Theory of Operation

The HEDS-5500/5540, HEDS-5600/5640, HEDM-5500/5540 and HEDM-5600 translate the rotary motion of a shaft into either a two- or a three-channel digital output.

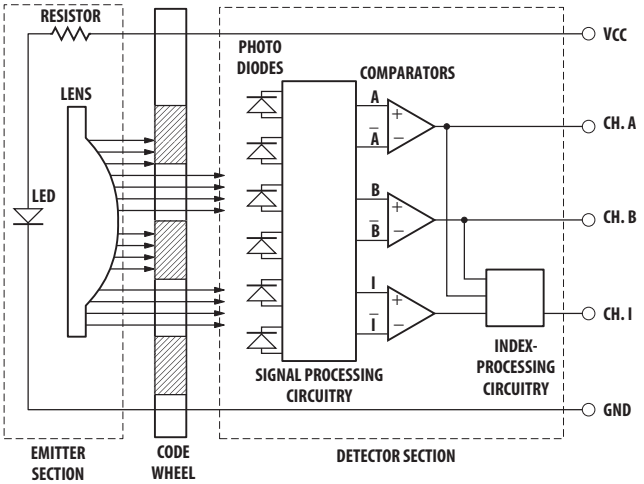
As seen in the block diagram, these encoders contain a single Light Emitting Diode (LED) as its light source. The light is collimated into a parallel beam by means of a single polycarbonate lens located directly over the LED. Opposite the emitter is the integrated detector circuit. This IC consists of multiple sets of photodetectors and the signal processing circuitry necessary to produce the digital waveforms.

The codewheel rotates between the emitter and detector, causing the light beam to be interrupted by the pattern of spaces and bars on the codewheel. The photodiodes which detect these interruptions are arranged in a pattern that corresponds to the radius and design of the codewheel. These detectors are also spaced such that a light period on one pair of detectors corresponds to a dark period on the adjacent pair of detectors. The photodiode outputs are then fed through the signal processing circuitry resulting in A, $\overline{A}$, B and $\overline{B}$ (also I and $\overline{I}$ in the HEDS-5540/5640 and HEDM-5540). Comparators receive these signals and produce the final outputs for channels A and B. Due to this integrated phasing technique, the digital output of channel A is in quadrature with that of channel B (90 degrees out of phase).

In the HEDS-5540/5640 and HEDM-5540, the output of the comparator for I and $\overline{I}$ is sent to the index processing circuitry along with the outputs of channels A and B.

The final output of channel I is an index pulse PO which is generated once for each full rotation of the codewheel. This output PO is a one state width (nominally 90 electrical degrees), high true index pulse which is coincident with the low states of channels A and B.

Block Diagram



Note: Circuitry for CH I is only for HEDS-5540/5640, HEDM-5540/5540 Three Channel Encoder

Definitions

Count (N): The number of bar and window pairs or counts per revolution (CPR) of the codewheel.

One Cycle (C): 360 electrical degrees (°e), 1 bar and window pair.

One Shaft Rotation: 360 mechanical degrees, N cycles.

Position Error (Δθ): The normalized angular difference between the actual shaft position and the position indicated by the encoder cycle count.

Cycle Error (ΔC): An indication of cycle uniformity. The differ¬ence between an observed shaft angle which gives rise to one electrical cycle, and the nominal angular increment of 1/N of a revolution.

Pulse Width (P): The number of electrical degrees that an output is high during 1 cycle. This value is nominally 180°e or 1/2 cycle.

Pulse Width Error (ΔP): The deviation, in electrical degrees, of the pulse width from its ideal value of 180°e.

State Width (S): The number of electrical degrees between a transition in the output of channel A and the neighbouring transition in the output of channel B. There are 4 states per cycle, each nominally 90°e.

State Width Error (ΔS): The deviation, in electrical degrees, of each state width from its ideal value of 90°e.

Phase (φ): The number of electrical degrees between the center of the high state of channel A and the center of the high state of channel B. This value is nominally 90°e for quadrature output.

Phase Error (Δφ): The deviation of the phase from its ideal value of 90°e.

Direction of Rotation: When the codewheel rotates in the counter-clockwise direction (as viewed from the encoder end of the motor), channel A will lead channel B. If the codewheel rotates in the clockwise direction, channel B will lead channel A.

Index Pulse Width (P_0): The number of electrical degrees that an index output is high during one full shaft rotation. This value is nominally 90°e or 1/4 cycle.

Absolute Maximum Ratings

Parameter	HEDS-55XX/56XX	HEDM-550X/560X	HEDM-5540/5640
Storage Temperature, T_S	-40°C to 100°C	-40°C to +70°C	-40°C to 85°C
Operating Temperature, T_A	-40°C to 100°C	-40°C to +70°C	-40°C to 85°C
Supply Voltage, V_{CC}	-0.5 V to 7 V	-0.5 V to 7 V	-0.5 V to 7 V
Output Voltage, V_O	-0.5 V to VCC	-0.5 V to VCC	-0.5 V to VCC
Output Current per Channel, I_{OUT}	-1.0 mA to 5 mA	-1.0 mA to 5 mA	-1.0 mA to 5 mA
Vibration	20 g, 5 to 1000 Hz	20 g, 5 to 1000 Hz	20 g, 5 to 1000 Hz
Shaft Axial Play	± 0.25 mm (± 0.010 in.)	± 0.175 mm (± 0.007 in.)	± 0.175 mm (± 0.007 in.)
Shaft Eccentricity Plus Radial Play	0.1 mm (0.004 in.) TIR	0.04 mm (0.0015 in.) TIR	0.04 mm (0.0015 in.) TIR
Velocity	30,000 RPM	30,000 RPM	30,000 RPM
Acceleration	250,000 rad/sec^2	250,000 rad/sec^2	250,000 rad/sec^2

Output Waveforms