4A23 USER'S MANUAL

PRELIMINARY

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WARNINGS

HIGH VOLTAGES

The 4A23 analog ground is isolated from system ground and can be at dangerous potentials during normal operation. DO NOT touch the 4A23 card or the input section shield when operating.

STATIC ELECTRICITY

CMOS integrated circuits on the 4A23 can be damaged by exposure to electrostatic discharges. The following precautions should be taken when handling the 4A23 to prevent possible damage.

A. Leave the 4A23 in its antistatic bag until needed.

B. All work should be performed at an antistatic workstation.

C. Ground equipment into which 4A23 will be installed.

D. Ground personnel with conductive bracelet through 1 meg resistor to ground.

E. Avoid wearing synthetic fabrics, particularly Nylon.

DESCRIPTION

GENERAL

The 4A23 is a high resolution, low power, delta-sigma, A-D card for the PC/104 bus. 8 differential or 16 single ended inputs are provided. The inputs have 500V isolation from system ground for noise elimination and to permit floating measurements.

The 4A23 has 5 programmable input ranges: 25 mV, 50 mV, 100 mV, 1V, 2.5V, and 5V full scale. All ranges except the 5V range can be bipolar. A-D input is conditioned with a chopper stabilized instrumentation amplifier for minimum offset drift < 50 nV/°C. A high quality reference is used to insure overall gain stability of < 7 PPM/°C

Conversion rate can be programmed from 3.76 Hz to 202 Hz, with higher rates trading off conversion rate for noise.

The 4A23 can be run in polled or interrupt driven modes, allowing background data acquisition. Interrupts 2,3,4,5,7,10,11, or 12 can be used

All calibration information is stored in an on card EEPROM, so no zero or full scale calibration potentiometer are needed.

The low overall power consumption (<300mW) reduces thermocouple induced offsets that can cause problems in lower input ranges. An on-card temperature sensor is available for thermocouple cold-junction compensation. The 4A23s reference voltage is brought out to the input connector for ratiometric type applications.

Driver software for background data collection is provided, as is source code for driver and example programs.

HARDWARE CONFIGURATION

I/O ADDRESS

. The 4A23 card uses 2 contiguous addresses in I/O space. The 4A23 base address has 4 optional locations. These are set with jumpers W6, and W7. Jumper blocks W6, and W7 are three pin headers with two valid jumper positions, up and down. Up means away from the J1 and J2 bus connectors.

The following table shows the 4A23 base addresses for different jumper settings:

BASE ADDRESS	W6	W7	
0220H	down	down	(DEFAULT)
0222H	down	up	
0224H	up	up	
0226H	up	up	

SINGLE-ENDED/DIFFERENTIAL INPUT

The 4A23 can be configured with single ended or differential inputs. If single ended input are chose, there are 16 inputs available. If differential inputs are chosen, 8 differential inputs are available.

Differential inputs are suggested for low level inputs or applications where the input cable is long.

Differential mode is selected by moving jumpers W2,W3,W4, and W5 to the up position. Single ended mode is selected by moving W2,W3,W4, and W5 to the down position.

MODE	W2	W3	W4	W5	
SINGLE-ENDED	down	down	down	down	(DEFAULT)
DIFFERENTIAL	up	up	up	up	

CONVERSION RATE

Jumper W1 selects the A-D chips input clock and therefore the conversion rate. When W1 is in the down position, the standard 32.768 KHz input clock is chosen. This results in the standard 3.75 to 202 Hz A-D conversion rate. When W1 is in the up position, a 65.536 KHz A-D clock is used, giving double the normal conversion rates. This double speed option actually tends to have lower signal to noise ratios, so is the default setting.

HARDWARE CONFIGURATION

I/O CONNECTOR

The 4A23 uses a 34 pin, right angle male header for its analog input connector. The suggested mating connector is AMP PN 746194-9. This is an IDC (flat cable) type connector.

The analog input connector pinout is as follows:

PIN	FUNC (Sing/Diff)	PIN	FUNC (Sing/Diff)
1	Input shield	2	Input shield
3	Input 0/+0	4	Input 1/+1
5	Input 2/+2	6	Input 3/+3
7	Input 4/+4	8	Input 5/+5
9	Input 6/+6	10	Input 7/+7
11	Input shield	12	Input shield
13	Input 8/-0	14	Input 9/-1
15	Input 10/-2	16	Input 11/-3
17	Input 12/-4	18	Input 13/-5
19	Input 14/-6	20	Input 15/-7
21	Input shield	22	Input shield
23	Input common	24	Input common
25	+ 2.5V reference	26	+ 2.5V reference
27	Input common	28	Input common
29	M2 bit	30	M3 bit
31	M4 bit	32	Unreg -7 power
33	Input shield	34	Unreg +7 power

Note that single ended analog inputs use Input common as their ground reference, not Input shield. The input shield connection is intended for use as an input guard only and may be several millivolts away from true input ground. Input common should be used for differential input common mode reference.

The three isolated output bits (M2,M3,M4) are 5V CMOS level output bits with input shield being the common return. These outputs should not be loaded by more than 1 mA each since they are powered by the small isolation DC-DC converter.

A-D OPERATION

GENERAL

The 4A23 uses a Cirrus CS5526. The CS5526 is a 20 bit delta-sigma A-D converter. This converter has low power requirements and a serial interface that make it suitable for the 4A23's isolated input design. The delta sigma design results in very high accuracy and linearity. It does not suffer from the 'memory' and creep problems common with integrating type A-D chips

The CS5526 A-D has on chip calibration registers for full scale and offset. This avoids the need for potentiometers and the problems that they bring. These registers are loaded from the on card calibration EEPROM by the A-D software when the input range is selected or changed. This is necessary since the offset and full scale calibration values change with the input range selected. Changes in conversion rate do not affect full scale or offset since they only change digital filter parameters.

The 4A23 has six input voltage ranges 5V, 2.5V, 1V, 100mV, 50 mV and 25 mV full scale. The 5V range has -2.5V maximum negative input due to A-D input amplifier common mode range limits.

Unipolar and bipolar input mode are supported by the CS5526 A-D chip but the supporting software and EEPROM calibration data only support bipolar operation for this revision.

16 input channels are available for user inputs. In addition, a zero volt, 2.5V reference and card temperature input can be selected for calibration and thermocouple cold junction compensation T

CONVERSION RATE

The A-D on the 4A23 can be programmed to do conversions at 8 different rates, 3.76 Hz, 7.51 Hz, 15 Hz, 30Hz, 60Hz, 123.2Hz, 168.9Hz and 202.3Hz. These rates double with the conversion rate jumper set to the high speed position. A-D input noise increases with conversion rate, so lower rates are suggested for most applications . Noise free resolutions (with double speed enabled) are approximately:

7.51 Hz	18 bits
15 Hz	17 bits
30 Hz	17 bits
60 Hz	16 bits
120 Hz	12 bits

A-D OPERATION

CALIBRATION

The 4A23 is calibrated at MESA but can be re-calibrated if necessary. To do a voltage only calibration requires that reference voltages of approximately 4V, 2V, 0.8V,0.08V,0.04V, and 0.02V available. The reference voltage source should be accurate to 50 PPM or better.

Calibration is performed via the program 4A23CAL.EXE. 4A23CAL is invoked with the hexadecimal port address of the 4A23 plus the optional T parameter if a temperature calibration is to be performed:

```
4A23CAL 220 [T]
```

4A23CAL prompts you to connect different voltages to the input channel. When 4A23CAL is done, it will write the new calibration data into the 4A23's EEPROM. If the T option is specified, 4A23CAL will do a temperature only calibration.

We do supply 4A23CAL to the user but strongly suggest that 4A23 card calibration be done at MESA.

ACCURACY

The 4A23 has a basic accuracy limit of .+-05 % This applies over the full operating temperature range of the card. This accuracy assumes that the supplied 4A23 software is used to copy the EEPROM calibrate data from the 4A23 card into the A-D chip registers. The main source of error in the higher voltage ranges is temperature drift in the reference voltage. The main source of error in the lower ranges is parasitic thermocouple voltages from small temperature differentials in semiconductors in the input path. Thermocouple offsets can be minimized by mounting the 4A23 away from sources of heat.

The temperature channel is mainly for internal use and calibration is only guaranteed to be accurate to +- 5°C .

4A23 SOFTWARE

GENERAL

The 4A23 uses a TSR driver program to access the 4A23 hardware. This driver hides may of the details of accessing the 4A23, making the data acquisition application programs task easier. The driver uses the EEPROM calibration data to calibrate the A-D data.

The driver allows data acquisition to be done as a background (interrupt driven) task, with the acquired data saved in a driver maintained FIFO. The standard FIFO size is 64 entries deep. This means that the foreground task can easily poll keyboards, do disk I/O or other tasks without interfering with the data acquisition sample rate;

4A23DRVR

The TSR driver is called 4A23DRVR.EXE. 4A23DRVR is launched with three command line parameters. These parameters are the 4A23 base address, the hardware interrupt number that the 4A23 will use, and the software interrupt number used for communication with the driver. For example:

```
4A23DRVR 220 5 60
```

Would launch the driver with a 4A23 base address of 220H, a hardware interrupt number of 5, and a software interrupt number of 60H. Note that the base address and software interrupt are specified in hex, but the hardware interrupt is specified in decimal as is standard practice with hardware interrupts.

The base address must match the base address setting of the 4A23 in the system. This is the address selected via jumpers W6, and W7. The hardware interrupt must not be used by any other peripheral in the system. Usually while at least one of IRQ 5,9,10,11, and 12 are available in AT PC/104 systems. The software interrupt uses one of the so-called user interrupt vectors from 60H to 6FH. The driver attempts to check if the software interrupt is used before installing itself, but you should make sure that no other installed software uses the same interrupt vector.

Once installed, all communication to the driver is done via the software interrupt. The same calling convention and data record structure is used for all driver functions. The driver is accessed by calling its software interrupt with the register pair CX:BX (CX=segment,BX=offset) pointing to the data record.

4A23 SOFTWARE

4A23DRVR RECORD STRUCTURE

To avoid a multiplicity of record structures for 4A23DRVR communication, a single record is used. It is the responsibility of the calling program to allocate the record structure and provide 4A23DRVR with a pointer to it. The calling program must set CX:BX to point to the record on entry. The record size is 13 bytes total.

The range value is the actual value used to select the range in the CS5526 A-D chip. These are listed in the 5526.PAS file in the source section of the distribution disk. When status is returned, true status is represented by an 0FFH byte in the status field and false status by a 00 in the Status field. When A-D data is returned, the data is just as read from the converter except that it is sign extended to 32 bits.

The record structure is as follows:

DATA	DATA SIZE	BYTE OFFSET
Function number	byte	0
Return code	byte	1
Status	byte	2
Pointer offset	word (16 bits)	3
Pointer segment	word (16 bits)	5
Data	longint (32 bits)	7
Channel	byte	11
Range	longint	12

4A23DRVR FUNCTIONS

These are determined by the function number in the Function number field of the data record.

The following is a list and brief description of the driver functions. For more information on the 4A23DRVR functions, you should refer to the 4A23DRVR source code in the SOURCE directory of the 4A23 distribution floppy. Applicable files are 4A23DRVR.PAS, 4A23LOW.PAS and 4A23DFUN.PAS, 4A23DLOW.PAS.

4A23 SOFTWARE

4A23DRVR FUNCTIONS

FUNCTION	NUMBER

DrFuncGetVersion 0
Returns Version # in Data field

DrFuncGetConvStatus 1
Returns converter running status is Status field: running = true, stopped = false.

DrFuncGetDriverStatus 2
Return configuration status of driver is Status field: true = configured, false = not configured.

DrFuncGetFIFODataStatus 3
Return FIFO data available status in Status field: true = data available, false = FIFO empty

DrFuncGetFIFOOvflStatus 4
Return FIFO overflow status in Status field: true = FIFO has overflowed, false = no overflow. Overflow status can be cleared by stopping the conversions and then restarting them.

DrFuncStartConversions 5
Start background data conversions.

DrFuncStopConversions 6
Stop background data conversions. Also clears FIFO, FIFO overflow status and scan count.

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4A23DRVR FUNCTIONS

FUNCTION	NUMBER

DrFuncGetTemperature 7

Returns card temperature channel (at 1Vfull scale)

DrFuncGetFIFOData 8

Returns FIFO data, FIFO channel and FIFO range in Data, Channel, and Range fields

DrFuncGetScanCount 9

Returns the current scan count (number of times around the data aquisition loop) in the Data field

DrFuncGetAtoDRecPtr 10

Return pointer to AtoD Record in Pointer segment and Pointer offset fields

DrFuncGetCalibRecPtr 11

Return pointer to Calibrate Record Pointer segment and Pointer offset fields

DrFuncSetConvRate 12

Sets the conversion rate. Uses 32 bit value from 5526.PAS ADRateXX constants

4A23 SOFTWARE

4A23DRVR RETURN CODES

The return code field of the Interrupt record indicates whether or not the function was successful, or if the function failed, why. Return codes are as follows:

RETURN CODE	MEANING
00	Successful completion
01	Failed
02	Bad parameter

Failed usually means an unimplemented function. Bad parameter means that the channel or range number is not valid.

4A23DCFG

After 4A23DRVR is installed, it need to be configured in order to set up its operating parameters and background data aquisition loop. This is done with the program 4A23DCFG. 4A23DCFG loads various user specified parameters and a sequence table into the driver. The user parameters and sequence table are in an ASCII text file. This file is referered to as a sequence file. 4A23DCFG is invoked with the sequence file filename and the 4A23DRVR software interrupt number on the command line:

```
4A23DCFG SEQFILE 60
```

Would configure the driver using software interrupt 60H with the sequence file SEQFILE.

SEQUENCE FILE FORMAT

The sequence file specified on the 4A23DCFG command line is an ASCII text file consisting of lines terminated with a CR LF. Each line starts with a token (an ascii name) and zero, one or two parameters. A combination of a token followed by its parameters is called a statement. Lines that start with a ; (semicolon) are ignored, and can be used for comments. The tokens are not case sensitive, but are printed here in upper case for emphasis.
There is an example sequence file (SEQFILE) in the DRIVER directory of the 4A23 distribution floppy. The sequence file has three sections, a parameter specification section, a A-D startup section , and a data aquisition loop section. The maximum length of the combined A-D startup and aquistion loop sections is 128 statements.

4A23 SOFTWARE

SEQUENCE FILE FORMAT

The sequence file has 2 sections, a parameter specification section and a acquisition loop section The parameter specification section has only one possible statement

SETRATE XX

This sets the A-D conversion rate. The valid rate values are:

3.76, 7.51, 15, 30.1, 60, 123.2, 168.9, 202.3

The next section of the sequence file is the acquisition loop section. This section has the list of A-D read operations that the driver will do. This list of operations will be sequentially executed, and repeated indefinitely. The acquisition loop section must start with the LOOPSTART statement. All statements in the acquisition loop section cause a A-D read operation to take place. This means that the total acquisition loop time is approximately the A-D conversion time plus a small amount of overhead.

The following statements can be used in the acquisition loop:

```
PUSHDATA CC RR
PUSHRDATA CC RR
PUSHZERO RR
PUSHTEMP
TOSS CC RR
```

CC is a channel number and can has range from 0 to 15. RR is a range specifier, and can any of the following values: 5V, 2.5V, 1V, 100MV, 50MV, and 25MV.

PUSHXXXX statements cause A-D data, channel number, and range to be "PUSHED" onto the data FIFO. The data FIFO is a first in first out buffer with each entry consisting of A-D data, the channel the data came from, and the range setting. The FIFO size is normally 64 entrys deep. The advantage of this FIFO structure is that the time sequence of the A-D data is not lost as long as the user program does not let the FIFO overflow.

PUSHDATA is the normal way to read A-D data. PUSHRDATA is the same as PUSHDATA but revereses the input leads. This only applies to differential inputs. PUSHRDATA will do exacly the same thing as PUSHDATA with single ended inputs.

PUSHZERO pushes an A-D reading at the specified range with the inputs grounded. This can be used for autozeroing the 4A23 in applications where the factory preset zero is not close enough.

PUSHTEMP pushes an A-D reading (at 1V full scale) of the temperature output pin or the reference chip.

TOSS statements read the A-D and simply discard the data. They can be used for a No-Op time delay in the aquisition loop.

4A23 SOFTWARE

SEQUENCE FILE FORMAT

Here is an example of a sequence file that: sets the conversion rate to 15 conversions per second, reads channels 0 though 3 at 5V full scale, channels 4 through 7 at 1V full scale, does two zero reads at 5V and 1V, and a temperature read.

```
SETRATE 15
LOOPSTART
PUSHDATA 0  5V
PUSHDATA 1  5V
PUSHDATA 2  5V
PUSHDATA 3  5V
PUSHDATA 4  1V
PUSHDATA 5  1V
PUSHDATA 6  1V
PUSHDATA 7  1V
PUSHZERO  5V
PUSHZERO  1V
PUSHTEMP
```

4A23 SOFTWARE

4A23DRDM

4A23DRDM is a simple demonstration program of the 4A23 card & 4A23DRVR combination. 4A23DRDM reads data from the drivers FIFO and displays it on the screen. 4A23DRDM determines where to display the data by its channel number read from the FIFO. 4A23DRDM is launched with the software interrupt number of the driver on the command line:

```
4A23DRDM 60
```

Would launch the demo program, and have the program use software interrupt 60H to communicate with the 4A23DRVR program.

Assuming that 4A23DRVR is not already loaded, the full sequence of commands needed to run 4A23DRDM would be as follows:

```
4A23DRVR 220 5 60
4A23DCFG SEQFILE 60
4A23DRDM 60
```

The assumptions here being that the 4A23 is located at the default 220H base I/O location, that IRQ 5 is free and unencumbered, and that software interrupt 60H is free.

The sequence file SEQFILE would of course have to contain some PUSHDATA, or PUSHZERO or PUSHTEMP statements in its aquisition loop section for 4A23DRDM to display anything.

REFERENCE INFORMATION

SPECIFICATIONS

	MIN	MAX	UNIT	NOTES
POWER SUPPLY				
Voltage	4.5	5.5	V	
Supply current (no external load)	---	75	mA	
ISOLATED POWER				
Voltage	5.5	7.25	V	
Load current	---	2.5	mA	+ - Loaded
INPUT CHARACTERISTICS				
Input current	-1	+1	nA	at 25ºC
Capacitance to system ground	---	50	pF	
Isolation voltage	---	500	VDC	
Isolated Common mode dV/dT	---	20	V/uSec	
Maximum input voltage	-3	+6	V	
ACCURACY				
Resolution	---	20	bits	
Calibrated accuracy all ranges	-.05	+.05	% FSR	
Gain TempCo	-7	+7	PPM/ºC	

REFERENCE INFORMATION

BUS LOADING:

Input capacitance	---	15	pF
Input leakage current	---	5	uA
Output drive capability	150	---	pF
Output sink current	8	---	mA

ENVIRONMENTAL:

Operating temperature range			
-I version	-40	+85	°C
-C version	0	+70	°C
Relative humidity	0	90	Percent
			Non-condensing

REFERENCE INFORMATION

WARRANTY

Mesa Electronics warrants the products it manufactures to be free effects in material and workmanship under normal use and service for the period of 2 years from date of purchase. This warranty shall not apply to products which have been subject to misuse, neglect, accident, or abnormal conditions of operation.

In the event of failure of a product covered by this warranty, Mesa Electronics, will repair any product returned to Mesa Electronics within 2 years of original purchase, provided the warrantor's examination discloses to its satisfaction that the product was defective. The warrantor may at its option, replace the product in lieu of repair.

With regard to any product returned within 2 years of purchase, said repairs or replacement will be made without charge. If the failure has been caused by misuse, neglect, accident, or abnormal conditions of operation, repairs will be billed at a nominal cost.

If any failure occurs, the following steps should be taken:

1. Notify Mesa Electronics, giving full details of the difficulty. On receipt of this information, service data, or shipping instructions will be forwarded to you.

2. On receipt of the shipping instructions, forward the product, in its original protective packaging, transportation prepaid to Mesa Electronics. Repairs will be made at Mesa Electronics and the product returned transportation prepaid.

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REFERENCE INFORMATION

REFERENCE INFORMATION

SCHEMATIC DIAGRAMS