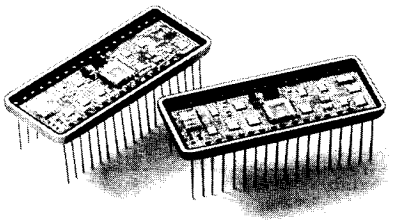
HSCDX-14*

14 BIT HYBRID CONTROL DIFFERENTIAL TRANSMITTER



DESCRIPTION

The HSCDX-14* series are the smallest solid state control differential transmitters available. They are high reliability units consisting of two 36 pin double DIP packages.

Input isolation transformers are available but will seldom be required because the solid state signal input is true differential with high AC and DC common mode rejection. The AC analog output signals are the sin and cos of the difference between the synchro or resolver angle input and the digital angle input, modulated by the carrier frequency.

The HSCDX-14 is part of Data Device Corporation's second generation of hybrid synchro-digital conversion products, which includes S/D converters, D/S converters, control transformers, and multi-speed converters.

APPLICATIONS

Control differential transmitters (CDX) subtract digital angles from analog synchro or resolver angles. They are used to provide angle offsets or correction angles when a resolver or synchro type output is required, and are especially adapted to computer controlled systems.

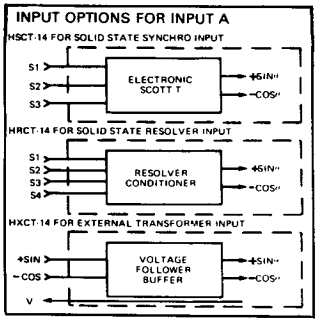
Because of their small size and low power requirements, the HSCDX-14 series of control differential transmitters is especially ideal for remotely located and hard to access equipment where high MTBF is critical. They are well suited to the most stringent and severe industrial or military ground and avionics applications. In conjunction with other devices, they are readily adapted for closed loop control. Designed for printed circuit board mounting by standard techniques, the HSCDX-14 can be readily incorporated into other equipment by the OEM user.

FEATURES

- *ACCURACY:*
  ±4 Minutes Normal Accuracy
  ±2 Minutes High Accuracy
- *SIGNAL AND REF. INPUTS:*
  Internal solid state isolation or external isolation transformers
  All common L-L voltage levels and frequencies
- *LOGIC INPUT:*
  TTL and CMOS compatible
  14 bit parallel binary angle
- *POWER REQUIRED:*
  +15V DC and logic voltage supply

*Patented

I



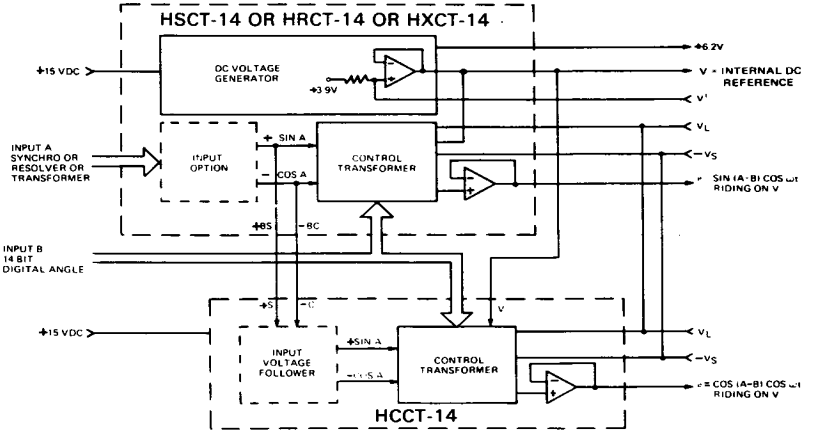


FIGURE 1. BLOCK DIAGRAM

TECHNICAL INFORMATION

1. INTRODUCTION

As shown in the block diagram Figure 1, the HSCDX-14 control differential transmitter consists of two control transformer modules. One module is a complete unit with an input option, DC voltage generator, and a sin output. This module, with synchro, resolver, or transformer input, is called the HSCT-14 series and is described in a separate data sheet. The second HSCDX-14 module is a cos output control transformer and is called the HCCT-14. It relies on the first module for input conditioning and for DC voltage transformation.

The HSCDX-14 has two inputs: an analog synchro or resolver signal, and a 14 bit digital angle. It provides two AC outputs which are the sin and cos respectively of the difference between the synchro or resolver angle A and the digital angle B. The outputs ride on the internal D.C. Reference V and are modulated at the carrier freguency.

Power for the internal CMOS logic in both units must be provided at pins V_L. The user connects pin V_L to the +6.2V internal power supply when the external logic supply voltage is less than 6.2V, and to the external logic supply when the logic voltage is $\geq$6.2V.

Pin $-V_S$ provides the negative power supply voltage for the internal op-amps. This voltage is usually chosen to be either 0 to minimize power consumption, or −7V to optimize the common mode voltage or voltage range of the input option. Pin V' is used to bring the internal analog ground to normal ground potential when V_L = 6.2V and $-V_S$ = −7V.

As indicated in Figure 1, there are three types of input options: an electronic Scott-T for direct synchro input (HSCDX); a signal conditioner for direct resolver input (HRCDX); and a voltage follower buffer (HXCDX). Depending on the line voltage, there are actually six possible options: two HSCDX, three HRCDX, and one HXCDX. The HXCDX input requires an external signal conditioner such as a synchro or resolver isolation transformer or a solid state buffer.

Interconnection layout is not critical. The analog outputs are derived from op-amps, have low output impedance, and are short circuit proof.

2. POWER SUPPLIES

Two power supplies are required: +15 VDC nominal supply and a logic voltage supply V_L. The +15V supply can vary from +11 to +16.5V with no change in the specifications. The logic supply voltage can range from +4.5V to the voltage of the +15V supply. The logic supply is used in two ways, depending on the nature of the digital logic. When the digital input logic is TTL or DTL, current is drawn from the logic supply by 22K pull-up resistors (see Figure 2). When the logic supply voltage is greater than 6.2V, the logic supply must provide power to drive the internal CMOS logic through pin V_L.

A power supply for $-V_S$, which supplies the negative power supply voltages for the internal op-amps, is optional. $-V_S$ may be any voltage between ground and a negative voltage fifteen volts less than the positive logic supply voltage V_L. For instance, if V_L = 6.2V, $-V_S$ can range from 0V to −8.8V. For minimum power dissipation, $-V_S$ is connected to normal ground, and no connection is made to V'. The internal ground will then be at 3.9V. As $-V_S$ is made more negative, the common mode of the solid state input options HSCT-14 and HRCT-14 increases, the input voltage range of the buffer input option HXCT-14 increases, and the voltage of the internal ground V may be decreased. If V_L = 6.2V and $-V_S$ = −7V, V' may be grounded so that V is at normal ground potential. The solid state input common mode, the buffer input voltage range, and the power consumed will all be increased as indicated in the specifications table.

While testing or evaluating the HSCDX-14 series, it is advisable to limit the power supply currents. Limit the +15V supply current to 75 mA, and the logic supply current to 5 mA. Power supply transients greater than 18V may damage the module.

SPECIFICATIONS

For listed temperature, power supply, and signal amplitude ranges.

PARAMETER	VALUE
RESOLUTION	14 bits
ACCURACY	
Normal Accuracy	±4 minutes max
High Accuracy Option "a"	±2 minutes max
SOLID STATE BUFFER INPUT (HSCDX AND HRCDX UNITS)	
Carrier Frequency Range	47 – 1000 Hz
Synchro and Resolver Input Characteristics	
Voltage Options and Minimum Input Impedance (Balanced)	
Synchro (HSCDX)	Z_{IN} Line to Line / Z_{IN}, Each Line to GND
90V L-L (Option H)	130 KΩ / 85 KΩ
11.8V L-L (Option L)	17.5 KΩ / 11.5 KΩ
Resolver (HRCDX)	Z_{IN} Single Ended / Z_{IN} Differential / Z_{IN}, Each Line to GND
90V L-L (Option H)	175 KΩ / 350 KΩ / 175 KΩ
26V L-L (Option M)	50 KΩ / 100 KΩ / 50 KΩ
11.8V L-L (Option L)	23 KΩ / 46 KΩ / 23 KΩ
Common Mode Range (DC Common Mode Plus Recurrent AC Peak)	
	$-V_S$ = 0V / V_L = +6.2V and $-V_S$ = −7V
90V L-L (Option H)	150V max / 300V max
26V L-L (Option M)	45V max / 90V max
11.8V L-L (Option L)	20V max / 60V max
VOLTAGE FOLLOWER INPUT (FOR TRANSFORMER UNITS)	
HXCT Input Characteristics	
Carrier Frequency Range	47 – 1000 Hz
Voltage Range	
$-V_S$ = 0V	1V rms nominal; 1.15V max; 0.1V min
V_L = +6.2 and $-V_S$ = −7V	3V rms nominal; 3.5V max; 0.1V min
Max Voltage Without Damage	15V rms continuous
	100V peak transient
Input Impedance	Z_{IN} > 10 MΩ (transient protected voltage follower)
TRANSFORMER CHARACTERISTICS	
400 Hz SIGNAL TRANSFORMER	
Carrier Frequency Range	360 – 1000 Hz
Minimum Input Impedances (Balanced)	
	Synchro Z_{IN} (Z_{SO}) / Resolver Z_{IN}
90V L-L (Option 4H)	180 KΩ / 100 KΩ
26V L-L (Option 4M)	– / 30 KΩ
11.8V L-L (Option 4L)	20 KΩ / 30 KΩ
Breakdown Voltage to GND	700V peak
60 Hz SIGNAL TRANSFORMER	
Carrier Frequency Range	47 – 440 Hz
Input Voltage Range	10 – 100V rms L-L; 90V rms L-L nominal
Input Impedance	148 KΩ min L-L balanced resistive
Input Common Mode Voltages	±500V rms, transformer isolated
Output Description	Resolver output, +sin (+S) and −cos (−C) derived from op-amps. Short circuit proof.
Output Voltage	1.0V rms nominal riding on DC reference V. Output voltage level tracks input level.
Power Required	4 mA typ, 7 mA max from +15V supply
DIGITAL INPUT	
Logic Type	TTL/DTL/CMOS compatible, depending on logic supply voltage
Coding	Natural binary angle; positive logic
Number of Bits	14
Loading	±1μA max (transient protected CMOS)
ANALOG OUTPUTS	
Outputs e:	
$e = +\sin(A-B)\cos\omega t$ and $e = +\cos(A-B)\cos\omega t$	A = Synchro or resolver input angle; B = digital input angle; ω = signal carrier frequency
Scale Factor Error	±2% max (absolute error, not a function of angle)
Scale Factor Variation With Digital Angle B	±0.25% max
Maximum Output	1V rms (operates over full ±180° range of (A-B))
DC Offset	±25 mV max (varies smoothly as function of digital angle B)

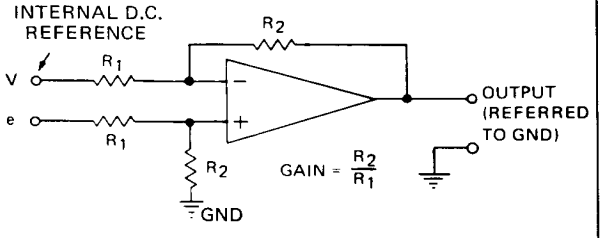
PARAMETER	VALUE
ANALOG OUTPUTS (Cont'd)	
Internal D.C. Reference V	
Voltage	3.9 VDC nominal when $-V_S = 0$. Can be set to zero for suitable $-V_S$ voltage levels.
Current Capability	±1 mA
Bias Voltage	
Voltage	6.2VDC
Current Capability	±0.1 mA
Buffered +Sin A and −Cos A (+BS and −BC)	
Voltage Level	1V rms nominal
Current Capability	±1 mA
DYNAMIC CHARACTERISTICS	
Input Rate	Maximum conversion rate limited only by rate at which digital input changes
Settling Time	
For Normal Tracking	No lag error
For 179° step change	10μs to final value
TEMPERATURE RANGE	
Operating	
−1 Option	−55°C to +125°C
−3 Option	0°C to 70°C
Storage	−55°C to +135°C

POWER SUPPLIES

	+15 VDC	Logic Supply	−VS (Optional)
Voltage Limits	+11V to +16.5V	+4.5V to +15 supply voltage	0 to (V_L − 15V)
Max Voltage Without Damage	+18V	+18V	−(18V-V_L)
Current or Impedance	+50 mA* max	Z_{IN} = 5 KΩ min	−50 mA* max

*Does not include current required by 60 Hz active transformer.

PHYSICAL CHARACTERISTICS	
Converter Modules (Two)	
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	1 oz max (28 g)
400 Hz Transformer Modules	
Type	Encapsulated module. Signal input uses 2 modules (T1A and T2B). Ref uses 1 module (T2).
Size	0.8 x 0.6 x 0.3 inch (2 x 1.5 x 0.8 cm)
Weight	0.4 oz max (11 g)
60 Hz Transformer Modules	
Type	Encapsulated module. Signal transformer and reference transformer each consist of one such module.
Size	1.125 x 1.125 x 0.42 inch (2.86 x 2.86 x 1.07 cm)
Weight	0.7 oz max (20 g)



CIRCUIT FOR REFERENCING OUTPUT TO NORMAL GROUND

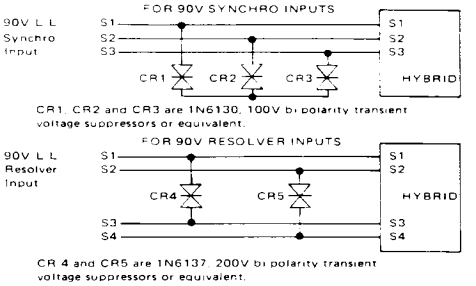
3. SYNCHRO AND RESOLVER INPUT (ANGLE A)

Solid State Buffer Input (HSCDX and HRCDX):

The solid state signal and reference inputs are true differential inputs with high AC and DC common mode rejection, so that separate isolation transformers will seldom be required. Input impedance is maintained with power off. The common mode voltage range (recurrent AC peak + DC common mode voltage) depends on $-V_S$ and should not exceed the following values:

INPUT	COMMON MODE IF $-V_S = 0$	MAXIMUM IF $-V_S = -7V$	MAX TRANSIENT PEAK VOLTAGE
90V L-L	150V Peak	300V Peak	350V
26V L-L	45V Peak	90V Peak	150V
11.8V L-L	20V Peak	60V Peak	150V

90V line-to-line systems generally have voltage transients which exceed the 350V specification listed above. These transients can destroy the thin film input resistor network in the hybrid. Therefore, 90V L-L solid state input modules should always be protected by installing voltage suppressors as shown below.

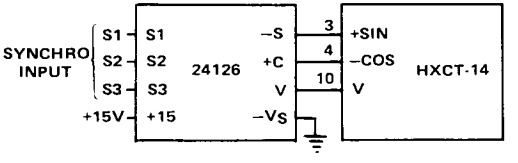


CONNECTIONS FOR VOLTAGE TRANSIENT SUPPRESSORS

Voltage Follower Buffer Input:

HXCDX units require a signal isolation transformer, a Scott-T, or a similar signal conditioner. They may be preferred in applications where the signal conditioner can be integrated with other components, as in many multiplexed systems. The HXCDX-14 input is high impedance and compatible with any device providing resolver type signals of appropriate amplitude riding on internal analog ground V. The maximum input voltage amplitude depends on $-V_S$ and will be greater if the magnitude of $-V_S$ is increased, as discussed in the Power Supplies section.

The 60 Hz signal transformer 24126 is an active device with op-amp outputs, and requires connection to the +15V power supply as shown below. An active transformer is provided because a passive transformer would be much larger at 60 Hz than at 400 Hz.



4. DIGITAL INPUT ANGLE B

The logic 0 level is from 0 to .3V_L and the logic 1 level from .7V_L to V_L. For TTL/DTL logic, V_L is 6.2V (see Figure 2), so 22K pull-up resistors to +5V should be added by the user to each digital input line.

5. OUTPUTS SIN (A-B) AND COS (A-B)

The outputs e are AC voltages sin (A-B) cos ωt, and cos (A-B) cos ωt, at the carrier frequency. The amplitude of e is 0.38 mV per LSB of angle difference A-B, where 1 LSB = .02197 degrees = 1.318 minutes. The maximum output amplitude reached is 1 volt rms nominal, which represents an angular difference of ±90°. The phase of the modulation cos ωt indicates whether the angle difference A-B is positive or negative. The maximum loading is 1 mA rms.

The outputs e ride on V, the D.C. Reference. When $-V_S$ is grounded, V = + 3.9V nominal. A difference circuit as shown, may be used to reference e with respect to normal ground instead of V, and also to provide gain.

6. DYNAMIC CHARACTERISTICS

The HSCDX-14 differential control transmitter is essentially a fast logic circuit. During normal tracking, when the synchro or resolver update information is continuously available and the digital input is updated in LSB steps, there is no lag error in the output, and it is continuously available. If an instantaneous 179° step occurs in either input, the settling time to within final accuracy is 10μs.

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.

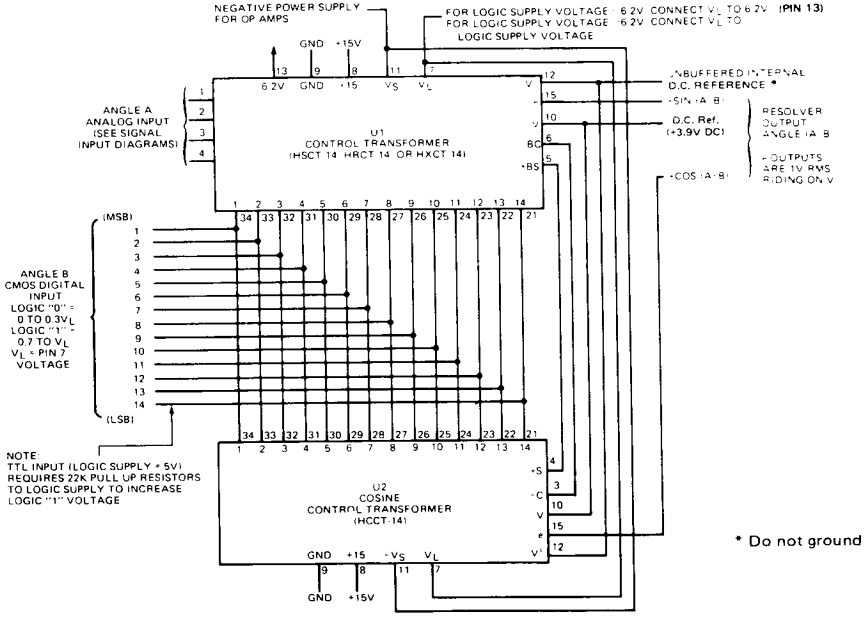
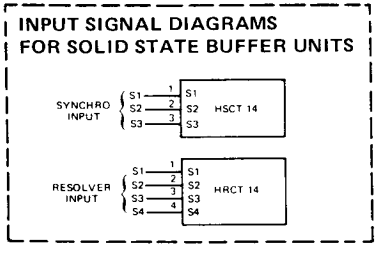
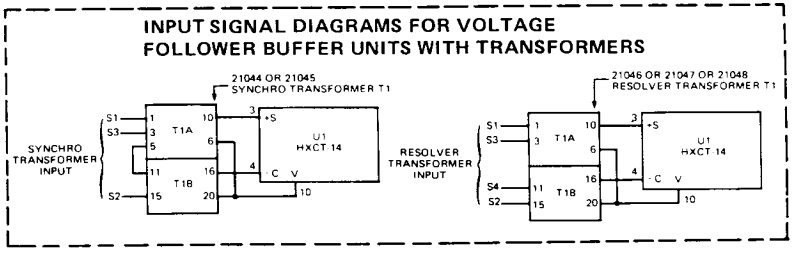


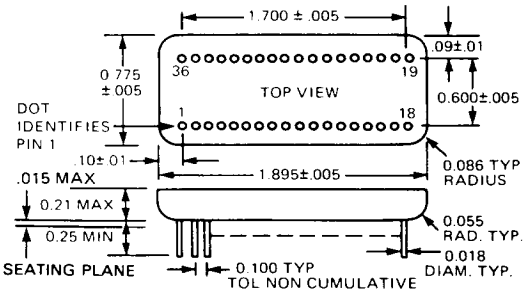
FIGURE 2. INTERCONNECT DIAGRAM





CONTROL TRANSFORMER MODULE DIAGRAMS

1. Mechanical Outline (HSCT, HRCT, HXCT, and HCCT)
   36 pin double DIP



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

2. Pin Assignments

PIN	FUNCTION HSCT	HRCT	HXCT	HCCT	PIN	FUNCTION
1	S1	S1	N.C.	N.C.	19	TP 3
2	S2	S2	N.C.	N.C.	20	TP 1
3	S3	S3	+SIN	−C	21	BIT 14 LSB
4	S4	N.C.	−COS	+S	22	BIT 13
5	+BS	+BS	+BS	−BC (TP)	23	BIT 12
6	−BC	−BC	−BC	+BS (TP)	24	BIT 11
7	V_L				25	BIT 10
8	+15V				26	BIT 9
9	GND				27	BIT 8
10	V (Internal D.C. Ref.)				28	BIT 7
11	$-V_S$				29	BIT 6
12	V'				30	BIT 5
13	6.2V	6.2V	6.2V	N.C.	31	BIT 4
14	TP 4				32	BIT 3
15	e				33	BIT 2
16	TP 5				34	BIT 1 MSB
17	NC				35	TP6
18	TP2				36	TP7

Note: Test Points TP are for Factory Use Only

Note:

Mechanical outlines and schematic diagrams for all signal transformers (400 Hz, 21044 to 21048 and 60 Hz, 24126) can be found with HSDC-8915 product information.

ORDERING INFORMATION

The HSCDX differential control transmitters consist of two control transformer modules:

A sin output with choice of synchro, resolver, or voltage follower buffer input (HSCT, HRCT, or HXCT).

A cos output without choice of input (HCCT).

If signal isolation transformers are required for HXCDX units, they must be ordered separately from part 2 below.

1. Order a differential control transmitter consisting of two hybrid modules as follows:

HSCDX−14−H−1−a−883B

- Reliability Grade:
  - 883B = Fully compliant with MIL-STD-883
  - B = Screened to MIL-STD-883 but without QCI testing
  - Blank = Standard DDC procedures
- Accuracy:
  - Blank = ±4 minutes
  - a = ±2 minutes
- Temperature Range (Operating):
  - 1 = −55°C to +125°C
  - 3 = 0°C to +70°C
- Voltage Levels:
  1. Synchro solid state input (HSCDX)
     - H = 90V L-L
     - L = 11.8V L-L
  2. Resolver solid state input (HRCDX)
     - H = 90V L-L
     - M = 26V L-L
     - L = 11.8V L-L
  3. Voltage follower input (HXCDX):
     Omit voltage level specification. One HXCDX model accepts all normal voltage levels.
- Resolution = 14 Bits
- Input Type
  - HSCDX = Solid state synchro
  - HRCDX = Solid state resolver
  - HXCDX = Voltage follower buffer. Requires external signal conditioner such as an isolation transformer.

2. 400 Hz and 60 Hz transformers may be ordered by part number (P/N) as follows.

Type	Frequency	Ref. Voltage	L-L Voltage	Part Numbers Ref. Xfmr.	Signal Xfmr.
Synchro	400 Hz	115V	90V	21049	21045*
Synchro	400 Hz	26V	11.8V	21049	21044*
Resolver	400 Hz	115V	90V	21049	21048*
Resolver	400 Hz	26V	26V	21049	21047*
Resolver	400 Hz	26V	11.8V	21049	21046*
Synchro	60 Hz	115V	90V	24133-1†	24126-1†
				-3†	-3†

* The part number for each 400 Hz synchro or resolver isolation transformer includes two separate modules as shown in the line drawings.

†-1 and -3 indicates operating temperature ranges available.

3. Order each sin or cos control transformer module as follows. Part 1 of the ordering information describes the alternatives in each portion of the part number.

HSCT−14−H−1−a−883B

- Reliability Grade:
  - 883B = Fully compliant with MIL-STD-883
  - B = Screened to MIL-STD-883 but without QCI testing.
  - Blank = Standard DDC procedures
- Accuracy
  - Omit or a
- Temperature Range (Operating):
  - 1 or 3
- Voltage Level
  - H, M, or L
  - Omit for HXCT and HCCT
- Resolution = 14 bits
- Type
  - HSCT = Control transformer with solid state synchro input
  - HRCT = Control transformer with solid state resolver input
  - HXCT = Control transformer with voltage follower buffer input
  - HCCT = Cosine control transformer

D

I