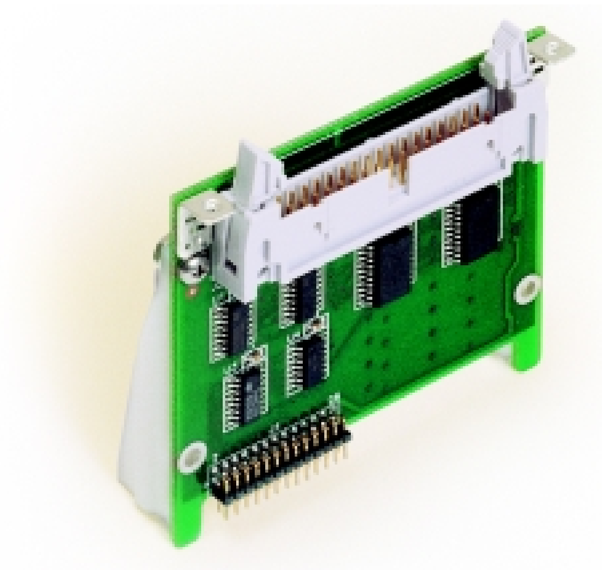

Digital I/O Cards (SR9200 Series)

Smart Star Modular C-Programmable Control System

User's Manual

010215 - A

Digital I/O Cards User's Manual

Part Number 019-0085 • 010215 - A • Printed in U.S.A.

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TABLE OF CONTENTS

1. DIGITAL I/O CARDS

Chapter 1 describes the features of the digital I/O card, one of the I/O cards designed for the Smart Star embedded control system. The Smart Star embedded control system is described in complete detail in the ***Smart Star User's Manual***.

The Smart Star is a modular and expandable embedded control system whose configuration of I/O, A/D converter, D/A converter, and relay cards can be tailored to a large variety of demanding real-time control and data acquisition applications.

The typical Smart Star system consists of a rugged backplane with a power supply, a CPU card, and one or more I/O cards. The CPU card plugs into a designated slot on the backplane chassis, which has seven additional slots available for I/O cards to be used in any combination. A high-performance Rabbit 2000 microprocessor on the CPU card operates at 25.8 MHz to provide fast data processing.

1.1 Features

The SR9200 digital I/O cards offer protected digital inputs and high-current driver outputs in three banks, each containing 8 I/O points. One bank's configuration is fixed as protected digital inputs, one bank's configuration is fixed as high-current driver outputs, and one bank may be configured either as protected digital inputs or as high-current driver outputs, depending on the model of digital I/O card selected. The high-current driver outputs are either all sinking or all sourcing, depending on the model of digital I/O card selected.

Table 1 lists the digital I/O cards that are available for the Smart Star control system.

Table 1. Smart Star Digital I/O Cards

I/O Card	Model	Features
Digital I/O	SR9200	16 digital inputs, 8 digital sinking outputs
	SR9210	8 digital inputs, 16 digital sinking outputs
	SR9220	8 digital inputs, 8 digital sinking outputs
	SR9205	16 digital inputs, 8 digital sourcing outputs
	SR9215	8 digital inputs, 16 digital sourcing outputs
	SR9225	8 digital inputs, 8 digital sourcing outputs

Appendix A provides detailed specifications.

1.2 Installing Digital I/O Cards

1. Orient the backplane with the CPU card already installed and facing towards you as shown in Figure 1.

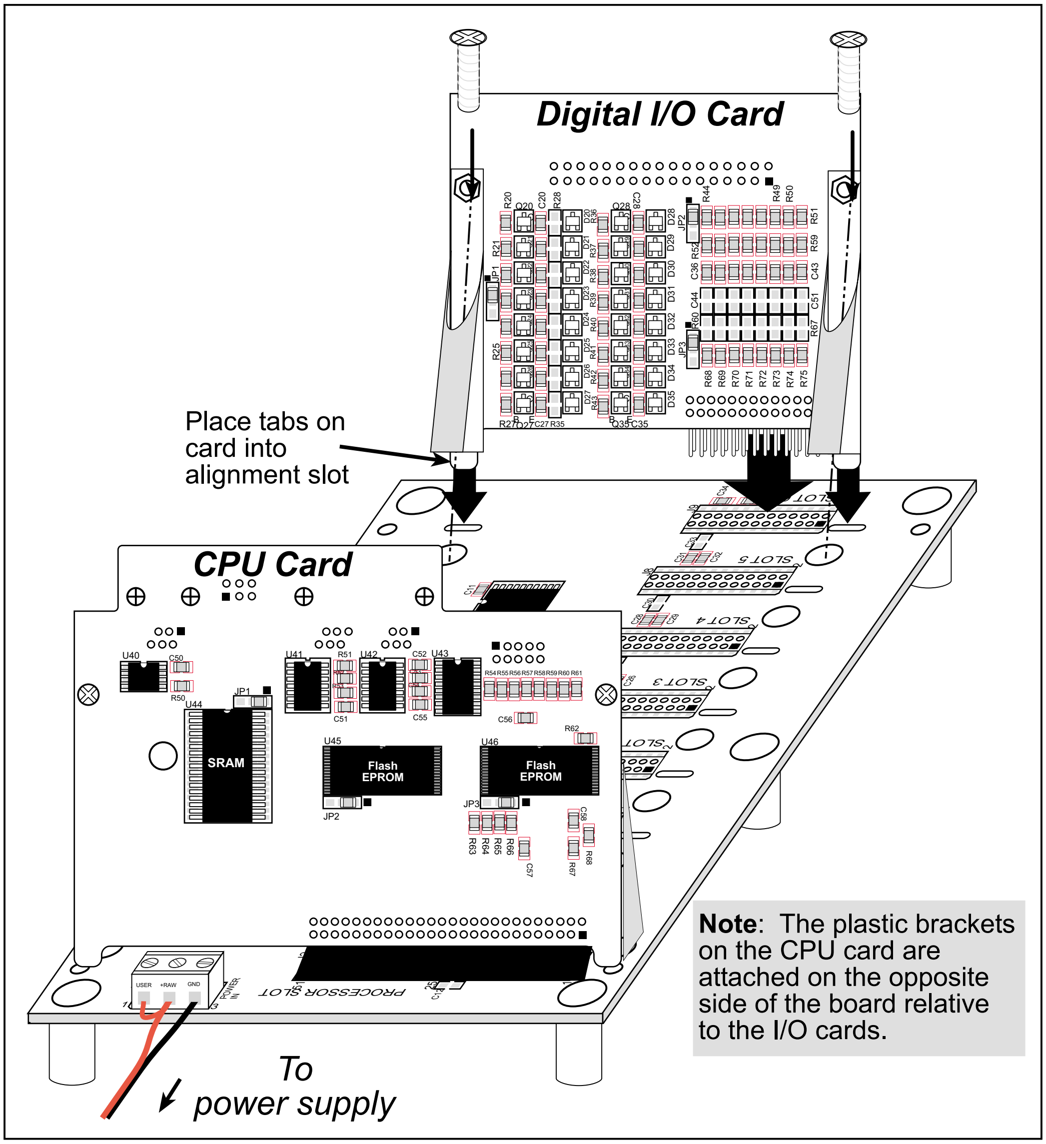


Figure 1. Installing Digital I/O Cards on the Backplane

2. Position the digital I/O card above the backplane over any unused slot position (**SLOT 0** to **SLOT 6**) as shown in Figure 1. Note the slot number and the type of I/O card since Dynamic C addresses the I/O cards by slot number.
3. Carefully insert the digital I/O card header into the slot on the backplane and line up the tabs on the card with the slots on the backplane as shown in Figure 1.
4. Use the two 4-40 screws supplied with the I/O card to ensure that the plastic brackets anchor the I/O card firmly on the backplane. Tighten the screws as needed.

1.3 User Interface

Figure 2 shows the complete pinout for the user interface on header J2. Note that pin 1 is indicated by a small arrow on the ribbon cable connector.

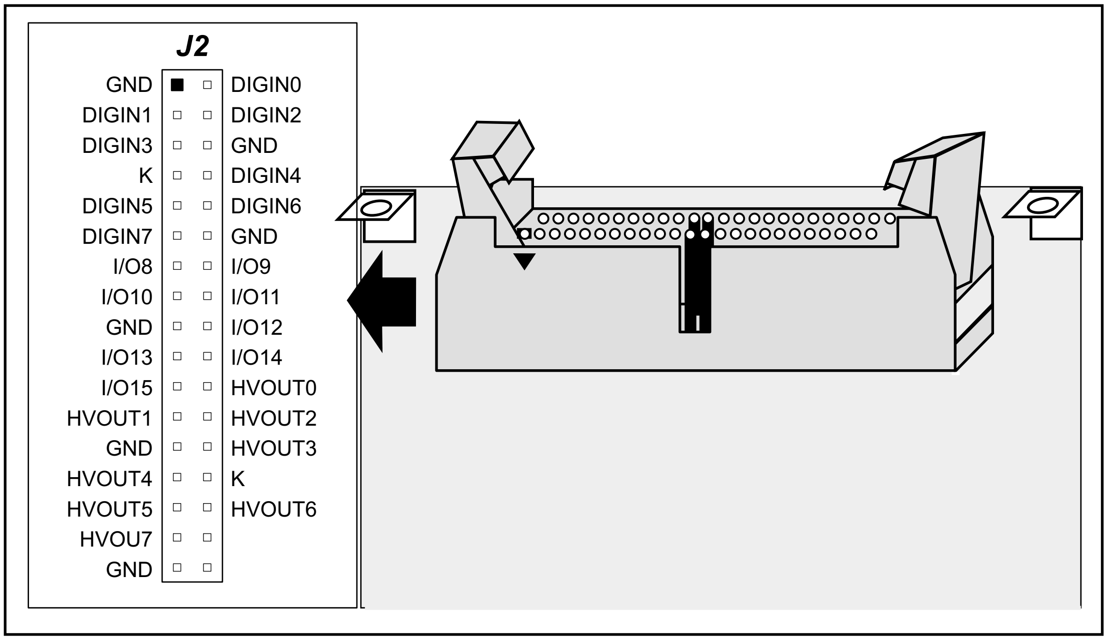
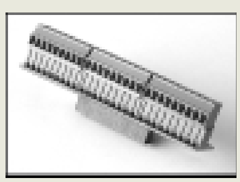
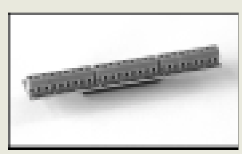


Figure 2. Digital I/O Card User Interface Pinout

1.4 User Connections

Connections to the digital I/O cards are made via a ribbon cable connector or optional field wiring terminals that are either pluggable or have screw terminals. Table 2 lists the Z-World part numbers for the FWTs.

Table 2. Guide to FWT Selection

FWT Description	I/O Cards	Z-World Part Number	
		Pluggable Terminals 	Screw Terminals 
FWT27	Digital I/O	101-0420	101-0424

Appendix B, “Field Wiring Terminals,” provides further information on FWTs, including their dimensions and pinouts.

1.5 Digital Inputs and Outputs

The digital I/O card has 24 I/O points that are factory configured as either inputs or outputs in banks of eight, depending on the model.

Figure 3 shows the locations of the I/O banks.

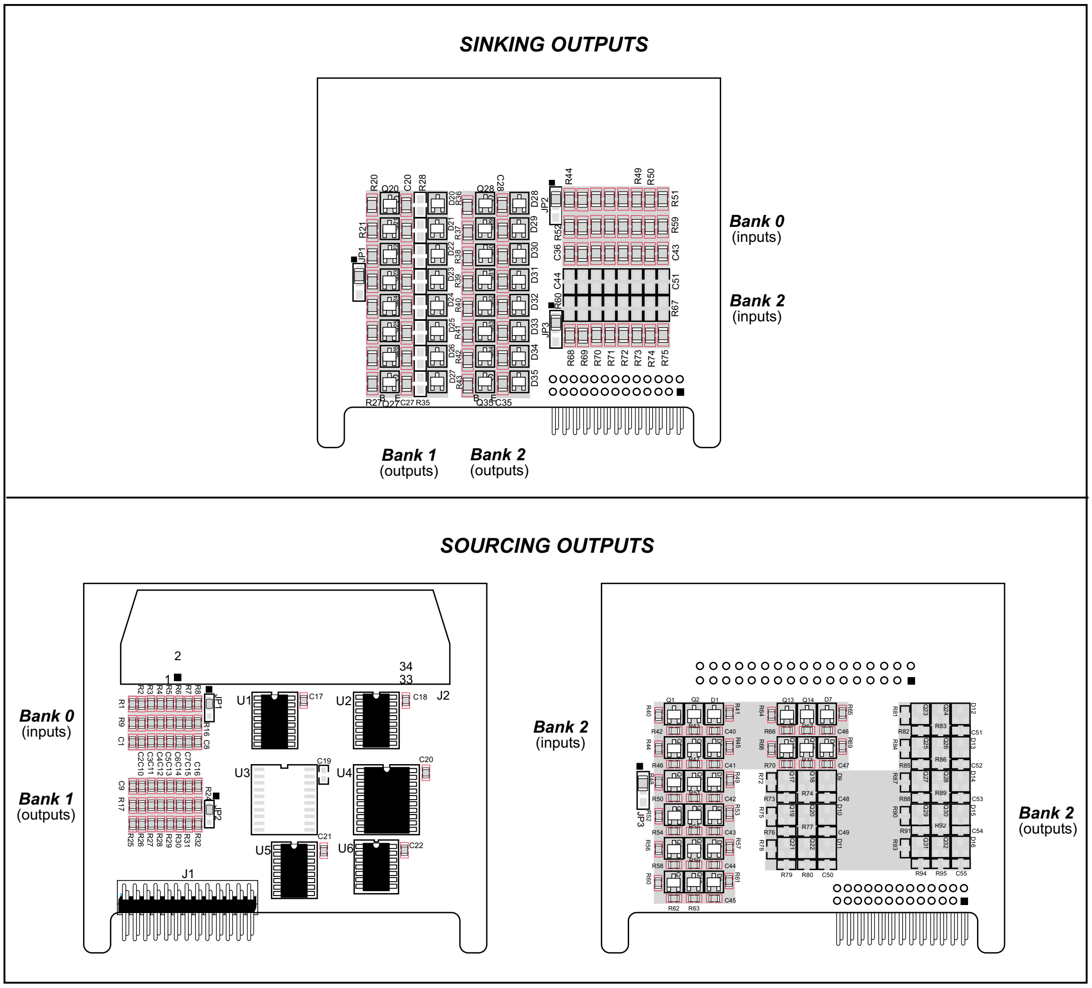


Figure 3. Locations of Banks

The I/O points on Bank 0 are always inputs, and the I/O points on Bank 1 are always outputs. The I/O points on Bank 2 were configured at the factory as either inputs *or* outputs, depending on the model of the digital I/O card. Table 3 lists the factory configurations.

Table 3. Digital I/O Card Bank 2 Factory Configurations

Model	Bank 2 Configured As
SR9200	Inputs
SR9210	Sinking outputs
SR9220	—
SR9205	Inputs
SR9215	Sourcing outputs
SR9225	—

The operation of Bank 2 is determined by the components on the digital I/O card. There is no jumper setting to select between inputs and outputs for Bank 2.

1.5.1 Digital Inputs

Table 4 provides the pinout configuration for the input points.

Table 4. Digital Inputs Pinout

Pin	Bank 0	Pin	Bank 2
2 DIGIN0	IN0	13 I/O8	IN8
3 DIGIN1	IN1	14 I/O9	IN9
4 DIGIN2	IN2	15 I/O10	IN10
5 DIGIN3	IN3	16 I/O11	IN11
8 DIGIN4	IN4	18 I/O12	IN12
9 DIGIN5	IN5	19 I/O13	IN13
10 DIGIN6	IN6	20 I/O14	IN14
11 DIGIN7	IN7	21 I/O15	IN15

The protected digital inputs, shown in Figure 4, are factory configured with 10 kΩ pull-up resistors. Digital I/O cards are also available in quantity with the protected digital inputs pulled down as shown in Figure 4.

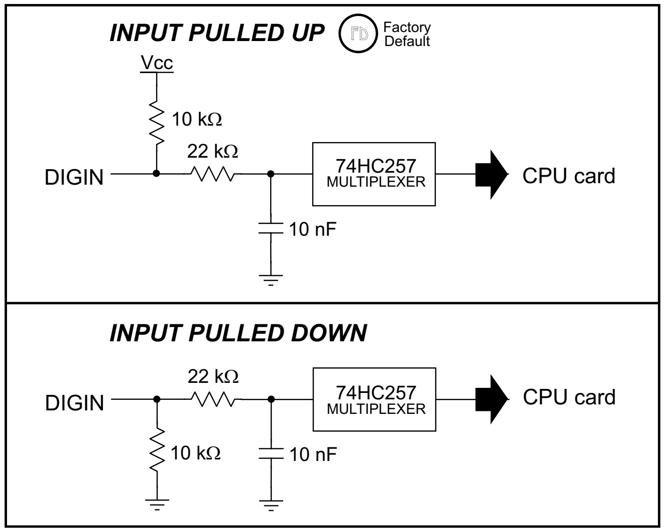


Figure 4. Protected Digital Inputs

A 0 Ω surface-mount resistor is used as a jumper to select whether the inputs are pulled up or down, as shown in Figure 5.

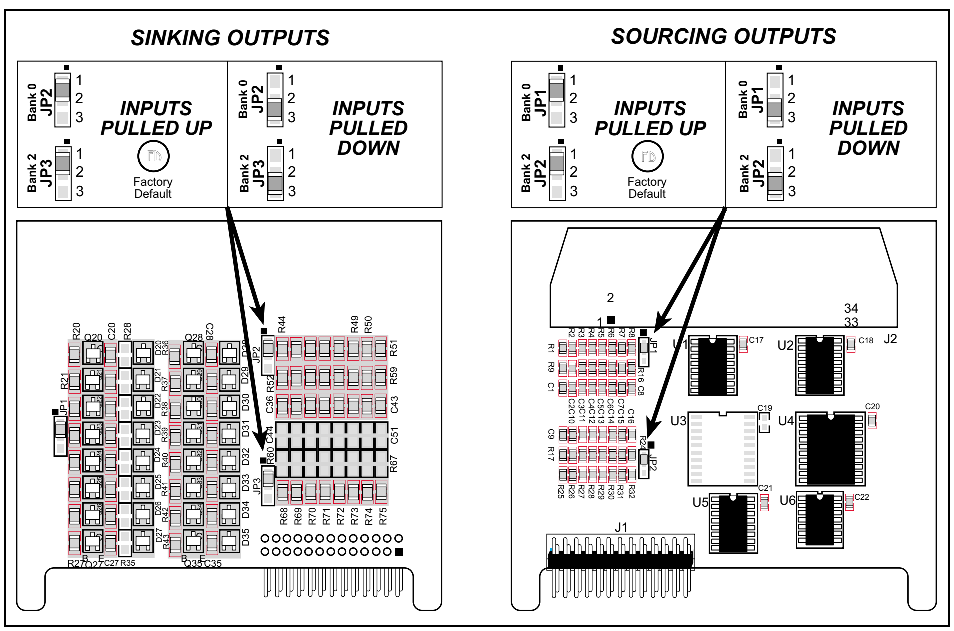


Figure 5. Selecting Pulled Up or Pulled Down Digital Inputs

The digital inputs are able to operate continuously from -30 V to +30 V, and have a logic threshold of 2.5 V. They are protected against spikes up to ±48 V.

1.5.2 Digital Outputs

The high-current digital outputs are either sinking or sourcing, depending on the model of the digital I/O card. Table 5 provides the pinout configuration for the output points.

Table 5. Digital Outputs Pinout

Pin	Bank 2	Pin	Bank 1
13 I/O8	OUT8	22 HVOUT0	OUT0
14 I/O9	OUT9	23 HVOUT1	OUT1
15 I/O10	OUT10	24 HVOUT2	OUT2
16 I/O11	OUT11	26 HVOUT3	OUT3
18 I/O12	OUT12	27 HVOUT4	OUT4
19 I/O13	OUT13	29 HVOUT5	OUT5
20 I/O14	OUT14	30 HVOUT6	OUT6
21 I/O15	OUT15	31 HVOUT7	OUT7

Figure 6 shows the power distribution on the digital I/O card.

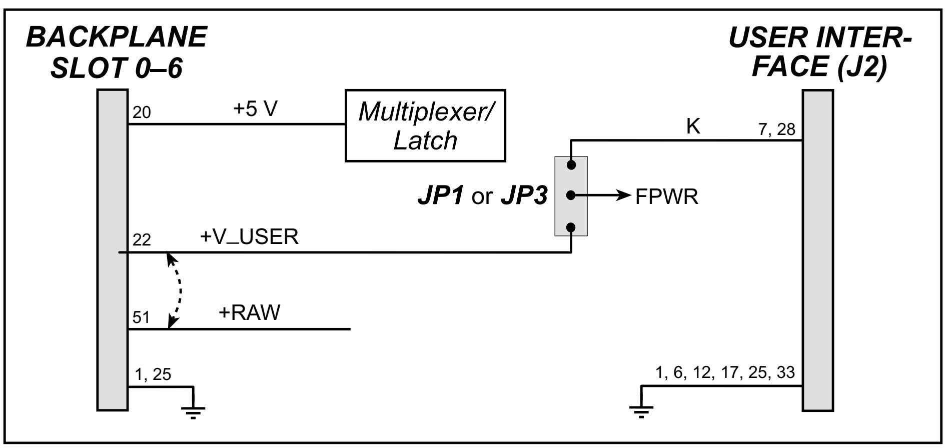


Figure 6. Digital I/O Card Power Distribution

When designing your interface with the Smart Star system, you need to establish whether you will use the **+V_USER/+RAW** supply on the backplane or your own independent **K** supply to drive the high-current outputs. The selection of this **FPWR** power supply is implemented via a 0 Ω surface-mount resistor on header JP1 (sinking outputs) or header JP3 (sourcing outputs) as shown in Figure 7. The factory default is to use **+V_USER/+RAW**, but digital I/O cards are available in quantity with the **FPWR** power supply jumpered to your own independent **K** supply.

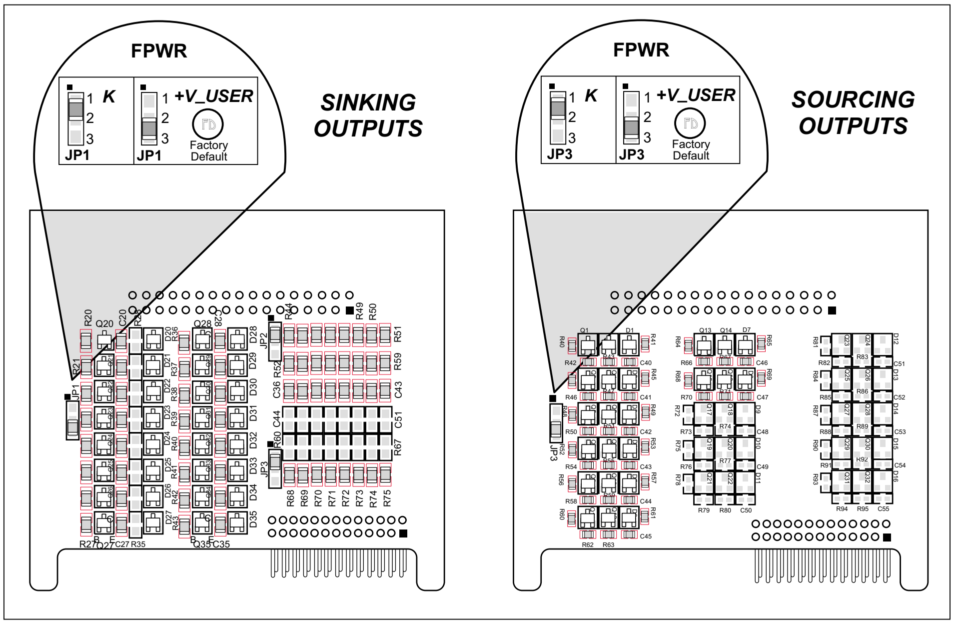


Figure 7. Selecting Power Supply for High-Current Sinking or Sourcing Outputs

Figure 8 shows how to connect a load to the high-current outputs based on whether your digital I/O card model has sinking or sourcing outputs.

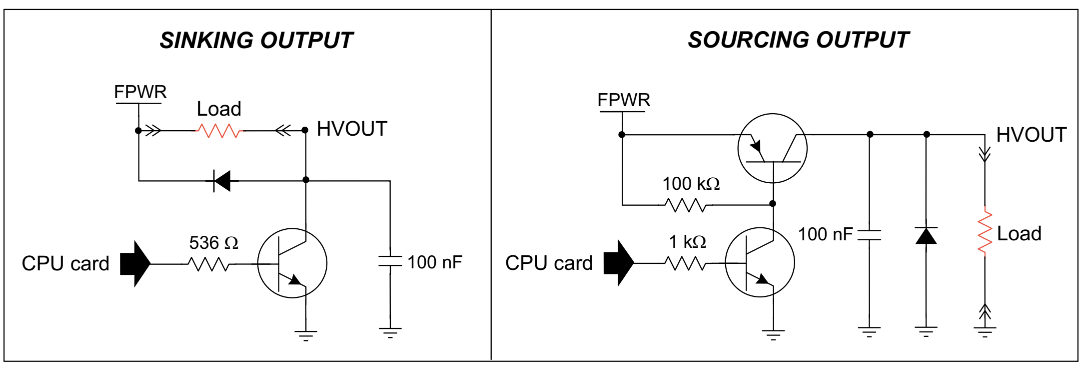


Figure 8. Connecting a Load to the High-Current Outputs

Each high-current output is able to sink or source up to 200 mA continuously, with a load limit of 40 V. Each high-current output may be switched independently, or a whole bank may be switched at once. The total current draw should be kept below 2.0 A when all high-current outputs on one digital I/O card are operating simultaneously, and the total current draw from your **+V_USER/+RAW** supply for all the I/O cards should be kept below 7.0 A.

Note that the power supply provided in the Smart Star Tool Kit has a maximum output of 1.1 A.

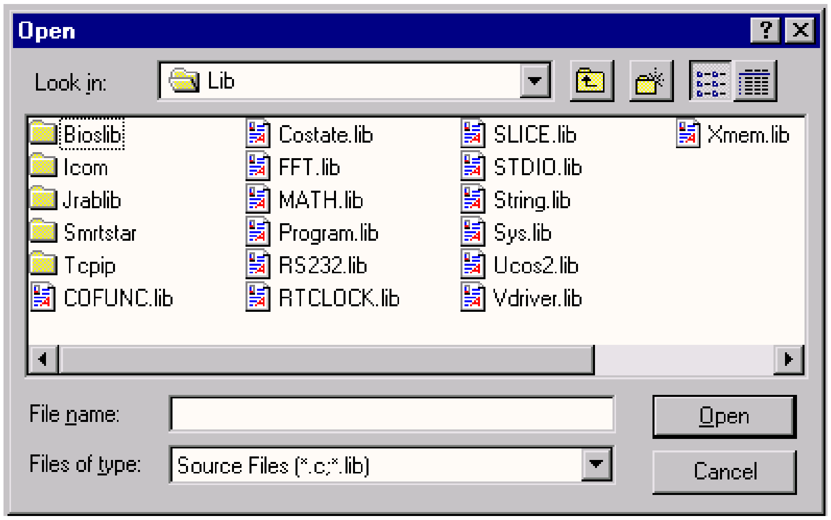
2. SOFTWARE

Dynamic C Premier is an integrated development system for writing embedded software. It runs on an IBM-compatible PC and is designed for use with Z-World controllers and other controllers based on the Rabbit microprocessor.

Chapter 2 provides the libraries, function calls, and sample programs related to the Smart Star digital I/O cards.

2.1 Dynamic C Libraries

With Dynamic C running, click **File** > **Open**, and select **Lib**. The following list of Dynamic C libraries and library directories will be displayed.



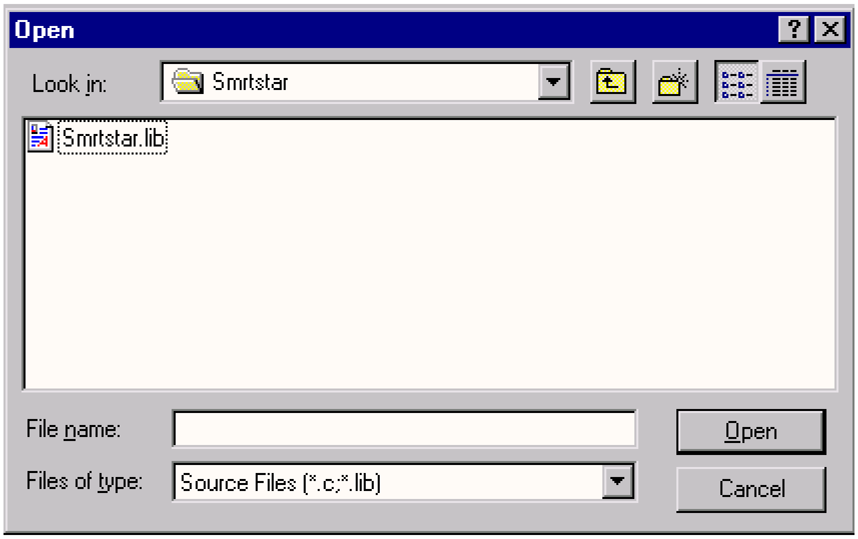
One library directory is specific to the Smart Star.

- **SMRTSTAR**—libraries associated with features specific to the Smart Star control system.

Other functions applicable to all devices based on the Rabbit 2000 microprocessor are described in the ***Dynamic C Premier User's Manual***.

2.1.1 Library Directories

The **SMRTSTAR** directory contains libraries required to operate the Smart Star control system.



- **SMRTSTAR.LIB**—This library supports all the functions needed by the Smart Star systems including digital I/O cards, relay cards, D/A converter and A/D converter cards, and serial communication.

Functions dealing with the digital I/O cards are described in this manual. Functions relevant to the other I/O cards are described in the manual specific to the I/O card. Functions dealing with the backplane and the CPU card are described in the ***Smart Start (SR9000) User's Manual***.

2.2 Smart Star Digital I/O Card Function APIs

2.2.1 Digital Output APIs

`int digIn(int channel);`

Reads the state of a digital input channel (IN0–IN15, IN8–IN15 is not available on all versions of the digital I/O card).

Parameter

`channel` is the digital input channel to read. **`channel`** should be passed as

```
channel = (slotnumber * 128) + (channelnumber)
```

or

```
channel = ChanAddr(slotnumber, channelnumber)
```

where **`slotnumber`** is 0–6, and **`channelnumber`** is 0–15.

Return Value

The state of the digital input channel, 0 or 1.

See Also

`digBankIn, digOut, digBankOut`

`int digBankIn(int bank);`

Reads the state of Bank 0 or Bank 2 (if installed) digital input channels—Bank 0 consists of IN0–IN7 and Bank 2 consists of IN8–IN15.

Parameter

`bank` is the bank of digital input channels to read. **`bank`** should be passed as

```
bank = (slotnumber * 16) + (banknumber)
```

or

```
bank = BankAddr(slotnumber, banknumber)
```

where **`slotnumber`** is 0–6, and **`banknumber`** is 0 or 2.

Return Value

An input value in the lower byte, where each bit corresponds to one channel.

See Also

`digIn, digOut, digBankOut`

2.2.2 Digital Output APIs

`void digOut(int channel, int value);`

Writes a value to an output channel (OUT0–OUT15, OUT8–IN15 not available on all versions of the digital I/O card).

Parameters

`channel` is the digital output channel to write. **`channel`** should be passed as

```
channel = (slotnumber * 128) + (channelnumber)
```

or

```
channel = ChanAddr(slotnumber, channelnumber)
```

where **`slotnumber`** is 0–6, and **`channelnumber`** is 0–15.

`value` is the output value, 0 or 1.

Return Value

None.

See Also

`digBankOut, digIn, digBankIn`

`int digBankOut(int bank, int value);`

Writes a byte value to Bank 1 or Bank 2 (if installed) digital output channels—Bank 1 consists of OUT0–OUT7 and Bank 2 consists of OUT8–OUT15.

Parameter

`bank` is the bank of digital output channels to write. **`bank`** should be passed as

```
bank = (slotnumber * 16) + (banknumber)
```

or

```
bank = BankAddr(slotnumber, banknumber)
```

where **`slotnumber`** is 0–6, and **`banknumber`** is 1 or 2.

`value` is the output value, where each bit correspons to one channel.

Return Value

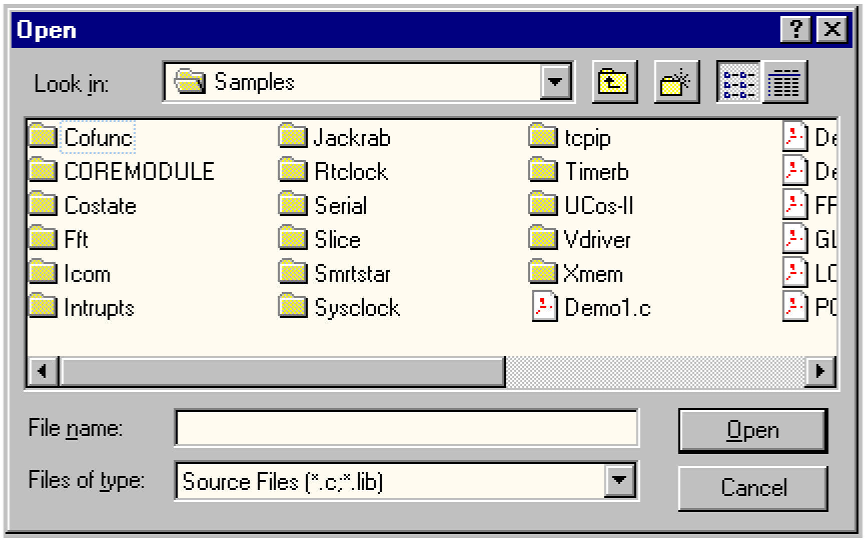
An input value in the lower byte, where each bit corresponds to one channel.

See Also

`digOut, digIn, digBankIn`

2.3 Sample Programs

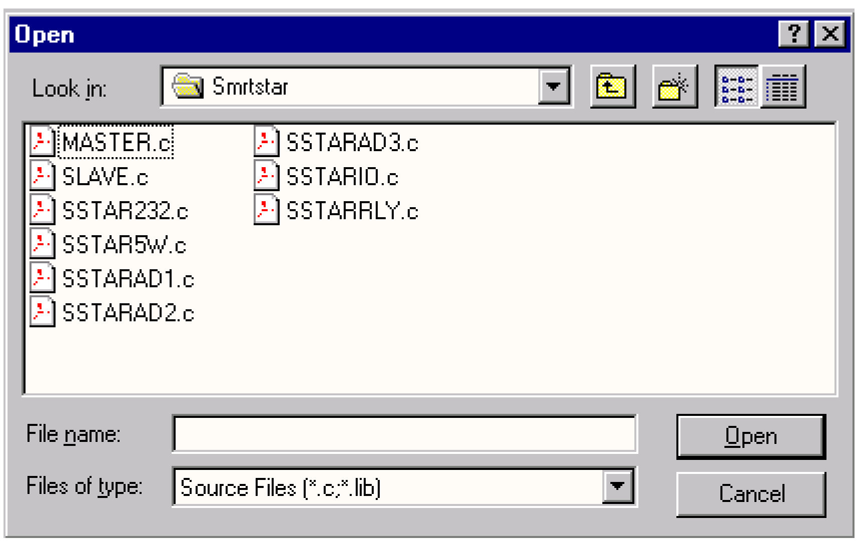
Sample programs are provided in the Dynamic C **Samples** folder, which is shown below.



The various folders contain specific sample programs that illustrate the use of the corresponding Dynamic C libraries. For example, the sample program **PONG.C** demonstrates the output to the **STDIO** window.

The **SMRTSTAR** folder provides sample programs specific to the Smart Star control system. Each sample program has comments that describe the purpose and function of the program. Follow the instructions at the beginning of the sample program.

Let's take a look at sample programs for the backplane and the CPU card in the **SMRTSTAR** folder.



- **SSTARIO.C**—Demonstrates digital I/O using individual channels and whole banks. The sample program is set up for 8 inputs and 16 outputs. If necessary, you may change the macros in the sample program to match your digital I/O card.

2.4 Using Dynamic C

To run a sample program, open it with the **File** menu (if it is not still open), compile it using the **Compile** menu, and then run it by selecting **Run** in the **Run** menu. The CPU card must be in Program Mode (see Section 3.1, "Switching Between Program Mode and Run Mode," in the ***Smart Start (SR9000) User's Manual***) and must be connected to a PC using the programming cable as described in Section 2.3, "Programming Cable Connections," in the ***Smart Start (SR9000) User's Manual***.

More complete information on Dynamic C is provided in the ***Dynamic C Premier User's Manual***.

APPENDIX A. DIGITAL I/O CARD SPECIFICATIONS

Appendix A provides the specifications for the Smart Star digital I/O card.

A.1 Electrical and Mechanical Specifications

Figure A-1 shows the mechanical dimensions for the digital I/O card.

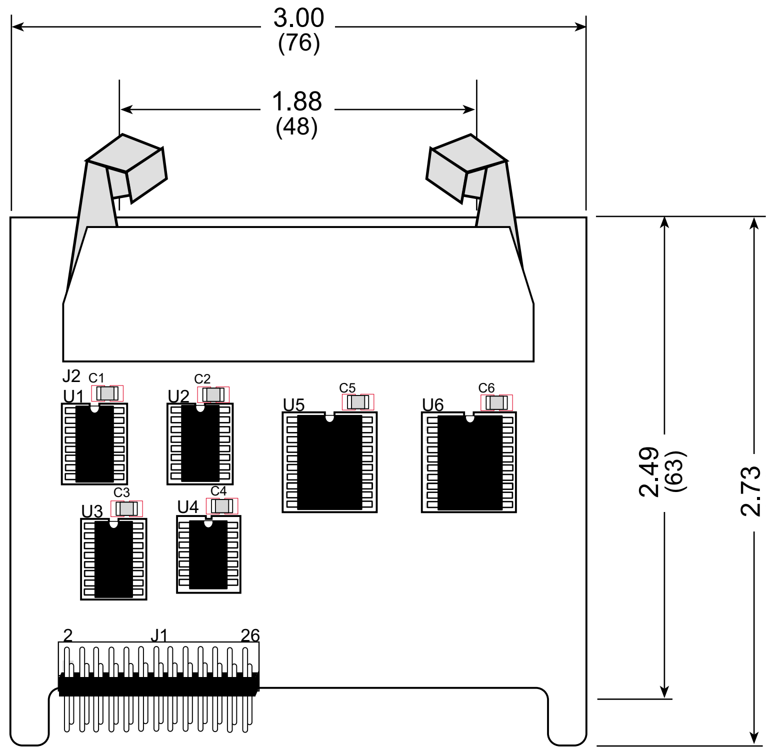


Figure A-1. Digital I/O Card Dimensions

All diagram and graphic measurements are in inches followed by millimeters enclosed in parentheses.

Table A-1 lists the electrical, mechanical, and environmental specifications for the digital I/O card.

Table A-1. Digital I/O Card Specifications

Parameter	**Specification**
Board Size	2.73" × 3.00" × 0.44" (70 mm × 76 mm × 11 mm)
Connectors	one 2 × 17 latch/eject ribbon connector, 0.1 inch pitch
Operating Temperature	–40°C to +70°C
Humidity	5% to 95%, noncondensing
Power Requirements	5 V DC at 65 mA from backplane (+5 V supply) 9 V to 30 V DC for **+RAW/+V_USER** from backplane or 9 V to 30 V DC for K on user interface header J2 Maximum draw 2.0 A from **+RAW/+V_USER** on backplane
Digital Inputs	Continuous operation from -30 V to +30 V, logic threshold at 2.5 V, protected against spikes ±48 V, 10 kΩ pull-up/pull-down resistors
Digital Outputs	Each output can sink (source) up to 200 mA continuously with load limit of 40 V, each output may be switched independently or bank of eight may be switched all at once, load current supplied from **+RAW/+V_USER** on backplane or user-supplied **K** on user interface header J2

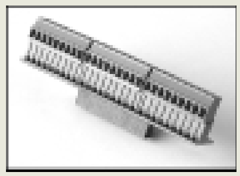
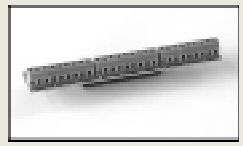
APPENDIX B.
FIELD WIRING TERMINALS

Appendix B explains how to prepare the connector on an I/O card to accept a field wiring terminal, and how to secure the field wiring terminal to the I/O card. The dimensions for the field wiring terminals are included.

B.1 Selecting and Installing a Field Wiring Terminal

Connections to the I/O cards are made via a ribbon cable connector or optional field wiring terminals that are either pluggable or have screw terminals. Three different Field Wiring Terminals (FWTs) are available. Table B-1 lists the I/O cards and the Z-World part numbers for the corresponding FWTs.

Table B-1. Guide to FWT Selection

FWT Description	I/O Cards	Z-World Part Number	
		Pluggable Terminals 	Screw Terminals 
FWT27	Digital I/O (SR9200 series)	101-0420	101-0424
FWT18	A/D Converter (SR9300 series) D/A Converter (SR9400 series) Relay (SR9510)	101-0421	101-0425
FWT18R	Relay (SR9500)	101-0422	101-0426

Before you can install the FWT you selected for your I/O card, you must remove the tabs from the connector on the I/O card. To do so, move the tab inwards as shown in Figure B-1. Then insert a screwdriver into the space below the tab on the side of the connector and gently nudge the tab up and out. If you are careful, the tab will remain intact to be saved and snapped back in place should you need to use a ribbon cable connector in the future.

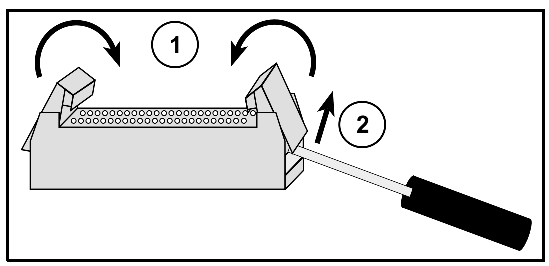


Figure B-1. Remove Tabs from Connector on I/O Card

Plug the FWT connector into the connector on the I/O card. Be sure to position the pluggable or screw connectors so that the edge of the FWT they are on faces outwards from the I/O card as shown in Figure B-2. Position the mylar insulator above the FWT as shown in Figure B-2 to protect the header pins on the printed circuit board, and secure the FWT using the two 4-40 × ¼ screws supplied.

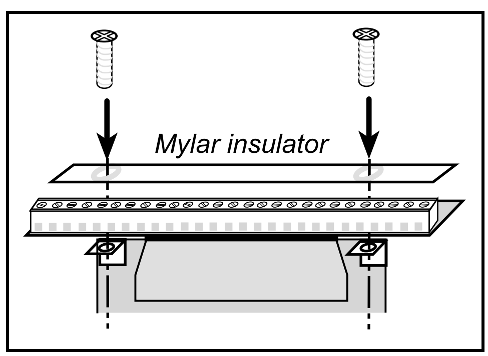


Figure B-2. Secure FWT to I/O Card

B.2 Dimensions

Figure B-3 shows the FWT dimensions.

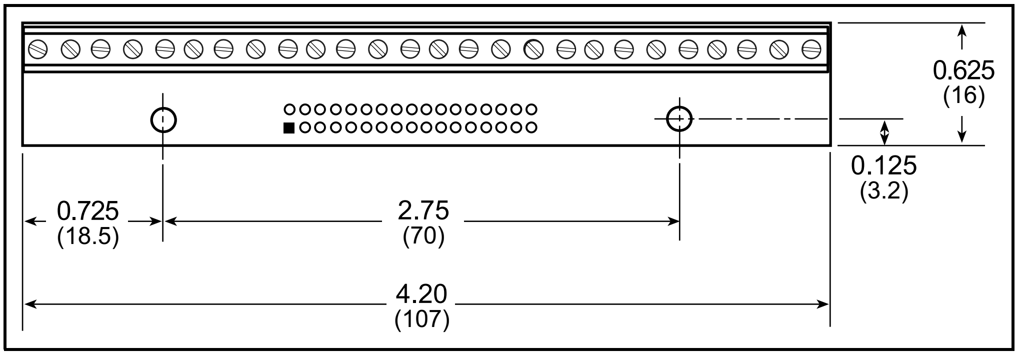


Figure B-3. FWT Dimensions

B.3 Pinouts

Figure B-4 shows the pinout for FWT27s used on digital I/O cards. Note that only 23 of the I/O points are available on the FWT27—the HVOUT7 digital output is not available on the FWT27.

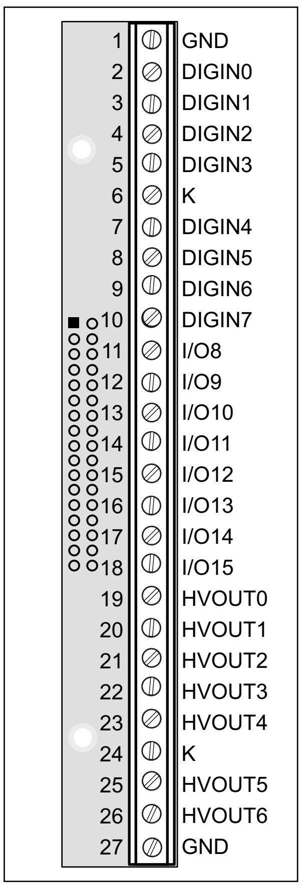


Figure B-4. FWT Pinout for Digital I/O Cards

APPENDIX C. SMART STAR SLOT ADDRESS LAYOUT

Appendix C provides information about the register addresses for the various I/O card slots on the backplane. The information in this appendix will be of interest to more advanced users.

The slots on the Smart Star backplane are accessed as external registers via the Rabbit 2000's assembly **IOE** prefix or via standard Rabbit BIOS functions. More convenient functions specific to the Smart Star control system have been written to provide more flexibility; for example, there is now a provision for the automatic update of shadow registers for each slot and for each register.

The Smart Star design routes four address bits to each slot, providing 16 register addresses for each slot. These bits are passed through as bits 0–3 of the register address. The slot number itself is assigned to bits 6–8 of the address. In addition, the backplane design requires that bits 13 and 14 be high and that bit 9 be low. The simplest way to enforce this is to use a base address of 0x6000. Table C-1 provides the address layout for accessing the Galaxy slots, where S*n* is the binary representation of the slot number (0–6), R*n* is the binary representation of the register numbers (0–15), and *X* means the value does not matter.

Table C-1. Smart Star External Register Address Bitmap

A15	A14	A13	A12	A11	A10	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0
0	1	1	0	*X*	*X*	0	S2	S1	S0	*X*	*X*	R3	R2	R1	R0

This bit mapping of the external register address provides the register addresses for each slot as listed in Table C-2.

Table C-2. Slot External Register Addresses

Slot Number	Address Range
0	0x6000–0x600F
1	0x6040–0x604F
2	0x6080–0x608F
3	0x60C0–0x60CF
4	0x6100–0x610F
5	0x6140–0x614F
6	0x6180–0x618F

C.1 Digital I/O Card Channel Layout

The digital I/O card layout is complicated by the standard Z-World method of minimizing chip layout while adding channel arrangement flexibility. In particular, the nibble-wise layout of digital input channels requires fewer chips if fewer channels are desired. This is a common feature on Z-World products and should not surprise most users. The digital output channel layout is straightforward.

It is also possible to access the digital I/O channels in banks of eight channels. This method is significantly faster than reading eight channels one at a time, and so was included in the API.

Table C-3. Digital I/O Card Bank/Channel Mapping

Local Board Address	Input Bank	Output Bank	Input Channels	Output Channels
0x00	0		0–3/8–11	
0x01	2		4–7/12–15	
0x02		1		0–7
0x03		2		8–15

INDEX

SCHEMATICS

090-0101 Digital I/O Card–Sinking (SR9200) Schematic

090-0118 Digital I/O Card–Sourcing (SR92x5) Schematic

090-0103 FWT27 Schematic

REVISION HISTORY			REVISION APPROVAL			
REV	ECO	DESCRIPTION	PROJECT ENGINEER	APPROVAL DATE	DOCUMENT CONTROL	APPROVAL DATE

APPEND THE FOLLOWING DOCUMENTS WHEN CHANGING THIS DOCUMENT:

DRAWN BY: (INITIAL RELEASE)

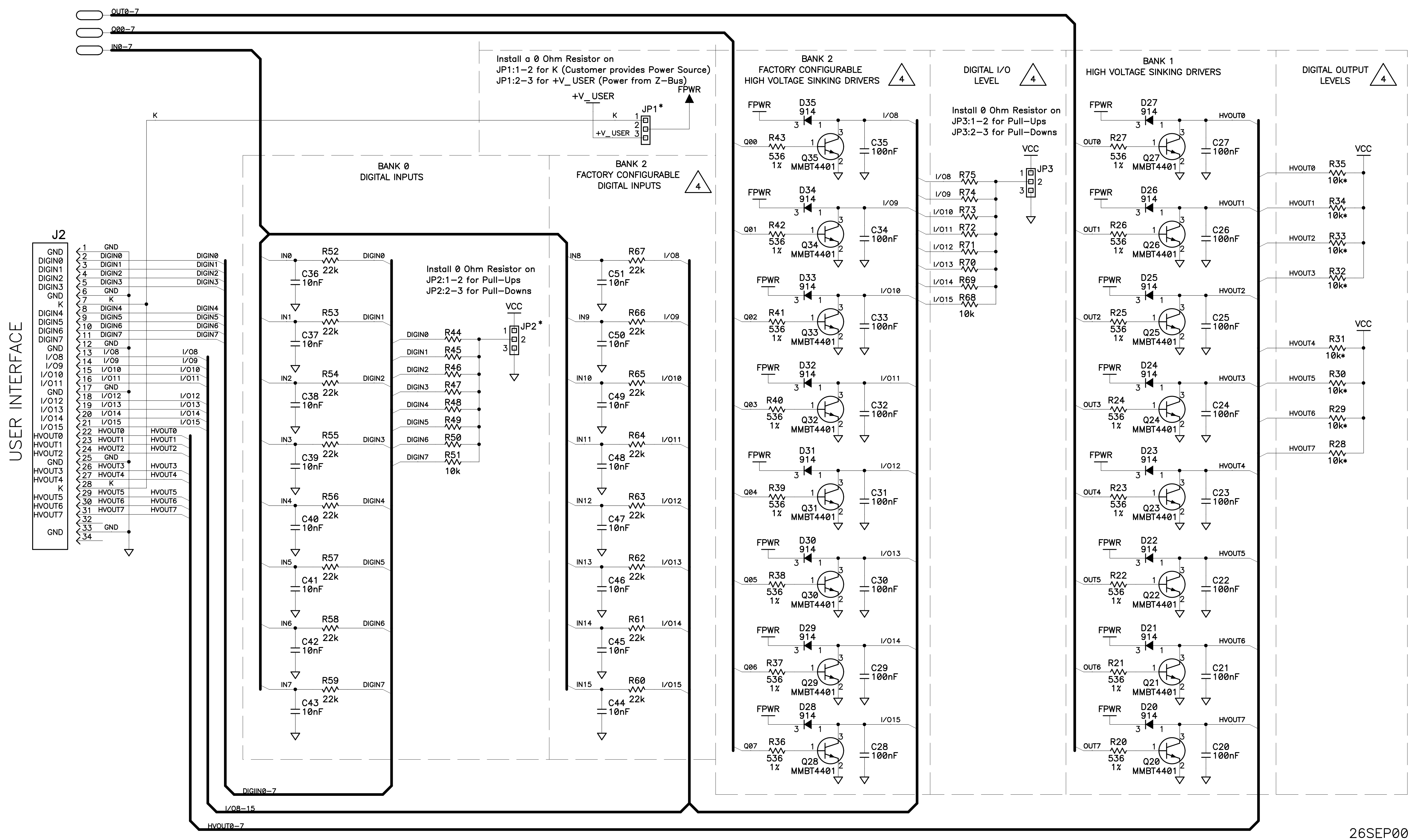
REVISED BY:

PRO

B

DATE

NONE



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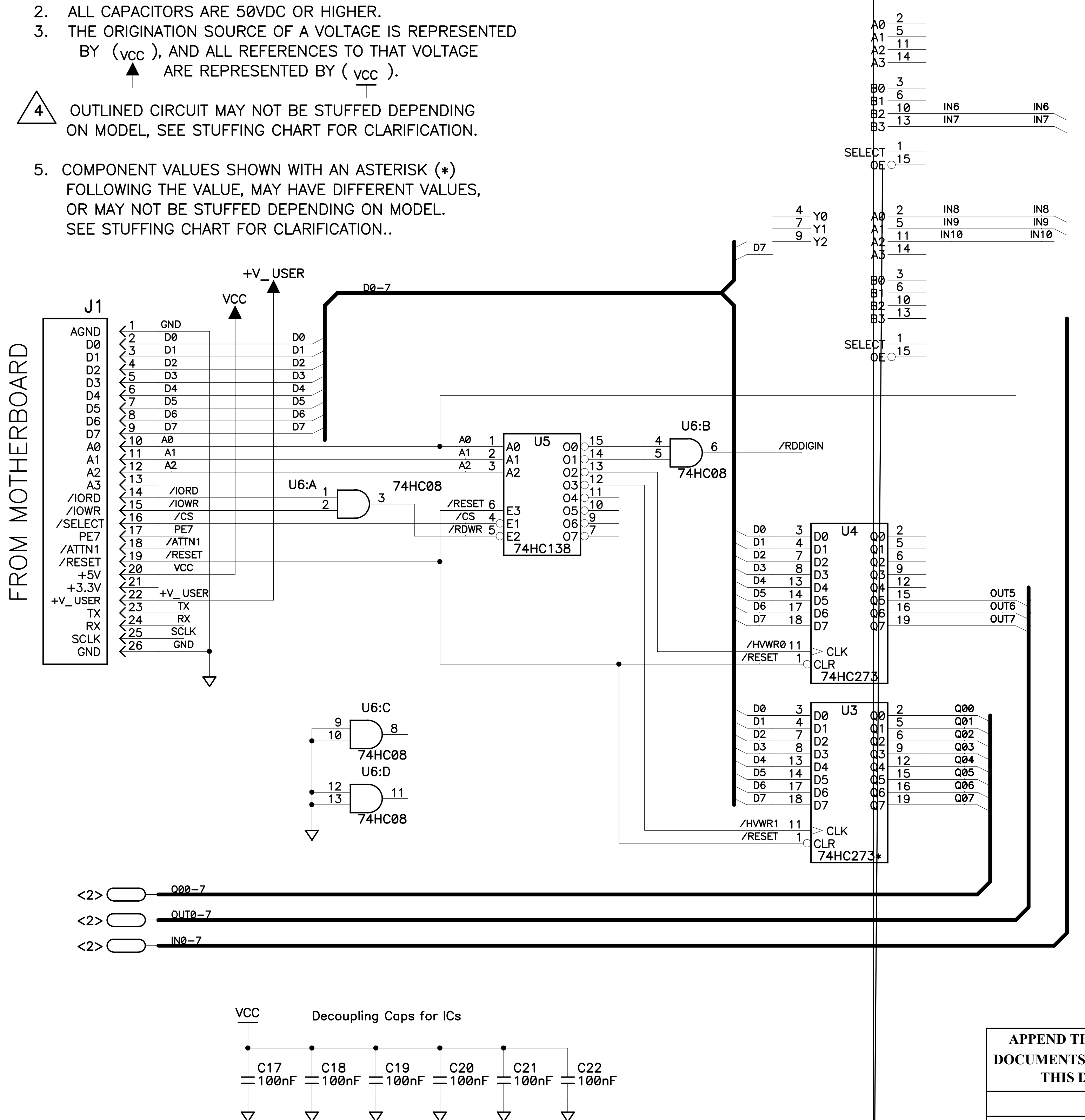
SIZE	DWG NO.		
B	090-0101		
SCALE NONE	REV LTR A	SHEET 2	OF 2

NOTES: UNLESS OTHERWISE SPECIFIED;

1. ALL RESISTOR VALUES ARE IN OHMS, 1/16W, 5%
2. ALL CAPACITORS ARE 50VDC OR HIGHER.
3. THE ORIGINATION SOURCE OF A VOLTAGE IS REPRESENTED BY (VCC), AND ALL REFERENCES TO THAT VOLTAGE ARE REPRESENTED BY (VCC).
4. OUTLINED CIRCUIT MAY NOT BE STUFFED DEPENDING ON MODEL, SEE STUFFING CHART FOR CLARIFICATION.
5. COMPONENT VALUES SHOWN WITH AN ASTERISK (*) FOLLOWING THE VALUE, MAY HAVE DIFFERENT VALUES, OR MAY NOT BE STUFFED DEPENDING ON MODEL. SEE STUFFING CHART FOR CLARIFICATION..



REVISION HISTORY			REVISION APPROVAL			
REV	ECO	DESCRIPTION	PROJECT ENGINEER	APPROVAL DATE	DOCUMENT CONTROL	APPROVAL DATE
A	E11383	INITIAL RELEASE, TRACKS A/W @ REV-A				

TABLE A

REF DES	DEVICE	DEVICE VOLTAGE INFORMATION					DEVICE: FILTER CAP
		AGND	GND	VCC	-5V	NO CONNECTS	REF DES(s)
U1	74HC257		8	16			C17
U2	74HC257		8	16			C18
U3	74HC273		10	20			C19
U4							C20
U5							C21
							C22

STUFFING TABLE

			MODEL		
CIRCUIT		PART	SR9205 16 INPUT 8 OUPUT	SR9215 8 INPUT 16 OUTPUT	SR9225 8 INPUT 8 OUTPUT
FPWR SELECT				ZERO OHM ACROSS PINS 2-3	ZERO OHM ACROSS PINS 2-3
BANK 2				ZERO ohm ACROSS PINS 2-3 100k OHMS	NOT INSTALLED
HIGH VOLTAGE SOURCING DRIVERS	CURRENT DRIVER	R72-95 C48-55 D9-16 Q17-32	NOT INSTALLED	INSTALLED	NOT INSTALLED
HIGH VOLTAGE SOURCING DRIVERS	DRIVER CHIP	U3 C19	NOT INSTALLED	INSTALLED	NOT INSTALLED
DIGITAL INPUTS	INPUT CONDITIONING	R17-24 C9-16	INSTALLED	NOT INSTALLED	NOT INSTALLED
DIGITAL INPUTS	DRIVER CHIP	U2 C18	INSTALLED	NOT INSTALLED	NOT INSTALLED
INPUT LEVEL SELECT		JP1	ZERO OHM ACROSS PINS 1-2	ZERO OHM ACROSS PINS 1-2	ZERO OHM ACROSS PINS 1-2

APPEND THE FOLLOWING DOCUMENTS WHEN CHANGING THIS DOCUMENT:	DRAWING CONTENT:	
	DRAWN BY: (INITIAL RELEASE) KAH	09NOV00
	REVISED BY: K.SCHALLER	30JAN01
	APPROVALS: INITIAL RELEASE	
	PROJECT ENGINEER:	
	ENGINEERING MANAGER:	
	SIGNATURES	DATE

TITLE

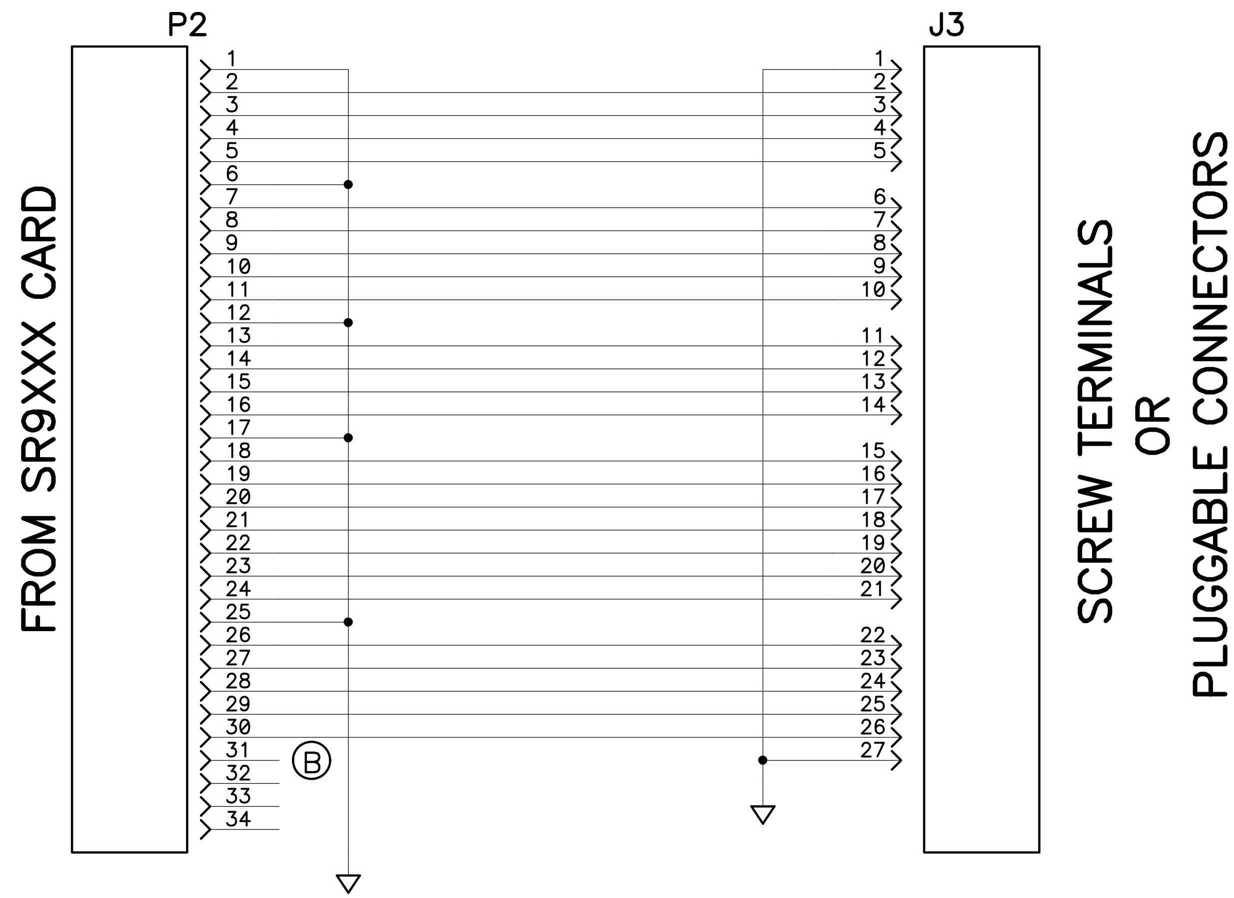
SCHEMATIC DIAGRAM SR92x5 SERIES SOURCE OUTPUT BOARD

Z-WORLD
2900 SPAFFORD ST.
DAVIS, CA 95616
530 - 757 - 4616

SIZE B | DWG NO. 090-0118

SCALE NONE | RELEASE DATE | SHEET 1 OF 2

REVISION HISTORY			REVISION APPROVAL			
REV	ECO	DESCRIPTION	PROJECT ENGINEER	APPROVAL DATE	DOCUMENT CONTROL	APPROVAL DATE
A	E11217	INITIAL RELEASE				
B	E11326	DISCONNECT PIN 31 FROM GND	DM	22DEC00		



APPEND THE FOLLOWING DOCUMENTS WHEN CHANGING THIS DOCUMENT:	

DRAWING CONTENT:

DRAWN BY: (INITIAL RELEASE) KEITH HOEK	02DEC99
REVISED BY: ERIC PEAK	22DEC00

APPROVALS: INITIAL RELEASE

PROJECT ENGINEER:	
ENGINEERING MANAGER:	
SIGNATURES	**DATE**

TITLE
SCHEMATIC DIAGRAM SR9XXX SERIES 27 POSITION FIELD WIRING TERMINAL

Z-WORLD
2900 SPAFFORD ST.
DAVIS, CA 95616
530 - 757 - 4616

SIZE	DWG NO.
A	090-0103

SCALE	NONE	RELEASE DATE		SHEET	1	OF	1