

# MCOR CRATE

## OPERATIONS MANUAL

Model 2513



**Preliminary**

**BiRä**  
Systems  
INNOVATIVE PRODUCTS THROUGH PARTNERSHIPS

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## 1.0 Introduction

This manual describes the Bi Ra System's Model 2513 – MCOR System Crate (A multi-channel corrector magnet driver system). The MCOR System provides precision bi-polar output currents with minimal zero-cross over distortion.

The manual is intended to describe the principle features, operations and specifications.

### 1.1 MCOR Crate Physical Description

The MCOR Model 2513 is a 19" rack mounted 6U x 220 mm crate. The crate has 17 slots; 16 (slot 0 thru 15) for the removable power modules (MCOR 12 and MCOR 30) and the far left slot control system interface card Model 2512-C4. The control slot employs two 96-pin VME connectors and the 16 power slots have single 48-pin connectors on the backplane to achieve a modular architecture.

The MCOR power modules slide into standard card rails and two locking extractor handles hold each module in place. The power modules are access by twisting two ¼ turn captive fastens and lowering a single hinged clear lexan front cover. The crates front cover provides safety during operation and a positive air flow for cooling.



Figure 1: Shows MCOR crate load with 16 Power Modules and interface card on far left.

### 1.2 MCOR Crate Functional Description

The MCOR Crate's interface/control card (Model 2512-C4) communicates with the outside world thru connectors J1 (ExtIntlk), J2 (CrateOK), J3 (Input Reference Voltages), J4 (Output Monitors), and J9 (Bitbus) on the rear backplane of the crate (see figure 1.2 below). The interface card may be either analog or digitally based, depending on the end-users individual control system requirements. Each power module provides the control card with an independently derived monitor signal, to verify that all correctors are operating within the specified tolerance.

The MCOR's backplane (4 layer) provides all of the power and signal connectivity between the power modules, the control card and the outside world. A single unipolar bulk power supply provides the main DC power to the crate through the 180A Powerpole connector (DC Power Input) on the rear panel. This connector is attached internally to a pair of PCB mount busbars that distribute the bulk DC power across the backplane. The +5, +15 and -15 utility voltages are distributed via standard copper traces to the individual modules through the backplane. A standard 48-pin, type "E" DIN connector provides the signal and power connections from the backplane to each power module. The interface card connects to the backplane using a VME format for connector arrangement, positioning, and module width. No internal chassis wiring is necessary. All other external connections, including the outputs to the magnets and the control system cables, are accomplished through PC mounted connectors on the backplane. The crates are tested and certified on fixtures that emulate actual load conditions.

The MCOR system employs a modular architecture, so that any individual channel is serviceable without disturbing the operation of adjacent channels in the same crate.

### 1.2.1 MCOR Crate Enclosure Specifications

Dimensions: 19" rack mount, 10.50" height, 21.50" depth.  
 Cooling: Recommend Bi Ra Model 4922 Blower (330 CFM)  
 Weight: 25 lb. (11.3kg)



Figure 1.2

## 1.3 Installation

The following items are required to install a fully powered and cooled MCOR Crate (model 2513).

### 1.3.1 Power Requirements

Single phase 115 VAC is required MCOR Crate utility power and blower unit (Model 4922 is recommended). Bi Ra Systems technical staff will be pleased to assist on the selection of the single unipolar bulk power supply which provides main power to the crate.

### 1.3.2 Rack Space

A standard 19" rack with minimum of (12V) of vertical space and 24" depth (Bulk Power Supplies tend to range from 20" to 24").

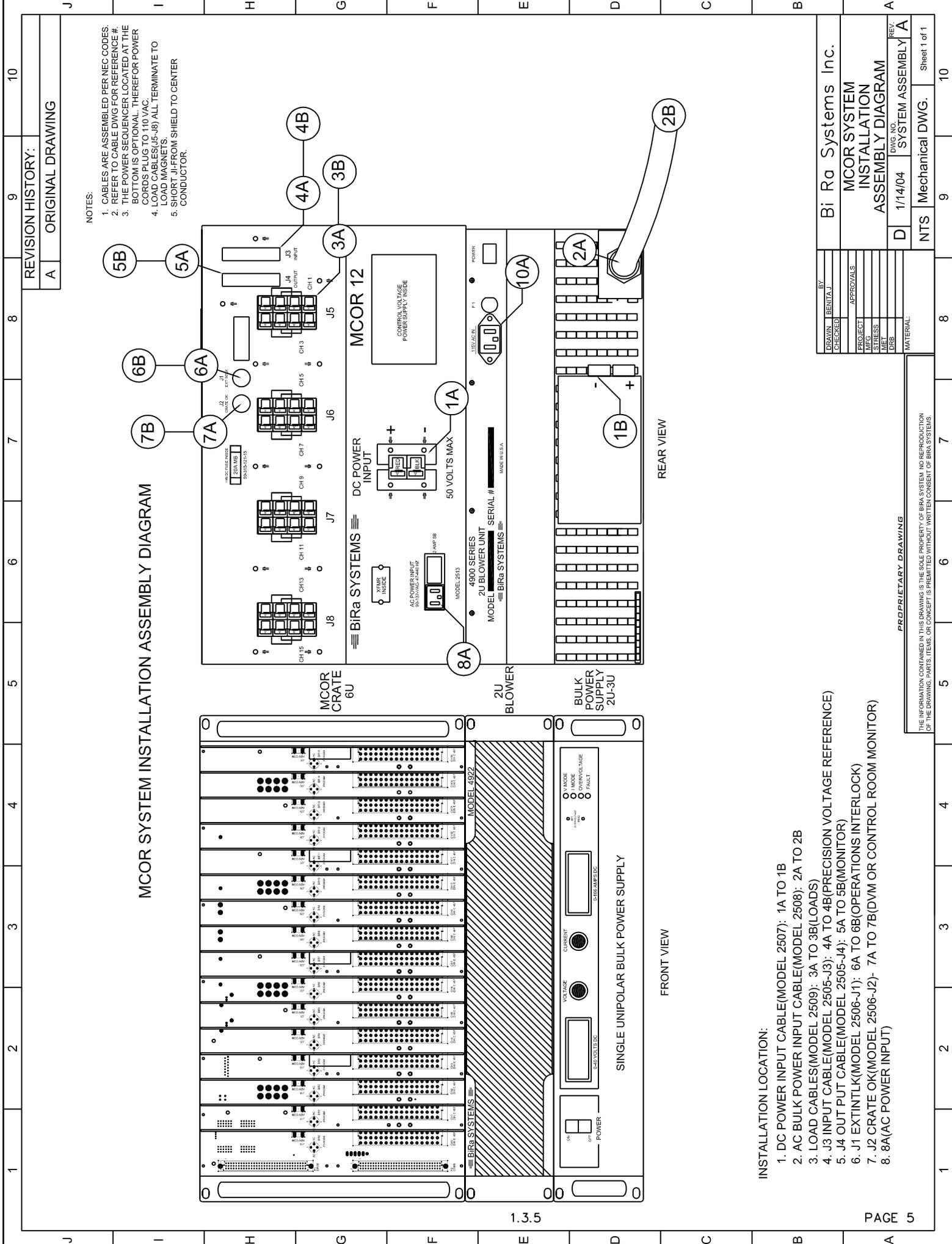
### 1.3.3 Unpacking Units

Carefully unpack units and check for any damage that might have occurred through shipment. MCOR Crate and blower should have a standard power cord each (115 VAC) with shipment. Guide rails in crate should be inspected after shipment to insure proper sitting.

### 1.3.4 Systems Configuration

A standard configuration of MCOR System assembly is shown in figure 1.3.1.

### 1.3.5 Crate Cable Assembly



NOTES:  
 1. CABLES ARE ASSEMBLED PER NEC CODES.  
 2. REFER TO CABLE DWG FOR REFERENCE #.  
 3. THE POWER SEQUENCER LOCATED AT THE BOTTOM IS OPTIONAL. THEREFOR POWER CORDS PLUG TO 110 VAC.  
 4. LOAD CABLES(J5-J8) ALL TERMINATE TO LOAD MAGNETS.  
 5. SHORT JI-FROM SHIELD TO CENTER CONDUCTOR.

MCOR SYSTEM INSTALLATION ASSEMBLY DIAGRAM

REVISION HISTORY:

A	ORIGINAL DRAWING
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INSTALLATION LOCATION:

- DC POWER INPUT CABLE(MODEL 2507): 1A TO 1B
- AC BULK POWER INPUT CABLE(MODEL 2508): 2A TO 2B
- LOAD CABLES(MODEL 2509): 3A TO 3B(LOADS)
- J3 INPUT CABLE(MODEL 2505-J3): 4A TO 4B(PRECISION VOLTAGE REFERENCE)
- J4 OUT PUT CABLE(MODEL 2505-J4): 5A TO 5B(MONITOR)
- J1 EXTINTLK(MODEL 2506-J1): 6A TO 6B(OPERATIONS INTERLOCK)
- J2 CRATE OK(MODEL 2506-J2)- 7A TO 7B(DVM OR CONTROL ROOM MONITOR)
- 8A(AC POWER INPUT)

BY	BENITAJ
CHECKED	
APPROVALS	
PROJECT	
INFO	
STRESS	
IMET	
DRB	
MATERIAL:	

Bi Ra Systems Inc.  
 MCOR SYSTEM  
 INSTALLATION  
 ASSEMBLY DIAGRAM

D	1/1/4/04	DWG NO.	REV.
NTS		SYSTEM ASSEMBLY	A
		Mechanical DWG.	Sheet 1 of 1

PROPRIETARY DRAWING  
 THE INFORMATION CONTAINED IN THIS DRAWING IS THE SOLE PROPERTY OF BIRA SYSTEM. NO REPRODUCTION OF THE DRAWING PARTS, ITEMS, OR CONCEPT IS PERMITTED WITHOUT WRITTEN CONSENT OF BIRA SYSTEMS.

## 2.0 MCOR Crate Interface Card

### 2.1 Overview

The MCOR corrector chassis must interface with different types of control systems presently in use. In order to accommodate these control schemes, as well as any future configurations, the MCOR crate architecture places the total control system interface on a single VME-standard card. This interface card occupies the left-most slot of the crate. It is responsible for monitoring voltage reference inputs, output voltages and fault conditions.

### 2.1 MCOR Interface Card Physical Description

The Bi Ra Model 2512-C4 interface card is a standard VMEbus-compatible 6U by 220 mm board installed in slot 0 in an Eurocard crate. Two 96-pin I/O connectors connect the interface card to the MCOR crate's backplane. The Interface card (see figure 2.0) employs sixteen test jacks in the front of the card to enable local measurement of the MCOR output currents. A second set of front test jacks enable local measurements of the reference voltages. A front mounted reset switch sets the interface's Crate OK latch and resets the MCOR's fault protection latch. An optional crate door switch sets the Inhibit Bus to the Inhibit state when the crate door is opened.

### 2.3 MCOR Interface Card Functional Description

The Model 2512-C4 Crate Interface card functions as a control-monitor interconnect between an MCOR magnet driver crate backplane, current set-point reference voltages, system fault/enable discrete lines and magnet-current monitoring signals input to an analog monitor. The Interface card can be used in sixteen Bi Ra 2510 (MCOR12) systems or eight 2510R30 (MCOR30) systems.

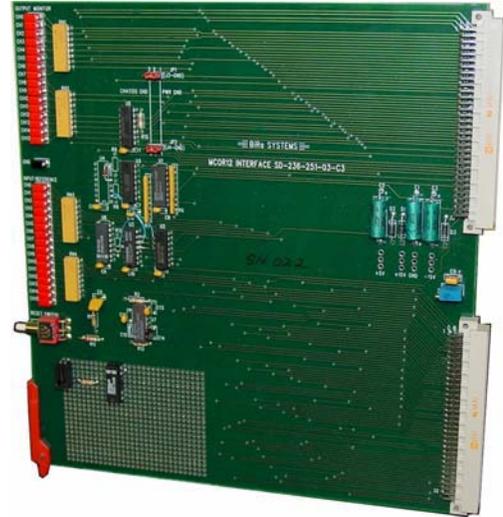
The interface card provides a simple, inexpensive, application-adaptive capability for magnet power systems by concentrating control-protective circuitry on a single card that can be adapted to system control/monitoring requirements. This simplifies interfacing in a diversity of control and monitoring regimes because the MCOR magnet driver modules need not to have the specialized circuitry for interfacing to the many possible control system implementations.

### 2.3.1 MCOR Interface Card Specification Features

Figure 2.0

System Bus Signals, all to/from the crate backplane

- Reset Bus – A high-true, TTL-level, single ended logic signal, typically input to the backplane by external equipment or by actuation of the Reset Switch.
- Crate OK – A differential logic signal from an RS485 driver. If the Crate OK latch is set, the crate OK+ line is TTL-high and the OK- line is TTL low.
- Inhibit Bus – A high true, TTL-level, single ended logic signal, input to the crate backplane via the Crate Interlock BNC connector by external equipment or by actuation of the crate door-switch.
- MCOR Faults – Sixteen, TTL-level, low-true fault signals from the MCOR power modules; any fault resets the “Crate OK” latch.
- External Interlock – A high-true TTL-level signal that is a summation of the readiness states of external equipment.
- Reference Voltages – are +/- 10Volt bipolar voltages from external reference voltage power supplies that determine the MCOR’s current set-point.



## 3.0 MCOR Crate Cooling Unit

### 3.1 Overview

The crate is completely air-cooled, using standard rack mounted fans and plenums that draw in cool air from the aisle through a filter. The air is then pushed up through the crate and into the rack, keeping the rack interface at positive pressure.

### 3.2 FEATURES

- 2U Chassis – 19" rack mount 3.48" Height, 9.60" Depth.
- Weight 6lb.
- Power 120V AC 60Hz
- Washable front removable air filter
- Ball Bearing AC fans provide 330 CFM
- Dual plenum design

### 3.3 APPLICATIONS

- Cooling for 160mm,220mm depth modules
- Diverts lower warmed air to rear of Cabinet
- RM option diverts lower air to front of Cabinet

### 3.4 General Description

The Model 4922 blower is a 19" rack mountable (2U) unit that was designed to cool 160mm or 220mm depth modules. The bottom air plenum diverts the air from below to rear of cabinet. The top plenum distributes the airflow more uniformly across the bottom of the crate to enhance the units cooling capabilities. This unit draws the cooling air through a front foam filter which is easily removable for cleaning while in operation. The chassis is rugged in construction and features long life Ball Bearing AC fans.



Front View of Model 4922 shown

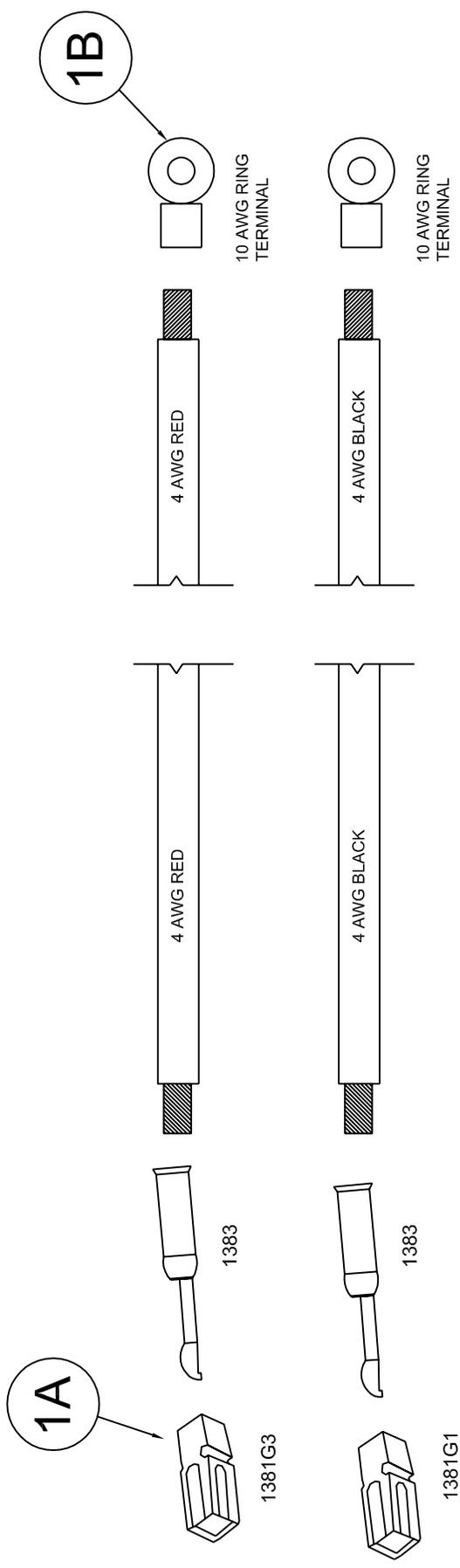


Rear View of Model 4922 shown



7	8	9	10
REVISION HISTORY:			
A	ORIGINAL DRAWING		
B			
C			

WIRING LIST:	
DC POWER INPUT	TO DC BULK POWER
(+) RED	TO RED
(-) BLK	TO BLK



PARTS LIST:

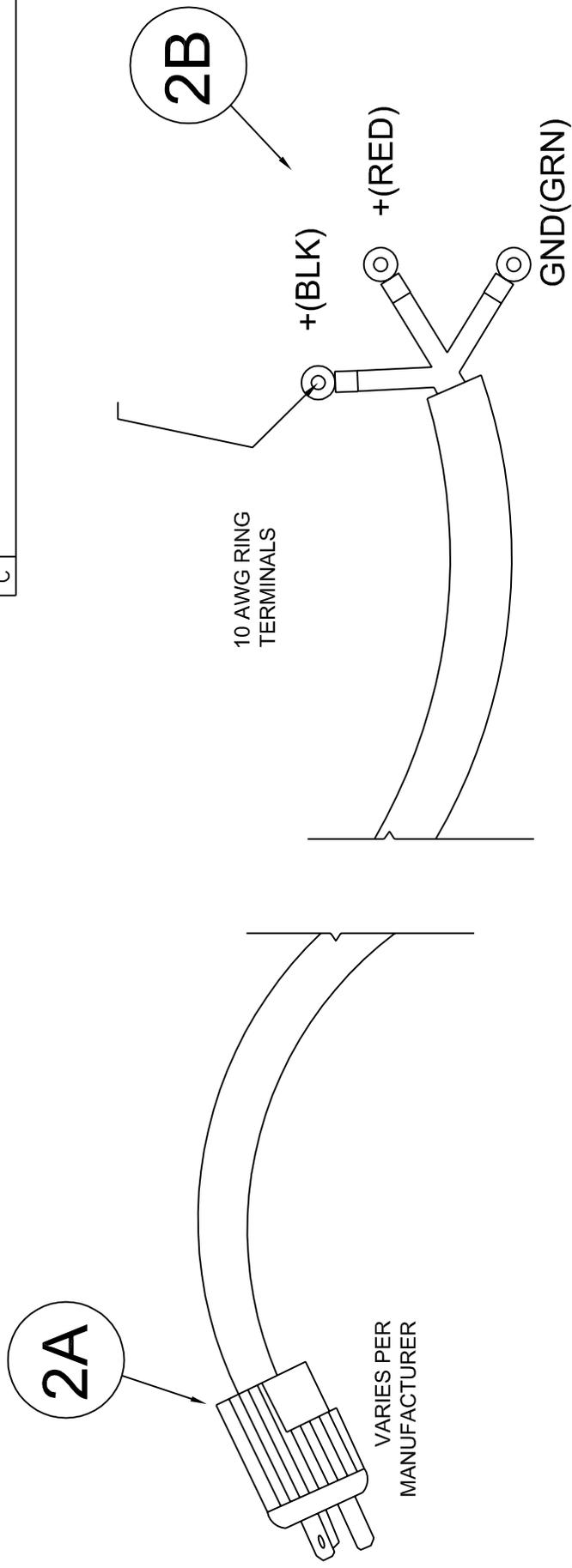
ITEM#	PART#	DESCRIPTION	QUANTITY
1	1381G3	RED	1
2	1381G1	BLACK	1
3	1383	CONTACT	2
4	WR4WGBLK	4 AWG BLK	AR
5	WR4WGRE	4 AWG RED	AR
6	RT10YL	RING TERM	2
7	2" DIA	BLK NYLON MESH	AR

TOOL LIST:  
 CRIMP TOOL: IDEAL #30-500 22-10 AWG

- NOTES:
1. CONNECTIONS WILL BE MADE PER WIRING CHART.
  2. WIRES WILL BE HAND SOLDER INTO PP180 CONTACTS.
  3. YOU WILL MAKE A RED WIRE AND BLACK WIRE FOR EACH CABLE.
  4. USE YELLOW SHINK TUBING AFTER YOU SOLDER(2 1/2").
  5. LENGTH OF CABLES ARE USER DEFINED.
  6. CABLE 4WG THHN STR RED/BLK 500V.

PRECISION CONTROL#	BY CHECKED	ENTIA JURADO
PAINTING:	PROJECT	
	STRESS	
	MEET	
	DIB	
QTY PER UNIT: 188.	MATERIAL	
NTS		Mechanical DWG.
Bi Ra Systems Inc.		MCOR
DC POWER INPUT CABLE		ASSEMBLY DIAGRAM
D	7/16/04	DWG. NO. 2507
REV.	A	
Sheet 1		

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REVISION HISTORY:			
A	ORIGINAL DRAWING		
B			
C			



PARTS LIST:

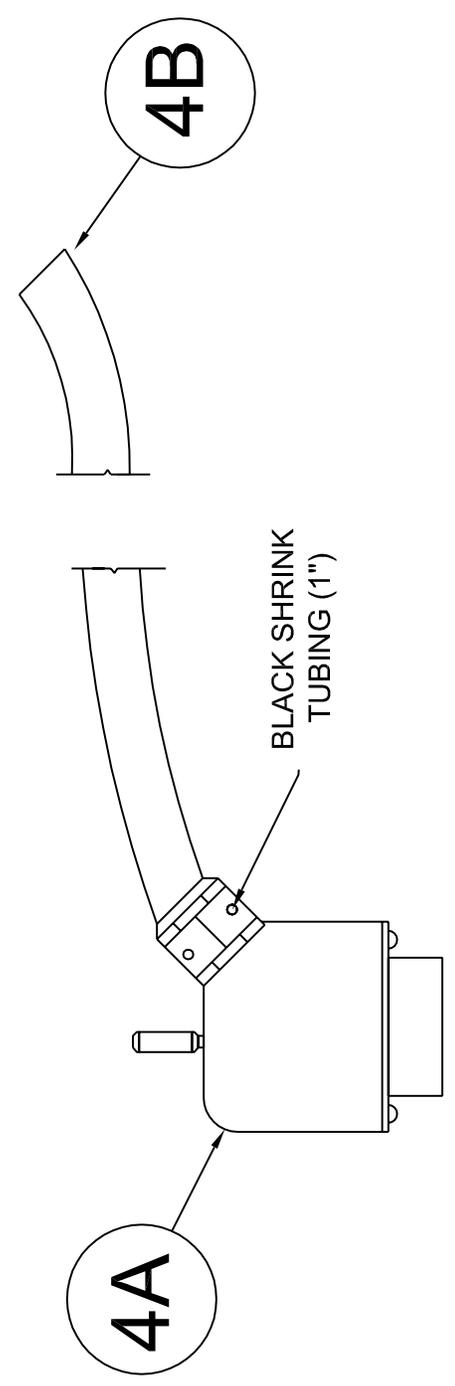
ITEM#	PART#	DESCRIPTION	QUANTITY
1	1938/3	3 CONDUCTOR CORDAGE	AR
2	RT10YL	RING TERM	3
3	HBL2321	PLUG, 250V (OPTIONAL)	1

TOOL LIST:  
 CRIMP TOOL: IDEAL #30-500 22-10 AWG

- NOTES:
1. WIRE TO BULK POWER SUPPLY.
  2. LENGHT IS USER DEFINED.
  3. CABLE IN ACCORDANCE WITH NEC.
  4. LABEL WHITE WIRE WITH RED TAPE.(BOTH ENDS)

PRECISION CONTROL#	BY: BENTA-BURGHOOD	Bi Ra Systems Inc.
CHECKED	APPROVALS	MCOR AC BULK POWER INPUT
PROJECT		CABLE ASSEMBLY DIAGRAM
STRESS		
MET		
DES		
MATERIAL		
QTY PER UNIT: 100	D 7/16/04	DWG. NO. 2508
	NTS	Mechanical DWG. Sheet 1

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A	ORIGINAL DRAWING		
B			
C			



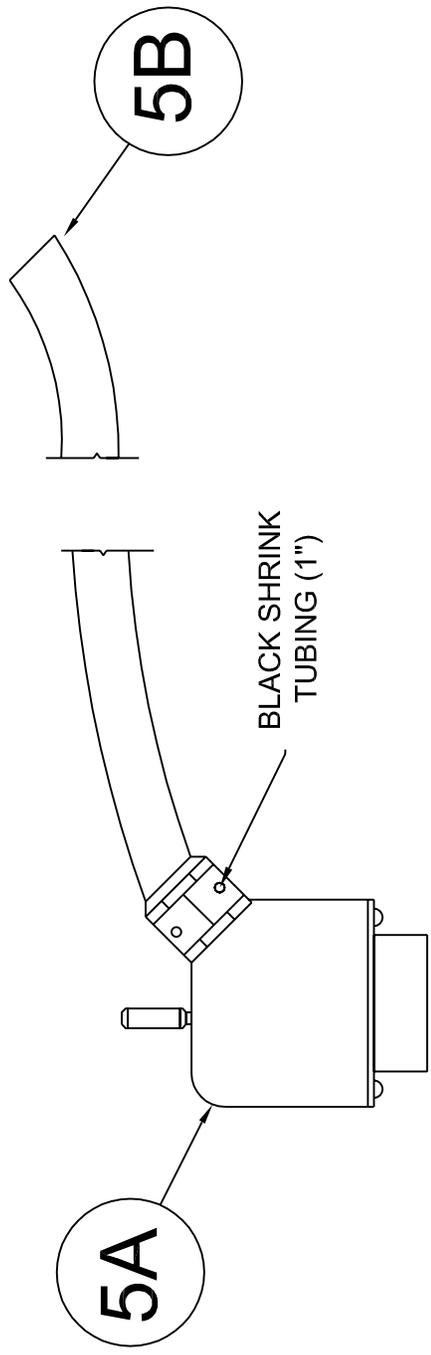
PARTS LIST:

ITEM#	PART#	DESCRIPTION	QUANTITY
1	AMP 203816-3	PIN CONTACT	36
2	AMP 204744-1	6 POSITION CONNECTOR	1
3	AMP 205083-3	CONNECTOR HOOD	1
4	6089/18C	MULTIPAIR, GRAY JACKET	AR
5	1/2" DIA	BLACK SHRINK TUBING	1"

- NOTES:
1. STRIP AND CRIMP FOR INDIVIDUAL CONNECTIONS.
  2. OTHER END OF CABLE(4B) IS LEFT UNTERMINATED.
  3. LENGTHS OF CABLES ARE USER DEFINED.

PRECISION CONTROL#	BY: ENITA ULIBADO	Bi Ra Systems Inc.
	CHECKED: ANZEL	
PAINING:	PROJECT APPROVALS	MCOR J3 INPUT CABLE ASSEMBLY DIAGRAM
	STRESS	
	MET	
	DRB	
	MATERIAL	
QTY PER UNIT:	DWG. NO. 2503-J3	REV. A
188.	D 7/15/04	
	NTS	Mechanical DWG. Sheet 1

7	8	9	10
REVISION HISTORY:			
A	ORIGINAL DRAWING		
B			
C			



PARTS LIST:

ITEM#	PART#	DESCRIPTION	QUANTITY
1	AMP 203816-3	PIN CONTACT	36
2	AMP 204744-1	6 POSITION CONNECTOR	1
3	AMP 205083-3	CONNECTOR HOOD	1
4	6089/18C	MULTIPAIR, GRAY JACKET	AR
5	1/2" DIA	BLACK SHRINK TUBING	1"

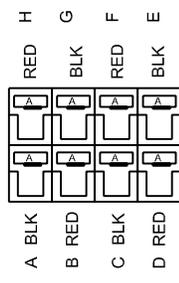
NOTES:

1. STRIP AND CRIMP FOR INDIVIDUAL CONNECTIONS.
2. OTHER END OF CABLE(5B) IS LEFT UNTERMINATED.
3. LENGTHS OF CABLES ARE USER DEFINED.

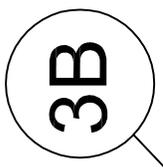
PRECISION CONTROL#	BY: BENTAJUBAO	Bi Ra Systems Inc.
CHECKED	APPROVALS	MCOR J4 OUTPUT CABLE ASSEMBLY DIAGRAM
PROJECT		
STRESS		
MET		
DRB		
MATERIAL		
QTY PER UNIT:	D 7/15/04	REV. A
	DWG. NO. 2503-J4	
	NTS	Mechanical DWG. Sheet 1

REVISION HISTORY:

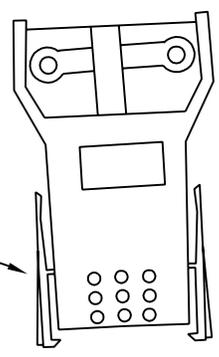
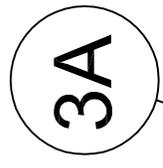
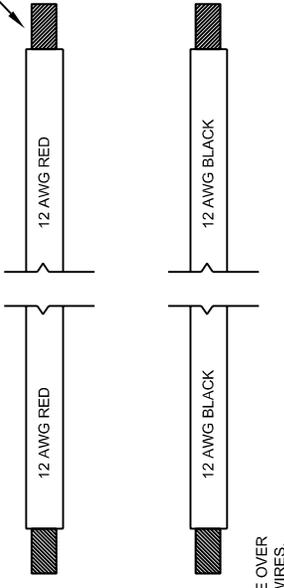
A	ORIGINAL DRAWING
B	
C	



CONFIGURATION FOR J5



FRONT VIEW



4.1.5

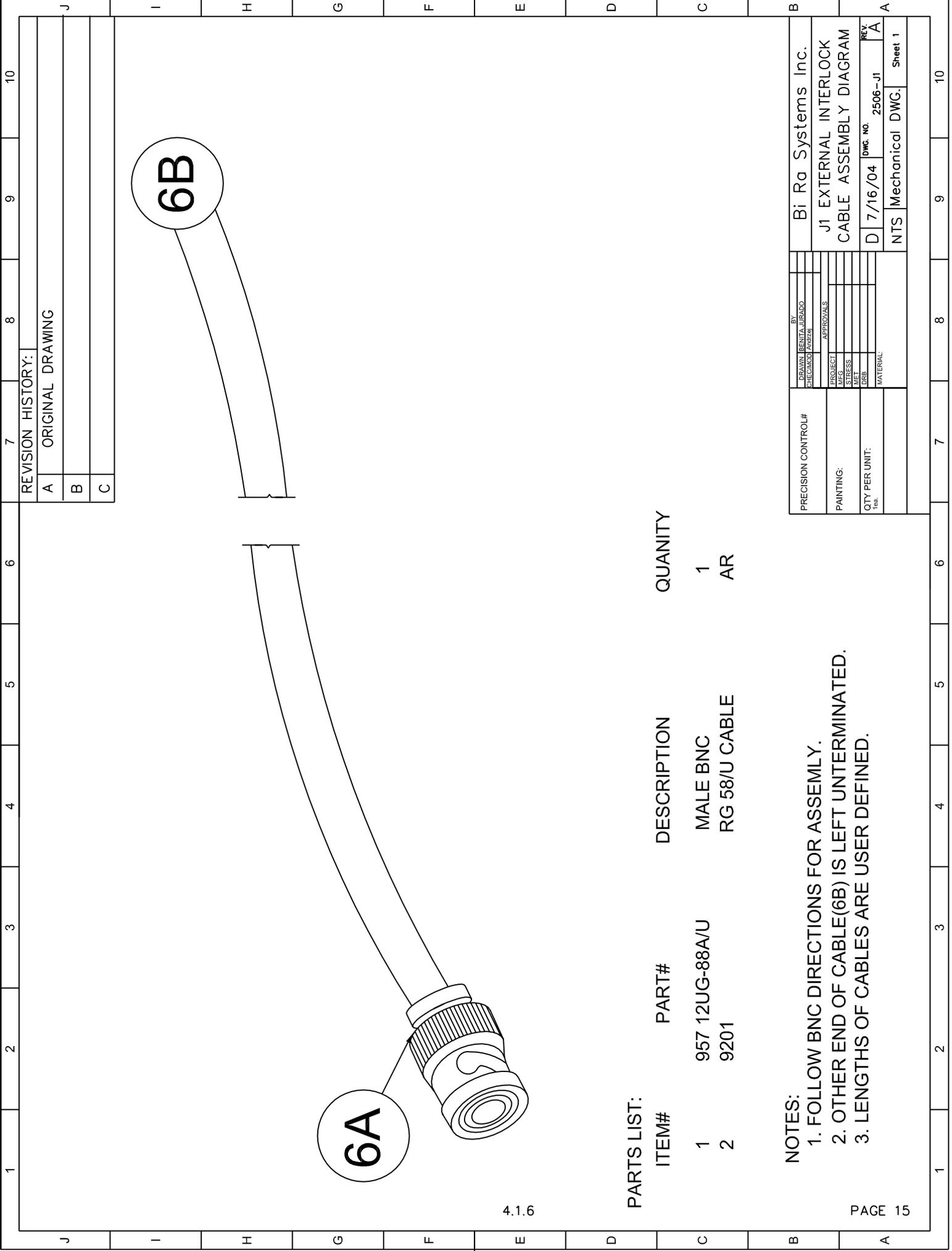
PARTS LIST:

ITEM#	PART#	DESCRIPTION	QUANTITY
1	1327	RED	4
2	1327G6	BLACK	4
3	261G2-LPBK	CONTACT	8
4	9912 010	BLACK	AR
5	9912 002	RED	AR
6	1/2" DIA	BLK SHRINK TUBING	1"
7	2" DIA	BLK NYLON MESH	AR

NOTES:

1. CABLES FOR J5 THUR J8 ARE ASSEMBLED ALL THE SAME.
2. HOUSINGS INTERLOCK TOGETHER TO MAKE ASSEMBLIES.
3. LENGTHS OF CABLES ARE USER DEFINED.

PRECISION CONTROL #	DRAWN BY: BENTAJURADO	Bi Ra Systems Inc.
	CHECKED:	
	APPROVALS:	
PAINTING:	PROJECT:	MCOR (J5-J8) LOAD
	MEG:	CABLE ASSEMBLY DIAGRAM
	STRESS:	
	DES:	
	DBB:	
QTY PER UNIT:	DWG. NO. 2509	REV. A
lbs.	D 11/15/04	
	NTS	Mechanical DWG.
		Sheet 1



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REVISION HISTORY:			
A	ORIGINAL DRAWING		
B			
C			

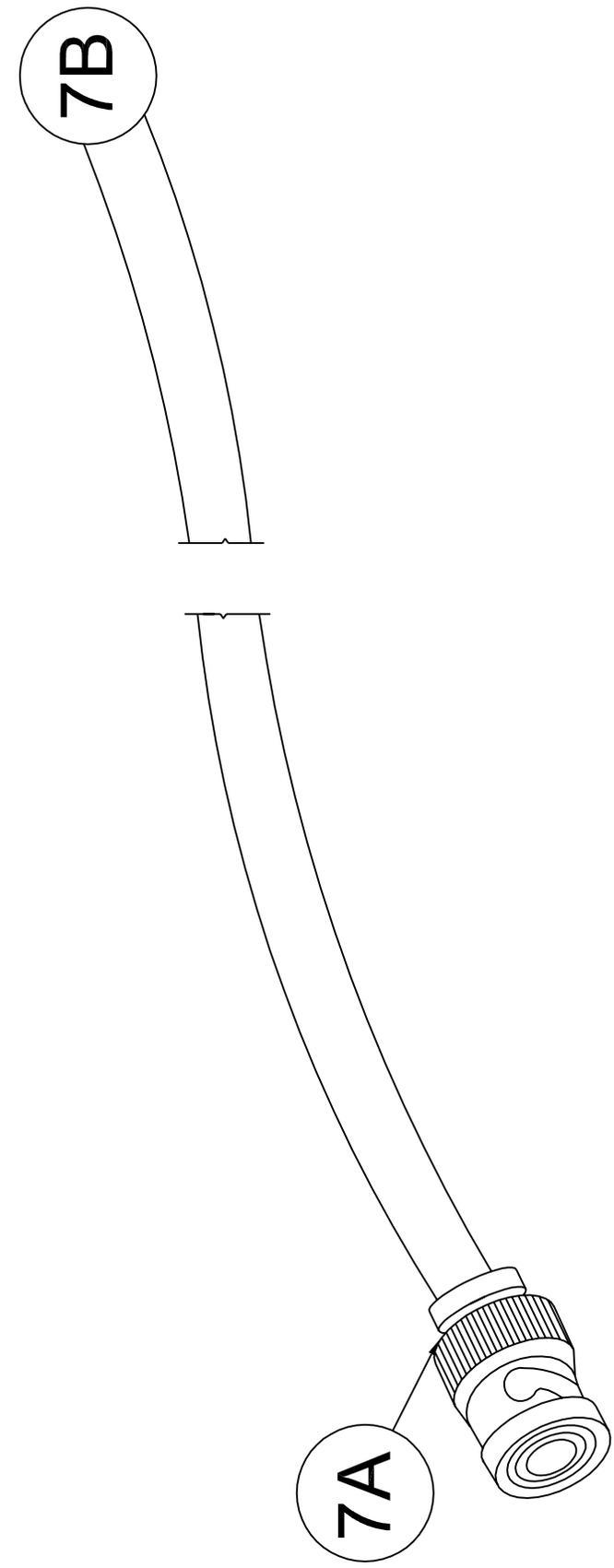
PARTS LIST:

ITEM#	PART#	DESCRIPTION	QUANTITY
1	957 12UG-88A/U	MALE BNC	1
2	9201	RG 58/U CABLE	AR

- NOTES:
1. FOLLOW BNC DIRECTIONS FOR ASSEMBLY.
  2. OTHER END OF CABLE(6B) IS LEFT UNTERMINATED.
  3. LENGTHS OF CABLES ARE USER DEFINED.

PRECISION CONTROL#	BY DRAWN: [REDACTED] CHECKED: [REDACTED]	Bi Ra Systems Inc.
PAINTING:	APPROVALS	J1 EXTERNAL INTERLOCK
QTY PER UNIT: <small>(See)</small>	PROJECT STRESS MET DWB	CABLE ASSEMBLY DIAGRAM
	MATERIAL	D 7/16/04 DWG. NO. 2506-JT REV. A
		NTS Mechanical DWG. Sheet 1

REVISION HISTORY:	
A	ORIGINAL DRAWING
B	
C	



**PARTS LIST:**

ITEM#	PART#	DESCRIPTION	QUANTITY
1	957 12UG-88A/U	MALE BNC	1
2	9201	RG 58/U CABLE	AR

**NOTES:**

1. FOLLOW BNC DIRECTIONS FOR ASSEMBLY.
2. OTHER END OF CABLE(7B) IS LEFT UNTERMINATED.
3. LENGTHS OF CABLES ARE USER DEFINED.

PRECISION CONTROL#	BY	Bi Ra Systems Inc.
	DRAWN BENITA JURADO	
	CHECKED ANDREZEB	
	APPROVALS	
	PROJECT	J2 CRATE "OK"
	DWG. NO.	2506-J2
	REV	A
	DATE	7/16/04
	MATERIAL	
	NTS	Mechanical DWG.
		Sheet 1



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<p>DESCRIPTION</p> <p>CABLE 20PR 20GA IND+0/A SHIELD 40 FEET</p> <p>CONN PIN CONTACT 20-24AWG CRIMP 36 PCS</p> <p>36 POSITION CONNECTOR 1 EA</p> <p>CONN HOOD AMP 205083-3 1 EA</p>																																																																																																																																																									
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<p>PRECISION CONTROL #</p> <p>BY: DRAWN BENITA JURADO</p> <p>CHECKED ANDRZEJ</p> <p>APPROVALS</p> <p>PROJECT</p> <p>TIME</p> <p>STRESS</p> <p>DATE</p> <p>ENV</p> <p>MATERIAL</p> <p>PAINTING:</p> <p>QTY PER UNIT: 100</p> <p>REV: A</p> <p>DWG. NO. J4-SIGNAL</p> <p>NTS Mechanical DWG. Sheet 1</p>																																																																																																																																																									
<p>Bi Ra Systems Inc.</p> <p>MCOR 12 J4 OUTPUT SIGNAL</p> <p>CABLE ASSEMBLY DIAGRAM</p> <p>D 7/16/04</p>																																																																																																																																																									

#### 4.1.10 MCOR 12 (16 channel ) I/O Connector Wiring Pin-Out Table

##### J4 OUTPUT “SAM”

	A	B	C
1			
2			
3	Monitor 0	Monitor 3	Monitor 6
4	Common 0	Common 3	Common 6
5			
6			
		<b>O</b>	
7	Monitor 1	Monitor 4	Monitor 7
8	Common 1	Common 4	Common 7
9			
10			
11	Monitor 2	Monitor 5	? Ground ?
12	Common 2	Common 5	? Ground ?

##### J3 INPUT “DAC”

	A	B	C
1			
2			
3	+Reference 0	+Reference 3	+Reference 6
4	-Reference 0	-Reference 3	-Reference 6
5			
6			
		<b>O</b>	
7	+Reference 1	+Reference 4	+Reference 7
8	-Reference 1	-Reference 4	-Reference 7
9			
10			
11	+Reference 2	+Reference 5	
12	-Reference 2	-Reference 5	

##### DC Output Connectors (looking at rear of crate, Pin # and Channel/Polarity)

	J8		J7		J6		J5	
	H - 7+	A - 6-	H - 5+	A - 4-	H - 3+	A - 2-	H - 1+	A - 0-
	G - 7-	B - 6+	G - 5-	B - 4+	G - 3-	B - 2+	G - 1-	B - 0+
	F - 7+	C - 6-	F - 5+	C - 4-	F - 3+	C - 2-	F - 1+	C - 0-
	E - 7-	D - 6+	E - 5-	D - 4+	E - 3-	D - 2+	E - 1-	D - 0+

#### 4.1.11 MCOR 30 (8 channel ) I/O Connector Wiring Pin-Out Table

##### J4 OUTPUT “SAM”

	A	B	C
1	Monitor 0	Monitor 6	Monitor 12
2	Common 0	Common 6	Common 12
3	Monitor 1	Monitor 7	Monitor 13
4	Common 1	Common 7	Common 13
5	Monitor 2	Monitor 8	Monitor 14
6	Common 2	Common 8	Common 14
		<b>O</b>	
7	Monitor 3	Monitor 9	Monitor 15
8	Common 3	Common 9	Common 15
9	Monitor 4	Monitor 10	
10	Common 4	Common 10	
11	Monitor 5	Monitor 11	Ground
12	Common 5	Common 11	Ground

##### J3 INPUT “DAC”

	A	B	C
1	+Reference 0	+Reference 6	+Reference 12
2	-Reference 0	-Reference 6	-Reference 12
3	+Reference 1	+Reference 7	+Reference 13
4	-Reference 1	-Reference 7	-Reference 13
5	+Reference 2	+Reference 8	+Reference 14
6	-Reference 2	-Reference 8	-Reference 14
		<b>O</b>	
7	+Reference 3	+Reference 9	+Reference 15
8	-Reference 3	-Reference 9	-Reference 15
9	+Reference 4	+Reference 10	
10	-Reference 4	-Reference 10	
11	+Reference 5	+Reference 11	
12	-Reference 5	-Reference 11	

##### DC Output Connectors (looking at rear of crate, Pin # and Channel/Polarity)

	J8		J7		J6		J5	
	H -15+	A -12-	H -11+	A - 8-	H - 7+	A - 4-	H - 3+	A - 0-
	G -15-	B -12+	G -11-	B - 8+	G - 7-	B - 4+	G - 3-	B - 0+
	F - 14+	C -13-	F - 10+	C - 9-	F - 6+	C - 5-	F - 2+	C - 1-
	E - 14-	D -13+	E - 10-	D - 9+	E - 6-	D - 5+	E - 2-	D - 1+

## 5.0 WARRANTY

Equipment manufactured by Bi Ra Systems for use in the United States is warranted against defects in design, workmanship, and materials for a period of one (1) year from the date of shipment. Bi Ra Systems will repair or replace, at its option, any such equipment found to be defective on a return to factory basis. Repair charges will be applicable after the warranty period has expired. Transportation charges for shipping the equipment to Bi Ra Systems shall be paid by the customer, while transportation charges for the return of the repaired equipment will be paid by Bi Ra Systems. Priority shipping methods are available at the customer's expense. SOFTWARE products by Bi Ra Systems are furnished under the terms and conditions of a separate Software Product License Agreement is warranted for a period of ninety (90) days from the date of shipment to conform to the Software Product Description (SPD) applicable at the time of purchase. This warranty is contingent upon the proper use of the software as detailed in the Software Product License Agreement and is limited to the remedy of any non-conformance of the Software to the SPD. **PRODUCTS PURCHASED BY BI RA SYSTEMS FOR RESALE WILL CARRY THE ORIGINAL EQUIPMENT MANUFACTURER'S WARRANTY, IF ANY.**

These warranties shall not apply to equipment or software that has been modified or serviced by other than a Bi Ra Systems or an authorized distributor service engineer.

All warranties are contingent upon proper use of the product or system. These warranties will not apply (i) if adjustment, repair or parts replacement is required because of accident, unusual physical, electrical, or electro-magnetic stress, neglect, misuse, failure of electric power, air conditioning, humidity control, transportation, failure to rotating media not furnished by Bi Ra Systems, operation with media not meeting or not maintained in accordance with Bi Ra Systems specification or causes other than ordinary use; or (ii) if the product or system has been modified by the purchaser; or (iii) where Bi Ra Systems serial numbers or warranty date decals have been removed or altered. In addition to the foregoing, any application on-site warranty will not apply (i) if prerequisite equipment (as specified by Bi Ra Systems price list, equipment specifications, or contract(s) is missing, or (ii) if the product or system has been installed by the purchaser without the supervision of or prior written approval of Bi Ra Systems. Equipment may contain used parts which are equivalent to new in performance when used in the equipment. **BI RA SYSTEMS MAKES NO WARRANTY OR MECHANABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR ANY OTHER WARRANTY EITHER EXPRESS OR IMPLIED, EXCEPT AS IS EXPRESSLY SET FORTH HEREIN.**

Outside the United States, the equipment warranty is limited to the replacement of the equipment and excludes shipping, insurance, taxes, forwarders' fees, customs, or any other charges.

**THE WARRANTY PERIOD MAY VARY IN COUNTRIES OUTSIDE THE UNITED STATES. CONTACT BI RA SYSTEMS OR YOUR LOCAL AUTHORIZED DISTRIBUTOR FOR SPECIFIC WARRANTY DETAILS.**

### LIMITATIONS OF LIABILITY

The purchaser's exclusive remedy or any claim of any kind for loan or damage connected with, or resulting from the design, manufacture, sale, delivery, resale, or repair or use of any products furnished by Bi Ra Systems including but not limited to any claim of negligence or other breach, shall be the repair or replacement, F.O.B. factory, of the product or part thereof giving rise to such claim. Bi Ra Systems liability for such repair or replacement shall in no event exceed the contract price allocable to the products or part which gives rise to the claim. **BI RA SYSTEMS SHALL IN NO EVENT BE LIABLE FOR INCIDENTAL OR CONSEQUENTIAL DAMAGES.**

### RETURN OF PRODUCTS

Bi Ra Systems must be notified before any product is returned for any reason. The Customer Service Department must issue a Return Material Authorization (RMA) number before any product can be accepted for credit, exchange, or repair. In order to provide an RMA number, Customer Service will need the complete model number, serial number, original purchase order number, and details regarding the reason for return and the service required.

All returns for CREDIT or EXCHANGE are subject to Bi Ra Systems approval and will incur a minimum restocking charge of ten (10) percent, as well as any incoming transportation charges or other fees incurred by Bi Ra Systems.

All returns for WARRANTY REPAIR must include a description of the problem and the name of a technical contact in case the problem must be discussed. If the product is out of warranty, the customer must contact Bi Ra Systems for an estimate of the repair charges and include a purchase order number for the estimated repair charges.

Transportation charges for shipping the products to Bi Ra Systems shall be paid by the customer. Transportation charges for the return of the products that have been exchanged shall be paid by the customer, while transportation charges for the return of the repaired equipment will be paid by Bi Ra Systems. The return shipment will be by UPS services, air freight, or truck. Premium methods of shipment are available at the customer's expense and will be used only when requested. If Bi Ra Systems selects the carrier, Bi Ra Systems will not thereby assume any responsibility or liability in connection with the shipment nor shall the carrier be in any way construed to be the agent of Bi Ra Systems.

After obtaining a Return Material Authorization (RMA) number, customers should return the product to:

BI RA SYSTEMS, INC.  
2410 Midtown PL NE  
ALBUQUERQUE, NEW MEXICO 87107  
TELEPHONE: (505) 881-8887  
FAX:(505) 888-0651