CSI

synchro/resolver to digital converter
tracking   10-12-14 bit
series 168F200/300/100

1-5

GENERAL DATA:

The 168F series is a family of miniature, low profile, high performance synchro (and resolver) to digital converters. Units measure 2.625 × 3.125 × .40 inches, weigh only 3.5 ounces, and incorporate the industry standard pin-out. The converters accept either 3 wire synchro or 4 wire resolver input data over a frequency range of 50 Hz to 1200 Hz without external modules. Converters are available in 10, 12 or 14 bit resolutions.

Typical of tracking-type converters, the analog synchro (or resolver) input data is accurately and continuously converted into binary digital angle data. The 168F series is a true "type II" servo loop converter. Their high input impedance and inherent transient protection insure trouble-free systems integration.

All units are completely trimmed and adjustment-free; allowing absolute interchangeability. Reliability is assured by the use of high grade components rigidly encapsulated and electrically stressed to the lowest possible levels.

APPLICATIONS:

ORDNANCE CONTROL – RADAR TRACKING SYSTEMS – NAVIGATION SYSTEMS – COLLISION AVOIDANCE SYSTEMS – PROCESS CONTROL

FEATURES:

☐ Single module operates 50-1200 Hz
☐ Low profile module
☐ Insensitive to amplitude and frequency variations
☐ High speed tracking
☐ High input impedance
☐ High accuracy, 4 minutes ±.9LSB (14 bits)
☐ Choice of TTL, HC, LSTTL or CMOS logic
☐ Multiple input option
☐ Over-voltage and transient protected
☐ 0° to 70°C or –55° to 105°C temperature ranges
☐ 10, 12 or 14 bit resolutions
☐ Industry standard pin-out
☐ Choice of synchro or resolver input types
☐ Insensitive to harmonic distortion

RELIABILITY:

The 168F series is a second generation tracking type S/D converter. These units represent a significant improvement in performance and employ the latest in component and circuit technology. Reliability is assured by the use of military type passive components and industry standard high volume integrated circuits. Single PC board construction greatly reduces mechanical solder connections.

ELECTRICAL SPECIFICATIONS:

PARAMETER	VALUE		
	168F200	**168F300**	**168F100**
☐ RESOLUTION, BITS:	10	12	14
☐ ACCURACY:[1]	±30 minutes	±8.5 minutes	±4 minutes ±.9LSB
☐ SYNCHRO INPUT RATES:			
MAXIMUM TRACKING RATE:	25,000°/sec	11,000°/sec	3600°/sec
ACCELERATION FOR 1 LSB LAG:[2]	10,000°/sec²	1800°/sec²	400°/sec²
SETTLING TIME FOR 179° STEP: [2]	100ms	225ms	600ms
☐ POWER SUPPLIES: [3]			
+15VDC @ MAX (TYP) ma:	25(15)	25(15)	25(15)
-15VDC @ MAX (TYP) ma:	35(25)	35(25)	35(25)
+5VDC @ MAX (TYP) ma:			
TTL UNITS:	225(175)	225(175)	250(200)
HC UNITS:	10(5)	10(5)	10(5)
LSTTL UNITS:	100(75)	100(75)	125(90)
CMOS UNITS:	10(5)	10(5)	10(5)
☐ DIGITAL OUTPUTS: [4]	Parallel Positive Natural Binary Angle		
	Converter Busy, logic "1" = CB		
☐ DIGITAL INPUT: [5]	Inhibit, logic "0" = INH		
☐ SYNCHRO/RESOLVER INPUTS:[6]	11.8Vrms L-L 50-1200Hz into 100Kohms		
	90Vrms L-L 50-1200Hz into 800K ohms		
☐ REFERENCE INPUT:	10-130Vrms 50-1200Hz into 400K ohms		
☐ INPUT TYPE: [7]	Solid State Scott-T		
☐ OPERATING TEMPERATURE RANGES:	0° to 70°C (-55° to 105°C opt.)		

NOTES:

(1) Accuracy applies for:
  (a) ±10% signal amplitude variation.
  (b) 25% signal harmonic distortion.
  (c) over power supply range.
  (d) over operating temperature range.

(2) Higher acceleration rates and faster settling times at specified carrier frequencies higher than 60Hz, consult factory.

(3) All units can operate on voltages between ±12VDC to ±17VDC. The tolerance on the +5VDC supply is ±5%.

(4) Fan-outs:
  (a) TTL units: 16ma sink @ logic "0".
  (b) HC units: 3.2 ma @ logic "0".
  (c) LSTTL units: 8ma sink @ logic "0".
  (d) CMOS units: 360μa sink @ logic "0".

(5) Fan-in: 15K ohm pull-up resistor to +5VDC, all models.

(6) Other voltages available.

(7) Any one stator and/or rotor line may be grounded. Common mode voltages up to specified L-L voltage have no effect on operation.

INTERFACE DATA:

INPUT SYNCHRO SIGNALS—The input synchro signals are connected to S1, S2, and S3. Input resolver signals are connected to S1, S2, S3 and S4. These signals are applied to a solid-state Scott-T or a resolver isolation amplifier. Some of the outstanding features of the solid-state input are: (a) 80DB common-mode rejection, (b) common-mode voltages up to specified L-L voltage have no effect on operation, (c) any one stator and/or rotor line may be grounded, (d) high input impedance at all input levels, (3) over voltage as high as 1000% without damage and (f) complete frequency independence.

POWER SUPPLIES—Only three power supplies are required. Although specified for ±15VDC operation the 168F series will operate on ±12VDC power supplies with only a 20% reduction in maximum tracking rate.

CAUTION: Application of reverse polarity to any one of the three power supply inputs will cause catastrophic failure.

LOGIC INPUTS/OUTPUTS—The 168F series is available with TTL, HC, LSTTL or CMOS logic with load and drive capabilities as specified under Electrical Specifications. The Converter Busy (CB) output is a 1-3 μsecond positive pulse which brackets the output code change to indicate output update. The Inhibit (INH) input locks the internal up-down counter, thus preventing the converter from tracking. Logic "0" or ground inhibits, logic "1" or open allows tracking. Application of extremely long Inhibit times can cause erratic operation.

TIMING—Whenever an input angle change occurs, the converter changes the digital angle in steps of 1 LSB and generates a Converter Busy pulse. During the 1-3 μsecond Converter Busy time the output data is changing and should not be transferred. The converter will ignore an Inhibit command applied during the Converter Busy interval. There are two methods of interfacing with a computer, (1) synchronously

and (2) asynchronously. A simple method of synchronously loading is to: (a) apply the Inhibit, (b) wait 5 μseconds, (c) transfer the data, and (d) release the Inhibit. Asynchronous loading is accomplished by transferring data on the trailing edge of the Converter Busy pulse.

DYNAMIC PERFORMANCE—The dynamic response of the 168F series has been optimized for 50Hz excitation frequency in order to give broad band operation, 50-1200Hz. For specified excitation frequencies higher than 60Hz improved dynamic performance can be obtained, i.e., higher tracking and acceleration rates and faster settling times. Consult factory for specific characteristics and part numbers.

THEORY OF OPERATION:

The synchro to digital converter determines the value of the input angle Φ (see block diagram) by comparing a digital feedback angle Θ 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 Function Generator performs the trigonometric computation: $\sin(\Phi\text{-}\Theta) = (\sin\Phi\cos\Theta-\cos\Phi\sin\Theta)$

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

$\Phi\text{-}\Theta$ is an analog representation of the error between Φ the input angle, and Θ the output angle. This analog error is first demodulated then fed to an analog integrator whose output controls the frequency of a voltage-controlled oscilator. 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.
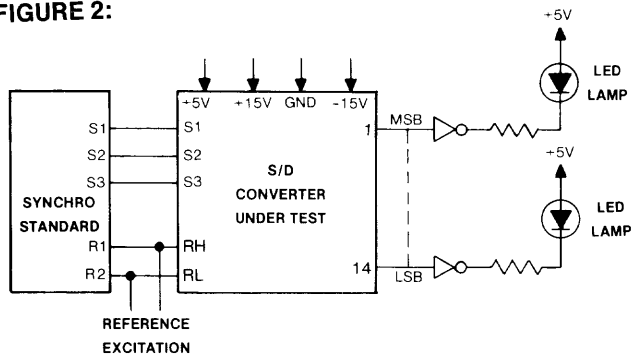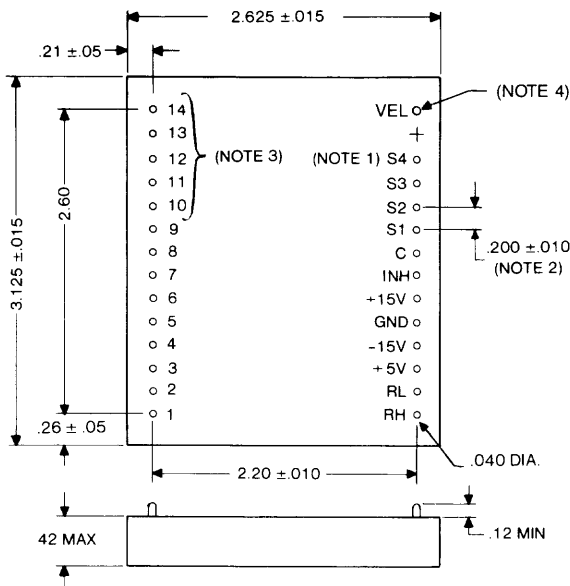
BLOCK DIAGRAM (Figure 1):
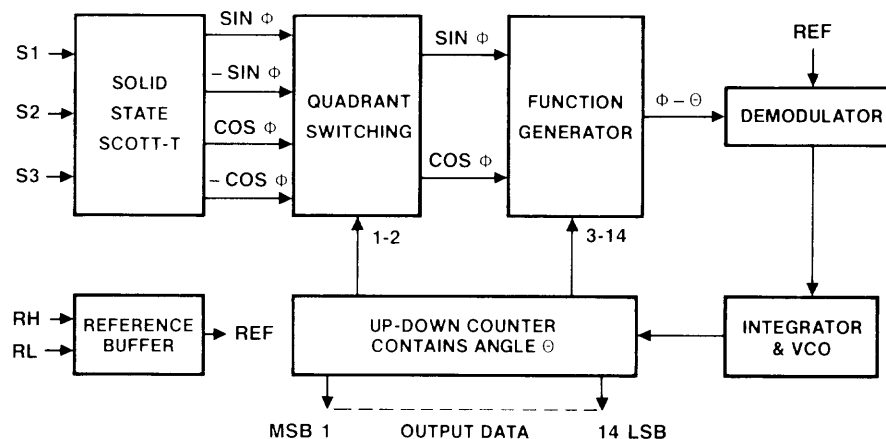
TESTING:

Testing the 168F series is simple and straightforward, just follow the guide in figure 2. All that is required is; three power supplies, ±15V and +5V, an accurate source of synchro or resolver signals such as a Synchro Standard, an A.C. ref-erence supply and a display to read the digital output. The Synchro Standard is set to the test angles. The angles corres-ponding to the lights which are on are added and compared with the standard angle. A table of angles versus bits is given in figure 3.

FIGURE 2:

CONFIGURATION:

NOTES:

1. S4 pin appears on multiple input and resolver input models only.

2. Non-cumulative.

3. 14 bit units have 14 bit pins.
   12 bit units have 12 bit pins.
   10 bit units have 10 bit pins.

4. Optional velocity output (See TB-5).

WEIGHT: 3.5 oz.

FIGURE 3: BIT WEIGHTS

ANGLE VS. BITS

		Deg/Bit	Min/Bit
MSB	1	180	10,800
	2	90	5,400
	3	45	2,700
	4	22.5	1,350
	5	11.25	675
	6	5.625	338
	7	2.813	168.8
	8	1.406	84.36
	9	0.7031	42.86
	10	0.3516	21.096
	11	0.1758	10.548
	12	0.08799	5.279
	13	0.04395	2.637
LSB	14	0.02197	1.318

ORDERING INFORMATION:

	168F SUFFIX	INPUT TYPE	L-L VOLTAGE	LOGIC TYPE
*	X00	SYNC	11.8V	TTL
*	X01	SYNC	90V	TTL
*	X02	RSVR	11.8V	TTL
*	X03	RSVR	90V	TTL
	X24	SYNC	11.8V	HC
	X25	SYNC	90V	HC
	X26	RSVR	11.8V	HC
	X27	RSVR	90V	HC
*	X08	SYNC	11.8V	LSTTL
*	X09	SYNC	90V	LSTTL
*	X10	RSVR	11.8V	LSTTL
*	X11	RSVR	90V	LSTTL
	X12	SYNC	11.8V	CMOS
	X13	SYNC	90V	CMOS
	X14	RSVR	11.8V	CMOS
	X15	RSVR	90V	CMOS

*Not recommended for new designs

X in part number determines resolution
X = 1 for 14 bit converter
X = 2 for 10 bit converter
X = 3 for 12 bit converter

Standard temperature range (0° to 70°C), add suffix ET to part number for extended range (−55° to 105°C).

For velocity option, add suffix V to part number (Example: 168F300ETV)

For multiple input option consult factory.