

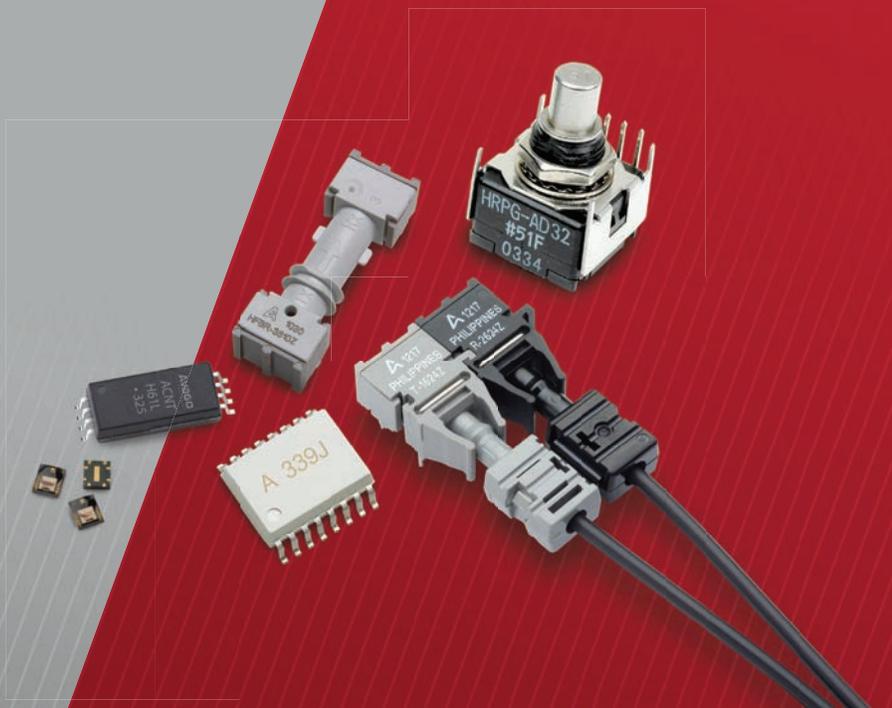
Your Imagination. Our Innovation.



## Avago Product Solutions for Industrial Motor Drives



### Application Solutions

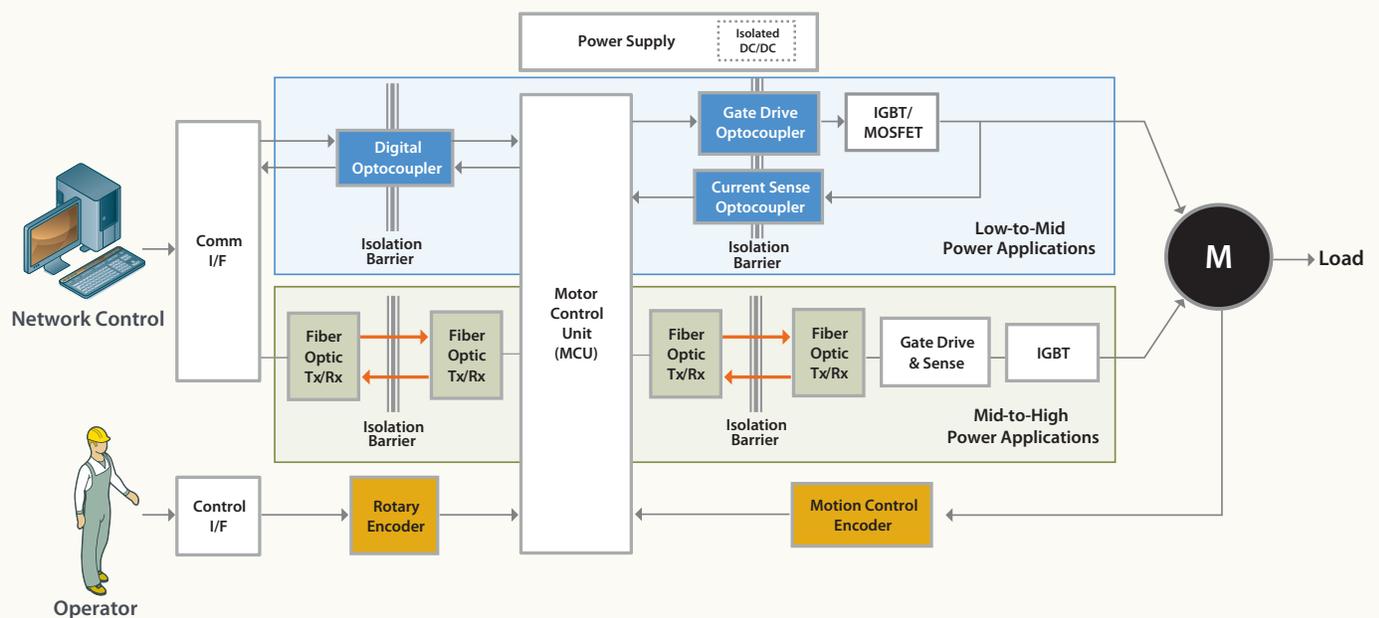


# Delivering Superior Efficiency, Reliability and Accuracy with Unmatched Protection

Electric motors are ubiquitous in industrial applications. Whether it is a DC type, an AC type or a special type like a stepper motor or brushless DC motor, electric motors play a vital role in the operation of motorized machines in industrial environments. In every motor system, there exists a motor drive subsystem for which Avago Technologies offers a wide range of product solutions that include optocouplers, fiber optic solutions, and rotary and motion control encoders (See Figure 1).

As the world becomes increasingly energy conscious and industries worldwide have a renewed focus on energy efficiency for electric motors, there emerge new technical challenges at the component and system levels of industrial motor drive design concerning power, size, performance, reliability and safety. Modern motor drives are expected to drive more current while delivering high efficiency, reliability and accuracy with optimal high voltage protection. Avago Technologies has amassed a unique portfolio of products addressing difficult technical challenges faced by motor system designers today.

**Figure 1. Typical Industrial Motor Drive Subsystem**



# Avago's Broad Portfolio of Motor Drive Solutions

Product Category	Gate Drive Optocouplers	Current/Voltage Sensing Optocouplers	Digital Optocouplers
Optocoupler Solutions	<b>ACNT-H313</b> 2.5A Gate Drive Optocoupler (14.2mm) Viorm = 2262 Vpeak	<b>ACNT-H79x</b> High Linearity Isolation Amplifier (14.2mm) Viorm = 2262 Vpeak	<b>ACNT-H61L</b> Low Power 10MBd Digital Optocoupler (14.2mm) Viorm = 2262 Vpeak
	<b>ACPL-302J</b> 2.5A Gate Drive Optocoupler with DC-DC Flyback Controller Viorm = 1230 Vpeak	<b>ACPL-798J</b> 16-bit Sigma-Delta Isolation Modulator Viorm = 1414 Vpeak	<b>ACPL-M62L</b> Open Drain, Ultra Low Power 10MBd Digital Optocoupler Viorm = 567 Vpeak
	<b>ACPL-337J</b> 4.0A Gate Drive Optocoupler Viorm = 1414 Vpeak	<b>ACPL-C790/A/B</b> High Linearity Isolation Amplifier Viorm = 1414 Vpeak	<b>ACPL-x2xL</b> Compact, Low Power 5MBd Digital Optocoupler Viorm = 1140 Vpeak
	<b>ACPL-339J</b> 1.0A Gate Drive Optocoupler w/ Dual Outputs Viorm = 1414 Vpeak	<b>ACPL-C87x</b> Optically Isolated Voltage Sensor Viorm = 1414 Vpeak	<b>ACSL-7210</b> Dual-channel Bi-directional 25MBd Digital Optocoupler Viorm = 567 Vpeak

Product Category	Gate Driver Isolation Tx/Rx	Data Comm Isolation Tx/Rx
Fiber Optic Solutions	<b>HFBR-1521ETZ, HFBR-2521ETZ, AFBR-1529Z, AFBR-2521CZ</b> DC-5MBd Versatile Link™ POF Tx/Rx	<b>AFBR-59xxZ</b> 125MBd Fast Ethernet and 250MBd Link TRx
	<b>AFBR-1529Z, AFBR-1629Z, AFBR-2528CZ</b> DC - 10MBd Versatile Link POF Tx/Rx	<b>HFBR-1505CZ, HFBR-2505CZ</b> DC-2MBd Interbus Tx/Rx
	<b>AFBR-16xxZ, AFBR-26x4Z/25x9Z</b> DC - 50MBd Versatile Link POF Tx/Rx	<b>HFBR-1515BZ, HFBR-2515BZ</b> DC-12MBd Profibus Tx/Rx
	<b>AFBR-39xxxxRZ*</b> 5/50MBd FO Short Link Isolation 1/2/3/4 Inch Creepage & Clearance	<b>HFBR-1506AMZ, HFBR-2506AMZ, AFBR-1555ARZ/2555ARZ</b> 2MBd - 16MBd Sercos Tx/Rx

\* Available in early 2015

Product Category	Rotary Encoders	Motion Control Encoders	
		Absolute Type	Incremental Type
Motion Control Solutions	<b>HRPG-Axxx#xxx</b> Miniature Panel Mount Rotary Switches Detent or Smooth, Multiple Terminations, Versatile Mount	<b>A Eaton-601x</b> 10 and 12-bit Single Turn Housed Magnetic Encoders	<b>HEDM/HEDS/DEDL/DEDR-5xxx, AEDx-8xxx</b> Bearingless Housed Encoders 2 & 3-channel Options with Resolution from 50 to 3600 CPR
		<b>A Eaton-84AD</b> 12 and 14-bit High Temp Multi-turn Absolute Encoders	<b>HEDS-90xx/91xx/97xx, HEDL/HEDT-90xx/91xx, AEDS/AEDT-9140</b> Incremental Transmissive Encoder Modules with Wide Options 2 & 3-channel Options with Resolution from 50 to 2048 CPR
		<b>A Eaton-9000</b> 17-bit Single-turn Absolute Encoder, 2048 CPR Analog Incremental	<b>AEDS/AEDT/AEDB-9340</b> Incremental Transmissive Encoder Modules 6-channel Output (A, B, I, U, V, and W)
			<b>AEDR-83xx, AEDR-84xx</b> 2-channel Incremental Reflective Encoder with Resolution from 75 to 318 LPI
		<b>AEDR-85xx (up to 304 LPI), AEDR-871x (up to 318 LPI)</b> 3-channel High Resolution Digital Incremental Reflective Encoders Built-in Interpolation up to 4X for AEDR-8500 and up to 16X for AEDR-871x Operating Voltage of 3.3V or 5V Supply	
		<b>AEDR-872x</b> 2-channel Analog & 1 Digital Index Incremental Reflective Encoders Interfaces with External Interpolator for Ultra High Resolution Applications	



# Maximizing Efficiency in Motor Drives

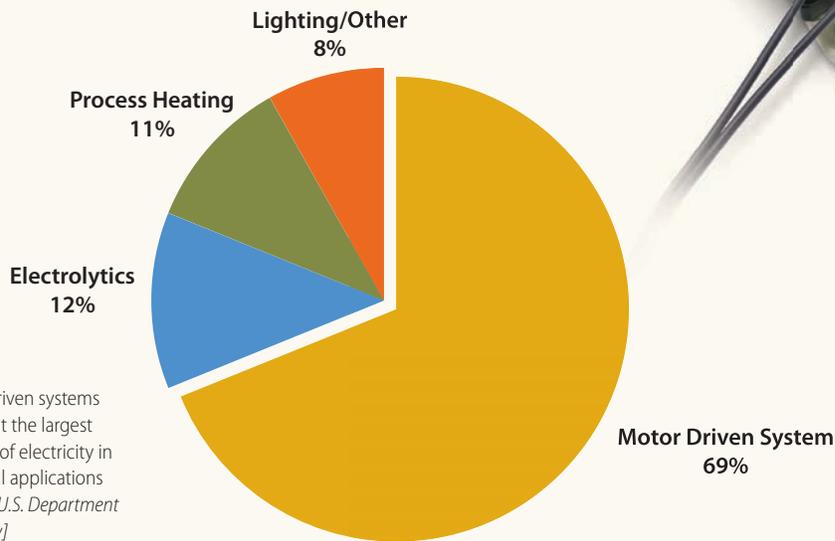
It is estimated that electric motors account for more than two thirds of electricity consumption in industrial applications. Improving power efficiency of industrial motor drives is an integral part of global energy efficiency initiatives to help reduce industrial energy consumption. In a typical industrial motor drive operation, a significant amount of power is lost in the inverter stage due to inefficiency in the IGBT or MOSFET switching. Avago Technologies provides several innovative gate drive solutions that maximize power efficiency in the inverter.

Improving power efficiency of industrial motor drives would substantially reduce industrial electricity consumption.





The combined Avago Versatile Link™ and Amantys Power Insight™ solution optimizes power efficiency for high power inverters.



Motor driven systems represent the largest end use of electricity in industrial applications  
 [Source: U.S. Department of Energy]



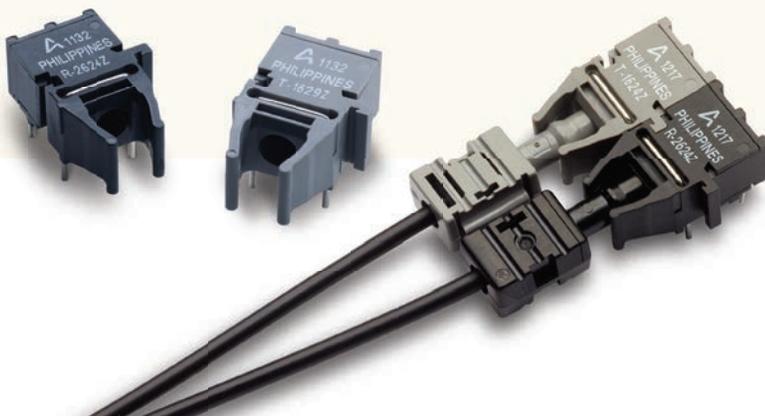
### Dual-Output Gate Drive Optocoupler Minimizing Switching Losses in MOSFET Buffer Stage

The Avago ACPL-339J is a 1.0A gate drive optocoupler device with dual outputs optimized for driving both high-side and low-side gates of the MOSFET buffer stage which drives the IGBT device. The device features an internal active timing control circuitry preventing cross conduction and minimizing switching losses in the MOSFET buffer stage. The use of the ACPL-339J maximizes gate design flexibility and inverter power efficiency.

The ACPL-339J maximizes gate design flexibility and inverter power efficiency.

### Fiber Optic Solution with Amantys Power Insight™ Protocol Monitoring IGBT Switching Characteristics & Intelligently Controlling Switching Rate

Avago Technologies has combined high reliability fiber optic solutions with innovative digital processing and communications to improve motor drive efficiency and availability. Avago's market-proven 50MBd Versatile Link™ transmitter and receiver devices (i.e., AFBR-162xZ and AFBR-262xZ) support the Amantys Power Insight™ protocol. The solution enables real-time monitoring, diagnostics and adjustment of power transistor switching rates over existing Versatile Link IGBT control interface commonly used in high power inverters.



High reliability optocouplers and fiber optic solutions are essential to long term operation and availability of industrial motors.



## Ensuring High Reliability in Motor Drives

Many Avago gate drive optocouplers like the Avago ACPL-337J and ACPL-302J are fully-featured and highly-integrated devices. Integrating multiple functional blocks of a system in one chip not only reduces system BOM cost, size and power, but also improves overall system reliability.

In addition, Avago Technologies provides a wide array of industrial-grade fiber optic solutions for highly reliable data communications and industrial networking. Fiber optic communication plays an important role in many industrial motor drive applications ensuring signal integrity and providing mission-critical system control and status communications. Especially for systems that operate in noisy and unshielded environments in which signal integrity could be compromised, it is imperative that fiber optics be used for data links from the MCU to the gate driver and the communication interfaces.

## Industrial Grade Fiber Optic Solutions Ensuring Signal Integrity & Providing Highly Reliable Data Communications

Avago's Versatile Link™ plastic optical fiber (POF) Tx/Rx solutions have been widely deployed in industrial motor drive applications. With high immunity to radio frequency interference (RFI) and electromagnetic interference (EMI), the devices are used to ensure drive signals are reliably delivered from the MCU to the gate driver. Furthermore, the solutions are versatile supporting data rates up to 125MBd and link distances up to 50 meters using standard POF cable. This makes the Versatile Link™ solutions an ideal choice for many challenging industrial motor drive applications.

The Avago AFBR-5972Z is a 125MBd Ethernet fiber optic transceiver solution, providing system designers with the ability to implement either 100Mbps or 10Mbps Ethernet communications with link distances up to 50 meters using standard POF cable. The transceiver features a compact form factor similar to the UTP connector.

The Avago HFBR-15xxxZ and HFBR-25xxxZ are families of fiber optic transmitter and receiver devices designed for industrial networking applications including SERCOS, PROFIBUS and INTERBUS-S. The devices are housed in a dual-in-line package that is made of high strength, heat resistant, chemical resistant and UL 94 V-0 flame retardant plastic. The package is designed for auto-insertion and wave soldering, which is ideal for high volume production applications.

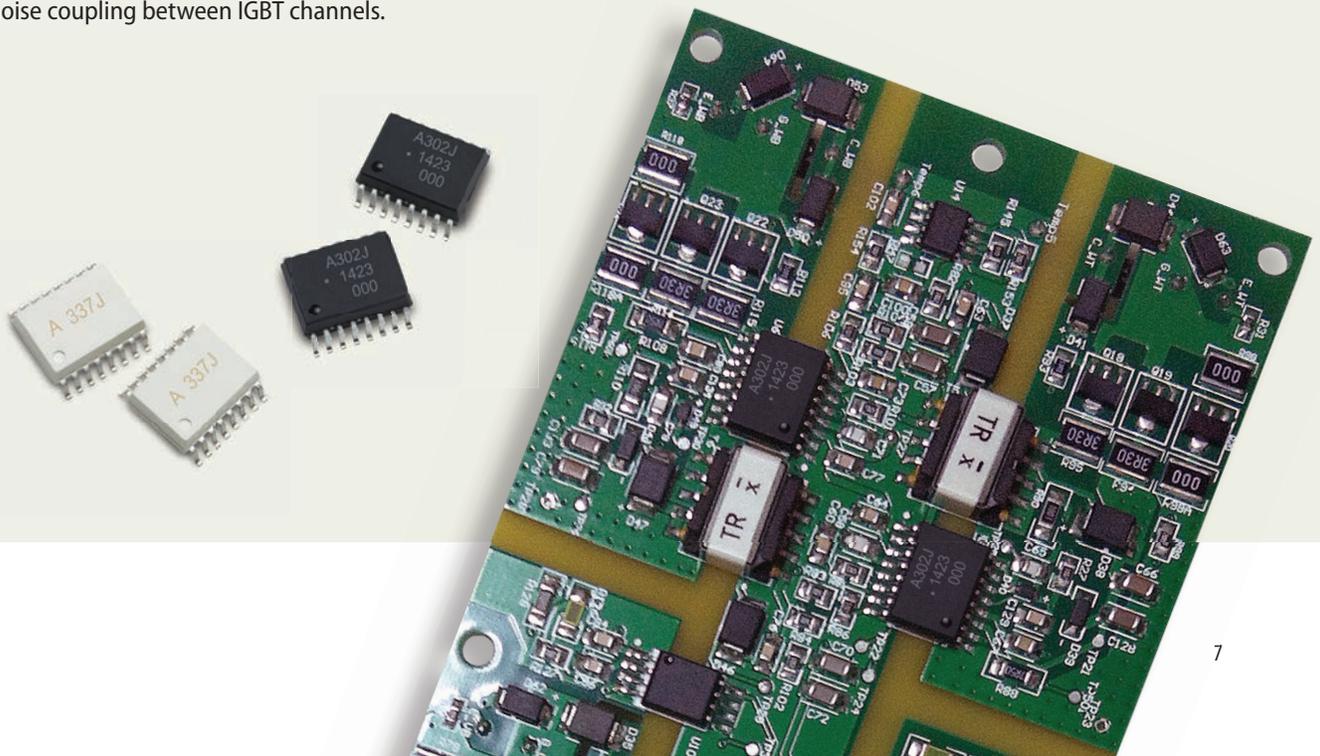


## Highly Integrated Gate Drive Optocouplers Simplifying Gate Drive Design & Improving System Reliability

The Avago ACPL-337J is a 4A gate drive optocoupler device capable of driving high power MOSFET or IGBT directly, eliminating an output buffer stage. The device also features integrated LED driver, active Miller clamp, high DESAT blanking current source, and Under Voltage Lock-Out (ULVO) feedback control circuit, providing a highly integrated gate drive solution for industrial motor drive applications.

The Avago ACPL-302J is a 2.5A gate drive optocoupler device with integrated flyback controller, simplifying and improving isolated DC-DC converter design. By integrating the flyback controller, the ACPL-302J allows fewer discrete components and small high-efficiency transformer to be placed next to the device thereby reducing the overall footprint and minimizing electromagnetic interference (EMI) and noise coupling between IGBT channels.

The ACPL-302J simplifies gate drive design and improves system reliability.



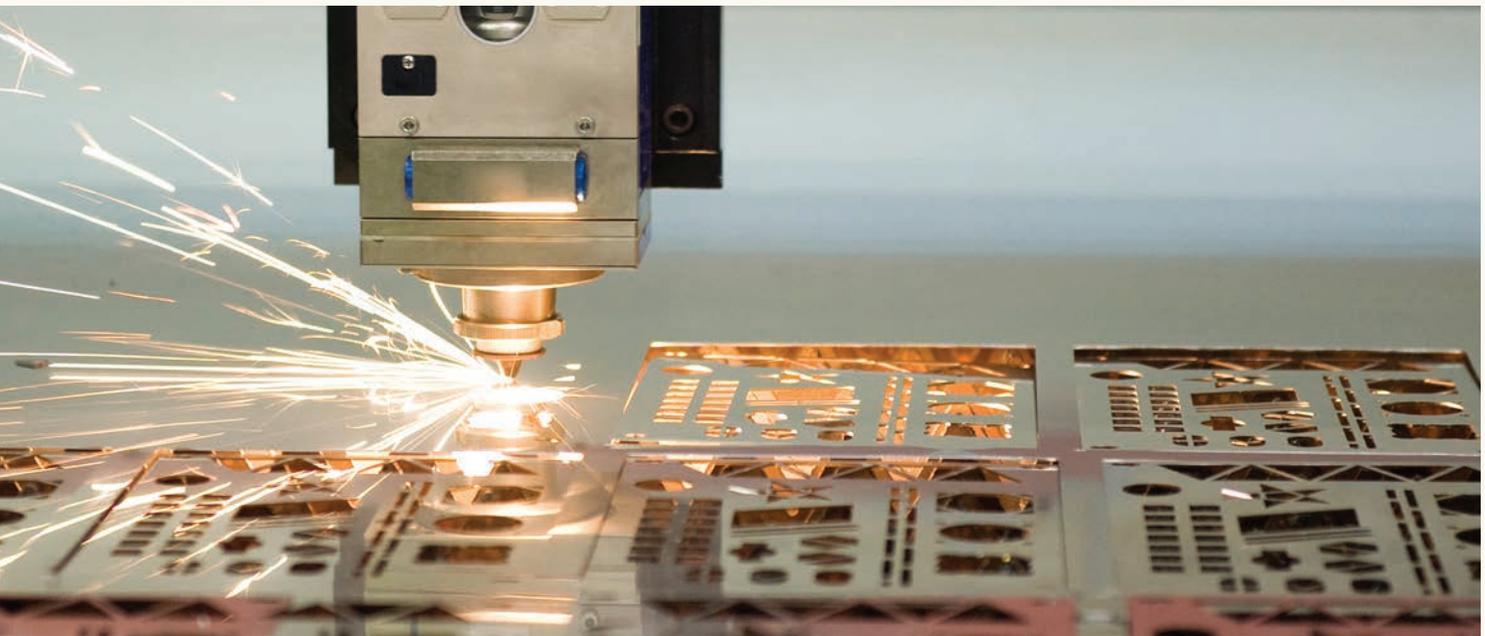
# Controlling Motor Drives with High Accuracy

Many industrial motor applications like industrial robots in manufacturing and process industries require accurate motor control. Feedback of position information from the motor back to the MCU improves the motor commanded position accuracy of an end effector. For sophisticated motor control applications, motion information is typically fed back to the MCU to help control a path of an end effector in space. Avago Technologies provides a wide range of motion control optical encoders that meet stringent positioning and velocity sensing requirements for industrial motor drive applications. Avago also offers high resolution rotary switches used for human-machine interface for rotary control and data entry purposes.

In addition, the MCU also collects current and voltage information from the inverter stage to calculate output signals enabling effective control and fault management. Combining high precision sigma-delta A/D conversion and robust optical coupling technology in a miniature package, Avago's isolation amplifier product family provides an ideal solution for current and voltage sensing designs.\*

High resolution motion encoder enables accurate control of an end effector of milling machinery.

*\*For more information on Avago Current/Voltage Sensing Optocouplers, refer to Avago document AV00-0196EN "Time to upgrade your current sensing technology!"*





Avago high resolution rotary switches are ideal for rotary control and data entry on instrument control panels.



### High Resolution Single-turn Absolute Optical Encoder Solution Delivering Best-in-class Accuracy

The Avago AEAT-9000 is an all-in-one single-turn absolute encoder device supporting 17-bit resolution with +/-1 step code monotony, 500kHz 2048-CPR analog Sine/Cosine output and incremental 2048-CPR digital output. The device incorporates novel LED regulation with an error output pin designed for monitoring LED degradation and a Zero\_RST pin used to set the encoder start position to any position. The modular package of the AEAT-9000 enables the device to be directly integrated on the motor, simplifying motor system design and enhancing motor performance.

The Avago HEDM/HEDS/HEDL/HEDR-5xxx and AEDx-8xxx are series of bearingless housed encoder devices supporting resolutions from 50 to 3600 counts per revolution (CPR). The devices come in a 2-channel or 3-channel output option with/without integrated line driver. With the aid of an alignment jig, the devices require minimal alignment time and are easy for installation and assembly into servo motors.



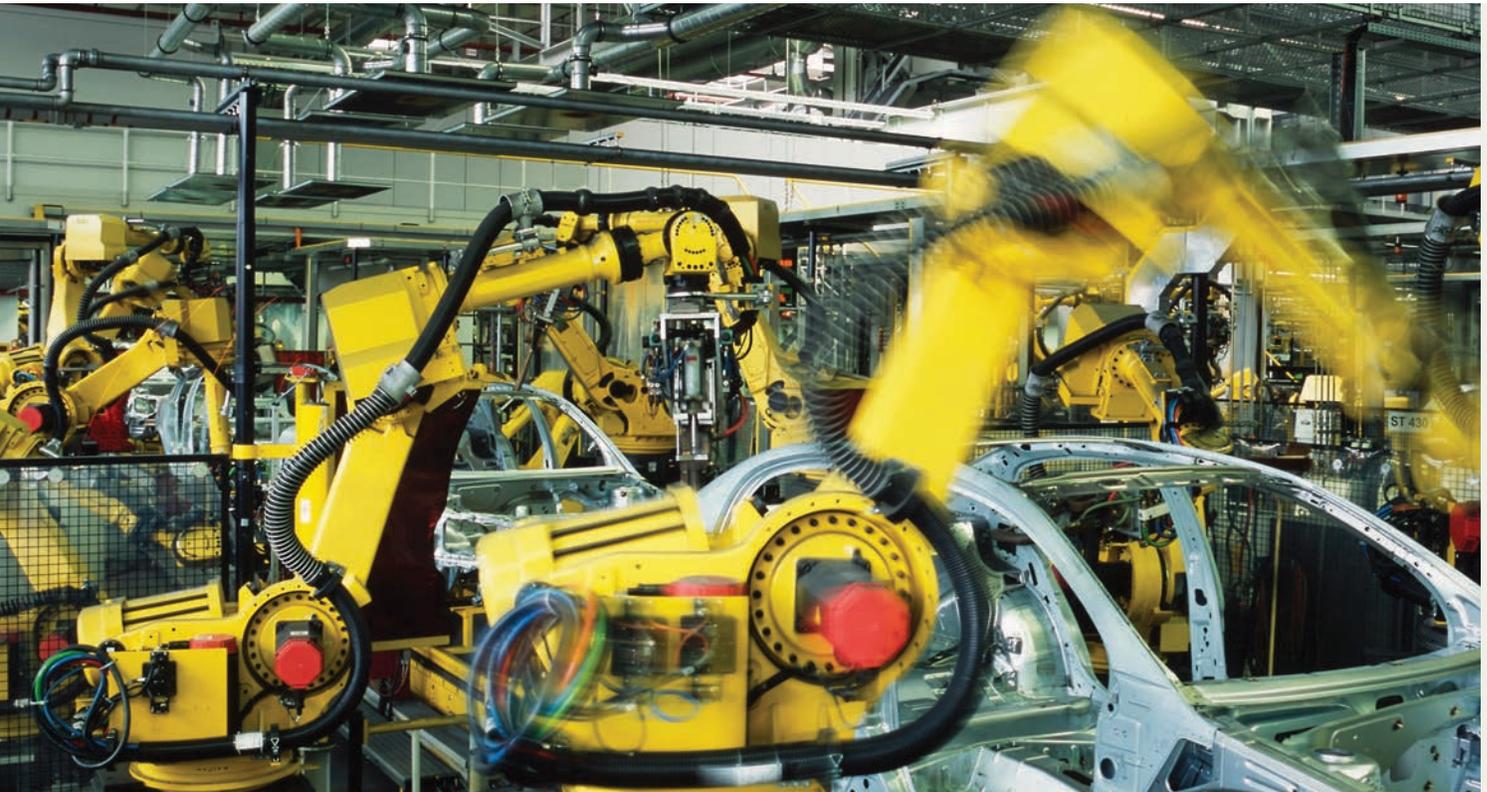
### High Resolution Panel Mount Rotary Switches Ideal for Rotary Control and Data Entry

The Avago HRPG-Axxx#xxF is a family of miniature panel mount rotary switches designed for rotary control and data entry purposes. Available options include detent or smooth rotation, multiple terminations and versatile mounting capabilities.

### Industry's Smallest 3-channel Reflective Incremental Optical Encoder Solution Ideal for Low Power, Space Constrained Applications

The Avago AEDR-87xx is a series of 3-channel reflective optical encoder devices featuring a low supply voltage option, dual analog/digital output options and 318 LPI encoding resolution. The devices are packaged in the industry's smallest form factor for a 3-channel reflective optical encoder, making it ideal for low power, space constrained applications.

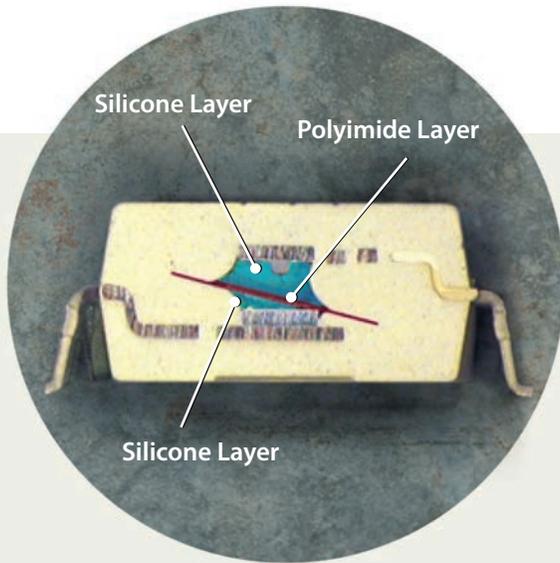




Robust high voltage protection and signal isolation are critical to preventing catastrophic failures and ensuring human safety.

## Protecting Motor Drives with Unmatched Isolation

Avago Technologies is a leading provider of isolation products for industrial motor drive applications, leveraging on market-proven and time-tested optocoupler technology and innovative fiber optic technology. Avago optocoupler products provide unmatched high voltage isolation meeting international safety standards with  $V_{orm}$  up to 2,262 V<sub>peak</sub>. For high transient voltage suppression applications, Avago Technologies offers a unique selection of fiber optic devices capable of suppressing up to 50 kV of transient peak voltage.



Avago optocouplers have 3 layers of insulation with thick polyimide film exceeding industry safety standards and  $V_{orm}$  up to 2,262 Vpeak.



### Compact Optocouplers with 14.2mm Creepage & Clearance Providing Cost-effective High Voltage Isolation

The Avago ACNT-Hxxx is a family of 14.2mm optocoupler devices for high voltage applications. The ACNT-H313 is a high efficiency 2.5A gate drive optocoupler designed for driving IGBT. The ACNT-H61L is a low power 10MBd digital optocoupler designed for system control and data communications. The ACNT-H790 is a high-linearity isolation amplifier designed for current and voltage sensing. With the industry's highest insulation voltage in compact SSO-8 footprint, the ACNT-Hxxx family is the most complete and cost-effective set of optocoupler solutions providing unmatched on-board isolation for high voltage applications.

### Innovative Fiber Optic Short Link Isolation with up-to-4 inch Creepage & Clearance Suppressing up to 50 kV of Transient Peak Voltage.

The Avago AFBR-39xxxxRZ is a series of fiber optic Tx/Rx short-link isolation devices capable of suppressing up to 50 kV of transient peak voltage per IEC 60664-1 specification. The devices support data rates from DC to 50 MBd and creepage & clearance from one to four inches, suitable for high voltage on-board isolation for high transient voltage suppression applications.

Avago fiber optic short-link isolation devices are suitable for high-voltage on-board isolation targeting high transient voltage suppression applications.





# Your Imagination. Our Innovation

Avago Technologies is a leading designer, developer and global supplier of a broad range of analog, digital, mixed signal and optoelectronics components and subsystems with a focus in III-V compound semiconductor design and processing. Backed by an extensive portfolio of intellectual property, Avago products serve four primary target markets: wireless communications, wired infrastructure, enterprise storage, and industrial and other. Avago has a global employee presence and rich heritage of technical innovation spanning over six decades.

Avago has strong market positions across a broad range of market segments with highly differentiated products that include:

- Film Bulk Acoustic Resonator (FBAR) Filters
- RF Front End Modules
- Parallel Optics Transceivers
- High Speed SerDes ASIC
- HDD Read Channel & PreAmps
- RAID and SAS I/O Controllers
- PCIe Switches
- Optocouplers
- Motion Encoders
- Industrial Fiber Solutions
- LED Display & Signage Solutions



For product information and a complete list of distributors, please visit our website:

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