

## Description:

The **E5 Series** rotary encoder has either a molded polycarbonate or a machined aluminum enclosure, which utilizes either a 5-pin or 10-pin finger-latching connector. This optical incremental encoder is designed to easily mount to and dismount from an existing shaft to provide digital feedback information.

The **E5 Series** is easy to add to existing applications and only consists of five main components: base, cover, hub/code wheel, optical encoder module and internal differential line driver (differential version only).

The single-ended output version (**E5S, E5MS**) is normally designed for applications of 6 feet or less. For longer cable lengths, the differential output version (**E5D, E5MD**) is recommended.

The base and cover are both constructed of either rugged 20% glass filled polycarbonate (standard versions) or machined aluminum and have a clear anodized protective finish (metal versions). Attachment of the base to a surface may be accomplished by utilizing one of several machine screw bolt circle options. Positioning of the base to the centerline of a shaft is ensured by use of a centering tool (sold separately). The cover is securely attached to the base with two 4-40 flat head screws to provide a resilient package protecting the internal components.

The internal components consist of a shatterproof mylar disk mounted to a precision machined aluminum hub and an encoder module. The module consists of a highly collimated solid state light source and monolithic phased array sensor, which together provide a system extremely tolerant to mechanical misalignments.

For differential versions: the internal differential line driver (26C31) can source and sink 20mA at TTL levels. The recommended receiver is industry standard 26C32. Maximum noise immunity is achieved when the differential receiver is terminated with a 110 ohm resistor in series with a .0047µf capacitor placed across each differential pair. The capacitor simply conserves power; otherwise power consumption would increase by approximately 20mA per pair, or 60mA for 3 pairs.

A secure connection to the **E5 Series** encoder is made through a 5-pin (single-ended versions) or 10-pin (differential versions) finger-latching connector (sold separately). The mating connectors are available from US Digital with several cable options and lengths.

## Features:

- Quick, simple assembly and disassembly
- Rugged screw-together housing
- Positive finger-latching connector
- Low cost
- Accepts ±.010" axial shaft play
- Small size
- Tracks from 0 to 100,000 cycles/sec
- 32 to 1250 cycles per revolution (CPR)
- 128 to 5000 pulses per revolution (PPR)
- 2 channel quadrature TTL squarewave outputs
- Optional index (3rd channel)
- -40 to +100°C operating temperature
- Mounting compatibility with Agilent HEDS-5500
- Fits shaft diameters from .079" to .394" (1/8" to 3/8" or 2mm to 10mm)
- Single +5v supply
- Flush back, through shaft hole, or extended back
- Flat or self-aligning base
- Adapts to 1.812" bolt circle (2 or 3 holes)
- US Digital warrants its products against defects in materials and workmanship for two years. See complete warranty for details.

## Absolute Maximum Ratings:

Parameter	Max.	Units
Vibration (5 to 2kHz)	20	g
Shaft Axial Play	±0.01	in.
Shaft Eccentricity Plus Radial Play	0.004	in.
Acceleration	250,000	rad/sec <sup>2</sup>

➤ Note that radial play translates directly to position inaccuracy.

**Polycarbonate  
Single-ended (E5S)**



**Polycarbonate  
Differential (E5D)**



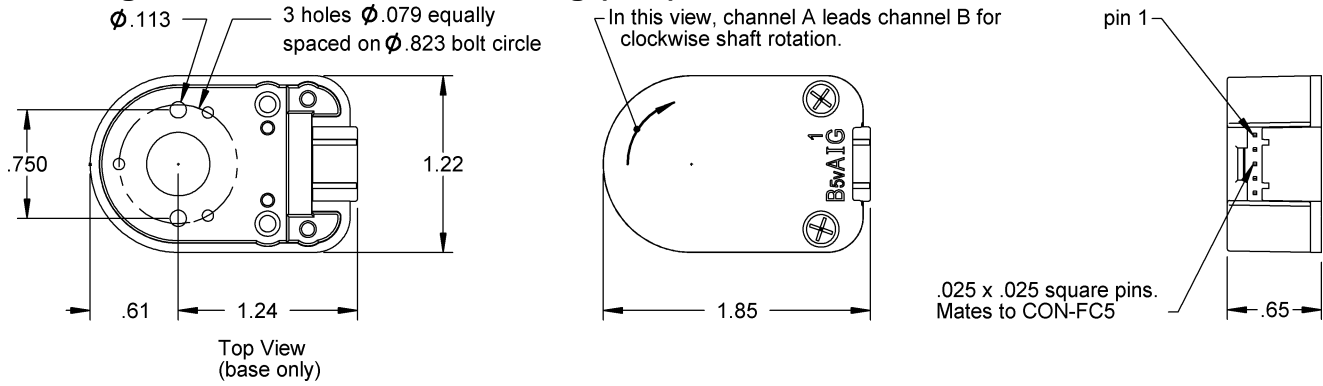
**Metal  
Single-ended (E5MS)**



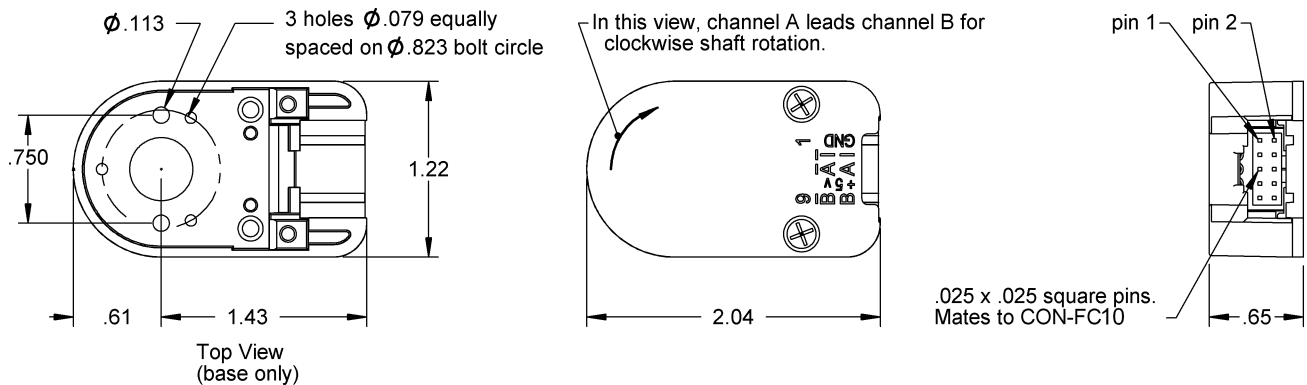
**Metal  
Differential (E5MD)**



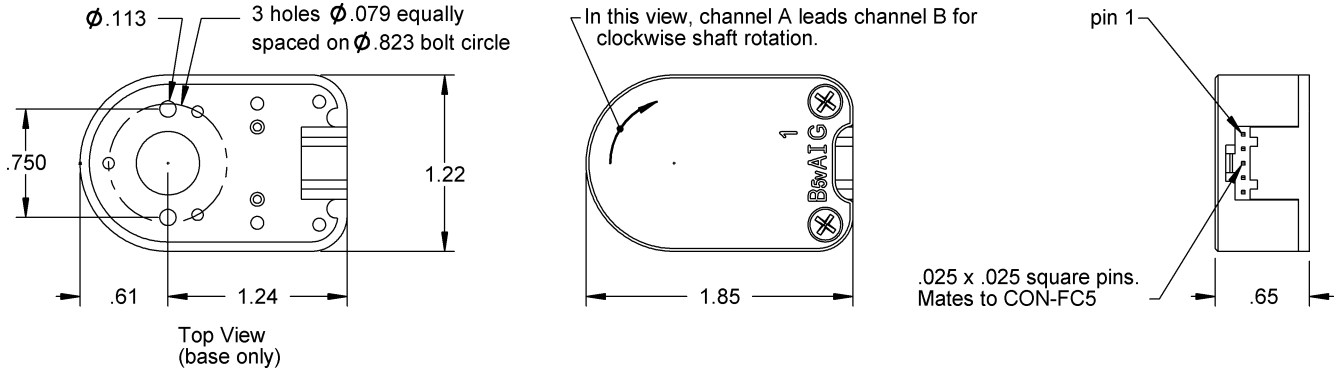
## Standard Single-ended Mechanical Drawing (E5S):



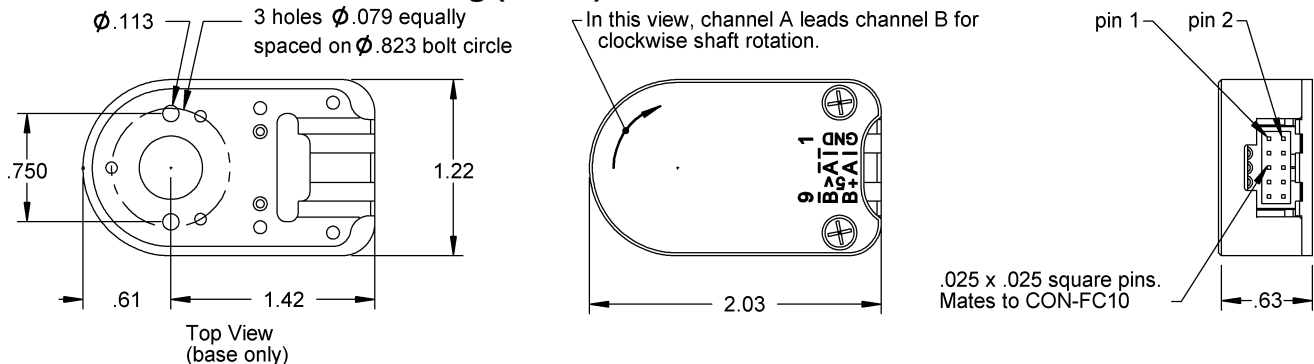
## Standard Differential Mechanical Drawing (E5D):



## Metal Single-ended Mechanical Drawing (E5MS):



## Metal Differential Mechanical Drawing (E5MD):



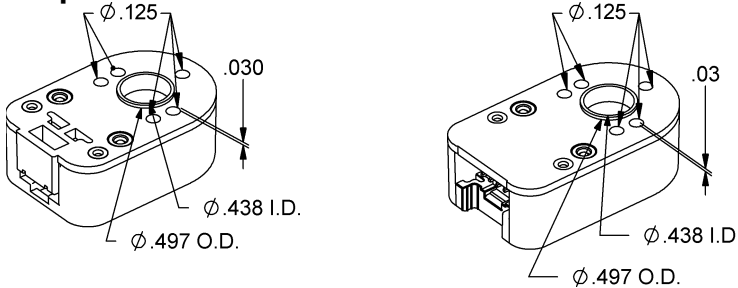
## Options:

### 3-option:



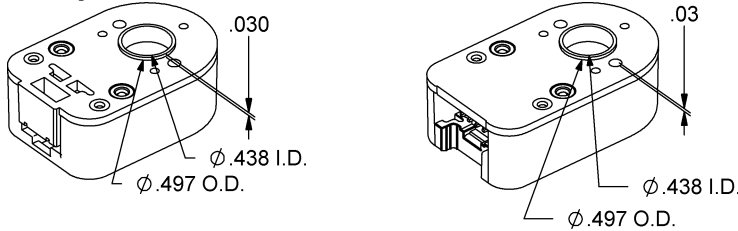
The 3-option makes all five of these hole diameters .125". The .438" diameter center hole can also mate with a motor boss.

### A-option:



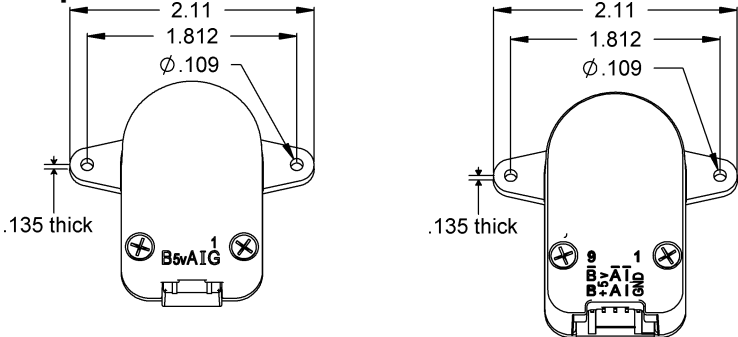
The A-option adds a .497" diameter alignment shoulder designed to slip into a .500" diameter recess in the mounting surface centered around the shaft.

### A3-option:



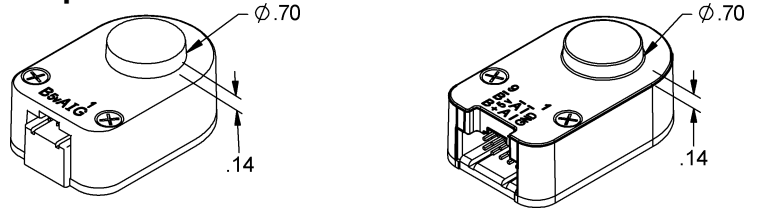
The A3-option adds both of the above options (A-option and 3-option).

### G-option:



This option includes molded ears on the E5 base which enable it to be mounted to a 1.812" diameter bolt circle. The mounting holes are designed to fit 4-40 screws. Because the ears are molded to the E5 base this does not increase the thickness of the encoder and does not add to the required shaft length. This option will work with shaft lengths of .445" to .570"

### E-option:



The E-option provides a cylindrical extension to the cover allowing for longer shafts of up to .750".

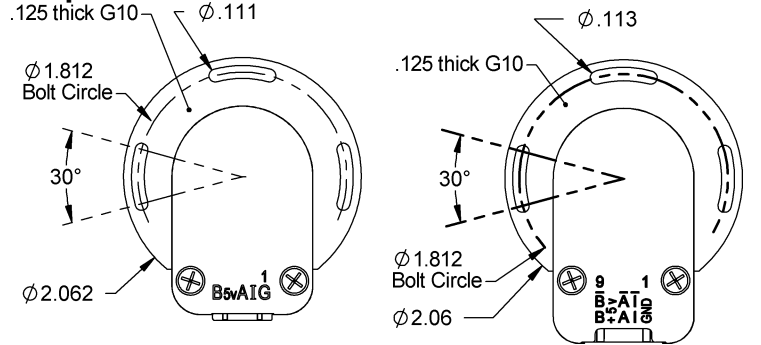
### H-option:



The H-option adds a hole to the cover for the shaft to pass through.

- > Shafts 2mm to 4mm, a .203" diameter hole is supplied.
- > Shafts 3/16" to 1/4", a .295" diameter hole is supplied.
- > Shafts 5/16" to 10mm, a .438" diameter hole is supplied.

### R-option:



This adapter is an 1/8" thick fiberglass adapter which is pre-mounted to the base of the encoder. It allows the E5 to be rotated  $\pm 15^\circ$  while operating for index orientation. Use three 4-40 x 1/4" screws (sold separately). When installing the hub, with the 3 screws loose, rotate the index to the approximate position. After assembly, with the 3 screws loose, rotate while operating to the desired index location and tighten. Note that this adds 1/8" to the required shaft length. **Please note:** Only available in polycarbonate versions (E5D and E5S).

### T-option:



When mounting holes are not available, a pre-applied transfer adhesive (with peel-off backing) is available for "stick-on" mounting. Use the centering tool (sold separately) to slide the base into position. T-option specifies transfer adhesive on the standard mounting base.

**Please note:** Only available in polycarbonate versions (E5D and E5S).

## Mechanical Specifications:

Parameter	Dimension	Units
Moment of Inertia	8.0 x 10 <sup>-6</sup>	oz-in-s <sup>2</sup>
Hub Set Screw Size	3-48 or 4-48	in.
Hex Wrench Size	.050	in.
Encoder Base Plate Thickness	.135	in.
3 mounting Screw Size	0-80	in.
2 mounting Screw Size	2-56 or 4-40	in.
3 Screw Bolt Circle Diameter	.823 ±.005	in.
2 Screw Bolt Circle Diameter	.750 ±.005	in.
Required Shaft Length	.445 to .570*	in.
With E-option	.445 to .750*	in.
With H-option	>=.445*	in.
Weight		
Polycarbonate Single-ended (E5S)	0.82	oz.
Polycarbonate Differential (E5D)	0.91	oz.
Metal Single-ended (E5MS)	1.31	oz.
Metal Differential (E5MD)	1.39	oz.

\* Add .125" to the required shaft length when using R-option.

## Torque Specifications:

Parameter	Torque
Hub Set Screw to Shaft	2-3 in.-lbs.
Cover (4-40 screws through cover into base)	2-3 in.-lbs.
Base to Mounting Surface	4-6 in.-lbs.
Base to Mounting Adapter Plate	4-6 in.-lbs.
Adapter Plate to Mounting Surface (4-40 screws)	4-6 in.-lbs.

## Disk Optics:

Be sure to keep different diameters, resolutions and options separated. The resolution of the optoelectronic modules and the code wheels must match. Index and non-index parts cannot be mixed since the optical patterns are different. An identifier is stamped on each optoelectronic module.

### For Agilent Modules (HEDS):

The 2-channel (non-index) version can be identified by a 9100 or 9200. The 3-channel (index) version can be identified by a 9140. One letter specifies the resolution as shown in the table below.

### For US Digital Modules (EM1):

Only available in 3-channel (index) version and are identified by a 1 for 1" disk. The second number identifies the resolution as shown in the table below (*in italics*).

Disk	Standard	Index	Disk	Standard	Index
32	-	1-32	400	H	H
50	S	S	500	A	A
96	C	C	512	I	I
100	C	C	540	I	-
110	C	-	720	-	1-720
120	C	-	900	-	1-900
192	E	E	1000	B	1-1000
200	E	E	1016	J	-
250	F	F	1024	J	1-1024
256	F	F	1250	-	1-1250
360	G	G			

## Single-ended Electrical Specifications:

For complete details see the EM1 / HEDS data sheet.

### Phase Relationship:

A leads B for clockwise shaft rotation, and B leads A for counterclockwise rotation viewed from the cover / label side of the encoder (*see the EM1 / HEDS data sheet*).

## Differential Electrical Specifications:

Specification	Min.	Typ.	Max.	Units	Notes
Supply	4.5	5.0	5.5	Volts	
Current Consumption					
Index - 32 CPR	-	28	53	mA	No load
Index - 720, 900, 1000, 1024, 1250 CPR	-	56	59	mA	No load
Index - All Other Resolutions	-	58	88	mA	No load
Non-index <1000 CPR	-	18	43	mA	No load
Non-index >=1000 CPR	-	58	88	mA	No load
Output Voltage					
Sourcing to +5	2.4	3.4	-	Volts	@ -20mA
Sinking to Ground	-	0.2	0.4	Volts	@ 20mA

> For complete details see the EM1 / HEDS data sheet.

## Compatible Cables / Connectors:

Finger-latching:		
5-pin	10-pin	Description
CON-FC5-22*	CON-FC10	Connector
CA-3133-1FT**		Connector on one end with 4 12" wires
CA-3132-1FT**		Connector on one end with 5 12" wires
CA-3131-6FT**	CA-4217-6FT	Connector on one end of a 6' shielded round cable
	CA-4174-6FT***	Same as CA-4217, but for L-option only
CA-3620-6FT**	CA-3619-6FT	Connectors on both ends of a 6' shielded round cable
	CA-3807-FT***	Same as CA-3807, but for L-option only

\* 22 AWG is standard. 24, 26 and 28 AWG are also available.

\*\* Single-ended output and accompanying cables are typically designed for cable lengths of 6 feet or less; for longer cable lengths, differential output and accompanying cables are recommended.

\*\*\* Avago / Agilent / HP compatible cable assembly.

### Attention:

- > Specify cable length when ordering.
- > Custom cable lengths are available. See the **Cables / Connectors** data sheet for more information.

## Pin-outs:

Pin	5-pin Single-ended	10-pin Differential Standard	10-pin Differential Agilent (L-option)
1	Ground	Ground	No connection
2	Index	Ground	+5VDC power
3	A channel	Index-	Ground
4	+5VDC power	Index+	No connection
5	B channel	A- channel	A- channel
6		A+ channel	A+ channel
7		+5VDC power	B- channel
8		+5VDC power	B+ channel
9		B- channel	Index-
10		B+ channel	Index+

## Accessories:

### Spacer Tools:

**SPACER-4218** Price: **\$0.53**

### Base Mounting Screws:

**SCREW-184** (qty. 3) Price: **\$0.26**  
080 x 1/4"

**SCREW-176** (qty. 2) Price: **\$0.26**  
256 x 1/4"

**SCREW-290** (qty. 2) Price: **\$0.26**  
4-40 x 1/4"

> Quantity shown are required for mounting.

### Hex Tools:

**HEXD-3404** Price: **\$5.25**  
Hex driver, .050" flat-to-flat for 3-48  
or 4-48 set screws.

**HEXW-349** Price: **\$0.53**  
Hex wrench, .050" flat-to-flat for 3-48  
or 4-48 set screws.

### Centering Tool:

This reusable tool provides a simple method for accurately centering the **E5 Series** base onto the shaft. It is recommended for the following situations:

- > When using mounting screws smaller than 4-40.
- > When the position of the mounting holes is in question.
- > When using the 3-hole mounting pattern.
- > When using the T-option transfer adhesive.

CTOOL -

Price  
**\$5.25**

Shaft Diameter:	
079	237
118	250
125	312
156	315
157	375
187	394
197	

## Ordering Information:

### E5S

#### Standard:

\$40.95 / 1  
\$36.44 / 10  
\$31.07 / 50  
\$27.53 / 100

### E5S

#### Index/HiRes:

(Hi Res: >=1000 CPR)

\$50.37 / 1  
\$44.82 / 10  
\$38.22 / 50  
\$33.86 / 100

### E5D

#### Standard:

\$54.60 / 1  
\$48.57 / 10  
\$41.42 / 50  
\$36.72 / 100

### E5D

#### Index/HiRes:

(Hi Res: >=1000 CPR)

\$63.88 / 1  
\$56.83 / 10  
\$48.46 / 50  
\$42.96 / 100

### Cost Modifiers:

- > Add \$6.00 for R-option.
- > Add \$6.00 for T-option.
- > Add \$3.00 for PKG1-option.
- > Add \$4.00 for PKG2-option.
- > Add \$7.00 for PKG3-option.

### E5MS

#### Standard:

\$61.95 / 1  
\$57.75 / 10  
\$51.45 / 50  
\$49.35 / 100

### E5MS

#### Index/HiRes:

(Hi Res: >=1000 CPR)

\$71.24 / 1  
\$66.41 / 10  
\$59.17 / 50  
\$56.75 / 100

### E5MD

#### Standard:

\$75.60 / 1  
\$69.89 / 10  
\$61.80 / 50  
\$58.54 / 100

### E5MD

#### Index/HiRes:

(Hi Res: >=1000 CPR)

\$86.94 / 1  
\$80.37 / 10  
\$71.07 / 50  
\$67.32 / 100

E5

### Version:

**S** = Polycarbonate single-ended.  
**D** = Polycarbonate differential.  
**MS** = Metal single-ended.  
**MD** = Metal differential.

### CPR:

32\*\*  
50  
96  
100  
110\*  
120\*  
192  
200  
250  
256  
360  
400  
500  
512  
540\*  
720\*\*  
900\*\*  
1000  
1016\*  
1024  
1250\*\*

### Shaft Diameter:

Code	Size
079	2mm
118	3mm
125	1/8"
156	5/32"
157	4mm
187	3/16"
197	5mm
237	6mm
250	1/4"
312	5/16"
315	8mm
375	3/8"
394	10mm

### Options: (specify in order shown)

**I** = Index (3rd channel).  
**L** = Avago / Agilent / HP compatible pin-out.<sup>†</sup>  
**E** = Adds an extension to cover.  
**H** = Adds hole in cover.  
**A** = Adds self-aligning shoulder to base.  
**3** = Changes diameter of all five base mounting holes to .125".  
**A3** = Adds self-aligning shoulder to base and changes diameter of all five base mounting holes up to .125".  
**G** = Adds 1.812 mounting "ears" to base.  
**R** = Adds 3-slot adapter to bottom of base.<sup>††</sup>  
**T** = Adds transfer adhesive to base.<sup>††</sup>

### Options Notes:

<sup>†</sup> Only available with differential versions (**E5D** and **E5MD**).  
<sup>††</sup> Only available with polycarbonate versions (**E5D** and **E5S**). A centering tool is highly recommended when using the T-option.

### Packaging Options:

(default) = Encoder components packaged in bulk. One spacer tool and one hex driver per 100 encoders.  
**PKG1** = Each encoder packaged individually. One spacer tool and one hex driver per 100 encoders.  
**PKG2** = Each encoder packaged individually with one spacer tool and one hex wrench per encoder.  
**PKG3** = Each encoder packaged individually with one spacer tool, one hex wrench, and one centering tool per encoder.

**Important:** When a centering tool is needed it may be most cost effective to use the default packaging option and to order a centering tool separately. This is especially true when ordering a single encoder.

### CPR Notes:

\* Index option not available.  
\*\* 32, 720, 900, 1250 CPR only available with index.

Technical Data, Rev. 06.26.07, June 2007  
All information subject to change without notice.