

CSI

synchro/resolver to digital converter

high speed tracking 10-12-14 bit

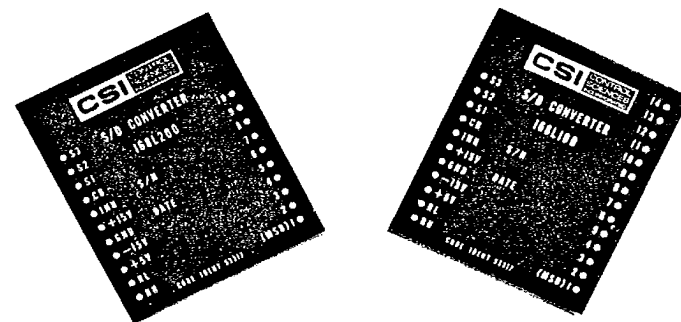
series 168L200/300/100

GENERAL DATA:

The 168L series is a family of ultra fast, low profile, high performance synchro (and resolver) to digital converters. Units measure 2.625 x 3.125 x .4 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 for frequencies of 2600Hz to as high as 10KHz 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 168L series is a true "type II" servo loop converter. Their high input impedance and inherent transient protection ensure trouble-free system 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:**

MACHINE TOOL CONTROLS - HIGH SPEED SERVO SYSTEMS - HIGH PERFORMANCE

INDUSTRIAL INSTRUMENTATION - MAPPING, PLOTTING, and CONTOUR FOLLOWING SYSTEMS

FEATURES:

- Ultra high speed tracking
- Ultra high acceleration response
- High input impedance
- High accuracy, 4 minutes \pm .9LSB (14 bits)
- Choice of TTL, LPTTL, or LSTTL logic
- Low profile module
- Industry standard pin-out
- Over-voltage and transient protected
- 0° to 70°C or -55° to 105°C temperature ranges
- 10, 12 or 14 bit resolutions
- Choice of synchro or resolver input types
- Insensitive to harmonic distortion
- Insensitive to amplitude and frequencies variations

RELIABILITY:

The 168L series is a third 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.

DELIVERY:

CSI maintains quantities of the 168L series S/D converter and can deliver small quantities from stock with balances to follow within 30 days. Consult factory for exact delivery schedules.

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ELECTRICAL SPECIFICATIONS:

PARAMETER	VALUE		
	168L200	168L300	168L100
<input type="checkbox"/> RESOLUTION, BITS:	10	12	14
<input type="checkbox"/> ACCURACY: ⁽¹⁾	±30 minutes	±8.5 minutes	±4 minutes ±.9LSB
<input type="checkbox"/> SYNCHRO INPUT RATES:			
MAXIMUM TRACKING RATE:	129,600°/sec	43,200°/sec	10,800°/sec
ACCELERATION FOR 1 LSB LAG: ⁽²⁾			
STANDARD:	1,000,000°/sec ²	88,000°/sec ²	6,600°/sec ²
MAXIMUM (on special order):	3,159,000°/sec ²	528,000°/sec ²	22,000°/sec ²
ACCELERATION CONSTANT-K _A : ⁽²⁾			
STANDARD:	3,000,000 sec ⁻²	1,000,000 sec ⁻²	300,000 sec ⁻²
MAXIMUM (on special order):	9,000,000 sec ⁻²	3,000,000 sec ⁻²	1,000,000 sec ⁻²
SETTLING TIME FOR 179° STEP:	10-20ms	20-40 ms	50-100 ms
<input type="checkbox"/> POWER SUPPLIES: ⁽³⁾			
+15VDC @ MAX (TYP) ma:	60(45)	60(45)	60(45)
-15VDC @ MAX (TYP) ma:	60(45)	60(45)	60(45)
+ 5VDC @ MAX (TYP) ma:			
TTL UNITS:	225(175)	225(175)	250(200)
LPTTL UNITS:	45(30)	45(30)	75(50)
LSTTL UNITS:	100(75)	100(75)	125(90)
<input type="checkbox"/> DIGITAL OUTPUTS: ⁽⁴⁾	Parallel Positive Natural Binary Angle Converter Busy, logic "1" = CB		
<input type="checkbox"/> DIGITAL INPUT: ⁽⁵⁾	Inhibit, logic "0" = INH		
<input type="checkbox"/> SYNCHRO/RESOLVER INPUTS: ⁽⁶⁾	11.8 Vrms L-L 2600Hz into 100K ohms 90 Vrms L-L 2600Hz into 800K ohms		
<input type="checkbox"/> REFERENCE INPUT:	10-130 Vrms 2600Hz into 400K ohms		
<input type="checkbox"/> INPUT TYPE: ⁽⁷⁾	Solid State Scott-T		
<input type="checkbox"/> OPERATING TEMPERATURE RANGES:	0° to 70°C (-55° to 105°C optional)		

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 available at specified carrier frequencies higher than 2600Hz; 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) LPTTL units: 3.2ma sink @ logic "0"
 - (c) LSTTL units: 8ma sink @ logic "0"
- (5) Fan-in: 15K ohm pull-up resistor to +5VDC, all models.
- (6) Other voltages available, 1-200V.
- (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 for 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, (e) 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 168L 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.

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LOGIC INPUTS/OUTPUTS—The 168L series is available with TTL, LPTTL, or LSTTL logic with load and drive capabilities as specified under Electrical Specifications. The Converter Busy (CB) output is a positive .2-1.0 μ second 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 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 2 μ seconds, (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 168L series has been optimized for 2600Hz excitation frequency in order to give ultra fast response. For specified excitation frequencies higher than 2600Hz improved dynamic performance can be obtained, i.e., higher acceleration rates and faster settling times. Consult factory for specific characteristics and part numbers. Operation to 5KHz (14 Bit) or to 10KHz (10 or 12 Bit) available.

THEORY OF OPERATION

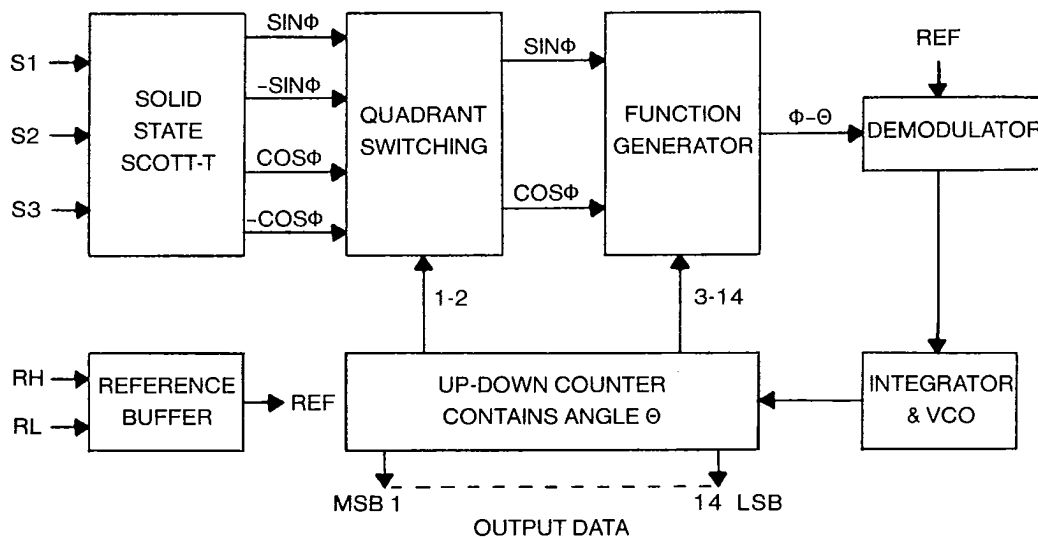
The synchro to digital converter determines the value of the input angle Φ (see block diagram) by comparing a digital feedback angle Θ with the synchro input angle. When the difference between the input angle and the feedback angle is zero, the output angle contained in the up-down counter is equal to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

The function Generator performs the trigonometric computation: $\sin(\Phi - \Theta) = (\sin\Phi\cos\Theta - \cos\Phi\sin\Theta)$

Note that for small angles, $\sin(\Phi - \Theta) \cong (\Phi - \Theta)$. 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.

$\Phi - \Theta$ 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 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.

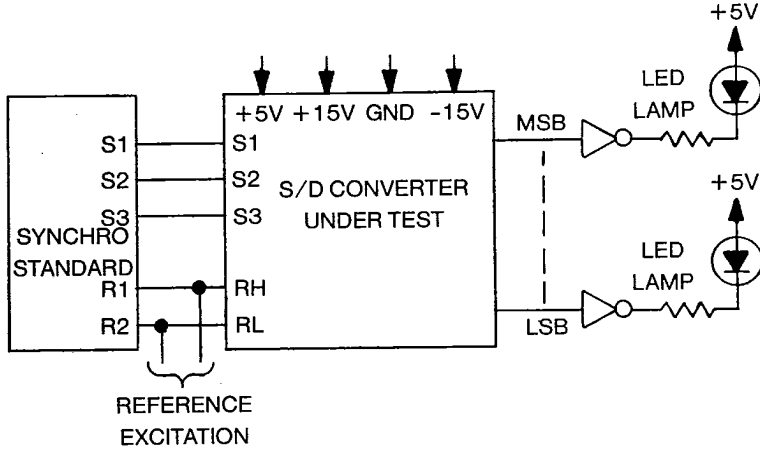
BLOCK DIAGRAM: (Figure 1)



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TESTING: (Figure 2)

Testing the 168L 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. reference supply and a display to read the digital output. The Synchro Standard is set to the test angles. The angles corresponding 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.

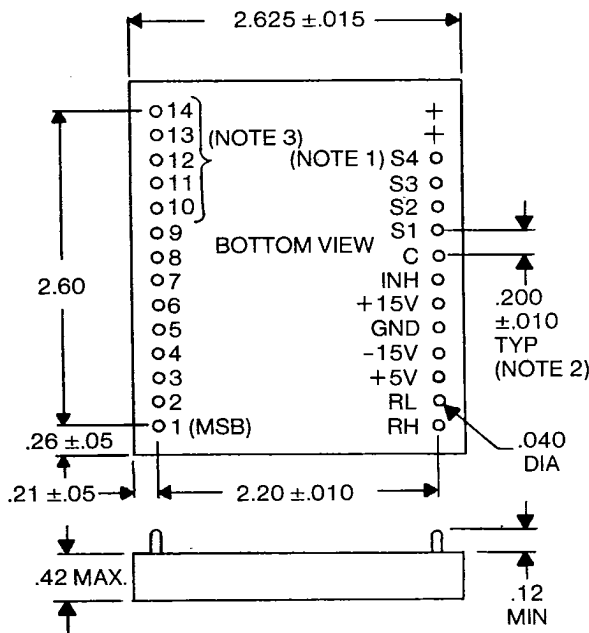


BIT WEIGHTS: (Figure 3)

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

CONFIGURATION: (Figure 4)



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

WEIGHT: 3.5 oz.

ORDERING INFORMATION (Figure 5)

168L 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
X04	SYNC	11.8V	LPTTL
X05	SYNC	90V	LPTTL
X06	RSVR	11.8V	LPTTL
X07	RSVR	90V	LPTTL
X08	SYNC	11.8V	LSTTL
X09	SYNC	90V	LSTTL
X10	RSVR	11.8V	LSTTL
X11	RSVR	90V	LSTTL

X in part number determines resolution

X = 1 for 14 bit converter

X = 2 for 10 bit converter

X = 3 for 12 bit converter

* For other input voltages, consult factory.

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

EXAMPLE: Part # 168L105ET would be a 14 bit synchro to digital converter with a 90V input, LPTTL logic and extended operating temperature range capability.

For multiple input option-consult factory.

WARRANTY:

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