TRACER-E

RUGGEDIZED PC/104 Digital I/O

Revision: June 12, 2003

Apex Embedded Systems

Reference Manual

TRACER-E Reference Manual

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Support Policy

General Support Policy.

We support all hardware products for a period of 3 months from time of delivery. See limited warranty terms.

Recommended sequence in obtaining customer support

Review user manuals for additional information not found in demo software.

Go to our website at www.apexembedded.com/support.html.

Contact us via email at help@apexembedded.com.   Technical support related inquiry answered typically within a 24-hour period.

Need custom modifications?

Contact us for customization or modifications to our standard product. If you need large quantities we can generally save you money through optimizing card designs to meet your exact needs.

Welcome

Dear Valued Customer:

Thank you for your interest in our products and services.

Apex Embedded Systems "Continuous improvement" policy utilizes customer feedback to improve existing products and create new product offerings based on needs of our customers.

Continued Success,

Apex Embedded Systems

Benefits and Features

The TRACER-E is the toughest PC/104 DIO module on the market today!

Executive
Summary

What is the TRACER-E? The TRACER-E is a high current PC/104 digital I/O and counter/timer module. It is designed for use in systems where high reliability is of utmost importance while operating in harsh environments. The board provides 48 lines of 8255 compatible GPIO and three 16-bit 8254 compatible counter/timers.

What are the Benefits to using the TRACER-E?

- Designed for operation in harsh environments. All components and materials used in our products are designed to operate in the extended temperature range, under high shock and vibration. We have utilized MIL-SPEC drivers in the TRACER-E design to insure the greatest MTBF for mission critical applications.

- Operating Temperature from -40 to 85ºC

- High-current outputs 65mA sink, 15mA source. This is true even while operating at high temperatures.

- LED Status indicator. Useful in determining general status and in system debugging. A wide variety of signals can be routed to the LED via software selection.

- 8255 Software compatible interface structure. The hardware provides two 8255 compatible I/O ports that provide 48 lines of general purpose I/O.

- Direct interfacing to OPTO-22's isolated I/O racks. Digital I/O connectors organized to allow direct connection to OPTO-22's isolated I/O racks including the G4 series, the PB16-H, PB16-J, PB16-K, PB16-L, PB8H and the PB24HQ.

- Polarized Locking I/O Connectors.

- 8254 Software compatible counter/timers. Three 16-bit counter/timers are based on an 82C54. Counter/Timer operation to 40MHz.

- Broad selection of interrupt sources which are fully software configurable.
- Industry Standard Form Factor. Compliant to the PC/104 standard form factor ensuring consistent system packaging
- No tantalum or electrolytic capacitors used in the design.
- Counter/Timer can be easily configured to support quadrature encoder signals.
- Long-Term Product Availability. Apex Embedded Systems is committed to delivering long life cycle products.
- FPGA customization available.
- Designed and manufactured in Wisconsin by Apex Embedded Systems. We will do whatever we can to assist you in designing in our products.

Photo

Counter/Timer (J13)

Digital I/O
8255 #2
(J9)

Digital I/O
8255 #1
(J12)

Interrupt A
Select (J10)

Interrupt B
Select (J8)

Interrupt C
Select (J6)

EXT IRQ
Source (J7)

EXT IRQ
Source (J5)

Base Address and
Mode Select (J11)

Status LED
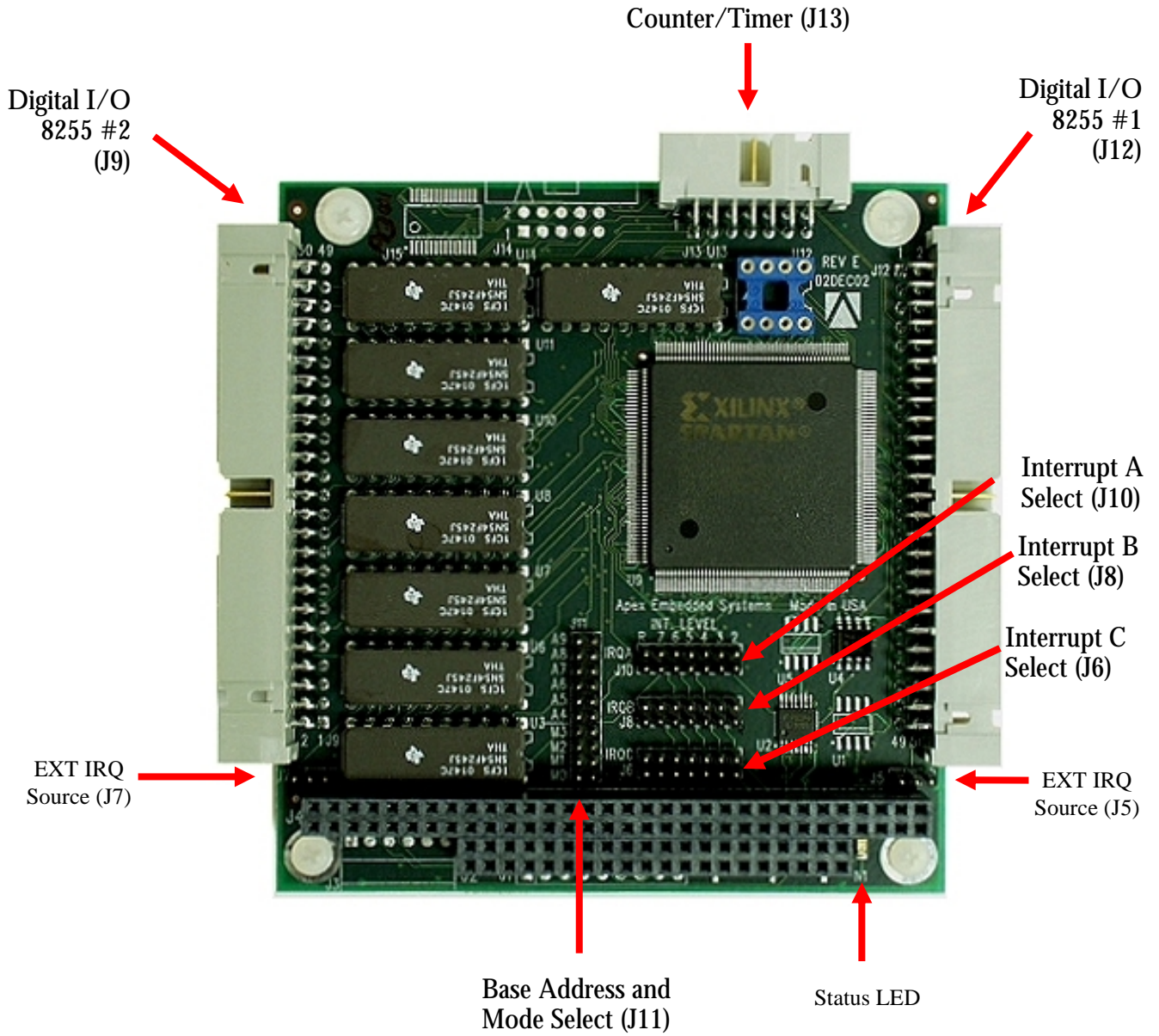
Block Diagram
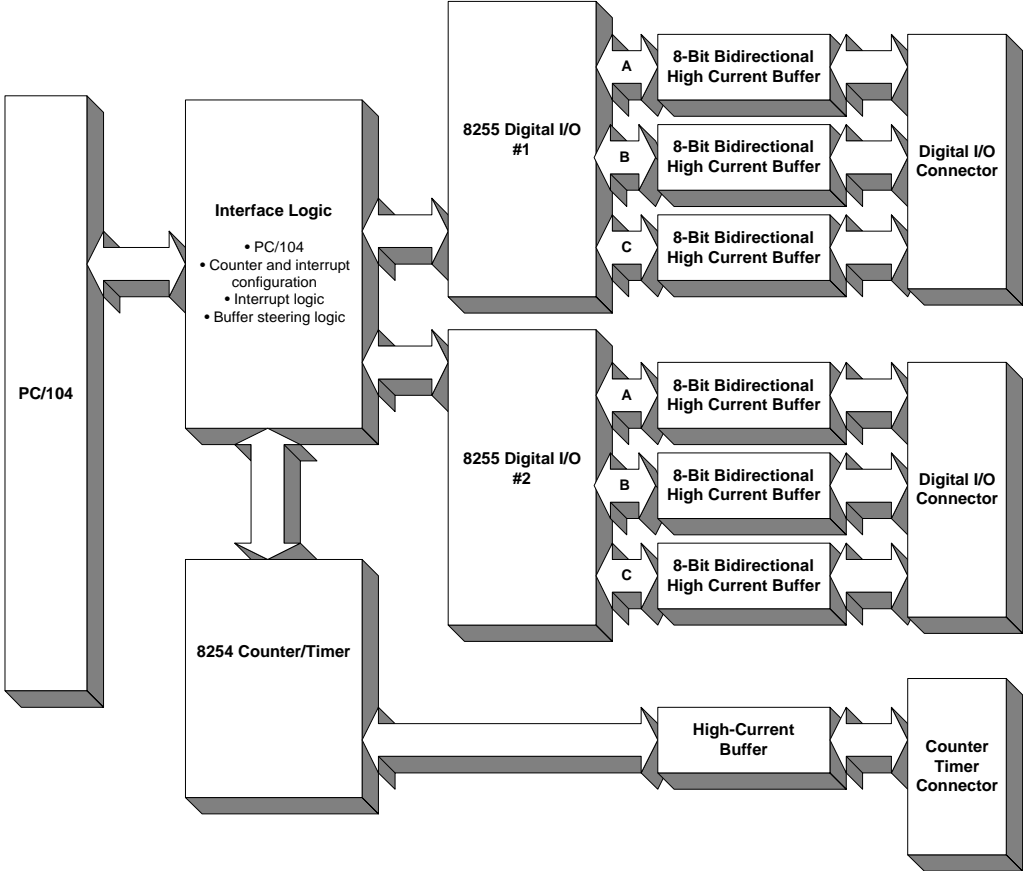
Hardware Configuration

Base Address and Configuration

1	■ ●	2	BA9
3	● ●	4	BA8
5	● ●	6	BA7
7	● ●	8	BA6
9	● ●	10	BA5
11	● ●	12	BA4
13	● ●	14	M3
15	● ●	16	M2
17	● ●	18	M1
19	● ●	20	M0

Base Address — pins 1 through 12
Mode Selection — pins 13 through 20
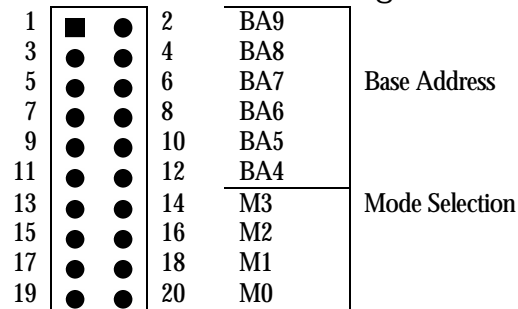
Example Base Address

Base Address = 768 or 0x300 (11 0000 0000$_2$)

1	▦ ●	2	BA9
3	● ●	4	BA8
5	● ●	6	BA7
7	● ●	8	BA6
9	● ●	10	BA5
11	● ●	12	BA4
13	● ●	14	M3
15	● ●	16	M2
17	● ●	18	M1
19	● ●	20	M0

Base Address — pins 1 through 12
Mode Selection — pins 13 through 20
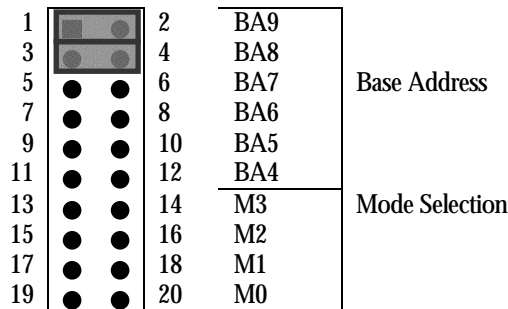
Mode	M3	M2	M1	M0
Normal, Legacy*	0	0	0	0

Note: 1 = Jumper installed, 0 = Jumper not installed.
* Factory Default

Base Address Table

Base Address	BA9	BA8	BA7	BA6	BA5	BA4
0x220	1	0	0	0	1	0
0x240	1	0	0	1	0	0
0x250	1	0	0	1	0	1
0x260	1	0	0	1	1	0
0x280	1	0	1	0	0	0
0x290	1	0	1	0	0	1
0x2A0	1	0	1	0	1	0
0x2B0	1	0	1	0	1	1
0x2C0	1	0	1	1	0	0
0x2D0	1	0	1	1	0	1
0x2E0	1	0	1	1	1	0
0x2F0	1	0	1	1	1	1
*0x300	1	1	0	0	0	0
0x310	1	1	0	0	0	1
0x320	1	1	0	0	1	0
0x330	1	1	0	0	1	1
0x340	1	1	0	1	0	0
0x350	1	1	0	1	0	1
0x360	1	1	0	1	1	0
0x370	1	1	0	1	1	1
0x380	1	1	1	0	0	0
0x390	1	1	1	0	0	1
0x3A0	1	1	1	0	1	0
0x3B0	1	1	1	0	1	1
0x3C0	1	1	1	1	0	0
0x3D0	1	1	1	1	0	1
0x3E0	1	1	1	1	1	0
0x3F0	1	1	1	1	1	1

Note: 1 = Jumper installed, 0 = Jumper not installed.
* Factory Default

Apex offers factory configured hard-coded jumper settings for high vibration requirements. Resistors are soldered to the board in place of jumpers to insure successful operation in high vibration conditions.

Register Set

Register Set
Summary

Offset Address	Direction	Function
0	Read/Write	8255 Device #1 Port A Register
1	Read/Write	8255 Device #1 Port B Register
2	Read/Write	8255 Device #1 Port C Register
3	Write	8255 Device #1 Configuration Register
4	Read/Write	8255 Device #2 Port A Register
5	Read/Write	8255 Device #2 Port B Register
6	Read/Write	8255 Device #2 Port C Register
7	Write	8255 Device #2 Configuration Register
8	Read/Write	8254 Counter/Timer 0 Data
9	Read/Write	8254 Counter/Timer 1 Data
10	Read/Write	8254 Counter/Timer 2 Data
11	Write	8254 Counter/Timer Mode Configuration Register
12	Read/Write	8254 Counter/Timer Input Setup Low Byte Register
13	Read/Write	8254 Counter/Timer Input Setup High Byte Register
14	Read/Write	General Setup Low Byte Register
15	Read/Write	General Setup High Byte Register

8255 Device #1
Registers

Detailed register information for 8255 device #1. Both bit names and associated connector placement are shown where applicable (i.e. ref.pin#).

Base + 0   **8255 Device #1 Port A Register**   **Read/Write**

D7	D6	D5	D4	D3	D2	D1	D0
1A7	1A6	1A5	1A4	1A3	1A2	1A1	1A0
Associated Connector Pins:							
J12.1	J12.3	J12.5	J12.7	J12.9	J12.11	J12.13	J12.15

Base + 1   **8255 Device #1 Port B Register**   **Read/Write**

D7	D6	D5	D4	D3	D2	D1	D0
1B7	1B6	1B5	1B4	1B3	1B2	1B1	1B0
Associated Connector Pins:							
J12.33	J12.35	J12.37	J12.39	J12.41	J12.43	J12.45	J12.47

Base + 2   **8255 Device #1 Port C Register**   **Read/Write**

D7	D6	D5	D4	D3	D2	D1	D0
1C7	1C6	1C5	1C4	1C3	1C2	1C1	1C0
Associated Connector Pins:							
J12.17	J12.19	J12.21	J12.23	J12.25	J12.27	J12.29	J12.31

Base + 3   **8255 Device #1 Configuration Register**   **Write**

D7	D6	D5	D4	D3	D2	D1	D0
Mode	Group A				Group B		
Set	M3	M2	A	CU	M1	B	CL

8255 Configuration codes valid for the Tracer. Only Mode 0 is supported.

Port Direction					Hex Value	Decimal Value
A	**CH**	**CL**	**B**			
IN	IN	IN	IN		0x9B	155
IN	IN	IN	OUT		0x99	153
IN	OUT	OUT	IN		0x92	146
IN	OUT	OUT	OUT		0x90	144
OUT	IN	IN	IN		0x8B	139
OUT	IN	IN	OUT		0x89	137
OUT	OUT	OUT	IN		0x82	130
OUT	OUT	OUT	OUT		0x80	128

Digital I/O Connector J12, 8255 #1.

A7	1	■ ●	2	GND
A6	3	● ●	4	GND
A5	5	● ●	6	GND
A4	7	● ●	8	GND
A3	9	● ●	10	GND
A2	11	● ●	12	GND
A1	13	● ●	14	GND
A0	15	● ●	16	GND
C7	17	● ●	18	GND
C6	19	● ●	20	GND
C5	21	● ●	22	IRQ_IN0
C4	23	● ●	24	GND
C3	25	● ●	26	GND
C2	27	● ●	28	GND
C1	29	● ●	30	GND
C0	31	● ●	32	GND
B7	33	● ●	34	GND
B6	35	● ●	36	GND
B5	37	● ●	38	GND
B4	39	● ●	40	GND
B3	41	● ●	42	GND
B2	43	● ●	44	GND
B1	45	● ●	46	GND
B0	47	● ●	48	GND
+5V	49	● ●	50	GND

J12

External IRQ Source 0 (IRQ_IN0) J5

1   2   3

J5   ■ ● ●

Jumper Position	Function
1-2*	External Interrupt source 0 input at J12 pin 22 (J12.22)
2-3	J12 pin 22 grounded (for OPTO 22 rack compatibility) External Interrupt Source 0 not available.

* FACTORY CONFIGURATION

8255 Device #2
Registers

Detailed register information for 8255 device #2. Both bit names and associated
connector placement are shown where applicable (i.e. ref.pin#).

Base + 4		8255 Device #2 Port A Register					Read/Write
D7	**D6**	**D5**	**D4**	**D3**	**D2**	**D1**	**D0**
2A7	2A6	2A5	2A4	2A3	2A2	2A1	2A0
Associated Connector Pins:							
J9.1	J9.3	J9.5	J9.7	J9.9	J9.11	J9.13	J9.15

Base + 5		8255 Device #2 Port B Register					Read/Write
D7	**D6**	**D5**	**D4**	**D3**	**D2**	**D1**	**D0**
2B7	2B6	2B5	2B4	2B3	2B2	2B1	2B0
Associated Connector Pins:							
J9.33	J9.35	J9.37	J9.39	J9.41	J9.43	J9.45	J9.47

Base + 6		8255 Device #2 Port C Register					Read/Write
D7	**D6**	**D5**	**D4**	**D3**	**D2**	**D1**	**D0**
2C7	2C6	2C5	2C4	2C3	2C2	2C1	2C0
Associated Connector Pins:							
J9.17	J9.19	J9.21	J9.23	J9.25	J9.27	J9.29	J9.31

Base + 7		8255 Device #2 Configuration Register					Write
D7	**D6**	**D5**	**D4**	**D3**	**D2**	**D1**	**D0**
Mode		Group A				Group B	
Set	M3	M2	A	CU	M1	B	CL

8255 Configuration codes valid for the Tracer. Only Mode 0 is supported.

Port Direction					Hex Value	Decimal Value
A	**CH**	**CL**	**B**			
IN	IN	IN	IN		0x9B	155
IN	IN	IN	OUT		0x99	153
IN	OUT	OUT	IN		0x92	146
IN	OUT	OUT	OUT		0x90	144
OUT	IN	IN	IN		0x8B	139
OUT	IN	IN	OUT		0x89	137
OUT	OUT	OUT	IN		0x82	130
OUT	OUT	OUT	OUT		0x80	128

Digital I/O Connector J9, 8255 #2.

```
A7    1  ■  ●   2   GND
A6    3  ●  ●   4   GND
A5    5  ●  ●   6   GND
A4    7  ●  ●   8   GND
A3    9  ●  ●  10   GND
A2   11  ●  ●  12   GND
A1   13  ●  ●  14   GND
A0   15  ●  ●  16   GND
C7   17  ●  ●  18   GND
C6   19  ●  ●  20   GND
C5   21  ●  ●  22   IRQ_IN1
C4   23  ●  ●  24   GND
C3   25  ●  ●  26   GND
C2   27  ●  ●  28   GND
C1   29  ●  ●  30   GND
C0   31  ●  ●  32   GND
B7   33  ●  ●  34   GND
B6   35  ●  ●  36   GND
B5   37  ●  ●  38   GND
B4   39  ●  ●  40   GND
B3   41  ●  ●  42   GND
B2   43  ●  ●  44   GND
B1   45  ●  ●  46   GND
B0   47  ●  ●  48   GND
+5V  49  ●  ●  50   GND
```

J9

External IRQ Source 1 (IRQ_IN1) J7

```
      1   2   3
J7  [ ■   ●   ● ]
```

Jumper Position	Function
1-2*	External Interrupt source 1 input at J9 pin 22 (J9.22)
2-3	J9 pin 22 grounded (for OPTO 22 rack compatibility) External Interrupt Source 1 not available.

* FACTORY CONFIGURATION

- Blank -

8254
Counter/Timer
Registers

Data registers to/from the each of the three counter/timers.

Base + 8			8254 Counter/Timer 0 Data				Read/Write
D7	**D6**	**D5**	**D4**	**D3**	**D2**	**D1**	**D0**
D7	D7	D5	D4	D3	D2	D1	D0

Base + 9			8254 Counter/Timer 1 Data				Read/Write
D7	**D6**	**D5**	**D4**	**D3**	**D2**	**D1**	**D0**
D7	D7	D5	D4	D3	D2	D1	D0

Base + 10			8254 Counter/Timer 2 Data				Read/Write
D7	**D6**	**D5**	**D4**	**D3**	**D2**	**D1**	**D0**
D7	D7	D5	D4	D3	D2	D1	D0

Counter/Timer configuration register.

Base + 11		8254 Counter/Timer Mode Configuration Register					Write
D7	**D6**	**D5**	**D4**	**D3**	**D2**	**D1**	**D0**
SC1	SC0	RW1	RW0	M2	M1	M0	BCD

BCD   =   Binary Coded Decimal (BCD) Counter (4 decades) if set to one, otherwise 16-bit binary counter.

M[2:0]   =   Counter/Timer Mode Select:
                                  000 = Mode 0, Interrupt on terminal count
                                  001 = Mode 1, Hardware retriggerable one-shot
                                  X10 = Mode 2, Rate generator
                                  X11 = Mode 3, Square wave generator
                                  100 = Mode 4, Software triggered strobe
                                  101 = Mode 5, Hardware triggered strobe (retriggerable)

RW[1:0]   =   Read/Write:
                                    00 = Counter latch command
                                    01 = Read/Write least significant byte only
                                    10 = Read/Write most significant byte only
                                    11 = Read/Write least significant byte first, then
                                          most significant byte.

SC[1:0]   =   Select Counter:
                                    00 = Select Counter 0
                                    01 = Select Counter 1
                                    10 = Select Counter 2
                                    11 = Read-Back Command (see read operations)

Counter/Timer
Setup Register

The counter/timer setup register is used to route the desired signals to the counter/timer clock inputs. In addition, the polarity of the gate inputs can be selected as well.

Base + 12	8254 Counter/Timer input Setup Low Byte Register						Read/Write
D7	**D6**	**D5**	**D4**	**D3**	**D2**	**D1**	**D0**
CLK1_INV	CLK12	CLK11	CLK10	CLK0_INV	CLK02	CLK01	CLK00

Base + 13	8254 Counter/Timer input Setup High Byte Register						Read/Write
D7	**D6**	**D5**	**D4**	**D3**	**D2**	**D1**	**D0**
GT0	GT2_INV	GT1_INV	GT0_INV	CLK2_INV	CLK22	CLK21	CLK20

GT2_INV = Counter #2 gate input polarity:
  0 = clock input non-inverted (default)
  1 = clock input inverted

CLK2_INV = Counter #2 clock input polarity:
  0 = clock input non-inverted (default)
  1 = clock input inverted

CLK2[2:0] = Counter #2 clock input selection:
  000 = CT_IN2 (default)
  001 = CT_OUT0
  010 = CT_OUT1
  011 = IRQ_IN2
  100 = 4 MHz oscillator
  101 = 10 MHz oscillator
  110 = 20 MHz oscillator
  111 = 40 MHz oscillator

GT1_INV = Counter #1 gate input polarity:
  0 = clock input non-inverted (default)
  1 = clock input inverted

CLK1_INV = Counter #1 clock input polarity:
  0 = clock input non-inverted (default)
  1 = clock input inverted

CLK1[2:0] = Counter #1 clock input selection:
  000 = CT_IN1 (default)
  001 = CT_OUT0

> 010 = CT_OUT2
> 011 = IRQ_IN2
> 100 = 4 MHz oscillator
> 101 = 10 MHz oscillator
> 110 = 20 MHz oscillator
> 111 = 40 MHz oscillator

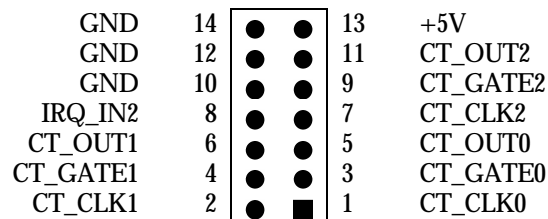GT0_INV =   Counter #0 gate input polarity:
                0 = clock input non-inverted (default)
                1 = clock input inverted

GT0   =   Counter #0 gate input selection:
                0 = CT_GATE0 (default)
                1 = CT_GATE1

CLK0_INV =   Counter #0 clock input polarity:
                0 = clock input non-inverted (default)
                1 = clock input inverted

CLK0[2:0] =   Counter #0 clock input selection:
                000 = CT_IN0 (default)
                001 = CT_IN1
                010 = CT_OUT2
                011 = IRQ_IN2
                100 = 4 MHz oscillator
                101 = 10 MHz oscillator
                110 = 20 MHz oscillator
                111 = 40 MHz oscillator

Counter/Timer connector J13:

GND	14	● ●	13	+5V
GND	12	● ●	11	CT_OUT2
GND	10	● ●	9	CT_GATE2
IRQ_IN2	8	● ●	7	CT_CLK2
CT_OUT1	6	● ●	5	CT_OUT0
CT_GATE1	4	● ●	3	CT_GATE0
CT_CLK1	2	● ■	1	CT_CLK0

```
                    011 = IRQ_IN0        (J12.22)
                    100 = IRQ_IN1        (J9.22)
                    101 = IRQ_IN2        (J13.8)
                    110 = 8255 #1 Bit C0  (J12.31)
                    111 = 8255 #2 Bit C0  (J9.31)

LED[3:0]     =      LED drive source.
                    0000 = base address decode (default) *
                    0001 = Counter/Timer 0 Input (CI0)
                    0010 = Counter/Timer 1 Input (CI1)
                    0011 = Counter/Timer 2 Input (CI2)
                    0100 = Counter/Timer 0 Output
                    0101 = Counter/Timer 1 Output
                    0110 = Counter/Timer 2 Output
                    0111 = Interrupt Source A (ISA) *
                    1000 = IRQ_IN0
                    1001 = IRQ_IN1
                    1010 = IRQ_IN2
                    1011 = none
                    1100 = Interrupt Source B (ISB) *
                    1101 = Interrupt Source C (ISC) *
                    1110 = LED off always
                    1111 = LED on always

                    * LED minimum pulse size is approximately 0.016 seconds
```

Chapter

4

4

Connector Summary

Digital I/O Connector J12, 8255 #1.

A7	1	■ ●	2	GND
A6	3	● ●	4	GND
A5	5	● ●	6	GND
A4	7	● ●	8	GND
A3	9	● ●	10	GND
A2	11	● ●	12	GND
A1	13	● ●	14	GND
A0	15	● ●	16	GND
C7	17	● ●	18	GND
C6	19	● ●	20	GND
C5	21	● ●	22	IRQ_IN0
C4	23	● ●	24	GND
C3	25	● ●	26	GND
C2	27	● ●	28	GND
C1	29	● ●	30	GND
C0	31	● ●	32	GND
B7	33	● ●	34	GND
B6	35	● ●	36	GND
B5	37	● ●	38	GND
B4	39	● ●	40	GND
B3	41	● ●	42	GND
B2	43	● ●	44	GND
B1	45	● ●	46	GND
B0	47	● ●	48	GND
+5V	49	● ●	50	GND
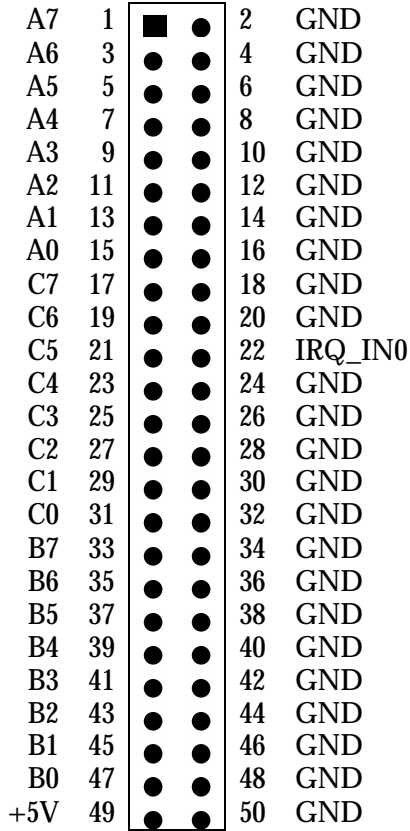
Note: # implies active low   **J12**

External IRQ Source 0 (IRQ_IN0) J5
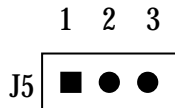
```
      1   2   3
J5  [ ■   ●   ● ]
```

Jumper Position	Function
1-2*	External Interrupt source 0 input at J12 pin 22 (J12.22)
2-3	J12 pin 22 grounded (for OPTO 22 rack compatibility) External Interrupt Source 0 not available.

* FACTORY CONFIGURATION

Digital I/O Connector J9, 8255 #2.

A7	1	■ ●	2	GND
A6	3	● ●	4	GND
A5	5	● ●	6	GND
A4	7	● ●	8	GND
A3	9	● ●	10	GND
A2	11	● ●	12	GND
A1	13	● ●	14	GND
A0	15	● ●	16	GND
C7	17	● ●	18	GND
C6	19	● ●	20	GND
C5	21	● ●	22	IRQ_IN1
C4	23	● ●	24	GND
C3	25	● ●	26	GND
C2	27	● ●	28	GND
C1	29	● ●	30	GND
C0	31	● ●	32	GND
B7	33	● ●	34	GND
B6	35	● ●	36	GND
B5	37	● ●	38	GND
B4	39	● ●	40	GND
B3	41	● ●	42	GND
B2	43	● ●	44	GND
B1	45	● ●	46	GND
B0	47	● ●	48	GND
+5V	49	● ●	50	GND
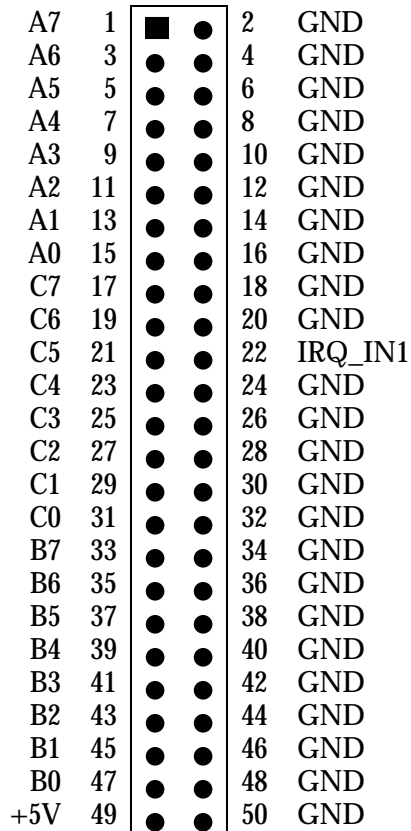
Note: # implies active low

J9

External IRQ Source 1 (IRQ_IN1) J7

1   2   3

J7 ■ ● ●

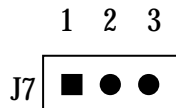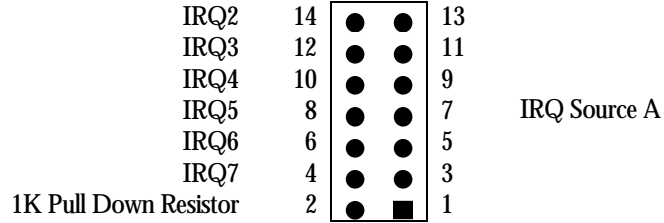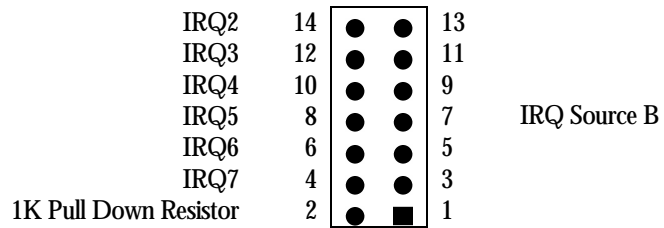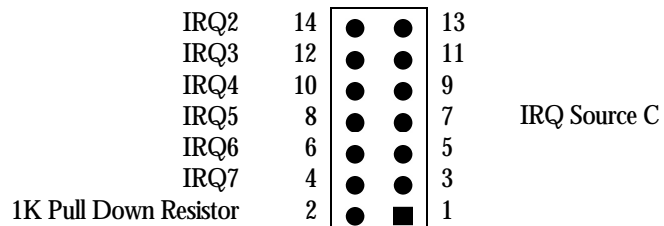| Jumper Position	Function
1-2*	External Interrupt source 1 input at J9 pin 22 (J9.22)
2-3	J9 pin 22 grounded (for OPTO 22 rack compatibility) External Interrupt Source 1 not available.

* FACTORY CONFIGURATION

PC/104 IRQ Source A Connector J10

IRQ2	14	● ●	13
IRQ3	12	● ●	11
IRQ4	10	● ●	9
IRQ5	8	● ●	7
IRQ6	6	● ●	5
IRQ7	4	● ●	3
1K Pull Down Resistor	2	● ■	1

IRQ Source A

PC/104 IRQ Source B Connector J8

IRQ2	14	● ●	13
IRQ3	12	● ●	11
IRQ4	10	● ●	9
IRQ5	8	● ●	7
IRQ6	6	● ●	5
IRQ7	4	● ●	3
1K Pull Down Resistor	2	● ■	1

IRQ Source B

PC/104 IRQ Source C Connector J6

IRQ2	14	● ●	13
IRQ3	12	● ●	11
IRQ4	10	● ●	9
IRQ5	8	● ●	7
IRQ6	6	● ●	5
IRQ7	4	● ●	3
1K Pull Down Resistor	2	● ■	1

IRQ Source C

Counter/Timer Connector J13

```
GND   14  ● ●  13   +5V
GND   12  ● ●  11   CT_OUT2
GND   10  ● ●   9   CT_GATE2
IRQ_IN2  8  ● ●   7   CT_CLK2
CT_OUT1   6  ● ●   5   CT_OUT0
CT_GATE1  4  ● ●   3   CT_GATE0
CT_CLK1   2  ● ■   1   CT_CLK0
```
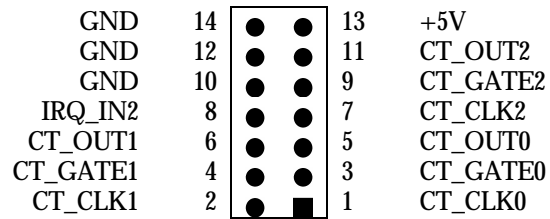
Signal Direction

Name	Direction
CT_CLK0	Input to Tracer Board
CT_GATE0	Input to Tracer Board
CT_OUT0	Output from Tracer Board
CT_CLK1	Input to Tracer Board
CT_GATE1	Input to Tracer Board
CT_OUT1	Output from Tracer Board
CT_CLK2	Input to Tracer Board
CT_GATE2	Input to Tracer Board
CT_OUT2	Output from Tracer Board
IRQ_IN2	Additional interrupt input

Chapter

5

Specification

General		
	Dimension	PC/104 form factor
	Power Supply	5.0 VDC ± 10%, 600mA typical
	Card Type	PC/104 8-bit bus
	Temperature Range	-40 to +85C operating
		-55 to +125C storage

Counter/Timer		
	Functionality	Compliant to the 82C54-2
	Counter/Timers	Quantity of 3, each 16-bits
	Maximum input frequency	40 MHz
	On-board oscillator	40 MHz ±0.01% (100ppm) divided down to 4, 10, 20MHz
	Input Voltage, all inputs:	TTL compatible
	Low	-0.5V min, 0.8V max
	High	2.0V min, 5.5V max
	Current	5uA max (high), -1.2mA max (low)
	Output Voltage, all outputs:	TTL compatible
	Low	0.5 V max @ 24mA, 0.55V @ 64mA
	High	2.4 V @ - 3mA, 2.0V @ -15mA
	Pull up/down resistors	10K on all inputs and jumper selectable

Digital I/O Circuitry		
	Functionality	82C55A, quantity of two
	Number of digital I/O lines	48
	Direction	All lines programmable for input or output in groups of eight
	Input Voltage, all inputs:	TTL compatible
	Low	-0.5V min, 0.8V max
	High	2.0V min, 5.5V max
	Current	5uA max (high), -1.2mA max (low)
	Output Voltage, all outputs:	TTL compatible
	Low	0.5 V max @ 24mA, 0.55V @ 64mA
	High	2.4 V @ - 3mA, 2.0V @ -15mA
	Pull up resistors	10K on all digital I/O

Interrupt Control		
	Number of System Interrupts	3
	Selectable interrupt levels	IRQ2,IRQ3,IRQ4,IRQ5,IRQ6,IRQ7
	Pull-down resistor	1K resistor selectable via jumper on each interrupt

Chapter

6

Application Notes

Connecting a quadrature output incremental optical shaft encoder to the counter/timer input.

Wiring: Phase A   CT_GATE1   J13.4
             Phase B   CT_CLK1   J13.2
             Common   GND   J13.14
             Power   +5V   J13.15

Counter/Timer Setup Register:
             CT_GATE1 inverted   =   True
             CT_CLK1 inverted   =   False
             CT_CLK1 source   =   CT_IN1
             CT_GATE0 inverted   =   True
             CT_GATE0 source   =   CT_GATE1
             CT_CLK0 inverted   =   True
             CT_CLK0 source   =   CT_IN1

Base_Address + 12 <= 0000 1001
Base_Address + 13 <= 1?01 1???
        where '?' is the configuration for Counter/Timer #2.

Software setup:
```
base_address = 0x300;

Counter/Timer Setup Register = 0x0000
 CT0: Clock: Inverted=False, Source=CT_IN0
      Gate:  Inverter=False, Source=CT_GATE1
 CT1: Clock: Inverted=False, Source=CT_IN1
      Gate:  Inverter=False, Source=CT_GATE1
 CT2: Clock: Inverted=False, Source=CT_IN2
      Gate:  Inverter=False, Source=CT_GATE2
```

24

Apex Embedded Systems

PC-Based Solutions for Industrial and Portable Applications

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      Monona, WI 53716