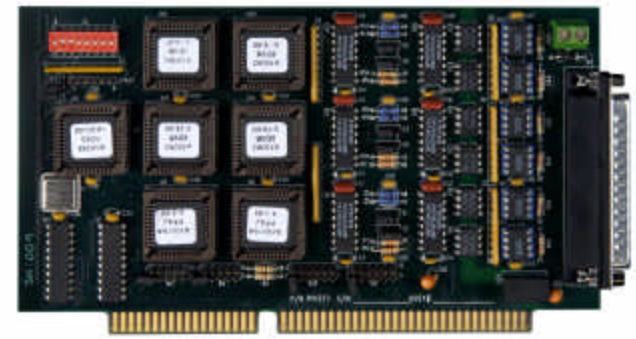
ISA-6 February 6, 2001

# Product Specification for Model ISA-6



The Model ISA-6 is a ISA bus form factor and bus compatible module that provides from one to six channels of magnetostrictive transducer interface. When commanded by the PC, the module interrogates the transducers and converts the timing information to position values. The module operates with start/stop, trailing edge start/stop, pulse width modulated or SSI transducers. Each channel can support one to thirty one recirculations or from one to 31 magnets. All operations are controlled by the host PC software. A 56 MHz oscillator provides excellent resolution even in the multi-magnet mode. The transducers are electrically isolated from the PC104 power supply. Transducer and power supply connections are made via a 37 pin DSUB connector on the rear of the board. Transducer power can be brought to the board on a 2 position screw terminal connector. The module also provides a time base that can be used by PC software to time the update of the transducers.

***FEATURES***

- Supports from 1 to 6 magnetostrictive transducers
- Can be configured with any combination of Start/Stop, Pulse Width Modulated or SSI transducers
- 56 MHz Count oscillator provides 0.001 inch resolution with 2 recirculations
- 24 bit counter for each transducer
- 24 or 25 bit SSI position
- Software selectable recirculations or magnets, 1 to 31
- Multiple magnet mode measures from 1 to 31 magnets on each of the transducers
- Optical isolation between the transducer and the board to prevent damage to PC
- Cables directly to the transducer, +24V transducer power can be distributed by the board.
- Separate 2 pin screw terminal for +24V transducer power
- Occupies only 8 bytes of I/O space
- Software controlled interrupt supports IRQ3, 4, 5, 6, 7 and 9 when installed in 8 bit slot
- Additionally supports IRQ 10,11,12,13 and 15 when installed in 16 bit slot
- Status register provides ready indication for each channel as well as board functions
- Half length ISA board is 7.275 inches long
- Switch selectable I/O address, selectable in 8 byte increments from 0 to 7FFH

**Rapid Controls Inc.**
Box 8390 ▪ Rapid City, SD ▪ 57709
Phone: 605-348-7688 ▪ Fax: 605-341-5496
http://www.rapidcontrols.com/ ▪ email: info@rapidcontrols.com

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***SPECIFICATIONS***

- 56 MHz oscillator provides 0.001 inch resolution with 2 recirculations
- Multi-magnet mode requires Start Stop transducer and must be interrogated once for each magnet
- 37 pin DSUB connector to the transducers
- Transducer I/O is RS422 compatible
- Recirculations are software settable from 1 to 31.
- Magnet number in Multi-magnet mode is software settable from 1 to 31
- 8 Bit I/O Bus Interface , base address settable from 0 to 7FFH in 8 byte increments
- 16 Bit bus connections for IRQ 10,11,12,13,15
- Power Requirements: 5 VDC @ 500 ma.
- Size: 7.275 x 4.2 inch (185 x 107 mm).

***Model numbering***

Specify Model: **ISA-6-ABCDEF**

**A** - Channel A type
**B** - Channel B type
**C** - Channel C type
**D** - Channel D type
**E** - Channel E type
**F** - Channel F type

The channel type can be any of the following:

**R** - **Leading Edge Start/Stop* or PWM**
**S** - **SSI**
**T** - **Trailing Edge Start/Stop* or PWM**
**N** - **None**

For example, a board with 3 start stop transducers in channels A,B and c and 3 SSI transducers in channels D,E and F would have model **ISA-6-RRRSSS .**

*Multiple magnet operation requires a Start/Stop transducer type.

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Box 8390 ▪ Rapid City, SD ▪ 57709
Phone: 605-348-7688 ▪ Fax: 605-341-5496
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# 1 Theory of operation

## 1.1 Board functions and addressing

The board is comprised of 8 logical sections; Address decoding, time base and channel A through F transducer control and data.

### 1.1.1 Address decoding

The ISA-6 board occupies 8 bytes of I/O space. The base address of this I/O space is determined by the setting of Dip switch 1. When the switch is OFF it is a 1.

| Switch | S1-1 | S1-2 | S1-3 | S1-4 | S1-5 | S1-6 | S1-7 | S1-8 |
|---|---|---|---|---|---|---|---|---|
| Binary value | 8 | 10H | 20H | 40H | 80H | 100H | 200H | 400H |
| Example 300H | On | On | On | On | On | Off | Off | On |
| Example 308H | Off | On | On | On | On | Off | Off | On |
| Example 208H | Off | On | On | On | On | Off | On | On |
| Example 700H | On | On | On | On | On | Off | Off | Off |

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Phone: 605-348-7688 ▪ Fax: 605-341-5496
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### 1.1.2 Board I/O map

The I/O map is divided into two sections. The lower four bytes are used for channel mapping and the upper four bytes are used to control which channel is mapped into the lower four bytes as well as other board level functions.

| Address | Function | $2^0$ | $2^1$ | $2^2$ | $2^3$ | $2^4$ | $2^5$ | $2^6$ | $2^7$ |
|---|---|---|---|---|---|---|---|---|---|
| Base + 0 | Rd transducer data low byte | Data $2^0$ | Data $2^1$ | Data $2^2$ | Data $2^3$ | Data $2^4$ | Data $2^5$ | Data $2^6$ | Data $2^7$ |
| Base + 1 | Rd transducer data mid byte | Data $2^8$ | Data $2^9$ | Data $2^{10}$ | Data $2^{11}$ | Data $2^{12}$ | Data $2^{13}$ | Data $2^{14}$ | Data $2^{15}$ |
| Base + 2 | Rd transducer data high byte | Data $2^{16}$ | Data $2^{17}$ | Data $2^{18}$ | Data $2^{19}$ | Data $2^{20}$ | Data $2^{21}$ | Data $2^{22}$ | Data $2^{23}$ |
| Base + 3 | Rd transducer status<br>Wr transducer command | | | | | | | | |
| Base + 4 | Rd channel select | Chan $2^0$ | Chan $2^1$ | Chan $2^2$ | 0 | 0 | 0 | 0 | 0 |
| | Wr channel select | Chan $2^0$ | Chan $2^1$ | Chan $2^2$ | N/A | N/A | N/A | N/A | N/A |
| Base + 5 | Rd high IRQ interrupt select | Intr Sel $2^0$ | Intr Sel2$^1$ | Intr enable | 0 | 0 | 0 | 0 | 0 |
| | Wr high IRQ interrupt select | Intr Sel $2^0$ | Intr Sel $2^1$ | Intr enable | N/A | N/A | N/A | N/A | N/A |
| Base + 6 | Rd Time Base select | Time base Sel $2^0$ | Time base Sel $2^1$ | Time base Sel $2^2$ | 0 | 0 | 0 | 0 | 0 |
| | Wr Time base select | Time base Sel $2^0$ | Time base Sel $2^1$ | Time base Sel $2^2$ | N/A | N/A | N/A | N/A | N/A |
| Base + 7 | Rd Board Status | Timer done | Intr 1 | Intr 2 | | | | | |
| | Wr Board command | Clear Timer Done | | | | | | | |

### 1.1.3 Base + 4: Channel select register

Each of the six channels can be mapped into the lower four bytes of the I/O map by setting the channel select register at base + 4. Once the channel select register is set, the four bytes of that channel are continuously available for reading and writing in the lower four bytes of the I/O map.

### 1.1.4 Base + 5: High IRQ Interrupt source select register

Channels D and E interrupts or the time base can be enabled as the source for the high interrupts IRQ which can be connected via jumper X-11 to IRQ 10, 11,12,13 or 15. The source can be channel D or channel E interrupt output or the timer done flag.

### 1.1.5 Base + 6: Time base select register

A time base is continuously generated by the board. The timer done flag of this time base can be read and used as a source for the interrupt described in section 3.1.15. The rate of this time base is determined by the value loaded into the time base select register. The timer is turned off by loading a value of 0. Any value other than 0 will result in a time of one millisecond * the value loaded. The range is one to seven milliseconds. The timer done bit can be read in the board status register and is cleared by writing a bit in the board command register.

### 1.1.6 Base + 7: Board status and command register

The board status register can be read to determine if the timer has elapsed or if channel D or E interrupts are active. The board command register can be used to clear the timer done flag.

## 1.2 Start/Stop, PWM transducers

The host PC104 processor writes a recirculation value and mode to the Control/Status register, loading the recirculation count. The control register write causes an interrogation pulse to be issued from the EPLD which in turn causes a 1 microsecond pulse to be issued from the Intertogate + and - outputs of the board. The transducer immediately responds with a 1 microsecond Gate + and - pulse. This pulse increments the recirculation register and starts the position counter counting. After the time required for the torque pulse to propagate down the transducer from the magnet ( 9 * inches microseconds) another Gate + and Gate - pulse is returned from the transducer. This again increments the recirculation counter. If it is not the last recirculation another one microsecond interrogate pulse is issued. This process continues until the last interrogation when the last Gate+ and Gate - pulse returned stops the position counter and sets the process completed flag. The 24 bit counter can now be read and will hold a value of (inches * Gradient * 56 * recirculations).

When operating in the PWM mode the counter counts from the leading edge to the trailing edge of the Gate pulse. The multi-magnet mode functions the same as the recirculation mode except that only one interrogate pulse is issued. The magnet measured is determined by the recirculation count programmed. Since only a single magnet can be measured at one time, the transducer must be interrogated once for each new magnet position desired. The software must wait each time for all of the magnets to respond, this is best accomplished by waiting a time equal to 9 * (length of the transducer + 10) microseconds between interrogations.

## 1.3 Channel Registers (base +0 , +1, + 2)

### 1.3.1

| | $2^0$ | $2^1$ | $2^2$ | $2^3$ | $2^4$ | $2^5$ | $2^6$ | $2^7$ |
|---|---|---|---|---|---|---|---|---|
| Read Base + 0 | Data $2^0$ | Data $2^1$ | Data $2^2$ | Data $2^3$ | Data $2^4$ | Data $2^5$ | Data $2^6$ | Data $2^7$ |
| Read Base + 1 | Data $2^8$ | Data $2^9$ | Data $2^{10}$ | Data $2^{11}$ | Data $2^{12}$ | Data $2^{13}$ | Data $2^{14}$ | Data $2^{15}$ |
| Read Base + 2 | Data $2^{16}$ | Data $2^{17}$ | Data $2^{18}$ | Data $2^{19}$ | Data $2^{20}$ | Data $2^{21}$ | Data $2^{22}$ | Data $2^{23}$ |

### 1.3.2 Programming (Start/Stop and PWM), Command Data Register (base + 3)

| | $2^0$ | $2^1$ | $2^2$ | $2^3$ | $2^4$ | $2^5$ | $2^6$ | $2^7$ |
|---|---|---|---|---|---|---|---|---|
| Write Command Base + 3 | Recircs $2^0$ | Recircs $2^1$ | Recircs $2^2$ | Recircs $2^3$ | Recircs $2^4$ | PWM Mode | Multi magnet Mode | Interrupt Enable |
| Read Status Base + 3 | Recircs $2^0$ | Recircs $2^1$ | Recircs $2^2$ | Recircs $2^3$ | Recircs $2^4$ | PWM Mode | Multi magnet Mode | Data Ready |

The PWM mode bit should be set to 1 for PWM transducers and 0 for Start Stop.
The Multimagnet bit should be set to 1 for multi magnet operation and 0 for single magnet operation.
The PWM and Multimagnet bits are mutually exclusive. Setting them both to 1 will lead to undefined results.

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### 1.4 SSI transducers

The host PC processor writes a bit length value to the Control/Status register causing the clock generator to start the clock data process. The board generates the proper number of clock pulses at 218 KHz and clocks in the data response from the transducer. When all 24 or 25 bits have been clocked into the registers the data ready flag is set. If interrupts were enabled the interrupt line is driven high. Data is available in the four registers. The transducer controls the resolution and data format, Gray code or binary.

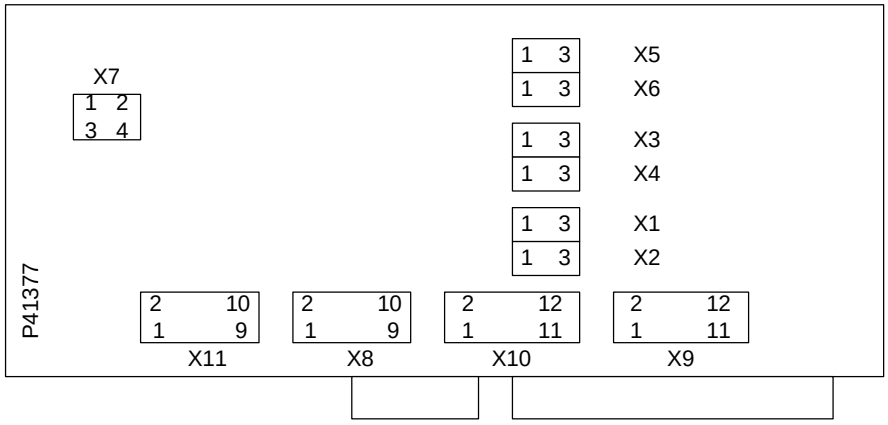
#### 1.4.1 Programming (SSI), Data Registers

| | $2^0$ | $2^1$ | $2^2$ | $2^3$ | $2^4$ | $2^5$ | $2^6$ | $2^7$ |
|---|---|---|---|---|---|---|---|---|
| Read Base + 0 | Data $2^0$ | Data $2^1$ | Data $2^2$ | Data $2^3$ | Data $2^4$ | Data $2^5$ | Data $2^6$ | Data $2^7$ |
| Read Base + 1 | Data $2^8$ | Data $2^9$ | Data $2^{10}$ | Data $2^{11}$ | Data $2^{12}$ | Data $2^{13}$ | Data $2^{14}$ | Data $2^{15}$ |
| Read Base + 2 | Data $2^{16}$ | Data $2^{17}$ | Data $2^{18}$ | Data $2^{19}$ | Data $2^{20}$ | Data $2^{21}$ | Data $2^{22}$ | Data $2^{23}$ |

#### 1.4.2 Programming (SSI), Command / Status Registers (Base + 3)

| | $2^0$ | $2^1$ | $2^2$ | $2^3$ | $2^4$ | $2^5$ | $2^6$ | $2^7$ |
|---|---|---|---|---|---|---|---|---|
| Write Command Base + 3 | N/A | N/A | N/A | N/A | N/A | Set for 25 bit. Clear for 24 bit | N/A | Interrupt Enable |
| Read Status Base + 3 | Data $2^{24}$ | 0 | 0 | 0 | 0 | 0 | N/A | Data Ready |

# 2 Jumpers




## 2.1 Jumper map

## 2.2 Jumpers X1 through X6

Jumpers X1 through X6 are usually factory set and must be set according to the type of transducer connected to channel A through F respectively. Connect 1 to 2 for Start/Stop and PWM type transducer. Connect 2 to 3 for SSI transducers.

## 2.3 Jumper X7

Currently unused.

## 2.4 Jumper X8, Channel C IRQ

Jumper X8 can be used to connect the interrupt from channel C to any of the high IRQ's on 16 bit connector.

| Position | IRQ |
|---|---|
| 1 to 2 | 10 |
| 3 to 4 | 11 |
| 5 to 6 | 12 |
| 7 to 8 | 13 |
| 9 to 10 | 15 |

## 2.5 Jumper X9 , Channel B IRQ

Jumper X9 can be used to connect the interrupt from channel B to any of the low IRQ's on the 8 bit connector.

| Position | IRQ |
|---|---|
| 1 to 2 | 3 |
| 3 to 4 | 4 |
| 5 to 6 | 5 |
| 7 to 8 | 6 |
| 9 to 10 | 7 |

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| | |
|---|---|
| 11 to 12 | 9 |

**2.6 Jumper X10 , Channel A IRQ**

Jumper X10 can be used to connect the interrupt from channel A to any of the low IRQ's on the 8 bit connector.

| Position | IRQ |
|---|---|
| 1 to 2 | 3 |
| 3 to 4 | 4 |
| 5 to 6 | 5 |
| 7 to 8 | 6 |
| 9 to 10 | 7 |
| 11 to 12 | 9 |

2.7 **Jumper X11 , Board IRQ**

Jumper X11 can be used to connect the board level interrupt to any of the high IRQ's on 16 bit connector.

| Position | IRQ |
|---|---|
| 1 to 2 | 10 |
| 3 to 4 | 11 |
| 5 to 6 | 12 |
| 7 to 8 | 13 |
| 9 to 10 | 15 |

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# 3 Connections

## 3.1 J1, 8 bit ISA bus connector, required.

## 3.2 J2, 16 bit ISA bus connector, optional

## 3.3 P1, 37 pin DSUB connector.

| | | | |
|---|---|---|---|
| 1 | Gate A - | 20 | Gate A + |
| 2 | Interrogate A+ | 21 | Interrogate A - |
| 3 | Transducer ground | 22 | Transducer Power |
| 4 | Gate B - | 23 | Gate B + |
| 5 | Interrogate B + | 24 | Interrogate B - |
| 6 | Transducer ground | 25 | Transducer Power |
| 7 | Gate C - | 26 | Gate C + |
| 8 | Interrogate C + | 27 | Interrogate C - |
| 9 | Transducer ground | 28 | Transducer Power |
| 10 | Gate D - | 29 | Gate D + |
| 11 | Interrogate D + | 30 | Interrogate D - |
| 12 | Transducer ground | 31 | Transducer Power |
| 13 | Gate E - | 32 | Gate E + |
| 14 | Interrogate E + | 33 | Interrogate E - |
| 15 | Transducer ground | 34 | Transducer Power |
| 16 | Gate F - | 35 | Gate F + |
| 17 | Interrogate F + | 36 | Interrogate F - |
| 18 | Transducer ground | 37 | Transducer Power |
| 19 | Transducer ground | | |

Transducer power on pins 22, 25, 28, 31, 34 and 37 is not required by the PC4-TEMPO board but can be used to connect the + voltage from P2 to to the transducer (Red).

## 3.4 P2, 2 position screw terminal

| | |
|---|---|
| 1 | Transducer power input |
| 2 | Transducer ground |

Transducer power can be supplied to the transducers via P2 pin 1. A diode prevents accidentally applying a negative voltage to the transducers. Transducer ground is connected via P2 pin 2.

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Box 8390 ▪ Rapid City, SD ▪ 57709
Phone: 605-348-7688 ▪ Fax: 605-341-5496
http://www.rapidcontrols.com/ ▪ email: info@rapidcontrols.com