PC104-DIO48

User's Manual

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1 SOFTWARE INSTALLATION

The board has switches and jumpers to set before installing the board in your computer. By far the simplest way to configure your board is to use the *Insta*Cal™ program provided as part of your software package. *Insta*Cal™ will show you all available options, how to configure the various switches and jumpers (as applicable) to match your application requirements, and will create a configuration file that your application software (and the Universal Library) will refer to so the software you use will automatically know the exact configuration of the board.

Please refer to the *Extended Software Installation Manual* regarding the installation and operation of *Insta*Cal™. The following hard copy information is provided as a matter of completeness, and will allow you to set the hardware configuration of the board if you do not have immediate access to *Insta*Cal™ and/or your computer.

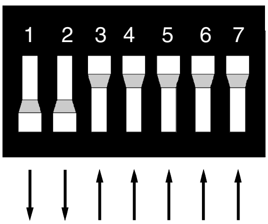
2 HARDWARE INSTALLATION

2.1 BASE ADDRESS

The PC104-DIO48 employs the PC bus for power, communications and data transfer. As such it draws power from the PC, monitors the address lines and control signals and responds to it's I/O address, and it receives and places data on the eight data lines.

The base address is the starting location that software writes to and reads from.

The base address switch is the means for setting the base address. Each switch position corresponds to one of the PC bus address lines. The down position activates that address bit.



SWITCH	HEX
1	200
2	100
3	80
4	40
5	20
6	10
7	08

BASE ADDRESS SWITCHES – 300h Shown.

Figure 2-1. Base Address Switches

The actual address is constructed by calculating the HEX or decimal number Base Address Select Switches which corresponds to the base address bits the PC104-DIO48 will respond to. For example, in Figure 2-1, switches 1 and 2 down, all others are up. Switch 1 = 200 hex (512 decimal) and switch 2 = 100 hex (256 decimal). When added together they equal 300 hex (768 decimal).

Certain address are reserved for use by the PC (Table 2-1). Others are free and can be used by the PC104-DIO48 and other expansion boards. We recommend that BASE = 300 hex (768 decimal) be tried first. See Figure 2-2 for the orientation of the switch block.

Table 2-1. PC I/O Addresses

HEX RANGE	FUNCTION	HEX RANGE	FUNCTION
000-00F	8237 DMA #1	2C0-2CF	EGA
020-021	8259 PIC #1	2D0-2DF	EGA
040-043	8253 TIMER	2E0-2E7	GPIB (AT)
060-063	8255 PPI (XT)	2E8-2EF	SERIAL PORT
060-064	8742 CONTROLLER (AT)	2F8-2FF	SERIAL PORT
070-071	CMOS RAM & NMI MASK (AT)	300-30F	PROTOTYPE CARD
080-08F	DMA PAGE REGISTERS	310-31F	PROTOTYPE CARD
0A0-0A1	8259 PIC #2 (AT)	320-32F	HARD DISK (XT)
0A0-0AF	NMI MASK (XT)	378-37F	PARALLEL PRINTER
0C0-0DF	8237 #2 (AT)	380-38F	SDLC
0F0-0FF	80287 NUMERIC CO-P (AT)	3A0-3AF	SDLC
1F0-1FF	HARD DISK (AT)	3B0-3BB	MDA
200-20F	GAME CONTROL	3BC-3BF	PARALLEL PRINTER
210-21F	EXPANSION UNIT (XT)	3C0-3CF	EGA
238-23B	BUS MOUSE	3D0-3DF	CGA
23C-23F	ALT BUS MOUSE	3E8-3EF	SERIAL PORT
270-27F	PARALLEL PRINTER	3F0-3F7	FLOPPY DISK
2B0-2BF	EGA	3F8-3FF	SERIAL PORT

The PC104-DIO48 BASE switch may be set for address in the range of 000 to 3F8 so it should not be hard to find a free address area for your PC104-DIO48. Once again, if you are not using IBM prototyping cards or some other board which occupies these addresses, then 300-31Fh are free to use. Addresses not specifically listed, such as 390-39Fh, are free.

2.2 INSTALLING THE BOARD

1. Turn the power off.

2. Push the board firmly down into the expansion bus connector. If it is not seated fully it may fail to work and could short circuit the PC bus power onto a PC bus signal. This could damage the motherboard in your PC as well as the PC104-DIO48.

2.3 CABLING TO THE DIO48 CONNECTOR

The connector is a standard 50-pin, male, header connector. A mating female connector (C50FF-##) may be purchased from Measurement Computing.

2.4 SIGNAL CONNECTION

All the digital outputs/inputs on the connector are CMOS TTL. TTL is an electronics industry term, short for Transistor Transistor Logic, which describes a standard for digital signals which are either 0V or 5V (nominal).

Under normal operating conditions, the voltages on the 82C55 pins range from near 0 volts for the low state to near 5.0 volts for the high state. Before connecting the PC104-DIO48 to external devices, review the electrical specification in this manual to ensure that the boards input voltage specifications are not exceeded. In addition to voltage and load matching, digital signal sources often need to be de-bounced. More details on digital interfacing are in the section on Interface Electronics in this manual.

Figure 2-2. PC104-DIO48 Board Layout and Pin 1 Location

IMPORTANT NOTE: The PC104-DIO48 uses two 82C55 digital chips for digital I/O. The 82C55 digital I/O chip initializes all ports as inputs on power up and reset. A TTL input is a high impedance input. If you connect another TTL input device to the 82C55 it will probably be turned ON every time the 82C55 is reset, or, it might be turned OFF instead. Remember, an 82C55 which is reset is in INPUT mode.

To safeguard against unwanted signal levels, all devices being controlled by an 82C55 should be tied low (or high, as required) by a 2.2K ohm resistor.

You will find positions for pull up and pull down resistor packs on your PC104-DIO48 board. To implement these, please turn to the application note on pull up/down resistors.

2.5 UNCONNECTED INPUTS

Keep in mind that unconnected inputs *float*. If you are using a PC104-DIO48 board for input, and have unconnected inputs, ignore the data from those lines.

In other words, if you connect bit A0 and not bit A1, do not be surprised if A1 stays low, stays high or tracks A0. It is unconnected and so, is not specified. The 82C55 is not malfunctioning. In the absence of a pull-up/down resistor, any input which is unconnected is unspecified.

You do not have to tie input lines, and unconnected lines will not affect the performance of connected lines. Just make sure that you mask out any unconnected bits in software.

2.6 CONNECTOR DIAGRAM

The connector accepts female 50-pin header connectors, such as those on the C50FF-2, a 2-foot cable with connectors.

If frequent changes to signal connections or signal conditioning is required, please refer to the information on the CIO-TERM100, CIO-SPADE50 and CIO-MINI50 screw terminal boards.

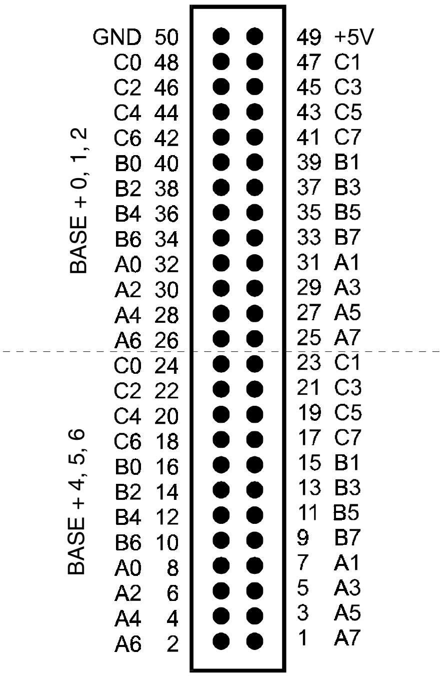


Figure 2-2 I/O Connector

3 CONTROL & DATA REGISTERS

We recommend that you use the Universal Library for all high level programming. The following is basic information on the 82C55 control and data registers and a table of control bytes for MODE 0 only. To learn more about the other 82C55 modes, you will need the component data book available from the component manufacturer.

Each PC104-DIO48 has two 82C55 parallel I/O chips. Each chip contains three data and one control register occupying four consecutive I/O address locations. The number of I/O locations occupied by a PC104-DIO48 board is equal to 4 times the number of 82C55 chips on the board or eight total.

The first address, or BASE ADDRESS, is determined by setting a bank of switches on the board.

The register descriptions follow all follow the format:

7	6	5	4	3	2	1	0
A7	A6	A5	A4	A3	A2	A1	A0

The numbers along the top row are the bit positions within the 8-bit byte and the numbers and symbols in the bottom row are the functions associated with each bit.

To write to or read from a register in decimal or HEX, the bit weights in Table 2-1 apply:

Table 3-1. Bit Weights

BIT POSITION	**DECIMAL VALUE**	**HEX VALUE**
0	1	1
1	2	2
2	4	4
3	8	8
4	16	10
5	32	20
6	64	40
7	128	80

To write a control word or data to a register, the individual bits must be set to 0 or 1 then combined to form a byte. Data read from registers must be analyzed to determine which bits are on or off.

The method of programming required to set/read bits from bytes is beyond the scope of this manual. It is covered in most Introduction To Programming books.

Board registers and their function are listed on the following table. Each register has eight bits which may be one byte of data or they may be eight individual read/write functions.

Table 3-2. Board I/O Addresses

ADDRESS	READ FUNCTION	WRITE FUNCTION
BASE + 0	Port A Input of 1st 82C55	Port A Output (1st 8255)
BASE + 1	Port B Input	Port B Output
BASE + 2	Port C Input	Port C Output
BASE + 3	None. No read back on 82C55	Configure 1st 82C55
BASE + 4	Port A Input of 2nd 82C55	Port A Output (2nd 8255)
BASE + 5	Port B Input	Port B Output
BASE + 6	Port C Input	Port C Output
BASE + 7	None. No read back on 82C55	Configure 2nd 82C55

3.1 DIGITAL I/O REGISTERS

PORT A DATA

BASE ADDRESS + 0 (1st 82C55)

BASE ADDRESS + 4 (2nd 82C55)

7	6	5	4	3	2	1	0
A7	A6	A5	A4	A3	A2	A1	A0

PORT B DATA

BASE ADDRESS + 1 (1st 82C55)

BASE ADDRESS + 5 (2nd 82C55)

7	6	5	4	3	2	1	0
B7	B6	B5	B4	B3	B2	B1	B0

Ports A & B may be programmed as input or output. Each is written to and read from in bytes, although for control and monitoring purposes, individual bits are typically used.

Bit set/reset and bit read functions require that unwanted bits be masked out of reads and ORed into writes.

PORT C DATA

BASE ADDRESS + 2 (1st 82C55)

BASE ADDRESS + 6 (2nd 82C55)

7	6	5	4	3	2	1	0
C8	C7	C6	C5	C4	C3	C2	C1
PCH3	PCH2	PCH1	PCH0	PCL3	PCL2	PCL1	PCL0

Port C can be used as one 8-bit port of either input or output, or it can be split into two 4-bit ports which can be independently input or output. The notation for the upper 4-bit port is PCH3 - PCH0, and for the lower, PCL3 - PCL0.

Although it can be split, every read and write to port C carries eight bits of data so unwanted information must be ANDed out of reads, and writes must be ORed with the current status of the other port.

OUTPUT PORTS

In 82C55 mode 0 configuration, ports configured for output hold the output data written to them. This output byte may be read back by reading a port configured for output.

INPUT PORTS

In 82C55 mode 0 configuration, ports configured for input read the state of the input lines at the moment the read is executed, transitions are not latched.

For information on modes 1 (strobed I/O) and 2 (bi-directional strobed I/O), refer to an Intel or AMD data book, 82C55 data sheet.

82C55 CONTROL REGISTERS

BASE ADDRESS + 3 (1st 82C55)

BASE ADDRESS + 7 (2nd 82C55)

7	6	5	4	3	2	1	0
MS	M3	M2	A	CU	M1	B	CL
	Group A				Group B		

The 82C55 can be programmed to operate in Input/ Output (mode 0), Strobed Input/ Output (mode 1) or Bi-Directional Bus (mode 2).

Information on programming the 82C55 in mode 0 is included here. Those wishing to use the 82C55 in modes 1 or 2, must procure a data sheet from Intel Corporation Literature Department. Visit their web site to obtain this data sheet.

When the PC is powered up or RESET, the 82C55 is reset. This places all 24 lines in Input mode and no further programming is needed to use the 24 lines as TTL inputs.

To program the 82C55 for other modes, the following control code byte must be assembled into an 8-bit byte.

MS = Mode Set. 1 = mode set active

M3	M2	Group A Function
0	0	Mode 0 Input / Output
0	1	Mode 1 Strobed Input / Output
1	X	Mode 2 Bi-Directional Bus

A	B	CL	CH	Independent Function
1	1	1	1	Input
0	0	0	0	Output

M1 = 0 is mode 0 for group B. Input / Output

M1 = 1 is mode 1 for group B. Strobed Input / Output

The Ports A, B, C-High, and C-Low, can be independently programmed for input or output.

The two groups of ports, group A and group B, may be independently programmed in one of several modes. The most commonly used mode is mode 0, input/output mode. The codes for programming the 82C55 in mode 0 are listed in Table 2-3.

Table 2-3. Mode 0 - Port I/O Select Codes

D4	D3	D1	D0	HEX	DEC	A	CU	B	CL
0	0	0	0	80	128	OUT	OUT	OUT	OUT
0	0	0	1	81	129	OUT	OUT	OUT	IN
0	0	1	0	82	130	OUT	OUT	IN	OUT
0	0	1	1	83	131	OUT	OUT	IN	IN
0	1	0	0	88	136	OUT	IN	OUT	OUT
0	1	0	1	89	137	OUT	IN	OUT	IN
0	1	1	0	8A	138	OUT	IN	IN	OUT
0	1	1	1	8B	139	OUT	IN	IN	IN
1	0	0	0	90	144	IN	OUT	OUT	OUT
1	0	0	1	91	145	IN	OUT	OUT	IN
1	0	1	0	92	146	IN	OUT	IN	OUT
1	0	1	1	93	147	IN	OUT	IN	IN
1	1	0	0	98	152	IN	IN	OUT	OUT
1	1	0	1	99	153	IN	IN	OUT	IN
1	1	1	0	9A	154	IN	IN	IN	OUT
1	1	1	1	9B	155	IN	IN	IN	IN

NOTE: D7 is always 1; D6, D5, and D2 are always 0.

4 SPECIFICATIONS

Power consumption

+5V Operating	130 mA typical, 200 mA max

Digital Input / Output

Digital Type	82C55
Configuration	4 ports of 8, 4 ports of 4, programmable by port as input or output
Number of channels	48 I/O
Output High	3.0 volts min @ −2.5 mA
Output Low	0.4 volts max @ 2.5 mA
Input High	2.0 volts min, +5.5 volts absolute max
Input Low	0.8 volts max, –0.5 volts absolute min
Power-up / reset state	Input mode (high impedance)
Miscellaneous	Locations provided for installation of pull-up or pull-down resistors.

Environmental

Operating temperature range	0 to 50°C
Storage temperature range	–20 to 70°C
Humidity	0 to 90% non-condensing

5 ELECTRONICS AND INTERFACING

This brief introduction to the electronics most often needed by digital I/O board users covers the following subjects:

- Pull-up/pull-down resistors
- Transistors
- Power MOSFETs
- Solid State Relays
- Voltage dividers
- Low pass filters for digital inputs
- Noise; sources and solutions

IMPORTANT NOTE:

WHEN AN 82C55 IS POWERED ON OR IS RESET, ALL PINS ARE SET TO HIGH IMPEDANCE INPUT.

The implication of this is that if you have output devices such as solid state relays, they may be switched on whenever the computer is powered on or reset. To prevent unwanted switching and to drive all outputs to a known safe state after power-on or reset, pull all pins either high (to +5VDC) or low (to GND) through a 2.2K ohm resistor.

To install pull up/down resistor packs, refer to the following application note.

5.1 PULL UP & PULL DOWN RESISTORS

This section deals with pull up/pull down resistors and 82C55 digital I/O chips.

Whenever the 82C55 is powered-on or reset, the control register is set to a known state; that state is mode 0, all ports set to inputs.

When used as an output device to control other TTL input devices, the 82C55 applies a voltage level of near 0V for low and near 5V for high.

The concept of voltage level of an 82C55 in input mode is meaningless. Do not connect a volt meter to the floating input of an 82C55. It will show you nothing of meaning. In input mode the 82C55 is in 'high Z' or high impedance. If your 82C55 were connected to another input chip (the device you were controlling), the inputs of that chip are left floating whenever the 82C55 is in input mode.

If the inputs of the device you are controlling are left to float, they may float up or down. The direction they float depends on the characteristics of the circuit and is unpredictable! This is why it often appears that the 82C55 has gone high after power-up. The result can be that your controlled device gets turned on! This is why you need pull up/pull down resistors.

Figure 4-1 shows an 82C55 digital output with a pull-up resistor attached.

The pull-up resistor provides a reference to +5V while its value of 2,200 ohms allows about 2.3 mA to flow through the circuit.

If the 82C55 is reset and enters high impedance input mode, the line is pulled high. At that point, both the 82C55 AND the device being controlled will “see” a high signal.

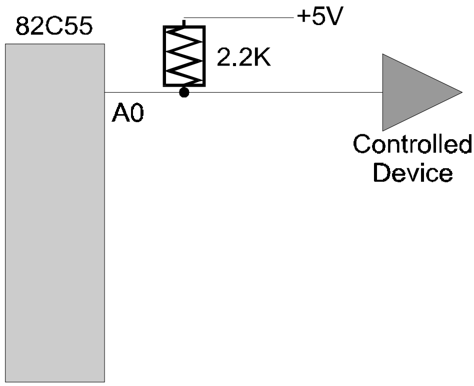


Figure 5-1. Output Being Pulled Up

If the 82C55 is in output mode, the 82C55 has enough power to override the pull-up resistor's high signal and drive the line low. If the 82C55 asserts a high signal, the pull-up resistor guarantees that the line goes to high (about +5V).

Of course, a pull-down resistor accomplishes the same task except that the line is pulled low when the 82C55 is reset. The 82C55 has more than enough power to drive the line high.

The board is equipped with positions for pull-up/down resistors Single Inline Packages (SIPs). The positions are marked RN1 through RN6 and are located beside the 82C55s.

A 2.2K ohm, 8-resistor SIP is made of eight, 2.2K resistors. One side of each resistor are all connected to a common point. The other ends go to eight SIP pins. The common line, at one end of the SIP, is marked with a dot or a line.

The SIP may be installed as pull-up or pull-down. At each location, RN1 - RN6, there are 10 holes in a line. One end of the line is marked “HI”, the other end is marked “LO”. The eight holes in the middle are connected to the eight lines of a port, A, B, or C. To ‘pull up’ the digital lines for a particular port, install the SIP resistor with the marked end toward the ‘HI’ label. To pull down the digital lines for a particular port, install the SIP resistor with the marked end toward the ‘LO’ label.

Install and solder the SIP in place.

A resistor value of 2.2K is recommended. Use other values only if you have calculated the necessity of doing so.

5.2 TTL TO SOLID STATE RELAYS

Many applications require digital outputs to switch AC and DC voltage motors on and off and to monitor AC and DC voltages. These AC and high DC voltages cannot be controlled or read directly by the TTL digital lines of a PC104-DIO48.

Solid State Relays, such as those available from Measurement Computing Corp. allow control and monitoring of AC and high DC voltages and can provide 750V isolation. Solid State Relays (SSRs) are the recommended devices for interfacing to AC and high DC signals.

The most convenient way to use solid state relays with a PC104-DIO48 board is to purchase a Solid State Relay Rack. A SSR Rack is a circuit board with output buffer chips which are powerful enough to switch the SSR. It provides sockets for SSRs.

SSR Racks are available from the Measurement Computing Corporation.

If you only want to drive one or two SSRs, all you need is a 74LS244 output buffer chip between the 82C55 output and the SSR. Of course the SSR will need a 5 volt power source as well.

5.3 VOLTAGE DIVIDERS

If you wish to measure a signal which varies over a range greater than the input range of a digital input, a proper voltage divider will drop the voltage of the input signal to a safe level.

A voltage divider takes advantage of Ohm's law, which states,

Voltage = Current * Resistance

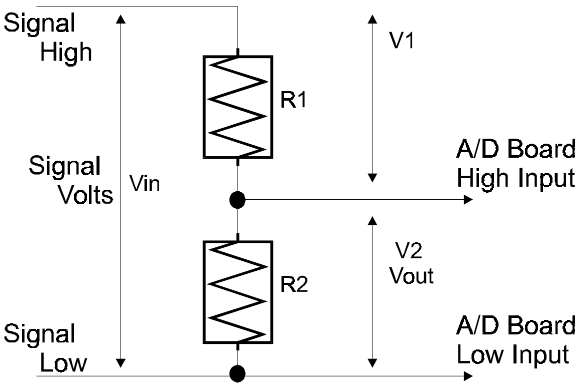
and Kirkoff's voltage law which states,

The sum of the voltage drops around a circuit will be equal to the voltage drop for the entire circuit.

Implied in the above is that any variation in the voltage drop for the circuit as a whole will have a proportional variation in all the voltage drops in the circuit.

In a voltage divider, the voltage across one of the resistors in a circuit is proportional to the ratio of that resistor to the total resistance in the circuit.

Therefore, you setup a voltage divider choosing two resistors with the proper proportions relative to the full scale of the voltage input and the maximum signal voltage to the board.



SIMPLE VOLTAGE DIVIDER - $\frac{\mathbf{Vin}}{\mathbf{Vout}} = \frac{\mathbf{R1+R2}}{\mathbf{R2}}$

Figure 5-2. Voltage Divider

Dropping the voltage proportionally is called attenuation. The formula for attenuation is:

$\text{Attenuation} = \frac{R1 + R2}{R2}$	The variable Attenuation is the proportional difference between the signal voltage max and the full scale of the analog input.
$2 = \frac{10K + 10K}{10K}$	For example, if the signal varies between 0 and 20 volts and you wish to measure that with an analog input with a full scale range of 0 to 10 volts, the Attenuation is 2:1 or just 2.
$R1 = (A-1) * R2$	For a given attenuation, pick a handy resisitor and call it R2, the use this formula to calculate R1.

Digital inputs may also require the use of voltage dividers. For example, if you wish to measure a digital signal that is at 0 volts when off and 24 volts when on, you cannot connect that directly to the digital inputs. The voltage must be dropped to 5 volts max when on. The attenuation is 24:5 or 4.8. Use the equation above to find an appropriate R1 if R2 is 1K. Remember that a TTL input is 'on' when the input voltage is greater than 2.5V but less than 5.0V.

IMPORTANT NOTE: The resistors, R1 and R2, are going to dissipate power in the divider circuit according to the equation, Current = Voltage / Resistance And power (watts) is current-squared times resistance ($W=I^2*R$). The higher the value of the resistance (R1 + R2) the less power dissipated by the divider circuit. Here is a simple rule:

For Attenuation of 5:1 or less, no resistor should be less than 10K.

For Attenuation of greater than 5:1, no resistor should be less than 1K.

5.4 LOW PASS FILTERS DE-BOUNCE INPUTS

A low pass filter is placed on the signal wires between a signal and an DIO board. It attenuates frequencies greater than the cut-off frequency preventing them from entering the digital inputs.

The key term in a low pass filter circuit is cut-off frequency. The cut-off frequency is that frequency above which no variation of voltage with respect to time may enter the circuit. For example, if a low pass filter had a cut-off frequency of 30 Hz, interference associated with line voltage (60 Hz) would be filtered out but a signal of 25 Hz would be allowed to pass.

Also, in a digital circuit, a low pass filter might be used to “de-bounce” (filter) an input from a switch or external relay. (Unless switch/relay contacts are mercury-whetted, they tend to bounce briefly on closure, generating a pulsating noise signal. This can easily lead to erroneous counts unless filtered out.)

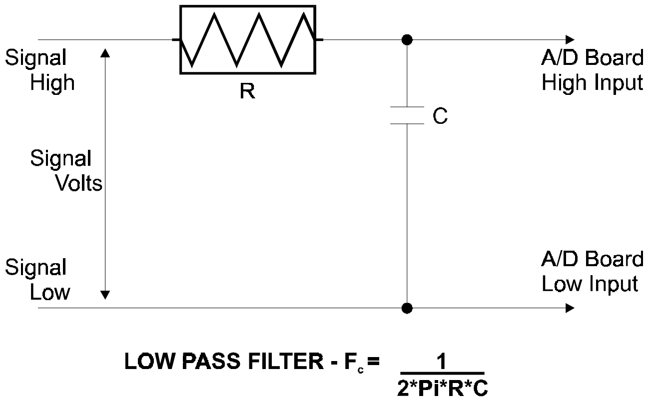


Figure 5-3. Low-Pass Filter

A simple low-pass filter may be constructed from one resistor (R) and one capacitor (C) (Figure 5-3). The cut-off frequency is determined according to the formula:

$$Fc = \frac{1}{2 \pi R C}$$

Where π= 3.14...
R = ohms
C = farads

and

$$R = \frac{1}{2\pi C \ Fc}$$

Fc = cut-off frequency in cycles/second.

EC Declaration of Conformity

We, Measurement Computing Corporation, declare under sole responsibility that the product:

Part Number	Description
PC104-DIO48	48-Bit Digital I/O Board

to which this declaration relates, meets the essential requirements, is in conformity with, and CE marking has been applied according to the relevant EC Directives listed below using the relevant section of the following EC standards and other normative documents:

EU EMC Directive 89/336/EEC: Essential requirements relating to electromagnetic compatibility.

EU 55022 Class B: Limits and methods of measurements of radio interference characteristics of information technology equipment.

EN 50082-1: EC generic immunity requirements.

IEC 801-2: Electrostatic discharge requirements for industrial process measurement and control equipment.

IEC 801-3: Radiated electromagnetic field requirements for industrial process measurements and control equipment.

IEC 801-4: Electrically fast transients for industrial process measurement and control equipment.

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