VEGA
MODEL 2790502

RESOLVER TO ENCODER CONVERTER with HALL EFFECT SIMULATION FOR MOTOR CONTROL APPLICATIONS

*** APPLICATIONS ***

➤ **Ideal For Closed Loop Positioning Systems**
➤ **Machine Tools**
➤ **Servo Motor Control**
➤ **Spindle Motor Control**
➤ **PLC Positioning Control**
➤ **Index/Rotary Tables**
➤ **Transfer Lines**
➤ **Positioning Systems**
➤ **Robotic Applications**
➤ **Dispensing Systems**

RESOLVER TO DIGITAL INTERFACE

➤ **Works with Harowe/Danaher, Tamagawa, Kerfott, Singer, AMCI or most any Synchro/Resolver**
➤ **Incremental encoder output signals**
➤ **Makes resolvers as easy to use as an encoder**
➤ **Jumper Selectable line counts 250, 256, 500, 512, 1000, 1024, 2000, and 2048 A-quad-B with Index and complements**
➤ **Jumper Selectable Excitation Frequency including 2.5, 5.0, and 10 kHz**
➤ **Jumper Selectable Hall Cycles (1,2,3,4,5,6,8,10)**

With the VEGA 2790502 converter you can have both the ruggedness of a resolver and the digital simplicity of an encoder interface. The 2790502 can be used with almost any resolver. The INDEX/MARKER pulse (Channel Z) will occur once per transducer cycle at the zero degree position.

*** ADVANCED FEATURES ***

➤ **Incremental Encoder Output (*Absolute within 1 Resolver cycle)**
➤ **Non-Phase Locked Loop Design for Faster Loop Closure (Less than 50 uSec @ 10 kHz)**
➤ **High Resolution and Highly Accurate**
➤ **Tuned Filter for Noise Immunity**
➤ **A-Quad-B, Index and Complements**
➤ **TTL/Line Driver Outputs**
➤ **Quadrature encoder signals to 4 mHz**
➤ **Single +5 vDC Supply Operation**
➤ **Loss of Signal Detection**
➤ **Fault Signal Output (Line Driver, Open Collector, and Active Pull-Up)**
➤ **Status LED's for Power, A, B, Z, Hall A, Hall B, Hall C, Signal HI, Signal MID, and Fault**
➤ **Configurable Fault signal conditioning for Fail-Safe operations**
➤ **Compact Design and Easy to Install**

2790502 SPECIFICATIONS

Excitation 2 Phase:	2.5, 5, or 10 kHz
Resolver Input:	0.8 to 18 vpp
Power Requirements:	5 vDC @ 250 mA
Drive Capacity:	200 mA Peak
Mechanical:	2.825 x 5.25 x 1.00
Accuracy:	+/- 3 arc minutes typical

CONVERTER ACCURACY AND TRACKING RATE

The 2790 board was designed for high speed applications. The standard converter accuracy is +/- 2 arc minutes. The maximum tracking rate of the 2790 series of converters is a function of the excitation frequency and the quadrature counts. With a 2.5 kHz excitation and 4000 quadrature counts per cycle the maximum tracking rate would be 9600 RPM. With 10.0 kHz excitation and 4000 quadrature counts the maximum tracking rate would be 38400 RPM.

SIMULATED HALL EFFECT OUTPUTS

The 2790502 Resolver to Digital Converter uses the resolver signals to produce three Hall type signals at TTL levels to duplicate the signals required by drives using Hall effect sensors to determine the shaft position for commutation purposes. This makes the 2790502 IDEAL for retrofitting Drives for AC Servomotors requiring indicators of motor shaft position in order to properly commutate the winding power.

PRICING AND DELIVERY

Model	Description
2790502	Resolver to Digital w/Hall
2790DIN	DIN Rail Kit
2790CK1	Solder Connector Kit
2790CK2	Crimp Connector Kit

2790502 Rev. P

PEOPLE IN CONTROL OF MOTION

VEGA 2790502 RESOLVER TO ENCODER SPECIFICATIONS AND CONNECTIONS

P1 RESOLVER CONNECTOR

PIN#	FUNCTION	COLOR
1	Sine HI	Red
2	Sine LO	Black
3	Sine Shield	SHLD
4	Cosine HI	Yellow
5	Cosine LO	Blue
6	Cosine Shield	SHLD
7	Feedback HI	Red/Wht
8	Feedback LO	Yel/Wht
9	Feedback Shield	SHLD
10	+5 vDC (*External)	N/A

P2 POWER CONNECTOR

PIN#	FUNCTION	COLOR
*1	+5 vDC (*Same as P1-10)	Red
*2	DC Ground (*Same as P1-1)	Black

P3 ENCODER CONNECTOR

| PIN#	FUNCTION	COLOR
1	DC Ground (*Same as P2-2)	Black
2	Channel A+	Grey
3	Channel B+	Yellow
4	Channel Z+	Blue
5	Reserved	N/A
6	Reserved	N/A
7	!Hall A	N/A
8	Fault (TTL)	Blu/Red
9	Reserved	N/A
10	+5 vDC (*Same as P2-1)	Red
11	Hall B (S2)	Wht/Blu
12	Hall A (S1)	Yel
13	!Hall B	N/A
14	Channel A-	Violet
15	Channel B-	Orange
16	Channel Z-	Green
17	Reserved	N/A
18	Reserved	N/A
19	!Fault (Active Pull-Up Output)	Red/Blk
20	!Fault (TTL)	Blu/Blk
21	Reserved	N/A
22	Reserved	N/A
23	!Hall C	N/A
24	Hall C (S3)	Yel/Wht
25	Active Pull-Up Source vDC	Blu/Wht

QUADRATURE OUTPUT

The VEGA 2790 series of converter boards use RS-422-A differential drivers to provide 40 mA into a 100 ohm differential load. These outputs are also TTL compatible.

The output latency is dependent on the excitation frequency. At 2.5 kHz the response will be less than 400 uSec and at 10.0 kHz the response will be less than 100 uSec.

Quadrature is provided via Channel A+, Channel A-, Channel B+ and Channel B-. A count is considered to occur whenever there is a transition in either the Channel A or Channel B output signals. The Channel Z (Index) occurs once per resolver cycle.

QUADRATURE OUTPUT FORMAT
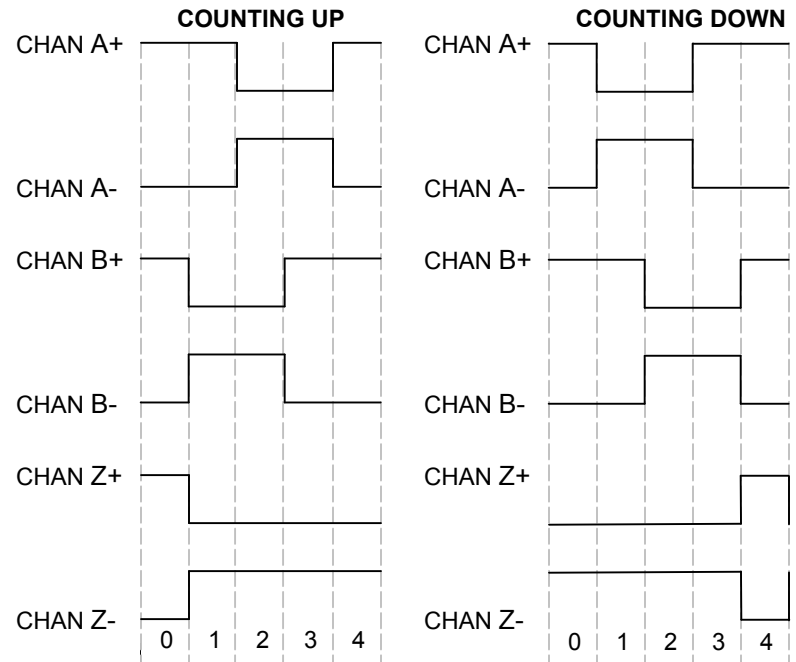
HALL EFFECT OUTPUT

Motors with Hall Effect Sensors and magnet are arranged to provide an output from the sensors to which the magnet is adjacent. The magnet may be adjacent to one sensor or between two sensors. When it is between two sensors, both sensors output a signal. This permits the detection circuitry to resolve the motor shaft position into 6 different sectors. The 2790502 produces signals that emulate the Hall Effect sensors for a seamless interface. The 2790 series supports up to 10 hall cycles per resolver cycle with differential hall signal outputs.

HALL EFFECT OUTPUT FORMAT

ABC State	101	001	011	010	110	100	101	001

VEGA

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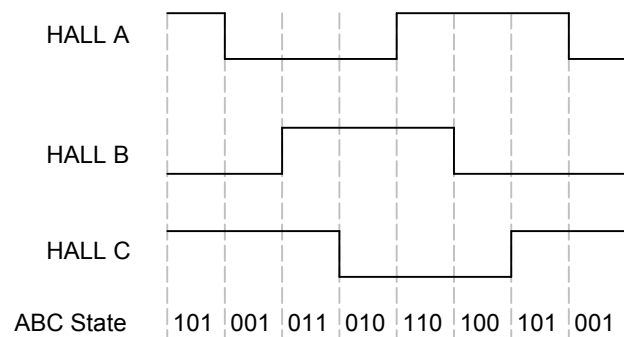
FREQUENCY SELECTION (B1-B2)

The 2790 series of converters provide selectable excitation frequencies via SWB1 jumpers B1 and B2. Most Hall effect applications will use the 10 kHZ setting.

The 2790 also provides jumper selection of the active filter network for the return signal to provide the maximum noise immunity at the selected frequency. For the typical Hall effect application operating at 10 kHZ J11 jumper should be removed. For excitation frequencies below 10 kHZ J11 should be installed. For low level signal condition J10 can be removed to achieve a x4 internal gain.

DECIMAL/BINARY SELECTION (B3)

The 2790 converter card provides both decimal and binary counting modes. Installing SWB1 jumper B3 selects binary counting mode to provide selection between 256, 512, 1024, and 2048 line counts. Removing jumper B3 selects the decimal counting mode to provide selection between 250, 500, 1000, and 2000 line counts.

LINE COUNT SELECTION (B4-B5)

The 2790 converter board provides 8 jumper selectable line counts. Binary counts are selected by installing SWB1 jumper B3 and installing the appropriate combination of jumpers B4 and B5. Most systems using encoder style feedback are set to the x4 quadrature counting mode so that the effective quadrature counts are 4 times greater than the physical line count of the encoder.

HALL CYCLES (B6-B8)

On the 2790502 converter board Jumpers B6-B8 select the number of hall cycles per resolver cycle.

RESERVED (B9)

On the 2790502 converter board Jumper B9 is reserved and the jumper should be removed.

See Figure 1.0 for SWB1 Jumper Chart.

CHANNEL Z NORMAL/INVERTED SELECTION (J2)

The 2790 converter board provides jumper selectable inversion of the Z Channel (Index) for systems requiring an active low signal. Jumper J2 pins 2-3 select the channel Z Normal mode and pins 1-2 select the Channel Z Inverted mode.

FAULT MODE OUTPUT SELECTION

The 2790 converter board provides several methods of interface for fail safe fault detection.

DIFFERENTIAL FAULT SIGNAL SET-UP (J4)

Installing a jumper on J4 pins 1-2 enables the RS-422-A differential drivers and provide up to 40 mA into a 100 ohm differential load. These outputs are also TTL compatible and are located on pins 8 and 20 of the P3 connector.


TTL OR LINE DRIVER INTERFACE
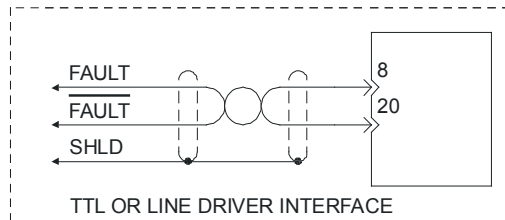
TRI-STATE A-QUAD-B FAULT SIGNAL SET-UP (J4)

Install a jumper on J4 pins 2-3. The 2790 board will Tri-State the A-Quad-B signals during a Fault condition. The Differential Fault signals are also Tri-Stated and are NOT a valid interface with this set-up. This interface will allow an immediate Fault sense by equipment with loss of signal detection.

ACTIVE PULL-UP FAULT SIGNAL SET-UP

This interface is a fail-safe design so that in a loss of power condition the fault signal on Pin 19 of the P3 connector will be 0 vDC. Pin 19 will be the source voltage with no fault present and can drive up to 600 mA. The source voltage for the Pull-up must be provided on Pin 25 of the P3 connector and can range from 5-40 vDC.

ACTIVE PULL-UP INTERFACE
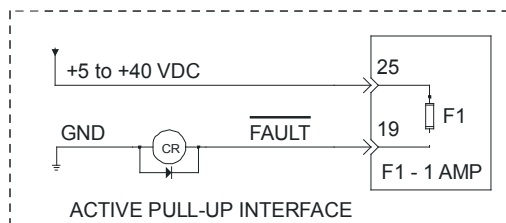
FUNCTION	B1	B2	B3	B4	B5	B6	B7	B8	B9	Quadrature Counts
2.5 kHZ	0	0								
5.0 kHZ	1	0								
10.0 kHZ	0	1								
Reserved	1	1								
Decimal Count			0							
Binary Count			1							
250/256 Lines				0	0					1000 Decimal/1024 Binary
500/512 Lines				1	0					2000 Decimal/4048 Binary
1000/1024 Lines				0	1					4000 Decimal/4096 Binary
2000/2048 Lines				1	1					8000 Decimal/8192 Binary
1 Hall Cycle/Rev						0	0	0		
2 Hall Cycle/Rev						1	0	0		
3 Hall Cycle/Rev						0	1	0		
4 Hall Cycle/Rev						1	1	0		
5 Hall Cycle/Rev						0	0	1		
6 Hall Cycle/Rev						1	0	1		
8 Hall Cycle/Rev						0	1	1		
10 Hall Cycle/Rev						1	1	1		
Default									0	
Reserved									1	

- Figure 1.0 -

1 Indicates installed jumper   Indicates default setting

2) Install the 2790 board as described in the application drawing 2790502.

3) Select the fault signal conditioning method by setting the JB4 jumper as described in the JUMPER SETTINGS section based on the application requirements.

4) Select the Z Channel inverted option by setting J2 to short pins 1 and 2. The DEFAULT is non-inverting and having pins 2 and 3 shorted on J2.

5) Select the excitation frequency by JB1-2 of SWB1 (see jumper table Fig. 1.0). 10 kHZ is the DEFAULT setting with JB1 removed and JB2 installed on SWB1.

6) Select the passive filter setting by J11 for the corresponding frequency setting. The DEFAULT setting is for a board set to 10 kHZ and J11 is removed.

7) Select the counting style of Binary or Decimal by JB3 of SWB1 (see jumper table Fig. 1.0). Binary is the DEFAULT setting for SSI applications with the jumper installed.

8) Select the line count per revolution by setting JB4-5 of SWB1 (see jumper table Fig. 1.0). 1000 lines per revolution (4000 quadrature counts per revolution) is the DEFAULT setting with JB4 removed and JB5 installed.

9) Jumpers JB6-8 select the number of Hall Cycle per Resolver Cycle. The DEFAULT is 1 Hall Cycle per resolver cycle with JB6-8 all removed.

9) J10 selects in the input course gain range and allows for interface to a broad range of resolver transformation ratios. Installing a jumper on pins 1 and 2 sets the gain to 0.25 (gain of ¼). Installing a jumper on pins 2 and 3 sets the gain to 1.0 (DEFAULT). Removing the jumpers completely sets the gain to 4.0.

10) Turn the gain potentiometer fully counter-clockwise. Then turn the gain potentiometer clock-wise until the (Green) MID LED comes on. The signal return on "ST1" test point should now be 3.8 volts peak to peak. Phase the position loop if necessary by reversing the Sine HI and Sine LO wires to reverse the count direction. At this point the basic set-up is complete and the position loop can now be closed. Set the position loop gain of the servo system and then continue to Step 11.

11) After the position loop has been closed the phase balance of the 2790 board can be adjusted. To adjust the phase balance of the 2790 board, observe the excitation return on the "ST1" test point. Adjust the oscilloscope to 100 mvDC per division and offset the signal so that just the peak of the signal is visible. Jog the axis at 30% of its feedrate. If the phase is unbalanced the peak of the sine wave will bounce and become blurred. Adjust the balance pot on the 2790 to achieve 20 mvDC or less bounce.

LED STATUS INDICATORS

CHA = Channel A State Indicator
CHB = Channel B State Indicator
CHZ = Channel Z (Index/Marker) Indicator
PWR = Power Status Indicator

HEA = Hall Effect A State Indicator (S1)
HEB = Hall Effect B State Indicator (S2)
HEC = Hall Effect C State Indicator (S3)

FLT = Loss of Signal Indicator
MID = Return Signal Proper Indicator
HSG = High Signal Indicator

TEST POINTS

GND = Analog Ground
PA+ = Sine HI (3.6 vDC Peak to Peak)
PA- = Sine LO (3.6 vDC Peak to Peak)
PB+ = Cosine HI (3.6 vDC Peak to Peak)
PB- = Cosine LO (3.6 vDC Peak to Peak)

SIG = Signal Return (0.8-18.0 vDC Peak to Peak)
ST1 = Stage 1 Signal (3.8 vDC Peak to Peak)
SCL = Tracking Clock

EXPLANATION OF POLES FOR DC MOTORS AND RESOLVERS

Commutation

Originally, dc motors used commutators and brushes to commutate the current in a wound rotor to provide torque in one direction or the other. Brushless dc motors use magnets on the rotor instead of windings, and require a means for indicating to the drive electronics, the orientation of the motor shaft in order for the electronics to commutate the current to the stator windings.

Early brushless dc motors frequently used auxiliary magnets mounted on the rotor and 3 Hall effect detectors on the stator to indicate the orientation of the rotor. The Hall effect detectors would indicate 6 distinct rotor positions to the drive electronics. Later motors frequently used integral resolvers to detect the rotor position, and the associated electronics would provide signals which emulated the output of the Hall detectors.

Poles

Brushless dc motors are frequently specified to have 2, 4, and sometimes 6 or more poles. The motors are invariably three phase. Current is commutated among the three windings to provide a magnetic field vector that rotates in one direction for clockwise and the other for counter-clockwise. The magnetic field vector will make one rotation per three phase electrical cycle. A 2 pole motor has a single magnet on the rotor with a north and a south pole, hence 2 poles or one pole pair. A 4 pole motor has 2 magnets, each with a north and a south pole, hence 4 poles or 2 pole pairs, and so on.

A 2 pole (single magnet) motor will make one rotor rotation per rotation of the magnetic field vector. That is, the rotor will make one revolution per motor electrical cycle. A 4 pole (two magnet) motor will require two electrical cycles to make one revolution, and a 6 pole (3 magnet) motor will require three electrical cycles per revolution.

A three pase Brushless motor will have 3 windings. A 2 pole motor will have the windings distributed to 3 stator poles spaced 120deg apart. A 4 pole motor will have its windings distributed to 6 stator poles spaced 60deg apart. A 6 pole motor will have its windings distributed to 9 stator poles spaced 40deg apart.

Hall effect emulation

Similarly, for appropriate commutation, the Hall effect emulation must provide one Hall cycle per motor electrical cycle. That is, a 2 pole motor will require one Hall cycle per revolution, a 4 pole motor, two Hall cycles per revolution, and a 6 pole motor, three Hall cycles per revolution.
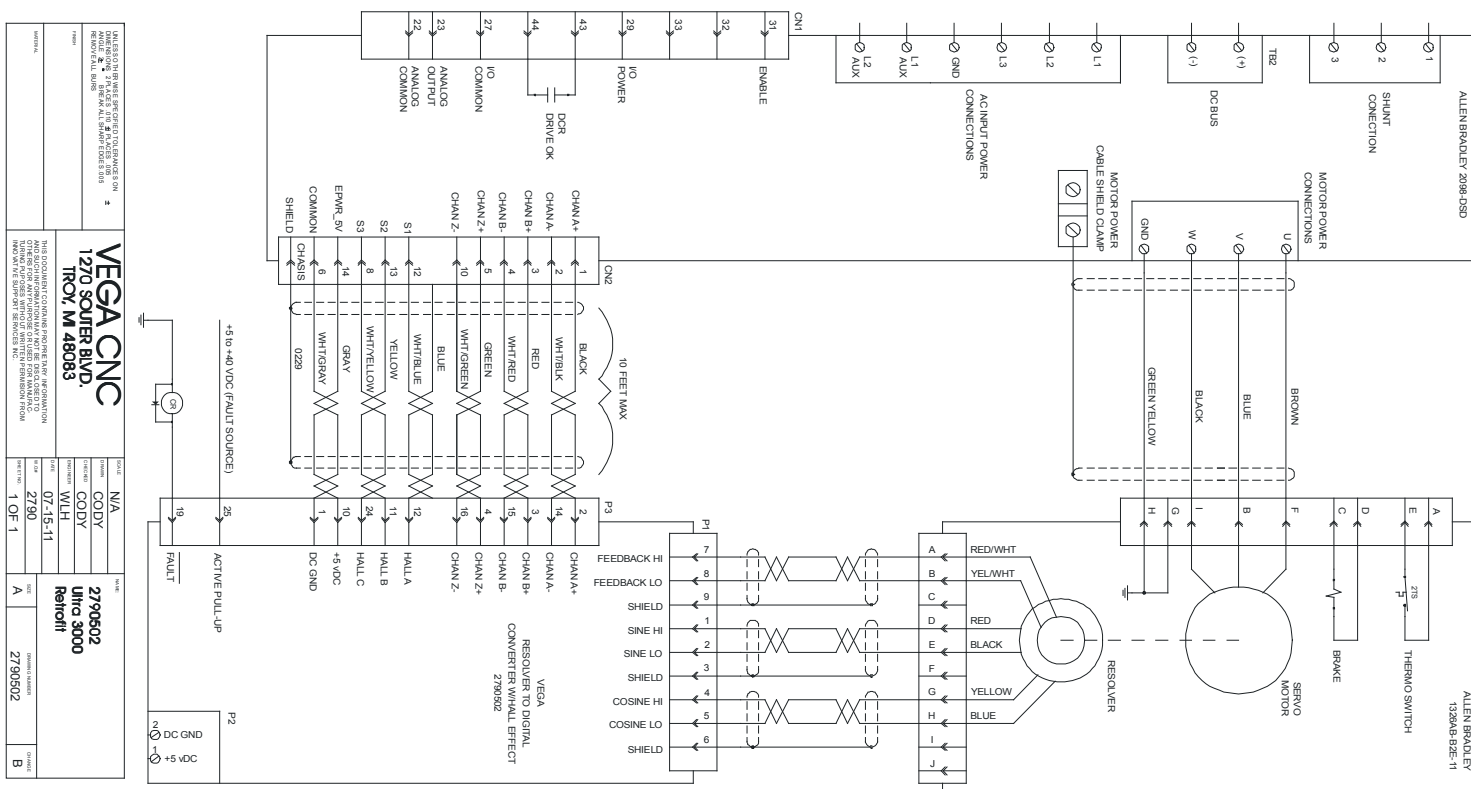
Resolvers

Resolvers are sometimes similarly described as having 2, 4, or more poles. This simply means that the resolver makes respectively, one, two, or more, electrical cycles per rotor revolution.

The bottom line

Reduce everything to cycles. There will always be one Hall cycle per motor electrical cycle. There will always be an integral number of resolver cycles per shaft revolution. And there will always be an integral number of Hall cycles per resolver cycle.
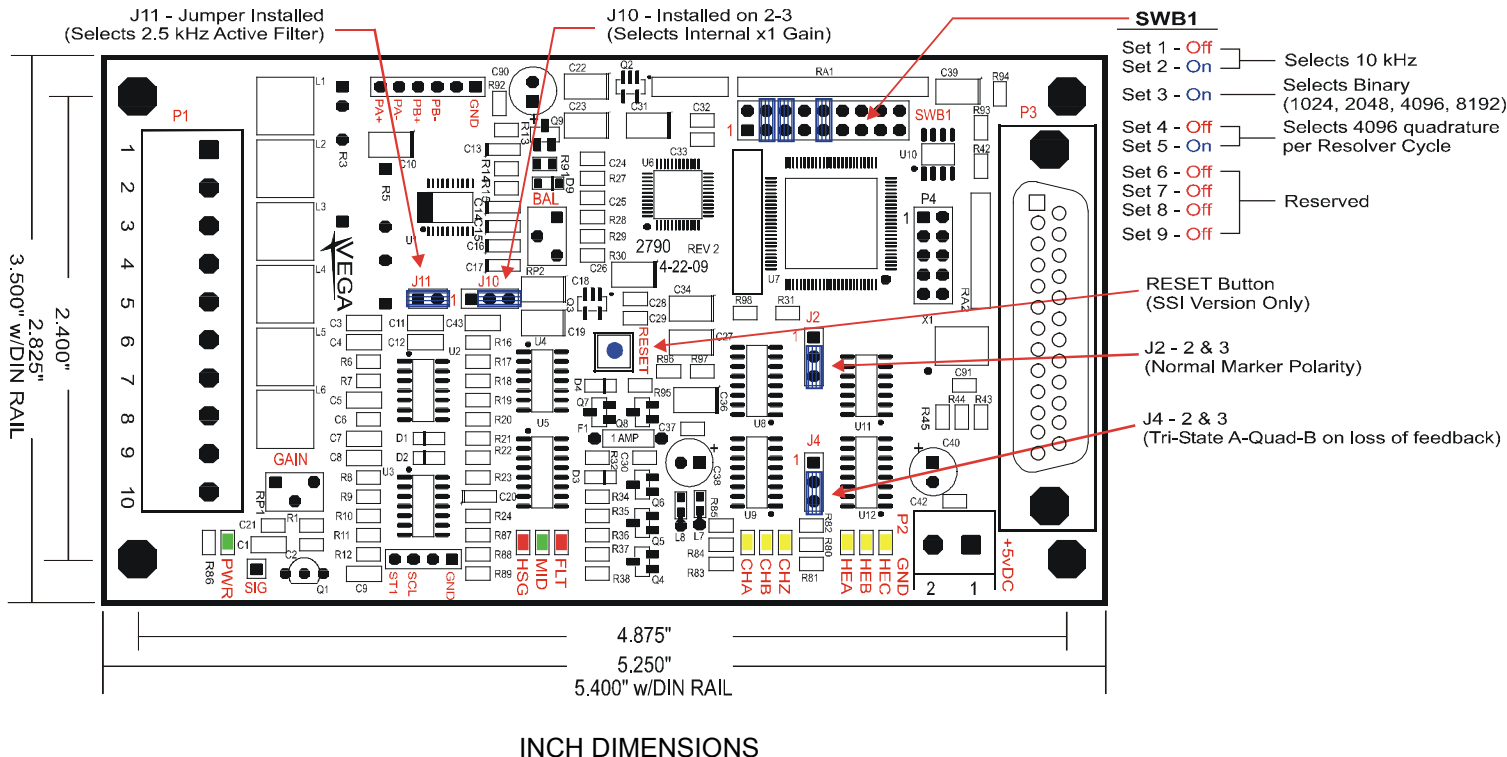
APPLICATION INTERFACE

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SYMPTOM	CHECKS	SOLUTION
No Power LED	Check +5 vDC	+5 vDC Present → Board Failure – Replace board
Fault LED (Low Signal) Continuous	Remove power and ohm between "PA+" and "PA-" note value. Ohm between "PB+" and "PB-" note value.	Resistance values are less than 30 ohms – Check for shorts between "PA-" and "PA+" as well as ground. Check for shorts between "PB-" and "PB+" as well as ground.
	Check "PA+" and "PB+"test point for 3.6 volts peak to peak sine excitation	Signal not present → Board Failure – Replace board
	Check "PA-" and "PB-"test point for 3.6 volts peak to peak sine excitation	Signal not present → Board Failure – Replace board
	Check "ST1" test point for 3.8 volts peak to peak	Repeat Step 9-10 of the Resolver Set-Up Procedure
Fault LED (Low Signal) Intermittent	Check "PA+" and "PB+"test point for 3.6 volts peak to peak sine excitation	Signal not present → Board Failure – Replace board
	Check "PA-" and "PB-"test point for 3.6 volts peak to peak sine excitation	Signal not present → Board Failure – Replace board
	Remove power and ohm between "PA+" and "PA-" note value. Ohm between "PB+" and "PB-" not value.	Resistance values differ by more than 3 ohms of each other → Check resolver windings – Replace slider or cables
	Remove power and ohm between "PA+" and "PA-" note value. Ohm between "PB+" and "PB-" note value.	Resistance values are less than 30 ohms – Check for shorts between "PA-" and "PA+" as well as ground. Check for shorts between "PB-" and "PB+" as well as ground.
Cyclic Error	Check "ST1" test point for bounce	Repeat step 11 of the Resolver Set-Up Procedure
	Remove power and ohm between "PA+" and "PA-" note value. Ohm between "PB+" and "PB-" note value.	Resistance values are less than 30 ohms – Check for shorts between "PA-" and "PA+" as well as ground. Check for shorts between "PB-" and "PB+" as well as ground.
	Remove power and ohm between "PA+" and "PA-" note value. Ohm between "PB+" and "PB-" note value.	Resistance values are differ by more than 3 ohms of each other → Check resolver windings – Replace resolver or cables
	Check "PA+" and "PA-"test point for 3.6 volts peak to peak sine excitation	Signal not present → Board Failure – Replace board
	Check "PB+" and "PB-"test point for 3.6 volts peak to peak sine excitation	Signal not present → Board Failure – Replace board
HSG LED (High Signal) Continuous	Check "ST1" test point for 3.8 volts peak to peak	Repeat Step 9-10 of the Resolver Set-Up Procedure
HSG LED (High Signal) Intermittent	Check "ST1" test point for 3.8 volts peak to peak	Follow procedures described in the Fault LED (Low Signal) Intermittent section
MID LED (Signal Midpoint) Continuous	Signal Proper	No Problem… Life is Good
MID LED (Signal Midpoint) Intermittent	Check "ST1" test point for bounce	Repeat step 11 of the Resolver Set-Up Procedure
Feedback Polarity is Reversed	None	Swapping the Sine HI with the Sine LO wires will reverse the counting direction of the A-quad-B

J11 - Jumper Installed
(Selects 2.5 kHz Active Filter)

J10 - Installed on 2-3
(Selects Internal x1 Gain)

SWB1

Set 1 - Off	Selects 10 kHz
Set 2 - On	
Set 3 - On	Selects Binary (1024, 2048, 4096, 8192)
Set 4 - Off	Selects 4096 quadrature per Resolver Cycle
Set 5 - On	
Set 6 - Off	
Set 7 - Off	Reserved
Set 8 - Off	
Set 9 - Off	

RESET Button
(SSI Version Only)

J2 - 2 & 3
(Normal Marker Polarity)

J4 - 2 & 3
(Tri-State A-Quad-B on loss of feedback)

4.875"
5.250"
5.400" w/DIN RAIL

2.400"
2.825"
3.500" w/DIN RAIL

INCH DIMENSIONS

POWER REQUIREMENTS

The 2790502 converter requires +5 vDC supply @ 250 mAmp for operation. The supplied power should have less than 50 mVolts of noise and drift.

Recommended Power Supplys (If Required)

Mean Well MDR-20-5 (+5 vDC @ 3 Amps)
Mean Well MDR-40-5 (+5 vDC @ 6 Amps)

CABLE SPECIFICATIONS

The 2790 series of converters provide stable and precise sine and cosine excitations. These signals and the return signal are analog and proper routing and shielding techniques should be observed. Shielded twisted pair cables should be used for all interface signals

Recommended Cable

Shielded Single Twisted Pair with Drain Wire
Belden #8103 or equivalent

Connector Kits and Mounting Options

KIT #2790CK1
    Includes:
        (1) DB-25 Male Solder Cup Connector
        (1) DB-25 Plastic Hood and Hardware

KIT #2790CK2
    Includes:
        (1) DB-25 Male Crimp Style Connector
        (25) Gold Male Crimp Pins
        (1) DB-25 Plastic Hood and Hardware

 * Use Molex Crimper HTR2445A or
   general purpose crimper HT202A (Jameco PN 99443)

KIT #2790DIN
    Includes:
        (1) DIN Rail Mount for 2790 boards

REPAIR AND TECHNICAL SUPPORT

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