

MODEL 102 4-channel Simultaneous Sampling A/D Converter

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INTRODUCTION

The Lawson Labs, Inc. Model 102 is a 90 KHZ 4-channel simultaneous sampling 12-bit A/D subsystem for IBM PC/XT/AT and compatible computers. It has its own pacing clock, data buffer and sequencing circuitry. Once programmed, it will run without host computer intervention until the data buffer is full. With the bundled software, the Model 102 can stream continuous data to disk at rates up to 94 KHZ depending on the speed of your hard disk. Even a 10 MHZ XT class computer can stream to RAM disk at 45 KHZ. An AT class computer with a fast hard drive can stream to the hard disk at or near the maximum sampling rate of the card. Note that DMA is not used and interrupts are not required.

This reduces the possibility of obscure incompatibilities causing reliability problems.

The 16K sample data buffer can be used in the conventional fashion or as a circular buffer, i.e. it can preserve pre-trigger as well as post-trigger data. A programmable counter determines the proportion of pre- and post-trigger scans. The data can be virtually all pre-trigger, virtually all post-trigger, or anywhere in between. The Model 102 also places information from two digital inputs with the analog data. These event marker inputs allow easy correlation of asynchronous activity. An external clock input and clock output are provided to further aid in synchronization.

Eight bits of optically isolated output and 4 bits of digital input (in addition to the two event markers) are provided. A 16-bit event counter is available for general purpose use in some modes of operation. Interrupt capabilities are also present. The support software supplied with the Model 102 serves as a no-frills data acquisition package. It also serves as an example for BASIC programmers. Because of the power and flexibility of the Model 102, some programming experience is recommended if you intend to incorporate the Model 102 drivers into your application software.

The bundled support program allows you to set up the Model 102 for your particular application through menu-driven software. In addition, you can save your set up on disk so that a given configuration can be easily recalled.

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SECTION 1. Installation

Your Model 102 board comes packaged in pink anti-static material. The board should be returned to anti-static packaging whenever it is not installed in a computer.

Note: Always handle printed circuit boards by the edges.

There are seven dip switches located near the bottom edge of the Model 102. These switches determine the base port address of the card. The base address can be placed virtually anywhere in the available I/O space, including places reserved by the operating system. We recommend addresses between 544 (220 Hexadecimal) and 624 (270 hex). The switch positions for base address 544 are 1,2,4,5 and 6 ON; 3 and 7 OFF. If there are other special purpose cards in your computer you should check their documentation to make sure the port addresses do not conflict. There is also an interrupt level jumper near the gold edge connector. As shipped, the interrupts are disabled. If you want interrupt capabilities, you must dedicate interrupt level 3,5 or 7 to the Model 102. The Model 102 cannot share an interrupt level. For interrupt level 3, place the jumper horizontally on the highest pair of pins, for level 5, the middle pair,

and for level 7, the lowest. To disable interrupts, place the jumper vertically on the upper right or leave it off. Make certain that you know the dip switch position of your card before closing the cover. Follow the directions in your Operations Manual for removing the cover of your computer. Remember to double check that the power is off. Install the Model 102 carefully in a vacant full length PC, XT, or AT expansion slot. Make sure the card is firmly seated in the connector. You will need to remove and later replace the screw at the metal mounting bracket. Reclose the case.

FIGURE 1. Base Address Dip Switch Selection Chart

Base address	Hex	1= ON		0= OFF				
		7	6	5	4	3	2	1
544	220	0	1	1	1	0	1	1
552	228	0	1	1	1	0	1	0
560	230	0	1	1	1	0	0	1
568	238	0	1	1	1	0	0	0
576	240	0	1	1	0	1	1	1
584	248	0	1	1	0	1	1	0
592	250	0	1	1	0	1	0	1
600	258	0	1	1	0	1	0	0
608	260	0	1	1	0	0	1	1
616	268	0	1	1	0	0	1	0
624	270	0	1	1	0	0	0	1

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The Model 102 requires 8 consecutive port addresses. Valid possibilities range from 256 to 998 decimal. To obtain the base address from the dip switch positions use 0 for ON and 1 for OFF in the following formula. $SW7 * 64 + SW6 * 32 + SW5 * 16 + SW4 * 8 + SW3 * 4 + SW2 * 2 + SW1$. Multiply the above by 8 to obtain the base address.

Figure 2. Connector Pinout

Pin 13 . . Ground	Pin 25 . . -3 Analog input
Pin 12 . . Digital output A	Pin 24 . . +3 Analog input
Pin 11 . . Digital output B	Pin 23 . . -2 Analog input
Pin 10 . . Digital output C	Pin 22 . . +2 Analog input
Pin 9 . . Digital output D	Pin 21 . . -1 Analog input
Pin 8 . . Guard	Pin 20 . . +1 Analog input
Pin 7 . . Trigger input	Pin 19 . . -0 Analog input

Pin 6 . . Ext. clock input	Pin 18 . . +0 Analog input
Pin 5 . . Digital input 7	Pin 17 . . Digital output H
Pin 4 . . Digital input 6	Pin 16 . . Digital output G
Pin 3 . . Digital input 5	Pin 15 . . Digital output F
Pin 2 . . Digital input 4	Pin 14 . . Digital output E
Pin 1 . . Clock output	

You will probably want to check the Model 102 for basic function with a DC voltage source. A 1.5 volt battery is convenient. Connect the positive battery terminal to the +0 input pin and the minus battery terminal to the -0 input pin. Because the inputs are fully differential, a third wire is required from the minus battery terminal to the chassis of the computer.

Note: For maximum reliability connect all unused analog inputs to ground.

Turn on the computer. If the Power On self-test (POST) does not behave normally, turn off the power immediately and refer to the Troubleshooting Section of this manual. Back up your support disk before continuing.

SECTION 2. Operation

Create a directory for the Model 102. Copy the programs on your support disk to that directory and make that directory the default directory. First type MSHERC to install the graphics drivers. Then type M102 to begin the program. You will be asked for the ADC (Analog to Digital Converter) address. If you have used the settings for port address 544, enter that number now. Otherwise enter the address corresponding to your dip switch setting. You should now see the main menu. The options are described below.

OPTION 1. Read Digital Inputs

The current digital input information is shown. The digital inputs will accept TTL or 5 volt CMOS logic levels or contact closures to ground. The screen reflects any changes immediately. Digital inputs 7 and 6 are the event marker inputs. Inputs 5 and 4 are general purpose digital inputs. The trigger and external clock inputs have special functions in some modes of operation, but they can always be read at this location. The scan-in-progress bit goes to a one while conversion is in progress. This bit would normally be needed only by assembly language programmers operating in single scan mode. The interrupt status bit switches from 0 to 1 when the data buffer is 1/4 full or 3/4 full and from 1 to 0 when the buffer is 1/2 full or

full.

OPTION 2. Set digital outputs

All the digital outputs (except the clock output) are optically isolated. They do not put out any current, rather, they behave like switch closures to the guard pin. They are normally used in conjunction with external pull-up resistors. Digital outputs A,B,C and D are used to control the external multiplexers (if any). Digital outputs E,F,G, and H are available for any use. These are controlled by a 4-bit word that is reset to zeros at power up.

OPTION 3. The Mode Settings

Normally, it is assumed that the Model 102 will be run from its internal clock with the interrupts disabled. You can change either of these using option 3. Most of the software functions will accept external clocking, but some care is required to avoid stray clocks when switching the clocking mode. The third mode bit, Circ Bf (Circular buffer), switches the auxiliary counter configuration. With Circ Bf off, the auxiliary counter is available for general purpose use. With Circ Bf on, the counter will count conversions and its output will switch the conversion clock on or off. Note that the circular buffer is left enabled after triggered acquisition.

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OPTION 4. The Scanning Sequence

Two, three or four simultaneous channels may be digitized at each scan. Single channel data can also be taken. The scan sequence is defined by the first and last channel number for each scan. The channels are designated 0,1,2, and 3 so a scan sequence of 0 to 3 would take four channels of data beginning with channel #0. Specifying channel 1 to 0 would also result in four channels/scan but the data would be stored with channel 1 first, then 2, 3 and 0 last. For single-channel use the first and last channel numbers are the same. Remember that after changing the scanning sequence, the clock will be stopped. To distinguish the simultaneous scans described above from the extended scans described below, the simultaneous scans will sometimes be called short scans.

Extended scanning is also possible. Extended scans are groups of short scans done sequentially. External multiplexers are required for expansion beyond four channels. With four multiplexers, one on each input channel, sixteen groups of four simultaneous channels can be sampled sequentially.

A separate multiplexer is required for each simultaneous channel. The external scanning sequence is set in the same fashion as the short scanning sequence. Extended scan channels 0 to 15 are valid. Specifying

external channels 4 to 9 would scan six channels, 4,5,6,7,8,9,4,5,6,7,8,9...etc. If the short scan was for three channels, then three times six, or eighteen data points will be sampled and stored before the first repeats. If no external multiplexers are in use, specify 0 to 0. If only one external channel is to be used, enter that channel number as both the first and last channel, for example, 11 to 11. After changing the scanning sequence the read and write data buffer counters are realigned.

OPTION 5. Single Scan Operation

For single scan operation, conversions are performed when requested by the host computer. Selecting "Read Single Extended Scan" from the menu causes 1 to 16 short scans to be displayed. The external channel number is shown at the right edge of the screen. To the left is status information. The first character shown under "status" will switch from - to + and back periodically. This bit switches once for each 16K samples acquired. The next two characters are the event markers. They show "-" for a low level input and "6" or "7" respectively for a high level input. Note that the event marker information is not current, instead, it was latched at the time of the scan. Remember that selecting "Read Single Extended Scan" leaves the conversion clock off.

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OPTION 6. Setting The Clock Rate

The scanning clock can be set in 1/2 microsecond intervals anywhere from 11 microseconds/scan (90.9KHZ) to 30 milliseconds/scan (33HZ). Thereafter, periods up to ten minutes can be selected in 10 millisecond intervals. The scanning interval must be multiplied by the number of channels per scan to obtain the throughput. The software does not prevent you from selecting an unobtainable rate. Typical maximum scanning periods and rates are .0425 milliseconds for four channels (23.5 KHZ scans or 94KHZ samples/second). For three channels a .0325 millisecond scanning interval yields a 30.8 KHZ scanning rate which corresponds to a 92.3 KHZ throughput. For two channels a .022 millisecond scanning interval yields a scanning rate of 45.5 KHZ and a throughput of 91 KHZ. The single channel sample interval must be .011 milliseconds(90.9 KHZ) or longer.

Note that when starting the software the clock rate is unknown, shown as ????. Not resetting the clock allows access to previously captured data which may be in the data buffer. Note that increasing the number of channels per short scan may raise the required throughput above attainable limits.

OPTION 7. Viewing Buffer Contents

Data is stored sequentially in the 16K sample on-board data buffer. When the end of the buffer is reached, the data is again written at the buffer's beginning. Data is read by the host computer on a first in, first out basis. If data is to be read while sampling is proceeding, care must be taken to insure that data is not over-written before it can be read. Also, if data is read faster than it is being written, discontinuities will result. Data is displayed in the same format as in Option 5 above. If the conversion clock is running, the data may be overwritten as you watch. For clarity, you will probably want to turn off the conversion clock before selecting Option 7. If the number of samples per extended scan does not divide evenly into 16386, and the data is overwritten, then the channel labeling for subsequent buffers will not align. If you do not see meaningful data, read a single scan first, to realign the read and write counters, then reselect Option 7. After that step you will begin reading from the start of the data buffer again.

OPTION 8. Triggering/Streaming/Counting

Selecting this option brings up the Triggering menu. The possibilities are described below.

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Do a preset number of scans

Once the scanning sequence and rate have been established, a block of data up to 16K samples in length can be captured. The start of the sampling period can be hardware or software controlled. If the external trigger input is at a high logic level, then sampling begins as soon as the N scans are programmed. If the external trigger is low (0 volts), sampling will not start until the trigger goes up. In addition, if the trigger goes down during the sampling period, the counting (but not the sampling) will stop until the trigger goes up again. The N scans are always written at the start of the sample buffer so a second N scans will overwrite the first.

Pre/post triggering

You will be prompted for the number of pre-trigger extended scans. Once that information has been provided the card will be running, accumulating pre-trigger data. Make sure you wait long enough for the desired number of pre-trigger scans to complete before proceeding. Next you are asked if the trigger is a single event or a repetitive one. If you answer S for single, the card will immediately await a positive edge on the external trigger input. If you respond R for repetitive, first a negative edge is located and a few microseconds later, the card will look for a positive edge. This procedure reduces the chance of having the card trigger on a slightly ragged negative edge. Even so, a slowly changing trigger input may cause occasional negative edge triggering. A "waiting for trigger" message is displayed. After the trigger, you will

see the auxiliary counter count down the programmed number of post-trigger scans to zero. Note that the post-trigger period will be restarted if a second trigger signal occurs before the post-trigger scans complete. In that case the counter may continue to count without ever reaching zero. If this happens, press a key and retry the process with a larger number of pre-trigger scans. Note that extended scanning is not supported in this mode.

Read a counter/ Set a counter

These utilities have been included mainly as programmer's examples. The 8253 counter chip on the Model 102 is the same one used in a standard XT computer. However, the counter has many modes and will behave strangely if mis-programmed. You can read the counters at will without fear of the consequences, but be wary of setting them. When not in circular buffer mode, the auxiliary counter (counter 2) can be set in mode 3 with a count of 0. Then the count read at counter 2 will reflect the number of negative edges at the external trigger input. Remember that the counters always count down and that they will roll over from a count of 0 to a count of 65535.

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Stream to disk

First make sure the throughput required (in Option 6) is attainable with your disk drive. Then enter a valid file specification and provide the number of 8K data blocks to stream. Pressing a key during the streaming process will stop streaming without data loss. Streamed data files can't be longer than 2000M. Remember that you can stream to a RAM drive if one has been installed.

Calculate maximum streaming rate

After you provide a valid file specification, the computer will first determine the variation in your disk access times. From that variation, it will calculate a target margin. Then it will begin speeding up the conversion clock until the margin is approached. When the disk stops, the minimum scanning interval will be displayed. Pressing any key during the process will cause it to stop without obtaining a maximum rate. Running this test repeatedly will not always produce the same result because of disk access variations. To be safe, you may want to run a few percent slower than the maximum displayed rate. If you want to push the limits, you may find that you can go slightly faster. A large number for BUFFERS in your CONFIG.SYS file may reduce the average disk access time while increasing access time variability. Because streaming is limited by the worst case access time,

decreasing the BUFFERS setting in your CONFIG.SYS file to a minimum will probably maximize the streaming rate.

Graphics

You will be asked if you want to graph a streamed file or the current contents of the data buffer. If the data buffer contains pre- and post-trigger data, it will be rearranged so that the first point in the buffer is the first point in time. Note that the justification process requires about 32k bytes of vacant disk space on the default drive. Next, you review the displayed compression factor, external scan number, the first channel to plot, and the number of channels to plot. A compression factor of 1 plots normally, a factor of 2 overplots two points before advancing along the time axis thereby fitting double the data on the same screen. The first point to plot would normally be 0,1,2 or 3 if a short scan was four channels. The next entry, number of channels to plot, can be 1 to 4. If you chose to change any of the graphics parameters, you will be prompted for them and then given an opportunity to review the changes. Note that the channels are identified by their position in the scanning sequence and not by their control code or A/D channel number.

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You will see a Y axis with index marks every .5 volts. The X axis is at zero volts. Y axis resolution is one part in 320. Horizontally, 360 points are plotted. The trigger point is marked for circular buffer data. Beneath the graph are three lines. The top one is the overflow bit. Gaps here indicate discontinuous data. The next line is event marker 6 with event marker 7 at the bottom. For the event markers, a thick line indicates a low logic level. In the lower left corner of the screen is the first and last extended scan number currently being displayed. In the lower right is the elapsed time for the entire screen. Between are listed the valid commands. Commands are invoked by entering the first letter. N for New allows different channels from the same file to be graphed or a change of the compression factor. M returns to the Menu. The other commands, Page, Frame, and Dot each provide movement forward or backward through the data. If the shift key is not depressed, (Caps lock off), p will page forward through the data, f will advance 30 scans and d will advance one scan. Direction is reversed if shifted. A beep will sound if an end of the data buffer is reached. Note that only 16K samples are in the data buffer at any one time, so large compression factors or large extended scans can lead to fewer than 360 plotted points available in the data buffer. In that case, the plot will be shorter than 360 points. Also, under those conditions, the framing is disabled and the paging will not be as fluid.

Files

Option F on the main menu will yield the Filing menu. Four options are described below. The fifth option is "Return to main menu".

1) Save current graphics buffer

This option will write a 16K sample (32K byte) binary file with the specified file name and path. You may want to add a .bin file name extension to distinguish the file from its ASCII counterpart. The files produced have the same size and format as a streaming file with two 8K sample blocks specified. These files can be loaded for examination by the Graphics section or used as input files for the ASCII conversion option described below.

2) Load graphics buffer from disk

This option will read a 16K sample (32K byte) binary file with the specified file name and path. If a longer streaming file is specified, the first 16K samples only will be loaded.

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3) Convert binary file to ASCII file

Binary files are bit image files as read from the Model 102 A/D card. They are used internally by this program for graphics and data manipulation. When you want to transfer data to another program you will need to convert your data to ASCII format. ASCII files can also be viewed using the DOS "TYPE" command. You first must provide the name of the desired binary input file. That file can be either a streaming file or a 16K sample file written using option 1 above. Next, you provide an output file name. If your file is to be imported into Lotus, you must use a .prn file extension. Remember that any pre-existing file with the same name will be destroyed. Next, you can choose to have the event marker data included in your file. Finally, you select for Lotus or interlaced DADiSP style file format. The ASCII format file will be 4 to 5 times the size of the input file, so be sure plenty of disk space is available. Because the file conversion is coded in assembly language using a look-up table, the conversion speed is limited almost entirely by the speed of your disk drive. An AT class computer with an average hard drive can convert an 800K input file to ASCII in a minute. After the file conversion is complete, if there are any discontinuities in your data, the number will be displayed. Discontinuities are usually due to streaming data at higher

that sustainable rates. If your input file was not a streamed data file, one discontinuity is expected. If your input file was a "do N scans file" with undefined data in some of the data buffer, you should ignore the discontinuous data warning.

Because the input for the data conversion always comes from the disk, you must save the data before converting it. Select graphics (option 9) to preview the data, then, select F for Filing and using option 1 above, save the graphics buffer contents. If the data was taken in circular buffer mode, the data will be justified when you preview the data. Don't switch out of circular buffer mode before you have viewed your data or it will be overwritten. The file formats are shown below.

LOTUS (with markers):

```
"DATASET file specification"  
"DATE 05-20-1990"  
"TIME 11:39:40.00"  
"INTERVAL .05 "  
"AD0-Ex0", "Event", "AD1-Ex0", "Event", "AD2-Ex0", "Event",  
"AD3-Ex0", "Event"  
+1002 2 +0002 2 -3543 6 +1822 6  
+1004 7 +0101 7 -3521 7 +1822 0  
etc.
```

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The Lotus file format has all text in quotation marks. To import the data, use worksheet/file/import/numbers. Long scans will occupy rows and data points occupy columns. The Lotus file header contains the filename, the time and date that the file was converted (not written), and the scanning interval in milliseconds. The channels are labeled using the A/D channel number and external control code. All voltages are scaled in millivolts. The marker digit will be 6 if digital input 6 only is high, 7 if input 7 only is high, or 2 if both input 6 and 7 are up. If neither input is high, the markers digit will be 0.

The DADiSP header is basically the same but labels are not quoted and some additional housekeeping information is required. If marker information is included, it will be in the same format as for Lotus files, above.

DADiSP (without markers):

```
DATASET file specification  
VERSION :NXT  
NUM_SIGS 4  
DATE 05-20-1990  
TIME 11:39:40.00
```

```
INTERVAL .05
STORAGE_MODE INTERLACED
CHAN_NAME AD0-Ex0,AD1-Ex0,AD2-Ex0,AD3-Ex0
VERTICAL UNITS mv,mv,mv,mv
HORZ_UNITS Seconds
DATA
+1002 +0002 -3543 +1822
+1004 +0101 -3521 +1822
etc.
```

4) DOS Shell

This option gives you access to DOS without exiting the program. You can check file contents with the TYPE command, backup your data files, or check directory contents. You probably do not want to run another program under the DOS shell. There must be a copy of command.com in the search path for the shell to work properly. Type exit to return to the file menu.

When you select X to Exit from the main menu, you are asked if you want to save the configuration. If you respond Y, then the current settings will overwrite the previous ones in the M102.CFG file in the default directory.

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SECTION 3. Programming

The source code for the Model 102 is included on your program disk. The high level language is QuickBASIC 4.5. The code is heavily remarked. We recommend changing the subroutines themselves as little as possible because the exact order of many of the hardware-related instructions is significant. Programmers must start QuickBasic with the libraries option:

```
QB M102/L GRAPH
```

All the time-critical drivers for the Model 102 are in a GRAPH library. The library is written for the Microsoft Assembler version 5.1. The source file for GRAPH is GRAPH.ASM. If you want to modify the GRAPH library, you should follow this sequence to obtain a new executable file:

```
MASM GRAPH;
LINK GRAPH BQLB45.LIB;
ERASE GRAPH.LIB
LIB GRAPH.LIB+GRAPH.OBJ;
```

```
BC M102/O/X;  
LINK M102+GRAPH.LIB;
```

The resulting files are, in order, GRAPH.OBJ, GRAPH.QBL, GRAPH.LIB, M102.OBJ and M102.EXE. The first LINK may produce two unresolved external reference errors. To the best of our knowledge, they are harmless. If you change the M102.BAS file, only the last two steps are needed.

The hardware registers are fully described early in the M102.BAS source code. The sections concerning the fundamental operation of the card are straightforward and should be reasonably easy to follow. The graphics section is more complex and less linear. It is intended less as a programmer's model than as a quick way to get a look at the data. EGA drivers and other enhancements are planned for the not too distant future.

The interrupt protocol for PC/XT/AT computers is under-defined and conflict prone. Therefore Lawson Labs policy is to avoid interrupts to maximize reliability. We acknowledge, however, that there are legitimate uses for interrupts and have provided some hardware interrupt capability on the Model 102. In Circ Bf mode interrupts (if enabled) are generated by a negative edge at the output of the auxiliary counter. When out of Circ Bf mode (streaming or polled operation), interrupts (if enabled) occur when the data buffer is 1/2 full or full.

Every effort has been made to insure hardware and software compatibility. If you should uncover any problems, please report them to Lawson Labs. We will address them promptly and courteously.

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SECTION 4. Troubleshooting

- A. Power On Self Test (POST) does not work with card installed or card shows no function at all

First, check that the card is properly seated in the expansion connector. Then, check the dip switch positions and interrupt jumper position. There may be some other device using the port address you have selected. Try an ADC of 768 (300 hex). Starting with switch 7, and using 1 for ON, that becomes 1100000.

- B. Card shows poor reproducibility

Remember that the inputs are differential and that both the plus and minus inputs must be within 6 volts of ground. Try adding a wire connecting the minus voltage source and chassis ground at the computer. A steady voltage should yield a steady reading +/- 1 count.

- C. Card won't capture data

Check the mode setting. In circular buffer mode the conversion clock can be shut off by the auxiliary counter. If you have inadvertently set the card for an external clock, and none is present, no conversions will be done. You can tell if the clock itself is running by selecting "Read a counter" from the triggering menu and reading counter 1. If the counter is going, return to the main menu and select "Read digital inputs". The interrupt status bit should change once every 4K samples have been acquired. If it does not, the external clock must be enabled but not running. Also, double-check the throughput as shown at Option 6. If you attempt a throughput higher than possible, your data will be corrupted.

D. Channels are not labeled properly

The various channels are identified only by their relative positions in the data buffer. Any stray data reads will upset the process. If the scanning sequence, as currently specified, does not match the capture sequence, then the data will be mixed. Restarting the clock also resets the read and write counters. If that fails to realign the data, then use single scan mode to sort out the problem. Also, in triggered operation, the card cannot necessarily find its place in the external scanning sequence. If you need to use extended scanning in circular buffer mode, you must dedicate one channel to a distinctive signal and manually align the external scanning sequence.

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E. Data in circular buffer is discontinuous

The Model 102 must have been running for at least the time required to take the necessary number of pre-trigger scans before a trigger occurs or else some of the pre-trigger data will be spurious. Make sure to wait the required time before selecting single or repetitive trigger.

F. Data "capture N samples" buffer is discontinuous

In this mode, the N sample counter will stop whenever the external trigger output is low. You will probably find that a low trigger input caused extra samples to be taken causing the buffer to overflow. Remember that the data buffer will still contain old data beyond the specified number of scans.

G. Data in streaming files is discontinuous

You are probably going to have to slow down the conversion clock. Try reducing the number of BUFFERS in your CONFIG.SYS file. It may also be that a statistically unlikely series of unsuccessful write attempts caused the disk to fall behind. A disk performance utility may

reorganize your drive for greater efficiency. It can also tell you if your disk is suffering from an excessive number of read/write errors.

H. The external multiplexers are not switching properly

First make sure the multiplexer ground is connected to the guard terminal on the Model 102. Also remember that the multiplexer has a significant switching time. If the multiplexers work in single scan mode but not at speed, the problem is probably switching time. The A,B,C & D lines are clocked at the beginning of each sort scan. Depending on the number of multiplexers connected, the maximum scanning rate may be as slow as 10K. Contact Lawson Labs for ways to speed up the external multiplexers.

I. Cross talk between channels

Usually, cross talk can be traced to the cabling. Higher source impedances are more susceptible to crosstalk. Use twisted pairs of wire for each input channel or, in extreme cases, separate shielding may be required. If any of your signals have very high rates of change, there may be a slight (1 or 2 counts) influence on another channel. Because the Model 102 cannot capture very high frequencies anyway, the recommended solution is to pre-filter the fast signal to slow the rise and fall times.

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J. Digital outputs not working

The digital outputs are optically isolated from the computer. They function relative to the guard pin on the Model 102 only. Normally they require a pull-up resistor to an external power supply. The ground on the external supply should be connected to guard. The maximum recommended power supply voltage is 24 VDC. The maximum recommended operating current is 5 milliamps. That dictates a pull-up resistor of 1000 Ohms or larger for a 5 VDC supply. The smaller the pull-up resistor, the faster the outputs will operate.

K. Single buffer data is overwritten

The Circ Bf mode bit must remain set until the data is read from the A/D card buffer. If the clock is running and sampling was stopped by the auxiliary counter, then clearing the Circ Bf bit will overwrite your data.

L. Circular buffer not justified

The graphics section will attempt to justify data if the Circ Bf bit is active and the auxiliary counter (counter 2) is in mode 5. These conditions would normally prevail. If you change the mode or reprogram counter 2 before previewing your data, then justification will not be done.

M. Minus Overrange voltage read positive

If an input voltage goes much below the -6 volt common mode limit, that channel will read +5VDC. This is normal.

SECTION 5. Internal Adjustments

The internal adjustments are factory set and your Model 102 should not need periodic recalibration. There are 6 trimpots along the top edge of the Model 102. The round trimpot nearest the input connector is a non-critical trim for setting the -8 VDC power supply. It should not need adjustment. The next trimpot towards the keyboard is the gain adjustment. It allows the full scale sensitivity to be varied between +/-5 VDC and +/-3 VDC. The single gain adjustment affects all 4 channels. The last four trimpots are offset adjustments for input channels 0 through 3. The trimpot nearest the keyboard is channel 0. These can be adjusted to read zero volts when both the + and - input pins for that channel are at ground potential.

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SECTION 6 Model 102 Specifications for PC/XT/AT type computers

Capture 1,2,3 or 4 simultaneous channels

+/- 5 VDC full scale input range

+/- 6 VDC input common mode range

Overvoltage up to +/- 15 VDC without cross-channel interaction up to +/- 75 VDC continuous without damage transients up to 120 VDC without damage

12-bit resolution with no missing codes

+/-1 count reproducibility

Sampling interval programmable from 11 microseconds (90.9KHZ) to 300 milliseconds (33HZ) in .5 microsecond intervals and programmable from 300 milliseconds to 10 minutes with 10 millisecond resolution internal or external clocking

Overall DC accuracy +/- 0.1%

Interchannel skew +/- 5 nanoseconds maximum

Full power bandwidth 22.5KHZ (-3db)

16K sample on-board data buffer

Flexible pre/post triggering capability

2 4-bit optically isolated output ports with 5 milliamp
current sink capability, external pull-up required

6 bits digital input including 2 event markers, inputs are
compatible with TTL, 5V CMOS, and contact closures

Externally expandable to 16 sets of 4 simultaneous channels
General purpose 16-bit event counter

Typical power consumption 5 VDC 350 MA
 +/- 12 VDC 60 MA each

Size full length XT style card
 3.9 x 13.9 x .75 inches

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LIMITED WARRANTY

All Lawson Labs, Inc. products are 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, Inc. at 610 725-8800 or 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 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 the above exclusion may not apply to you.