4I22 COUNTER TIMER MANUAL

VERSION 1.0

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HANDLING PRECAUTIONS

STATIC ELECTRICITY

The CMOS integrated circuits on the 4I22 can be damaged by exposure to electrostatic discharges. The following precautions should be taken when handling the 4I22 to prevent possible damage.

A. Leave the 4I22 in its antistatic bag until needed.

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

C. Ground equipment into which 4I22 will be installed.

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

E. Avoid wearing synthetic fabrics, particularly Nylon.

INTRODUCTION

GENERAL

The MESA 4I22 is a 10 MHz, nine channel universal counter-timer card. An on card 10 MHZ crystal oscillator is provided as a time base. The 82C54 counters on the 4I22 may be used for event counting, frequency counting, frequency generation, pulse width modulators, digital one shots, interrupt timers and many other timing and counting applications.

Eight of the nine counters on the 4I22 have external clock, gate, and output connections. The ninth counter is used as a optional 10 MHz time base prescaler for the other eight counters. Gate and output polarity can be jumper selected as active high or low.

24 general purpose I/O bits are provided by a 82C55 PIA. 3.3K Pullup resistors on the parallel I/O simplify connection to contact closure, Opto-detector, and open collector outputs. All parallel port and timer inputs and outputs have interleaved grounds to reduce crosstalk.

Up to two of the counters may be used to generate any of the XT or AT interrupts.

CONFIGURATION

GENERAL

The 4I22 's port address and polarity selection options are set with jumpers. Each group of jumpers will be discussed separately by function. In the following discussions, when the words "up", "down", "right", and "left" are used it is assumed that the 4I22 card is oriented with its bus connectors J1 and J2 at the bottom edge of the card (nearest the person doing the configuration).

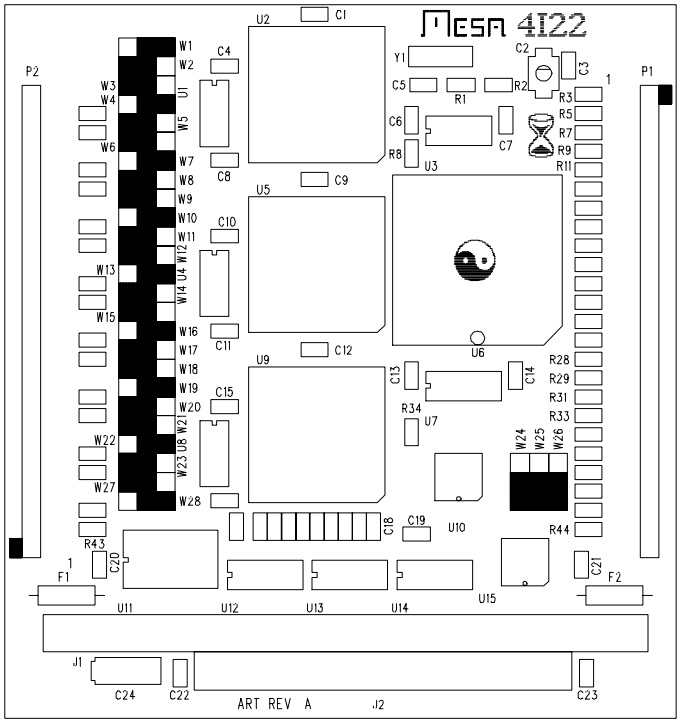
STANDARD CONFIGURATION

The 4I22 card is configured in the following manner when shipped from the factory. ***This means that if you would like to verify card operation, you should do it before you re-configure the 4I22.***

BASE ADDRESS	0200H
GATE POLARITY COUNTERS 1A THROUGH 3B)	NORMAL
OUTPUT POLARITY (COUNTERS 1A THROUGH 3B	NORMAL
CLOCK SOURCE (COUNTERS 1A THROUGH 3B)	INTERNAL
CLOCK PRESCALER CLOCK IS COUNTER 3C OUTPUT)	ENABLED

CONFIGURATION

DEFAULT JUMPER SETTINGS



CONFIGURATION

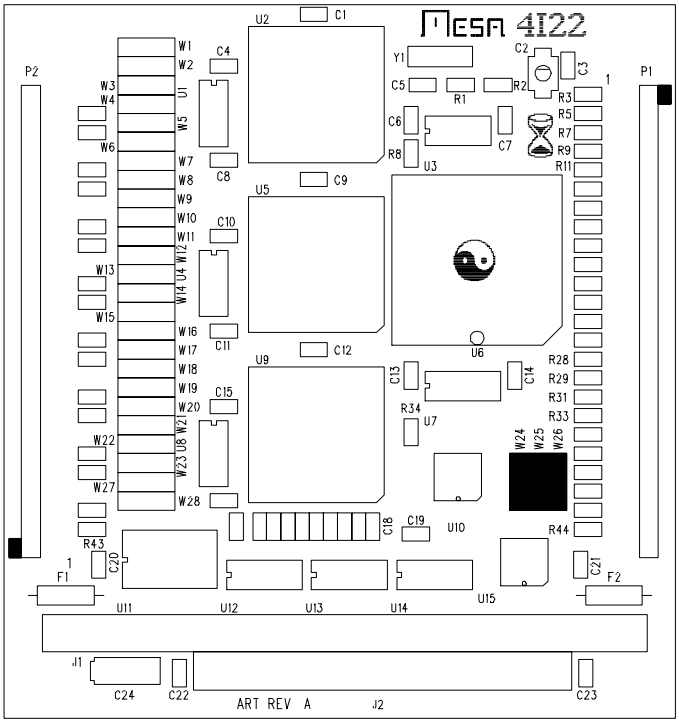
BASE ADDRESS SELECTION

The 4I22 occupies 16 contiguous addresses in I/O space. The 4I22 base address can be set at 8 different locations in the addressing range of the PC-BUS on a 16 byte boundary. Jumpers W24, W25, and W26 set the 4I22 base address which is the address of the first 82C54 (counter 1). The following table shows the possible base addresses.

	W24	W25	W26
200H	down	down	down
210H	down	down	up
220H	down	up	down
230H	down	up	up
240H	up	down	down
250H	up	down	up
260H	up	up	down
270H	up	up	up

CONFIGURATION

LOCATION OF BASE ADDRESS SELECT JUMPERS



CONFIGURATION

GATE AND OUTPUT POLARITY

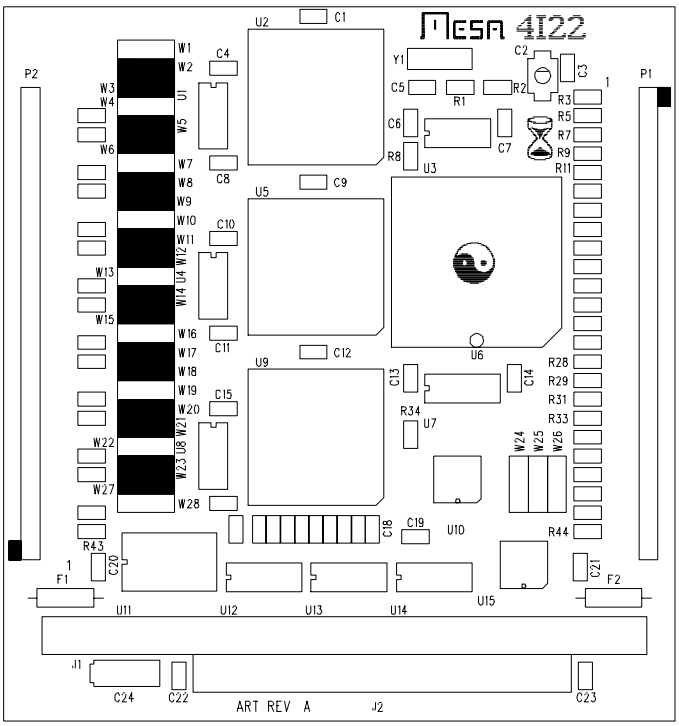
The polarity of the gate and output lines of counters 1A through 3B can be set with jumpers. The gate inputs are normally active high, that is, a high level enables counting. The output polarity depends on the counter mode. The following table lists the jumper positions for gate and output polarity setting. In all cases, a jumper placed in the left hand position selects direct input or output while a jumper placed in the right hand position selects the inverted input or output.

GATE AND OUTPUT POLARITY SETTING JUMPERS

	GATE	OUTPUT
Counter 1A	W2	W3
Counter 1B	W5	W6
Counter 1C	W8	W9
Counter 2A	W11	W12
Counter 2B	W14	W15
Counter 2C	W17	W18
Counter 3A	W20	W21
Counter 3B	W23	W27

CONFIGURATION

LOCATION OF GATE, AND OUTPUT, POLARITY JUMPERS



CONFIGURATION

CLOCK SOURCE SELECTION

Jumpers are provided on the 4I22 to allow selection of internal or external clock sources. The internal clock source can be the 10 MHz time base or the output of counter 3C. Counter 3C on the 4I22 is used as a prescaler for the on card 10 MHz time base. The other eight counters can use this internal clock source or use the external input pin. Using the prescaled output is useful for generating long time delays or low frequency outputs.

CLOCK SOURCE JUMPERS

The clock source jumpers select the internal clock when in the right hand position, and the external input when in the left hand position.

Counter 1A	W1
Counter 1B	W4
Counter 1C	W7
Counter 2A	W10
Counter 2B	W13
Counter 2C	W16
Counter 3A	W19
Counter 3B	W22

CLOCK PRESCALER

Jumper W28 determines whether the internal clock source is the 10 MHz time base or the output of counter 3C. When W28 is in the left hand position, the 10 MHz time base is used as the internal clock. When W28 is in the right hand position, the output of counter 3C is used as the internal clock.

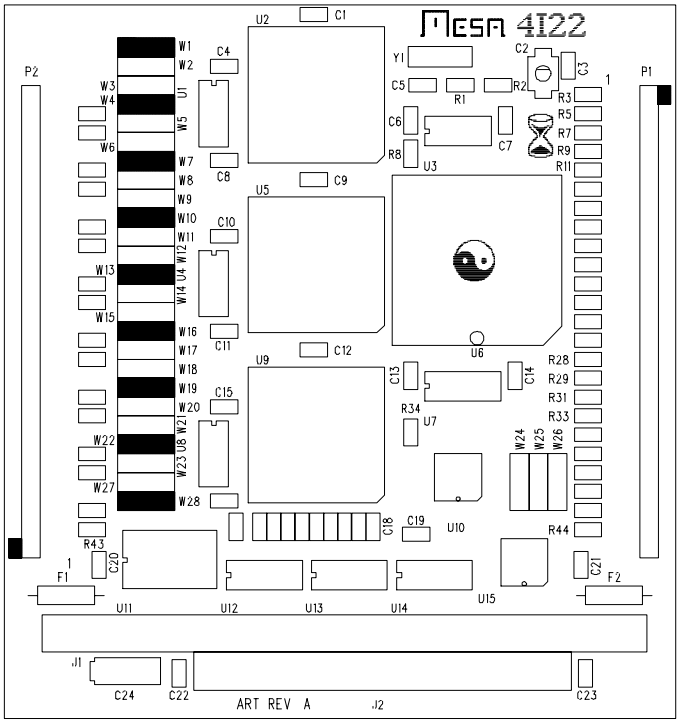
POWER OPTION

Pin 49 on both of the 4I22 I/O connectors is connected to system +5V through a fuse. This pin may be disconnected by removing the fuse. F1 is the fuse for P2 and F2 is the fuse for P1.

Note that the +5V fuse is rated at 1 Amp and can be replaced without soldering. Replacement part number is LittleFuse PN 250001.

CONFIGURATION

LOCATION OF CLOCK SOURCE AND PRESCALER SELECT JUMPERS



CONFIGURATION

INTERRUPT SELECTION

The outputs of counters 1A and 1B can be used to generate host interrupts. All interrupt masking ORing and selection is accomplished with a hardware latch which is controlled by software. No jumpers are required. See operation section for information on controlling the interrupt features.

I/O CONNECTOR PINOUT

TIMER - COUNTER CONNECTOR PINOUT

The 4I22 50 pin Counter timer port I/O connector pinouts is as follows:

P2 CONNECTOR

PIN#	SIGNAL	PIN#	SIGNAL
1	OUT 3B	25	OUT 2A
3	GATE 3B	27	GATE 2A
5	CLOCK 3B	29	CLOCK 2A
7	OUT 3A	31	OUT 1C
9	GATE 3A	33	GATE 1C
11	CLOCK 3A	35	CLOCK 1C
13	OUT 2C	37	OUT 1B
15	GATE 2C	39	GATE 1B
17	CLOCK 2C	41	CLOCK 1B
19	OUT 2B	43	OUT 1A
21	GATE 2B	45	GATE 1A
23	CLOCK 2B	47	CLOCK 1A
		49	+5V POWER

All Even numbered pins are connected to ground

I/O CONNECTOR PINOUT

PARALLEL PORT CONNECTOR PIN-OUT

The 4I22 50 pin Parallel port I/O connector pinouts is as follows:

P1 CONNECTOR

PIN#	**SIGNAL**	**PIN#**	**SIGNAL**
1	Port C bit 7	3	Port C bit 6
5	Port C bit 5	7	Port C bit 4
9	Port C bit 3	11	Port C bit 2
13	Port C bit 1	15	Port C bit 0
17	Port B bit 7	19	Port B bit 6
21	Port B bit 5	23	Port B bit 4
25	Port B bit 3	27	Port B bit 2
29	Port B bit 1	31	Port B bit 0
33	Port A bit 7	35	Port A bit 6
37	Port A bit 5	39	Port A bit 4
41	Port A bit 3	43	Port A bit 2
45	Port A bit 1	47	Port A bit 0
		49	+5V POWER

All Even numbered pins are connected to ground

INSTALLATION

GENERAL

When the 4I22 has been properly configured for its application, it can be inserted into a PC/104 stack. The standoffs should then be tightened to secure the 4I22 in its place. When the 4I22 is secured in the stack the 50 pin headers can be plugged in from the sides.

I/O CONNECTOR ORIENTATION

The 50 pin connectors on the 4I22 have their pin one ends marked with a white square on the circuit card. This corresponds with the red stripe on typical flat cable assemblies. If more positive polarization is desired, center polarized IDC header connectors should be used. These connectors will not fully mate with the pins on the 4I22 if installed backwards. A suggested center polarized 50 pin IDC header is AMP PN 1-746285-0.

OPERATION

GENERAL

Detailed operational information on the 82C54 counter-timer and 82C55 parallel port are beyond the scope of this manual. For complete information on these devices, you should refer to the manufacturers data sheets. The application examples assume that you have access to these data sheets. Source and object code for all of the application examples are included on the 4I22 utility disk.

RESET

System reset forces the 4I22 into a predefined state. After a system reset, all parallel I/O pins are in the input mode, and pulled high. Both on card interrupts are disabled. The counter- timers on the 4I22 have no external reset input, and will be in an undefined state at power up.

OPERATION

PORT MAPPING

The following table shows the timer-counter and parallel I/O port locations. With the base address set to BASE, the 82C54 and 82C55 ports would be located as follows:

U2 82C54 #1:	Counter 1A	BASE + 0
	Counter 1B	BASE + 1
	Counter 1C	BASE + 2
	Control Port	BASE + 3
U5 82C54 #2:	Counter 2A	BASE + 4
	Counter 2B	BASE + 5
	Counter 2C	BASE + 6
	Control Port	BASE + 7
U9 82C54 #3:	Counter 3A	BASE + 8
	Counter 3B	BASE + 9
	Counter 3C	BASE + A
	Control Port	BASE + B
U6 82C55:	Port A	BASE + C
	Port B	BASE + D
	Port C	BASE + E
	Control Port	BASE + F

OPERATION

INTERRUPT SELECTION

The outputs of counters 1A and 1B can be used to generate host interrupts. Each counter output has an individual enabling mask (IMASKA and IMASKB). These masked outputs are then ORed together. After reset the counter outputs are masked off.

There are two modes of interrupt operation the normal mode and the shared mode. The normal mode is selected by setting the interrupt mode to 1 (IMODE0 = 1, and IMODE1 = 0). In the normal mode the ORed signal is connected to the selected interrupt line. In the shared mode the interrupt used by the 4I22 can be shared with another card in the system. The shared mode is selected by setting the interrupt mode to 2 (IMODE0 = 0, and IMODE1 = 1). In the shared mode when an interrupt occurs the interrupt line is pulled high (open collector) this allows another card in the system using the same mode to share the interrupt line. (either card can pull the line high). In the shared mode you can enable a pulldown resistor (IMODE0 = 1, and IMODE1 = 1). After reset the interrupt is disabled (tristated) (IMODE0 = 0, and IMODE1 = 0).

Finally this interrupt source can be routed to any of the PC/104 interrupt lines. Using ISEL0..3.

Note : If more than one interrupt source is routed to the same system interrupt line, software must not enable more than one interrupt line driver at a time. This applies to multiple sources on one card and any other interrupt sources in the system.

OPERATION

INTERRUPT OPTION LATCH

The interrupt options are controlled by latch bits which are located as follows:

BASE + 8000H	ISEL0
BASE + 8001H	ISEL1
BASE + 8002H	ISEL2
BASE + 8003H	ISEL3
BASE + 8004H	IMODE0
BASE + 8005H	IMODE1
BASE + 8006H	IMASKA
BASE + 8007H	IMASKB

ISEL0..3 forms a binary number which is the interrupt number the source interrupt is routed to. The default is interrupt 0 which is not connected Note that it is possible to select an interrupt number which does not connect to the PC/104 bus.

IMODE0..1 selects one of four interrupt modes as follows:
0: Interrupts off (default)
1: Interrupts on
2: Shared interrupt (no pulldown)
3: Shared interrupt (pulldown)

IMASKA and IMASKB are the masks for OUT1A and OUT1B respectively. The default is both off.

APPLICATION EXAMPLES

EVENT COUNTING

Counter 1A is used in mode 0 for event counting. When jumpered for NORMAL gate polarity, the gate input can be left disconnected if not used. You must change the default configuration of counter 1A in order to use the external clock input. To do this, move jumper W1 into the left hand position. The example program EVECOUNT.EXE resets the counter and then displays the current count on the console device. Interrupts are not used, and the counter wraps around at 65536.

FREQUENCY COUNTER

A four digit 10 MHz frequency counter can be configured using three of the counters on the 4I22 (plus the prescaler). Counter 1B is used as a gate generator. Counter 1B is set to mode 1 (hardware triggerable one shot). Counter 3C is used as a prescaler for counter 1B. Counter 1C is used in mode 4 (software triggered strobe) as a trigger to generate the gate pulse. Counter 1A is used as the frequency counter proper. The 4I22 configuration must be changed in order for the example program to work. In addition, external connections must be made to interconnect the appropriate counters. The configuration changes (from the default configuration) are 1: Counter 1A clock source is external (W1 in left hand position) and 2: Counter 1B output polarity is reversed (W6 in right hand position). The external connections to be made are 1: Connect counter 1A gate (P2 pin 45) to counter 1B output (P2 pin 37) and 2: Connect counter 1B gate (P2 pin 39) to counter 1C output (P2 pin 31). The frequency counter input is counter 1A clock (P2 pin 47). The example program 4I22FREQ.EXE sets the gate time to 100 ms, allowing a maximum frequency read-out of 655350 Hz with 10 hz resolution. The frequency is displayed on the console. There are some synchronization problems that prevent reliable cascading of counters when used with an asynchronous input and the internal gate. Applications needing count resolution better that 65535 should use the interrupt output capability of counters 1A and 1B, and let the host processor handle the counter overflow. With the maximum 10 MHz input, the interrupt rate would be approximately 153 Hz. Alternatively, an external gate can be used.

SQUARE WAVE GENERATION

All counters can used to generate square waves with programmable frequencies at their outputs. Counter mode 3 is used to generate square waves. The example program 4I22SQR.EXE generates square waves on all outputs with frequencies descending by a factor of two from counter to counter. Counter 1A starts at 1 kHz and counter 3B ends up at 7.8125 Hz. Counter 3C is used as a prescaler.

APPLICATION EXAMPLES

DIGITAL ONE SHOT

Counters 1A through 3B can be used to generate an output pulse with programmable width. Counter mode 1 (hardware triggered one- shot) is used. The example program 4I22OS.EXE uses counter 1A. An active low 100 mS pulse is generated on every rising edge of counter 1A's gate input (P2 pin 45).

PULSE WIDTH MODULATION

Variable resolution pulse width modulation outputs can be generated by using one counter as a reference frequency generator (in mode 2 or 3) and one or more counters in the one shot mode (mode 1). The output of the reference counter connects to the gate input of one or more one shot counter(s). Unfortunately, it is awkward to generate a 0 output, as a 1 clock cycle pulse is the minimum pulse width in the one-shot mode. This is not a major problem in most real applications, as the power driver circuit will not "see" the minimum width (100 nsec) pulse. The 4I22 configuration must be changed in order for the example program to work. The configuration change (from the default configuration) is that the prescaler option is not used (W28 in left hand position). In addition, an external connection must be made from the output of counter 1A (P2 pin 43) to the gate of counter 1B (P2 pin 39). The example program 4I22PWM.EXE uses counter 1A as the reference counter and counter 1B as the one-shot timer. The example program generates a 10 bit resolution PWM output with a slow up and down ramp from 1/1024 duty cycle to full scale (always on) and back again. At 10 MHz, a 10 bit resolution output would have a repetition rate of 9.77 kHz. PWM outputs are suitable for high efficiency variable drive of integrating (slow response) loads. Examples are DC motors, solenoids, incandescent lamps, heaters, etc.

INTERRUPT GENERATION

The outputs of counters 1A and 1B can generate host interrupts. This is useful for low overhead, accurate time delays, implementing high speed "tick" clocks, interrupting the host on terminal count etc. The example program 4I22INT.EXE uses the counter 1A interrupt output and a command line specified bus interrupt. In order for the example program to work, you must have no enabled interrupt source on the selected interrupt. The example program implements a 3 pps annoying beep background task.

REFERENCE INFORMATION

SPECIFICATIONS

		MIN	MAX	UNIT	
POWER SUPPLY					
Voltage		4.5	5.5	V	
Supply current		---	75	mA	(no ext. load)
BUS LOADING:					
Input capacitance		---	15	pF	
Input leakage current	---	5	uA		
Output drive capability	150	---	pF		
Output sink current		12	---	mA	
I/O PORT LOADING:					
Input logic low		-.3	.8	V	
Input logic high		2.0	5.5	V	
Output low		---	.4	V	2.5 mA sink
Output high		3.0	---	V	2.5 mA source
CLOCK ACCURACY:					
Factory Trimmed		---	+-10	PPM	@ 25ºC
Accuracy over temperature		---	+-1	PPM/ºC	
ENVIRONMENTAL:					
Operating temperature range					
-I version		-40	+85	ºC	
-C version		0	+70	ºC	
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.

THE FOREGOING WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED. INCLUDING BUT NOT LIMITED TO ANY IMPLIED WARRANTY OF MERCHANTABILITY, FITNESS, OR ADEQUACY FOR ANY PARTICULAR PURPOSE OR USE. MESA ELECTRONICS SHALL NOT BE LIABLE FOR ANY SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES, WHETHER IN CONTRACT, TORT, OR OTHERWISE.

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.

REFERENCE INFORMATION

SCHEMATICS