CSI

synchro/resolver to digital converter
high accuracy 14 bit
series 168F100A

FEATURES
- **±2.6 arc minute accuracy**
- **Industry low profile module**
- **All common L-L levels**
- **47 to 1200Hz frequency range**
- **Tracking to 15rps**
- **Velocity output option**
- **TTL/CMOS compatible**

APPLICATIONS
- **Precise angle measurement**
- **Machine tool control**
- **Robotic control**
- **Antenna monitoring**

GENERAL DATA

The series 168F100A is a 14 bit synchro/resolver to digital converter featuring an accuracy of ±2.6 arc minutes. The converter measures 3.12" x 2.62" x 0.42" weighing only 3.5 ounces. The unit features the industry standard pin-out.

Operation is specified over a frequency range of 47 to 1200Hz. The converter employs a "Type II" servo loop, that exhibits no velocity errors and only minor acceleration errors. Ratiometric conversion techniques are used to ensure high-noise immunity and tolerance to long lead length.

The 168F100A employs a field proven Solid State Scott T input. This input features; high balanced input impedances, high common mode rejection, frequency independence and over-voltage protection to 1000%.

THEORY OF OPERATION

The synchro/resolver to digital converter determines the value of the input angle Θ, see block diagram, by comparing a digital feedback angle Φ with the 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 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, $\sin(\Theta-\Phi) = \Theta-\Phi$. 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 and Φ. This analog error voltage is first demodulated then fed to an analog integrator whose output controls the frequency of a voltage-controlled oscillator. The VCO clocks an up-down counter that is functionally an integrator. Therefore the converter in itself is a closed-loop servomechanism with two lags, making it a "Type II" tracking converter. The "Type II" tracking converter exhibits no velocity errors and only minor acceleration errors.

SPECIFICATIONS

Parameter	Value
Resolution	14 bits (0.022°)
Accuracy(1)	±2.6 arc minutes (0.044°)
Power Supplies(2)	
+15V	15mA max.
-15V	30mA max.
+5V	15mA max.
Reference input(3)	
Voltage	10 to 130Vrms
Frequency	47 to 1200Hz
Impedance	400KΩ
Stator Input(3)	
Voltage L-L	2.5 to 115Vrms
Impedance	
Synchro	$4.5(V_{L-L})K\Omega$
Resolver	$9(V_{L-L})K\Omega$
Digital Outputs	
Type	HCMOS
Drive Capability	2 std TTL loads
Parallel Binary Angle	positive logic 1 = 180° 14 = 0.022°
Converter Busy	0.5 to 1.5µsec positive pulse
Digital Input	
Type	HCMOS
Loading	33KΩ pull-up to +5V supply
Inhibit	Logic "0" inhibits
Velocity Output(4)	
Range	±10V for max. tracking
Polarity	Positive for increasing angle
Scale Factor Error	±20%
Reversal Error	±5%
Linearity	
0-50%	6%
0-100%	15%
Zero Offset	±3mV max.
Load	8KΩ min.
Temperature Ranges	
Operating	
Standard	0° to +70°C
Extended	-55° to +105°C
Storage	-55° to +125°C
Dimensions	3.125" x 2.625" x 0.42"
Weight	3.5 oz.

NOTES:

1. Accuracy applies for:
   a) +10%, -20% stator amplitude variation.
   b) over the specified reference voltage and frequency range.
   c) 10% reference and stator harmonic distortion.
   d) over the specified power supply ranges.
   e) over the operating temperature range.
2. Power supply tolerances are:
   a) ±15V range is ±11.5V to ±16V.
   b) +5V range is +4.75V to +5.25V.
3. See Ordering Information for specific voltage and frequency ranges.
4. Optional feature.

INTERFACING WITH THE CONVERTER

The Inhibit (INH) input and the Converter Busy (CB) output are used to interface to a computer. The Converter Busy is a positive pulse that occurs during the digital angle code changes; this pulse brackets the code changes. The Inhibit input is used to lock the up/down counters, causing the digital output bits to remain stable while data is being transferred. The transmission of invalid data when there is an overlap between the Converter Busy and the Inhibit command is also prevented.

Whenever an input angle change occurs, the converter changes the digital angle in steps of 1 LSB and generates a converter busy pulse (CB). The CB is a positive pulse of 0.5 to 1.5µsec in duration. Data changes approximately 0.2µsec after the leading edge of the CB pulse, and data can be transferred 0.5µsec after the leading edge.

There are two methods of transferring data; one is by transferring data on the trailing edge of the Converter Busy pulse and the other is by using the Inhibit input. A simple method of interfacing to a computer using the Inhibit input is to:

1. Set Inhibit input to logic "0".
2. Wait 0.5µsec.
3. Transfer the digital angle data.
4. Set Inhibit input back to logic "1".

The converter will ignore an inhibit applied during the CB interval until that interval is over. Extra CB pulses will not occur if the input angle changes while the counter is locked by the INH.

DYNAMIC CHARACTERISTICS

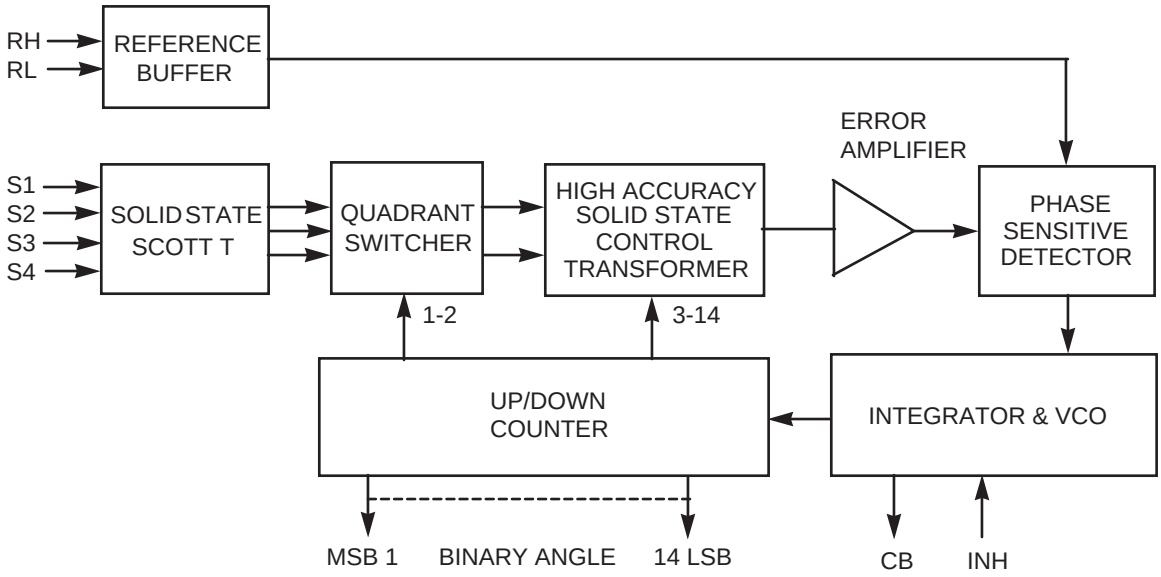
The 168F100A is a "Type II" tracking converter with very high acceleration constants. The loop dynamics are completely independent of power supply variations within their specified ranges. As long as the maximum tracking rate is not exceeded, there will be no velocity lag and only minor acceleration lag at the digital angle output. Acceleration lag (in degrees) can be calculated from the following equation:

$$E_a = \frac{\text{Acceleration Rate } (°/\text{sec}^2)}{\text{Acceleration Constant } (K_a)}$$

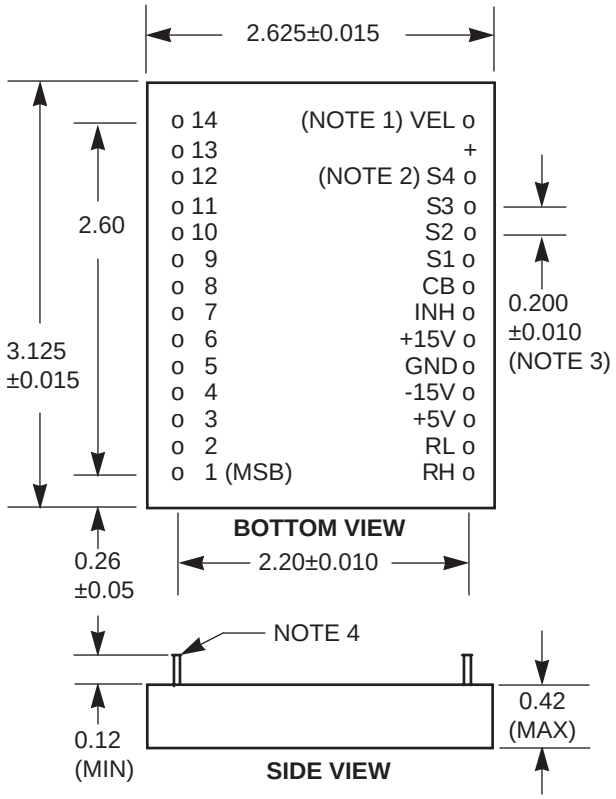
The converter dynamics are determined by the operating frequency range specified. Refer to the Dynamic Characteristics chart for dynamic performance of the various converter types.

DYNAMIC CHARACTERISTICS				
CONVERTER RESOLUTION	REFERENCE FREQUENCY	TRACKING RATE	Ka	SETTLING TIME
14 bit	47-1.2KHz	3rps	5K	1.6 sec
14 bit	360-1.2KHz	15rps	50K	150msec

BLOCK DIAGRAM



MECHANICAL OUTLINE



NOTES:

(1) Velocity pin VEL is present only on special order.
(2) S4 pin appears on resolver or multiple input models.
(3) Non-cumulative.
(4) Rigid 0.040 diameter pins for solder-in or plug-in applications.
(5) Dimensions are in inches.

ORDERING INFORMATION

168F	STATOR		REFERENCE	
SUFFIX	TYPE	VOLT	VOLTAGE	FREQENCY
100A	SYNC	90.0	10-130	47-1200Hz
101A	SYNC	11.8	10-130	350-1200Hz
102A	SYNC	90.0	10-130	350-1200Hz
103A	RSVR	11.8	10-130	350-1200Hz
104A	RSVR	26.0	10-130	350-1200Hz
105A	RSVR	90.0	10-130	350-1200Hz

Notes:

(1) Standard temperature range is 0° to +70°C; add suffix ET to part number for -55° to +105°C temperture range.
(2) Add suffix V to part number for velocity output option.
(3) Consult factory for non-standard input voltages and dynamic characteristics.

WARRANTY

All units are warranted against defects in materials and workmanship for 1 year from the 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.