



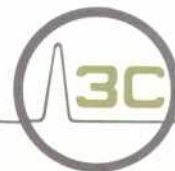
DICOTRON

*High precision optical encoders for converting
shaft position information into binary code*

*Linear and
Sine-Cosine
Digital
Shaft-Angle
Encoders*

DYCHRO
DEPARTMENT

COMPUTER CONTROL COMPANY, INC.
FRAMINGHAM, MASS. LOS ANGELES, CALIF.



ABOUT DICOTRON*

Computer Control Company's *DICOTRON Linear and Sine-Cosine Digital Shaft-Angle Encoders* represent another significant achievement in design engineering and manufacturing capability!

Because of rigid quality control from initial component selection to final inspection and testing, *DICOTRON* optical encoders have a clearly established history of outstanding technical performance under difficult and exacting environmental situations!

For example, various *DICOTRON* units are being used successfully in both the *Polaris* and *Regulus* programs, and as azimuth pick-offs in missile tracking theodolites!

Consistent with this already existing achievement record, the specific *DICOTRON* optical encoder models described herein will assure reliable and dependable performance whenever and wherever they are used!

DICOTRON

*Linear and Sine-Cosine
Digital Shaft-Angle Encoders*

Regular or Split-package DICOTRON Encoders have an accuracy of ± 1 bit including *quantizing, mechanical, optical, and electrical* errors! This accuracy is obtained when measuring *any* input angle with respect to zero reference. Rugged, reliable and compact, *DICOTRON* optical encoders are of solid-state modular construction and will fulfill or exceed applicable military specifications!

Basic components of a typical *DICOTRON* optical encoder include the following:

1. A precision *preloaded bearing assembly*.
2. A *coded glass disc* with a cyclic binary pattern (Gray code) in concentric tracks.** Each track is divided into a number of transparent and opaque areas — representing binary ONES and ZEROS, respectively.
3. A *high-intensity flash lamp illumination source and pulser assembly*, with provisions for external triggering.
4. *Slit optics* to obtain high resolution.
5. A *semiconductor light detector array* with one photocell for each concentric track.
6. A temperature-stabilized *multi-stage transistor amplifier* for amplifying the output of each photocell.
7. A *threshold circuit* providing a ONE - ZERO decision on each channel.
8. A *pulse generator* for reshaping and standardizing the output of each photocell amplifier.

Normally, the glass disc is mounted on the encoder input shaft. The shaft, in turn, is mechanically coupled to the drive mechanism whose angular position is to be measured. In some models, a pilot hole is provided for use with large diameter or hollow shafts.

In *split-package* encoders, the glass disc and associated optics are contained in one housing, and the amplifier portion is contained in another. This packaging technique enables the assemblies to be mounted at separate locations.

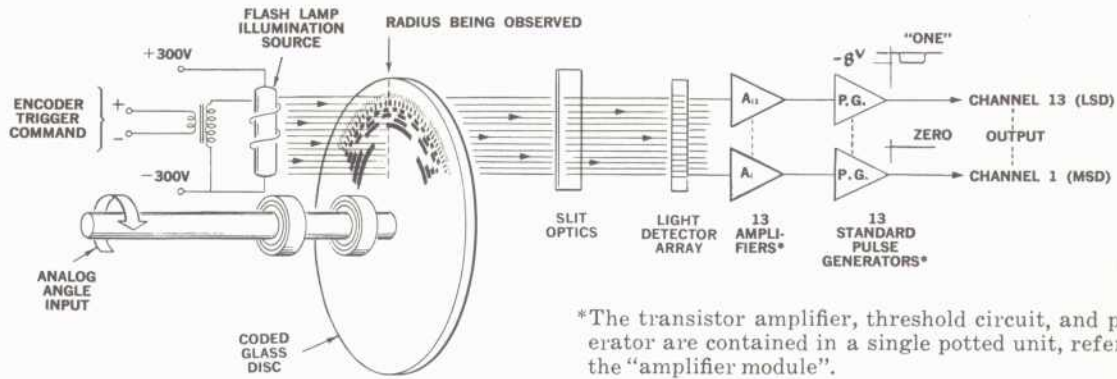
*Trademark applied for.

** *Linear Encoder*: The outermost track serves a dual function—
(1) *alignment* and
(2) *part of digital word*.

Sine-Cosine Encoder: The outermost track is for alignment only.

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Principle of Operation

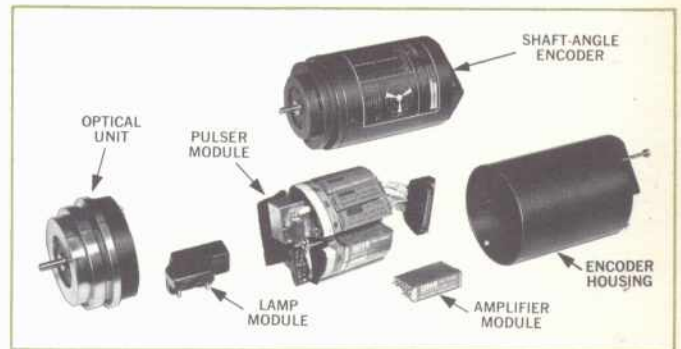


Typical DICOTRON 13-Bit Shaft-Angle Encoder/Signal Diagram

When the flash lamp is triggered, light strikes a radial segment of the disc, illuminating the code pattern of that segment. This code pattern is picked up by the associated photocell array and then amplified and shaped. The output is thus a parallel digital code that is functionally related to angular shaft position.

Cyclic binary (Gray) code is used because it eliminates ambiguity between adjacent segments.

Note: If desired, output data storage and conversion to *straight binary code* can be readily accomplished with standard Computer Control Company digital modules.

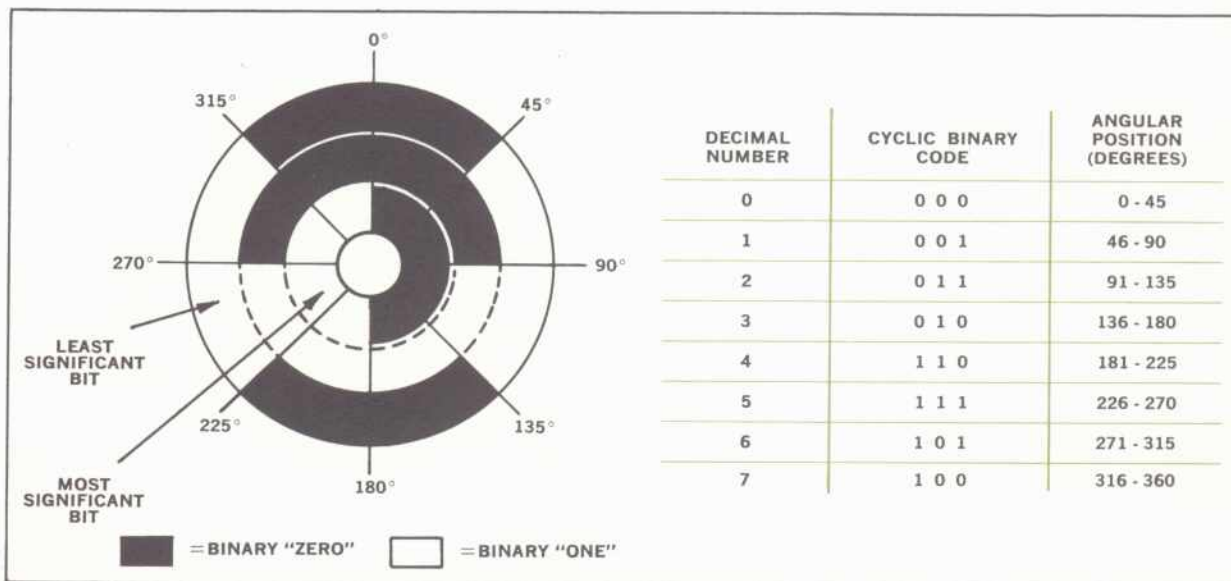


Typical DICOTRON 13-Bit Shaft-Angle Encoder/Exploded View

DICOTRON | Degree of Accuracy

The degree of accuracy is proportional to the number of concentric tracks on the glass disc. For example, if a circle is to be divided into 8 equal segments, then 3 tracks are necessary ($2^3=8$). Each segment would represent 45° angle and would be coded accordingly. Simi-

larly, if a circle is to be divided into 8192 equal segments, then 13 tracks are necessary ($2^{13}=8192$). In this case, each segment would represent an angular measurement of $\frac{360}{8192} \times 60$, or approximately 2.5 minutes of arc, and would also be coded accordingly.



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Mechanical Features

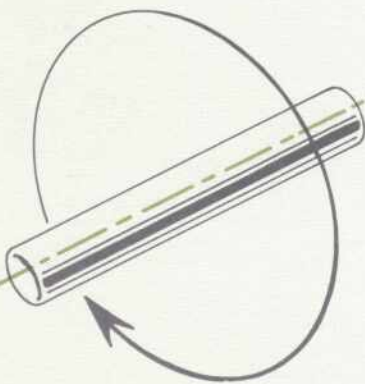
The "heart" of a DICOTRON mechanical structure is a pair of special duplex instrument-precision bearings, machine matched for identity and parallelism. Tolerances are in the order of millionths of an inch to achieve a specified preload.

After assembling the mechanical structure, the bearings are preloaded in the exact mechanical environment in which they will operate. The disc is then installed, mechanically aligned through a sensitive phase-measure-

ment procedure, and sealed permanently in place. Allowance is thus made simultaneously for all sources of rotational eccentricity, so that inaccuracies customarily introduced by use of secondary alignment fixtures are eliminated. The built-in alignment cell is always available to (1) *check optical performance*, (2) *test mechanical concentricity*, and (3) *study the effects of severe environmental use*.

IMPORTANT: *Because of ultra-precision standards, critical stages of DICOTRON encoder assembly are conducted in a dust-free environment!*

IMPORTANCE OF CENTERING THE DISC



The function of a DICOTRON digital shaft-angle encoder is to read shaft angles from a zero reference position. This requirement makes centering of the coded disc critical because any displacement of the center of the code pattern away from the actual center of rotation of the pattern will introduce first-order errors! To control the centering of the disc, it is necessary to have bearings with very low eccentricities, and to precisely position the disc on the true center of rotation of the bearing shaft assembly.

By building the alignment cell into the encoder, the unit itself becomes the alignment fixture. This design has many advantages. In particular, the center of the code pattern can be aligned, not to the center of the shaft, but to the true center of rotation of the shaft bearing assembly. Any eccentricity in the bearings or any misalignment in the shaft or assembly is thereby automatically compensated. An oscilloscope test reading is thus a true reading of the centering of the disc.

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Applications

Since there are no brushes or moving contacts, DICOTRON precision optical encoders can be used for accurate, instantaneous measurement of angular position of high-speed rotating shafts.

They are especially useful as *feedback elements in digital shaft-positioning servomechanisms*; for *coupling rotating analog devices into digital computers*; and for *converting two-speed analog shaft data into a single, linear, digital word for data processing*. By using DICOTRON precision optical encoders in a feedback loop to position one-speed or

two-speed sine-cosine resolvers, digital angle information can be quickly converted to a precise one-speed or two-speed sine-cosine voltage. In real-time systems, as much as 20 milliseconds computation time can be saved by the use of this sine-cosine generation technique!

DICOTRON precision optical encoders are currently used in *missile guidance*, *radar tracking*, and *submarine navigation* systems. They are also finding wide usage in specialized industrial applications!

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MODEL DV-13F

Optical Shaft-Angle Encoder

DESCRIPTION:

The DV-13F is a precision 13-bit optical encoder for converting shaft position information into parallel cyclic binary code. The digital output value differs from the input angle by no more than ± 1 bit, or ± 2.5 minutes of arc.

TYPICAL APPLICATIONS:

Use of the DV-13F on each shaft of a dual shaft speed analog data presentation permits direct data conversion into a single linear digital word for data processing systems. Where the primary dual speed data is a shaft rotation, angles can be resolved to one second of arc or better.

Feedback techniques permit use of the DV-13F for the conversion of a single linear digital word into multi-speed sine-cosine analog voltages, thus avoiding complex computation.

SPECIFICATIONS:

ACCURACY

Static Accuracy	± 1 bit, or ± 2.5 minutes of arc (measured from zero reference position)
Static Resolution	8192 parts per circle without ambiguity

MECHANICAL CHARACTERISTICS

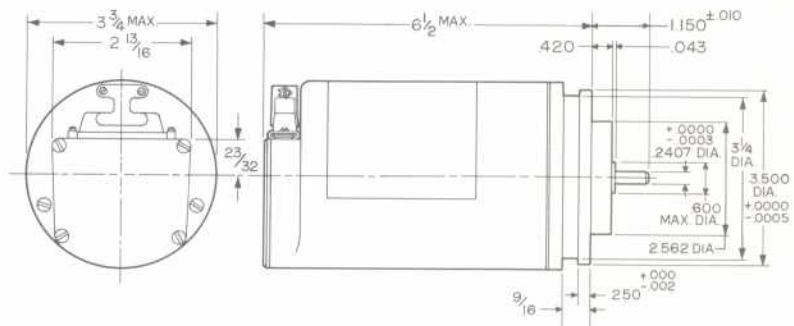
Axial Breakaway Torque	0.5 in-oz maximum
Input Shaft Inertia	130 gm-cm ² maximum
Weight	less than 8.5 lbs

ELECTRICAL OUTPUT CHARACTERISTICS

Code Type	parallel 13-bit cyclic binary
Sampling Rate	100 samples per second, nominal (Can accommodate sampling rates of 250 and higher.)
Pulse Amplitude	-8.0 ± 1 volts
Pulse Width	20 to 200 μ sec
Output Impedance	200 ohms

POWER REQUIREMENTS

"Strobe" Trigger Pulse	-10 volts, 5000 ohms	
D-C Voltages	+300 volts, 9 ma (100 pps)	-300 volts, 9 ma (100 pps)
	+10 volts, 15 ma	-18 volts, 130 ma



Model DV-13F Outline Drawing

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MODEL DV-13G

Split-Package Encoder

DESCRIPTION:

The Model DV-13G is similar to the Model DV-13F, except that the optical and amplifier assemblies are contained in separate housings. Power and signal connections are made through cabling furnished with each unit.

TYPICAL APPLICATIONS:

The DV-13G is particularly suited for applications with limited space requirements.

SPECIFICATIONS:

ACCURACY

Static Accuracy	± 1 bit, or ± 2.5 minutes of arc (measured from zero reference position)
Static Resolution	8192 parts per circle without ambiguity

MECHANICAL CHARACTERISTICS

Axial Breakaway Torque	0.5 in-oz maximum
Input Shaft Inertia	130 gm-cm ² maximum
Weight (Optical Assembly)	4.5 lbs
Weight (Amplifier Assembly)	4.0 lbs

ELECTRICAL OUTPUT CHARACTERISTICS

Code Type	parallel 13-bit cyclic binary
Sampling Rate	100 samples per second, nominal (Can accommodate sampling rates of 250 and higher.)
Pulse Amplitude	-8.0 ± 1 volts
Pulse Width	20 to 200 μ sec (as specified)
Output Impedance	200 ohms

POWER REQUIREMENTS

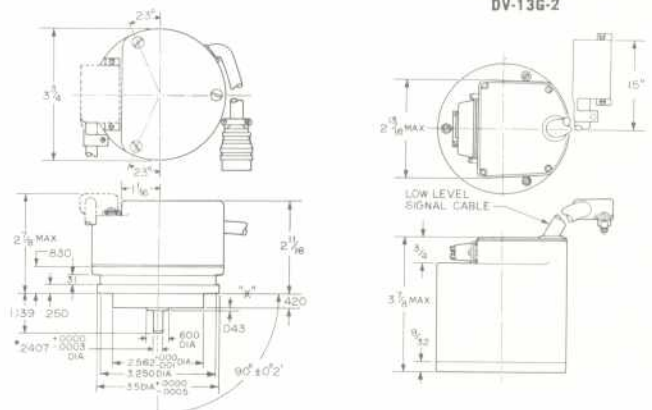
"Strobe" Trigger Pulse	-10 volts, 5000 ohms
D-C Voltages	+300 volts, 9 ma } (100 pps)
	-300 volts, 9 ma }
	+10 volts, 15 ma
	-18 volts, 130 ma



DV-13G-1



DV-13G-2



Model DV-13G Outline Drawing

DICOTRON SPECIAL ENCODER DESIGNS

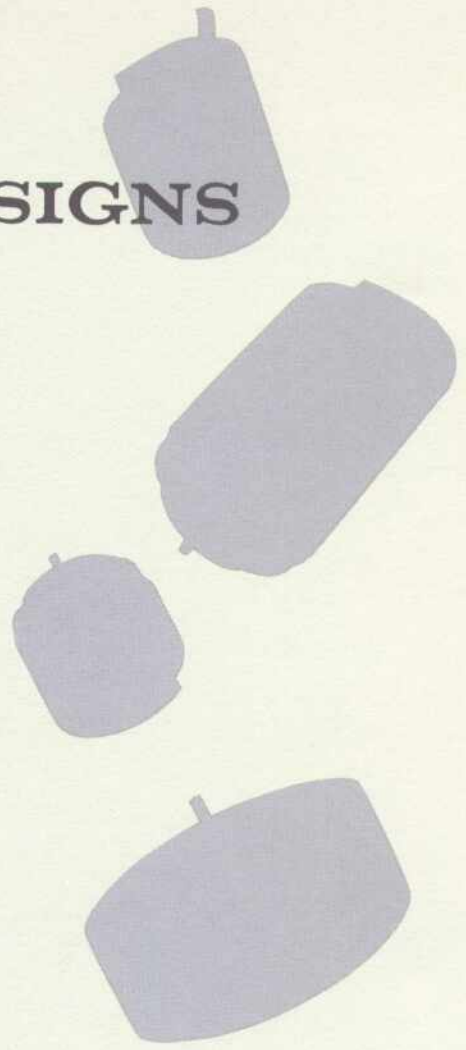
Computer Control Company, Inc. welcomes the opportunity to design and manufacture *special* DICOTRON models to individual customer requirements!

We will be pleased to review your specifications and to submit both price-and-delivery quotations and technical descriptions of appropriate *special* DICOTRON encoder designs to fit your mechanical mounting configuration, environmental conditions, sample-data requirements, etc.

The following are typical of the many *special* DICOTRON models designed to commercial and military specifications:

1. Incremental-counter encoders
2. Optical tachometers
3. Non-linear digitizers
4. Combined-function encoders
5. Shaft-angle encoders with special output functions (e.g., driving very long lines, data storage, serial outputs, conversion to straight binary)

Compatible digital modules are also available to enhance complete systems capability in any application.



DICOTRON

Series DX

Test Sets,
Optical Encoder



Series DX Typical Test Set

Test sets are available for all *Computer Control Company, Inc.* optical encoders and will perform the following functions:

1. Furnish necessary power for encoder operation.
2. Permit digital storage and display in straight binary or cyclic code.
3. Operate the test features of each encoder.

Series DX test sets operate on 115 volts ac, 60 cycles. 400-cycle models are available on request.

DICOTRON

Series DY

Power Supplies,
Optical Encoder

A complete line of hermetically sealed, regulated power supplies for 60 cps and 400 cps operation are available for all *Computer Control Company, Inc.* optical encoders.



Series DY Typical Power Supply

DICOTRON

*Linear and
Sine-Cosine
Digital
Shaft-Angle
Encoders*

DICOTRON Prices Quoted
To Your Quantity
And Delivery
Requirements



Other 3C products and services

A major area of specialization by *Computer Control Company, Inc. (3C)* is the design, development and manufacture of *special-purpose digital computers and systems*.

Further, 3C is also a leading supplier of *digital modules, magnetic core memory systems, SONILINES* (sonic delay lines), and *package test equipment*.

An abundance of literature describing these other areas of 3C proficiency is available by calling or writing to the address (es) listed below!

To communicate with 3C

EASTERN DIVISION

Mail: 983 Concord Street
Framingham, Mass.

Telephone: Area Code 617
CEdar 5-6220 (Bost.)
TRinity 5-6185 (Fram.)

TWX: FRAM MASS 17

Western Union

Direct telegram printer communications with Western Union are maintained for prompt handling of messages.

Cable Address: Compcn, Framingham, Mass., U.S.A.

WESTERN DIVISION

2251 Barry Avenue,
Los Angeles, Calif.

Area Code 213
GRanite 8-0481
BRadshaw 2-9135

W LA CAL 6634

Shipments

Except when specified otherwise, shipments are generally made as follows:

- (a) Under 20 pounds — Parcel Post
- (b) 20 to 75 pounds — Railway Express
- (c) Over 75 pounds — Truck or Carloading Company

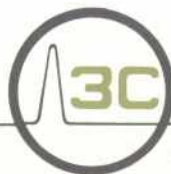
For expedited service we will gladly ship by Air Freight, Air Express, Air Parcel Post, etc., as requested.

Guaranteed availability of spare parts

Computer Control Company, Inc. guarantees to maintain the availability of spare parts for all of its DICOTRON products for an indefinite period of time.

Standard Encoder warranty

- a) Computer Control Co., Inc. warrants all 3C products against defects in workmanship, materials, and construction under normal use and service for a period of ONE YEAR from the date of purchase except that liability for defective transistors, diodes, bearings, and lamps shall conform and be limited to the obligations of the original manufacturer's warranties covering these components.
- b) This warranty does not extend to any of our products which have been subjected to misuse, neglect, accident, or improper installation or application. Nor shall it extend to products which have been repaired or altered outside of our factory.
- c) For service under this warranty, please advise the factory promptly of all pertinent details. Transportation charges covering return of defective products to our factory shall be at our expense if such products are determined to be defective within the limitations of this warranty. Computer Control Co., Inc. will repair or replace the defective product in accordance with its own best judgment.
- d) Computer Control Co., Inc. requests immediate notification for any claims arising from damage in transit in order to determine if carrier responsibility exists.



DYCHRO
DEPARTMENT

COMPUTER CONTROL COMPANY, INC.

EASTERN DIVISION: 983 Concord Street • Framingham • Massachusetts
WESTERN DIVISION: 2251 Barry Avenue • Los Angeles 64 • California