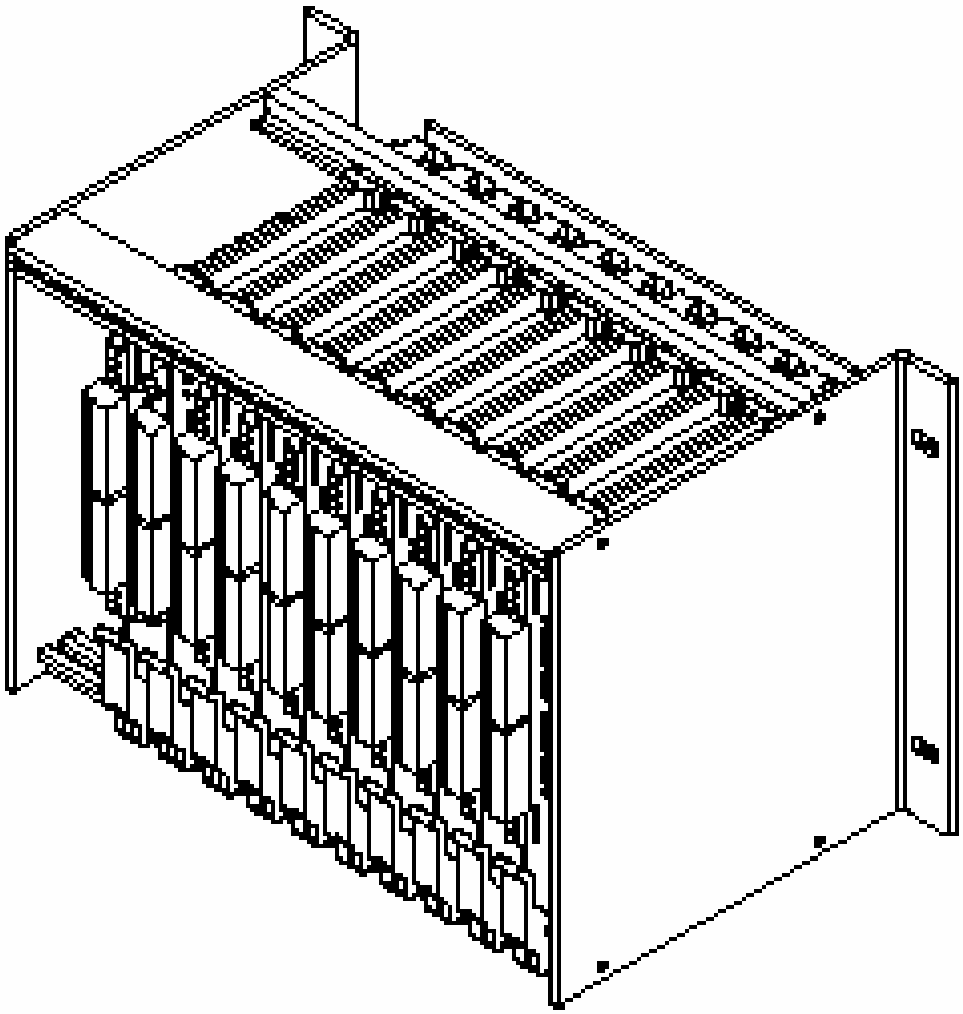
ENCODER REPEATER SYSTEM
OPERATION MANUAL



FANUC Robotics
Paintshop Automation

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INTRODUCTION

The line tracking encoder repeater system was designed to simplify and increase functionality of moving line robotic systems. Two, or up to twelve, robots can track a product and perform designed functions while the line is moving, utilizing one encoder attached to the conveyor chain. The ability to switch to a secondary back-up encoder, electronically, is also provided, and can be activated by either a manual switch or PLC output.

The basic unit consists of a card cage, power supply board, dual encoder input board, PLC interface board, and one dual encoder output board. The cage has the ability to receive up to 6 dual encoder output boards for service to twelve robots. It is a very compact unit, requiring only 64 square inches of back plane space in the cell control panel, or console, depending on system configuration. Cascading of the encoder signal to the next cell is from one of the outputs on an output board, which will limit the system to eleven robots, to the primary encoder input port on the encoder input board (encoder voltage selection must be set to 5VDC) of the next cell. Selection of the secondary encoder can only be done at the master repeater system (defined as the first unit to receive the signal from the encoder).

The unit can be powered by either 120VAC or 24VDC depending on the power supply board selected. The power source must be uninterrupted (above main disconnect) in either case, or all robots connected to the system will receive a disconnection alarm that will require the cycling of power on each controller to reset.

Three main types of encoders are supported with this system, the BEI #H25D-SS-2000-ABC-4469-SM16-S (non-explosion proof), #H38D-2000-ABC-4469-LED-SC-UL-S (explosion proof), and the FANUC #A290-0561-V531 (non-explosion proof). The BEI's are supplied with 24VDC, provided by the encoder input board via a jumper setting, with the FANUC encoder 5VDC is supplied via the same jumper.

Note: Distances between FANUC encoder and this system shall not exceed 100 feet in total cable length. System to robot controller shall not exceed 150 feet in total cable length.
Distances between BEI encoders and this system shall not exceed 150 feet in total cable length. System to robot controller shall not exceed 150 feet in total cable length.

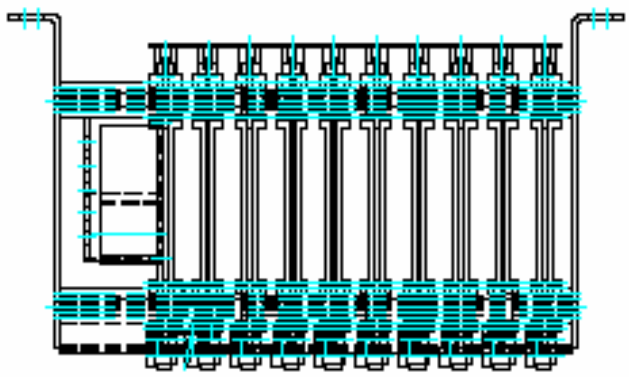
Regardless of encoder selection, only the A, A*, B, B* signals are repeated, requiring the cable plug at the robot controller to have the Z pulse pin jumped to the 5V pins and the Z* pulse pin jumped to the 0V pins. Standard cables NE-2002-954-001 (terminal strip to CPU), and NE-2012-993-001 (Harting bulkhead connector to CPU) provide this function.

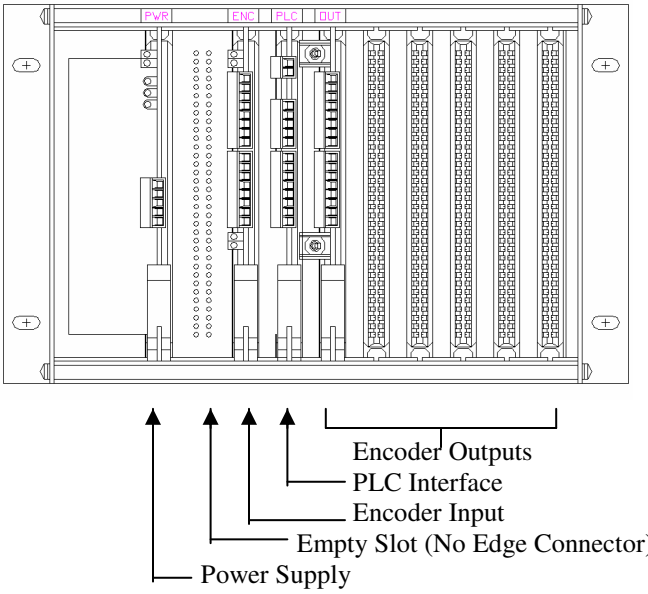
Encoders are mechanically geared to give approximately 40 pulses per millimeter of conveyor travel. Gear ratios of 10 to 200 have been successful. Typical line tracking applications range from 10ft/min to 50ft/min. Conveyor surge and reversal must be kept to a minimum. Primary and backup encoders must be mounted such that they spin in the same direction with conveyor movement.

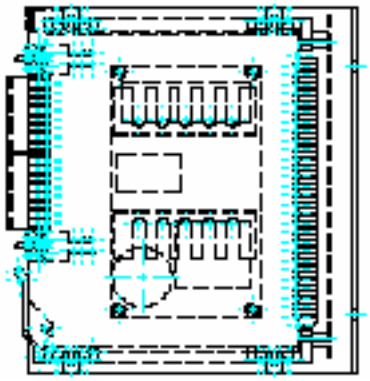
NE-2002-105-002 Encoder Repeater System Rack

This is the chassis for the Encoder Repeater System; it can be mounted on either a horizontal or vertical surface. There are 10 slots with 9 connector positions on the back plane for installing the desired configuration of cards. The wide area left open by the backplane is intended to go to the left-hand side when mounted horizontally and can be at the top or bottom when mounted vertically. For the remainder of these instructions it is assumed that the Encoder Repeater System to be mounted horizontally on a vertical surface.

Note below the recommended board placement within the rack.





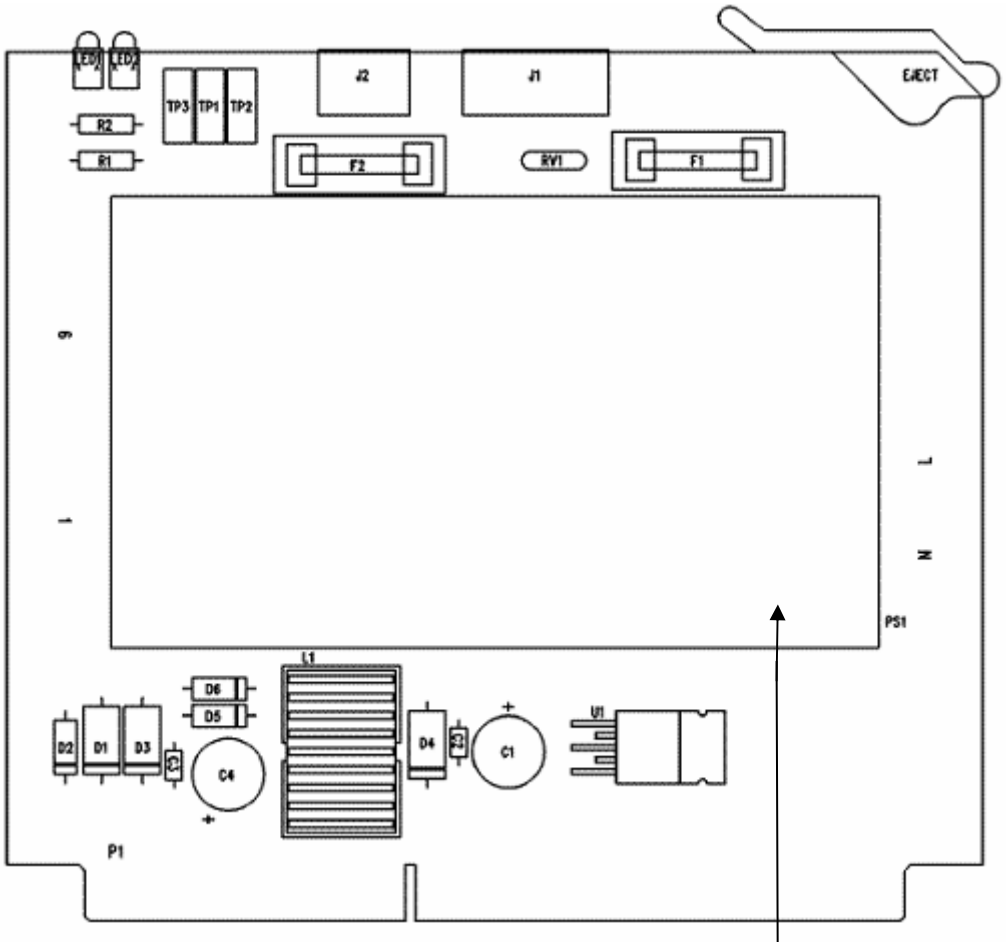


The power supply, whether it is the DC or AC input version will always be placed in the left most slot. The second slot is voided of an edge connector and should not be used to store spare boards. This space is provided to allow free air movements around the power supply board. The remaining 8 slots can have any of the remaining boards in any order, but it is recommended that the arrangement shown above be maintained. All cards are installed with the discharge tab engaged on the bottom rail of the rack and component side facing to the left.

Power supply Card(s)
These cards provide 5VDC and 24VDC power to the back plane to power the system components and input encoder(s). These cards must be placed in the left most back-plane card edge connector. Only one power supply card can be installed in each rack.

NE-2002-105-DC3 For DC Systems
This card is connected to a regulated 24VDC supply on connector J2. Nominal supply draw will be less than 1A, and is internally fused at 2A. This board is typically used when there is not a non-disconnected 120VAC circuit available to power the rack.

NE-2002-105-AC3 For AC Systems
This card is connected to a non-disconnected conditioned 120VAC supply on connector J1. The board is identical to the DC version, with the addition of a Condor AC power supply, mounted to the component side of the board. Nominal supply draw will be less than 1/2amp AC, and is internally fused at 1amp AC.

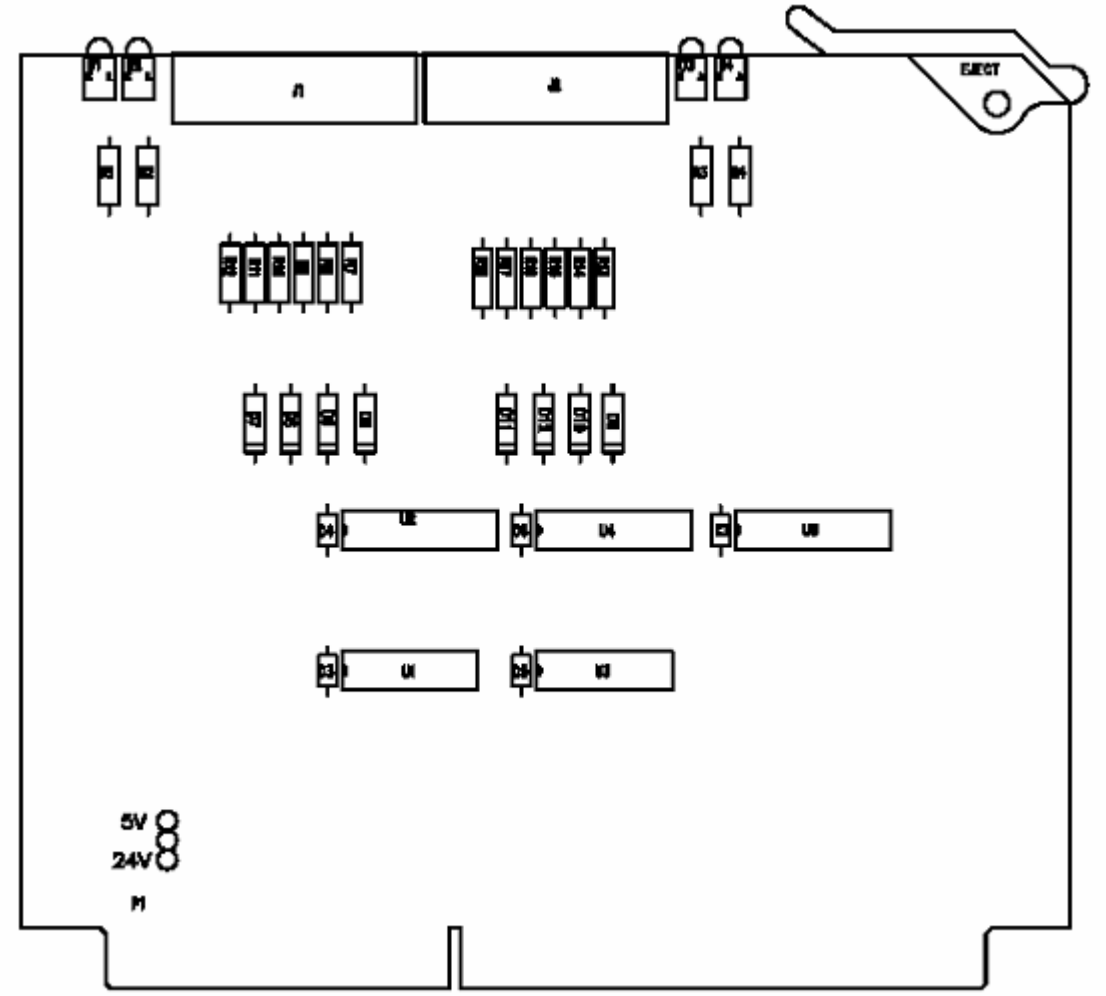


Condor Power Supply
(When used in AC Systems)

NE-2002-105-005 Dual Voltage Encoder Input Card

This card provides power to, and receives the signal from up to two encoders. The encoders may be of either, but not both, 5VDC or 24VDC quad type. The power selection jumper P1 must be set to the correct voltage for the corresponding encoder; this is a mini-shunt header type jumper. **The boards are factory set for a 24VDC encoder, and should be verified before applying power to the system**. Detection of encoder connection and selection of the primary or secondary encoder is performed on this board with signals received from the PLC interface board via the back-plane connection. It is not required to have two encoders connected, but if only one is used, it must be connected to the primary encoder connection J1. Power is present at both encoder input connectors, even though only one encoder can be selected at a time.

If the rack is receiving its signal from a previous system the board must be set to 5VDC and connected to the output connector of any encoder output board within the previous rack, regardless of the encoder(s) used to supply the previous system. Connection must be made to the primary encoder input (J1), which will reduce the total number of robots to be service in the "Master" cell to 11. Only one encoder input board can be installed in each rack.



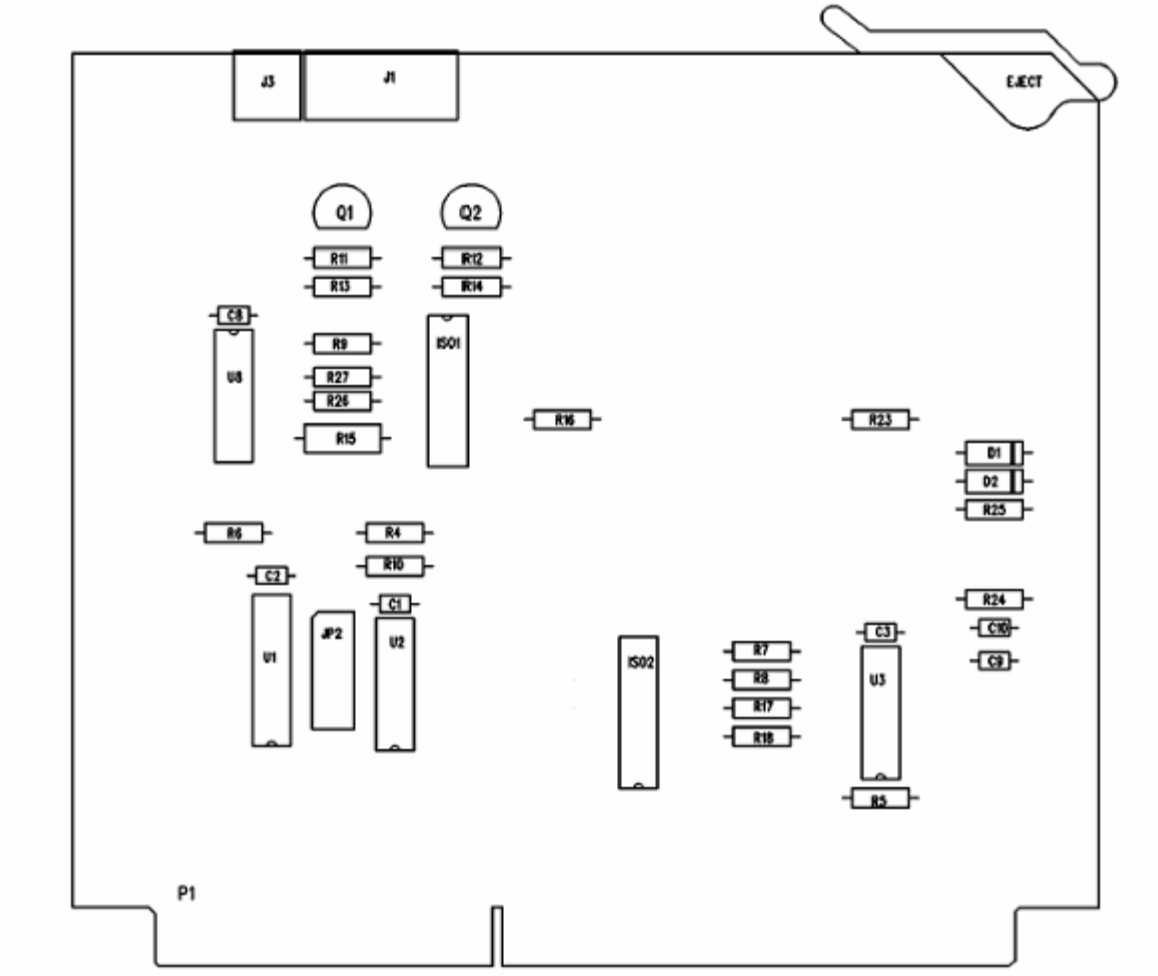
NE-2002-105-006 PLC Interface Board

This board is the interface to the system control PLC via 24VDC I/O. The 0VDC and 24VDC voltage is supplied from the board to the individual PLC input and output modules.

SES is the encoder selection signal that must be high (24VDC) to select the secondary encoder; primary encoder is the default. This signal is passed on to the encoder-input board through the rack back plane to the encoder input board, which in turn electronically selects the encoder signal to place on the back plane for the output boards. This signal will float low if left unconnected.

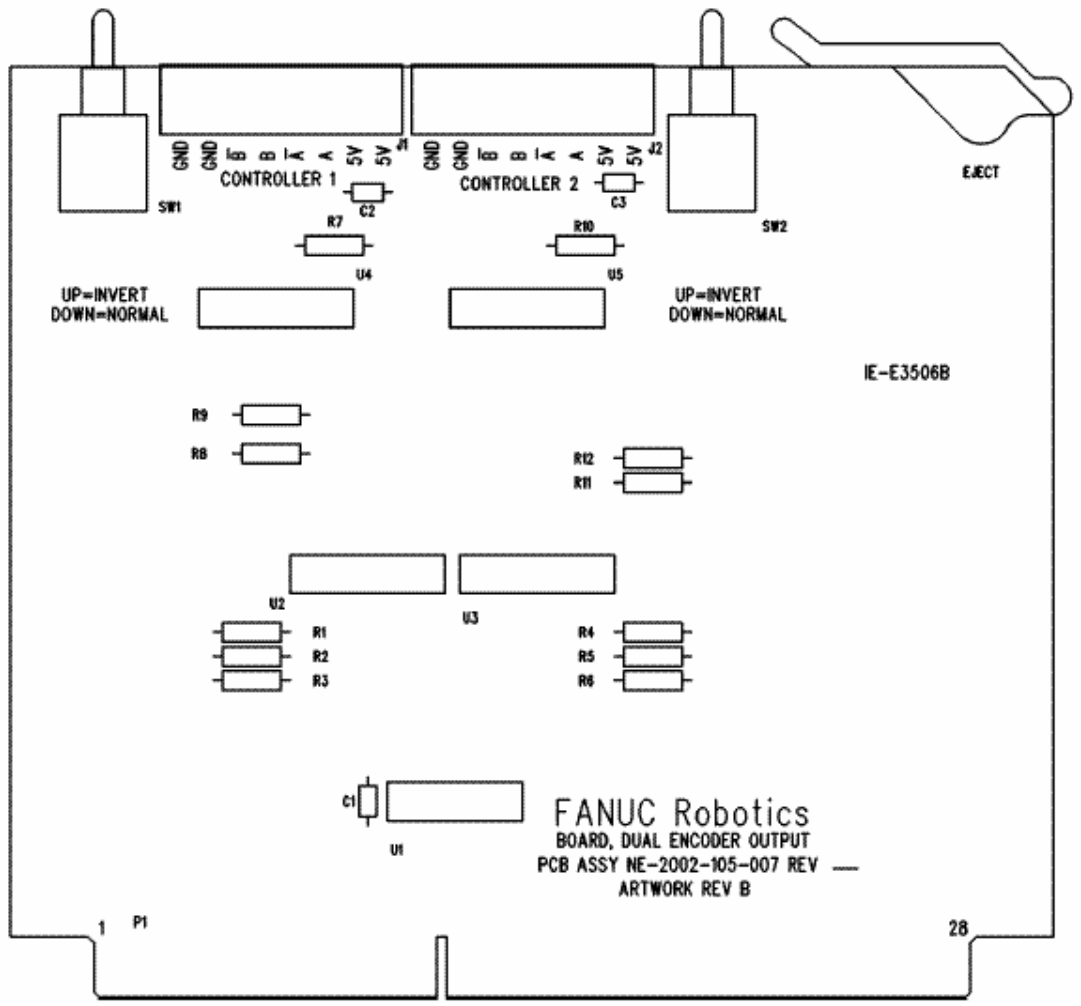
FWD is the signal that indicates conveyor direction; it is an output to the PLC input module at 24VDC. This signal is off (0VDC) if the conveyor encoder is sensing the reversal of direction, signal is high (24VDC) for forward conveyor motion.

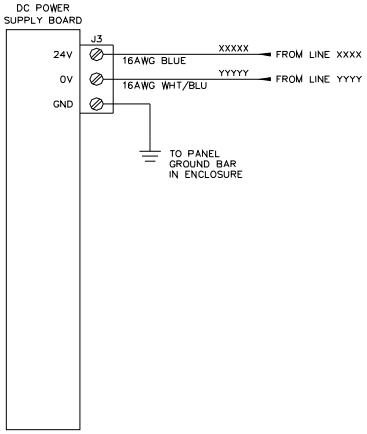
CHB is the conveyor heartbeat that is derived from the B pulse of the encoder. This signal can be adjusted by setting the shunt on JP2. This setting provides a divide by function to adjust the speed of the pulse to a rate, which is compatible with the capture rate of a standard PLC DC input module. The heart beat signal is also conditioned through R26 and 27 to provide a TTL level signal for use with an intrusion muting counter. Only one card of this type can be installed in each rack.

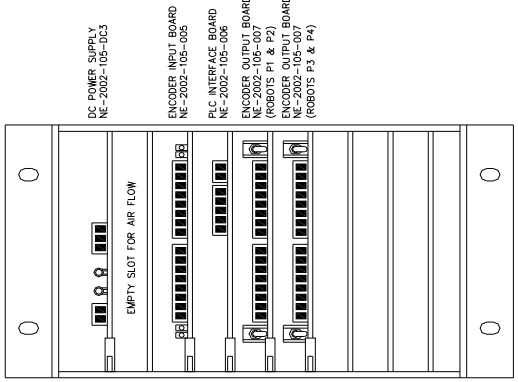


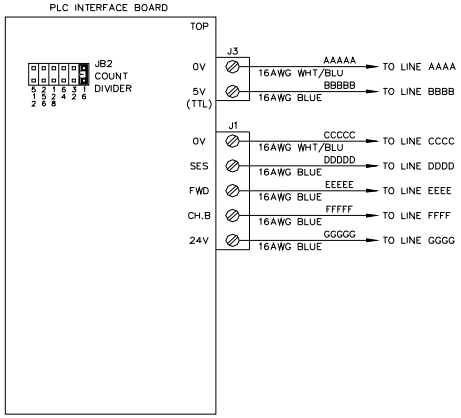
NE-2002-105-007 Dual Encoder Output Card

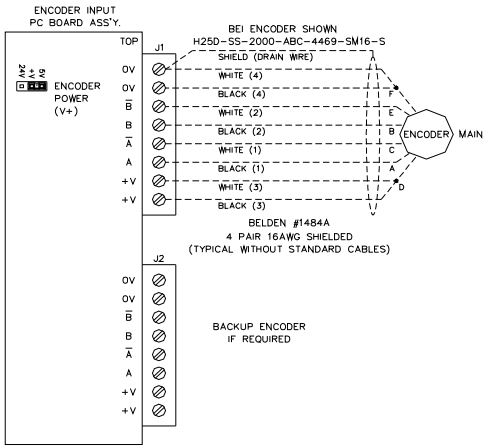
This board provides two isolated output channels of the active encoder signal that has been selected. Each output is optically isolated with the receiver of each signal providing the power for the optical isolators. It is recommended that the distance between this board and the receiving piece of equipment not exceed 150 feet in total cable length. This card can be placed into any open slot, up to the maximum of six cards per rack assembly. An invert signal switch is provided per output for direction correction of either signal without the need to change any wiring between the board and the receiver.

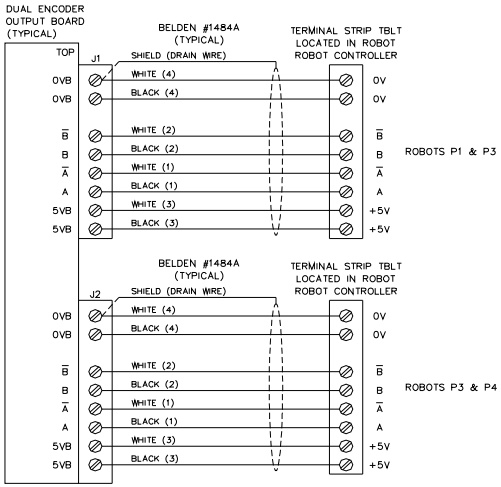












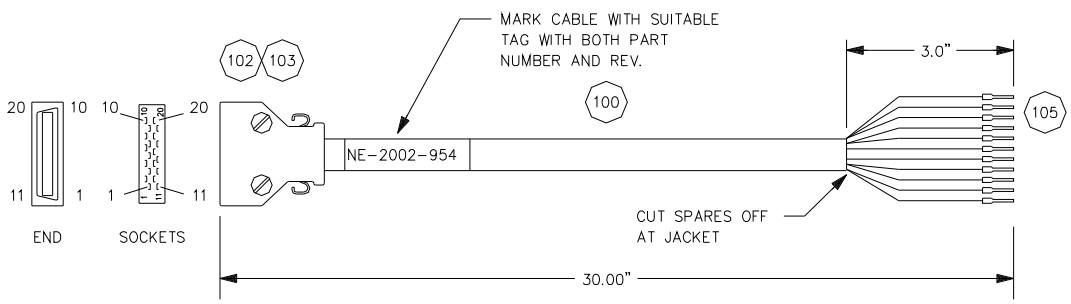
STANDARD CABLES
BEI ENCODER: NE-2012-922-XXX
FANUC ENCODER: NE-2012-923-XXX

STANDARD CABLES
HARTING STRAIGHT HOOD: NE-2012-919-XXX
HARTING ANGLED HOOD: NE-2012-920-XXX

Encoder Repeater Circuitry

CABLE WIRING CHART

TWISTED PAIR	SOCKET I.D.	WIRE COLOR	SIGNAL NAME
1	1	BLACK	A
	2	RED	$\overline{A}$
2	3	BLACK	B
	4	WHITE	$\overline{B}$
	5	JUMP TO PIN 9	
	6	JUMP TO PIN 12	
4	9	BLACK	+5V
	18	BLUE	+5V
5	20	BLACK	+5V
	12	BROWN	0V
6	14	BLACK	0V
	16	YELLOW	0V
	7	SPARE	SPARE
	8	SPARE	SPARE
	10	SPARE	SPARE
	11	SPARE	SPARE
	13	SPARE	SPARE
	15	SPARE	SPARE
	17	SPARE	SPARE
	19	SHIELD	SHIELD



CABLE TAG CHART

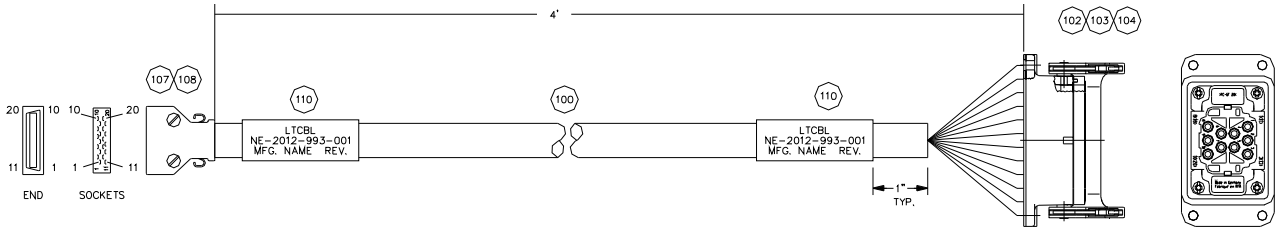
TWISTED PAIR	WIRE COLOR	SIGNAL TAG
1	BLACK	A
	RED	$\overline{A}$
2	BLACK	B
	WHITE	$\overline{B}$
3	BLACK	CUT BACK
	GREEN	CUT BACK
4	BLACK	+5V
	BLUE	+5V
5	BLACK	+5V
	BROWN	0V
6	BLACK	0V
	YELLOW	0V
SHIELD	SHIELD	SHIELD

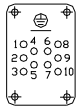
✳	DETAIL	SHEET	QTY.	MANUFACTURER	DESCRIPTION	MANF. PART NUMBER	FRNA PART NUMBER
	100		30"	BELDEN	CABLE 6 24AWG TWISTED/SHLD. PAIRS	9991	
	101						
	102		1	HONDA	20 PIN MINI-D CONNECTOR	PCR-E20FS	
	103		1	HONDA	CONNECTOR BACKSHELL	PCS-E20LB	
	104						
	105		11	TELEMECANIQUE	WIRE BARREL (22/20 AWG.) #DZ5-CE005	DZ5-CE005	

NE-2002-954: Internal Robot Controller Cable with Pigtail to CPU

CABLE WIRING CHART

TWISTED PAIR	SOCKET I.D.	WIRE COLOR	SIGNAL NAME
1	1	BLACK	A
	2	RED	$\overline{A}$
2	3	BLACK	B
	4	WHITE	$\overline{B}$
	5	JMP TO 9	Z
	6	JMP TO 12	$\overline{Z}$
4	9	BLACK	+5V
	18	BLUE	+5V
5	20	BLACK	+5V
	12	YELLOW	0V
6	14	BLACK	0V
	16	BROWN	0V
	7	N/C	
	8	N/C	
	10	N/C	
	11	N/C	
	13	N/C	
	15	N/C	
	17	N/C	
	19	SHIELD	SHIELD





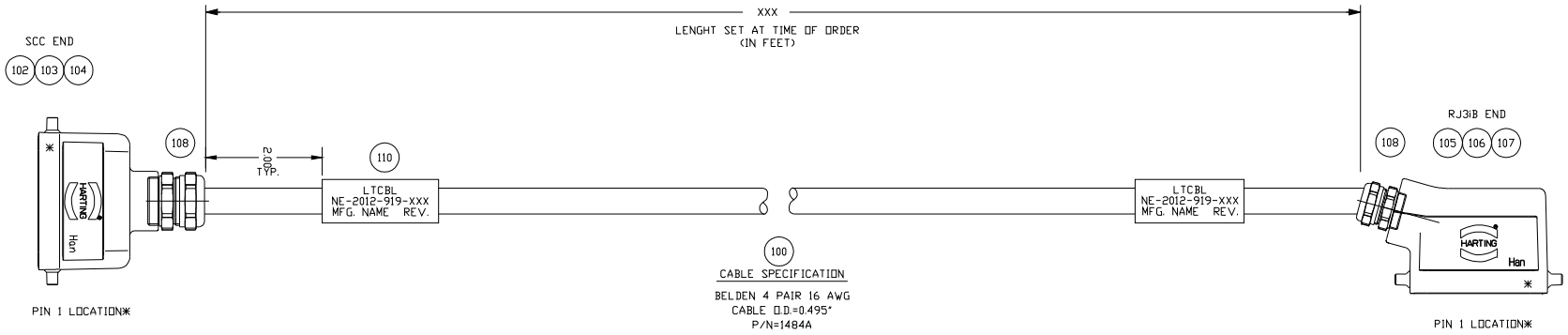
VIEW FROM TERMINATION SIDE

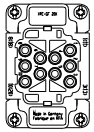
CABLE TAG CHART

TWISTED PAIR	WIRE COLOR	SIGNAL TAG	SOCKET NUM.
1	BLACK	A	1
	RED	A*	2
2	BLACK	B	3
	WHITE	B*	4
3	BLACK	N/C	
	GREEN	N/C	
4	BLACK	+5V	6
	BLUE	+5V	6
5	BLACK	+5V	7
	YELLOW	0V	8
6	BLACK	0V	9
	BROWN	0V	9
SHIELD	SHIELD	SHIELD	10

DETAIL	QTY.	MANUFACTURER	DESCRIPTION	MANF. PART NUMBER
100	5'	BELDEN	CABLE 6 24AWG TWISTED/SHLD. PAIRS	9991
101				
102	1	HARTING	BULKHEAD HOUSING (HAN6E)	09 30 006 0302
103	1	HARTING	10 SOCKET FEMALE INSERT (HAN10EE)	09 32 010 3101
104	9	HARTING	20AWG CRIMP SOCKET (GOLD)	09 33 000 6222
105				
106				
107	1	HONDA	20 PIN MINI-D CONNECTOR	PCR-E20FS
108	1	HONDA	CONNECTOR BACKSHELL	PCS-E20LB
109				
110	2	PANDUIT	SELF LAMINATING LABEL	PDL-7

NE-2012-993: Internal Robot Controller Cable with Harting Connector to CPU



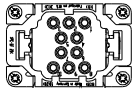


VIEW FROM
CONNECTOR SOCKET SIDE

TWISTED PAIR	WIRE COLOR	SIGNAL TAG	SOCKET NUM.
1	BLACK-1	A	1
	WHITE-1	A*	2
2	BLACK-2	B	3
	WHITE-2	B*	4
3	BLACK-3	+5V	6
	WHITE-3	+5V	7
4	BLACK-4	0V	8
	WHITE-4	0V	9
SHIELD	SHIELD	SHIELD	10

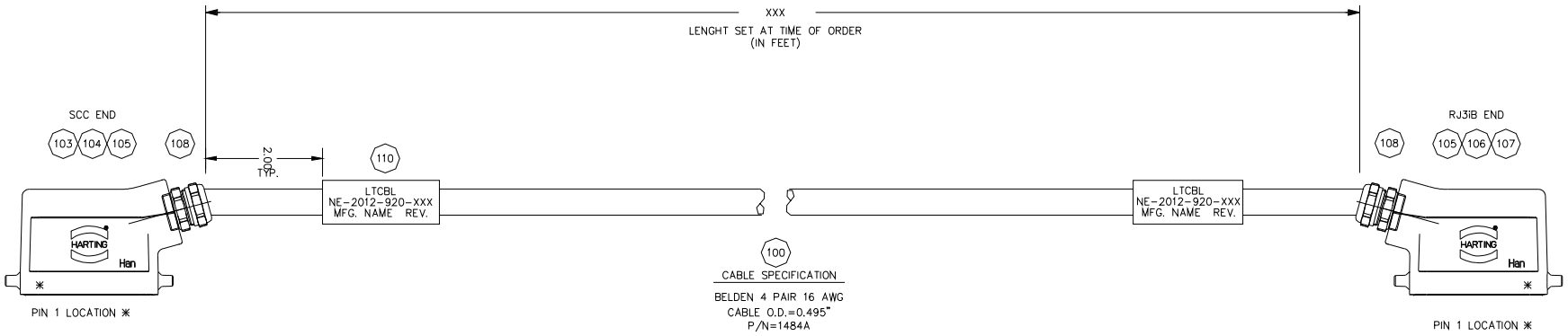
NOTE: PIN 5 NOT CONNECTED

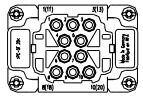
DETAIL	QTY.	MANUFACTURER	DESCRIPTION	MANF. PART NUMBER
100	AS	BELDEN	4 PAIR 16AWG 300V TRAY CABLE OA SHIELD .495" OD	1484A
101	REQ.			
102	1	HARTING	TOP ENTRY HOOD (LOW PG16)	09300061441
103	1	HARTING	10 SOCKET INSERT HAN 10EE (FEMALE)	09320103101
104	10	HARTING	18AWG CRIMP SOCKET (GOLD)	09330006218
105	1	HARTING	SIDE ENTRY HOOD (LOW PG16)	09300061541
106	1	HARTING	10 PIN INSERT HAN 10EE (MALE)	09320103001
107	10	HARTING	16AWG CRIMP PIN (GOLD)	09330006116
108	2	HARTING	PG16 CORD GRIP	09000005088
109				
110	2	PANDUIT	SELF LAMINATING LABEL	PDL-7



VIEW FROM
CONNECTOR PIN SIDE

NE-2012-919: Line Tracking Cable from Robot Controller to SCC Enclosure with Straight Hood



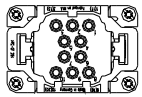


VIEW FROM
CONNECTOR SOCKET SIDE

TWISTED PAIR	WIRE COLOR	SIGNAL TAG	SOCKET NUM.
1	BLACK-1	A	1
	WHITE-1	A*	2
2	BLACK-2	B	3
	WHITE-2	B*	4
3	BLACK-3	+5V	6
	WHITE-3	+5V	7
4	BLACK-4	0V	8
	WHITE-4	0V	9
SHIELD	SHIELD	SHIELD	10

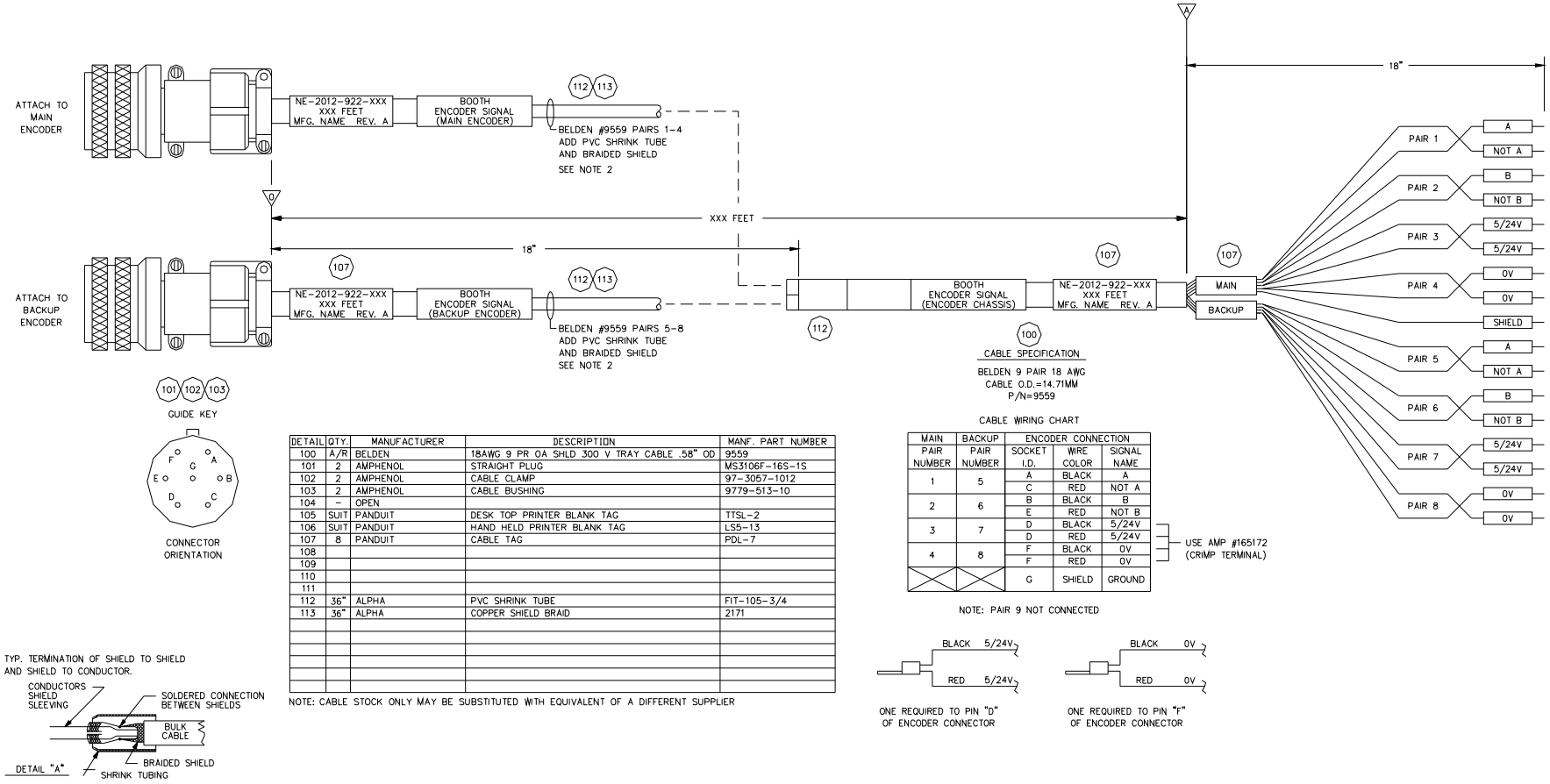
NOTE: PIN 5 NOT CONNECTED

DETAIL	QTY.	MANUFACTURER	DESCRIPTION	MANF. PART NUMBER
100	AS	BELDEN	4 PAIR 16AWG 300V TRAY CABLE OA SHIELD .495" OD	1484A
101	REQ.			
102				
103	1	HARTING	10 SOCKET INSERT HAN 10EE (FEMALE)	09320103101
104	10	HARTING	18AWG CRIMP SOCKET (GOLD)	09330006218
105	2	HARTING	SIDE ENTRY HOOD (LOW PG16)	09300061541
106	1	HARTING	10 PIN INSERT HAN 10EE (MALE)	09320103001
107	10	HARTING	16AWG CRIMP PIN (GOLD)	09330006116
108	2	HARTING	PG16 CORD GRIP	09000005088
109				
110	2	PANDUIT	SELF LAMINATING LABEL	PDL-7



VIEW FROM
CONNECTOR PIN SIDE

NE-2012-920: Line Tracking Cable from Robot Controller to SCC Enclosure with Side Mount Hood



DETAIL	QTY.	MANUFACTURER	DESCRIPTION	MANF. PART NUMBER
100	A/R	BELDEN	18AWG 9 PR OA SHLD 300 V TRAY CABLE .58" OD	9559
101	2	AMPHENOL	STRAIGHT PLUG	MS3106F-16S-1S
102	2	AMPHENOL	CABLE CLAMP	97-3057-1012
103	2	AMPHENOL	CABLE BUSHING	9779-513-10
104	–	OPEN		
105	SUIT	PANDUIT	DESK TOP PRINTER BLANK TAG	TTSL-2
106	SUIT	PANDUIT	HAND HELD PRINTER BLANK TAG	LS5-13
107	8	PANDUIT	CABLE TAG	PDL-7
108				
109				
110				
111				
112	36"	ALPHA	PVC SHRINK TUBE	FIT-105-3/4
113	36"	ALPHA	COPPER SHIELD BRAID	2171

NOTE: CABLE STOCK ONLY MAY BE SUBSTITUTED WITH EQUIVALENT OF A DIFFERENT SUPPLIER

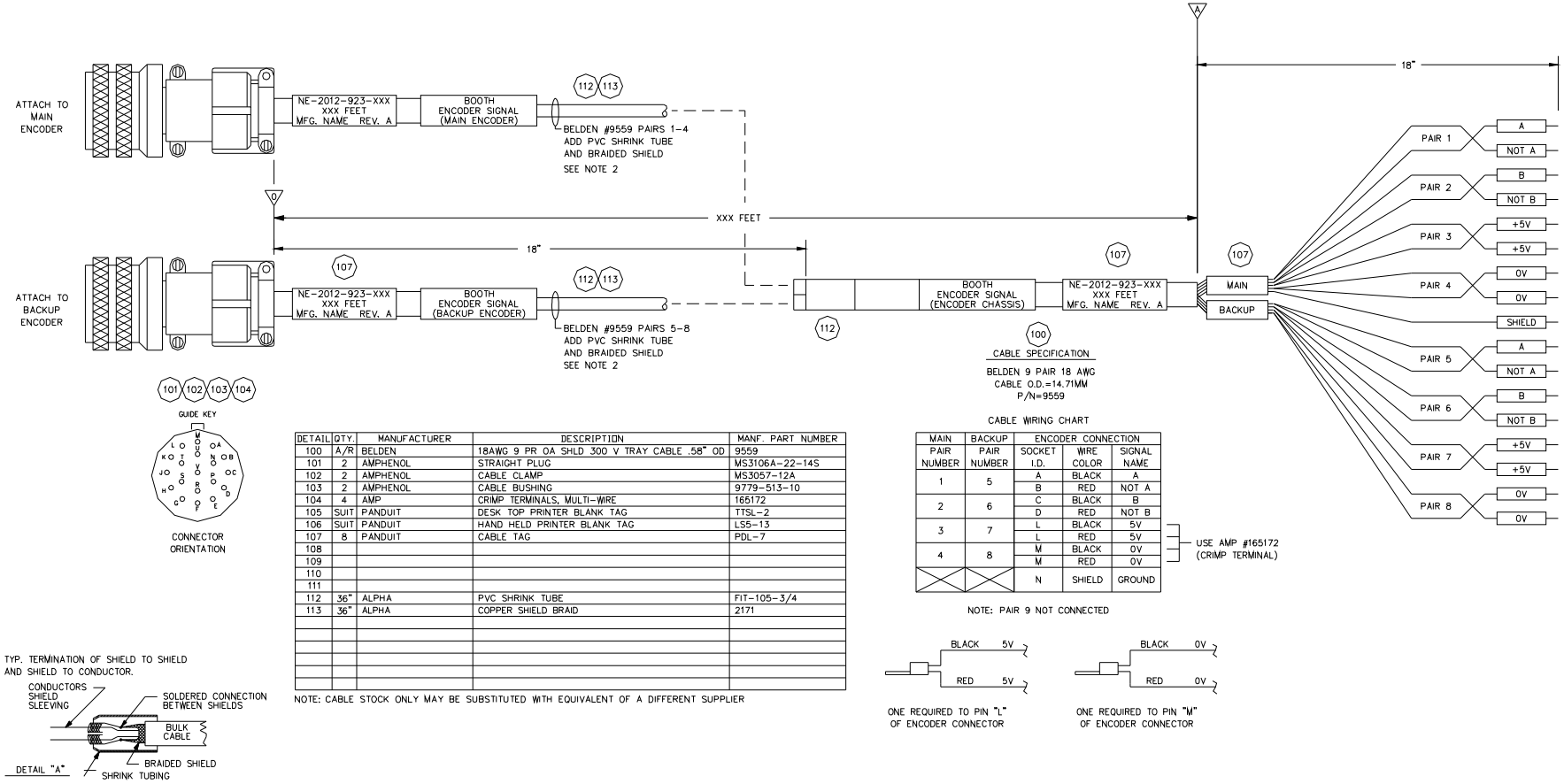
CABLE WIRING CHART

MAIN PAIR NUMBER	BACKUP PAIR NUMBER	ENCODER CONNECTION SOCKET I.D.	WIRE COLOR	SIGNAL NAME
1	5	A	BLACK	A
		C	RED	NOT A
2	6	B	BLACK	B
		E	RED	NOT B
3	7	D	BLACK	5/24V
		D	RED	5/24V
4	8	F	BLACK	0V
		F	RED	0V
		G	SHIELD	GROUND

USE AMP #165172 (CRIMP TERMINAL)

NOTE: PAIR 9 NOT CONNECTED

NE-2012-922: Encoder Signal Field Cable from BEI Encoder to Dual Input Card (NE-2002-105-005)



MAIN PAIR NUMBER	BACKUP PAIR NUMBER	ENCODER CONNECTION SOCKET I.D.	WIRE COLOR	SIGNAL NAME
1	5	A	BLACK	A
		B	RED	NOT A
2	6	C	BLACK	B
		D	RED	NOT B
3	7	L	BLACK	5V
		L	RED	5V
4	8	M	BLACK	0V
		M	RED	0V
		N	SHIELD	GROUND

DETAIL	QTY.	MANUFACTURER	DESCRIPTION	MANF. PART NUMBER
100	A/R	BELDEN	18AWG 9 PR OA SHLD 300 V TRAY CABLE .58" OD	9559
101	2	AMPHENOL	STRAIGHT PLUG	MS3106A-22-14S
102	2	AMPHENOL	CABLE CLAMP	MS3057-12A
103	2	AMPHENOL	CABLE BUSHING	9779-513-10
104	4	AMP	CRIMP TERMINALS, MULTI-WIRE	165172
105	SUIT	PANDUIT	DESK TOP PRINTER BLANK TAG	TTSL-2
106	SUIT	PANDUIT	HAND HELD PRINTER BLANK TAG	LS5-13
107	8	PANDUIT	CABLE TAG	PDL-7
108				
109				
110				
111				
112	36"	ALPHA	PVC SHRINK TUBE	FIT-105-3/4
113	36"	ALPHA	COPPER SHIELD BRAID	2171

NOTE: CABLE STOCK ONLY MAY BE SUBSTITUTED WITH EQUIVALENT OF A DIFFERENT SUPPLIER

NE-2012-923: Encoder Signal Field Cable from FANUC Encoder to Dual Input Card (NE-2002-105-005)

TROUBLESHOOTING

CAUSE	REMEDY
NO SIGNAL TO ROBOTS OR PLC	1.Verify AC or DC power to the rack 2.Verify 5VDC and 24VDC on rack power supply board test points 3.Verify encoder is connected 4.Verify connected encoder is selected 5.Verify cable lengths are not exceeded 6.Verify encoder input board jumper setting 7.Verify the encoder input board is seated well 8.Verify DC voltage at encoder 9. Encoder input signals A and *A as well as B and *B must be logical opposites. This can be measured with a volt meter if the encoder is not turning. LOGIC LOW 0-2V, .3V TYPICAL LOGIC HIGH 2.5-5.5V, 3.3V TYPICAL 10.Swap encoder 11.Swap encoder input board
DISCONNECT ALARM ON 1 ROBOT	1.Verify Z and *Z are jumpered logically opposite 2.Verify 5VDC from the controller on the encoder output board terminals, 4.75 to 5.5V is OK 3. Encoder output signals A and *A as well as B and *B must be logical opposites. This can be measured with a volt meter if the encoder is not turning. LOGIC LOW 0-2V, .3V TYPICAL LOGIC HIGH 2.5-5.5V, 3.3V TYPICAL 4.Verify cable lengths are not exceeded 5.Verify the encoder output board is seated well 6.Swap encoder output board
NO SIGNAL TO PLC(FWD), CHB IS OK	This is an arbitrary direction signal that is 24VDC for 1 direction and off for the other. Perform the following if the opposite logic is desired: -Swap A with B on the primary encoder input -Swap *A with *B on the primary encoder input -Swap A with B on the secondary encoder input -Swap *A with *B on the secondary encoder input
NO SIGNAL TO PLC(CHB), ROBOT IS OK	1.Verify external 0VDC and 24VDC are connected to the PLC board 2.Verify PLC board divide by jumper, typical applications require it to be set at 256 or 512 to slow the signal enough for the PLC to read it 3.CHB is designed for a typical 24VDC PLC or robot sourcing input and should not attempt to drive a load of more the 50mA 4.Visually inspect transistor Q1 on the PLC board 5.Replace the PLC board

CAUSE	REMEDY
NO SIGNAL TO COUNT OUTPUT, ROBOT IS OK	1.Verify count signal is referenced to the 0VDC on the same terminal strip and not to the 0VDC on the PLC signal terminal strip, although they may be jumpered 2.Verify PLC board divide by jumper, typical applications require it to be set at 256 or 512 to slow the signal enough to be read 3.This TTL signal is designed for a low current application and should not attempt to drive a load of more the 20mA 5.Replace the PLC board
INCORRECT COUNT SIGNAL TO PLC OR ROBOT	1.Verify mechanical connection between the encoder and the conveyor 2.Virify encoder signal shielding 3.Verify encoder cable is not routed with AC cabling 4.Inspect cable terminations for good housekeeping practices 5.Verify cable lengths are not excessive 6.Verify AC or DC power source reliable
BACKUP ENCODER DIRECTION ISSUES	The backup encoder should turn the same direction as the primary encoder, the following must be performed only if the 2 encoders spin opposite directions: -Swap A with B on the secondary encoder input -Swap *A with *B on the secondary encoder input
USE OF ENCODERS OTHER THAN: FANUC # A290-0561-V531 BEI # H25D-SS-2000-ABC-4469-SM16-S BEI #H38D-2000-ABC-4469-LED-SC-UL-S	These encoders listed have output circuitry and power requirements that are compatible with the encoder repeater. Different encoders may require additional power supplies and encoder signal driver circuitry.
USE ON CONTROLLERS OTHER THAN FANUC RJ3 or RJ3iB	Cabling to the line tracking encoder input within this document is specific to the FANUC RJ3 and RJ3iB robot controllers, future or other equipment may require different cabling
WIRING THE ENCODER TO A PLC HIGH SPEED COUNTER CARD	The robot output card may be wired to a PLC VHSC but 5VDC must be provided to the card. An alternate but less desired method is to put the VHSC on the input encoder signal, doing this will not support backup encoder selection.
DISCONNECT ALARM WHEN BACKUP ENCODER IS SELECTED	Depending on the status of the primary and secondary encoder signals, you most often will get an encoder disconnect alarm when switching to or from the backup encoder.