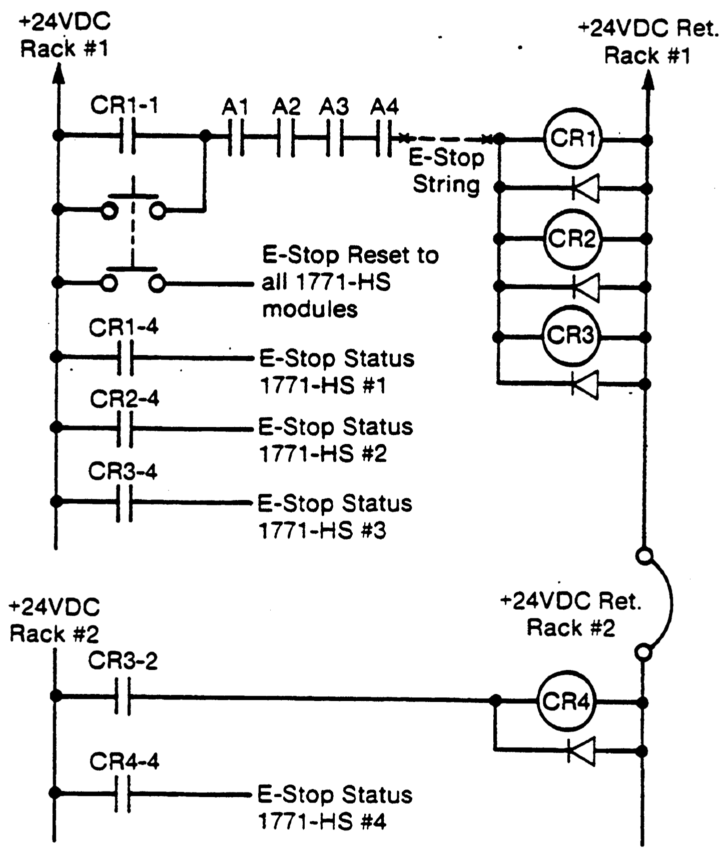


Notes:

1. No more than three (3) 650Ω, 24VDC relays are powered from each 1771-PS7 power supply.
2. Since there are two 1771-PS7 power supplies in this configuration, the 24VDC return lines should be connected together.

15792B

Figure 7.7 (continued)
E-Stop Circuitry and an Equivalent Ladder Diagram for Four Axis System Using a Spare Contact



Notes:
1. CR1 - CR4 are relays supplied with termination panels #1 - 4.
2. Contacts A1-A4 are 1771-HS module E-Stop contacts (pins 49 & 50 of 50 pin D-shell) for each of the 4 modules.

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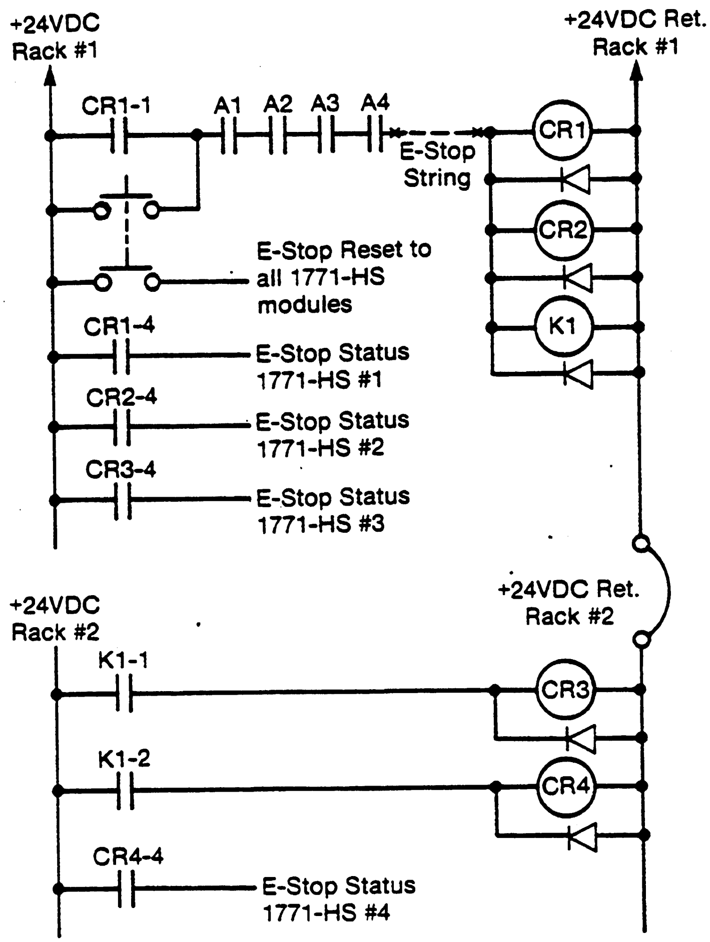
Figure 7.8
An Equivalent Ladder Diagram and E-Stop Circuitry for a Four Axis System Using an Additional Customer Supplied Relay



Notes:

1. CR1 - CR4 are relays supplied with termination panels #1 - 4.
2. K1 is customer supplied 650Ω 24VDC relay.
3. Contacts A1-A4 are 1771-HS module E-Stop contacts (pins 49 & 50 of 50 pin D-shell) for each of the 4 modules.

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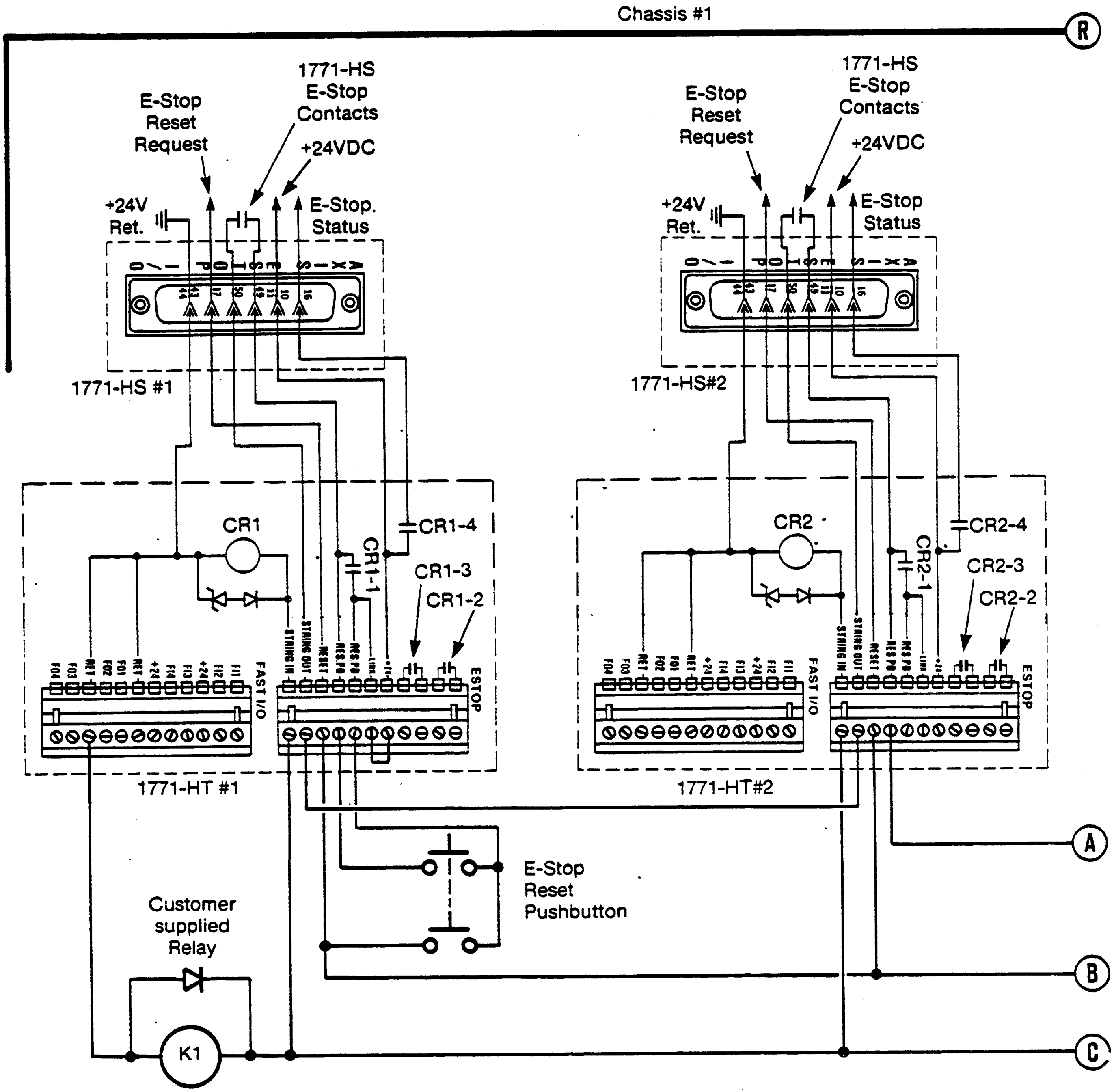
Figure 7.8 (continued)
An Equivalent Ladder Diagram and E-Stop Circuitry for a Four Axis System Using an Additional Customer Supplied Relay

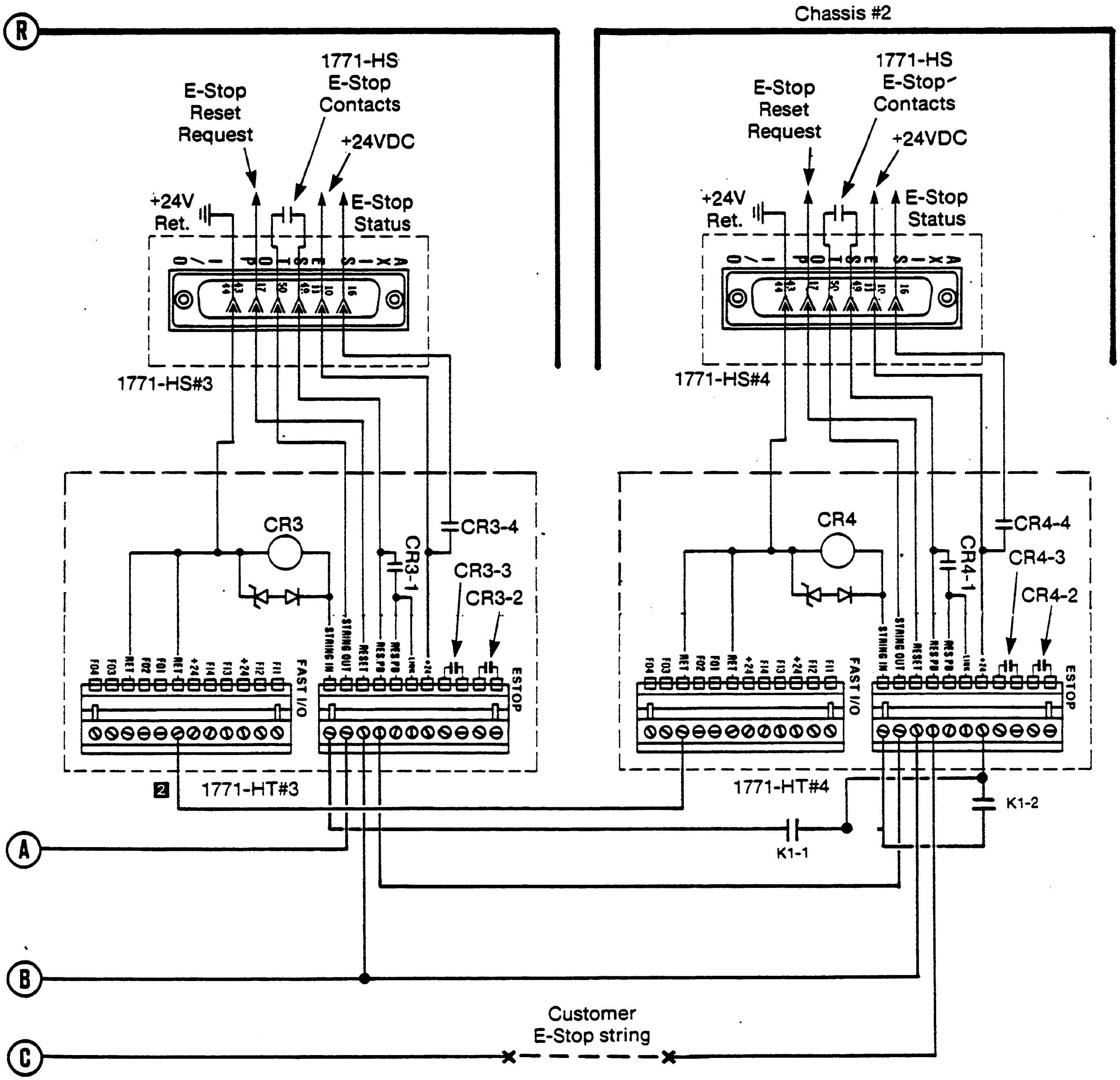


Notes:

1. No more than three (3) 650Ω, 24VDC relays are powered from each 1771-PS7 power supply.
2. Since there are two 1771-PS7 power supplies in this configuration, the 24VDC return lines should be connected together.

15795A

Figure 7.8 (continued)
An Equivalent Ladder Diagram and E-Stop Circuitry for a Four Axis System Using an Additional Customer Supplied Relay

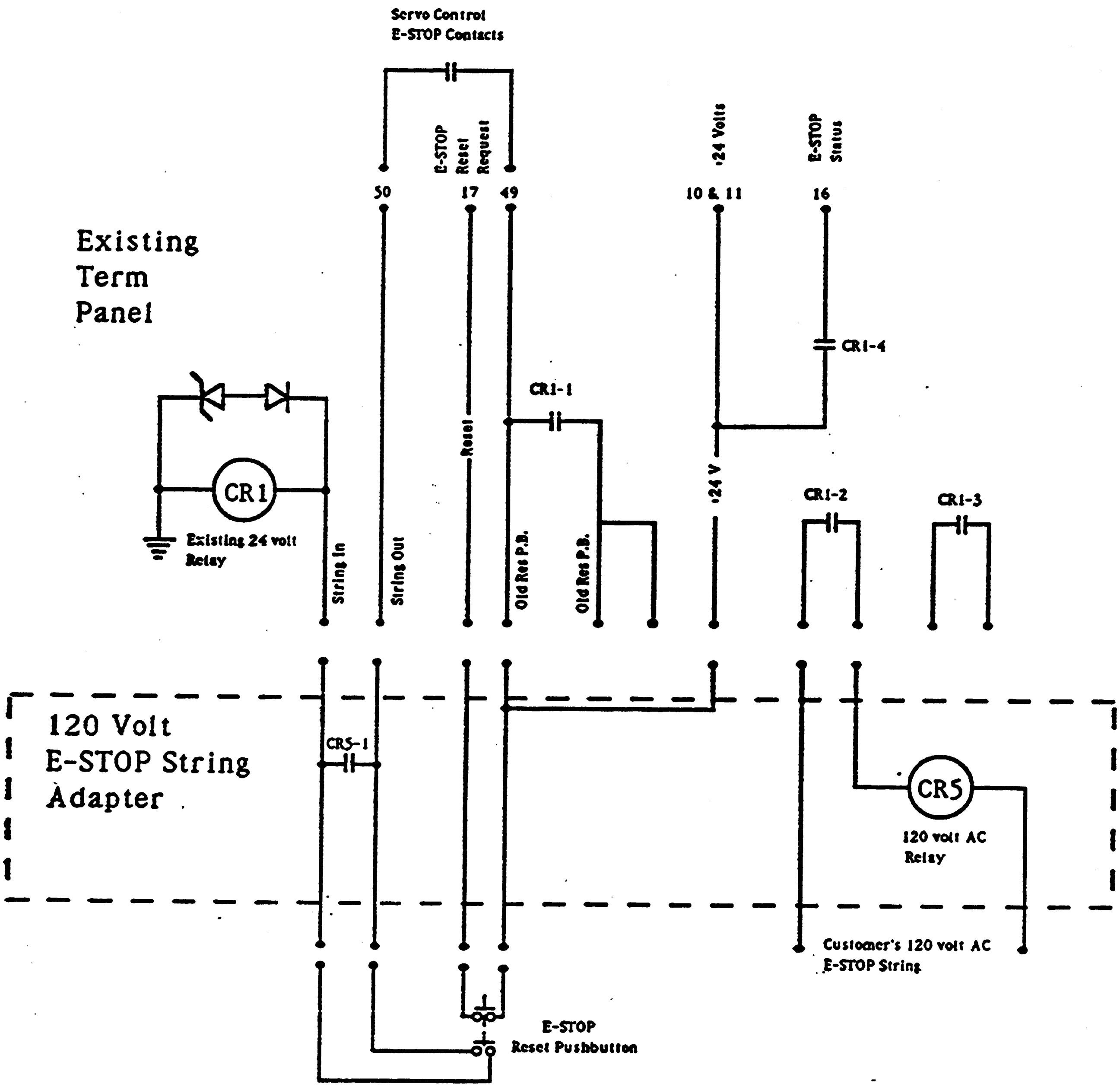


Notes:

1. No more than three (3) 650Ω, 24VDC relays are powered from each 1771-PS7 power supply.
2. Since there are two 1771-PS7 power supplies in this configuration, the 24VDC return lines should be connected together.

15795B

Figure 7.9
E-120 Volt E-Stop String Adapter



8.0 Chapter Overview

This chapter discusses:

- connecting feedback device
- wiring A-B drive connections

8.1 Feedback Device Connections

For feedback connections, use only a single, continuous, shielded cable segment. Connect the cable directly from the feedback device to the termination panel.

Feedback device connections include:

- local (40 feet or less) encoder +5VDC connections where the encoder is located less than 40 cable feet from the termination panel (see figure 8.3)

- remote (90 feet or less) encoder +5VDC connections where the encoder is located less than 90 cable feet from the termination panel. This can only be done if you use +5VDC customer supplied external power supply (see figure 8.4)

- remote (90 feet or less) encoder +15VDC connections where the encoder is located less than 90 cable feet from the termination panel (see figure 8.5)

- resolver (local or remote) feedback connections (see figure 8.9)

Important: Distances specified are "cable feet" from the termination panel to the feedback device. If you are not using the termination panel, then 10 additional feet of cable is allowed.

8.1.1
Power Limitations For Encoders

CAUTION: A maximum of 5 VDC @ 1.5A or 15 VDC @ .5A (7.5W) is available per 1771 I/O chassis to power encoders. Each servo controller module supports 2 feedback devices. Since up to 3 servo controller modules are allowed in the same I/O chassis, the maximum number of encoders per chassis is 6. Therefore:

1.5A/6 encoders = 250 mA/encoder

Do not exceed the total maximum available power. AB845N encoders require 200mA each and, thus, already meet this requirement.

if you use +15V supply connections available on the termination panel for remote installation, power per AB845N encoder will be:

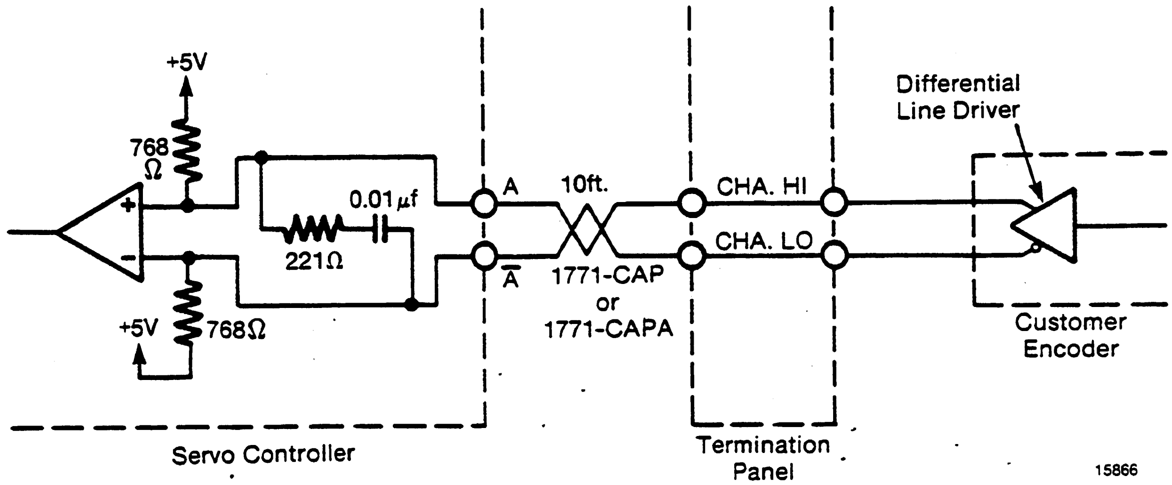
Power = (15V)(200mA) = 3W

Therefore, you can power up to 2 AB845N encoders remotely (90 feet maximum) without the need for an additional (customer supplied) power supply. Since 2 AB845N encoders using 15V requires 6W of power and 7.5W are available per chassis, 1.5W (7.5W-6W) can be used by the +5VDC termination panel connection to power an additional local encoder (40 feet maximum)

8.1.2 Connecting a Differential Encoder

Figure 8.1 show an encoder feedback equivalent circuit for feedback channel A.

Figure 8.1
Encoder Feedback Equivalent Circuit



For proper operation of the servo controller, wire the encoder such that the marker Z is true at the same time that channels A & B are true. If you are using an AB845N encoder this requirement will already be met if you follow the wiring diagrams of figures 8.3, 8.4 and 8.5. Use the wiring specifications in Table 8.A.

If you are not using an AB845N encoder, then use the following wiring procedure:

1. Obtain the encoder output timing diagram from the vendors data sheets. A typical one is provided in figure 8.2 as an example.

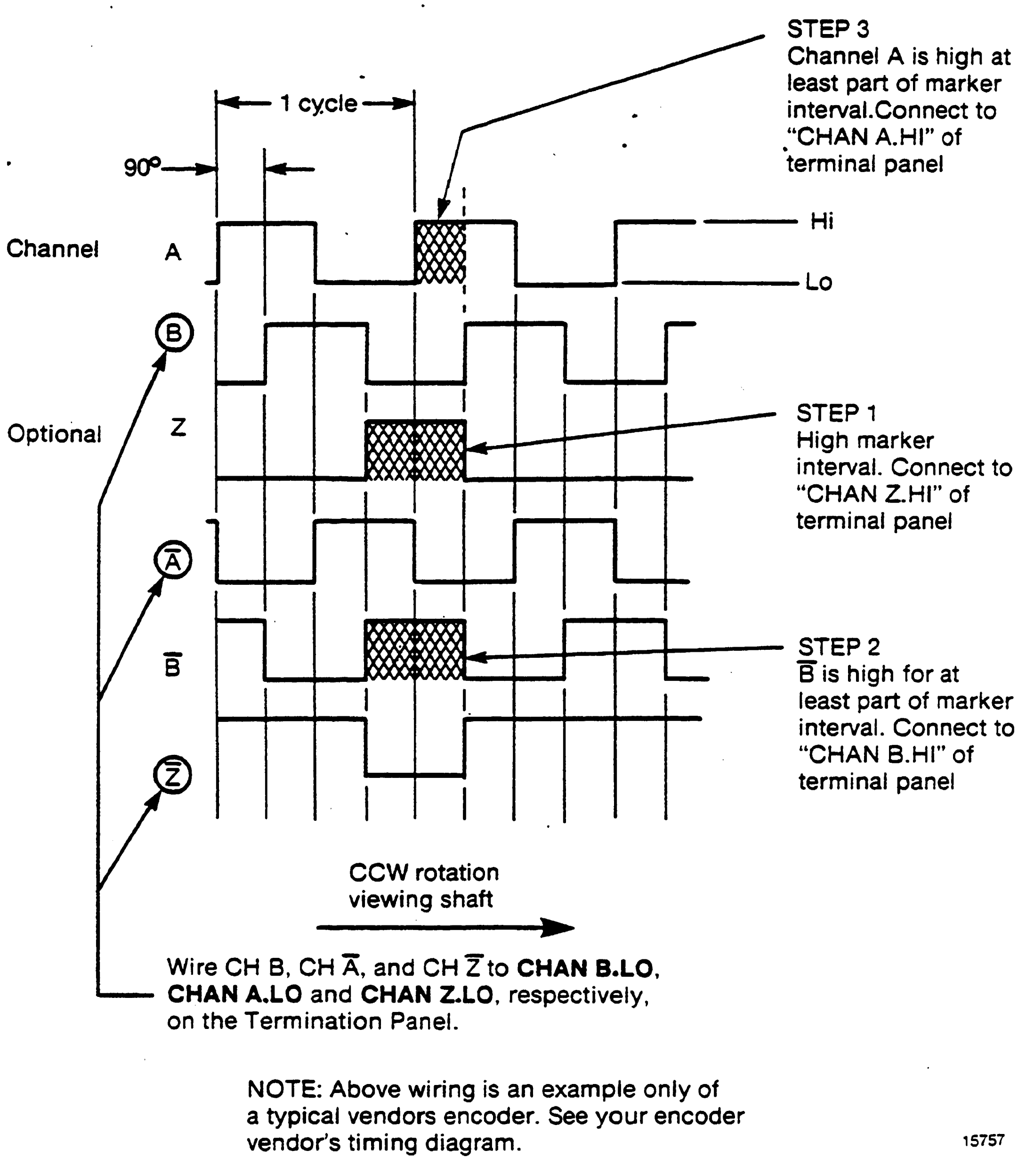
2. On the timing diagram, look at the marker Z and its complement, marker Z'. Whichever one is low for most of the encoder revolution and pulses high for the marker interval should be wired to "CH Z.HI" of the termination panel. Wire the remaining marker to "CH Z.LO" of the termination panel.

3. Look at channel B and its complement, channel B'. Whichever one is high for at least part of the marker interval should be wired to "CH B.HI" of the termination panel. It is possible that both channels meet this requirement depending on the encoder manufacturer, in which case, use either one. Wire the remaining phase to "CH B.LO" of the termination panel.

4. Look at channel A and its complement channel A' and repeat as in step 3 using "CH A.HI" of the termination panel and the remaining wire to "CH A.LO".

If the above wiring is not performed correctly, inconsistent homing of the axis may occur.

Figure 8.2
Typical Vendor Encoder Timing Diagram



Since an encoder may be mounted on either end of the ball screw, the encoder may spin CW or CCW for a given table direction. As a result, the direction (phasing) of the feedback may be backwards. If you switch Channel A wiring with Channel B wiring, you will change the direction of the feedback. Alternately, the handheld pendant, hooked to the servo controller module, enables you to reverse the polarity when testing direction and velocity. See Chapter 11 for details.

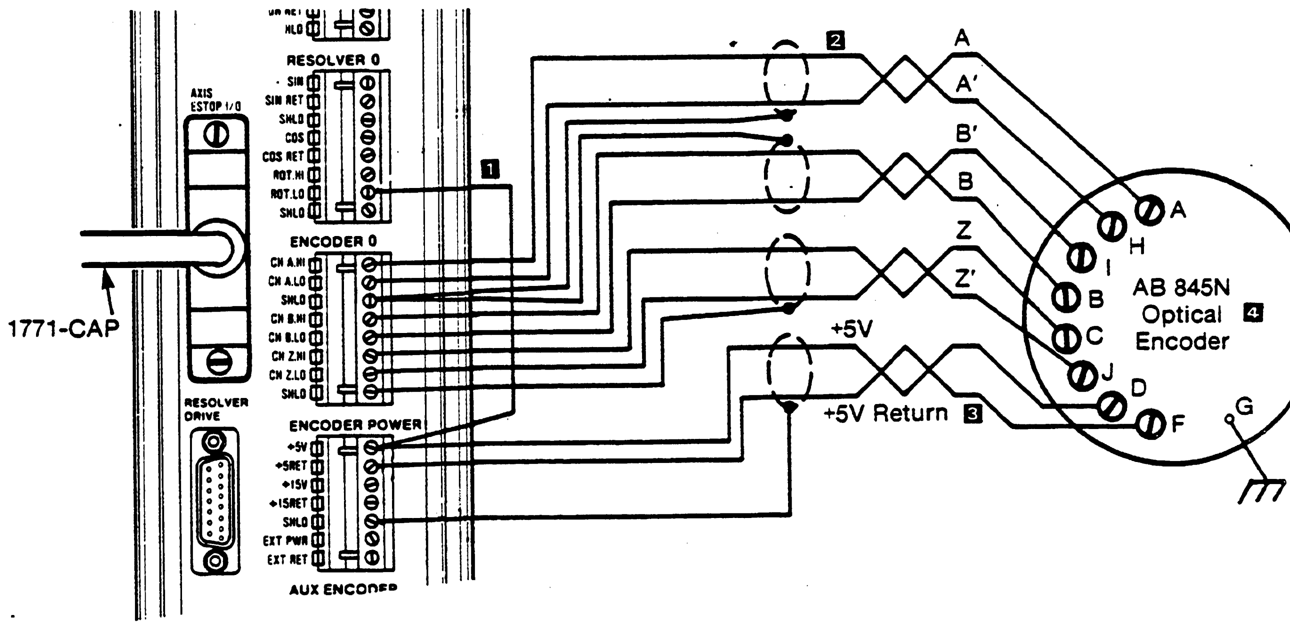
Important: Single-ended encoders are not compatible with the IMC 120 system.

Table 8.A
Encoder Wire Specifications

	Channel A,B, and Z	Encoder Power +5VDC and +5VDC RET	Encoder Power +15VDC and +15VDC RET
# of Individually Twisted and Shielded Pair (s)	3	1	1
Gauge	22	18	18
Maximum Length from termination panel to encoder (feet)	90	40*	90

* 90 feet if you use a +5V customer supplied external power supply; Customer must be able to adjust the voltage output of his supply to the proper value as measured at the encoder.

Figure 8.3
Local 5V Encoder Feedback Connections



Notes:

1. This jumper wire is necessary to properly configure the Servo Controller module for encoder operation. (16 - 20 gauge wire.)
2. Use 3 pair 22 gauge individually twisted and shielded cable. 90 ft. maximum length.
3. Use 1 pair 18 gauge twisted and shielded cable. 40 ft. maximum length.
4. Encoders must have +5V compatible differential line drive outputs on channels A, B, & Z. (DS 8830 or equivalent.) (AB 845N)

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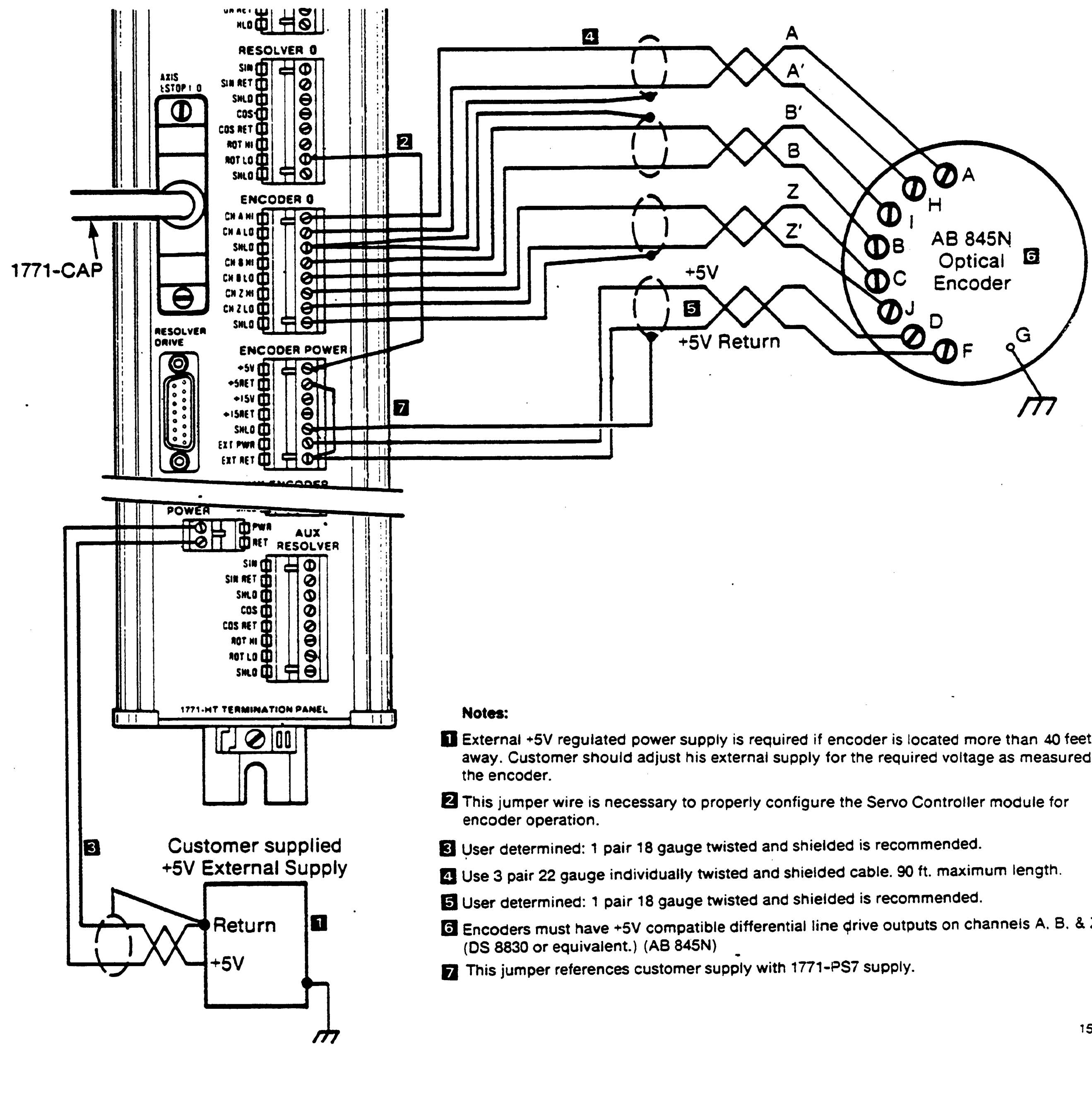
Figure 8.4
Remote 5V Encoder Feedback Connections



Notes:

1. External +5V regulated power supply is required if encoder is located more than 40 feet away. Customer should adjust his external supply for the required voltage as measured at the encoder.
2. This jumper wire is necessary to properly configure the Servo Controller module for encoder operation.
3. User determined: 1 pair 18 gauge twisted and shielded is recommended.
4. Use 3 pair 22 gauge individually twisted and shielded cable. 90 ft. maximum length.
5. User determined: 1 pair 18 gauge twisted and shielded is recommended.
6. Encoders must have +5V compatible differential line drive outputs on channels A, B, & Z. (DS 8830 or equivalent.) (AB 845N)
7. This jumper references customer supply with 1771-PS7 supply.

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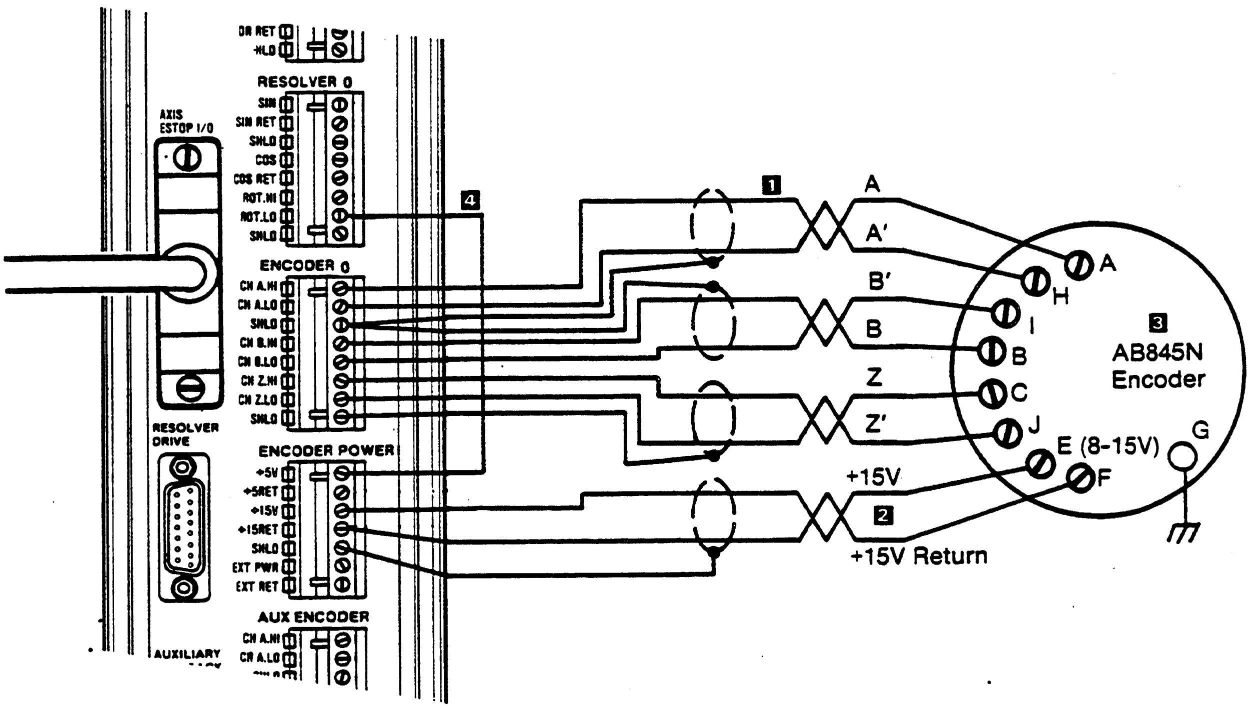
Figure 8.5
Remote 15V Encoder Feedback Connections



Notes:

1. Use 3 pair 22 gauge, individually twisted and shielded cable. 90 ft. maximum length.
2. Use 1 pair 18 gauge twisted and shielded cable. 90 ft. maximum length.
3. Encoder must have +5V compatible differential output signals on channels A, B, & Z. (DS 8830 line driver type outputs or equivalent.) (AB 845N)
4. Jumper required to correctly configure the Servo Controller module for encoder operation.

15701

8.1.3 Connecting to Linear Scales

Optimum operation of the IMC 120 with Linear scales requires that the A, B, and Z channels be wired correctly.

If you desire position feedback to up-count as the axis moves away from home-position, follow procedure 1. In the rare event that you desire the position feedback to down-count as the axis moves away from home-position, use procedure 2. Figures 8.6 and 8.7 represent typical timing diagrams for up-counting and down-counting linear scales.

Procedure 1

To wire up-counting linear scales correctly, use figure 8.6 and follow this procedure:

1. Obtain the scales output timing diagram from the vendor's data sheet. Note that the actual marker edge placement may not be specified, or may differ from unit to unit. In this case, use an oscilloscope to ascertain actual output timing.

2. Identify the Z channel edge which is intended to represent the actual marker position. Note that the signal level is not of interest, only rising or falling edges.

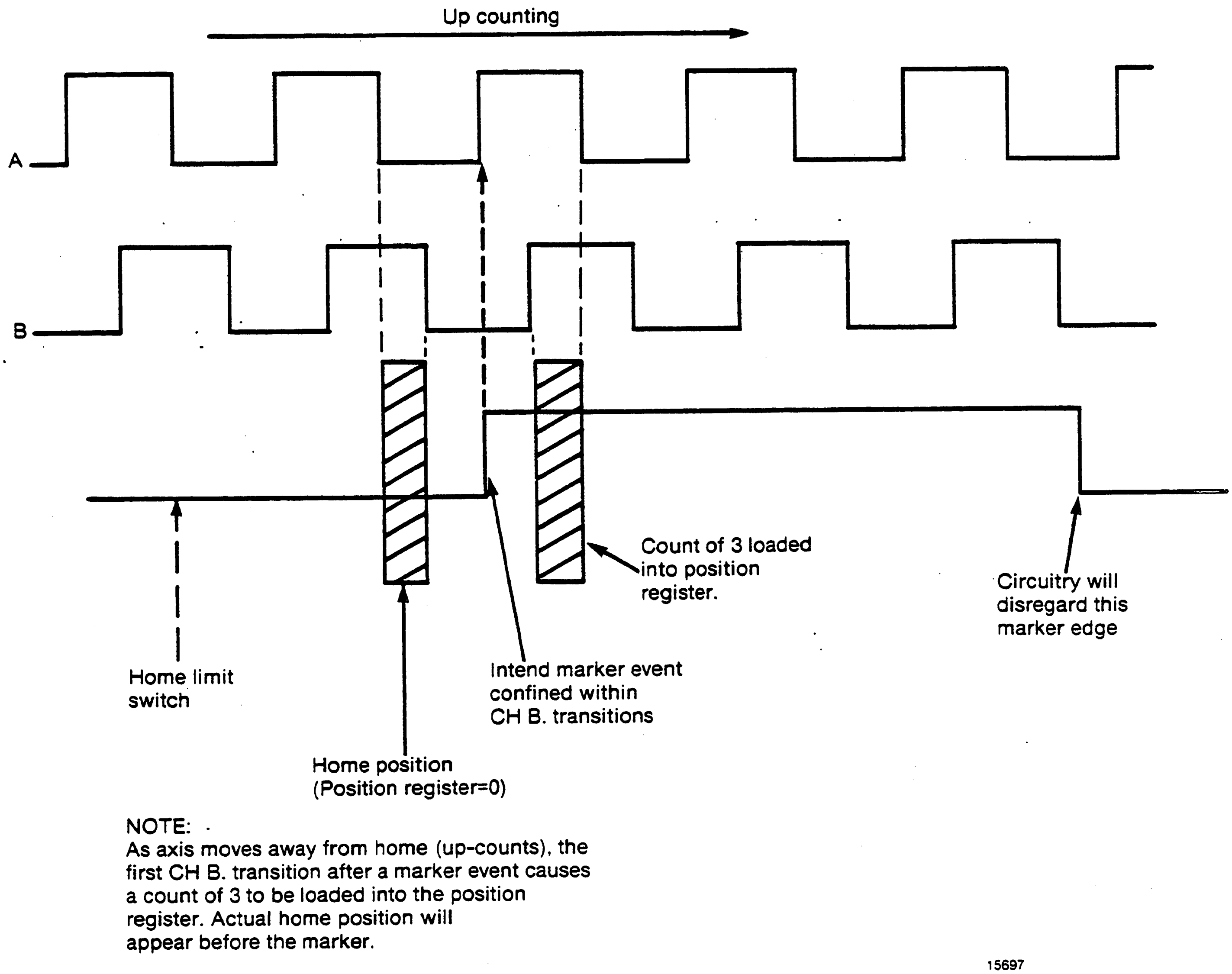
3. Inspect the A and B channels with respect to the Z channel. Pick either the A or B pair that coincides with the active Z edge and wire it to the CH A.HI and CH A.LO inputs.

4. The remaining quadrature pair should have its transitions clearly bracketing the active Z edge. Wire this pair into the CH B.HI and CH B.LO inputs.

5. Move the axis away from home position. The position display should count <u>upward</u> in the <u>positive</u> direction. If not, invert the feedback using the AMP utility or handheld pendant.

6. Examine the marker channel signals CH Z.HI/CH Z.LO as you move the axis in the increasing position direction. Wire the Z channel which makes a rising edge at the intended marker position into CH Z.HI. Terminate the remaining wire to CH Z.LO.

Figure 8.6
Typical Timing Diagram for Up-counting Linear Scales



Procedure 2

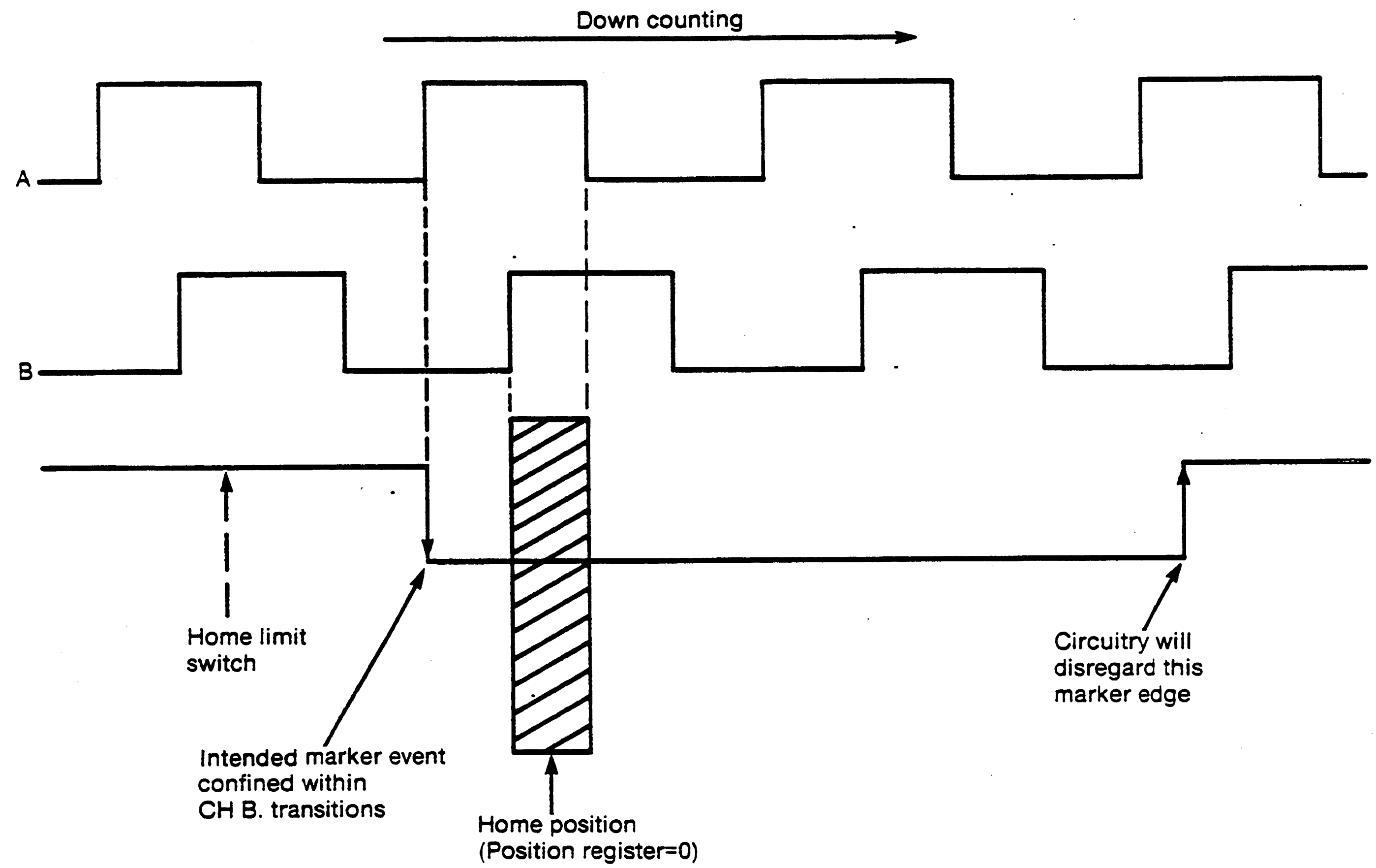
To wire down-counting linear scales correctly, use figure 8.7 and follow this procedure:

1. Perform steps 1 though 4 of procedure 1.

2. Move the axis away from home position. The position display should count downward in the negative direction. If not, invert feedback using the AMP utility (see chapter 21) or handheld pendant (see chapter 39).

3. Examine the marker channel signals CHZ_HI/CHZ_LO as you move the axis in the decreasing position direction. Wire the Z channel that makes a falling edge at the intended marker position into CHZ_HI. Terminate the remaining wire into CHZ_LO.

Figure 8.7
Typical Timing Diagram for Down-counting Linear Scales



NOTE:
As axis moves away from home (down-counts), the first CH B. transition after a marker event causes a count of 0 to be loaded into the position register. This is the home position.

8.1.4 Connecting Resolvers

To help you choose an IMC 120 compatible resolver, refer to Appendix C. Figure 8.8 shows a resolver feedback equivalent circuit. Figure 8.9 shows how to connect a resolver to the termination panel.

Figure 8.8
Resolver Feedback Equivalent Circuit

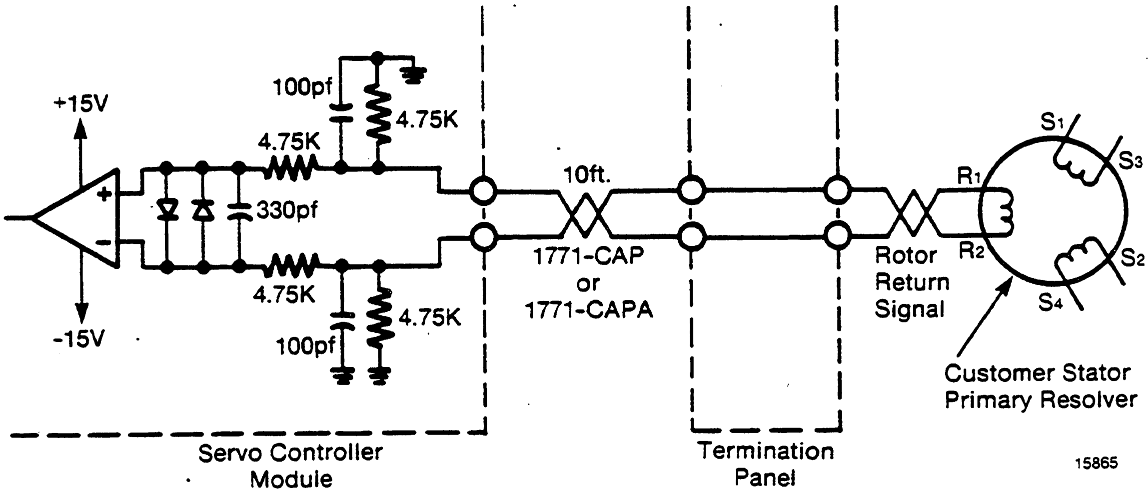
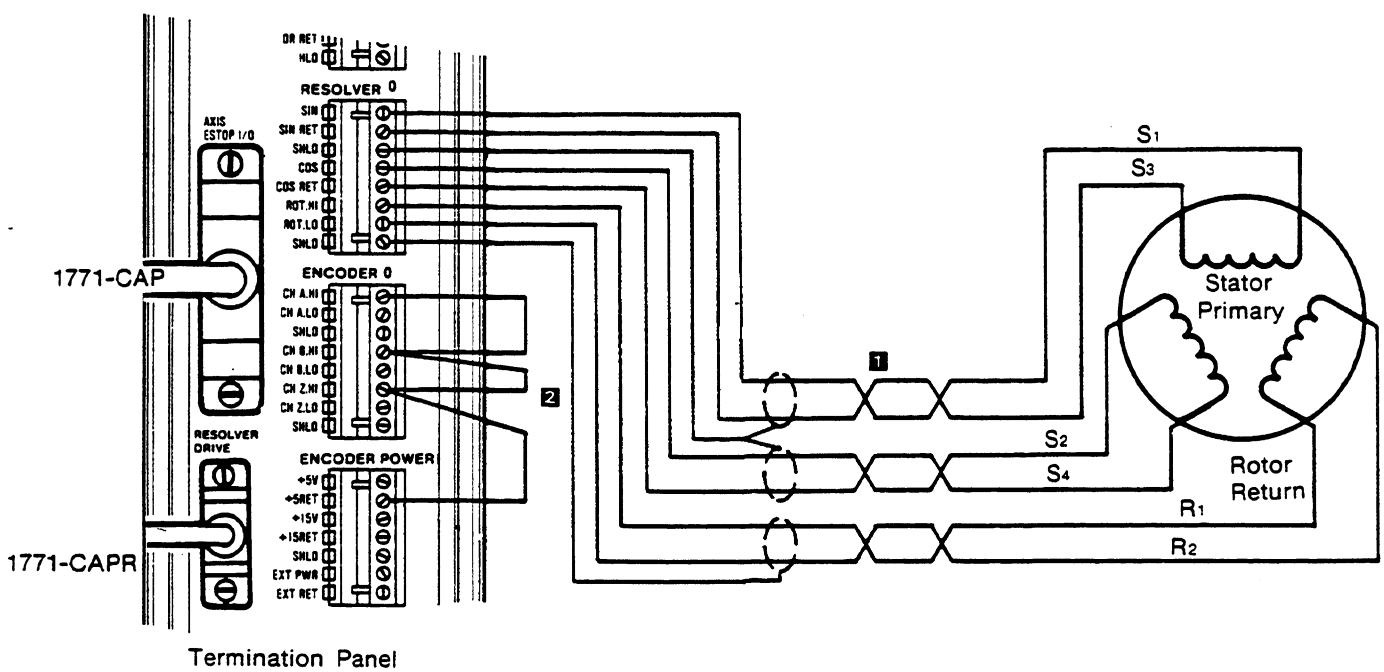


Figure 8.9
Connecting a Resolver



Notes:

1. 3 pair individually twisted and shielded 22 gauge wire. 90 ft. maximum length.
2. These jumpers are required in order to properly configure the Servo Controller module for resolver operation.

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8.2 Auxiliary Feedback Connections

Auxiliary feedback connections are used in the following applications:

- axis ratioing
- linear touch probing
- dual resolver feedback for absolute positioning

The servo controller module is set up so that the motion of the axis it controls follows the motion of another axis. This servo controller module acts as a slave to another axis, which is the master.
The master and slave feedback devices must be either both encoders or both resolvers.

8.2.1 Wiring Ratioed Axis

In ratioed motion, the servo controller module is set up so that the motion of the axis it controls follows the motion of another axis by a ratio defined in the MML program.

Figures 8.10 and 8.11 show the wiring of local and remote 5VDC encoders for axis ratioing applications. Figure 8.12 shows the wiring of resolvers for axis ratioing applications.

Several AMP parameters must be set for ratioed motion. Read Section 12.8, entitled Ratio/Probe Parameters in publication 1771-6.5.51, IMC 120 Motion Control System Programming Manual.

8.2.2 Wiring Linear Probe Feedback

A linear feedback touch probe feeds position data through a linear scale feedback device to the auxiliary feedback channel of the controller. The probe is considered to have fired when motion is detected on the auxiliary feedback channel. The controller uses the feedback from both channels to determine the probe position.

The linear probe feedback device is wired to the AUX ENCODER connector on the termination panel. The axis position feedback is wired to the ENCODER connector on the termination panel.

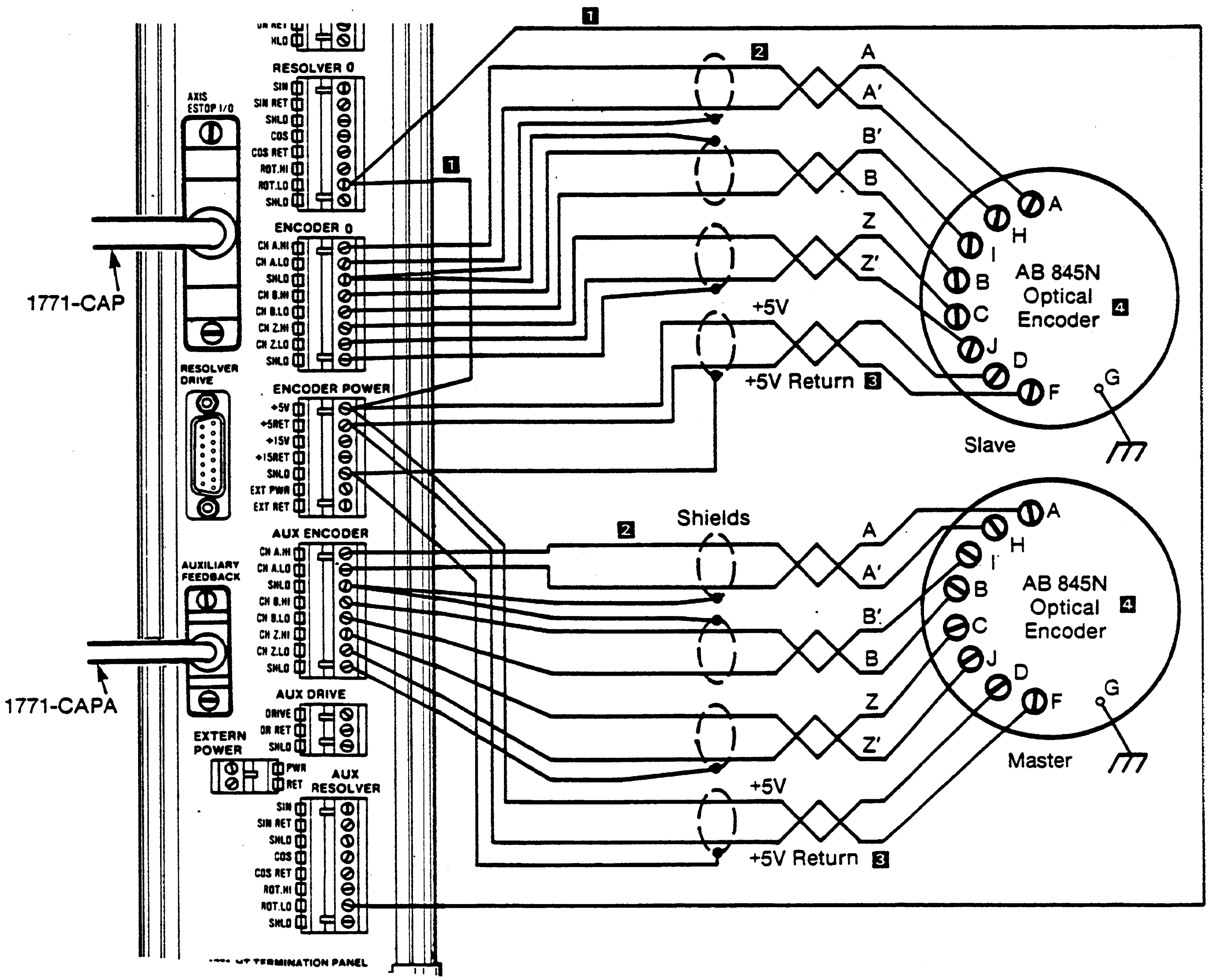
Several AMP parameters must be set for linear touch probe feedback. Read Section 12.8, entitled Ratio/Probe Parameters in publication 1771-6.5.51, IMC 120 Motion Control System Programming Manual.

8.2.3 Wiring Dual Resolvers

Dual Resolvers (master and vernier) can be connected for the purpose of checking axis absolute position at power up without homing. The vernier resolver is wired to the RESOLVER 0 connector and the master resolver is wired to the AUX RESOLVER connector as shown in figure 8.12.

When dual resolvers are installed, the axis must be homed once to initialize the absolute position. After this, the controller can check the axis absolute position after power up without homing. This feature can help simplify recovery from power failure.

Figure 8.10
Local 5VDC Encoder Wiring for Ratioing Applications



Notes:

1. This jumper wire is necessary to properly configure the Servo Controller module for encoder operation. (16 - 20 gauge wire.)
2. Use 3 pair 22 gauge individually twisted and shielded cable. 90 ft. maximum length.
3. Use 1 pair 18 gauge twisted and shielded cable. 40 ft. maximum length.
4. Encoders must have +5V compatible differential line drive outputs on channels A, B, & Z. (DS 8830 or equivalent.) (AB 845N)

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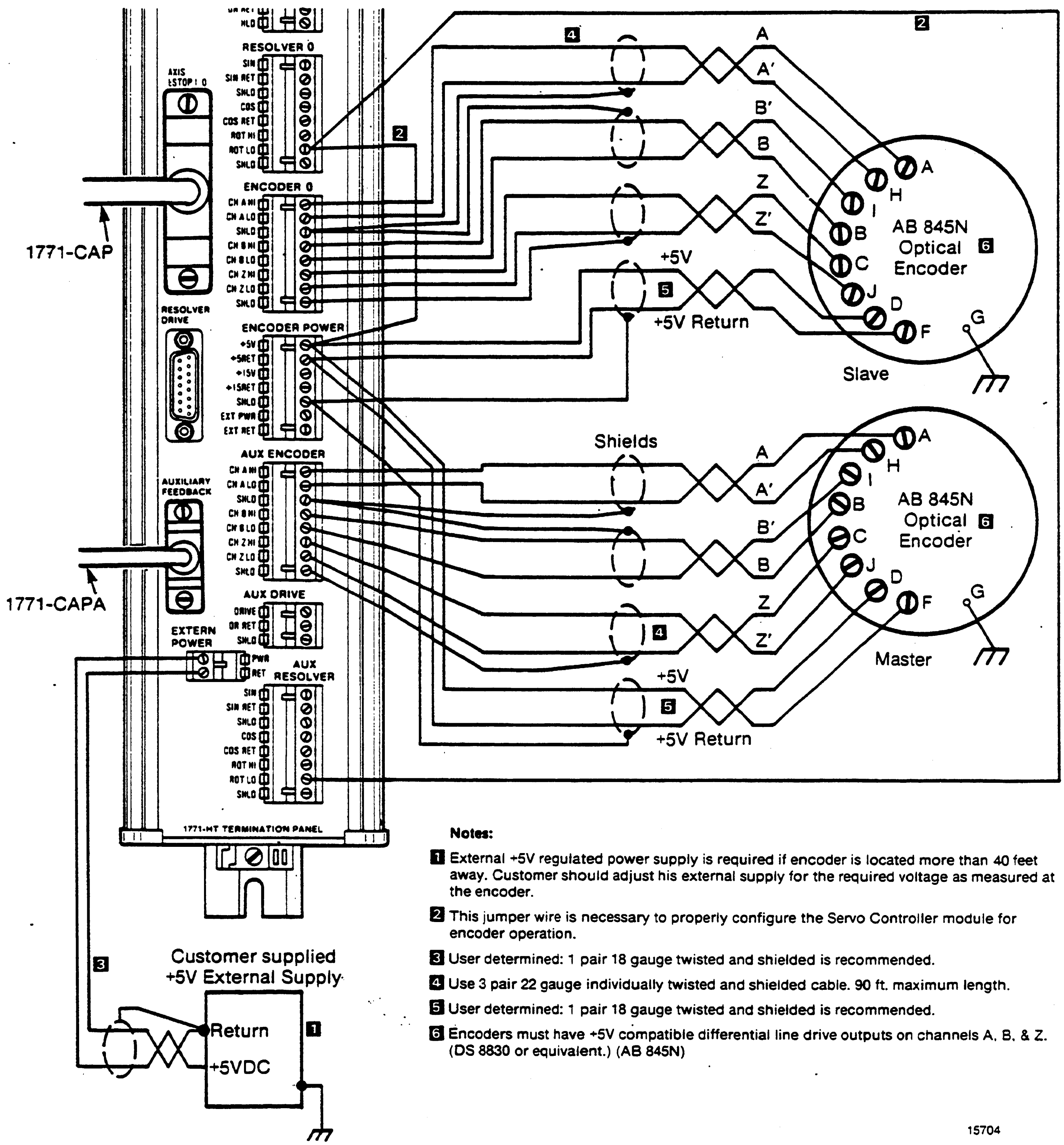
Figure 8.11
Remote 5VDC Encoder Wiring for Ratioing Applications



Notes:

1 External +5V regulated power supply is required if encoder is located more than 40 feet away. Customer should adjust his external supply for the required voltage as measured at the encoder.

2 This jumper wire is necessary to properly configure the Servo Controller module for encoder operation.

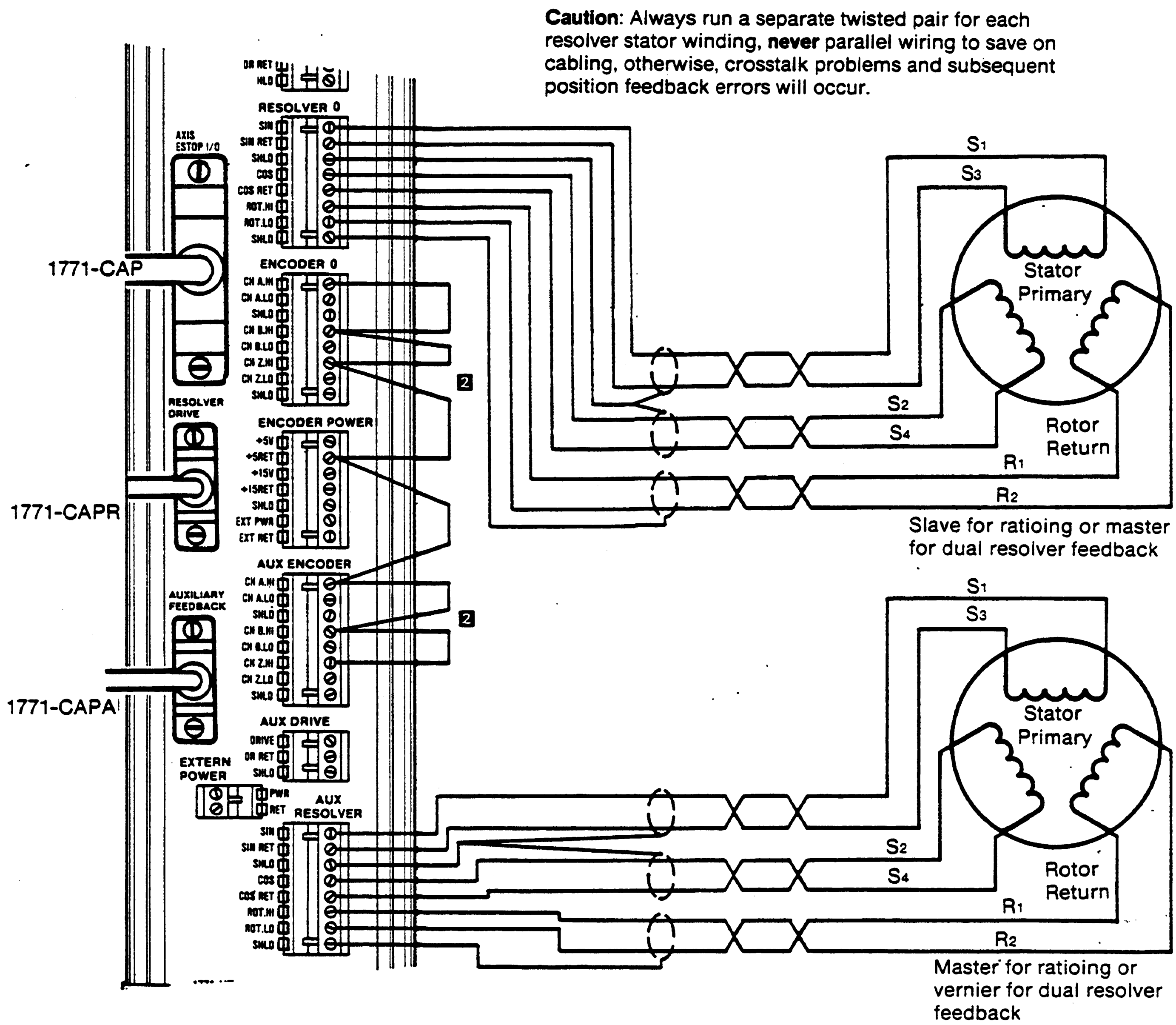
3 User determined: 1 pair 18 gauge twisted and shielded is recommended.

4 Use 3 pair 22 gauge individually twisted and shielded cable. 90 ft. maximum length.

5 User determined: 1 pair 18 gauge twisted and shielded is recommended.

6 Encoders must have +5V compatible differential line drive outputs on channels A, B, & Z. (DS 8830 or equivalent.) (AB 845N)

Figure 8.12
Resolver Wiring for Ratioing and Dual Resolver Applications



Notes:

1. 3 pair individually twisted and shielded 22 gauge wire. 90 ft. maximum length.
2. These jumpers are required in order to properly configure the Servo Controller module for resolver operation.

8.3 Wiring A-B Drive Connections

The IMC 120 supports series 1388, 1389, 1391, and 7930 servo controllers (amplifiers).

Before you make the termination panel to drive connections, you must mount, set pre-startup adjustments, and wire your servo controller system.

Table 8.B lists installation references for each servo controller system (amplifier) to enable you to do this.

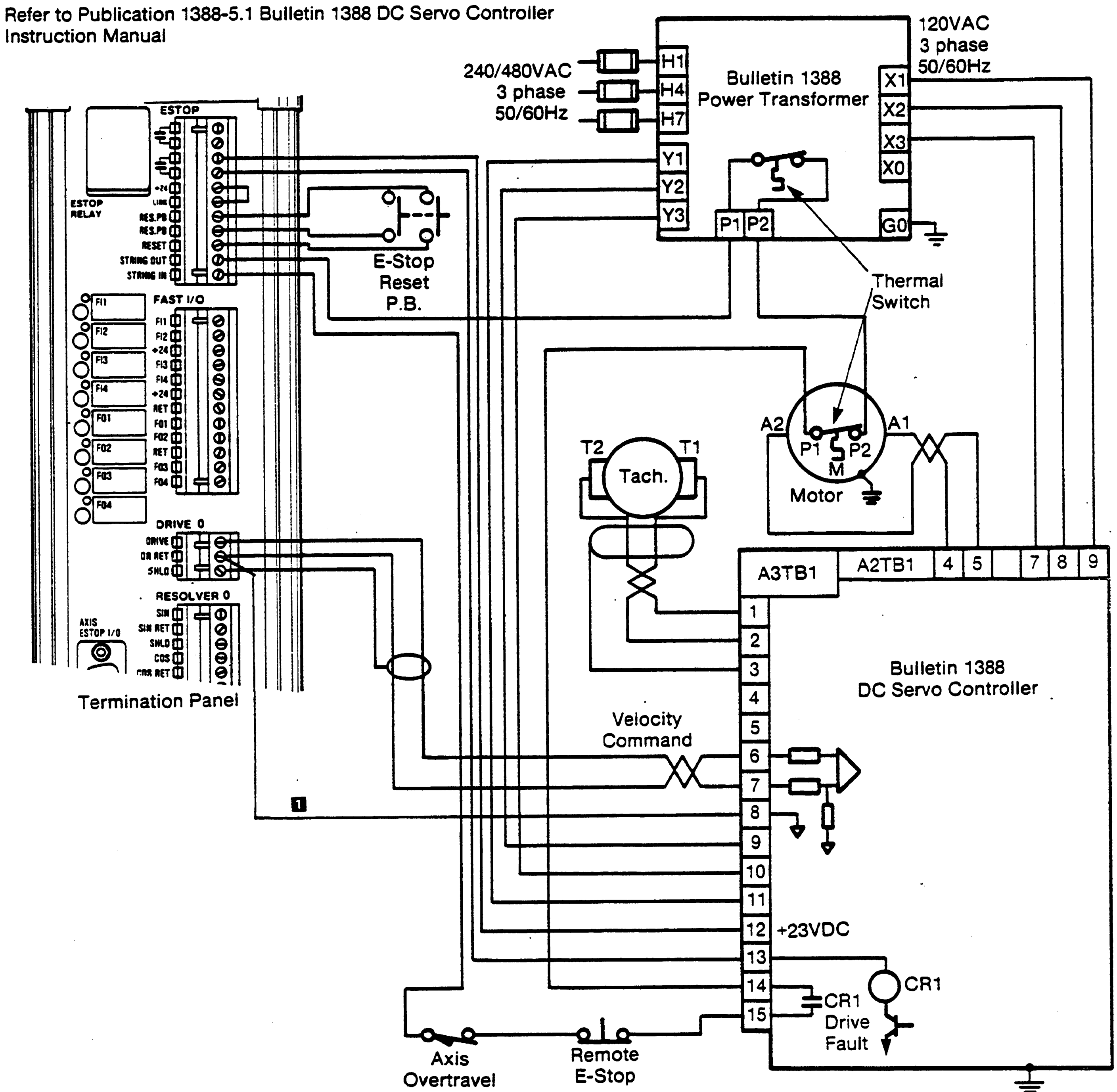
Table 8.B
A-B Drives Installation References

A-B Drive	Catalog No.	Title
1388	1388-5.1	Bulletin 1388 DC PWM Servo Controller Instruction Manual
1389	1389-5.0	Bulletin 1389 AC Servo Amplifier System Operator Instructions
1391	1391-5.0	Bulletin 1391 AC Servo Controller User Manual
7930	7930-4.1	Series 7930 Drive Package Installation Manual

The following figures show the termination panel to Allen-Bradley drive connections:

Figure	Wiring From Termination Panel to Allen-Bradley Drive
8.13	1388 DC PWM Servo Controller (Amplifier)
8.14	1389 AC Servo Controller (Amplifier)
8.15	1391 AC Servo Controller (Amplifier)
8.16	7930 DC Servo Controller (Amplifier)

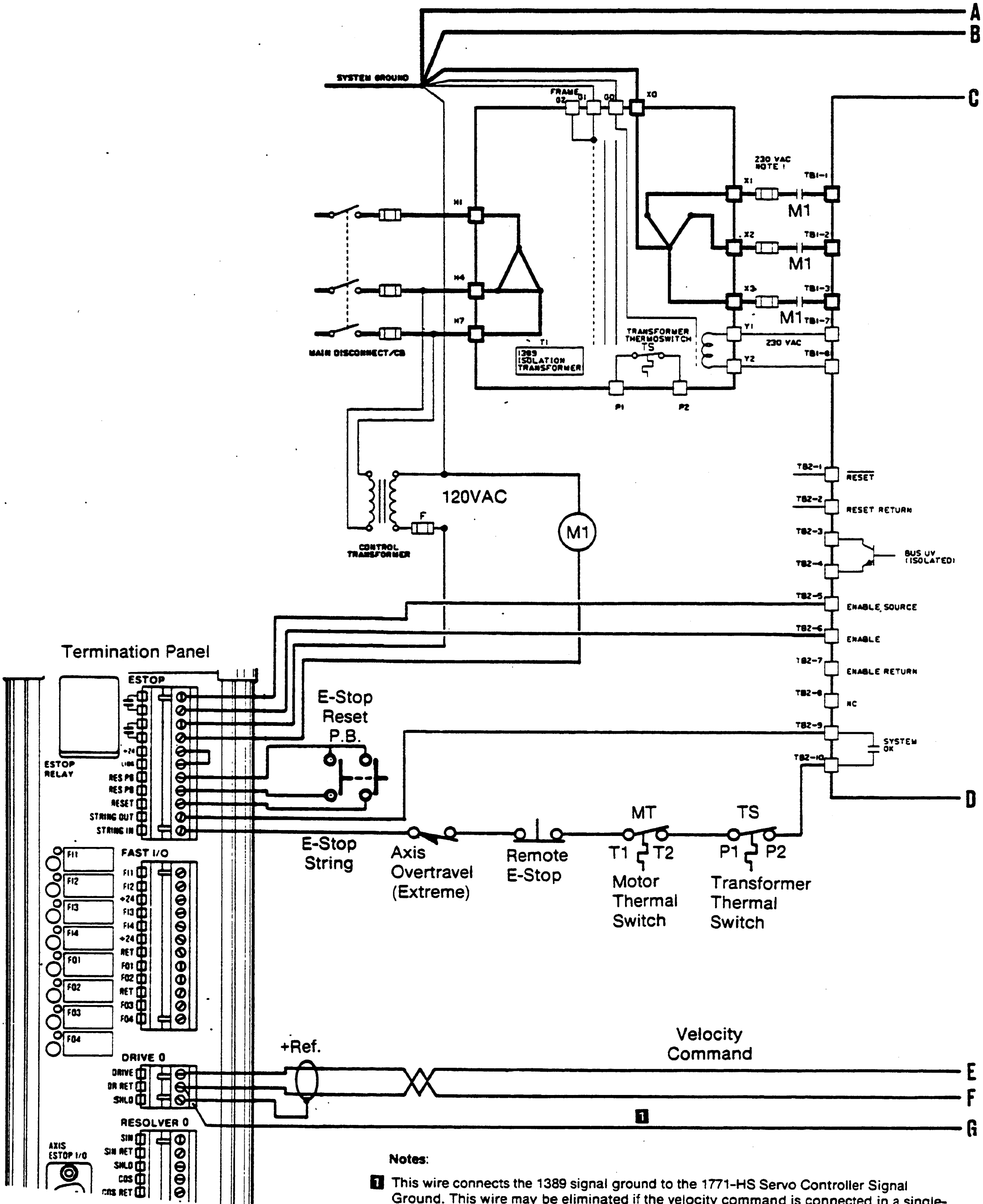
Figure 8.13
Wiring Diagram For Series 1388 Drives



Notes:

1. This wire connects the 1388 Signal Ground to the Servo Controller Signal Ground. This wire may be eliminated if the velocity command is connected in a single-ended manner.

Figure 8.14
Wiring Diagram For Series 1389 Drives



Notes:

1. This wire connects the 1389 signal ground to the 1771-HS Servo Controller Signal Ground. This wire may be eliminated if the velocity command is connected in a single-ended manner.

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Figure 8.14 (Continued)
Wiring Diagram For Series 1389 Drives

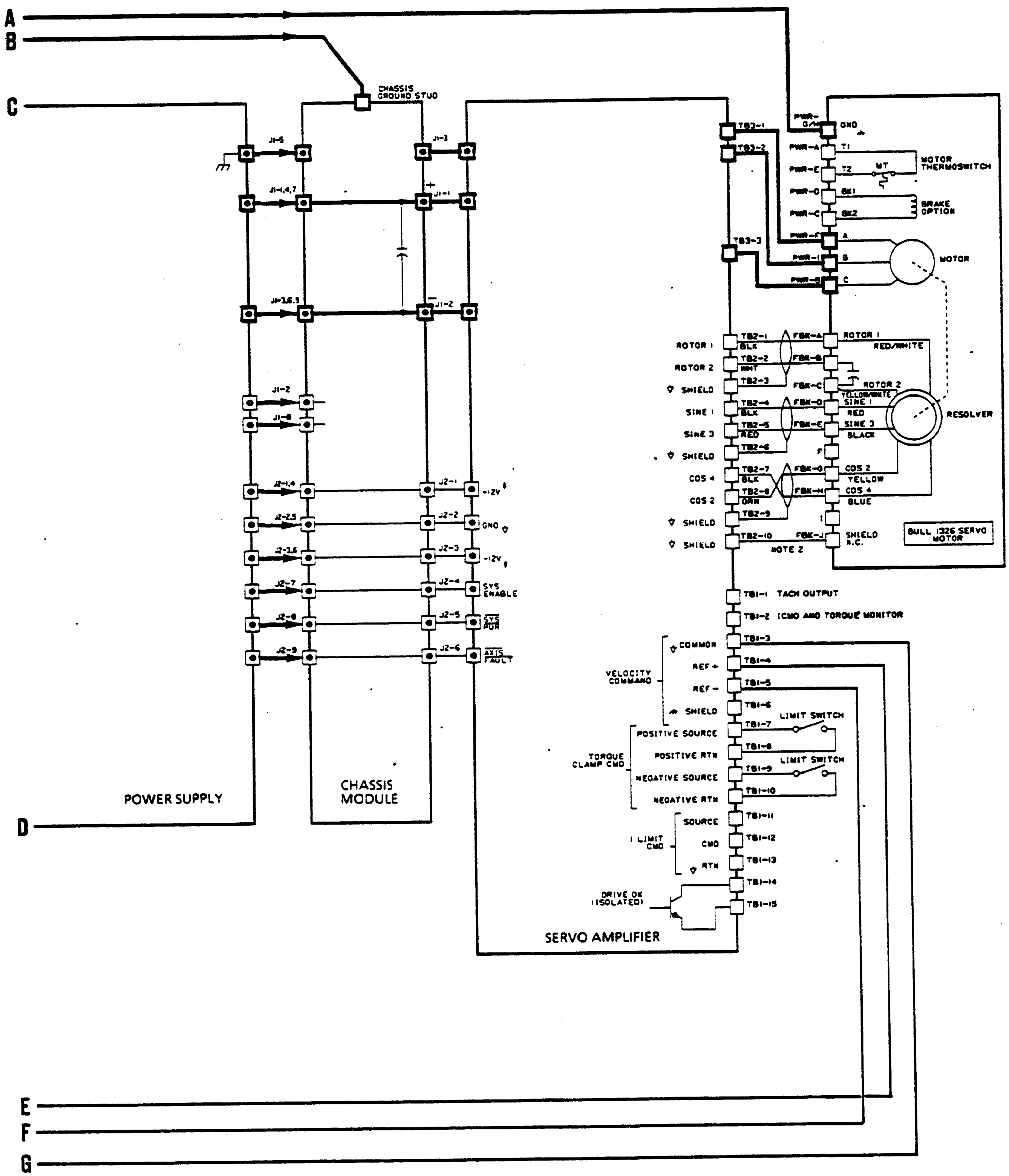

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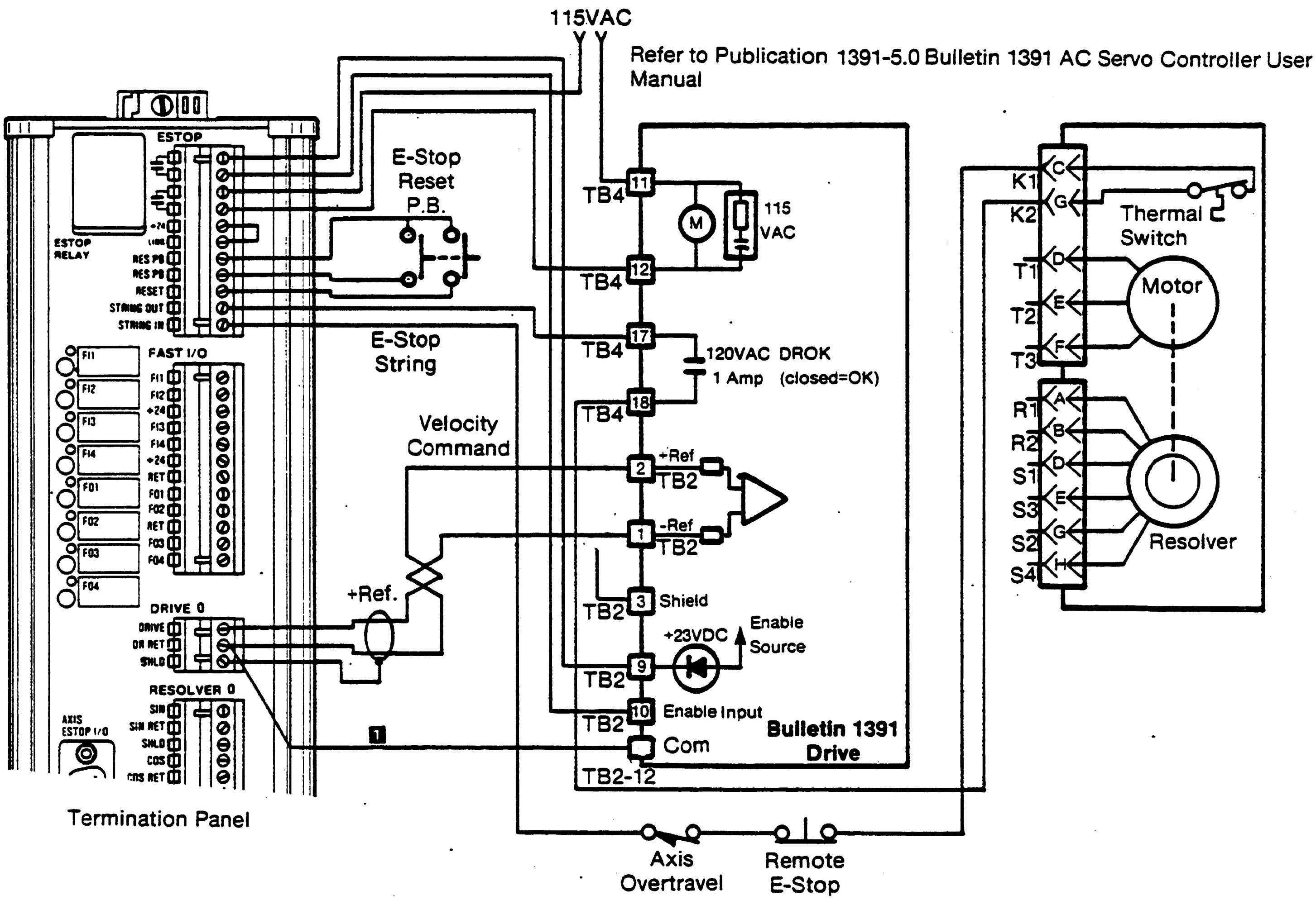
Figure 8.15
Wiring Diagram For Series 1391 Drives



Notes:

1 This wire connects the 1391 Signal Gnd to the Servo Controller Signal Gnd. This wire may be eliminated if the velocity command is connected in a single-ended manner.

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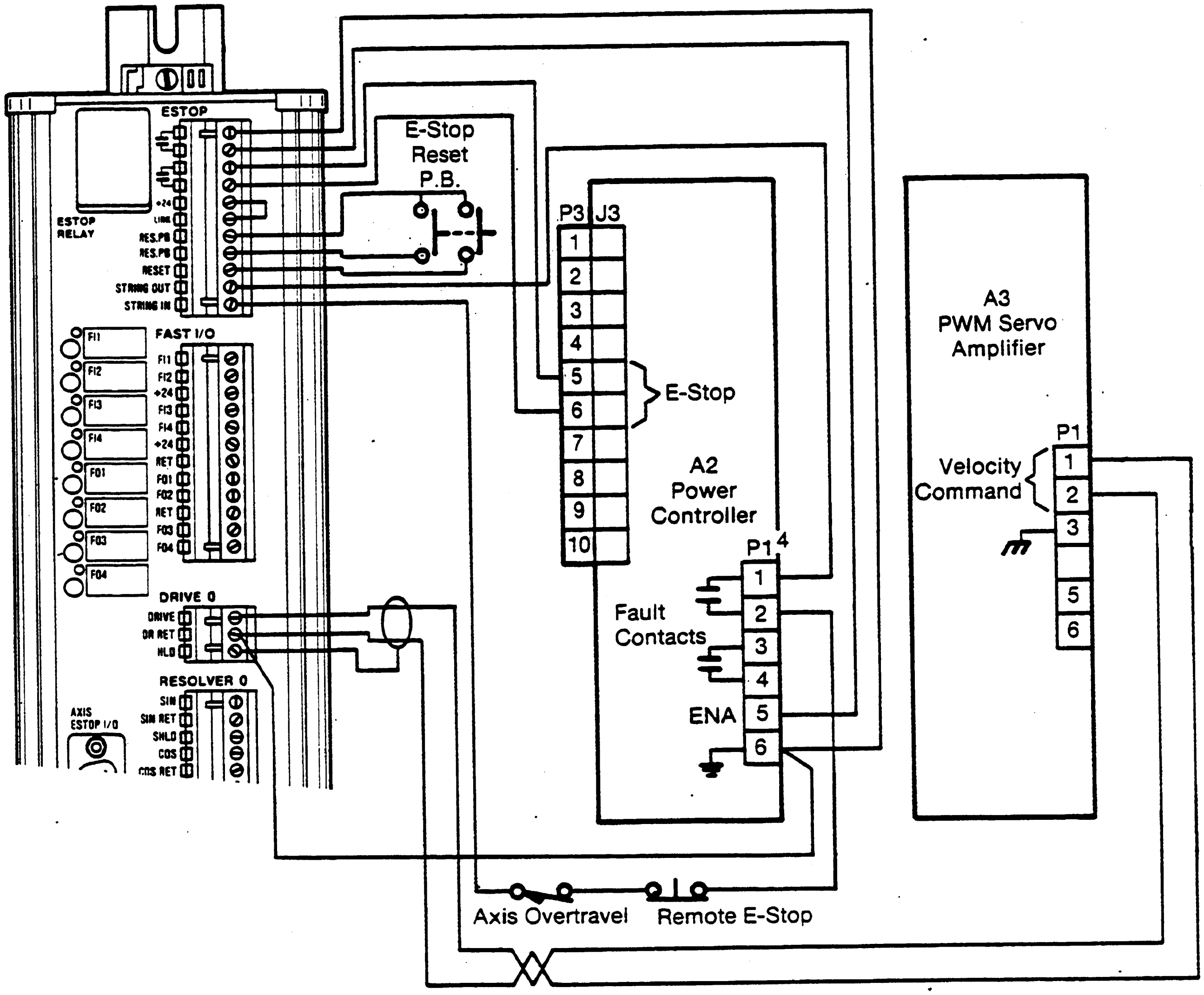
Figure 8.16
Wiring Diagram For Series 7930 Drives



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8.4 Connecting the Velocity Command

Use 18-22 gauge shielded/twisted pair wire to connect the analog velocity command output signal (consisting of DRIVE and DR RET connections) from DRIVE 0 termination panel connector to the corresponding terminals of the various servo drives shown in figures 8.13, 8.14, 8.15, and 8.16. Connect this signal so that the direction of motion that results from it matches the correct direction of motion as you have defined it.

Reversing these connections reverses the direction the axis moves in response to a given polarity of the velocity command. The handheld pendant allows you to change the polarity of the velocity command (see chapter 9).

CAUTION: Some vendors drive amplifiers only provide a single-ended input for the velocity command. If you reverse the servo controller DRIVE OUT connections, you will short out the velocity command. In this case, use the handheld pendant to change polarity or reverse the armature and tachometer connections at the servo motor.

9.0 Chapter Overview

This chapter discusses:

- powering up the IMC 120 system
- connecting your off-line development system to the IMC 120 servo controller module
- testing E-Stop Wiring without the Handheld Pendant (Defeating the Drives)
- plugging in the handheld pendant
- testing the E-Stop Button
- testing Fast I/O
- integrating the Axes
- testing homing
- testing master feedback in ratioing applications
- integrating dual resolvers

9.1 Powering Up the IMC 120 System

Before you turn the POWER switch ON at the 1771-PS7 power supply, you should make sure:

- AC line is wired correctly on the power supply
- that the voltage is set correctly (120V or 220V)
- all user power cables (cat. no. 1771-CAS) are connected and routed appropriately
- all cabling from the IMC 120 servo controller and optional resolver excitation modules to each termination panel is connected
- all wiring from each termination panel to drives, feedback devices, fast input and output devices, E-Stop string and E-Stop Reset button are connected

Use the following steps to power your IMC 120 system.

1. Turn the POWER switch of the 1771-PS7 power supply ON.

   The P/S ACTIVE led on the power supply should be lit. If you have a resolver feedback system, the POWER led on the resolver excitation module should be lit.

2. Turn the key switch of your processor to RUN.

   The PROC led on the processor panel should be lit. After each servo controller initializes and performs its quick hardware diagnostics, its RUN led should be lit. If the servo controller RUN led turns off, then the module is faulty and needs to be replaced.

   If the SYSTEM led lights on the servo controller module(s), the following problems could exist:

   - the lithium battery in the memory cartridge is low (refer to chapter 8 to replace the battery)
   - the communication to and from the PLC is faulty
   - broken wire
   - memory error exists

   If the MEMORY led lights on the servo controller module(s), the memory cartridge is not installed (refer to chapter 8 to install the memory cartridge).

3. The system powers up in E-Stop.

   The system will not come out of E-Stop until you download AMP parameters from the off-line development system.

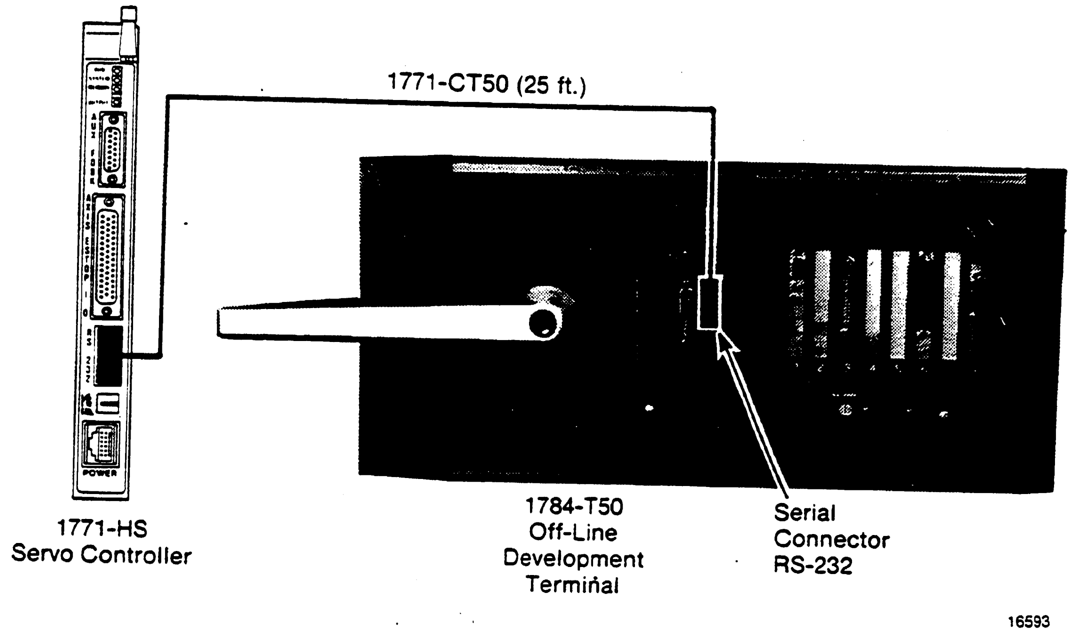
9.2 Connecting the Off-line Development System

Before you can download AMP parameters, you must connect the serial connector of the off-line development system to the RS232 connector of the servo controller module using the appropriate cable. You can use the the 1784-T50 terminal with the 1771-CT50 cable; the 1784-T35 terminal with the 1771-CT50 cable; or the 1784-T45 terminal with the 1771-CT45 cable. (To find out more about these terminals, see titles relating the the offline development system in the table on page 1-7.)

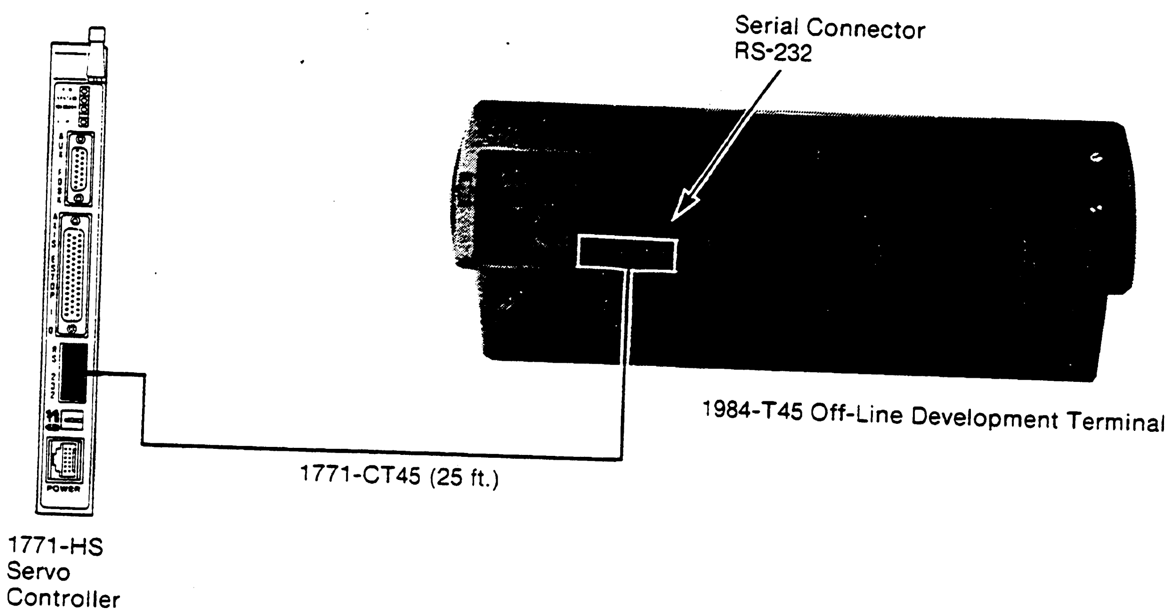
To download AMP parameters, read Chapter 11 of the IMC 120 Motion Control System Programming Manual, publication 1771-6.5.51.

Figure 9.1 shows this connection and the wiring diagram for the 1771-CT50 cable and the 1771-CT45 cable.

Figure 9.1
Connecting the 1784-T50 Off-Line Development System



Connecting the 1784-T45 Off-Line Development System



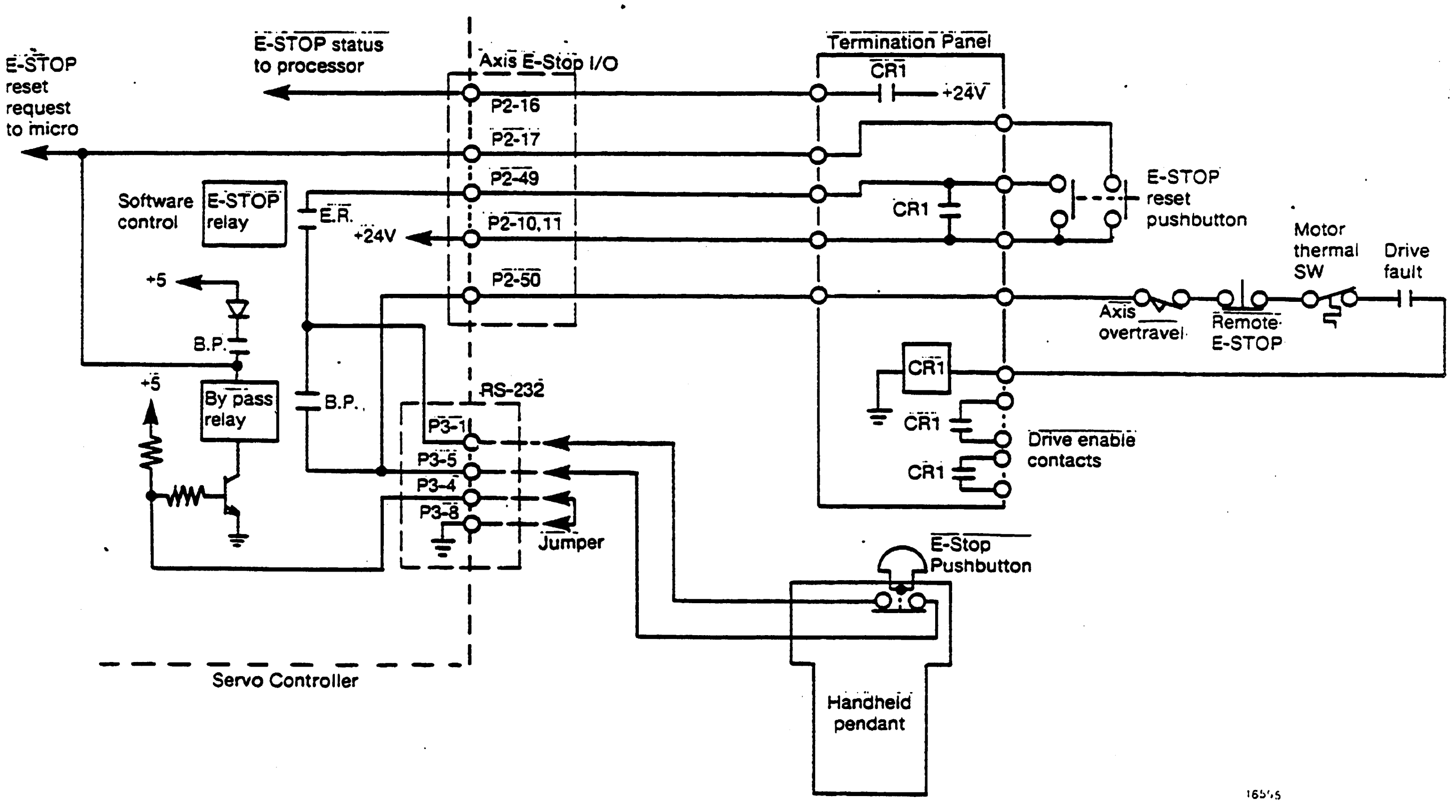
9.3 Testing E-Stop Wiring without the Handheld Pendant (Defeating the Drives)

You should first test your E-Stop wiring before you:

- plug in your handheld pendant
- test your fast I/O
- perform open and closed loop integration of drives and feedback devices

Figure 9.2 shows the wiring diagram for the E-Stop circuit. Use this figure to first check the E-STOP RESET pushbutton and then each contact on the E-Stop string.

Figure 9.2
E-Stop Circuitry



To check the E-STOP RESET pushbutton, perform the following steps:

1. Disconnect the motor from its ball screw

2. Disconnect the drive enable contacts.

3. Disconnect the E-Stop string at the termination panel

4. Short the (machine tool) hardware E-Stop string.

5. Press the E-STOP RESET pushbutton and hold it in.

   The bypass relay energizes and seals itself and the IMC 120 software detects an E-stop reset request and energizes the software controlled E-Stop relay in the servo controller module. Since the E-Stop string is shorted, K1 seals the E-Stop Reset pushbutton.

6. Release the E-Stop Reset pushbutton and K1 will remain on. K1 may be verified to be on either visually or via a continuity check on one of the normally open drive enable contacts.

   Remove the string out/string in jumper and K1 should drop out indicating an E-Stop condition.

7. Re-connect the E-Stop string and drive enable to the termination panel to get the system up and running.

WARNING: Leave the motor disconnected from its ball screw.

Now that you know that the circuitry for the E-Stop Reset pushbutton works, you can test each contact (i.e. the axis overtravel, remote E-Stop, motor thermal switches) on your E-Stop string. Since each element in the string is closed normally, open each contact on the string to ensure that the system goes into E-Stop.

9.4 Plugging in the Handheld Pendant

Plugging the handheld pendant into the RS-232 connector of the servo controller module while the system is running (not in E-Stop) causes the following things to happen in the E-Stop Circuitry:

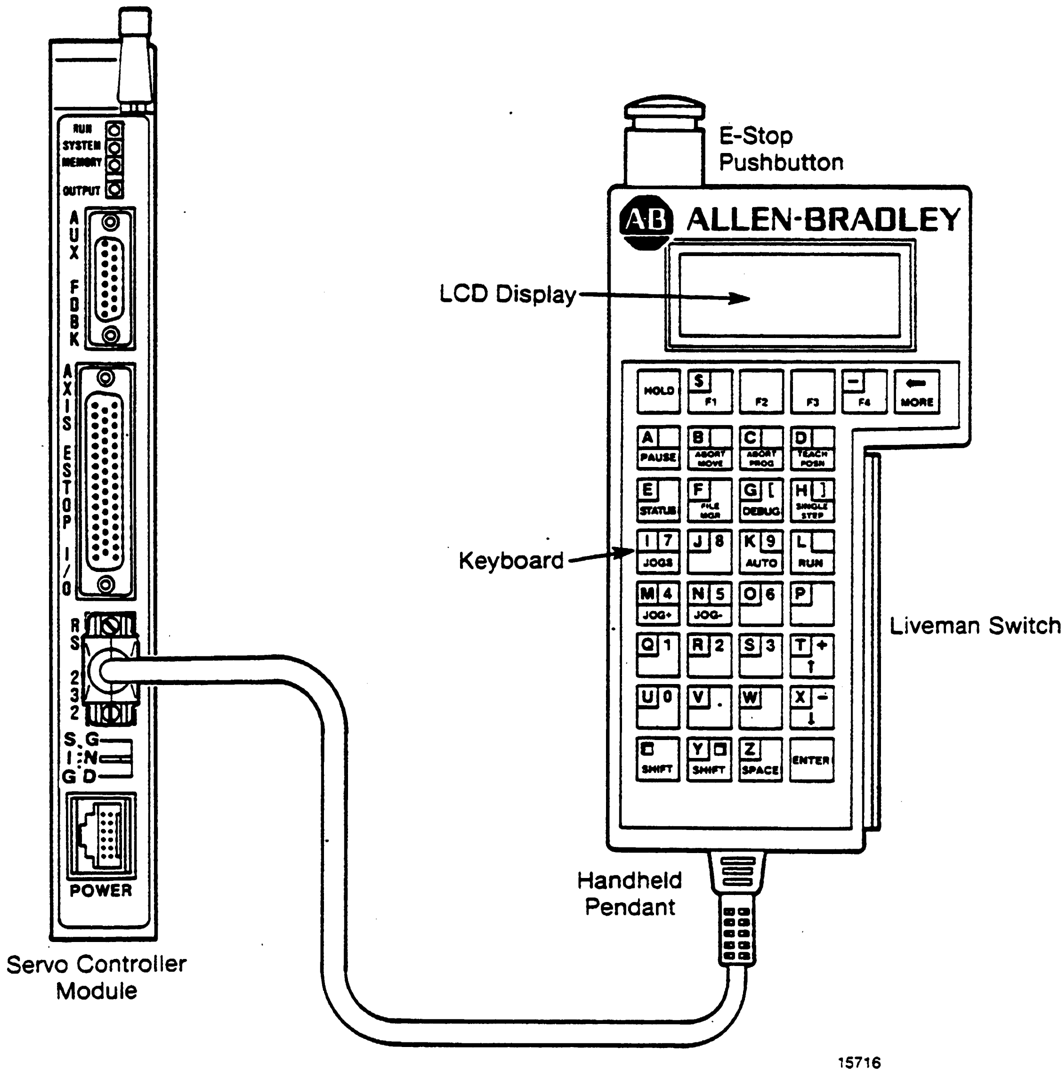
1. the E-Stop pushbutton circuit of the handheld pendant is now across the bypass relay contacts at pins P3-1 and P3-5.

2. The jumper (at pins P3-4 and P3-8) on the handheld pendant cable cause the bypass relay to turn off and unseal itself. From now on you must press the E-Stop Reset Pushbutton to re-energize the bypass relay.

3. The bypass relay contacts open and the E-Stop button on the handheld pendant is now inserted in the E-Stop string.

Hold in the E-STOP Reset pushbutton as you simultaneously unplug the handheld pendant from the servo controller module (see figure 9.3) so that the system avoids dropping into E-Stop.

Figure 9.3
Plugging the handheld pendant cable into the RS-232 connector of the Servo Controller Module



9.5
Testing the E-Stop Button

Push the E-Stop button in to check whether it works. Enter the status menu and select mode to see if the system is in E-Stop.

Pull out the E-Stop button and then press and hold the E-Stop Reset pushbutton to make the system come out of E-Stop. Then check whether the mode changes to NORMAL.

9.6 Testing Fast I/O

Input devices can be wired normally open or normally closed.

9.6.1 Testing Fast Inputs

Use the following steps to test fast inputs:

Normally open fast input devices

1. Close the input device.

2. Check to see if the fast input LED on the termination panel lights.

Normally closed fast input devices

1. Open the input device.

2. Check to see if the fast input LED on the termination panel goes off.

If not, then you know that there is a problem with the wiring between the termination panel and the input device.

3. check the status of the fast input at the servo controller module by using the handheld pendant:

Press Key	To Select
<DEBUG>	Debug Menu
<F3>	Debug
<F4>	Variable

Enter variable name FIN [#] where #= 1 through 4 and view the value of that FIN # that you entered.

9.6.2 Testing Fast Outputs

Outputs are set by executing the MML program.

Use the handheld pendant to set and then test values for FO1 through FO4:

Press Key	To Select
<DEBUG>	Debug Menu
<F3>	Debug
<F4>	Variable

Enter variable name FOUT [#] where #= 1 through 4 and set the value of FOUT [#] to 1. Then check whether that LED (FO1 through FO4) on the termination panel lights. Next check the output device to see if it is activated.

9.7 Integrating The Axes

To integrate axes you must first perform the open loop procedure and then the closed loop procedure. You must perform these procedures in conjunction with your servo drive manufacturers instructions.

Important: For these procedures to work, servo drives and motors must be capable of controlling axis motion according to your requirements. The IMC-120 servo controller module cannot overcome inherent limitations of drives, motors, or axis mechanisms.

The Open Loop Procedure involves:

- supplying voltage to the drive input
- checking phasing of the drive input and axis feedback
- checking axis motion for smoothness and response.

The Close Loop Procedure involves closing the axis position loop and checking axis response to commands from the IMC-120 servo controller module.

Before you begin axis integration, make sure that all system wiring has been completed:

- E-Stop string is wired and functioning properly. Verify that the extreme overtravel limit switches cause E-Stop and interrupt power to the drives.
- Feedback device has been wired according to section 8.1, Feedback Device Connections or section 8.2, Auxiliary Feedback Device Connections.
- The velocity command connections have been made between the IMC 120 servo controller module and the servo drive (section 8.4).
- Home limit switch is wired and verified to be functional (see section 7.1.2, Connecting the Home Limit Switch As a Fast Input).

Both the open and closed loop procedures involve handheld pendant tasks. Table 9.A lists the key strokes of each task and the chapter in the IMC 120 Handheld Pendant Operators Manual (Publication Number 1771-6.5.50) to refer to if you want to learn more. Steps in the open and closed loop procedures refer to the task that needs to be performed.

Table 9.A
Handheld Pendant Tasks

Task #	**Press Key**	**To Select**	**Refer to Chapter**
1. **Selecting Open Loop Jog.**	<DEBUG>	Debug Menu	6
	<F2>	Integration	
	<F3>	Open Loop Jog	
	<IMC-120>	Password*	
	<ENTER>	To enter Password	
	<ENTER>	Return to Debug Menu	
2. **Selecting Normal Jog.**	<DEBUG>	Debug Menu	6
	<F2>	Integration	
	<F3>	Normal Jog	
	<IMC-120>	Password*	
	<ENTER>	To enter Password	
	<ENTER>	Return to Debug Menu	
3. **Selecting the jog type**	<JOGS>	Jogs Menu	5
	<F1>	Jog type	
	<F1>	Continuous jog	
	<ENTER>	Return to Jogs main menu	
4. **Selecting the jog speed** (default AMP parameters)	<F2>	View four jog speeds	5
	<Fx> where x = 1,2, 3,or 4	Choose a suitable speed	
	<ENTER>	Return to Jogs main menu	

* Whenever a password is needed as noted above, the display reads: Enter Password To Complete Selection.

Table 9.A (Continued)
Handheld Pendant Tasks

Task #	Press Key	To Select	Refer To Chapter
5. **Inverting the Velocity Command Polarity**	< DEBUG >	Debug Menu	6
	< F2 >	Integration	
	< F1 >	Invert D/A	
	< IMC-120 >	Password*	
	< ENTER >	To enter Password	
	< ENTER >	Return to Debug main menu	
6. **Reverse the main feedback phase of your encoder or resolver.**	< DEBUG >	Debug Menu	6
	< F2 >	Integration	
	< F4 >	REV MAIN FB	
	< IMC-120 >	Password*	
	< ENTER >	To enter Password	
	< ENTER >	Return to Debug main menu	
7. **Reverse the master feedback phase of your encoder or resolver.**	< DEBUG >	Debug Menu	6
	< F2 >	Integration	
	< More >	More	
	< F1 >	REV AUX FB	
	< IMC-120 >	Password*	
	< ENTER >	To enter Password	
	< ENTER >	Return to Debug main menu	

* Whenever a password is needed as noted above, the display reads: Enter Password To Complete Selection.

Table 9.A (Continued)
Handheld Pendant Tasks

Task #	Press Key	To Select	Refer To Chapter
8. **Reverse the probe feedback phase of your linear encoder.**	<DEBUG>	Debug Menu	6
	<F2>	Integration	
	<F2>	Invert Probe	
	<IMC-120>	Password*	
	<ENTER>	To enter Password	
	<ENTER>	Return to Debug main menu	
9. **Monitoring Positioning, Following Error, and Speed of Master and Slave Axes**	<STATUS>	Status Menu	4
	<F3>	Slave (main) Axis Status	
	<MORE>	Master (auxiliary) Axis Status	

* Whenever a password is needed as noted above, the display reads: Enter Password To Complete Selection.

Open Loop Procedure

Use the following steps to perform open loop integration.

1. Remove power to the IMC-120 servo controller module and servo drive.

2. Remove servo drive fuses to ensure that the servo drives are disabled.

3. Disconnect the servo motor from the ball screw.

4. Replace the axis fuses, then re-apply power to the IMC-120 servo controller module and the servo drive.

5. Use the handheld pendant to select the OPEN LOOP JOG mode (see task #1).

6. Press the E-Stop Reset pushbutton and allow the system to come out of E-Stop. At this point, the IMC-120 servo controller module is not commanding motion (VELOCITY COMMAND = OV) and is not attempting to close the position loop.

7. If the motor rotates without acceleration, you may need to adjust the drive balance; refer to the servo drive manufacturers instructions.

   If the motor starts to accelerate, the leads from the tachometer to the servo drive are reversed or disconnected.

   If the motor is stationary or is moving very slowly, proceed to step 8.

8. As you watch the servo motor, command an open-loop jog in both directions (<JOG+> and <JOG->) at a low speed. To set up jogging on the handheld pendant, perform the following tasks in table 9.A.

   1. select open loop jog (see task #1)
   2. select jog type (see task #3)
   3. select low jog speed (see task #4)

   The motor should respond in both directions and return to a stationary position when the command is terminated.

WARNING: If sudden high speed rotation occurs, the velocity loop is not properly closed at the servo drive. Do not proceed until the problem has been corrected. See your drive manufacturers instructions for details.

---

9. Remove power to the IMC 120 servo controller module and the servo drives.

10. Remove servo drive fuses to ensure that the servo drives are disabled.

11. Connect the servo motor to the ballscrew. Locate the axis near the midpoint of its travel.

12. Replace the axis fuses, then re-apply power to the IMC 120 servo controller module and the servo drive.

13. Verify that the handheld pendant is still in the OPEN LOOP JOG mode.

CAUTION: Do not select NORMAL JOG mode (see task #1) during this procedure or sudden motion may occur. Keep all personnel away from this axis.

---

14. Press the E-Stop Reset pushbutton to allow the system to come out of E-Stop.

15. Check for correct phasing of the velocity command:

    - Pressing <JOG +> in OPEN LOOP JOG mode should cause axis motion in the direction that part programs will call positive (ignore the pendant position display).

    - Pressing <JOG -> in OPEN LOOP JOG mode should cause axis motion in the direction that part programs will call negative (ignore the pendant position display.)

    If the direction is incorrect, select INVERT D/A to invert the velocity command polarity (see task #5).

CAUTION: Keep the axis near its center of travel. Running the axis into its mechanical stops could damage equipment.

If you inadvertently run an axis far enough to trip an overtravel limit switch, you will cause an E-Stop and the power to shut off. Manually back the axis off the limit switch and then press the E-Stop Reset pushbutton to re-initialize the axis.

16. Run the axis at increasing speeds in both directions (see task #4 to change speeds). Check for smooth axis motion. There should be no mechanical vibration or cogging. If there is, take appropriate corrective action.

17. Verify that 1/2 the maximum velocity command causes axis motion at approximately 1/2 the maximum axis speed. Check this for both directions of axis motion. You may need to adjust the servo drive. Refer to the servo drive manufacturers instructions.

18. Using the handheld pendant, monitor axis position feedback as you move the axis slowly in both directions (see task #9). When the axis moves in the positive direction (JOG+), axis position should increase in the positive direction. When the axis moves in the negative direction (JOG-), axis position should change in the negative direction.

19. If you obtain opposite results, select INVERT FEEDBACK to invert the phase of the feedback (see task #6). Repeat step 18 to insure that you have corrected the problem.

20. **Important:** If you have inverted either D/A or FEEDBACK AMP parameters, upload AMP parameters so that they are the same as the AMP parameters stored offline. Also correct your wiring drawings so that they agree with AMP parameters.

Repeat this procedure for all axes being integrated.

Closed Loop Procedure

Follow this procedure to close the axis positioning loop. You MUST perform this procedure in conjunction with the servo drive manufacturers instructions.

You must perform the open-loop procedure before you can perform the closed-loop procedure.

1. Make sure that the axis is at the approximate midpoint of its travel.

2. Power up the IMC-120 servo controller module and the servo drive.

3. Using the handheld pendant, select the OPEN LOOP JOG mode (see task #1).

4. Press the E-Stop Reset pushbutton to allow the system to come out of E-Stop.

5. Using the handheld pendant, select the NORMAL JOG mode (see task #2). The IMC-120 servo controller module is not commanding motion, but is closing the position loop.

   If the open loop procedure was performed correctly, no axis motion should occur.

WARNING: The operator should be prepared to hit the E-Stop button in case unexpected motion occurs. If this happens, the open loop procedure was not performed correctly. Do not continue until the problem is corrected.

---

6. Verify that there is no axis motion. If necessary, adjust the drive balance (at the servo drive) so that:

   - the axis following error (see task #9) is zero
   - no motion occurs, when the IMC-120 servo controller module is not commanding motion (analog output voltage is zero).

7. Jog the axis in the positive direction <JOG+> at about 1/2 maximum traverse speed. Calculate to see if the following error is correct (see task #9 to monitor the following error):

   If loop closure method = standard

   $$\text{Following error} = \frac{\text{velocity}}{\text{gain} * 1000}$$

   If loop closure method = velocity feed forward

   $$\text{Following error} = \frac{(\text{velocity})(1\text{-feed forward const.})}{(\text{gain} * 1000)}$$

   See chapter 11 of the IMC 120 Motion Control System Programming Manual, Publication 1771-6.5.51, for additional AMP parameter details.

   If necessary, adjust the gain of the drive to achieve the correct following error.

8. Jog the axis in the negative direction <JOG-> at the same rate used in Step 7. The following error should be the same. If not, lower one of the D/A voltage values (either parameter #2580, Output Voltage at + Max Speed or parameter #2590, Output Voltage at - Max Speed) in AMP to compensate.

9. Repeat steps 7 and 8 to verify the correction. The following error should be the same for both directions.

10. Jog the axis in both directions at various speeds and observe the following error. At each speed, the following error should be the same for axis motion in either direction.

11. Jog the axis back and forth within its range of travel. Use feedrate override to vary axis speed. Verify that axis motion is smooth and stable at all speeds, including rapid traverse, in both directions.

    If it is not, check the AMP parameters that affect motion (see Chap. 11 in the IMC 120 Motion Control System Programming Manual, publication 1771-6.5.51, for AMP motion parameters). These parameters influence axis stability and positioning accuracy and may require minor adjustment at this point. If necessary, adjust the servo drive according to the manufacturers instructions to obtain the desired results.

    Repeat this closed-loop integration procedure for each axis.

9.8 Testing Homing Using the Home Position Switch

To home an axis to the home position switch, follow this procedure.

	Press	Result
1.	<JOGS>	display the Jog main menu.
		Select Jog Type:
2.	<F1>	display the Jog Type menu.
		Example: F1 = continuous F2 = incremental F3 = HOME F4 = return to pos
3.	<F3>	select HOME jog type
4.	<ENTER>	return to the Jog main menu
		Select a Jog Speed:
5.	<F2>	display the Jog Speed menu.
6.	<F1>, <F2>, <F3>, or <F4>	select the desired jog speed **Example:** * F1 = 50 IPM F2 = 100 IPM F3 = 200 IPM F4 = 500 IPM
7.	<ENTER>	return to the Jog main menu
8.	<JOG+> or <JOG->	jog to the home position witch.**

Notes:

* The values shown are examples only. The values you will see are the values set in AMP.

** When you jog to home, the IMC 120:

1. moves to home position switch (move direction and speed is determined by operator)

2. moves off the home position switch (move direction is determined by AMP parameter # 2260, Dir. To Move Off Limit Switch, and speed is determined by AMP parameter #1060, Speed to Move to Null/Marker)

3. moves toward home (the speed is determined by AMP parameter # 1060, Speed of Move To Null/Marker, and the direction depends on:

   - location of the null/marker
   - Home Calibration Value, AMP parameter # 1150
   - $PHASE system variable

The Home Position Value (AMP parameter #1140 is loaded into current position register.

The message HOME SUCCESSFUL is displayed on the handheld pendant.

Refer to Chapter 12, Homing Parameters of the IMC 120 Motion Control Programming Manual, Publication Number 1771-6.5.51.

9.9 Testing Homing Using Nearest Resolver Null or Encoder Marker

To home an axis to the nearest resolver null or encoder marker follow this procedure:

Press	Result
1. <JOGS>	display the Jog main menu.
2. <F1>	**Select Jog Type:** display the Jog Type menu. **Example:** F1 = continuous F2 = incremental F3 = HOME F4 = return to pos
3. <F3>	select HOME jog type
4. <ENTER>	return to the Jog main menu
5. <JOG+> or <JOG->	jog to the home position *

Notes:
*When you jog to home, the IMC 120:

1. moves to the nearest null or marker (home position). The IMC 120 moves to home position at the speed selected in the Speed to Move to Null/Marker system parameter in AMP.

2. loads current position into Home Position system parameter

3. Modifies home position with the Home Calibration Value system parameter and the $PHASE system variable. The message HOME SUCCESSFUL is displayed on the handheld pendant.

9.10 Testing Master Feedback Wiring

To check whether the master axis in a ratioing application is wired correctly, use this procedure:

1. plug in the handheld pendant into the servo controller that controls the slave axis.

2. Use these steps to display master axis status.

Press Key	Displays
<STATUS>	the Status menu
<F3>	the slave axis status
<MORE>	the master axis status

   Refer to Chapter 4, Monitoring IMC 120 Status, in the IMC 120 Handheld Pendant Operators Manual, Publication 1771-6.5.50.

3. Move the master axis to a known position at a known speed.

4. Check the master axis status display to verify whether this distance and speed is displayed.

9.11 Integrating Dual Resolvers

To integrate dual resolvers, use this procedure:

1. Make sure the master/vernier dual resolvers are wired correctly. Refer to figure 8.12

2. Make sure that the master resolver is moving in the right direction. Then make sure that the vernier resolver is moving in the same direction as the master. Use tasks #6 and #7 in table 9.A to reverse either the master or the vernier resolver feedback phases.

3. Identify extreme limits of axis travel (either hard stops or overtravel limit switches) and move the axis so that it is halfway between these limits (tape measure accuracy is permissible).

4. Disable the drives by putting the control in E-Stop.

5. Access the dual resolver setup page by doing the following:

Press Key	To Select
<DEBUG>	Debug Menu
<F2>	Integration
<More>	More
<F2>	Dual Resolver

Important: If you select this page by accident, press the <MORE> key to return to the previous page.

<IMC-120>	To enter Password

Important: The password prompt is necessary, since making changes from this page can affect the operation of the control.

6. Rotate the resolver package's main shaft until the master axis position is at 0.

7. Loosen the vernier's resolver mounting cleats.

8. Rotate the vernier axis until its position reads 2000. If the master axis drifts off of the 0, then repeat steps 6 and 8.

   Important: It is **not** necessary to set the master and vernier to exactly 0 and 2000. There is a tolerance value equal to 1/2 the difference between master and vernier counts in one revolution. However, if the values you attempt to record exceed this tolerance, you will get the message:

   "RESOLVER POSITIONS OUT OF TOL."

9. Secure the mounting cleats and couplings of the resolver.

10. Press the <Enter> key after manually adjusting the axes to save a new offset.

    Important: If the system does **not** accept the new offset, turn the <Shift> key off so the system acknowledges the <Enter> key. Then, repeat step 10.

11. Home the axis to the nearest resolver null (refer to section 9.9) or home position switch (refer to section 9.8). You only need to perform the homing cycle once.

9.11.1 Testing Dual Resolvers

Follow this procedure to test whether the dual resolvers are working correctly:

Use the status menu on the handheld pendant to verify axis positions before system shut down and after system power up.

1. Plug in the handheld pendant into the servo controller.

2. Move the axis to a known position.

3. Use these steps to display the master resolver position status. Note this position.

Press Key	Displays
<STATUS>	the Status menu
<F3>	the master position

Refer to Chapter 4, Monitoring IMC 120 Status, in the IMC 120 Handheld Pendant Operators Manual, Publication 1771-6.5.50.

4. Power down the system, then power the system back up.

5. Check the position of the axis; the position should be the same.

9.11.2 Powering Up Dual Resolvers

Powering Up an IMC-120 servo controller module configured with dual resolvers initiates the internally controlled absolute position cycle that consists of:

1. checking to see that the axis has been homed at least once.

   If the axis has been homed, the cycle continues. If the axis has never been homed then the cycle aborts and the axis is marked as not having been homed. To home the axis, refer to sections 9.8 and 9.9.

   The cycle also aborts if the axis is within a limit (specified by AMP parameter 3110, Min Counts From Travel Limits) of either travel limit. Travel limits are the far right or far left ends of the interval determined by the resolver ratio.

2. calculating the absolute position

3. asserting that the axis has been homed.

A.0 Appendix Overview

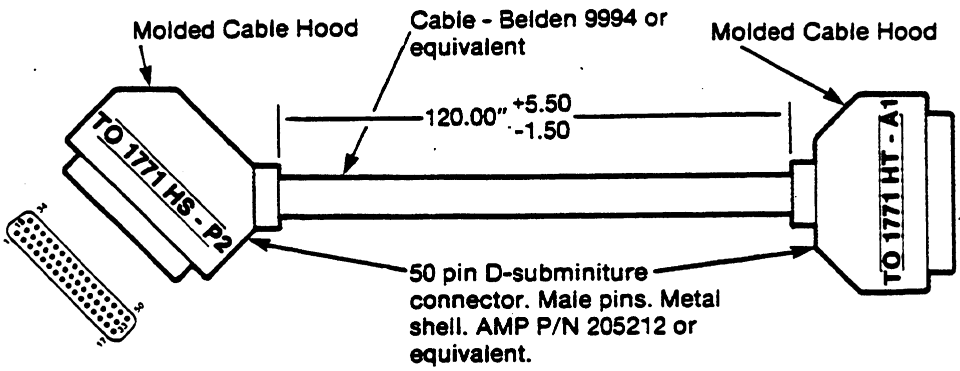
This appendix contains the drawings for the following cables:

- 1771-CAP (figure A.1)
- 1771-CAPA (figure A.2)
- 1771-CAPR (figure A.3)
- 1771-CT50 (figure A.4)
- 1771-CT45 (figure A.5)

Each drawing shows:

- the cable
- wiring diagram
- specifications for making the cable

Figure A.1
1771-CAP Cable Specifications and Wiring Diagram



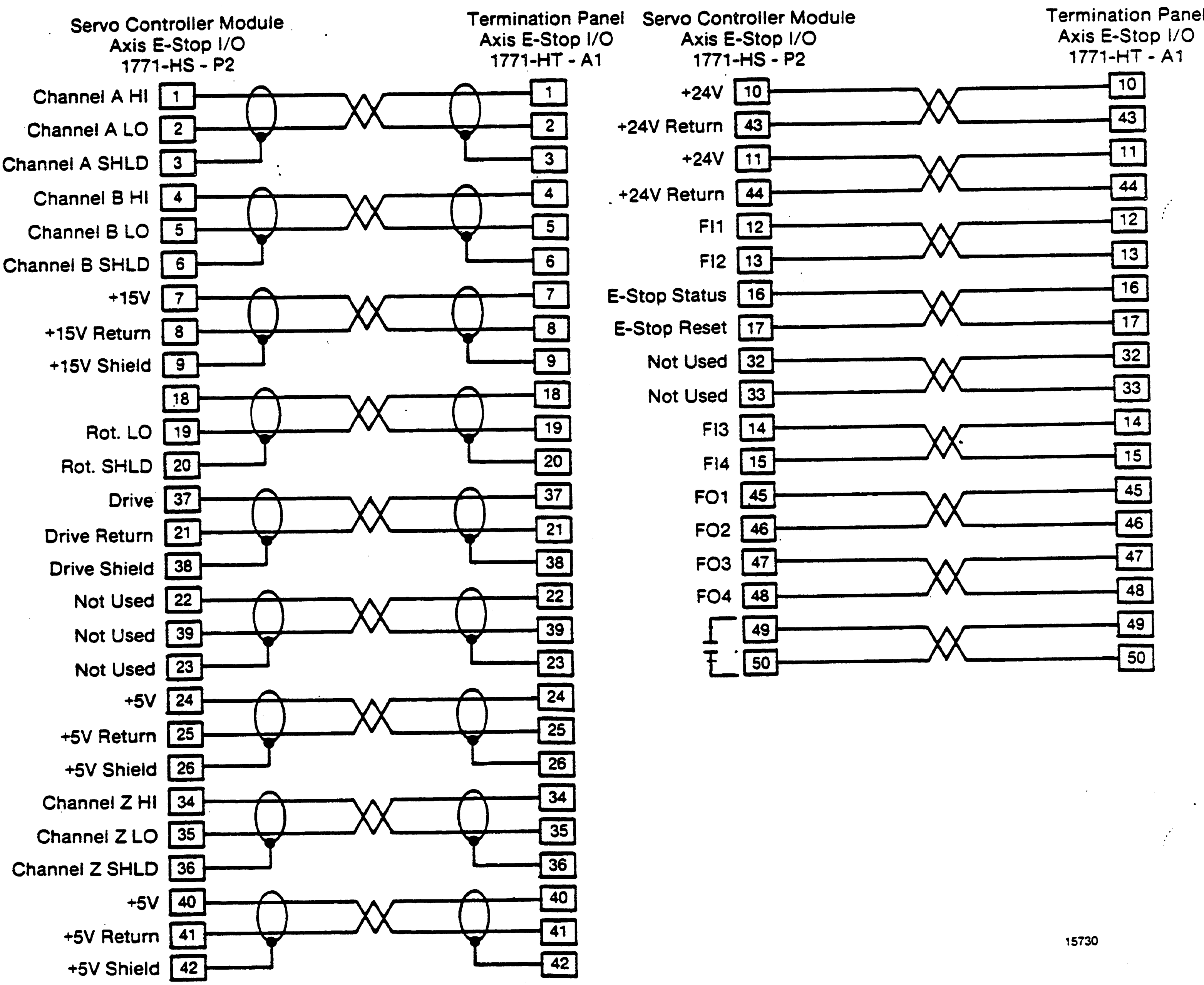


Figure A.2
1771-CAPA Cable Specifications and Wiring Diagram

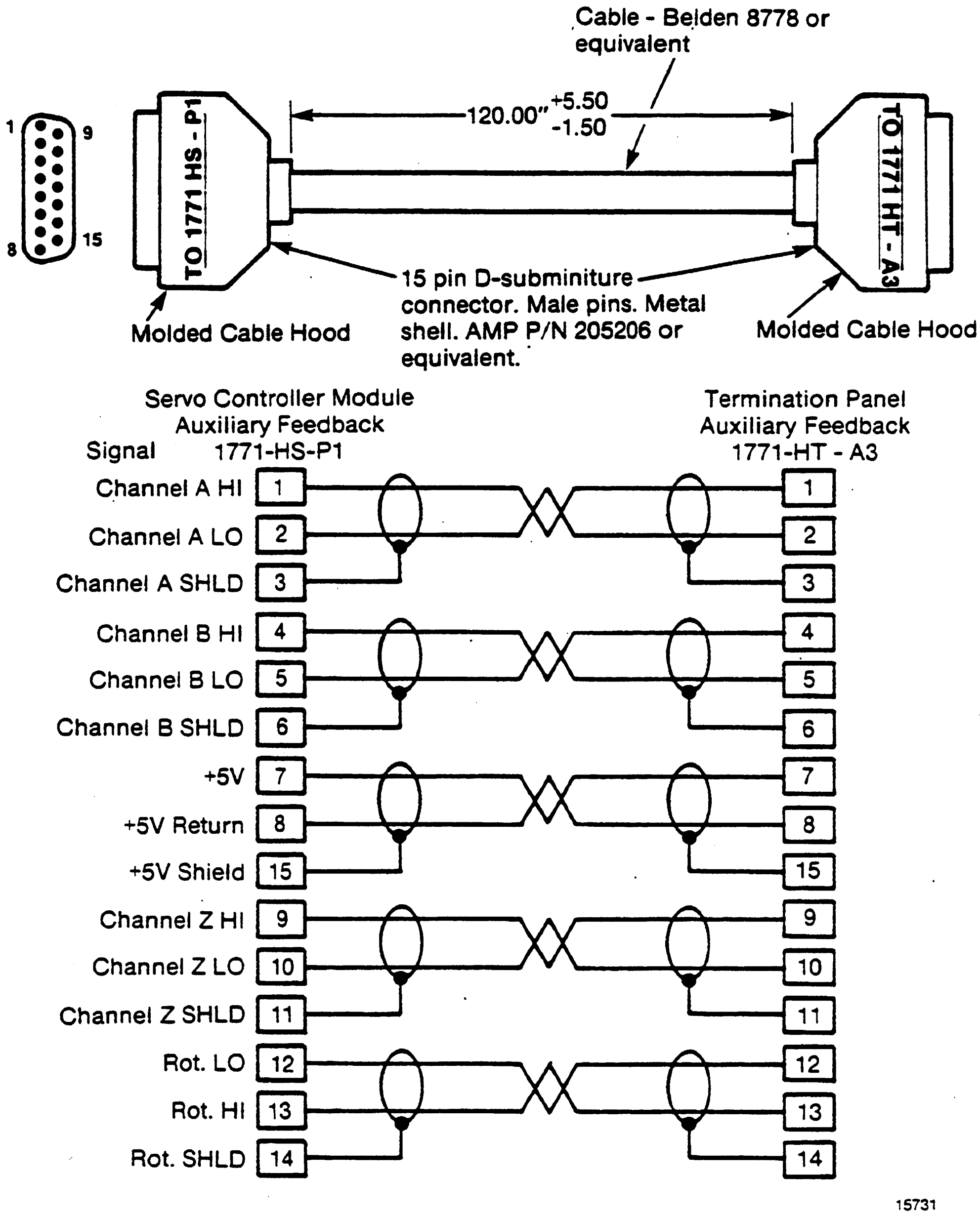
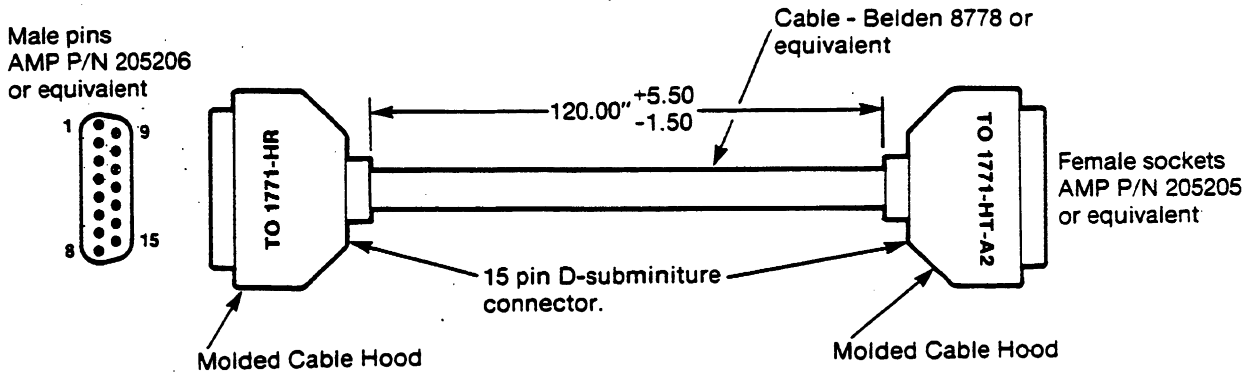


Figure A.3
1771-CAPR Cable Specifications and Wiring Diagram



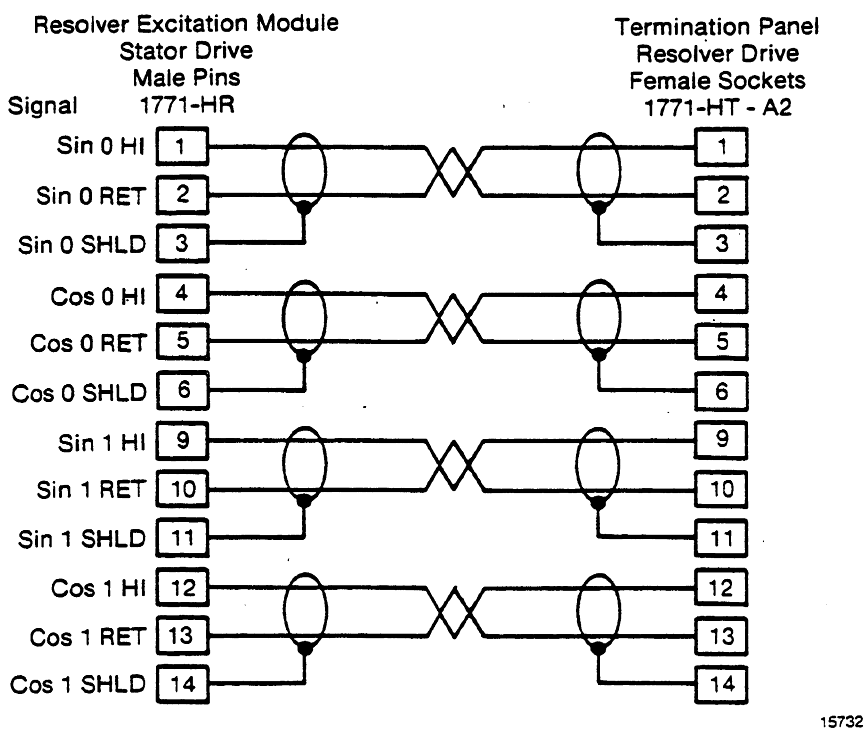


Figure A.4
1771-CT-50 Cable Specifications and Wiring Diagram

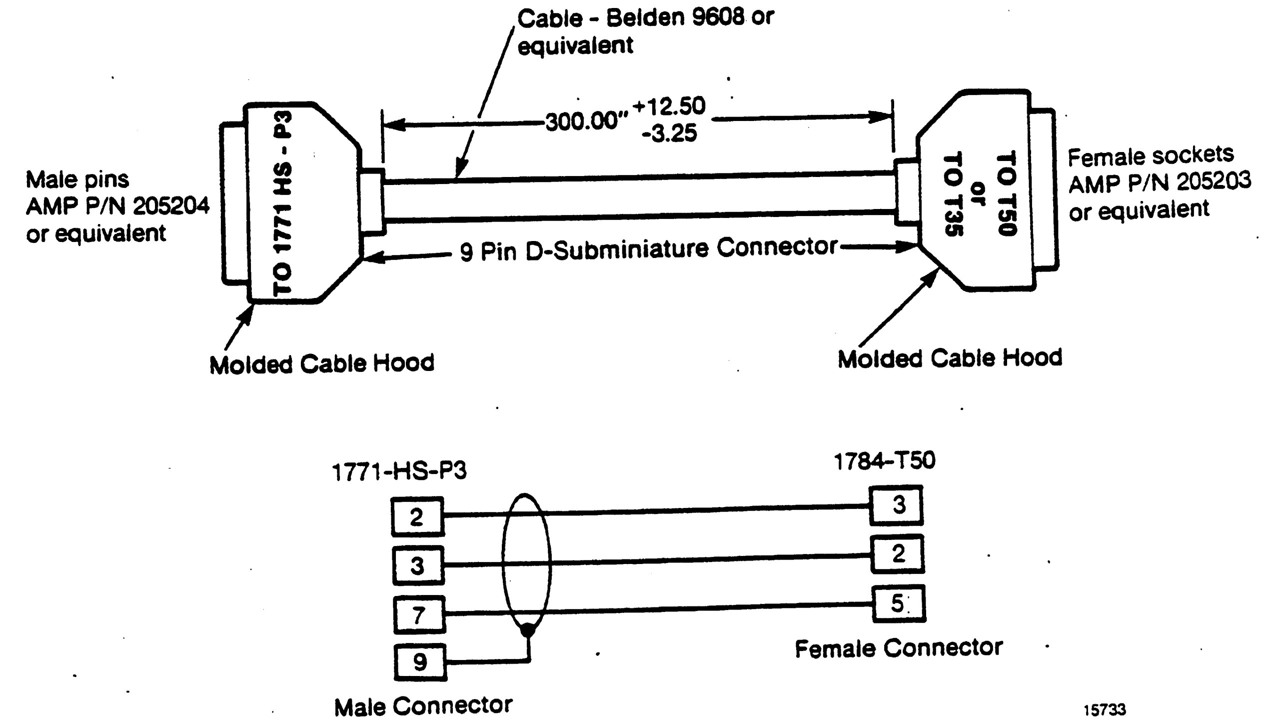
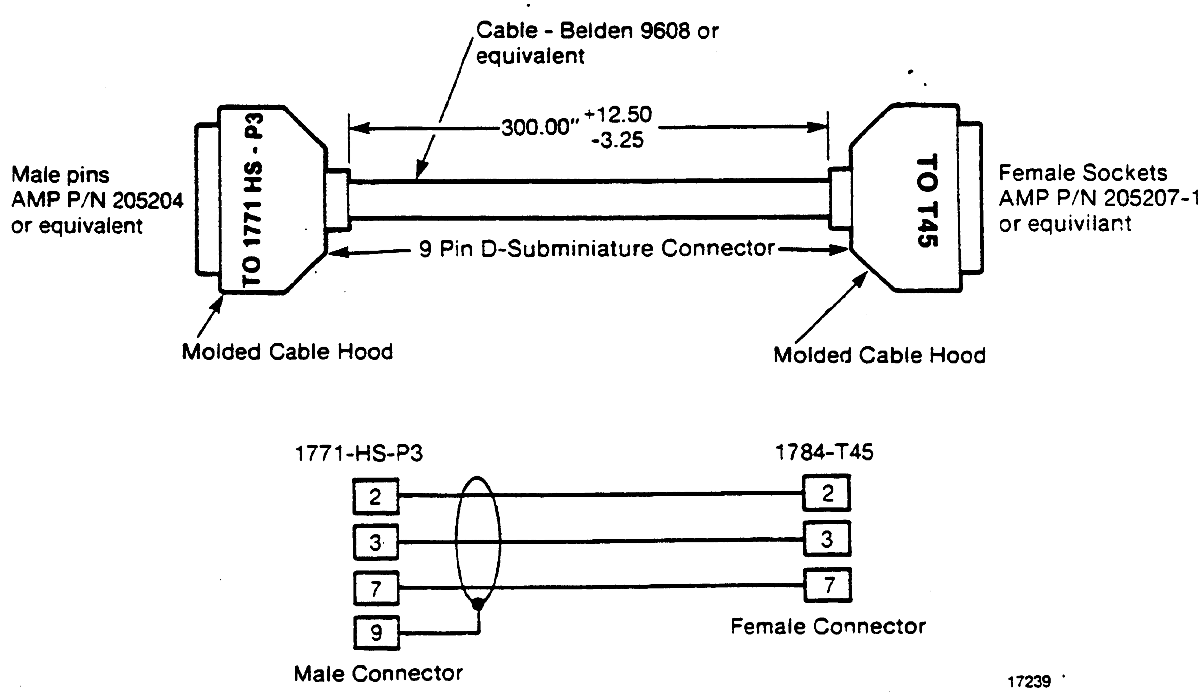


Figure A.5
1771-CT-45 Cable Specifications and Wiring Diagram



B.0 Appendix Overview

In this appendix, we discuss how you can wire your IMC 120 system without a termination panel. If you don't use a termination panel, you will need to wire from the IMC 120 system module (servo controller and optional resolver excitation) connectors to the following user devices:

- fast inputs and outputs
- E-Stop Reset pushbutton, E-Stop string, and E-Stop relay
- feedback devices (encoder or resolver)
- drives

Specifically we:

- list the connector pinout signals of the servo controller and resolver excitation modules
- discuss how to use the wiring diagrams in chapter 9 and these connector pinouts to help you wire your system
- list the distance limitations for locating these user devices

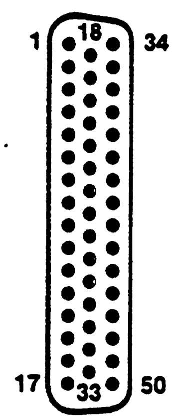
B.1 Pinout Signals for the Servo Controller Module

The following tables show the following user side connectors and pinout signals for the servo controller module.

Table	User Side Connector and Pinout Signals
B.A	AXIS E-STOP I/O
B.B	AUX FDBK
B.C	RS-232

Table B.A
50 Pin AXIS E-STOP I/O Connector and Pinout Signals

Signal	Pin #	
CHA. HI	1	
CHA.LO	2	
CHA.SHIELD	3	
CHB.HI	4	
CHB.LO	5	Controlled Axis
CHB.SHIELD	6	Encoder Feedback
CHZ.HI	34	
CHZ.LO	35	
CHZ.SHIELD	36	
+5V	40	
+5V RET	41	
+5V SHIELD	42	
+5V	24	
+5V RET	25	Controlled Axis
+5V SHIELD	26	Encoder Power
+15V	7	
+15V RET	8	
+15V SHIELD	9	
DRIVE	37	Controlled Axis
DRIVE RET	21	Velocity Command
DRIVE SHIELD	38	
ROT.HI	18	Controlled Axis
ROT.LO	19	Resolver Feedback
ROT.SHIELD	20	
FI1/TOUCH PROBE	12	
FI2	13	Fast Inputs
FI3	14	
FI4	15	
+24V	10	Fast Input
+24V	11	Power
FO1	45	
FO2	46	Fast Outputs
FO3	47	
FO4	48	
+24V RETURN	43	Fast Output
+24V RETURN	44	Load Return
ESTOP STATUS	16	
ESTOP RESET	17	Customer ESTOP
⏚	49	Connections
	50	



Axis E-Stop I/O

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Table B.B
15 Pin AUX FDBK Connector and Pinout Signals

Signal	Pin #	
CHA.HI	1	Auxiliary Feedback Encoder Connections
CHA.LO	2	
CHA.SHIELD	3	
CHB.HI	4	
CHB.LO	5	
CHB.SHIELD	6	
CHZ.HI	9	
CHZ.LO	10	
CHZ.SHIELD	11	
+5V	7	Auxiliary Encoder Power
+5V RETURN	8	
+5V SHIELD	15	
ROT.HI	13	Auxiliary Feedback Resolver Connections
ROT.LO	12	
ROT.SHIELD	14	

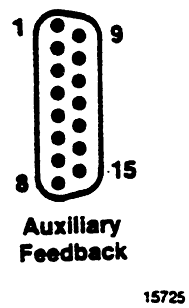
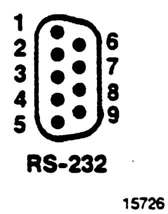


Table B.C
9 Pin RS-232 Connector and Pinout Signals

Signal	Pin #	
MUSHROOM PB 1	1	Connections for 1771-HD Hand Held Pendant and 1784-T50 Off Line Development System
MUSHROOM PB 2	5	
RS232 OUT	3	
RS232 IN	2	
+15V	6	
+15V RETURN	7	
TEACH ID	4	
TEACH ID RETURN	8	
SHIELD	9	

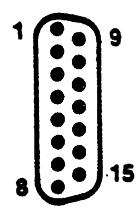


B.2
Pinout Signals for Optional Resolver Excitation Module

Table B.D shows the pinout numbers, signals, and locations for the Stator Drive connector of the resolver excitation module.

Table B.D
Stator Drive Connector and Pinout Signals

Pin #	Signal	
1	SIN0 HI	for Controlled Axis
2	SIN0 RET	
3	SIN0 SHLD	
4	COS0 HI	
5	COS0 RET	
6	COS0 SHLD	
7	not used	
8	not used	
9	SIN1 HI	for Auxilliary Axis
10	SIN1 RET	
11	SIN1 SHLD	
12	COS1 HI	
13	COS1 RET	
14	COS1 SHLD	
15	not used	



Stator Drive

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B.3 Distances to User Devices

Table B.E shows the maximum distances your user devices can be located from the IMC 120 system modules (servo controller or resolver excitation).

Table B.E
Maximum Distances of User Devices

Maximum Distance (in cable feet)	User Device
N/A	fast inputs and outputs
N/A	E-Stop Reset Pushbutton
50	+5V local encoder
100	+5V remote encoder with additional power supply
100	+15V encoder
100	resolver
50	drive amplifiers

B.4 Using the Wiring Diagrams in Chapters 7 and 8

Use the wiring diagrams in Chapter 9 to help wire your user devices to the IMC 120 servo controller and resolver excitation modules.

Match the connector signals from the servo controller and resolver excitation modules (see tables B.A, B.B, and B.D) and match them with the signals on the connector blocks of the termination panel. There is a one to one connection relationship between these connectors (except for the E-Stop and drive enable signals). Then follow the signals from these connector blocks to the various user devices.

Table B.F lists the following wiring diagrams in chapters 7 and 8 to help you wire your IMC 120 system without termination panels.

Important: Note the jumper wires that configure the servo controller module for encoder or resolver feedback are in figures 8.3, 8.4, 8.5, and 8.9.

Table B.F
Wiring Diagrams in Chapters 7 and 8

Figure	Description
7.1	Typical fast I/O connections
7.4	Touch Probe Interface Wiring
7.5	E-Stop circuitry for a one axis system
7.6	E-Stop Circuitry and Equivalent Ladder Diagrams for a Two or Three Axis System
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E-STOP Circuitry Drawings

Study the E-Stop Circuitry drawings and implement the equivalent circuit. You may not need the additional control relays (CR2 and CR3, etc.) if the drive amplifiers can be enabled at the same time. You will, however, have to purchase at least one control relay that is equivalent to the one used in our termination panel with the following specifications:

Potter and Brumfield
KHX 17D11-24
Coil: 24VDC 650 ohms
Contact 3A Resistive 120 VAC
Arrangement: 4 Form C

C.0
Appendix Overview

This appendix describes:

- the factors influencing resolver performance that you should consider when choosing the best resolver for your application.
- the factors that you should consider when choosing dual resolvers

C.1
Resolver Performance

Resolvers are precision analog devices. The electrical specifications of the resolver you choose affects the feedback performance of the IMC 120. Some resolvers, although technically compatible, will not perform as well as others.

The IMC 120 uses a technique for resolver feedback called "phase analog resolver to digital conversion". This means that you must use receiver resolvers (stator primary). Using brushless type resolvers enhance reliability and avoid generating noise in your application.

If you have an application that requires limited rotation of the resolver, you could use resolvers with "hairspring" connections to the rotor.

There are 2 main areas of resolver performance to look at when choosing the right resolver for your application:

- resolver output (rotor)
- resolver input (stator)

C.1.1
Resolver Output Considerations

The resolver you choose should have a rotor return signal with a reasonably high amplitude. The amplitude should be high enough to promote good zero-crossing detection. A higher slew rate at zero-crossing will optimize the performance of the zero-crossing comparator in the IMC 120, and will provide benefits in accuracy and noise immunity.

Two basic factors affect the amplitude of the output signal:

- resolver transformation ratio
- resolver rotor impedance

Resolver Transformation Ratio

The transformation ratio (TR) of a resolver indicates the ratio of output to input signal for a no load condition. In general, most resolvers have transformation ratios near 0.5 in a 1.0 to 5.0 kHz range. A typical range of transformation ratio is 0.3 to 2.0 kHz. A higher transformation ratio is desirable, since it increases the amplitude of the rotor return signal. Unfortunately, a higher transformation ratio is usually accompanied by a degraded (higher) output impedance.

If possible, you should look for resolvers that have their transformation ratios specified close to the frequency of operation: 2.5 kHz for the IMC 120. If the specifications for the resolver are cited reasonably close to 2.5 kHz (3.0 kHz, for example), you can still get a good estimate of the transformation ratio in your application.

Most resolver data sheets cite a nominal transformation ratio. Many resolvers claim a potential variation of up to $\pm$10%. You should include this effect in any of your calculations.

Resolver Rotor Impedance

The resolver rotor should be a good signal source, that is, it should have low output impedance. This will convey a good phase-shifted carrier signal back to the R/D converter on the IMC 120 servo controller module.

Look for the specification Z_{rs}: meaning the impedance (Z) of the rotor (r), with the stator shorted (s). Since resolvers are reactive devices, their impedance properties depend on their frequency of operation, and you should determine the impedance of the resolver at the frequency of operation to make an accurate projection of output signal amplitude. The frequency of operation for the IMC 120 is 2.5 kHz.

Making direct comparisons of resolver specifications from one frequency to another are difficult. Often, a resolver manufacturer will simply characterize a resolver in the lab to determine its parameters at an alternate frequency.

The net load seen by the resolver rotor is a complex impedance. It is composed of the shunt termination resistance of the IMC 120 (4.75K ohm line-to-line) in parallel with any parasitic cable capacitance.

For short cable lengths, the resistive part of the load will dominate. The voltage divider formed by the rotor output impedance and the shunt termination resistance of the servo controller results in a decrease in expected signal amplitude.

Longer cable lengths may result in accumulating shunt capacitance. This could form a "tank circuit" with the inductive component of the resolver rotor. In this case, it is possible that the rotor signal will increase in amplitude, but this may also result in an undesirable effect: a lag in change of phase of the resolver for "step" changes in rotor position.

C.1.2 Resolver Input Considerations

When you look at resolver input specifications, pay attention to:

- stator impedance
- maximum stator input current

Stator Impedance

When choosing your resolver, consider the load impedance of the stator windings of the resolver. The load as seen by the output of the IMC 120 resolver excitation module must not be greater than the drive capability of the output buffers.

Look for the specification Z_{SO}: the impedance of the stator with the rotor winding open. The rotor will always have some measurable impedance when it is open, but you can neglect this reflected load for many cases. The stator load impedance should be specified close to the frequency of operation: 2.5 kHz for the IMC 120.

Maximum Stator Input Current

The last parameter to consider is the input current limits of the resolver. Many resolvers are specified at stator drive levels of 4V to 12V RMS at the recommended frequency of operation. The output level of the IMC 120 resolver excitation module is approximately 7V RMS, and this should be generally acceptable.

Avoid resolvers that would be "overdriven" with a 2.5 kHz, 7V RMS carrier. If the stator currents are above these limits, linearity could degrade as the magnetic materials in the resolver operate outside their linear region.

C.2 Choosing Dual Resolvers

You should use a dual resolver package:

- that is of the master/vernier type; not of the coarse/fine type. The master/vernier ratio must be less than 1.
- in which each master and vernier resolver has the same make and model number so that each has similar drift and electrical characteristics

  Important: Remember that optimum resolver performance is more critical in dual resolver applications. Any errors of sufficient magnitude may result in erroneous home positions (multiple turns), as opposed to errors within only one turn.

- in which each master and vernier resolver are on the approved IMC 120 list of resolvers (refer to table 2.E)

The servo control can reliably accommodate dual resolvers with a maximum master/vernier ratio of 800/801. With this master/vernier ratio, maximum axis travel = servo resolution x 3,200,000.

For your application, determine allowable axis travel with the following formula:

allowable axis travel = (counts/cycle) x (master resolver turns) x (servo resolution)

Where:

- counts/cycle = 4000 feedback counts per electrical cycle of an IMC 120 compatible resolver
- master resolver turns = the master portion of the master/vernier ratio. For example, if the master/vernier ratio is 144/145, use 144.
- servo resolution = inches or millimeters of axis travel per feedback count.

For example, using an IMC 120 compatible resolver with 4000 counts/cycle, the master/vernier ratio is 144:145 and servo resolution is .0005 inches/count, then:

max. axis travel = (4000) x (144) x (.0005)
= 288 inches
= 24 feet

C.3 Dual Resolver Alignment Procedure

Use

This application note describes a method of aligning the master and vernier axes of a dual resolver system. The procedure does not require the use of any equipment other than the 1771-HD handheld pendant. The feature of the handheld pendant used for this procedure is the distance to null display. You must also use firmware revision levels 1.03 or above of the main CPU firmware, and 1.06 or above of the servo firmware for this procedure to function properly. Key numbers indicated in brackets [F2] refer to function keys of the handheld pendant.

Notes

Edit the AMP file and make the dual resolver travel limit parameter 1 count (default is 4000 counts). Compile and download this modified AMP file to the controller. Select the JOG TYPE to be CONTINUOUS and select the DISTANCE_TO_NULL display of the INTEGRATION menu [F2] under the debug menu on the handheld pendant. Move the axis and note the distance to null position update for a particular direction of the movement of the axis (clockwise or counterclockwise) main shaft. Leaving AMP at 1 count for this parameter provides the maximum axis travel. Therefore, you will not be required to download another AMP.

Identify the axis position which will be the minimum position of the travel. This will be at one extreme end of the axis travel. By performing the following steps, you will align the controller and the mechanical system to establish the machines minimum travel.

Master Axis Alignment Procedure:

1) Move the machine to the desired minimum position, then disable the drive by putting the control in E-Stop.

2) Position the axis exactly where you want it and secure it so that it does not move.

3) Align the master resolver null at this position by: selecting the DISTANCE_TO_NULL display under the INTEGRATION menu, loosening the mounting cleats that hold the master resolver to the backplate in the resolver package, and slowly rotating the master resolver until the DISTANCE_TO_NULL displayed is zero.

   Note: This adjustment must be made precisely because the position must be accurate to 1/4000th of a revolution.

4) When the adjustment is completed, tighten the master resolver mounting cleats.

Vernier Axis Alignment Procedure

1) You must switch the master (resolver 1) and vernier (resolver 2) plugs at the termination panel in order to view the null position on the vernier resolver. When the resolvers are switched, select the INTEGRATION menu [F2] under the DEBUG menu on the handheld pendant.

2) Loosen the mounting cleats on the vernier resolver and rotate the resolver until the distance to null displayed is equal to one count. Remember to turn the resolver slowly as you must be accurate to 1/4000th of a revolution.

3) Check again to be certain that the resolver cleats are tigtened.

4) Note the current axis position, then move the axis and make sure that the position update on the DISTANCE_TO_NULL display is the same as the direction noted in step 2 of this procedure. If the direction is different, reverse the SIN and SIN RETURN for the vernier resolver; (it should still be connected to the resolver 1 plug). Move the axis to the position noted earlier in this step.

5) Now switch the termination panel plugs to their original wiring (master connected to resolver 1 and vernier connected to resolver 2). The master should be aligned at this point. You can verify this by looking at the DISTANCE_TO_NULL display. It should display the zero null position.

Homing the Axis

Select the job type for this axis as HOME and proceed to HOME the axis. If the system is set up to HOME TO NULL in the AMP configuration, the axis will not move because it is already plsitioned at the null. If the system is configured to home to a switch the axis will first move to the limit switch and then move to the minimum position provided the closwest NULL off of the switch is the minimum position defined in step 3.

This completes the alignment procedure. If the axis is moved further in the negative direction from the minimum position in step 3, the system may indicate that it is out of alignment. Therefore, it is recommended that the home position be equal to, or more negative than, the negative software overtravel limit. This HOME position will be equal to the HOME position defined in the systems AMP parameters.

The axis should not require homing again once this procedure has been completed unless the master vernier resolver package is mechanically disconnected from the machine mechanics, or there is suspicion of the integrity of the mechanical couplings.

D.0 Appendix Overview

This Appendix contains error messages displayed on the handheld pendant or sent to the PLC for handling during power up and testing of the IMC 120 hardware.

D.1 Messages Displayed On The Handheld Pendant

Table D.A lists error messages that are displayed on the handheld pendant and the causes of the messages and ways to correct them.

Table D.A
Error Messages

ERROR#	ERROR MSG	CAUSE(S)	RECOVERY STEPS
3	CANNOT RESET NON-RECOVERABLE "WARN"	Tried to exit estop after a non-recoverable estop has occurred.	Power down then back up (currently, there are no non-recoverable errors present in the systems.
4	CANNOT RESET AMP NOT LOADED "WARN"	Tried to exit estop before AMP has been loaded, or after an unsuccessful AMP download.	Successfully download AMP.
130	CANNOT JOG IN AUTO MODE "WARN"	1. Jog request made with control in auto mode	1. Put control in Manual mode and resubmit the request
131	CANNOT JOG IN AUTO MODE "WARN"	1. Jog request made with control in auto mode	1. Put control in Manual mode and resubmit the request

ERROR#	ERROR MSG	CAUSE(S)	RECOVERY STEPS
133	ILLEGAL JOG INCREMENT "WARN"	1. Value < 0 or > 6	1. Reprogram the increment value
134	ILLEGAL JOG SPEED "WARN"	1. Value < 0 or > 3	1. Reprogram the speed value
135	ILLEGAL JOG TYPE "WARN"	1. Value < 0 or > 3	1. Reprogram the jog select value
138	AXIS ALREADY IN MOTION "WARN"	1. Axis is in motion	1. Try again once axis motion ceases
139	CANNOT RETURN IN AUTO MODE "WARN"	1. Control is in auto mode 2. Homing operation has occurred since manual mode was entered 3. Homing or jogging in progress	1. Place control in manual, reprogram 2. None 3. None
256	HOME OPERATION ABORTED "WARN"	(1) released JOG + or JOG-button (2) broken or incorrectly wired home switch	(1) n/a (2) replace or correctly wire home switch.
257	JOG AXIS BEFORE HOMING "WARN"	System has not seen a NULL marker since power-up.	Jog the axis in either direction at least one revolution of the feedback device; then home the axis.
258	HOMED TOO FAST "WARN"	Axis ran into the switch at too high velocity.	Slow down the speed at which the axis runs into the home switch.
259	RETURN TO POSN ABORTED "WARN"	1. The Return To Posn has been aborted by the PLC or 2. by releasing the [JOG +] or [JOG-] key on the HHP.	1. Start the function from the PLC again 2. Start the function from the HHP again by pressing either the [JOG +] or [JOG-] key

ERROR#	ERROR MSG	CAUSE(S)	RECOVERY STEPS
261	RETURN TO POSN SUCCESSFUL	1. Informational message saying the Return To Posn requested by the PLC or HHP was performed successfully.	1. N/A
263	HOMED SUCCESSFULLY	1. Informational message saying the homing operation requested by the PLC or HHP was performed successfully.	1. N/A
384	OVERTRAVEL "WARN"	Jog or speed move encounters a software overtravel	Push the "more" key
512	FEEDBACK IS MARGINAL (SLAVE) "WARN"	IMC 120 hardware detected a feedback failure on the slave feedback device. This error is not fatal unless it occurs multiple times during a 9.6ms iteration.	None; this is a warning message only. However if this message appears often, the feedback device should be checked.
513	FEEDBACK IS MARGINAL (MASTER) "WARN"	IMC 120 hardware detected a feedback failure on master feedback device. This error is not fatal unless it occurrs multiple times during a 9.6ms iteration.	None; this is a warning message only. However if this message appears often, the feedback device should be checked.
640	MEMORY CARD BATTERY LOW "WARN"	Battery backing up memory card is low	Upload all files and AMP to ODS; replace battery; download all files and AMP to the IMC 120
915	CANT RUN CONTROL IN ESTOP	1. Attempt to start or resume a program while in estop.	1. Perform an Estop Reset operation, then try to run the program again.
917	CANT RUN AXIS NOT HOMED	1. Attempt to run a program before the axis has been homed after power up.	1. Home the axis. Try to run the program again.
918	SORRY YOUR PASSWORD IS INCORRECT	1. Password was incorrect	1. Try again

ERROR#	ERROR MSG	CAUSE(S)	RECOVERY STEPS
919	CAN'T CHANGE WHEN NOT RATIOING	1. $DELPHASE can't be modified to a value other than the current value when not RATIOing.	1. Hit MORE key on HHP and select another variable to modify or RATIO the axis to a master via a MML program and try to modify $DELPHASE again
920	CAN'T ARM PROBE WHEN NO PROBE	1. $PROBE_ARMED can't be modified to TRUE via the handheld pendant when there is no probe or linear probe.	1. Hit MORE key on HHP and select another variable to modify or change probe type to be either trigger probe AMP utility
1024	OVERTRAVEL "ERROR"	The programmed position has exceeded an AMP specified positive or negative overtravel.	Programming error; program position somewhere within the overtravel limits or extend the limits.
1152	MASTER POSITION TOLERANCE "ERROR"	The master position feedback speed is greater than the AMP specified master position feedback tolerance.	Programming error; slow the master axis prior to entering RATIO mode to within the AMP specified tolerance or increase the AMP value.
2304	RATIO OVERTRAVEL "ERROR"	If there are overtravel limits present OR the axis has not been homed AND the program attempts to begin RATIOing this error occurs.	Programming error: overtravels may not be present on an axis that is RATIOing to a master; also, the axis must have been homed prior to attempting the RATIO.
3072	SLAVE FEEDBACK HIGH "ERROR"	Feedback from slave device was a value higher than physically possible for the device used. Caused by wrong no. of feedback counts: may be miswired, wrong AMP settings, or noise. This error causes estop.	Reset from estop. If the problem persists, check the wiring for noise, accurate wiring. Also, check AMP for gated or non-gated marker and AMP set for correct feedback counts.

ERROR#	ERROR MSG	CAUSE(S)	RECOVERY STEPS
3073	MASTER FEEDBACK HIGH "ERROR"	Feedback value from the master device was higher than physically possible for the device used. Caused by wrong no. of feedback counts: may be miswired, wrong AMP settings, or noise. This error causes estop.	Reset from estop. If the problem persists, check check the wiring for noise, accurate wiring. Also, check AMP for gated or non-gated marker and AMP set for correct feedback counts.
3074	SLAVE FEEDBACK LOW "ERROR"	Feedback from the slave device was a value lower than physically possible for the device used. Caused by wrong no. of feedback counts: may be miswired, wrong AMP settings, or noise. This error causes estop.	Reset from estop. If the problem persists, check the wiring for noise, accurate wiring. Also check AMP for gated or non-gated marker and AMP set for correct feedback counts.
3075	MASTER FEEDBACK LOW "ERROR"	Feedback value from the master device was lower than physically possible for the device used. Caused by wrong no. of feedback counts: may be miswired, wrong AMP settings, or noise. This error causes estop.	Reset from estop. If the problem persists, check check the wiring for noise, accurate wiring. Also, check AMP for gated or non-gated marker and AMP set for correct feedback counts.
3076	SLAVE QUADRATURE FAULT "ERROR"	The IMC 120 detected simultaneous transitions on the A and B channels of the slave encoder. This is an illegal condition. This error causes estop.	Reset from estop. If the problem persists, check the wiring to remove sources of noise. Also check the encoder, it may have failed.
3077	MASTER QUADRATURE FAULT "ERROR"	The IMC 120 detected simultaneous transitions on the A and B channels of the master encoder. This is an illegal condition. This error causes estop.	Reset from estop. If the problem persists, check the wiring to remove sources of noise. Also check the encoder, it may have failed.

ERROR#	ERROR MSG	CAUSE(S)	RECOVERY STEPS
3078	SLAVE FEEDBACK FAILURE "ERROR"	Multiple feedback failures were detected on the slave feedback device during a 9.6ms iteration.	Check the slave feedback device, then reset from estop.
3079	MASTER FEEDBACK FAILURE "ERROR"	Multiple feedback failures were detected on the master feedback device during a 9.6ms iteration.	Check the master feedback device, then reset from estop.
3080	EXCESS FOLLOWING ERROR "ERROR"	The value of the axis following error exceeded the limit established in AMP. This can be caused by an obstruction to axis motion, servo wiring error, or loss of feedback channel. This error causes estop.	Reset from estop. If the problem persists, check axis mechanics, wiring, and feedback device.
3200	LOST PLC COMMUNICATIONS "ERROR"	No communication with the PLC has occurred within a reasonable period of time (approximately 5 seconds). This error causes estop.	Reset from estop. If the problem occurs again, check the PLC.
3328	USER POWER LOST	The user power supply has been shorted or or disconnected. This error causes estop.	Check the user power and its connections to the PLC. After it is fixed, reset from estop.
3456	HARDWARE ESTOP	The user estop string has opened.	Insure that the device which opened the string is functioning properly, then reset from estop.
3712	FAST OUTPUTS DISABLED "HARDWARE ERROR"	A fast output is shorted. This disables all fast outputs and causes estop.	Clear the output fault then reset from estop.

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WORLD HEADQUARTERS
Allen-Bradley
1201 South Second Street
Milwaukee, WI 53204 USA
Tel: (414) 382-2000
Telex: 43 11 016
FAX: (414) 382-4444

EUROPE/MIDDLE EAST/AFRICA HEADQUARTERS
Allen-Bradley Europa B.V.
Amsterdamseweg 15
1422 AC Uithoorn
The Netherlands
Tel: (31) 2975/60611
Telex: (844) 18042
FAX: (31) 2975/60222

ASIA/PACIFIC HEADQUARTERS
Allen-Bradley (Hong Kong) Limited
Room 1006, Block B, Sea View Estate
28 Watson Road
Hong Kong
Tel: (852) 887-4788
Telex: (780) 64347
FAX: (852) 510-9436

CANADA HEADQUARTERS
Allen-Bradley Canada Limited
135 Dundas Street
Cambridge, Ontario N1R 5X1
Canada
Tel: (519) 623-1810
FAX: (519) 623-8930

LATIN AMERICA HEADQUARTERS
Allen-Bradley
1201 South Second Street
Milwaukee, WI 53204 USA
Tel: (414) 382-2000
Telex: 43 11 016
FAX: (414) 382-2400

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