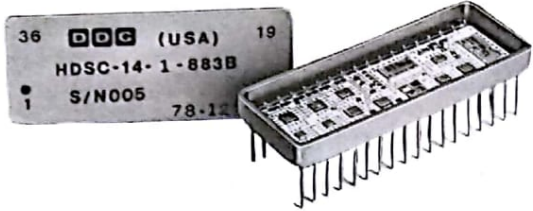


HDSC-14*



14 BIT HYBRID D/S AND D/R CONVERTER Generates Sin/Cos DC or Rotating PPI Sweep

FEATURES

- ONE HYBRID MODULE CONTAINS COMPLETE D/S AND D/R CONVERTER
- PIN PROGRAMMABLE FOR SYNCHRO OR RESOLVER OUTPUT
- VERSATILE FUNCTION MODULE WITH MANY APPLICATIONS BECAUSE D.C. COUPLED REFERENCE ACCEPTS ANY WAVEFORM
- ACCURACY: ± 4 minutes
- LOGIC: CMOS and TTL compatible
Parallel binary angle input
- POWER REQUIRED: $\pm 15V$ DC and logic voltage supply

DESCRIPTION

The HDSC-14* is a versatile multiplying digital-to-analog converter. The digital input represents angle and the output is pin programmable either for resolver type sin/cos or for three-line synchro output. The reference input will accept any waveform, even a sawtooth for CRT drive. Because the reference is D.C. coupled to the output, the HDSC-14 can be used in many configurations:

With a synchro or resolver reference input, the HDSC-14 is a digital-to-synchro or digital-to-resolver converter.

With a D.C. reference input, the unit can be used as a hybrid digital-to-sin/cos DC converter.

With the reference input proportional to the radius vector, the HDSC-14 converts polar to rectangular coordinates.

With a sawtooth reference input and a rotating digital input, the module can generate a cartwheel rotating sweep for PPI displays.

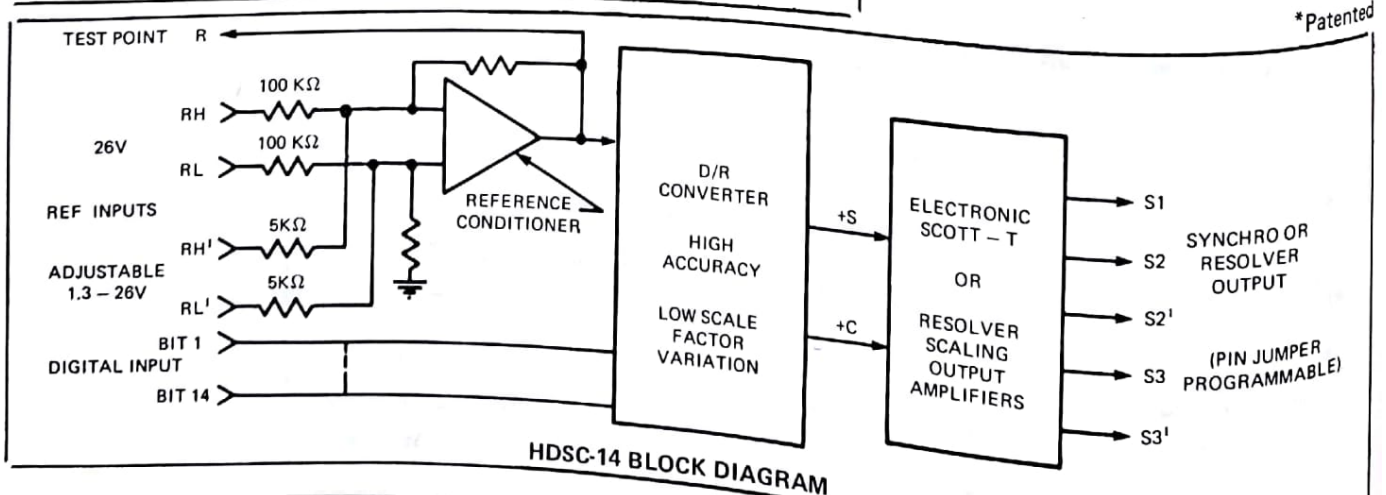
Packaged in a 36 pin double DIP, the HDSC-14 is the only D/S and D/R converter complete in one hybrid module.

Hybrid technology results in low weight, low power consumption, very high reliability, and a wider operating temperature range. A new, improved circuit design allows higher accuracy and reduces the output scale factor so that the output can drive displays directly. The output line-to-line voltage can be scaled by external resistors. Other features include high AC and DC common mode rejection at the reference input and output short circuit protection.

APPLICATIONS

Because of its high reliability, small size and low power consumption, the hybrid HDSC-14 is ideal for remotely located and hard to access equipment, and suited to the most stringent and severe industrial and military ground or avionics applications. All units are processed to MIL-STD-883 Class C, with Class B processing as a standard option.

Among the many possible applications are computer based systems in which digital information is processed, such as simulators, flight trainers, flight instrumentation, fire control systems, radar and navigation systems, and PPI displays including moving target indicators.



*Patented

SPECIFICATIONS

Apply over temperature range, power supply ranges, reference voltage and frequency range and 10% harmonic distortion in the reference.

PARAMETER	VALUE						
Resolution	14 bits						
ACCURACY AND DYNAMICS							
Output Accuracy	±4 minutes						
Differential Linearity	±1 LSB max						
Output Setting Time	Less than 20 μsec for any digital step change						
DIGITAL INPUT							
Logic Type	Natural binary angle, parallel positive logic CMOS and TTL compatible Inputs are CMOS transient protected. Each input has a 20-80 KΩ pull-up resistor to V _L						
Logic Voltage Level V _L	V = +4.5 V to +13 V Logic 0 = 0 to +0.2 V _L Logic 1 = 0.8 V _L to V _L						
Load Current	±1 μA max plus pull-up resistor current						
REFERENCE INPUT							
Type	Two differential solid state inputs, one for standard 26V input and one programmable						
Frequency Range	DC to 1000 Hz (to 10 KHz with reduced accuracy)						
Voltage	<table border="0"> <tr> <td>Standard Input</td> <td>Programmable Input</td> </tr> <tr> <td>26V ±10%</td> <td>1.3V min for full output</td> </tr> <tr> <td></td> <td>High voltages are scaled by adding two series resistors</td> </tr> </table>	Standard Input	Programmable Input	26V ±10%	1.3V min for full output		High voltages are scaled by adding two series resistors
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26V ±10%	1.3V min for full output						
	High voltages are scaled by adding two series resistors						
Input Impedance							
Single Ended	100 KΩ ±0.5%						
Differential	200 KΩ ±5% 5 KΩ ±0.5% 10 KΩ ±0.5%						
ANALOG OUTPUT							
Type	Pin programmable for synchro or resolver made						
Output Current	2 mA rms max						
Max Output Voltage (Tracks Reference Input Voltage)	11.8V rms L-L ±0.4% nominal in synchro mode 6.81V rms L-L ±0.4% nominal in resolver mode						
Scale Factor Variation	Simultaneous amplitude variation in all output lines as a function of digital angle is ±0.2% max						
D.C. Offset Each Line to Gnd	±50 mV max. Varies with input angle						
Short Circuit Protection	Fully protected						
POWER SUPPLIES							
Voltage	±15V -15V Logic Voltage V _L						
Voltage Limits	±5% ±5% +4.5V to 13V						
Max Voltage Without Damage	+18V -18V +15V						
Current or Impedance	30 mA max 30 mA max Z _{IN} = 1.5 KΩ min						
TEMPERATURE RANGES							
Operating	-55° C to +125° C						
-1 Option	0° C to +70° C						
-3 Option	-55° C to +135° C						
Storage							
PHYSICAL CHARACTERISTICS							
Type	36 pin double DIP						
Size	0.78 x 1.9 x 0.21 inch (2.0 x 4.8 x 0.53 cm)						
Weight	0.85 oz (24g)						

output is either amplified by scaling amplifiers for resolver output, or is both amplified and converted to a synchro output by an electronic Scott-T. In both cases, the output line currents are limited to 2 mA rms max, which is sufficient for driving S/D converters, solid state control-transformers, and displays. Output power amplifiers will be required, however, for a driving electro-mechanical devices such as synchros and resolvers.

The reference conditioner has a differential input with high AC and DC common mode rejection, so that a reference isolation transformer will seldom be required. There are two sets of reference inputs. The RH, RL input provides the maximum synchro or resolver output voltage for a standard 26V rms reference input. The RH', RL' input is used to scale the output for other reference voltage levels. Series resistors can be added to the reference input as described below either to accommodate lower reference levels for full output, or to reduce the output level.

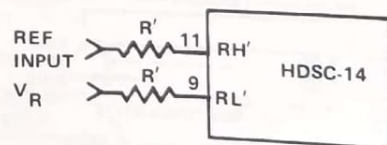
The reference conditioner output R is intended for test purposes. A signal between 2V and 2.5V at R indicates that a reference input signal is present.

OUTPUT SCALING AND REF. LEVEL ADJUSTMENT

The HDSC-14 operates like a multiplying D/A converter in that the voltage of each output line is directly proportional to the reference voltage.

The maximum line-to-line levels are determined by the output amplifiers and are nominally 11.8V for synchro output and 6.81V for resolver output. The RH, RL reference input is designed to provide this nominal output for the standard 26V reference level. The scaling adjustment is made by two internal 100 KΩ resistors in series with the reference conditioner input (see HDSC-14 Block Diagram). The maximum output levels without distortion are 10% greater than the nominal 11.8V and 6.81V levels.

The RH', RL' reference input has only 5 KΩ internal resistors in series with the reference conditioner input, so that nominal line-to-line output is obtained for a reference input of 1.3V. For higher reference voltages, two resistors R' must be inserted in series with the inputs as shown below. These resistors scale the HDSC-14 outputs down to the nominal 11.8V and 6.81V levels stated above, or to lower voltages if desired. The magnitude of the resistors R' in ohms is calculated as follows:



$$R' = \frac{5000}{1.3} (V_R - 1.3) \left(\frac{\text{NOMINAL L-L VOLTAGE LEVEL}}{\text{DESIRED L-L VOLTAGE LEVEL}} \right)$$

OUTPUT PHASING AND OUTPUT SCALE FACTOR

The analog output signals have the following phasing:
Synchro output

$$\begin{aligned} S3 - S1 &= (RH-RL) A_0 (1 + A(\theta)) \sin \theta \\ S2 - S3 &= (RH-RL) A_0 (1 + A(\theta)) \sin (\theta + 120^\circ) \\ S1 - S2 &= (RH-RL) A_0 (1 + A(\theta)) \sin (\theta + 240^\circ) \end{aligned}$$

Resolver output

$$\begin{aligned} S3 &= (RH-RL) A_0 (1 + A(\theta)) \sin \theta \\ S2 &= (RH-RL) A_0 (1 + A(\theta)) \cos \theta \end{aligned}$$

TECHNICAL INFORMATION

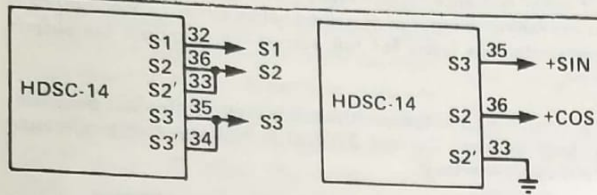
INTRODUCTION

As shown in the block diagram the signal conversion in the HDSC-14 is performed by a high accuracy digital to resolver converter whose sin and cos outputs have a low scale factor variation as a function of the digital input angle. This resolver

HDSC-14

The output amplitudes simultaneously track reference voltage fluctuations because they are proportional to (RH-RL). The amplitude factor A_0 is 11.8/26 for 11.8V rms L-L output. The maximum variation in A_0 from all causes is $\pm 0.2\%$. The term $A(\theta)$ represents the variation of the amplitude with the digital input angle. $A(\theta)$, which is called the scale factor variation, is a smooth function of θ without discontinuities and is less than $\pm 0.2\%$ for all values of θ . The total maximum variation in $A_0(1 + A(\theta))$ is therefore $\pm 0.4\%$.

Because the amplitude factor (RH-RL) $A_0(1 + A(\theta))$ varies simultaneously on all output lines, it will not be a source of error when the HDSC-14 is to drive a ratiometric system such as a synchro or resolver. However, if the outputs are used independently, as in X-Y plotters, the amplitude variations must be taken into account.



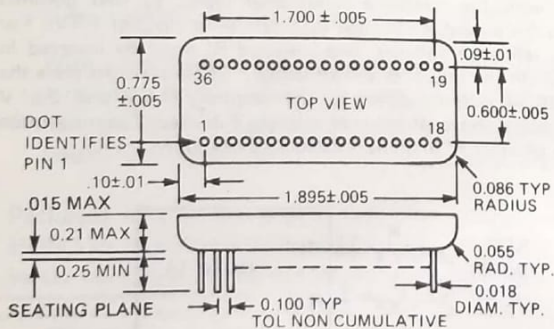
SYNCHRO OUTPUT RESOLVER OUTPUT
OUTPUT PIN PROGRAMMING

RELIABILITY

The use of MSI and thin film resistor networks, as well as careful thermal design, results in very high MTBF values. Summaries of MTBF calculations are available on request.

All HDSC-14 hybrids are built in accordance with requirements of MIL-STD-883 and are screened as shown in our Processing Flow Chart. This screening is based on the requirements of Method 5008 except for burn in, which is optional. To specify pre-burn in tests and burn in, add 883B to the part number. The computed MTBF value for MIL-STD-883B processing (including burn in) is 1,320,000 hours, Ground Fixed, at 25°C.

MECHANICAL OUTLINE



PACKAGE IS KOVAR WITH ELECTROLESS NICKEL PLATING
PINS ARE KOVAR WITH GOLD PLATING: (50 μ INCH MIN).
CASE IS ELECTRICALLY FLOATING

PIN CONNECTION TABLE

Pin	Name	Pin	Name	Pin	Name
1	TR	13	BIT 13	25	BIT 1 (MSB)
2	+15V	14	BIT 12	26	NC
3	GND	15	BIT 11	27	TP1
4	-15V	16	BIT 10	28	TP2
5	TP6 (-10V)	17	BIT 9	29	TP3
6	VL	18	BIT 8	30	TP4
7	TP7 (R)	19	BIT 7	31	TP5
8	RL	20	BIT 6	32	S1
9	RL'	21	BIT 5	33	S2'
10	RH	22	BIT 4	34	S3'
11	RH'	23	BIT 3	35	S3 (+SIN)
12	BIT 14 (LSB)	24	BIT 2	36	S2 (+COS)

NOTES:

1. Test points TP1 through TP5 are for factory use only.
2. Test point TP6 (-10V) can be used in situations requiring lower power supply voltages and lower output voltage. Consult factory for further information.
3. Test point TP7 (R) can be used for test purposes to detect whether a reference signal is present. See block diagram.

ORDERING INFORMATION

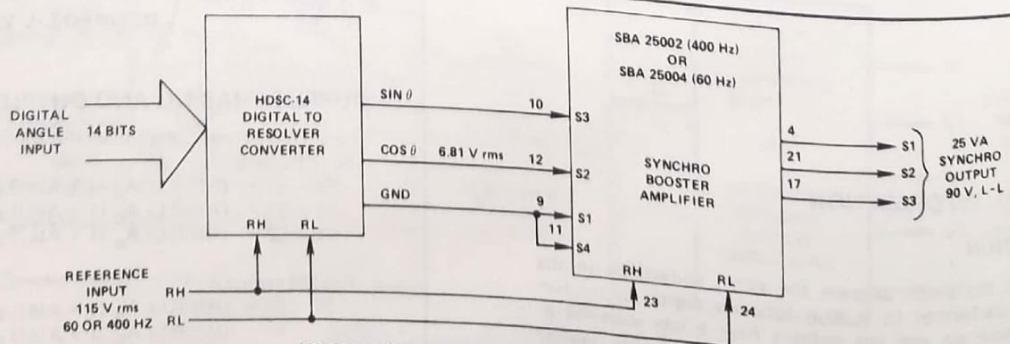
HDSC - 14 - 1 - 883B

MIL-STD-883 Processing:
883B = Conforms to MIL-STD-883B,
DDC procedures
Blank = Same, except pre burn in test
and burn in are omitted.

Operating Temperature Ranges (Ambient):
1 = -55°C to +125°C
3 = 0°C to +70°C

APPLICATION NOTE

The HDSC-14 can directly drive our Synchro Booster Amplifiers (Models SBA 25002 and 25004). The diagram below shows how to interconnect these two products.



HDSC-14/SBA CONNECTION DIAGRAM