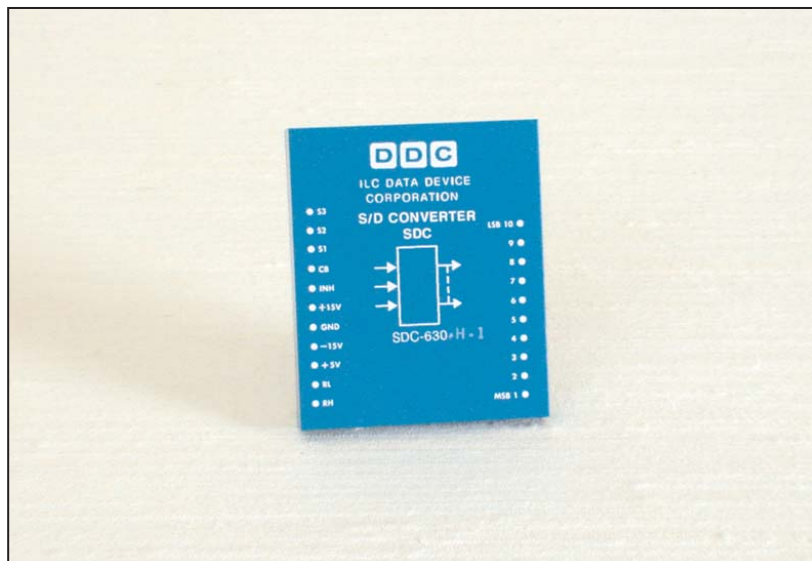


SDC-630/632/634\*

## 10-, 12-, 14-BIT SYNCHRO-TO-DIGITAL OR RESOLVER-TO-DIGITAL CONVERTER



### DESCRIPTION

The SDC-630/632/634 series are low cost, low profile Synchro-to-Digital (S/D) and Resolver-to-Digital (R/D) tracking converters with standard pin configurations. They use a unique control transformer algorithm that provides inherently higher accuracy and jitter-free output. Utilizing a type II servo loop, these converters have no velocity lag up to the specified tracking rate, and output data is always fresh and continuously available. Each unit is fully trimmed and requires no adjustment or field calibration.

### APPLICATIONS

These converters may be used wherever analog angle data from a synchro or resolver must be rapidly and accurately converted to digital form for transmission, storage or analysis. Because these units are extremely rugged and stable, and meet the requirements on MIL-STD-202E, they are suitable for the most severe industrial, commercial and military applications. Military ground support and avionics uses include ordnance control, radar tracking systems, navigation and collision avoidance systems.

\* Patented



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### FEATURES

- Standard Low Profile Converters with Optional Velocity Output
- Signal and Reference Input:
  - Internal Transformer Isolation
  - All Common L-L Levels and Frequencies
- Accuracy:
  - 10 Bit: 21 Minutes
  - 12 Bit: 8.5 Minutes
  - 14 Bit: 4 Minutes, 0.9 LSB or 2.6 Minutes (High Accuracy)
- Logic:
  - TTL Compatible
  - Parallel Binary Angle Output
- Power Required:
  - ±15 VDC and +5 VDC
- For new designs see DDC SDC-630/632/634\*A/ST Series

FOR MORE INFORMATION CONTACT:

Technical Support:  
1-800-DDC-5757 ext. 7771

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INPUT OPTIONS

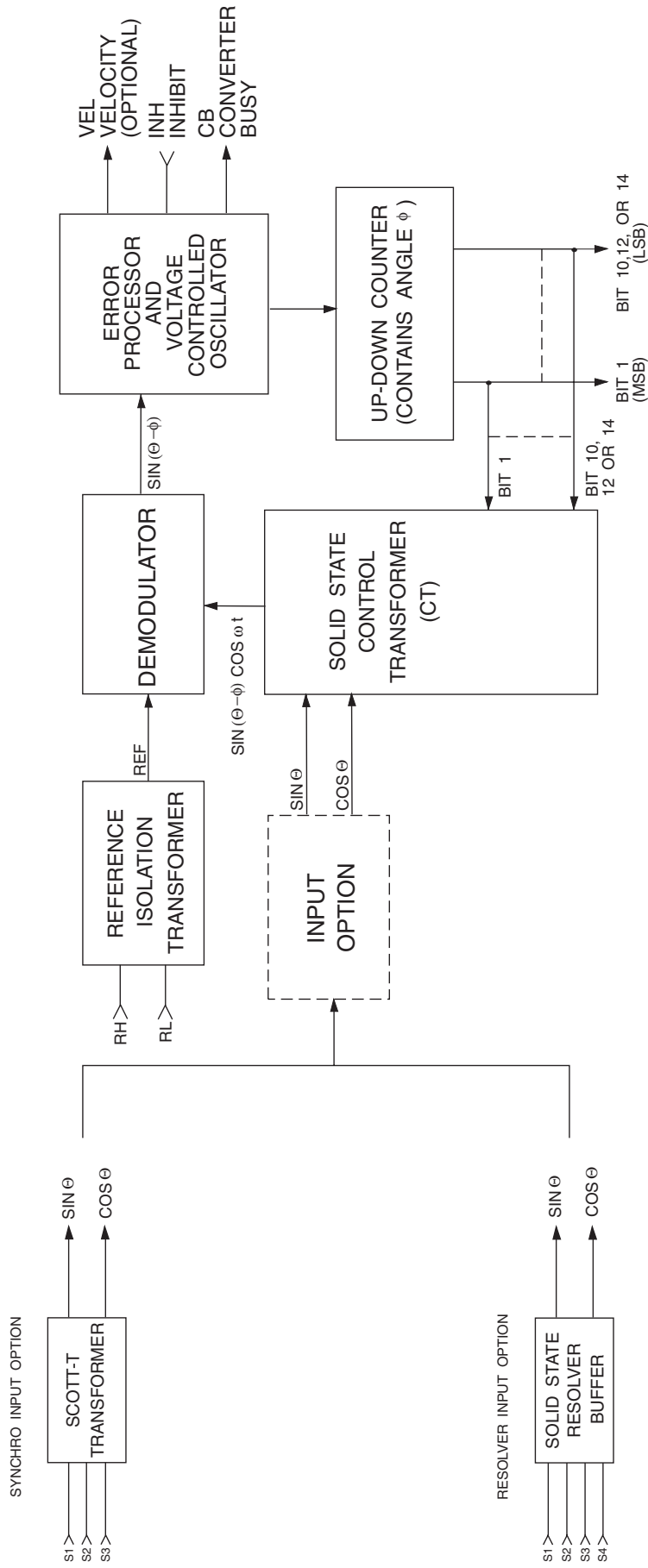


FIGURE 1. SDC-630/632/634 BLOCK DIAGRAM

**TABLE 1. SDC-630/632/634 SPECIFICATIONS**

(Apply over temperature range, power supply range, reference frequency and amplitude range, ±10% signal amplitude variation, and up to 10% harmonic distortion in the reference.)

PARAMETER	VALUE		
	SDC-630	SDC-632	SDC-634
<b>RESOLUTION</b>	10 bits	12 bits	14 bits
<b>ACCURACY</b> Standard Units High Accuracy Option	±21 min —	±8.5 min —	±4 min ±0.9 LSB ±2.6 min
<b>SIGNAL AND REFERENCE INPUT</b>	Signal Frequency Range	Signal Input Impedance (L-L Balanced, Resistive)	
Synchro Input* 90V L-L, 400 Hz (Option H) 90V L-L, 60 Hz (Option I) 11.8V L-L, 400 Hz (Option L)	350-1000 Hz 47-1000 Hz 350-1000 Hz	148 kΩ min 148 kΩ min 19 kΩ min	
Resolver Input* 90V L-L, 400 Hz (Option H) 26V L-L, 400 Hz (Option M) 11.8V L-L, 400 Hz (Option L)	350-1000 Hz 350-1000 Hz 350-1000 Hz	198 kΩ min 57 kΩ min 26 kΩ min	
<b>REFERENCE INPUT*</b>	Reference Voltage Range	Reference Input Impedance (Resistive)	
Options H, I Options M, L	40-150 Vrms 10-50 Vrms	300 kΩ min 80 kΩ min	
*Transformer Isolated. Other voltages and frequencies available on special order.			
<b>DIGITAL INPUT/OUTPUTS</b>			
Logic Type Inhibit Input (INH) Loading	TTL Logic "0" inhibits 0.2 Std. TTL loads plus 18 KΩ min pull-up resistor to +5V supply		
Outputs Type	Low power Schottky (can drive remote loads)		
10, 12, or 14 Parallel Data Bits	Natural Binary Angle; Positive logic		
Converter Busy (CB)	0.5 to 1.5 μsec positive pulse. Data changes on leading edge.		
Drive Capability	2 Std. TTL loads		
<b>VELOCITY OUTPUT (ON SPECIAL ORDER ONLY)</b>			
Type	Derived from an op-amp with low impedance output. Positive Output for increasing angle		
Voltage Range	10V Min		
Scale Factor (for SDC-634 - Others on Request) Options H, M, and L Option I	6V per rps nominal (10V = 15 rps) 3.3V per rps nominal (10V = 2.7 rps)		

**TABLE 1. SDC-630/632/634 SPECIFICATIONS (CONT.)**

(Apply over temperature range, power supply range, reference frequency and amplitude range, ±10% signal amplitude variation, and up to 10% harmonic distortion in the reference.)

PARAMETER	VALUE							
	Min		Typ		Min		Typ	
<b>DYNAMIC CHARACTERISTICS</b>								
Input Rate for Full Accuracy (Min Range) Options H, M, L (400 Hz) Option I (60 Hz)	0-22 rps		40		0-40 rps		50	
	0-8 rps		10		0-10 rps		12.5	
					0-1.25 rps		3	
Acceleration for 1 LSB Lag Options H, M, L (400 Hz) Option I (60 Hz)	12,600°/sec <sup>2</sup> typ		770°/sec <sup>2</sup> typ		4500°/sec <sup>2</sup> typ		295°/sec <sup>2</sup> typ	
610°/sec <sup>2</sup> typ					20°/sec <sup>2</sup> typ			
Settling Time For Normal Tracking (Up to Specified Input Rate) For 179° Step Change (Typical Values) Options H, M, L (400 Hz) Settling to 1 LSB Settling to Final Value Option I (60 Hz) Settling to 1 LSB Settling to Final Value	No lag error		No lag error		No lag error		No lag error	
	80 msec		100 msec		90 msec		110 msec	
	300 msec		500 msec		300 msec		360 msec	
					800 msec		1000 msec	
Velocity Constant (Type II servo loop)	K <sub>V</sub> =∞		K <sub>V</sub> =∞		K <sub>V</sub> =∞		K <sub>V</sub> =∞	
Acceleration Constant (Nominal Values) Options H, M, L (400 Hz) Option I (60 Hz)	K <sub>a</sub> =36,000sec <sup>2</sup>		K <sub>a</sub> =2,200sec <sup>2</sup>		K <sub>a</sub> =54,000sec <sup>2</sup>		K <sub>a</sub> =3,600sec <sup>2</sup>	
					K <sub>a</sub> =27,800sec <sup>2</sup>		K <sub>a</sub> =900sec <sup>2</sup>	
<b>POWER SUPPLIES</b>								
Nominal Voltage	+15 V Supply		-15 V Supply		+5 V Supply			
Voltage Range	+11 to +16.5 V		-11 to -16.5 V		+4.5 to +5.5 V			
Maximum Voltage Without Damage	+18 V		-18 V		+7 V			
Current								
SDC-630 (632) Typical	8 mA		(4)		18 mA		(18)	
Maximum	13 mA		(6)		30 mA		(30)	
SDC-634 Typical	10 mA				20 mA		100 mA	
Maximum	15 mA				30 mA		150 mA	
<b>TEMPERATURE RANGES</b>								
Operating								
-1 Option					-55°C to +105°C			
-3 Option					0°C to +70°C			
Storage					-55°C to +125°C			
<b>PHYSICAL CHARACTERISTICS</b>								
Size (Encapsulated Module)					3.125 x 2.625 x 0.43 inches		(7.94 x 6.67 x 1.07 cm)	
Weight					4 oz		(113 gm.)	

## TECHNICAL INFORMATION

### TIMING

FIGURE 2 shows the timing waveforms of the converter. Whenever an input angle change occurs, the converter changes the digital angle in steps of 1 LSB, and generates a converter busy impulse (CB). The CB is a positive pulse 0.5 to 1.5µsec long. Data changes on the leading edge of the CB pulse, and data can be transferred 0.5µsec after the leading edge.

The simplest method of interfacing with a computer is to transfer data at a fixed time interval after the inhibit is applied. The converter will ignore an inhibit applied during the “busy” interval until that interval is over. Timing is as follows: (a) apply the inhibit, (b) wait 0.5µsec, (c) transfer the data, and (d) release the inhibit. Extra CB pulses will not occur if the input angle changes while the counter is locked by the INH.

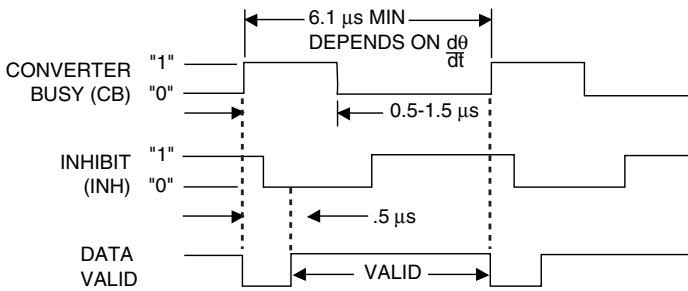


FIGURE 2. SDC-630/632/634 TIMING DIAGRAM

### DYNAMIC PERFORMANCE

A type II servo loop ( $KV = \infty$ ) and very high acceleration constants give these converters superior dynamic performance, as listed in the specifications. If the power supply voltages are not the +15 VDC nominal values, the specified input rates for full accuracy will increase or decrease in proportion to the fractional change in voltage. The +15 V supply voltage will determine the positive maximum velocity, and the -15 V supply voltage will determine the negative maximum velocity.

So long as the maximum tracking rate is not exceeded, there will be no lag in the converter output. If a step input occurs, as is likely when the power is initially turned on, the response will be critically damped. FIGURE 3 shows the response to a step input. After initial slewing at the maximum tracking rate of the converter, there is one overshoot which is inherent to a Type II servo. The overshoot settling to a final value is a function of the small signal settling time.

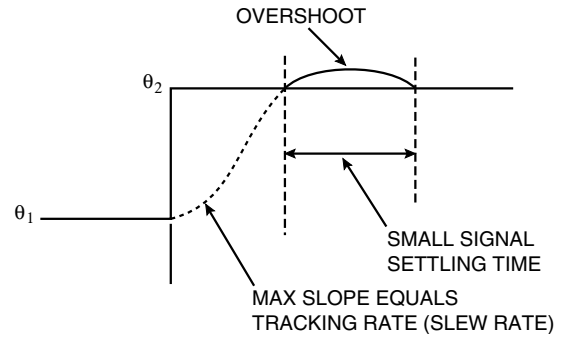


FIGURE 3. RESPONSE TO A STEP INPUT

The nominal open loop transfer function is given by

$$G = \frac{A^2 \left( \frac{S}{B} + 1 \right)}{S^2 \left( \frac{S}{10B} + 1 \right)}$$

where the parameters A and B are:

TABLE 2. TRANSFER FUNCTION PARAMETERS				
		SDC-630	SDC-632	SDC-634
400 Hz	A	190 sec <sup>-1</sup>	226 sec <sup>-1</sup>	167 sec <sup>-1</sup>
	B	91 sec <sup>-1</sup>	100 sec <sup>-1</sup>	56 sec <sup>-1</sup>
60 Hz	A	46 sec <sup>-1</sup>	58 sec <sup>-1</sup>	30 sec <sup>-1</sup>
	B	23 sec <sup>-1</sup>	26 sec <sup>-1</sup>	10 sec <sup>-1</sup>

### POWER SUPPLIES

The main power supplies can vary over their specified ranges with no change in the converter specifications except for a proportional change in the maximum tracking rates.

When testing or evaluating the converters, it is advisable to limit the current to each of the three power supplies. Set each limit to 50% greater than the maximum current listed for that supply in the specifications table.

### TRANSFORMER INPUT

To prevent damage to the input transformers, the maximum steady state voltage should not exceed the specified input voltage by more than 30%. The maximum common mode voltage (DC plus recurrent AC peak) should not exceed 500 V.

## ACCOMMODATING NON-STANDARD INPUT VOLTAGES

The signal and reference input levels of the SDC-630 series can be resistively scaled to accommodate non-standard voltages. A converter should be selected that is the next lower standard voltage and the voltage is then scaled up with resistors in series with the synchro and/or reference inputs.

For a synchro input (SDC), a resistor  $R_{SIG}$  is added in series with S1, S2 and S3, which is determined as follows:

$$R_{SIG} = 1.11K (\text{New L-L Voltage} - \text{Standard Unit Voltage})$$

That is, 1.11K for each volt above that for which the standard unit is designed.

Example: An SDC-634-L (11.8V) is to be used at 50V L-L.

$$R_{SIG} = 1.11K (50-11.8) = 42.4K$$

The closest available high grade resistor with a low temperature coefficient of resistance should be used, and the three resistors should be matched to each other as closely as possible. In general, a 0.1% difference will introduce 1.7 arc minutes of additional error due to the effect on  $\frac{\sin}{\cos}$  ratio relationship.

The ABSOLUTE value of the resistor is not critical.

In the case of the RESOLVER version (RDC), the equation is:

$$R_{SIG} = 2.2K (\text{New L-L level} - \text{Standard Unit L-L level})$$

The calculated resistors are connected in series with S1 and S2 respectively. Note only two resistors are required. The required resistor matching and its effect on accuracy, is the same as for a synchro input (See FIGURE 4).

The Reference Voltage treatment is similar, but the value selected is not critical.

$$R_{Ref} = 2.8K (\text{New Ref} - \text{Standard Ref})$$

Here, even a 10% tolerance is adequate.

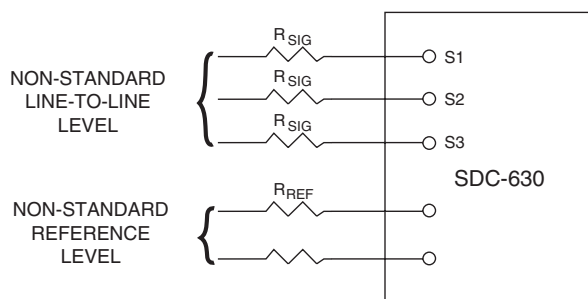
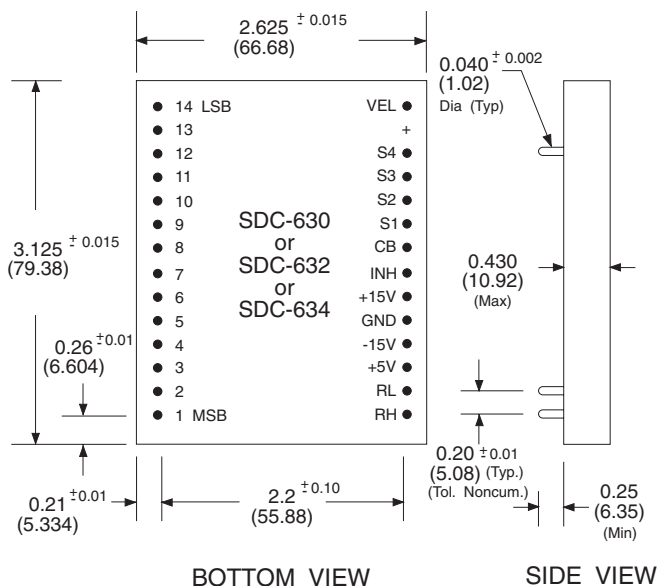


FIGURE 4. SIGNAL AND REFERENCE SCALING

Dimensions in inches (mm).



Notes:

1. Pin material is electroplated brass per MIL-F-14072, M222.
2. Case material is glass filled Diallyl Phthalate per MIL-M-14, Type SDG-F.
3. Pins 13 and 14 are omitted for SDC-632, and pins 11, 12, 13, and 14 are omitted for SDC-630.
4. Velocity output pin VEL is present only if requested on special order.
5. Pin S4 is present on Resolver units, and omitted on Synchro units.

FIGURE 5. SDC-630/632/634 MECHANICAL OUTLINE

## ORDERING INFORMATION

XXX-XXX-X-X-X-X

**Reliability Grade:**

R = Enhanced Reliability (Note 1)

**Accuracy:**

a = High Accuracy Version, ±2.6 Minutes (SDC-634 Only)

**Temperature Range:**

1 = -55°C to +105°C

3 = 0°C to +70°C

**Signal Input Voltage and Frequency:**

H = 90 V<sub>L-L</sub>, 400 Hz (Synchro or Resolver)

I = 90 V<sub>L-L</sub>, 60 Hz (Synchro Only)

M = 26 V<sub>L-L</sub>, 400 Hz (Resolver Only)

L = 11.8 V<sub>L-L</sub>, 400 Hz (Synchro or Resolver)

**Resolution:**

634 = 14 bits

632 = 12 bits

630 = 10 bits

**Input Type:**

SDC = Synchro

RDC = Resolver

Note 1. R version only available in -55°C to 105°C temperature range (Option 1). Enhanced reliability processing provides an additional 160 hour, 105° C burn-in and temperature cycling in accordance with MIL-STD-202.

Available Sockets

P/N 9010 = socket to barrel ends for soldering direct to socket pins

P/N 9046 = socket to pin ends to solder socket to PCB

P/N 9050 = socket to wire wrap pins

STANDARD DDC PROCESSING FOR DISCRETE MODULES/PC BOARD ASSEMBLIES		
TEST	METHOD(S)	CONDITION(S)
INSPECTION / WORKMANSHIP	IPC-A-610	Class 3
ELECTRICAL TEST	DDC ATP	—

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