EXP-GP

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4/02

User Guide

for the

EXP-GP

Signal Conditioning

Multiplexer

Revision C - September 1991

Part Number: 24814

New Contact Information

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Contents

CHAPTER 1

INTRODUCTION

1.1 GENERAL

The EXP-GP general-purpose accessory board is an 8-channel multiplexer/signal-conditioner module for processing low-level signals from transducers and other measurement/control devices and instruments. In addition to signal processing, the EXP-GP also furnishes excitation for the precision-bridge measuring circuits used by RTDs, strain gages, and other transducers.

The EXP-GP is designed primarily for use with its PC-bus-compatible data-acquisition modules (the DAS-8, DAS-16, and DAS-20 models). However, the EXP-GP can function with any analog input board from any manufacturer or as a stand-alone signal preamplifier/multiplexer.

Each of the module's eight channels uses a differential, bipolar input and offers switch-selectable gains of 1, 10, 100, and 1000 (2.5, 25, 250, and 2500 when using the X2.5 board-level switch). The module normally supports 2-, 3-, and 4-wire RTDs (DIN and SAMA standards); 1/4, 1/2, and full-bridge strain gages; and J-, K-, T-, R-, S-, B-, and E-type thermocouples. A single module can also accommodate a cascade of up to 64 analog signals (56 thermocouples w/CJC). Each input channel contains a 1mA precision current source (for current-excited transducers) and a 0.5-, 1.0-, 2.0-, 4.0-, or 10-volt (switch-selectable) precision reference. Signal input is via on-board screw terminals.

The EXP-GP software package includes examples and routines for using the module with the DAS-8, the DAS-16, and the DAS-20. The routines are for linearizing thermocouples, for setting up multiple EXP-GP modules, for using RTDs, etc.; they are also adaptable to custom programming by the user. If custom programming is required, every channel on every module is readily accessible via a 3-bit TTL/CMOS compatible address code.

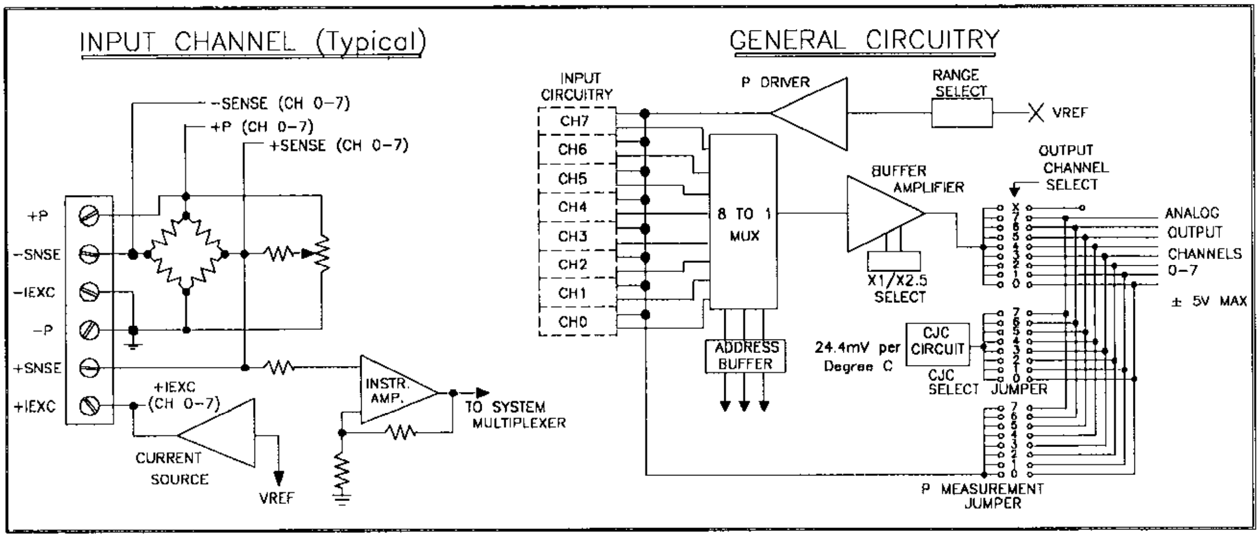
1.2 FEATURES

Among the noteworthy design features of the EXP-GP is the position of the MUX stage. Placing MUX after the amplification stage eliminates the affect of MUX current leakage on signal integrity. Other features are as follows:

- Compatible with the DAS-8, DAS-16, and DAS-20 modules.
- Supports J-, K-, T-, R-, S-, B-, and E-type thermocouples (w/CJC).
- Supports 2-, 3-, and 4-wire RTDs (DIN and SAMA).
- Supports 1/4, 1/2, and full-bridge strain gages.
- Provides signal conditioning with multiple gain selection.
- Software includes operational support as well as examples and routines for custom programs.

1.3 BLOCK DIAGRAM

EXP-GP circuits are as shown in the following block diagram.



Block diagram of EXP-GP circuitry.

1.4 SPECIFICATIONS

Instrumentation Amplifier:

Gains: Switch-selectable gains of 1, 10, 100, or 1000 for each channel. Using the X2.5 board-level jumper, gain selections become 2.5, 25, 250, or 2500.

GAIN	GAIN ERROR (TYPICAL)	GAIN ERROR (MAX.)
1000, 2500	0.2%	0.90%
100, 250	0.05%	0.40%
10, 25	0.02%	0.35%
1, 2.5	0.01%	0.15%

GAIN	INPUT OFFSET DRIFT	COMMON MODE REJECTION	GAIN NON-LINEARITY
*1000, 2500	5.1µV/°C	100dB	0.15%
100, 250	5.1µV/°C	100dB	0.075%
10, 25	6µV/°C	100dB	0.045%
1, 2.5	15µV/°C	94dB	0.045%

GAIN	GAIN TEMPERATURE COEFFICIENT
1000, 2500	20ppm
100,250	15ppm
10, 25	15ppm
1, 2.5	10ppm

Thermocouple Types:	J, K, E, S, R, B, T
Cold-Junction Compensation:	+24.4 mV/°C (0.1°C/bit) Adjustable.
Input Bias Current:	25nA Typical; 50nA Max.
MUX Settling Time:	4µs FS step to 0.01%.

Overvoltage Protection:

Common Mode:	±50V Continuous.
Analog Output Voltage:	±5VDC (Max.).
Analog Output Current:	10mA (Max.).

Excitation Voltage Source (Requires external +15VDC Source):

Source: External +15VDC Supply.

Range: 0 to 0.5, 1, 2, 4, and 10VDC.

Current:	350mA (Short-Circuit Protected).

Excitation Current Source:

Number of Sources:	8.
Excitation Current:	1mA (adjustable).
Compliance:	0 to 2VDC.
Maximum Voltage:	30VDC.

Power Requirements:

Voltage (+5V):	5VDC ±0.5V Adjustable @ 380mA Max.
Voltage (+15V):	+15VDC Needed if using bridge excitation.

Mechanical:

Dimensions:	16 X 4.75 in. (40.63 X 12.07 cm)
External Wiring:	Screw Terminals accept wire sizes 12-22 awg

Environmental:

Operating Temperature Range:	0 to 60°C.
Storage Temperature Range:	-40 to +100°C.

Humidity: 0 to 90% Non-condensing.

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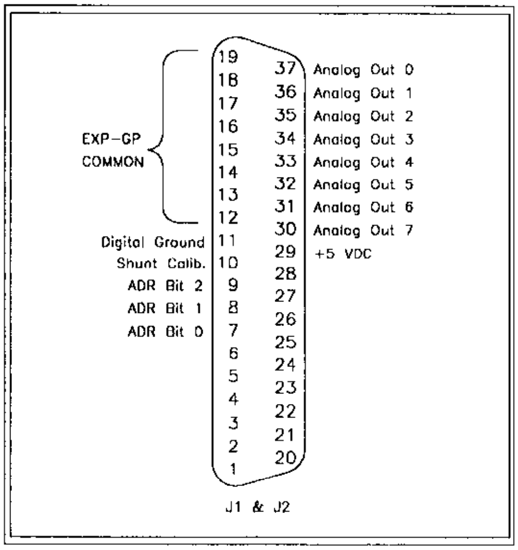
HARDWARE DESCRIPTION

2.1 CONNECTORS J1 AND J2

Figure 2-1. Pinouts for I/O Connectors J1 and J2.



2.2 ACCESSORIES AND CABLE SELECTION

The EXP-GP can operate with the DAS-8, DAS-16, or DAS-20 analog input boards; it can also operate with an 8/16-channel A/D board from any other manufacturer (refer to Section 2.3 of this manual for wiring). You must switch any 8/16-channel A/D board to be used with the EXP-GP to its single-ended-input. Use the following table and Figure 2-2 to determine your cable needs for operating the EXP-GP with other boards from the manufacturer.

BOARD	CABLE
DAS-8 (PGA)	C-1800
DAS-16 (F,G)	S-1600
DAS-20	CEXP-2000
STA-08	C-1000
STA-20	ADP-5037/GP
Cascaded EXP-GP	C-1000

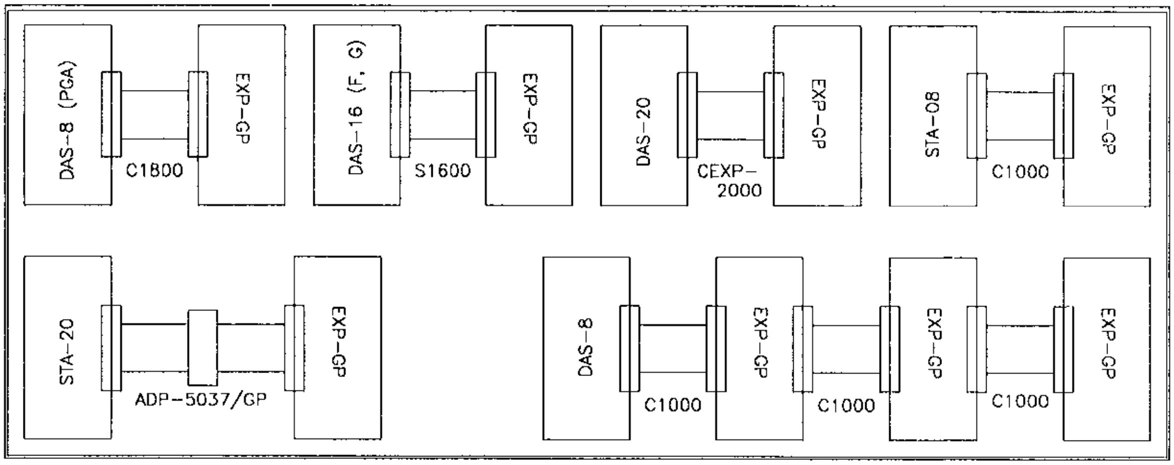


Figure 2-2. Diagrams of EXP-GP interconnections to other boards from the manufacturer.

2.3 POWER SUPPLIES AND GROUND RETURNS

An EXP-GP generally draws its power from the supply of the host computer via the DAS-8, DAS-16, or DAS-20. However, multiple EXP-GPs may require more power than a computer supply can deliver and may therefore require an auxilliary supply.

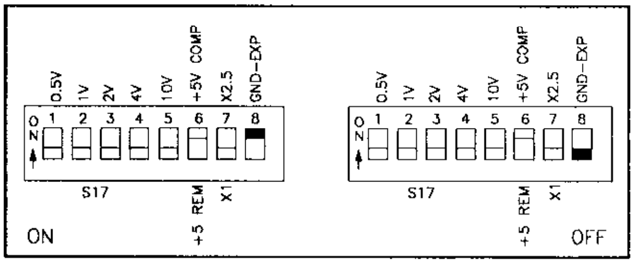
If an auxiliary supply is necessary, it must be a +5VDC supply capable of delivering 380mA for each EXP-GP. Connections for an auxilliary supply are the +5V REMOTE and +5V RTN screw terminals on TB9 (adjacent to the J2 connector); and when using an auxiliary +5V supply, set DIP Switch S17/Position 6 at +5 REM. If more than one EXP-GP is to use external power, wire each to the external supply from the +5V REMOTE and +5V RTN terminals and set Position 6 of their S17 DIP switches to +5 REM.

TB9 also has connections for an external source of bridge excitation. These connections are the +15V and +15V RTN screw terminals. The source must deliver 350mA at +15VDC to these terminals.

NOTE: If you intend to power multiple EXP-GPs from your computer supply, be sure the supply can deliver 380mA per EXP-GP module. Otherwise, you will risk serious damage to your computer supply.

When using any of the manufacturer's A/D boards with an EXP-GP, disconnect their Analog (LL) and Digital Grounds by setting the EXP-GP's DIP-Switch-S17/Position-8 to Off (down). If using EXP-GP as a stand-alone, connect the Analog and Digital Grounds together by setting DIP-Switch-S17/Position-8 to On (up). These settings are illustrated in Figure 2-3.

Figure 2-3. Diagram of DIP Switch S17 showing Switch Position 8 set to configure the EXP-GP for stand-alone grounding (ON) and for external-board grounding (OFF). Refer to Section 3.9 for other S17 positions.



2.4 GUIDELINES FOR USING MULTIPLE EXP-GPs

A single 8-channel A/D board can operate with a cascade of up to eight EXP-GP boards. This arrangement provides up to 64 analog input channels (56 with CJC; when using CJC or +VEXC, the number of channels decreases accordingly).

The cascade must be a daisy-chain using each EXP-GP's parallel J1 and J2 connectors and the required number of C-1000 cables. As mentioned in the preceding section, a multiple EXP-GP arrangement may require an auxilliary power source.

2.5 OUTPUT CHANNEL SELECTION

The multiplexed/conditioned inputs of an EXP-GP must be directed to a single output channel. Select an output channel by placing a jumper on the desired terminals of Jumper Block J4 (one of three jumper blocks adjacent to Connector J2, as shown in Figure 2-4). Note that the output channel of the EXP-GP must match the input channel of the supporting A/D board. Also note that no two EXP-GPs of a cascade can use the same output channel; each EXP-GP in the cascade must have its own output channel assignment.

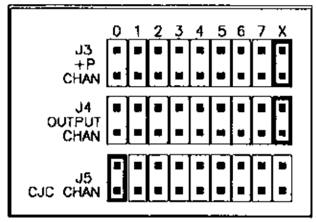


Figure 2-4. Diagram of J3, J4, and J5 jumper blocks. J4 is used for output channel selection. J3 and J5 are used as described in Sections 3.8 and 3.3, respectively.

NOTE: When using a DAS-8(PGA), DAS-16(F,G), or DAS-20 with an EXP-GP, configure it for single-ended operation.

2.6 GAIN SELECTION

EXP-GP input channels configure individually for gain, allowing you to "fine-tune" each channel for each input signal. In addition, an EXP-GP offers a choice of X1 or X2.5 gain multiplication. Resulting gain options for a board are 1, 10, 100, and 1000 or 2.5, 25, 250, and 2500.

A 3-position DIP switch selects individual input-channel gain from options of 1, 10, 100, and 1000 (the '1' option is obtained by setting the 10, 100, and 1000 positions to OFF, as shown in Figure 2-5). The 3-position gain switches and their corresponding channels are as follows:

Channel O: Switch S1	Channel 4: Switch S9
Channel 1: Switch S3	Channel 5: Switch S11
Channel 2: Switch S5	Channel 6: Switch S13
Channel 3: Switch S7	Channel 7: Switch S15

DIP Switch S17, Position 7 offers the X1/X2.5 gain multiplication choices. Figure 2-5 illustrates S17 and a channel GAIN switch.

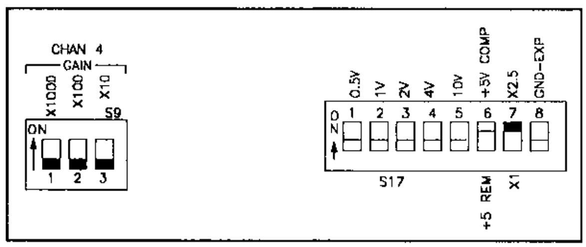


Figure 2-5. Switch S17 and a channel GAIN switch with a combination of gain settings that yield a channel gain of 2.5 on Channel 4.

For suggestions on gain versus channel usage, refer to Chapter 3.

NOTE: Configure any unused channel for a gain of X1 to reduce power consumption.

2.7 INPUT CHANNEL SELECTION

Input-channel selection on an EXP-GP uses a 3-bit TTL/CMOS address code (on Pins 7,8,and 9 of J1) that corresponds to the three digital ouptut bits from an A/D board (DAS-8, DAS-16, and DAS-20. The address code is straight binary, as follows:

A2	A1	A0	EXP-GP INPUT CHANNEL		3-BIT ADDRESS CODE DAS-8	DAS-16	DAS-20
0	0	0	CH0	A2=	OP3	OP2	DOUT2
0	0	1	CH1	A1=	OP2	OP1	DOUT1
0	1	0	CH2	A0=	OP1	OP0	DOUT0
0	1	1	CH3				
1	0	0	CH4				
1	0	1	CH5				
1	1	0	CH6				
1	1	1	CH7				

CHAPTER 3

APPLICATIONS

3.1 GENERAL

You can configure each of the eight EXP-GP channels for direct interface with 2-, 3-, and 4-wire devices. Configuration uses DIP switches (refer to Section 3.6) and on-board switching to route signals from the +SENSE, -SENSE, +IEXC, -IEXC, +P, and -P screw terminals to the various pins of the J1/J2 connectors.

3.2 THERMOCOUPLES AND SUGGESTED GAIN

The EXP-GP Board supports all the common thermocouple types, including J, K, T, R, S, B, and E. At the same time, the Board contains separate gain settings for each channel. These features allow thermocouples and other high- and low-level analog signals to be fed to a Board simultaneously.

The recommended gain for each thermocouple type is shown in the following chart. These recommendations are based upon the full-range temperature span for each thermocouple type, as given by the National Bureau of Standards' (NBS) *mV vs Temp* table.

THERMOCOUPLE TYPE	MAXIMUM OUTPUT	MAXIMUM DEG. C	SUITABLE GAIN
J	43mV	760	100
K	55mV	1370	100
T	21mV	400	250
E	76mV	1000	100
S	19mV	1760	250
R	21mV	1760	250
B	14mV	1760	250

NOTE Higher gains may be used for less than full-scale span. Gains based on a ±5V output.

Many applications do not use the entire temperature range; instead, they operate within a narrow temperature band. A narrow band of operation allows you to "fine tune" the input channel for the reduced range and to employ a simple linear-interpolation method for conversion to temperature. The linear interpolation (slope) method often results in greater accuracy over a restricted range than is otherwise possible.

3.3 CJC OUTPUT CHANNEL SELECTION AND FLOATING INPUTS

Built-in CJC circuitry enables the EXP-GP to produce 24.4 mV/°C (0.1°C/bit) with 0.0 mV at 0°C. As such, the EXP-GP should be shielded from drafts and direct sunlight in order to accurately reflect room temperature. The CJC signal may be routed to any unused A/D channel (via Jumper J5) for use in developing software compensation for the CJC function. NOTE that the CJC output channel must be a distinct, unused channel to avoid signal conflicts and erroneous results. If CJC is not used, Jumper J5 should be placed in the "X" position.

Since a thermocouple is a floating (non-ground referenced) voltage source, the EXP-GP low input leg (-SENSE) must be referenced to ground. **NOTE: You must configure the thermocouple input channel for a 2/4-wire input device (see Section 3.5), or you will risk erroneous readings.** Reference the low (-) thermocouple input side to ground easily by connecting a wire (jumper) between the -SENSE and the -IEXC terminals for the selected channel.

3.4 OPEN THERMOCOUPLE DETECTION AND INPUT FILTERING

You can configure the EXP-GP for OPEN thermocouple detection by installing a 100 MOhm resistor at the TCPL position(s) of the desired input channel(s). In addition to the TCPL designation, the board also contains an RX number for this resistor position at each channel. The RX number and corresponding channel number for these positions are listed as follows:

Channel 0: RX5	Channel 4: RX29
Channel 1: RX11	Channel 5: RX35
Channel 2: RX17	Channel 6: RX41
Channel 3: RX23	Channel 7: RX47

When installed, the biasing resistor slowly pulls an OPEN input channel to -5VDC, which can be sensed and flagged in software. NOTE that the low side of the thermocouple must be referenced to ground (see Section 3.3 for details).

3.5 THERMOCOUPLE WIRING DIAGRAM

To wire a thermocouple to any EXP-GP channel, attach the positive side of the device to the +SENSE terminal and the negative side to the -SENSE terminal. Note that the diagram below (Figure 3-1) shows the ground reference wire connected between the -SENSE and -IEXC terminals; the channel has been configured as a 2/4-wire input device (via S8).

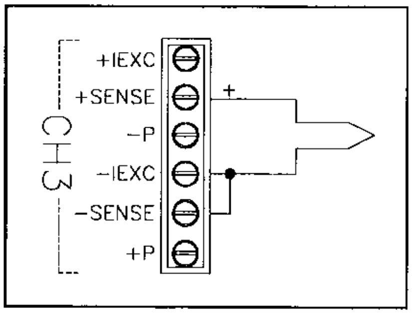


Figure 3-1. Thermocouple input wiring for a channel.

3.6 RTDs AND OTHER 2-, 3-, AND 4-WIRE DEVICES

The EXP-GP provides 1mA excitation for 2-, 3-, and 4-wire RTDs. Example programs supporting both DIN and SAMA standards are available on the accompanying diskette. Each RTD type requires different wiring and board configurations. Suggested gain for RTDs is X25 (Section 2.6). The following table and switch diagram will aid in the setup of the EXP-GP channels for various RTD inputs.

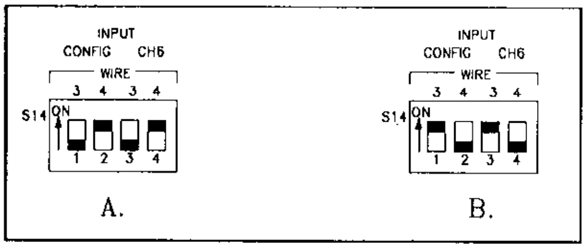


Figure 3-2. Channel Wire Input switch configurations for 2- and 4-wire RTDs (Part A.) and for 3-wire RTDs (Part B).

CHANNEL	SWITCH	CHANNEL	SWITCH
0	S2	4	S10
1	S4	5	S12
2	S6	6	S14
3	S8	7	S16

DIN and SAMA are the two RTD types most commonly used. Using either type with an EXP-GP channel configured for a gain of 25 permits temperature measurements from -200 to 260° C. The Distribution Software diskette contains the programs DO8-DRTD.BAS and DO8-SRTD.BAS for setting up measurement and performing linearization for DIN and SAMA RTD types. The tables used in these programs are accurate to 0.1%.

3.7 RTD WIRING DIAGRAMS

Use the wiring diagrams of Figure 3-3 as guides for RTD or RTD-based transducers.

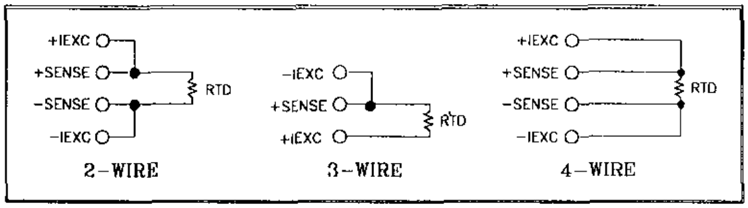


Figure 3-3. Wiring guides for RTDs.

Of the three choices of RTD wiring methods (2-, 3-, and 4-wire) available to you, the 4-wire offers optimum performance. In a 4-wire connection, one pair carries the excitation current while the other pair senses the voltage drop across the RTD and carries no current. Thus, there is no voltage loss in the sense wires of a 4-wire connection.

Since a 4-wire connection uses four wires, it is the more expensive choice of wiring methods. To compromise between cost and optimum performance, you may use a 3-wire connection with automatic lead-wire compensation. The EXP-GP electronically provides the lead-wire compensation in the 3-wire connection shown in Figure 3-3.

NOTE **If you use a 3-wire connection to any EXP-GP channel, you must recalibrate that channel accordingly. The recalibration is necessary because the manufacturer precalibrates all channels of the EXP-GP board for 2/4-wire measurements.**

3.8 BRIDGE MEASUREMENTS

The EXP-GP supports a number of transducers that use the resistance-bridge measurement technique (Strain Gages, etc.). Bridge measurement is one of the more accurate methods of determining unknown resistance values and is therefore quite popular for precision transducers based upon change in resistance with respect to physical parameters (temperature, pressure, strain, etc.). Essentially, bridge measurement techniques call for substituting an unknown resistance into one or more legs of a full bridge of known values. As you would expect, this technique requires excitation (voltage) whose value is scaled by the EXP-GP; the excitation is provided by an external source.

Should it be necessary to measure the excitation voltage at the point of load, connect the +P and -P lines from the point of load to +S and -S on an available EXP-GP channel configured for 2-wire measurement. The measured value can be used in software as the true bridge excitation voltage.

3.9 BRIDGE COMPLETION AND EXCITATION

The EXP-GP contains clearly labeled spaces for bridge resistors within the circuit areas of each channel. Using an external supply (+15 ±1.5V at 350 mA min), the Board can deliver bridge-excitation voltages of 0.5, 1.0, 2.0, 4.0, and 10 volts.

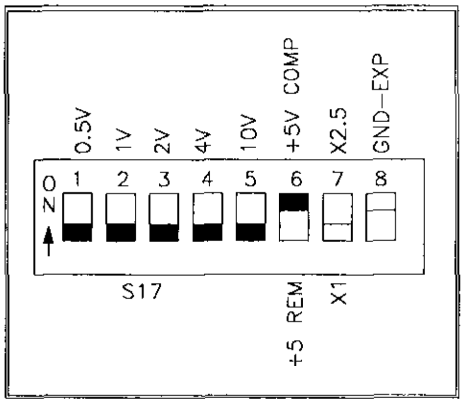


Figure 3-4. Switch S17 excitation volyage settings.

You connect the external supply between the +15V and -15VRTN terminals of Connector TB9, and you set the excitation voltage level using Switch S17 (Figure 3-4). Bridge circuitry and corresponding resistor identifications for each channel are shown in Figure 3-5.

For the majority of transducer applications employing bridges, the *deviation* of one or more resistors in a bridge from an initial value must be measured as an indication of the magnitude (or a change) of the measurand. Figure 3-6 shows a bridge with all resistances nominally equal; but one of them (R) is variable by a factor, (1 + X), where X is a fractional deviation around zero, as a function of (say) strain. As the equation indicates, the relationship between the bridge output and X is not linear, but for small rangesof X it is sufficiently linear for many purposes. For example, if Pin = 10V, and the maximum value of X is ±0.002, the output of the bridge will be linear to within 0.1% for a range of outputs from 0 to ±5mV, and to 1% for the range 0 to ±50mV (±0.02 range for X).

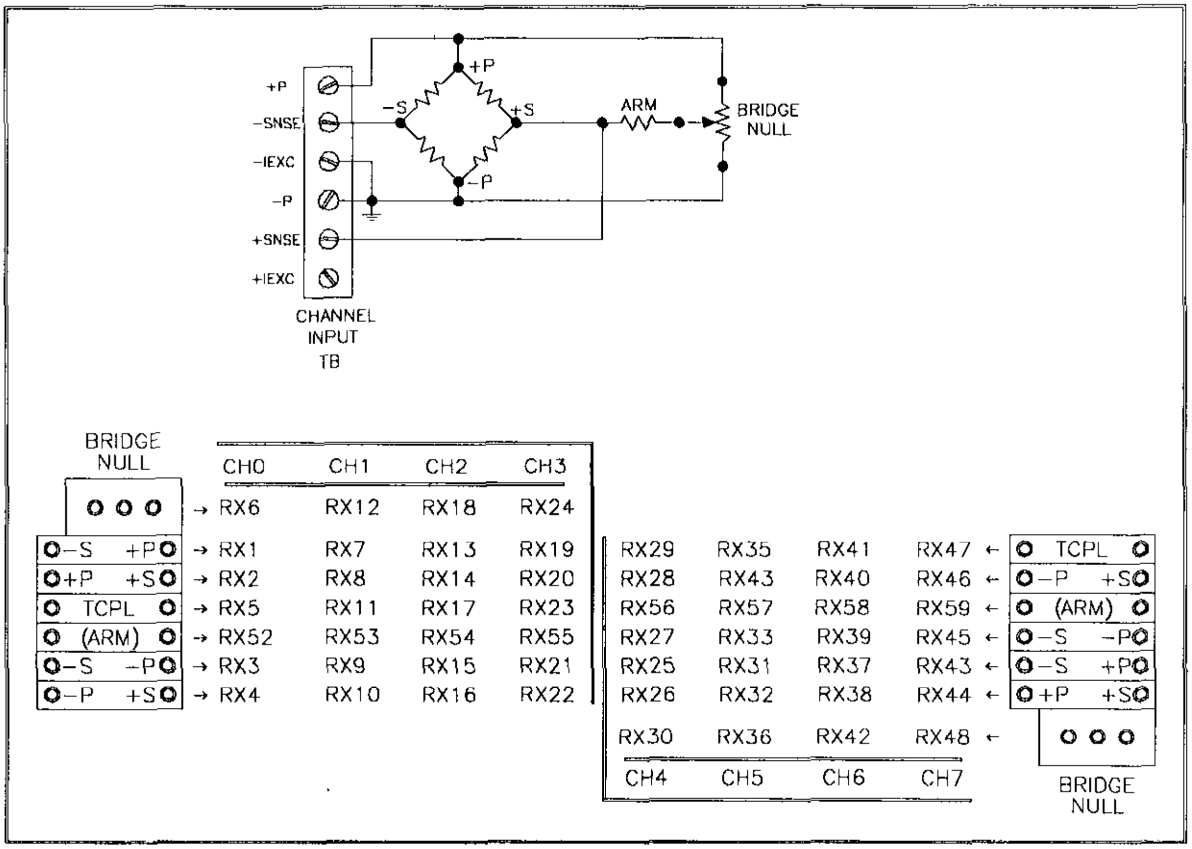
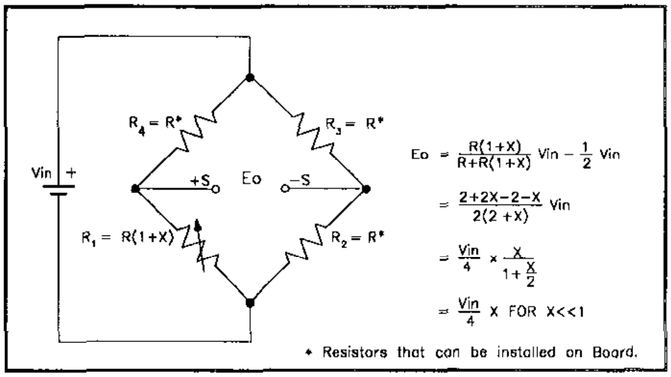


Figure 3-5. Bridge circuit and corresponding bridge resistors for each channel.

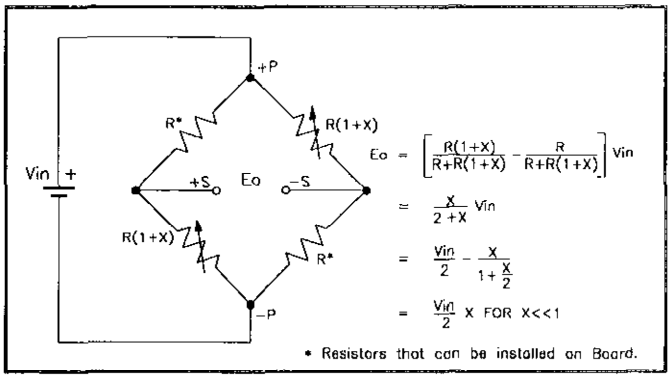
Figure 3-6. Bridge used to read deviation of a single variable element.



The *sensitivity* of a bridge is the ratio-to-the-excitation-voltage of the maximum expected change in the value of the output; in the examples given in the last paragraph, the sensitivities are ±500μV/V and ±5mV/V. The sensitivity can be doubled if two identical variable elements can be used, for example, at positions R3 and R1, as shown in Figure 3-6. An example of such a pair is two identically oriented strain-gage resistances aligned in a single pattern. Note that the output is doubled, but the same degree of nonlinearity exists.

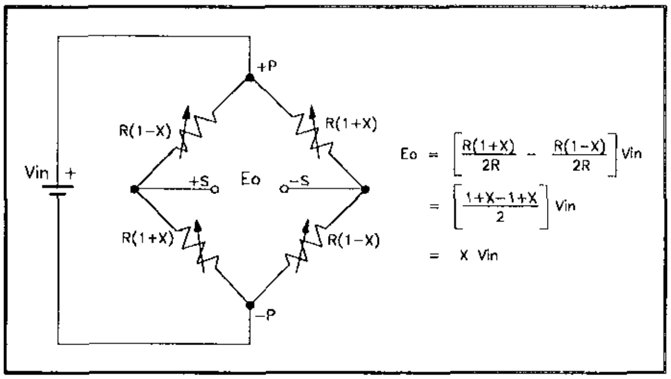
In special cases, another doubling of the output can be achieved. Figure 3-7 shows a bridge consisting of four resistors, two of which increase and two of which decrease in the same ratio. Two identical 2-element strain gages, attached to opposite faces of a thin carrier to measure its bending, could be electrically configured in this way. The output of such a bridge would be four times the output for a single-element bridge. Furthermore, the complementary nature of the resistance changes would result in a *linear* output.

Figure 3-7. Bridge with two variable elements.



Bridge completion may be done either on the EXP-GP or remotely. Configurations using remote bridge completion resistors require only that the EXP-GP be configured for 2/4-wire measurements and that signals and excitation be wired as shown in Figure 3-11.

Figure 3-8. All elements variable.



For bridge completion on the EXP-GP board, the board is pre-drilled to accept user-installed standard 1/4W resistors. Each of the Board's channel sections contains predrilled holes for the bridge resistors listed in Figure 3-5.

In addition to the EXP-GP board's bridge-resistor holes for each channel, the EXP-GP also contains holes for the user-installation of resistors RX49 and RX50, which can be shared by any or all channels. The RX49/RX50 set (shown in Figure 3-9 as Common Bridge Resistors) can form two legs of the shared bridge. To implement a quarter bridge with RX49/RX50, the user needs only to insert one additional resistor for each attached channel; the additional resistors (shown in Figure 3-9 as Bridge Completion Resistor) and their corresponding channels are listed in the table that follows. The user also needs to wire the +P, -P, and +SENSE terminals for each of these channels to the corresponding terminal on the TB9 screw-terminal block, as shown in Figure 3-9.

EXP-GP CHANNEL	BRIDGE COMPLETION RESISTOR
0	RX1
1	RX7
2	RX13
3	RX19
4	RX25
5	RX31
6	RX37
7	RX43

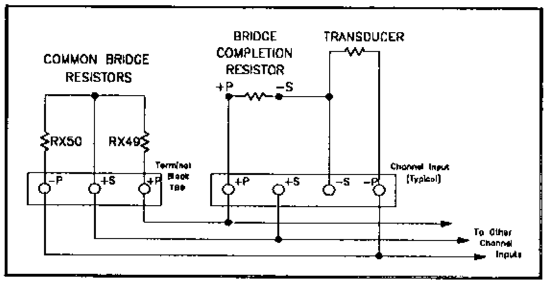


Figure 3-9. Connections for sharing Common Bridge Resistors RX49 and RX50 with any or all channels. Note that wiring from TB9 must connect to the channel input connectors.

Rather than set up Common Bridge resistors RX49 and RX50, the user may opt to share the bridge resistors of an existing channel with one or more additional channels. Connections for this type of bridge sharing should follow the diagram of Figure 3-10.

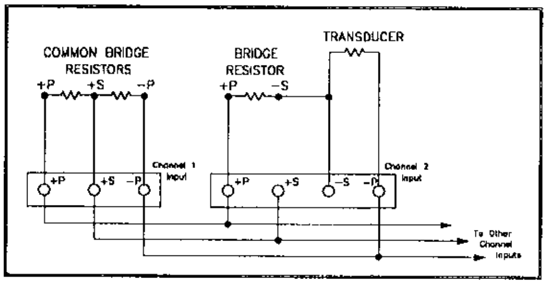


Figure 3-10. Connections for sharing bridge resistors between any or all EXP-GP channels. Note that interchannel wiring must connect to the channel input connectors.

For remote bridge completion, use the connections shown in Figure 3-11. These connections extend from the remote location to the channel terminal block on the EXP-GP board.

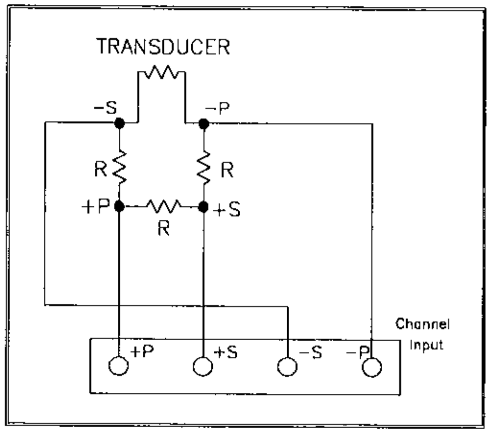


Figure 3-11. Connections for remote bridge resistors.

3.10 NULLING THE BRIDGE

Typically after any bridge completion, you will have to null the bridge. For example, if a bridge has been set up to measure strain and if all strain gages in the legs of the bridge are not under stress, the output of the bridge should be zero.

Each EXP-GP channel has spaces for an ARM resistor and a NULL potentiometer, as shown in Figure 3-5. These two components work together to null the bridge. Their values depend on the resistances in each leg of the bridge. The following list is a guide to the selection of their values.

Bridge Resistance (Per Leg):	350Ω
ARM Resistor:	75KΩ
NULL Potentiometer:	50KΩ

CHAPTER 4

SOFTWARE

4.1 GENERAL

The EXP-GP comes complete with several BASIC programs and subroutines designed to help users become familiar with the board and its various callable routines. These routines are for use in conjunction with the manufacturer's DAS-8, DAS-16, and DAS-20 modules.

This chapter contains instructions and procedures for EXP-GP users. At the same time, the material herein assumes the EXP-GP user to be familiar with one of the A/D boards listed above and its associated programming.

4.2 EXP-GP INPUT CHANNEL SELECTION USING THE DAS-8

The DAS-8 selects an EXP-GP input channel with a Mode 14 call routine. A Mode 14 call latches the OP0 through OP2 lines and then calls Mode 4 to perform an A/D conversion on the latched channel. Each additional EXP-GP channel selection by the DAS-8 requires another round of Mode 14 and Mode 4 calls. The most convenient method of scanning the 8 EXP-GP channels is by use of a "FOR ... NEXT" loop as follows:

```
xxx10     DIM DIO%(8)
xxx20     MD%=1:DIO%(0)=1:DIO%(1)=1      'Select DAS-8 input channel.
xxx30     CALL DAS-8(MD%,DIO%(0),FLAG%) 'Call Mode 1 routine.
xxx40     FOR I=0 TO 7        'EXP-GP loop counter.
xxx50     MD%=14:OP%=I        'Mode 14; Adr Bits set to I.
xxx60     CALL DAS-8(MD%,OP%,FLAG%)      'Call Mode 14; EXP-GP CH select.
xxx70     MD%=4               'Set Mode 4.
xxx80     CALL DAS-8(MD%,DIO%(I),FLAG%) 'Call Mode 4, Do A/D conversion.
xxx90     NEXT I              'Select next Ch, check for end
```

Following this procedure, the data from Channel 0 will be in DIO%(0), Channel 1 in DIO%(1), etc. If another EXP-GP is scanned, the same procedure may be used selecting a different DAS-8 input channel. Nested "FOR...NEXT" loops are quite efficient for scanning multiple EXP-GP's.

NOTE The DAS-16 and DAS-20 require a similar procedure. See the example programs.

4.3 TRANSDUCER ROUTINES

EXP-GP software includes several programs complete with subroutines for using the EXP-GP with RTD's and common thermocouples. The software supplies separate programs for the DAS-8, DAS-16, and DAS-20. These routines are stored in ASCII format for easy incorporation into your own BASIC programs. For more information on these programs, refer to the README.DOC file on your Distribution Software diskette and to the individual programs.

4.4 EXP-GP SOFTWARE

The following routine shows how data returned from the DAS-8 may be converted to volts. The returned data, D%(0), ranges from -2048 (-5 volts) to +2047 (4.9975 volts).

```
820 MD%=4: D%(0)=0:
822 CALL DAS8 (MD%,D%(0),FLAG)
830 AV = 500 Assumes EXP-GP channel is configured for gain = 500
850 V = (D%(0)*5)/(AV*2048)
```

■ ■ ■

CHAPTER 5

CALIBRATION

5.1 GENERAL

The manufacturer tests and calibrates each EXP-GP prior to shipment. Physical parameters such as component age, computer supply voltage variations, and normal amplifier drift are all factors of the need for periodic recalibration. Recalibrating the EXP-GP is a simple procedure requiring little time, and it should be done periodically to maintin the board's accuracy. Recalibration intervals vary according to the board's environment. Large thermal gradients, high humidity, and/or excessive vibration can require calibration as often as every three months. In a laboratory, office, and other stable environment, calibration intervals of six months to one year are normally adequate.

NOTE: **Perform calibration under actual usage conditions and while the board is fully configured (including gain settings). However, changing the gain of a particular channel will require recalibration of that channel.**

5.2 EQUIPMENT

- 5 1/2 Digit DVM.
- Accurate, noise-free DC voltage reference source.
- Accurate Digital thermometer (±2 °C).
- Small slot-head screwdriver or potentiometer trimmer.

5.3 CHANNEL ZERO ADJUSTMENT

1. Configure the EXP-GP for daily operation (measurement type and gain).
2. 2- and 4-wire device configurations require the +SENSE, -SENSE, and -IEXC terminals to be wired together. 3-wire device configurations require the +SENSE, +IEXC, and -IEXC terminals to be wired together.
3. Power the EXP-GP (via A/D board or independently, as described earlier).
4. Select the EXP-GP channel you wish to calibrate by using the A/D board to issue the corresponding 3-bit code.
5. Connect the low (-) side of the DVM to TP1 (located to the right of the J2 connector) and the high (+) side of the DVM to TP3 (located to the right of the J5 jumper block).
6. Adjust the OFF ADJ potentiometer for the channel being calibrated for best 0-VDC reading on the DVM. The following table shows the data channels and their corresponding potentiometers.

EXP-GP CHANNEL	OFF ADJ POT.
CH 0	R10
CH 1	R20
CH 2	R30
CH 3	R40
CH 4	R50
CH 5	R60
CH 6	R70
CH 7	R88

5.4 CJC CALIBRATION

1. Connect the DVM from EXP-GP Common to one of the jumper pins on J3 (any of the pins closest to J2).
2. Read the temperature from a Digital thermometer placed near CR59 on the EXP-GP.
3. Adjust R101 (CJC ADJ potentiometer) until a stable reading of 24.4 mV/°C is attained. For example a reading of 17.0/°C will yield 0.4148 volts.

5.5 OPTIONAL SHUNT CALIBRATION

EXP-GP shunt calibration uses two precision shunt-calibration resistors (RX49 and RX51) and a relay (K1). The relay is activated by a TTL high signal on Pin 10 of Connector J1. When the relay is enabled (closed), RX51 shunts RX49. This changes the bridge resistance with a subsequent change in measured voltage across +SENSE and -SENSE. When read, this proportional change in bridge resistance and voltage drop can be used to provide a software correction factor for the bridge or alternatively to determine if the bridge is still functioning. This voltage can be read at any one of the eight channels provided the common bridge-completion resistors (refer to Section 3.9) are installed and that the channel's +P, -P, and +SENSE terminals are connected to the corresponding terminals on the TB9 terminal block.

Figure 5-1 shows KX1 orientation and wiring for the shunt and relay.

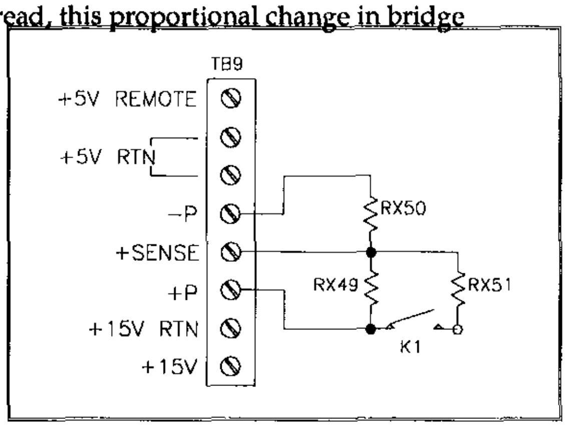


Figure 5-1. Wiring for optional shunt calibration.

5.6 CALIBRATION OF BRIDGE VOLTAGE EXCITATION

1. Set DIP Switch S17 for the desired excitation voltage (see Section 3.9) and connect a power supply (+15V [±1.5V] Min @ 350mA) between the +15V and +15VRTN terminals of TB9.
2. Connect the low side of the DVM to the -P terminal of TB9. Connect the high side to +P terminal of TB9.

3. Adjust the potentiometer indicated in the following table for the corresponding excitation voltage (selected in Step 1).

EXCITATION VOLTAGE (S17)	POTENTIOMETER
0.5V	R104
1V	R105
2V	R103
4V	R102
10V	R106

5.7 CALIBRATION OF EXCITATION CURRENT SOURCE

1. Set the DVM to measure current, and connect it between the -IEXC and +IEXC terminals (TB1 through TB8) for the channel to be calibrated.
2. Adjust the potentiometer indicated in the following table for 1 mA.

CHANNEL	POTENTIOMETER
CH 0	R6
CH 1	R16
CH 2	R26
CH 3	R36
CH 4	R46
CH 5	R56
CH 6	R66
CH 7	R76

■ ■ ■

CHAPTER 6

FACTORY RETURNS

Before returning any equipment for repair, please call   to notify MetraByte's technical service personnel. If possible, a technical representative will diagnose and resolve your problem by telephone. If a telephone resolution is not possible, the technical representative will issue you a Return Material Authorization (RMA) number and ask you to return the equipment. Please reference the RMA number in any documentation regarding the equipment and on the outside of the shipping container.

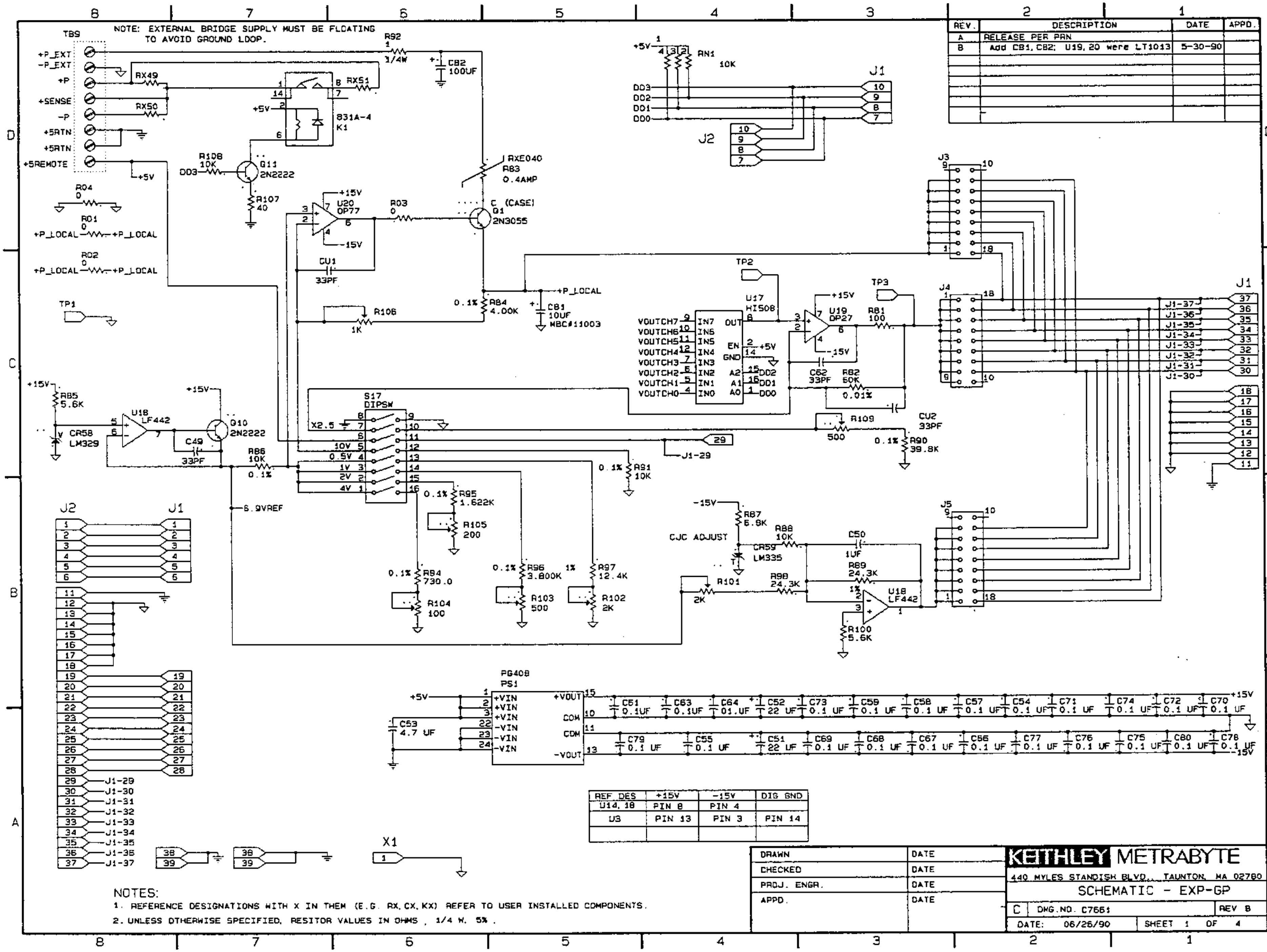
Note that if you are submitting your equipment for repair under warranty, you must furnish the invoice number and date of purchase.

When returning equipment for repair, please include the following information:

1. Your name, address, and telephone number.
2. The invoice number and date of equipment purchase.
3. A description of the problem or its symptoms.

Repackage the equipment. Handle it with ground protection; use its original anti-static wrapping, if possible.

Be sure to reference the RMA number on the outside of the package! ■



REV.	DESCRIPTION	DATE	APPD.
A	RELEASE PER PRN		
B	Add CB1, CB2; U19, 20 were LT1013	5-30-90	

REF DES	+15V	-15V	DIG GND
U14, 18	PIN 8	PIN 4	
U3	PIN 13	PIN 3	PIN 14

NOTES:

1. REFERENCE DESIGNATIONS WITH X IN THEM (E.G. RX, CX, KX) REFER TO USER INSTALLED COMPONENTS.
2. UNLESS OTHERWISE SPECIFIED, RESITOR VALUES IN OHMS, 1/4 W, 5%.

DRAWN	DATE
CHECKED	DATE
PROJ. ENGR.	DATE
APPD.	DATE

KEITHLEY METRABYTE

440 MYLES STANDISH BLVD., TAUNTON, MA 02780

SCHEMATIC - EXP-GP

C | DWG. NO. C7661 | REV B

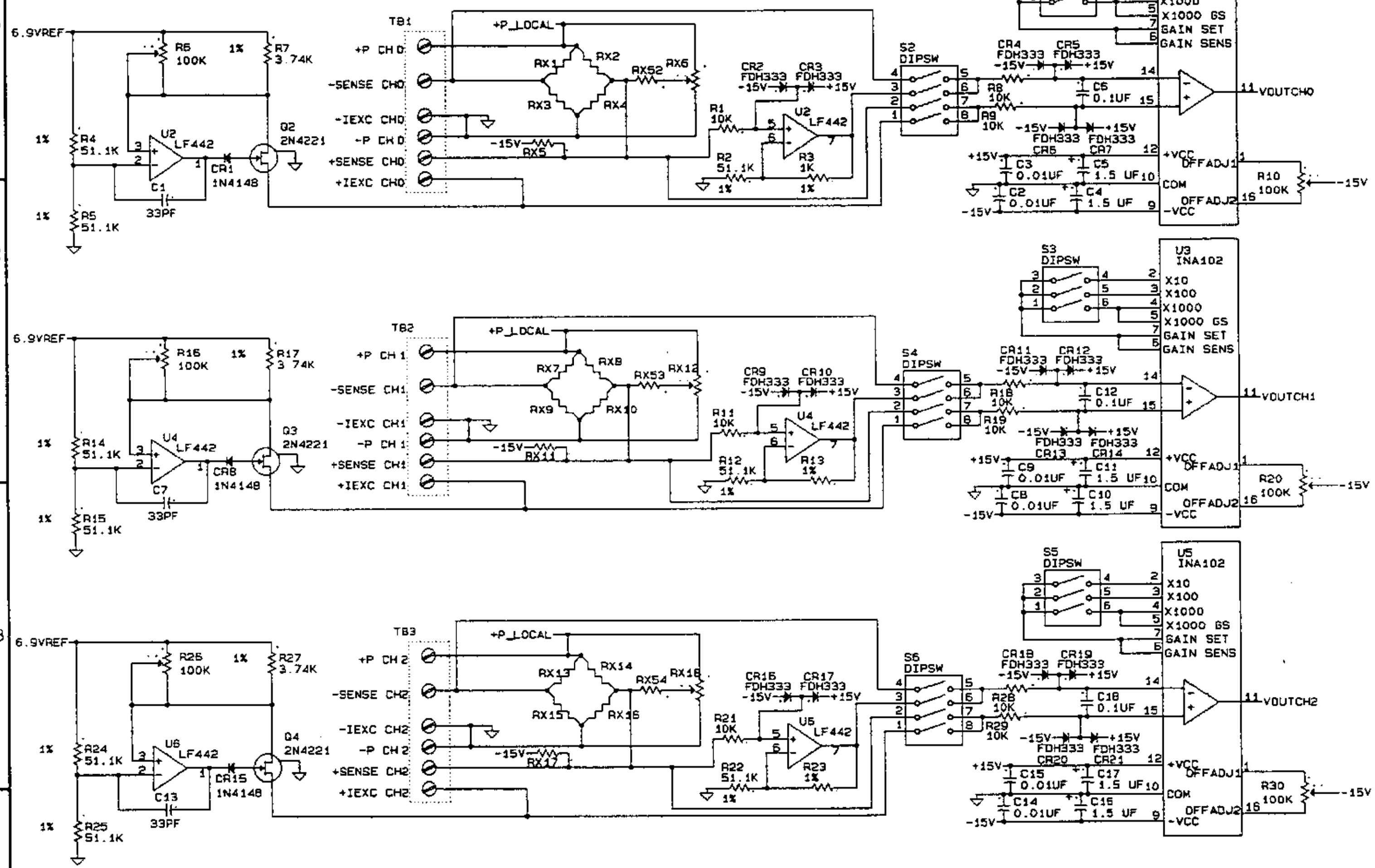
DATE: 06/26/90 | SHEET 1 OF 4

REV.	DESCRIPTION	DATE	APPD.
	SEE SHEET 1		

NOTE: ALL RX'S ARE 1/4 W. RECOMMENDED VALUE FOR EACH BRIDGE COMPLETION RESISTOR IS 350 OHMS.

* RX6=50K, RX52=75K FOR 6000 USTRAIN ADJ.

REF DES	+15V	-15V	GND
U2, 4, 6	PIN 8	PIN 4	



KEITHLEY METRABYTE

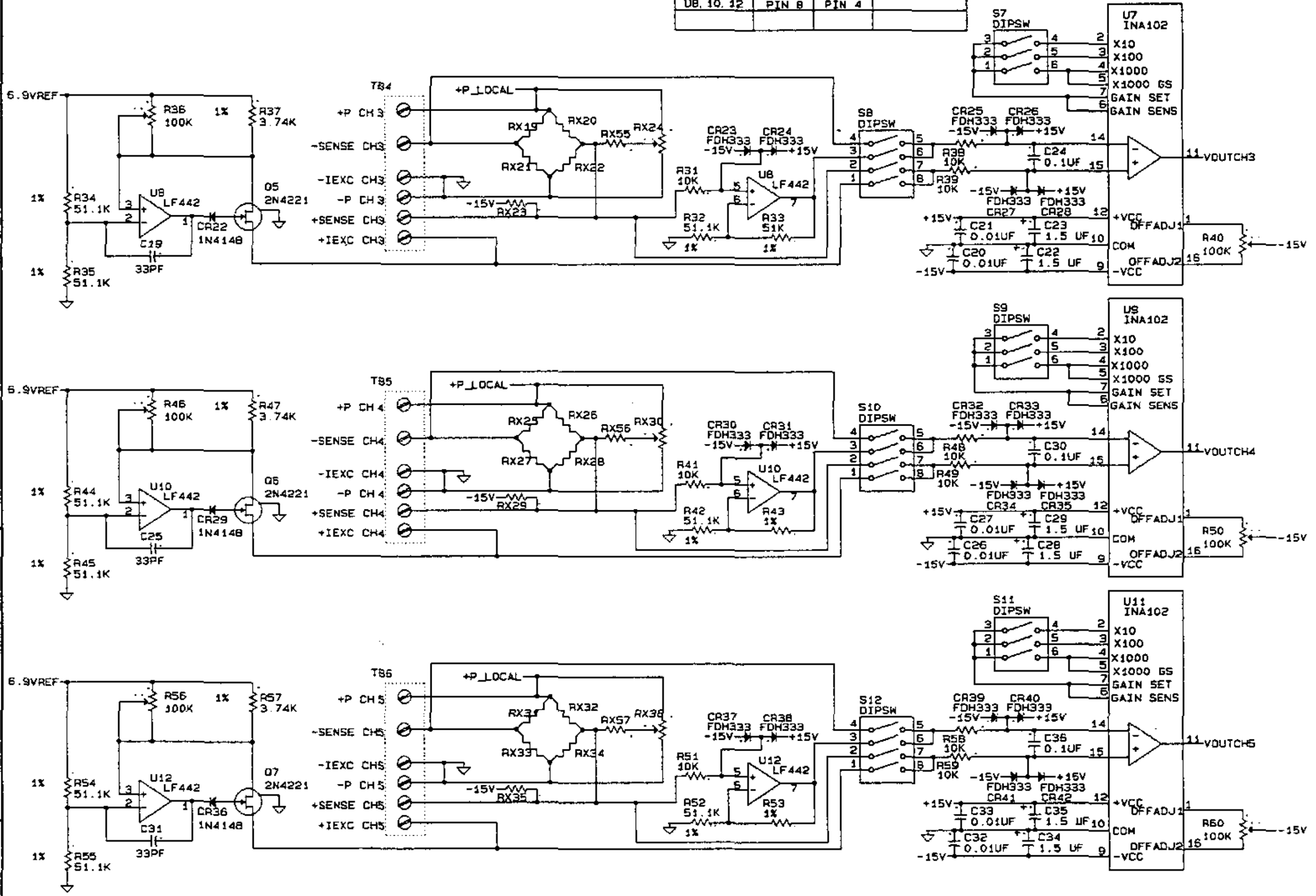
440 MYLES STANDISH BLVD., TAUNTON, MA 02780

SCHEMATIC - EXP-GP

C	DWG.NO. C7661	REV B
DATE: 06/25/90	SHEET 2 OF 4	

REV.	DESCRIPTION	DATE	APPD.
	SEE SHEET 1		

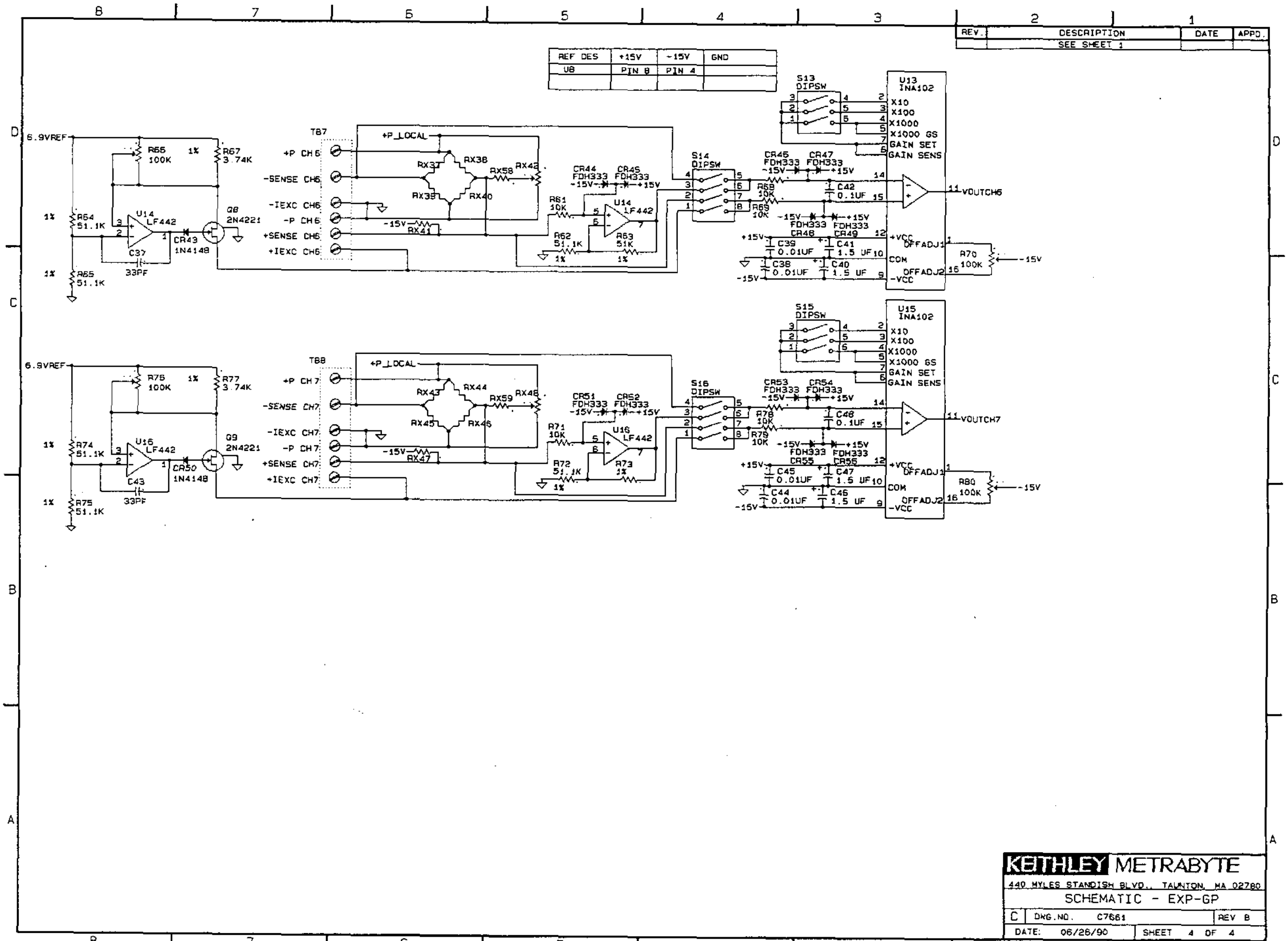
REF DES	+15V	-15V	GND
U8, 10, 12	PIN 8	PIN 4	



KEITHLEY METRABYTE
440 MYLES STANDISH BLVD., TAUNTON, MA 02780

SCHEMATIC - EXP-GP

C	DWG.NO. C7651		REV B
DATE: 06/26/90		SHEET 3 OF 4	



REV. | DESCRIPTION | DATE | APPD.
SEE SHEET 1
REF DES | +15V | -15V | GND
U8 | PIN 8 | PIN 4
6.9VREF
R66 100K 1%
R67 3.74K
R64 51.1K 1%
R65 51.1K 1%
U14 LF442
CR43 1N4148
C37 33PF
Q8 2N4221
TB7
+P CH6
-SENSE CH6
-IEXC CH6
-P CH6
+SENSE CH6
+IEXC CH6
+P_LOCAL
RX37
RX38
RX39
RX40
RX41
RX42
RX58
CR44 FDH333
CR45 FDH333
R61 10K
R62 51.1K 1%
R63 51K 1%
S14 DIPSW
S13 DIPSW
CR46 FDH333
CR47 FDH333
CR48 FDH333
CR49 FDH333
R68 10K
R69 10K
C42 0.1UF
C39 0.01UF
C41 1.5 UF
C38 0.01UF
C40 1.5 UF
U13 INA102
X10
X100
X1000
X1000 GS
GAIN SET
GAIN SENS
+VCC
COM
-VCC
OFFADJ1
OFFADJ2
VOUTCH6
R70 100K
+15V
-15V
R76 100K 1%
R77 3.74K
R74 51.1K 1%
R75 51.1K 1%
U16 LF442
CR50 1N4148
C43 33PF
Q9 2N4221
TB8
+P CH7
-SENSE CH7
-IEXC CH7
-P CH7
+SENSE CH7
+IEXC CH7
RX43
RX44
RX45
RX46
RX47
RX48
RX59
CR51 FDH333
CR52 FDH333
R71 10K
R72 51.1K 1%
R73 1%
S16 DIPSW
S15 DIPSW
CR53 FDH333
CR54 FDH333
CR55 FDH333
CR56 FDH333
R78 10K
R79 10K
C48 0.1UF
C45 0.01UF
C47 1.5 UF
C44 0.01UF
C46 1.5 UF
U15 INA102
VOUTCH7
R80 100K
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SCHEMATIC - EXP-GP
C DWG.NO. C7661 REV B
DATE: 06/26/90 SHEET 4 OF 4