MODEL 17B
DIFFERENTIAL MULTIPLEXER

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Rev. C

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INTRODUCTION

The Lawson Labs Model 17B Differential Multiplexer is an electronic switching device designed to be used in combination with any Lawson Labs A/D card. It will allow an input channel to be expanded to 16 independent channels. Up to four Model 17B Multiplexers can be used with one A/D. In conjunction with Model 66 Expansion Modules, up to 32 multiplexers can be handled by a single A/D card. The control output lines on the A/D determine which input is selected. Both the plus and minus connections are switched so that system flexibility and noise rejection are maximized. All inputs are protected against overvoltages of up to 150 volts.

The Model 17B Differential Multiplexer is a self-contained unit which connects to the computer via 7 or 8 wires. Because 16 differential circuits, each with a ground, require 48 wires, having the multiplexer outside the computer substantially reduces wiring congestion and the attendant hazards. The standard Model 17B Differential Multiplexer accommodates input signal levels between plus 5.5 and minus 5.5 volts. The Model 17B can also be connected as a dual 16-channel single-ended multiplexer.

SECTION 1. INSTALLATION

There are 40 terminals on the Model 17B. Because so many electrical connections must be made, it is advisable to proceed carefully. Labeling all wires will save time in the end.

Eight wires will be needed to connect the Model 17B to the A/D card. See the appropriate section in the A/D card's manual for pin locations. The interconnecting wire can be of any general-purpose type. We strongly recommend shielded wire for all connections. Small diameters and long lengths of wire will not interfere with system function except in extreme cases. For example, 50 feet of 26AWG shielded wire will not significantly affect the system. The "+" output should connect to one of the plus input pins on the A/D's connector and the "-" output should connect to the corresponding minus input at the A/D card. The examples in this manual assume the first Model 17B is connected to input #0. If another input is used, the control codes should be adjusted as described in the A/D manual. The ground terminal (G) on the Model 17B should be connected to chassis ground at the computer.

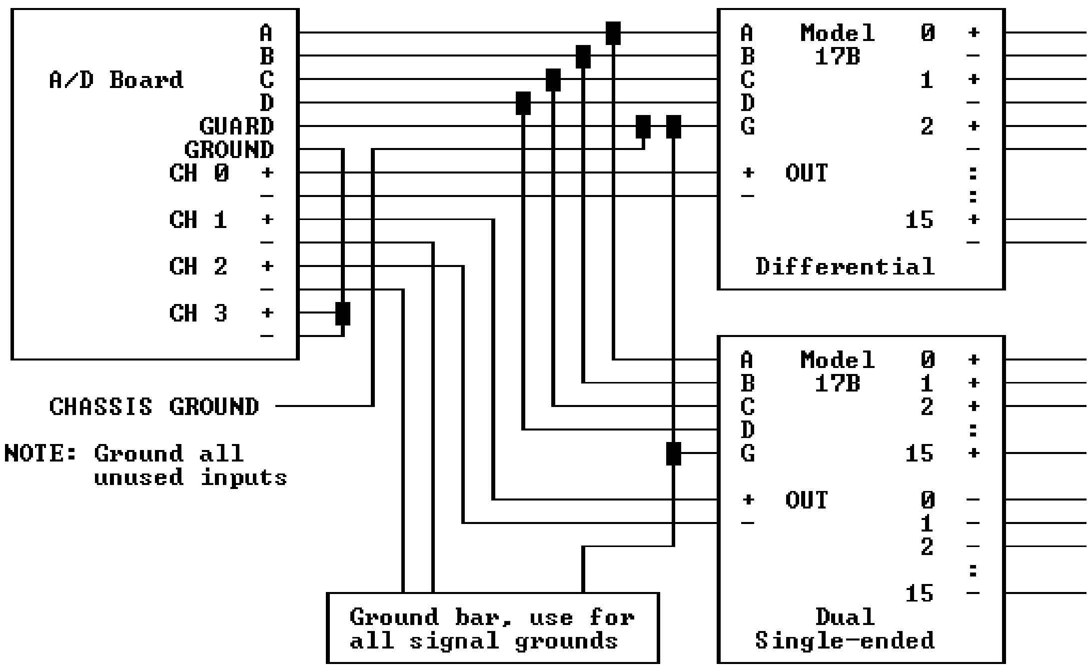
WARNING: Use a cover-securing screw (without paint) for chassis ground.

On some portable computers, no metal chassis contact is accessible. In that case, use the center screw of the power outlet as ground. We do not recommend using the ground pin on the A/D card connector instead of chassis ground because it is possible that under certain catastrophic conditions the ground current might be large enough to cause damage to the computer.

The control inputs to the Model 17B should now be connected to the isolated control output lines on the A/D card connector. Input A is connected to output A on the A/D, input B is connected to output B on the A/D, input C is connected to output C on the A/D, and input D is connected to output D on the A/D card. Connect the Guard pin on the A/D card connector to the G terminal on the Model 17B.

NOTE: There should now be two separate wires from the computer connected to the G terminal of the Model 17B.

FIGURE 1. TYPICAL INTERCONNECTIONS



Read differential inputs 0-15 at A/D channel 0

Read single-ended inputs 0-15 of + bank at A/D channel 1

Read single-ended inputs 0-15 of - bank at A/D channel 2

If you are using more than one Multiplexer, connect each Model 17B output to a different input on the A/D card's connector. The control and ground inputs on additional multiplexers should be connected to the matching terminals on any previously-connected Multiplexer.

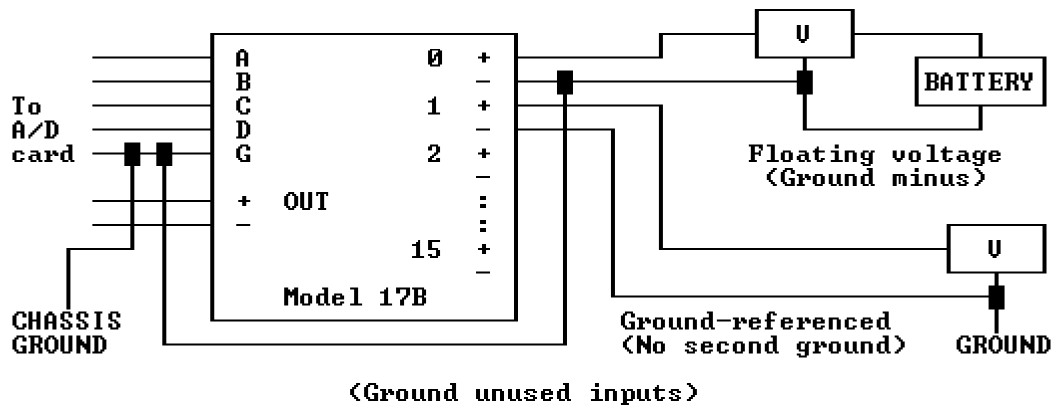
Before connecting the signal inputs to the Model 17B, check that the signal levels are compatible with the Multiplexer and A/D card. No harm will be done to the system if these levels are exceeded, (unless the overvoltage protection is exceeded), but the signal itself will be limited and the A/D will be overranged.

Connect the plus and minus wires from the first input channel to be switched to the input terminals labeled + 0 and - 0 on the Model 17B. Before attaching additional inputs, you may want to confirm that you can read channel 0 properly with the A/D card. This test is advisable because input overvoltages can cause cross-channel interactions. Connect the second signal to be switched to input 1, and so on. Reversing the plus and minus wires of a pair will cause the polarity of the readings on that channel to reverse. If the signals being switched are from differential sources, they may have three-wire outputs. The third connection, (sometimes the drain wire on the shield), is provided to prevent ground currents from causing measuring errors. These ground wires should be connected together and to the G terminal on the multiplexer.

NOTE: For maximum protection, any unused inputs should be connected to ground. This is done to protect the circuitry from static discharges which can be of extremely high voltage.

NOTE: The terminal labeled "X" is the -6VDC supply. It is there for compatibility with the Model 17A only. Normally, no connection should be made to the "X" terminal.

FIGURE 2. TYPICAL INPUT CONNECTIONS



When all connections have been made, check that the cable to the A/D card is plugged in. Also check that the Model 17B is plugged in and that the computer is on. After checking for function, provide strain-relief for all connections.

SECTION 2. OPERATION

Channel selection is accomplished by entering the A/D channel selection code plus the number of the desired multiplexer channel as the control code. For example, with the multiplexer at A/D channel CH, if you are using a Model 134 or 140, the instruction to select multiplexer channel MUXCHAN would be:

```
OUT ADC, 16 * CH + MUXCHAN
```

For a Model 141, the corresponding instruction would be:

```
OUT ADC, 128 + 16 * CH + MUXCHAN
```

Refer to your A/D card manual for more information on channel selection.

The following BASIC program will scan 16 channels of data and display readings in millivolts. Set CH equal to the actual A/D channel number in line 2040. Set BOARDCODE in line 2030 to 0 if you have a Model 134 or Model 140; set it to 128 if you have a Model 141.

```
1000 REM Sample program
1010 GOSUB 2000
1020 FOR MUXCHAN = 0 TO 15
1050 OUT ADC, BOARDCODE + 16 * CH + MUXCHAN
1060 GOSUB 4000
```

```
1070 PRINT V
1080 NEXT MUXCHAN
1090 END

2000 REM Set constants
2010 PAUSE = 0.1: REM For the 141, enter settling time + 0.1
2020 ADC = [value]: REM Your A/D board address
2030 BOARDCODE = [value]: REM 128 for Model 141, 0 for others
2040 CH = [value]: REM Your A/D board channel
2050 RETURN

3000 REM Delay for settling time of PAUSE sec.
3010 IF TIMER > 86395 THEN GOTO 3010
3020 START = TIMER
3030 IF TIMER < START + PAUSE THEN GOTO 3030
3040 RETURN
```

Include this subroutine if you are using a Model 140.

```
4000 REM Returns Model 140 voltage in millivolts
4010 OUT ADC + 1, 0
4020 IF INP(ADC) AND 128 THEN 4020
4030 X = INP(ADC)
4040 V = X MOD 16 + (INP(ADC + 1) MOD 16) * 10  + (INP( ADC + 2)
     MOD 16) * 100 + (INP(ADC + 3) MOD 16) * 1000
4050 IF X AND 32 THEN V = V + 10000
4060 IF X AND 64 THEN V = -V
4070 V = V * .25
4080 RETURN
```

Include this subroutine if you are using a Model 134. In line 4030, you may set AVERAGE anywhere from 1 to 255. Larger numbers reduce noise while smaller numbers increase speed.

```
4000 REM Returns Model 134 voltage in millivolts
4010 GOSUB 3000
4020 X = INP(ADC)
4030 TOTAL = 0: AVERAGE = 20
4040 FOR X = 1 TO AVERAGE
4050 IF INP(ADC - 1) AND 2 THEN 4050
4060 V = INP(ADC + 1) * 256! + INP(ADC)
4070 TOTAL = TOTAL + V
4080 NEXT X
4090 TOTAL = TOTAL / AVERAGE: V = (TOTAL - 32768) * .152588
4100 RETURN
```

Include this subroutine if you are using a Model 141.

```
4000 REM Returns Model 141 voltage in millivolts
4010 GOSUB 3000
4020 OUT ADC + 1, 1
4030 H = (INP(ADC + 2) AND &H0F)
4040 M = INP(ADC + 1)
4050 L = INP(ADC)
4060 OUT ADC + 1, 0
4070 COUNT = L + M * 256 + H * 65536
4080 V = COUNT * 9.536743E-03 - 5000
4090 RETURN
```

The above program will print the voltages at channels zero through 15 of the Multiplexer connected to input CH of the A/D card. By changing CH and the start and stop points in the loop counter (line 1020), any block of voltages can be printed. The PAUSE routine at line 3000 is only needed for the 134 and 141 A/D cards. The Model 134 PAUSE need only be the 0.5 millisecond settling time of the multiplexer. An empty loop can be used to generate that short delay, but the loop counter value will depend on the speed of your computer.

SECTION 3. TROUBLESHOOTING

A. Apparently meaningless numbers are produced:

1. Make certain that the Model 17B is plugged in to a live outlet.

2. Connect the + and - wires leading to the A/D input together. If the resulting reading is not within a few counts of zero, either there is a miswire or the wrong channel is being selected.

3. Check that none of the + or - input signals are outside the allowable voltage range. Under some circumstances, other channels can be affected by overranges.

4. A ground loop or missing ground wire can cause unpredictable results. If there is a redundant ground wire, try removing it. If you are using a wall socket ground for the external ground connection, make sure that it is actually at ground potential.

5. If more than one multiplexer, thermometer or other device is connected to the output port, then all external devices must be powered.

B. Some or all signals are of the wrong polarity:

1. If all the signals from a Multiplexer have the wrong polarity then the wires connecting the Multiplexer output to the Analog Interface input are crossed.

2. If one or several signals are of the wrong polarity, the wires connecting to the Multiplexer input for the affected channels are probably reversed.

C. Some or all signals show excessive scatter:

1. Make sure ALL input signals are within range.

2. A ground loop can cause excessive scatter. See A.4 (above) or SECTION 1 of this manual for grounding procedures.

3. It is possible that the signals being measured are oscillating. Try substituting a 1.5 volt battery or other stable voltage source for comparison.

4. If the signals being switched are high impedance, some errors may be introduced due to switching transients and series resistance. Inserting a pause in the program between setting the channel selection code and beginning the conversion will help.

5. Be sure the G terminal on the Model 17B is connected to the computer chassis ground or an appropriate alternate ground.

D. If channel 0 of the multiplexer is always read regardless of which channel of the Model 17B is selected by the output control lines, check to be sure that the Guard pin on the A/D card is connected to the G terminal on the Model 17B.

SECTION 4. SPECIFICATIONS

SIGNAL INPUTS:	16 channels Both plus and minus inputs are switched
SIGNAL INPUT RANGE:	+/- 5.5 volts
SWITCHING TIME:	0.5 ms maximum
SWITCH RESISTANCE TYPICAL:	On resistance 20 K ohms Off resistance 100 Megohms
INPUT PROTECTION:	All inputs protected against overvoltages of up to 130 volts transitory or 60 volts continuous
CONTROL INPUTS:	Fully compatible with all Lawson Labs A/D cards
TYPICAL CONTROL INPUT CURRENT:	0.06 milliamps Active low
POWER REQUIREMENT:	115 VAC, 6 Watts
SIZE:	6.25 x 3.75 x 2 inches

LIMITED WARRANTY

The Lawson Labs Inc. Model 17B Differential Multiplexer is guaranteed against defects in materials and workmanship for a period of one year from the date of delivery. Products must be returned to Lawson Labs for warranty service. Contact Lawson Labs at 800 321-5355 for return authorization before returning anything for service.

The above warranty is in lieu of all warranties express or implied. Lawson Labs, Inc. will not be liable for indirect or consequential damages caused by any defect in this product. Some states do not allow the limitation of consequential damages, so this exclusion may not apply to you.