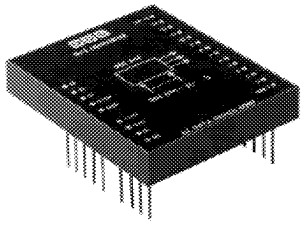
ILC DATA DEVICE CORPORATION®

DSC-644*

14-BIT D/S AND D/R CONVERTER LOW-PROFILE INDUSTRY STANDARD



DESCRIPTION

The DSC-644 is a low-profile Digital-to-Synchro (D/S) and Digital-to-Resolver (D/R) converter. It is only 0.52 inches high. The DSC-644 has a standard pin configuration and has a rugged design. The power output stage has overload and transient protection, and a thermal cut-off to prevent overheating. The output has short-circuit protection and an aluminum top plate to improve thermal dissipation. The DSC-644 also has a circuit design that provides a more accurate output with an improved transient response and a negligible scale factor variation. Reliability has also been increased.

The DSC-644 module contains an input reference isolation transformer. An internal output transformer is also included for all 400 Hz versions. The 60 Hz option requires a separate output transformer.

APPLICATIONS

The DSC-644 can be used when digitized shaft angle data must be converted to synchro or resolver form to drive control transformers control differential transmitters and angle indicators. Because these converters are very rugged and meet the requirements of MIL-STD-202E, they are suitable for the most severe industrial and military applications, including military ground support and avionics. They are ideal for computer-based systems where digital information is processed, such as simulators, flight trainers flight instrumentation, and fire control systems.

FEATURES

- ***1.5 VA Drive Capability***
- ***Protected Output:***
  Rugged Current-Limited Output
  Short-Circuit Protection
  Overvoltage Transient Protection
  Thermal Cutoff
- ***Metal Heatsink at Top of Case:***
  Conservative Thermal Design
- ***Very Low Scale Factor Variation:***
  0.05% Typical
- ***Output:***
  Internal 400 Hz Isolation Transformer
  All Common Synchro/Resolver Voltage Levels and Frequencies
- ***Digital Input:***
  CMOS and TTL Compatible
  Parallel Binary Angle Input

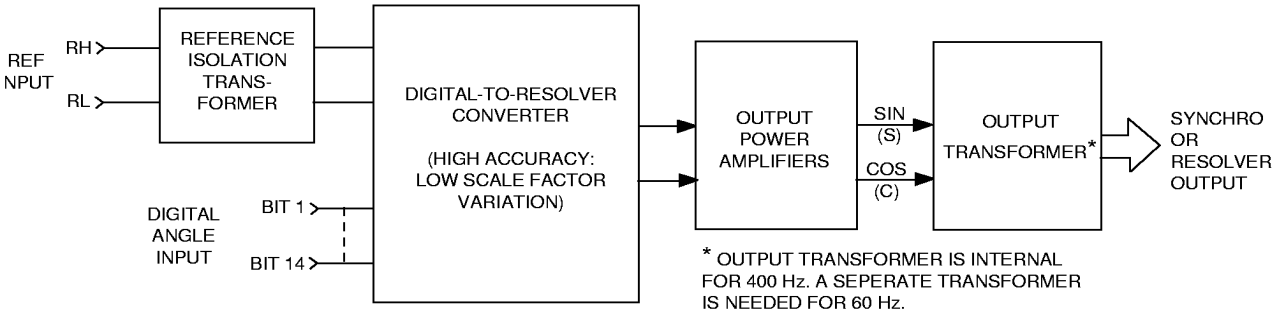


FIGURE 1. DSC-644 BLOCK DIAGRAM

*Patented

TABLE 1. DSC-644 SPECIFICATIONS

Applies over operating temperatures and frequency ranges, ±5% variation of power supplies. ±10% reference amplitude variation, up to 10% reference harmonic distortion, and for any balanced load up to full load.

PARAMETER	VALUE
RESOLUTION	14 bits
ACCURACY (TO FULL LOAD)	
Output Accuracy	±4 minutes
Differential Linearity	±1 LSB max
DIGITAL INPUT	
Logic Type	Natural binary angle. parallel positive logic TTL compatible Transient protected CMOS 33 kΩ pull-up to +5 V
Loading	0.13 Std TTL loads
REFERENCE INPUT (TRANSFORMER-ISOLATED)	**Reference Voltage Level*** / **Max. Ref. Current**
Units with 90 Vrms L-L output	115V rms / 0.6 mA
Units with 11.8 Vrms L-L output	26V rms / 0.6 mA
	* +20% absolute max. to avoid damage.
ANALOG OUTPUT (TRANSFORMER-ISOLATED)	
Drive Capability (L-L Balanced*)	
Synchro Output	
90V rms L-L, 360-440 Hz (Option H)	4 kΩ min
90V rms L-L, 57-440 Hz (Option 6)	4 kΩ min
11.8V rms L-L, 360-440 Hz (Option L)	70 Ω min
Resolver Output	
11.8 rms L-L, 360-440 Hz (Option L)	93 Ω min
Output Scale Factor Absolute (All Causes)	±2% max simultaneous amplitude variation on all output lines, including variation with digital angle. Output amplitude tracks reference input amplitude.
Variation With Digital Angle	±0.1% max
Output Quadrature	±0.3% max
* The output amplifiers will drive loads with any phase angle from -90° to +90°	
POWER SUPPLY	
Voltage	+15V / -15V / +5 V
Max Voltage Without Damage	+18V / -18V / +7 V
Average Current	150 mA max / 150 mA max / 5 mA max
Peak Current with Normal Load	330 mA max / 330 mA max / 5 mA max
Peak Current at Power Turn-on or Short Circuit	600 mA max / 600 mA max / 5 mA max
TEMPERATURE RANGES	
Operating (Temperature Of Metal Plate On Top Of Case	
-1 Option	-55°C to +85°C
-3 Option	0°C to +70°C
Storage	-55°C to +125°C
PHYSICAL CHARACTERISTICS	
Converter Module (encapsulated)	
Size	3.125 x 2.625 x 0.52 inch (7.94 x 6.67 x 1.32 cm)
Weight	5.1 oz max (145 g)
60Hz Transformer Module (encapsulated)	
Size	2.25 x 2.25 x 0.81 inch (5.7 x 5.7 x 2.1 cm)
Weight	10.5 oz max (298 g)

INTRODUCTION

The DSC-644 (see FIGURE 1) contains an internal digital-to-resolver (D/R) converter which has an inherently high accuracy and low scale factor variation. The circuit in the internal D/R converter is based on an algorithm whose theoretical math error is is only ±3.5 arc-seconds (less than 5% of 1 LSB), and whose theoretical scale factor variation with angle is less than ±0.015%. The output is well behaved, with negligible glitches at major transition points. The accuracy and scale factor error are now limited by the physical components, not by the algorithm.

The digital imputs are transient protected CMOS switches with 33 kΩ pull up resistors to the +5V supply, and can be driven by all standard TTL gates. If the TTL gates drive other loads as well, the circuit must allow the 33 kΩ resistors to pull up the logic level to within 1.0V of the +5V supply. Bit weights for the 14 binary inputs are given in the bit weight table. Angle is determined by adding bits in the logic 1 state.

TABLE 2. BIT WEIGHT TABLE

BIT	DEG/BIT	MIN/BIT
1 MSB	180	10,800
2	90	5,400
3	45	2,700
4	22.5	1,350
5	11.25	675
6	5.625	337.5
7	2.813	168.75
8	1.406	84.38
9	0.7031	42.19
10	0.3516	21.09
11	0.1758	10.55
12	0.0879	5.27
13	0.0439	2.64
14 LSB	0.0220	1.32

The internal reference input transformer provides isolation at both 60 Hz and 400 Hz, so a change of frequency will not cause damage. The input is specified for operation at a reference level of either 115V or 26V rms. The output signals are proportional to the applied reference, and any distortion in the reference input will appear in the output signals.

A thermal cutout disables the output power amplifiers when the internal temperature reaches 125°C. The output is automatically restored when the temperature drops again.

The DSC-644 will not be damaged by any sequencing order or interruptions in either the dc supplies or the reference input. However, if one of the dc supplies is shut down or subsequently powered up, maximum turn on current (450mA) will be drawn from the other 15V supply until the missing 15V supply is restored.

The 60 Hz synchro unit requires both a converter module (DSC-644-6) and a separate tansformer because of the transformer size. The output power amplifiers on the -6 module provide a 7V rms nominal ±2% resolver signal for the external transformer when the reference input is 115V rms.

Minimum load impedances are listed in the Specifications Table under Drive Capabilty. The DSC-644 can drive these impedances under the worst case conditions stated in the table. The minimum load impedances correspond to a 1.5VA drive capability when the line voltages and frequencies are at their nominal values. The metal top of the converter module should be provided with sufficient air circulation.

DDC also manufactures the DSC-544, another D/S converter which provides 60 and 400 Hz 90V L-L synchro output. The DSC-544 is a high efficiency, reference powered converter with a standard 0.82 inch high profile. It does not require ±15V power supplies. When driving the same load, the DSC-544 dissipates half as much power as the DSC-644. At 400 Hz the DSC-544 can drive 4.5VA compared to 1.5VA for the DSC-644. Both units can drive 1.5VA at 60 Hz, but the DSC-544 does not require an external transformer at this frequency.

OUTPUT PHASING AND SCALE FACTOR

The analog output signals have phasing as shown in FIGURES 2A and 2B.

The output amplitudes simultaneously track reference voltage fluctuations because they are proportional to RH-RL. The amplitude factor A_0 is 90/115V for 90 Vrms L-L output and 11.8/26 for 11.8 Vrms L-L output. The maximum variation in A_0 from all causes is ±1.9%. The term A (θ) represents the variation of the amplitude with the digital input angle. A(θ), which is called the scale factor variation, is a smooth function of θ without discontinuities and is less than ±0.001 for all values of θ. The total maximum variation in A_0 (1 + A(θ)) is therefore ±2%. Because Aθ is so small, the DSC-644 can be used to drive systems such as X-Y plotters or CRT displays in which the sin and cos outputs are used independently (not ratiometrically as in a control transformer).

DRIVING CT LOADS

When driving CT loads the DSC-644 must have enough power drive capability to drive the Z_{SO} of the load. Z_{SO} (stator impedance with rotor open-circuited) is measured as shown in FIGURE 3. TABLE 3 shows the load impedance of some typical control transformers.

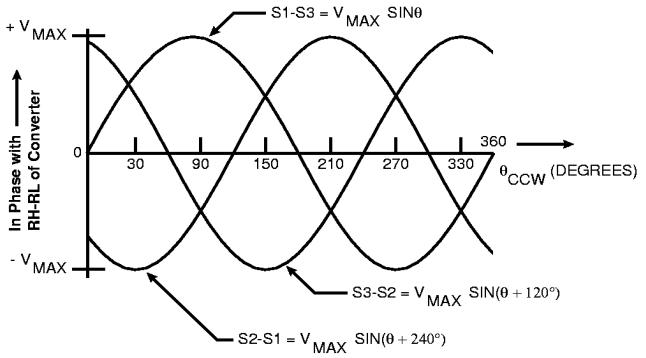


FIGURE 2A. SYNCHRO OUTPUT SIGNALS

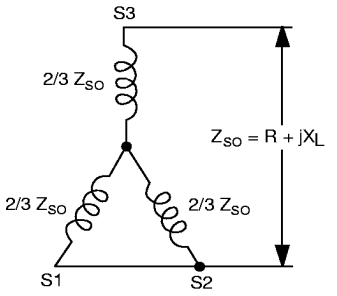


FIGURE 3. Z_{SO} MEASUREMENT

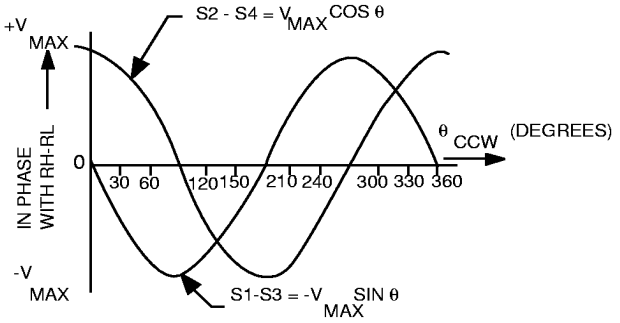


FIGURE 2B. RESOLVER OUTPUT SIGNALS

TABLE 3. TYPICAL CONTROL TRANSFORMERS AND THEIR LOAD IMPEDANCES

MILITARY PART NUMBER	SIZE	ZSO
26V 08CT4c	08	100 + j490
26V 11CT4d	11	21 + j132
11CT4e	11	838 + j4955
15CT4c	15	1600 + j9300
15CT6b	15	1170 + j6780
18CT4c	18	1420 + j13260
18CT6b	18	1680 + j5040
23CT4a	23	1460 + j11050
23CT6a	23	1250 + j3980

Control transformers are highly inductive loads and it is possible to save power by tuning such loads. Three capacitors may be placed across the legs of the synchro stator in a delta configuration:

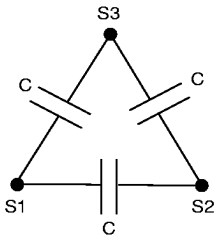


FIGURE 4. DELTA TUNING CONFIGURATION

The correct value of the capacitance in Farads is given by:

$$C = \frac{X_L}{4\pi f\,(R^2 + X_L^2)}$$

where f is the carrier frequency and R and X_L are the series real and reactive components of Z_{SO}. High grade capacitors must be used and they must be able to withstand the full AC output voltage.

When the load has been tuned more loads can be driven in parallel, because the load impedance is increased to:

$$Z = \frac{R^2 + X_L^2}{R}$$

ACCURACY TESTS

The accuracy of the DSC-644 may be tested with a high accuracy synchro/resolver angle indicator and a load such as a control transformer, as shown in FIGURE 5. The bit switches are set to the desired test angles and the output angle is measured under load. The accuracy should conform to the specifications.

TEST METHODS

The DSC-644 converter modules are high-quality products. These modules were designed to meet the specific test methods and conditions of MIL-STD-202E (see TABLE 4) unless alternative methods are specified by the customer in his procurement documentation.

TABLE 4. MIL-STD-202E TEST METHODS

METHOD	CONDITION	COMMENT
204C	C	10G, 2000 Hz vibration
213B	A	50G, 11 ms shock
106D*	--	Moisture
107D	A	Thermal shock
101D	B	Salt spray
105C	B	50,000 ft, altitude

* when conformally coated on P.C. board

PRINTED CIRCUIT BOARD MOUNTING

When mounting a converter on a printed circuit board, it is very important to keep logic level signals as far away from the AC and power signals as possible. Under no circumstances should AC or power pins be adjacent to data pins at the connector. It is also prudent to keep the AC and power pins separated from each other. The intent is to make it impossible to short circuit logic inputs/outputs to AC or power pins with scope probes, etc.

It is strongly recommended that circuit layouts be designed in such a way that plated through-holes are not required when mounting hybrid or discrete modules. If all lands connecting to pins are located on the opposite (DIP) side of the PC board from the module, there will be no risk of destroying a pin connection by ripping out the plated through-hole connection if the module has to be removed. It will also be much easier to unsolder a module without damaging it.

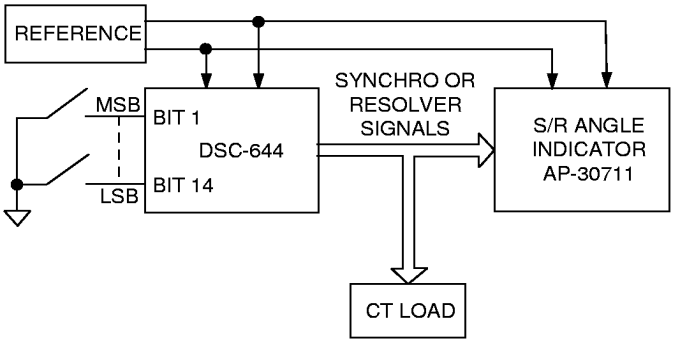
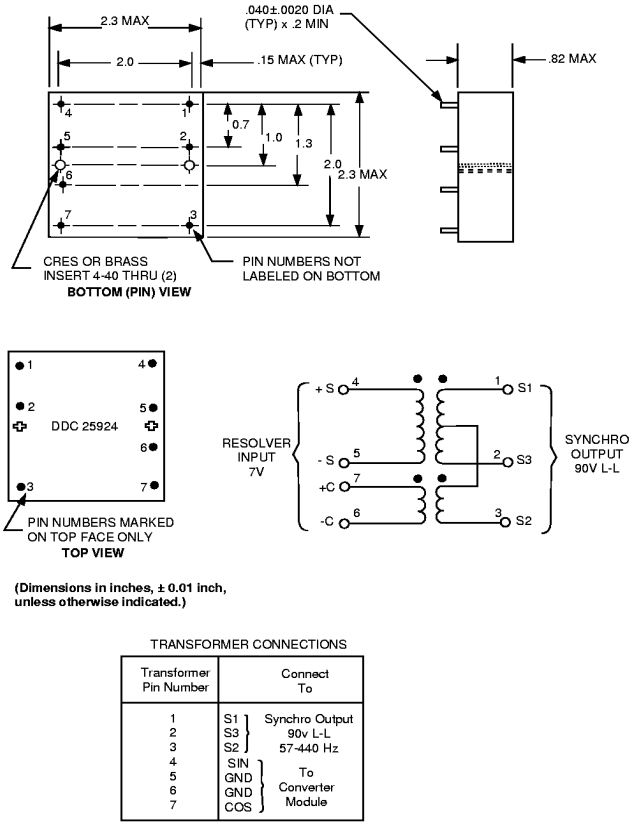


FIGURE 5. ACCURACY TEST CIRCUIT

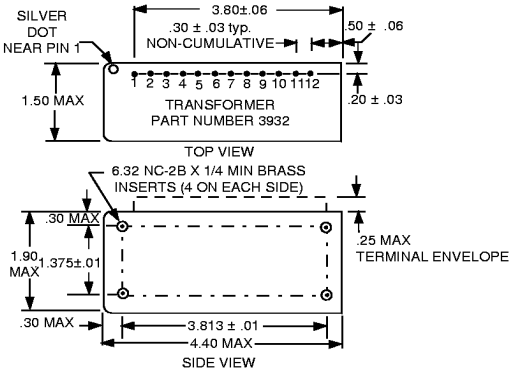


(Dimensions in inches, ± 0.01 inch, unless otherwise indicated.)

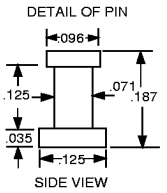
TRANSFORMER CONNECTIONS

Transformer Pin Number	Connect To	
1	S1	Synchro Output 90v L-L 57-440 Hz
2	S3	
3	S2	
4	SIN	To Converter Module
5	GND	
6	GND	
7	COS	

FIGURE 6. MECHANICAL OUTLINE, 60 HZ EXTERNAL SYNCHRO TRANSFORMER - DDC-25924



Dimensions are in inches.



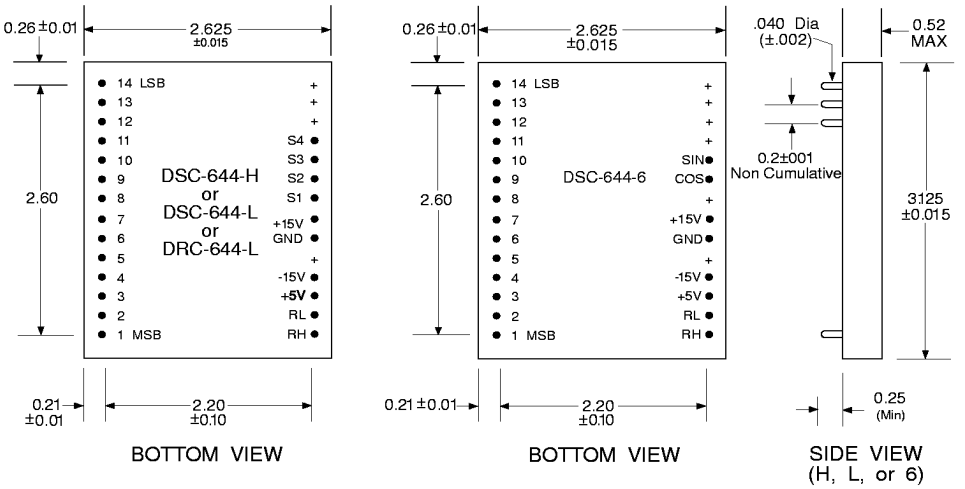
TRANSFORMER CONNECTIONS

Transformer Pin Number	Connect To	
1	S1	Synchro Output 90v rms L-L 47-440 Hz
2	S3	
3	S2	
4	SIN	To Converter Module
5	GND	
6	GND	
7	COS	
8	RH	Do Not Use
9	RL	
10	+R	Do Not Use
11	RC	
12	-R	

PIN CALL-OUTS SHOWN FOR REFERENCE ONLY.

*For 50Hz applications P/N DDC-3932 must be ordered.

FIGURE 7. MECHANICAL OUTLINE, 50 HZ EXTERNAL SYNCHRO TRANSFORMER - DDC-3932*



Notes:

1. Pin labels on bottom view are for reference only.
2. All dimensions shown are in inches.
3. Pin material meets solderability requirements of MIL-STD-202E, Method 208C.
4. Case material is glass filled Diallyl Phthalate per MIL-M-14, Type SDG-F, except top surface is a black anodized aluminum plate for heat transfer.
5. Pin S4 is present on resolver units only.
6. Any LSB pins not used should be grounded

FIGURE 8. DSC-644 MECHANICAL OUTLINE

ORDERING INFORMATION

1. Order converter modules as follows: 400 Hz units (H and L) have an internal output transformer. 60 Hz units require an external transformer that must be ordered separately as shown below. If a converter socket is required, order socket number 9010.

DXC–644–X–X–X

Reliability
R = Enhanced Reliability

Operating Temperature Range of Metal Top:
1 = -55°C to +85°C
3 = 0°C to +70°C

Output Voltage Level and Frequency:
H = 90 Vrms L-L, 360-440 Hz (Synchro only)
L = 11.8 Vrms L-L, 360-440 Hz (Synchro or Resolver)
6 = 90 Vrms L-L, 47-440 Hz (Synchro only). See Number 2 below.

Output Type:
DSC = Synchro
DRS = Resolver

2. For -6 Option:
   a) For 57-440 Hz application, either the transformer P/N DDC-3932 or DDC-25924 may be used.
   b) For 47-440 Hz applications, transformer P/N DDC-3932 must be used. Reference pins should not be connected.

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