Atmos Engineering, Inc

External Specification PN 410042

PC104 Air Data Atmodule PN 840025

Revision 6.0

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Revision Log

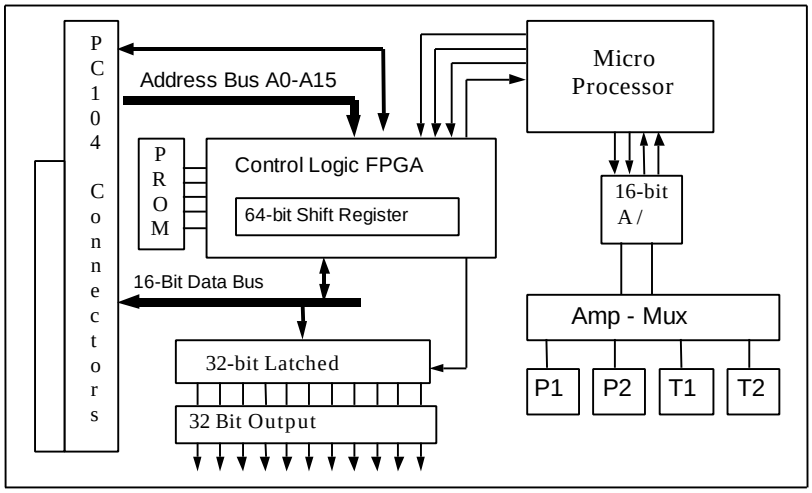
1	03-14-96	Initial release
2	03-31-97	Added detail to all sections
3	04-16-97	Revised for design review
4	04-17-97	Incorporated changes from the design review
5	05-1-97	Removed connector J4 Changed connector J3 to 50-pin header connector Added series damping resistors to digital output
6		Revised after board layout

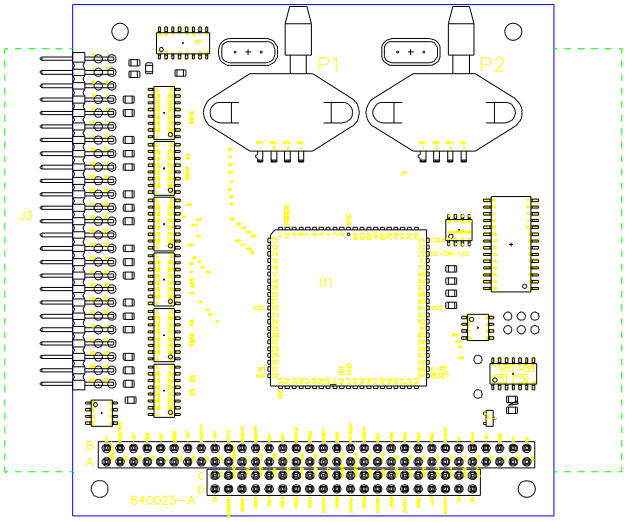
Definition of Terms

Module initialization time.	The time from when VDD is stable and the RSTDRV signal is false until the module registers contain valid pressure and temperature values.
Power supply rejection ratio	The variation of the measured output when the module supply voltage is varied from 5.0 volts to the limits of the supply voltage range.
Measurement time	The time measured from the read of the base address (P1) value until the data-registers are updated.
PSIA	Pressure in pounds per square inch absolute.
Measurement Accuracy	The maximum deviation from the actual value to the measured value. If the measurement accuracy is xxx then the measured value will be within ± xxx of the actual value.
Total Accuracy	The measurement accuracy of the module over temperature and all other operating conditions.
Static Accuracy	The measurement accuracy at 68 F. The static accuracy includes offset, linearity and pressure hysteresis.

Module Description

The PC104 Air Data Module is a PC104 complaint 16-bit-stackable module. The module measures two channels of absolute pressure and two channels of temperature. The static pressure channel (P1) has a zero to twenty PSIA measurement-range. The total pressure channel (P2) has a zero to thirty PSIA measurement-range. Temperature channel (T1) is an off board 1000 ohm platinum resistive temperature device (RTD). Temperature channel (T2) is an on board temperature sensor. The on board temperature is measured inside the pressure sensor housing. The module has 32-bits of latched digital output. The pressure, temperature, and digital output values are accessed with 16-bit memory read/write operations.





PC104 Standard

The module is compatible the IEEE draft standard P966.1, D1, October 1993 and the IEEE draft standard P996, D2/02 July 1990. These standards are not final and are subject to change. The Air Data Module is designed using all available information as of March 1997.

Power-On Reset

The power on reset is controlled by an on board voltage detector, and the reset signal from the PC104 bus (RESETDRV).

When power is applied the module resets the 32-bits of digital output to zero. The digital I/O is held reset while the bus reset signal (RESETDRV) is active.

Reset Initialization

There is a 130 mS delay from the RESETDEV signal going false until the module is ready for I/O operations. The module will not respond during this initialization time. During initialization the module processor powers up, configures the module hardware, measures the pressure and temperature values, and then updates the data registers.

Measurement Trigger

The pressure and temperature measurements are triggered from a read to the address containing the P1 value. The P1, P2, T1 and T2 registers will be updated one conversion time after the P1 register is read. Arbitration logic prevents the data registers from changing during a read or write operation. The P1, P2, T1 and T2 registers are updated simultaneously.

Measurement Time

	min	typ	max	Units
Measurement time for P1, P2, T1 and T2		TBD	80	mS

The first measurement is triggered automatically when power is applied.

Power Consumption

The module operates from the five-volt supply provide on the PC104 connectors J1 and J2.

	min	typ	max	Units
Supply current		TBD	100	mA
Power consumption			0.550	Watts

Data Format

The output format for the measured pressures and temperatures is 16-bit-two's-complement binary.

Decimal Value	Binary Value MSB LSB
+32767	(01111111)(11111111)
+00001	(00000000)(00000000)
+00000	(00000000)(00000001)
00000	(00000000)(00000000)
-00001	(11111111)(11111111)
-32677	(10000000)(00000001)
-32678	(10000000)(00000000)

The most negative value of –32,768 will be output under measurement-error conditions.

Pressure and Temperature Scaling

The pressure values are scaled for 1000 output counts per PSIA.

The temperature values are scaled for 100 output counts per degree F.

Measured Pressure PSIA	P1 or P2 Register Decimal Value	Measured Temperature Degrees F	T0 or T1 Register Decimal Value
0.000	00000	-100.00	-10000
1.000	10000	32.00	3200
20.000	200000	68.00	6800
30.000	300000	185.00	18500

Pressure Measurement

Two piezo-resistive pressure sensors are used to measure the static and the total pressure. The pressure sensors are connected to the module microprocessor via two 16-bit analog to digital converters. A pressure and temperature feedback signal is digitized from each pressure sensor, Digital calibration and compensation coefficients stored in non-volatile memory are used in a third order temperature compensation polynomial to calculate the corrected pressure.

Measurement Performance

Pressure Measurement Channel 1 (Static Pressure) 0 to 20 PSIA

	min	typ	max	
Maximum pressure	20 20000			PSIA Counts
Minimum pressure			0 0	PSIA Counts
Resolution		0.003		PSIA
Total accuracy (All effect over temperature)		0.024	0.050	PSIA
Static accuracy (Offset plus linearity error at 68 F)		0.010		PSIA
Differential non-linearity			0.002	PSIA
Output noise pk-pk		0.006		PSIA
Output scaling		1000		Counts/PSIA
Digital output range (non-error condition)	-32767		32767	Counts
Measurement error output value	-32768			Counts

Pressure Measurement Channel 2 (Total Pressure) 0 to 30 PSIA

	min	typ	max	
Maximum pressure	30			PSIA
Minimum pressure			0	PSIA
Resolution		0.004		PSIA
Total accuracy (All effect over temperature)		0.036	0.075	PSIA
Static accuracy (Offset plus linearity error at 68 F)		0.015		PSIA
Differential non-linearity			0.003	PSIA
Output noise pk-pk		0.008		PSIA
Output scaling		1000		Counts/PSIA
Digital output range (non-error condition)	-32767		32767	Counts
Measurement error output value		-32768		

Temperature Measurement Channel 2 On Board Sensor

	min	typ	max	
Measurement range	-40 -4000		185 15500	F Counts
Measurement resolution		0.2		F
Measurement accuracy at 68 F		1.0		F

Measurement accuracy full temperature range		3.0		F
Measurement time constant (still air)		120	180	seconds
Output noise pk-pk		0.2		F
Output scaling		100		Counts/F
Digital output range (non-error condition)	-32766		32767	Counts
Measurement error output-count		-32767		

Temperature Measurement Channel 1 Off Board RTD

	min	typ	max	
RTD resistance at 32 F		1000		Ohm
RTD alpha		0.00215		Ohm/Ohm/F
Measurement range	--100 -10000		200 20000	F Counts
Measurement resolution		0.1		F
Measurement accuracy at 68 F		0.6		F
Measurement accuracy full range		1.0		F
Signal averaging electrical time constant.		3		sec
Output noise pk-pk		0.2		F
Output scaling		100		Counts/F
Digital output range (non-error condition)	-32767		32767	Counts
Measurement error output-count		-32768		

External Temperature Probe

The module measures the resistance of the external RTD attached through connector J3. The resistance is converted to degrees F per the following table. The ohms-to-temperature transfer function tabulated below is programmed into the module at factory calibration and can be changed to accommodate different resistance-temperature curves.

Temperature		Resistance
C	F	Ohms
-100	-148	602.56
-90	-130	643.00
-80	-112	683.25
-70	-94	723.35
-60	-76	763.28
-50	-58	803.06
-40	-40	842.71
-30	-22	882.22
-20	-4	921.60
-10	14	960.86
0	32	1000.00
10	50	1039.03
20	68	1077.94
30	86	1116.73
40	104	1155.41
50	122	1193.97
60	140	1232.42
70	158	1270.75
80	176	1308.97
90	194	1347.07
100	212	1385.06

RTD Connection to Connector J3

RTD Wire	**J3 Connection**	**J3 Pin**
Red	RTD IN +	4
Black	RTD IN -	2
White	RTD Out +	3
	RTD Out -	1

Note: J3 pin one is left open.

Data Register Assignment

The four measured parameters are mapped into memory location starting at the base address location of 340 h. each parameter is read with a single 16-bit read. The module does not support 8-bit read operations.

Thirty-two bits of digital output are mapped into memory locations 348h and 34Ah. The data is written 16-bits at a time. The module does not support 8-bit write operations.

DATA REGISTER	R/W	I/O ADDRESS	LENGTH
P1 0 - 20 PSIA Static Pressure	Read	340 h	16 BITS
P2 0 - 30 PSIA Total Pressure	Read	342 h	16 BITS
T1 RTD	Read	344 h	16 BITS
T2 On Board Temp	Read	346 h	16 BITS
Digital Output bits 0 to 15	Write	348 h	16 BITS
Digital Output bits 16 to 31	Write	34A h	16 BITS

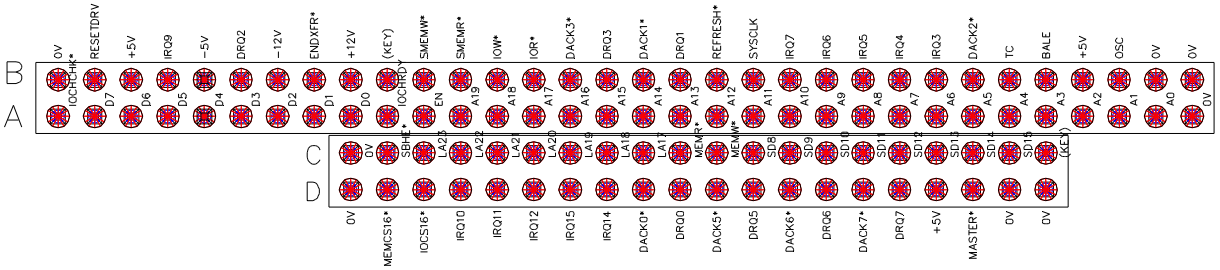
The module base-address (340 h) is set in the programmable logic array. This device interfaces to the PC104 bus. Changes to the base address require reprogramming this device.

The pressure and temperature measurements are triggered from a read to the address containing the P1 value . The P1, P2, T1 and T2 registers will be updated simultaneously one conversion time after the P1 register is read. Arbitration logic prevents the data registers from changing during a read or write operation.

Electrical Characteristics of the Data Out Signals

The 32 bits of output data on connector J3 are latched outputs from a HCT174 device with a series-damping resistor to control the rise-time and to isolate the 174 device from the load. The output drive of the 174 device is TTL compatible with a current source and sink of at least 4 mA

J1 And J2 Connector Top View

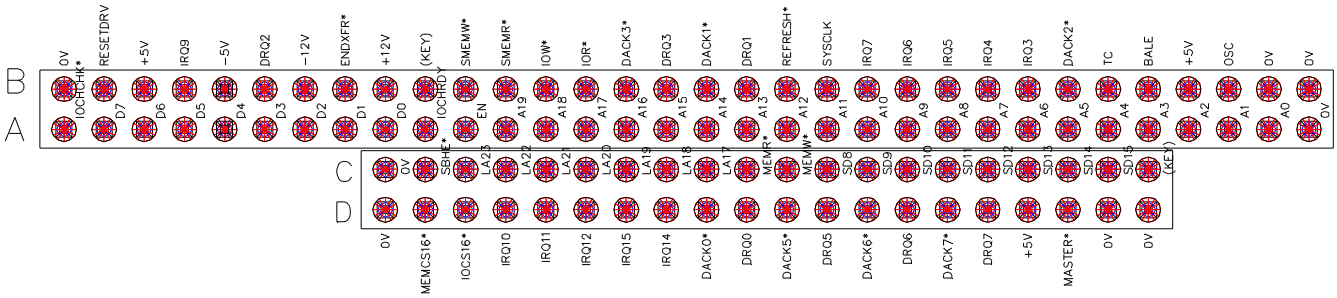


J1 Bus Signal Assignments

J1 PIN	Signal Name	Used	J1 PIN	Signal Name	Used
A1	IOCHCHK*		B1	0V	X
A2	D7	X	B2	RESETDEV	X
A3	D6	X	B3	+5V	X
A4	D5	X	B4	IRQ9	
A5	D4	X	B5	-5V	
A6	D3	X	B6	DRQ2	
A7	D2	X	B7	-12V	
A8	D1	X	B8	ENDXFR*	
A9	D0	X	B9	+12V	
A10	IOCHRDY	X	B10	(KEY)	Pin Removed
A11	EN	X	B11	SMEMW*	
A12	A19		B12	SMEMR*	
A13	A18		B13	IOW*	X
A14	A17		B14	IOR*	X
A15	A16		B15	DACK3*	
A16	A15	X	B16	DRQ3*	
A17	A14	X	B17	DACK1*	
A18	A13	X	B18	DRQ1	
A19	A12	X	B19	REFRESH*	
A20	A11	X	B20	SYSCLK	X
A21	A10	X	B21	IRQ7	
A22	A9	X	B22	IRQ6	
A23	A8	X	B23	IRQ5	
A24	A7	X	B24	IRQ4	
A25	A6	X	B25	IRQ3	
A26	A5	X	B26	DACK2*	
A27	A4	X	B27	TC	
A28	A3	X	B28	BALE	
A29	A2	X	B29	+5V	X
A30	A1	X	B30	OSC	
A31	A0	X	B31	0 V	X
A32	0V	X	B32	0 V	X

* Indicates active low signals. X indicates signal used by the module.

J1 And J2 Connector Top View



J2 Pin Assignment

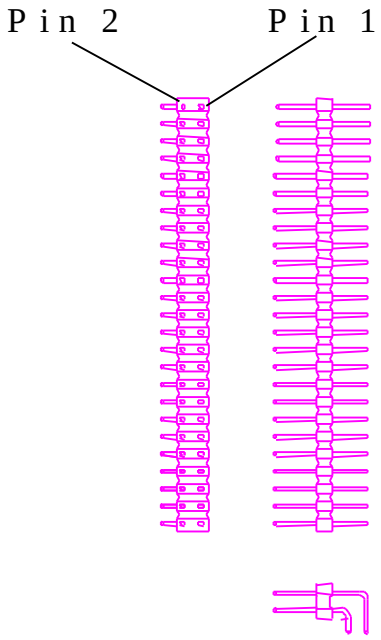
J2 PIN	Signal Name	Used	J2 Pin	Signal Name	Used
C0	0 V	X	D0	0 V	
C1	SBHE*		D1	MEMCS16*	
C2	LA23		D2	IOCS16*	X
C3	LA22		D3	RIQ10	
C4	LA21		D4	IRQ11	
C5	LA20		D5	IRQ12	
C6	LA19		D6	IRQ13	
C7	LA18		D7	IRQ14	
C8	LA17		D8	IRQ15	
C9	MEMR*		D9	DACK0*	
C10	MEMW*		D10	DRQ0	
C11	SD8	X	D11	DACK5*	
C12	SD9	X	D12	DACK6*	
C13	SD10	X	D13	DRQ6	
C14	SD11	X	D14	DACK7*	
C15	SD12	X	D15	DRQ7	
C16	SD13	X	D16	+5V	X
C17	SD14	X	D17	MASTER*	
C18	SD15	X	D18	0 V	X
C19	(KEY)	Pin Removed	D19	0 V	X

* Indicates active low signals. X indicates signal used by the module.

32-Bit Digital Output And RTD Connector (J3) Pin Assignment

PIN	SIGNAL	PIN	SIGNAL
1	RTD Out -	2	RTD In -
3	RTD Out +	4	RTD In +
5	0 V	6	0 V
7	5 V	8	0 V
9	D0	10	D1
11	0V	12	0 V
13	D2	14	D3
15	D4	16	D5
17	D6	18	D7
19	0 V	20	0V
21	D8	22	D9
23	D10	24	D11
25	D12	26	D13
27	0 V	28	0 V
29	D14	30	D15
31	D16	32	D17
33	D18	34	D19
35	0 V	36	0 V
37	D20	38	D21
39	D22	40	D23
41	D24	42	D25
43	0 V	44	0 V
45	D26	46	D27
47	D28	48	D29
49	D30	50	D31

Note: Pin 7 (Vdd) is current limited to 1 mA.



Mechanical

The module mechanical dimensions are specified in Atmos drawing 840025

The module dimensions conform to the PC104 standards document P996.1 D1 , October 1993.

Data Connector and RTD Connector Drawing (J3)

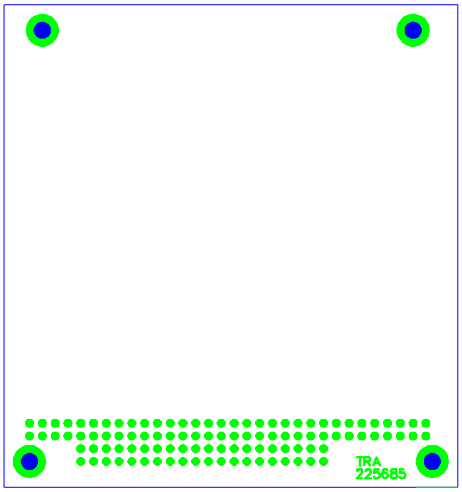
This connector is a right-angle-board-mount connector.

Module Conformal Coating
The module circuitry will be covered with water-resistant coating. The module is not intended for prolonged storage at high humidity levels.

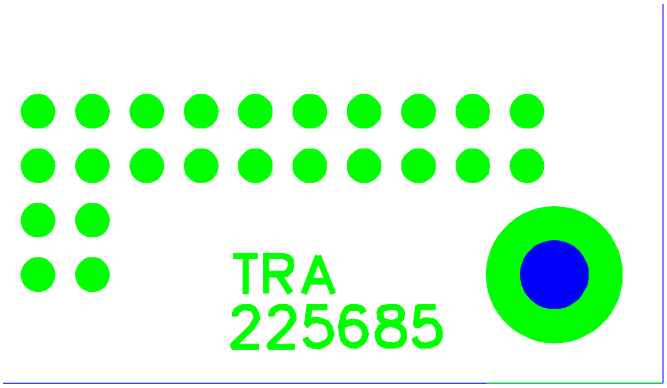
Customer Marking

The module shall be marked as shown below.

Bottom View of PCB showing Customer Marking
Marking is in copper with green translucent solder mask over it.



Expanded view of customer marking



Operating Environmental Conditions

Operating Temperature

	min	typ	max	
Operating temperature	-40		185	F

Operating Humidity

	min	typ	max	
Operating humidity	0		98	% RH

The module will operate after exposure to 98% relative humidity at 52F for 48 hours.

Operating shock

On cycle of 50 G 11 ms terminal saw-tooth profile.

Operating Vibration

20 GRMS random vibration at a frequency of 20 Hz to 2000 Hz.

Storage

The module is designed for extended storage in a dry environment.

Storage Life

15 years minimum storage life.

Storage Temperature

	min	typ	max	
Storage temperature	-67		195	F

Storage Humidity

The module circuitry will be covered with water-resistant coating. The coating type a application method will be submitted to TRA for approval. The module is not intended for prolonged storage at high humidity levels.

	min	typ	max	
Storage humidity	0		20	% RH

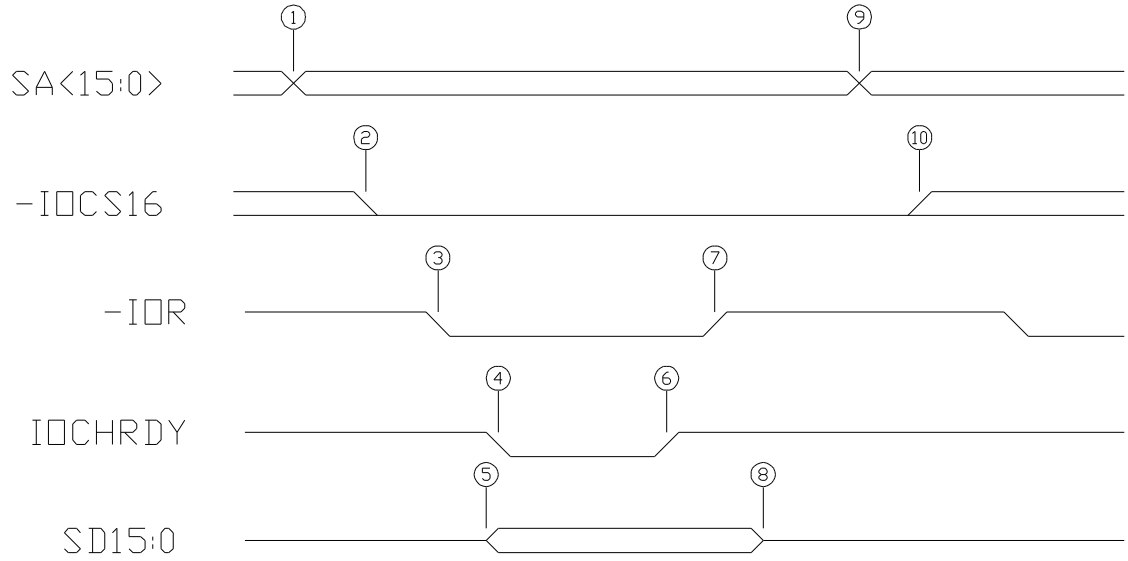
Storage Shock

TBD

Storage Vibration

TBD

Module Read Sequence (Address 340h , 342h , 344h , 346h)

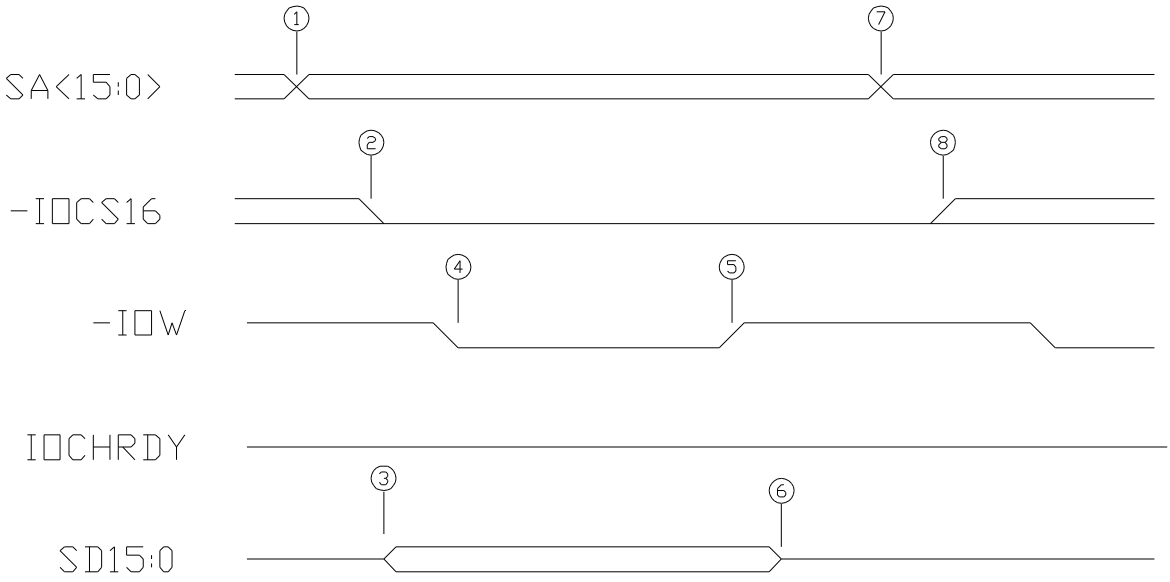


1) A valid address within the module address range is present.
2) The module drives -IOCS16 low in response to the valid address.
3) The host drives -IOR low (asserted).
4) The module drives IOCHRDY low (deasserted) in response to -IOR going low.
5) The module drives the data bus with the data to be read by the host.
6) The module releases the IOCHRDY line (asserted)
   The host pull up resistor brings this line high.
7) The host drives the -IOR line high (deasserted)
8) The module releases the data bus.
9) The host changes the address to an address outside the module address range.
10) The module releases the -IOCS16 line in response the address change.
    The host pull up resistor must brings this line high within 74 nS

Parameter	Module Typical	PC104 Spec
T1-2	20 nS	74 nS max
T3-4	35 nS	70 nS max
T1-3		91 nS min
T3-5	35 nS	
T4-6	550,760 nS	15600 nS max
T3-7	790,910 nS	
T7-8	17 nS	30 nS max
T9-10	130 nS	74 nS max

Times based on SYSCLOCK frequency of 8.4 MHz

Module Write Sequence (Address 348h , 34ah)



1) A valid address within the module address range is present.
2) The module drives -IOCS16 low in response to the valid address.
3) The host drives the data bus
4) The host drives -IOW low (asserted).
5) The host drives the -IOW line high (deasserted)
6) The host releases the data bus.
7) The host changes the address to an address outside the module address range.
8) The module releases the -IOCS16 line in response the address change.
   The host pull up resistor must brings this line high within 74 nS

Parameter	Module Typical	PC104 Spec
T1-2	35 nS	74 nS max
T7-8	130 nS	74 nS max ?
T5-6		25 nS min

Parameter	Test System Typical	PC104 Spec
T4-5	190 nS	