synchro/resolver to digital converter
single +5V power 12 bit
series 268D300

actual size

FEATURES

- +5V only operation
- 2" x 2" module outline
- 3-state output
- 8 bit byte or 12 bit word
- ±8.5 minute accuracy
- Fast tracking to 100 RPS
- 50Hz to 5KHz excitation
- Velocity output

APPLICATIONS

Precise Angle Measurement - Test
Robotics - Machine Tool Control
Antenna Monitoring - Simulation

General Data

The series 268D300 is a 12 bit synchro/resolver to digital converter packaged in a 2.0" x 2.0" x 0.4" micro-module weighing only 1.25 ounces. This converter operates from a single +5V power supply allowing for easy use in all digital systems. This new small size rivals that of hybrid and monolithic converters, yet maintains the ease of use and flexibility of modular converters.

The 268D300 is a continuously tracking "type II" converter with high acceleration constants and can track shaft speeds up to 100 RPS without additional error. The output is TTL/CMOS compatible natural parallel binary angle with 3-state latches.Outputs are addressable as either two bytes or a single 12 bit word.

Operation can be specified over a frequency range of 50Hz to 5KHz and an input signal range of 2.5 to 115 volts rms. The converter uses a ratiometric conversion technique which insures high noise immunity and tolerance to lead length when located at a distance from the synchro or resolver source.

Theory of Operation

The synchro to digital converter determines the value of the input angle Θ, see block diagram, by comparing a digital feedback angle Φ with the synchro input angle. When the difference between the input angle and the feedback angle is zero, the output angle contained in the up-down counter is equal to the synchro input angle.

The Solid State Control Transformer performs the trigonometric computation: $\sin(\Theta - \Phi) = (\sin\Theta\cos\Phi - \cos\Theta\sin\Phi)$.

Note that for small angles, $\sin(\Theta-\Phi) \simeq (\Theta-\Phi)$. The equality given by the above equation is true only in the first quadrant, i.e., 0° to 90°. The analog inputs to the Solid State Control Transformer have different values, depending on the quadrant in which the input angle lies.

$\Theta-\Phi$ is an analog representation of the error between Θ the input angle, and Φ the output angle. This analog error is first demodulated then fed to an analog integrator whose output controls the frequency of a voltage-controlled oscillator. The VCO clocks the up-down counter. The up-down counter is functionally an integrator, therefore the tracking converter in itself is a closed-loop servomechanism with two lags, making it a "type II" servo loop. The "type II" servo loop tracking converter exhibits no velocity errors and only minor acceleration errors.

Assuming that the "INHIBIT" is at a logic "1", then the digital word Φ will be strobed into the latches 1 microsecond after the up-down counter has been updated. If the three state "ENABLE" is at a logic "0", then the digital output word will be presented to the output pins of the module.

ELECTRICAL SPECIFICATIONS

Parameter	Value
Resolution	12 bits (0.088°)
Accuracy (1)	± 8.5 minutes (0.143°)
Power Suppy	
Voltage	+4.75 to +5.25V
Current	50mA max
Reference Input (2)	
Voltage	2.5 to 115Vrms
Frequency	50Hz to 5KHz
Impedance	>100K ohm
Signal Input (2)	
Voltage	2.5 to 115Vrms
Impedance	Volts x 9K ohm
Parallel Angle	
Type	TTL/CMOS compatible
Drive	Logic '0' = 2 TTL Logic '1' = 10 TTL HiZ = 10µA
Format	3-state positive logic 1 = MSB 12 = LSB
Converter Busy	
Type	TTL/CMOS compatible
Drive	2 TTL loads
Format	2µs (max) positive pulse
Inhibit	
Type	CMOS, 51K ohm pull-up
Format	Logic '0' latches output
Enable M & L	
Type	CMOS, 51K ohm pull-down
Format	Logic '0' enables output Logic '1' = Hi-Z
Velocity	
Range	±7.5V for max tracking
Polarity	+ = increasing angle
Loading	5K ohm min.
Temperature Ranges	
Operating	0 to 70° C
Storage	-55 to 125° C
Dimensions	2.0″ x 2.0″ x 0.4″
Weight	1.5 oz. max

NOTES

(1) Accuracy applies for:
- (a) +10%, -20% signal amplitude variation
- (b) over specified reference amplitude range
- (c) 10% reference and signal harmonic distortion
- (d) over specified power supply range
- (e) over operating temperature range

(2) See ordering information for specific reference or signal voltages and frequencies. Other voltages may be specified; consult factory.

CONNECTING THE CONVERTER

Connect +5Vdc to the +5V pin and +5Vdc return to the GND pin of the converter. These power lines must not be reversed, otherwise catastrophic failure will result.

In the case of a synchro the signals are connected to S1-S2-S3 according to the following convention:

$E_{S1-S3} = E_{RL-RH}SIN\Theta$
$E_{S3-S2} = E_{RL-RH}SIN(\Theta + 120°)$
$E_{S2-S1} = E_{RL-RH}SIN(\Theta + 240°)$

For a resolver, the signals are connected to S1-S2-S3-S4 according to the following convention:

$E_{S1-S3} = E_{RL-RH}SIN\Theta$
$E_{S2-S4} = E_{RH-RL}COS\Theta$

OPERATION OF THE CONVERTER

The digital output angle is pins 1 thru 12, pin 1 being the MSB = 180 degrees. The ENM and ENL pins are the 3-state enable inputs. When the ENM pin is at logic '0', bits 1 thru 8 are enabled. When ENL is at logic '0', bits 9-12 are enabled. When these two pins are at logic '1', their respective outputs are in the high impedance state. Both the pins have internal pull-down resistors; therefore, if the 3-state function is not being used, these pins may be left open.

The Inhibit (INH) and Converter Busy (CB) pins are used to interface to a computer. The CB is a 2 microsecond positive pulse which occurs during a digital output code change; the pulse brackets the code change. The INH input is used to lock the internal output latches, causing the digital output bits to remain stable while data is being transferred. This latch also prevents the transmission of invalid data when there is an overlap between CB and INH.

There are two methods of transferring data, one is by transferring data on the trailing edge of the CB pulse. The other method is by using the INH input. A logic '0' applied to the INH input locks the output latches. Converter updating is not affected no matter what the duration of the inhibit command. The INH input has an internal pull-up resistor and if the INH input is not used it may be left open. A simple method of interfacing to a computer using the INH input is to:

(1) Set INH to logic '0'
(2) Wait 2.0µs min.
(3) Transfer the data
(4) Set INH to logic '1'

The direction of rotation of the synchro or resolver is indicated by the Direction Output (DIR). A logic '0' indicates the digital output is counting up and a logic '1' indicates it is counting down. This direction data is always valid in advance of the Converter Busy pulse.

A negative pulse at the Ripple Clock (RC) output indicates when the synchro or resolver crosses electrical zero. The DIR and RC outputs can be used with external 74HC191 counters to serve as a revolution counter.

DYNAMIC CHARACTERISTICS

The 268D300 employs a "type II" servo loop with very high acceleration constants. The loop dynamics are completely independent of power supply variations within their specified ranges. As long as the maximum tracking rate is not exceeded there will be no velocity lag and only minor acceleration lag at the converter output. Acceleration lag (in degrees) can be calculated from the following equation:

$$Ea = \frac{\text{Acceleration (deg/sec)}^2}{Ka}$$

Refer to Dynamic Characteristics chart for dynamic performance of the converter at various reference frequencies.

DYNAMIC CHARACTERISTICS				
FREQUENCY	TRACKING RATE	Ka	SETTLING TIME*	BANDWIDTH
47Hz – 5.5KHz	20RPS	2K	650ms	20Hz
0.36 – 5.5KHz	50RPS	12K	200ms	60Hz
2.3 – 5.5KHz	100RPS	500K	80ms	175Hz

*Settling time for 179 degree step

The nominal open loop transfer functions for the 268D300 series are given by:

$$G_{60} = \frac{45^2 \left(\frac{S}{31} + 1\right)}{S^2 \left(\frac{S}{125} + 1\right)}$$

$$G_{400} = \frac{110^2 \left(\frac{S}{76} + 1\right)}{S^2 \left(\frac{S}{312} + 1\right)} \qquad G_{2600} = \frac{710^2 \left(\frac{S}{500} + 1\right)}{S^2 \left(\frac{S}{2000} + 1\right)}$$

VELOCITY OUTPUT

The Velocity output (VEL) is a DC voltage proportional to the angular velocity of the synchro/resolver shaft. Voltage polarity is positive for an increasing digital angle and negative for a decreasing digital angle.

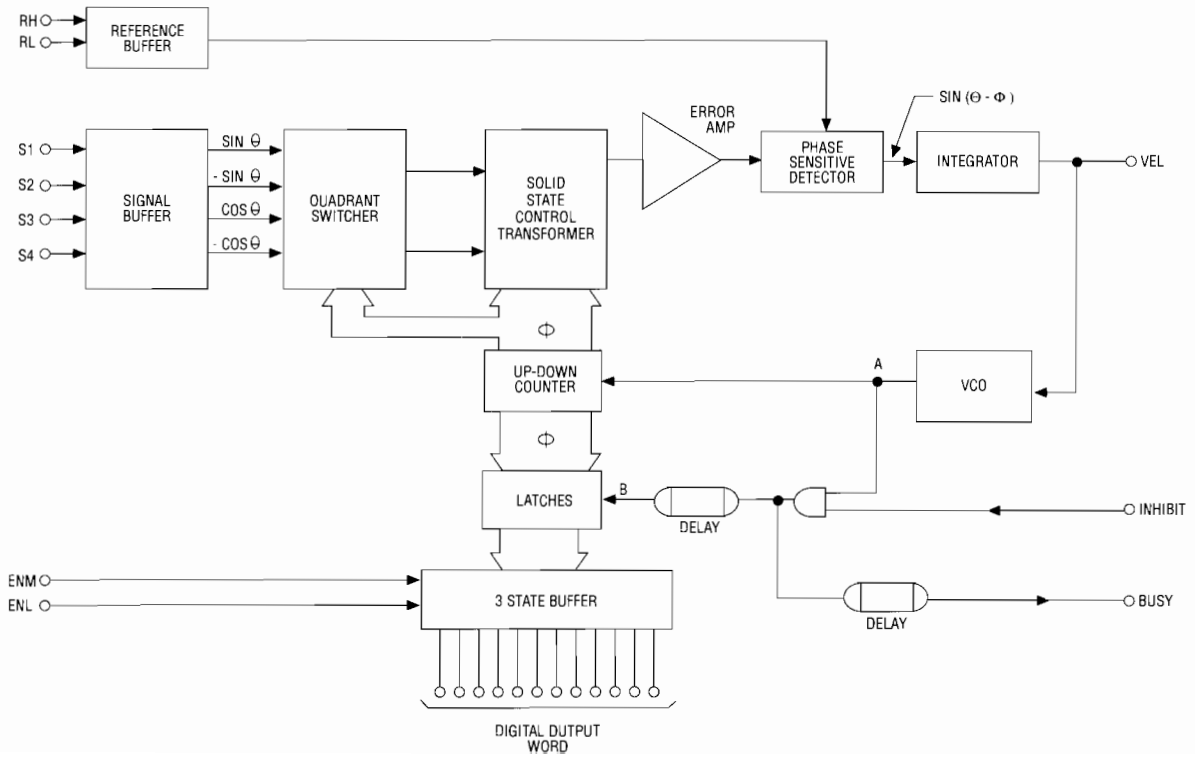
OPTIONAL ANALOG OUTPUTS

Two optional analog outputs are available on special order. Any one of these outputs can be supplied in lieu of the Velocity output and are at the VEL pin location. The two available optional outputs are the DC Error or the Inter-LSB voltage.

The DC Error signal is the output of the phase sensitive demodulator and is proportional to the error between the input angle and the output digital angle. This output has a voltage gradient of 25mv/LSB and is negative for increasing angle. This output is an indication that the input has exceeded the maximum tracking rate of the converter or, due to some internal malfunction, the converter is unable to reach a null. By connecting this output to comparators, a "built-in test" feature can be achieved.

The Inter-LSB signal is a dc analog voltage representing the synchro/resolver shaft position within the least significant bit of the digital output angle. This output has a voltage gradient of 5V/LSB and is negative for increasing angle.

BLOCK DIAGRAM



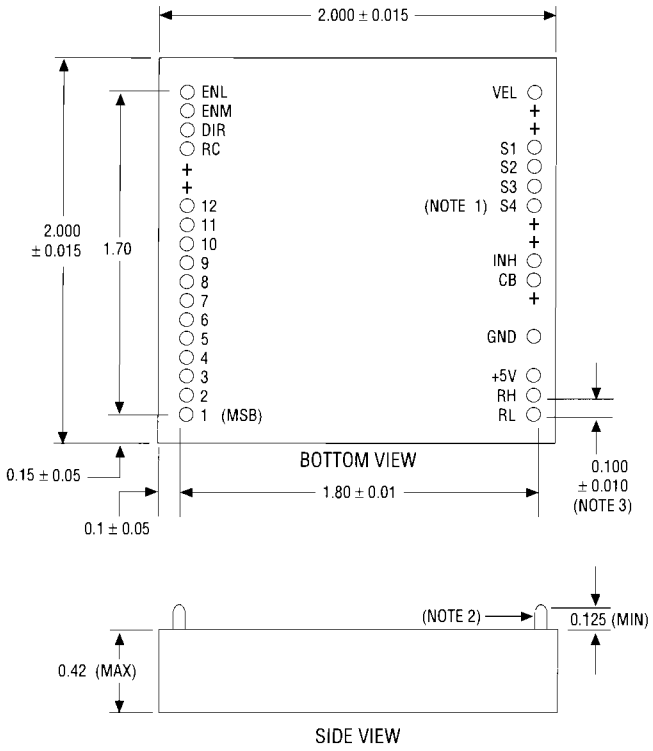
ORDERING INFORMATION

268D SUFFIX	INPUT TYPE	STATOR VOLTAGE	REFERENCE FREQUENCY
300	SYNC	11.8V	47-5000Hz
301	SYNC	90V	47-5000Hz
302	RSVR	11.8V	47-5000Hz
303	SYNC	11.8V	360-5000Hz
304	SYNC	90V	360-5000Hz
305	RSVR	2.5V	360-5000Hz
306	RSVR	5.9V	360-5000Hz
307	RSVR	11.8V	360-5000Hz
308	SYNC	11.8V	2.3-5.5KHz
309	RSVR	2.5V	2.3-5.5KHz
310	RSVR	5. 9V	2.3-5.5KHz
311	RSVR	11. 8V	2.3-5.5KHz

Consult factory for optional non-standard voltages and frequencies.

MECHANICAL OUTLINE

268D300



NOTES

1. S4 pin appears on multiple input and resolver models only.
2. Rigid .025 diameter pins suitable for solder-in or plug-in applications.
3. Non-cumulative.
4. Dimensions are in inches.

WARRANTY

All units warranteed against defects in materials and workmanship for 1 year from date of shipment. Liability is expressly limited to servicing, adjusting, or replacing any CSI product returned to our factory with delivery charges prepaid. In no case shall our liability exceed the original purchase price.

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