

Project: Draper 2010-11



Final Report Appendix H - Datasheets *Prepared for:* Draper Laboratory

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Windows®. Life without Walls™. Dell recommends Windows 7.



Dell Precision R5400

The Dell Precision™ R5400 is a high-performance dual-socket 2U rack workstation that provides an industry-standard alternative to blade workstations providing fully scalable high-performance graphics options.

A rack workstation that is big on performance and flexibility

Looking for a high-end workstation that delivers world-class performance and exceptional processing and graphics power, but is engineered for a high-density rack environment? Look no further. Developed in close collaboration with hardware and software partners, the Dell Precision R5400 rack workstation delivers no-compromise, high-performance workstation technologies in a flexible 2U chassis – an ideal solution for centralizing critical customer data and workstation assets in secure locations (data centers, OEM customer enclosures, etc.). This is particularly attractive for high-performance clusters/render farms, crowded heat and acoustically sensitive environments like financial trading or factory floors. Optimized for performance, reliability and scalability in environments where space is at a premium, the Dell Precision R5400 lets you power through complex tasks with configuration options simply not available on blade workstations today.

Visual realism with high-performance open GL graphics

Dell Precision workstations offer an intelligent selection of high-performance graphics cards that can satisfy a range of customer needs, from outstanding OpenGL® 3D performance to dependable 2D performance. With its two PCIe x16 slots, the Dell Precision R5400 is well equipped to house high-performance graphics cards to help meet the toughest of visualization challenges. Select from a wide range of industry-standard cards while retaining the option to change or upgrade at a later date.

Optimal scalability in a compact 2U chassis

The Dell Precision R5400 provides a highly scalable, cost-effective architecture that can easily be housed in a rack without the expense and potential redundant rack space associated with an enclosure for blades. Workstations address many different user needs and run a wide variety of applications, using graphics and other industry standard cards. The flexibility of this rack workstation is enhanced by a choice of PCI, PCIx or PCIe slot combinations – in addition to the graphics slots – making it easy to optimize for a particular solution.

Peace of mind through ISV application certification

Dell partners with leading ISVs to certify system and application compatibility, ensuring optimized performance in demanding

workstation environments. And, to assure access to the latest productivity enhancing technology solutions, Dell invests in the workstation ISV community by providing the hardware platforms needed to further multithreaded and 64-bit application development. By maintaining strong relationships with ISV application developers, Dell engineers can provide ongoing optimization and support, should you need it.

Advanced remote access to the performance of the Dell Precision R5400

The full performance of the Dell Precision R5400 can be accessed by using the optional Dell FX100 Remote Access Device. Part of Dell's Flexible Computing initiative, this solution (host card and remote user portal) benefits from having dedicated hardware running Teradici® PC-over-IP® (PCoIP) technology that leaves the workstation's CPU and network resources available to run the chosen applications. A more flexible and low-cost alternative to traditional wired KVM remote solutions, the Dell FX100 can deliver an outstanding remote user experience (network infrastructure dependent). For virtual remote desktop environments (no host card needed) the Dell FX100¹ is a certified PCoIP Hardware Zero Client with VMware View™ 4 enabling simple plug-and-play access to VMware View 4 Virtual Desktops. Please refer to the Dell FX100 Remote Access Device product brochure for more information on this world-class solution.

A new solution for some old challenges

The Dell Precision R5400, with the optional remote access solution, offers advanced relevant technologies designed to overcome some tough traditional challenges and succeed where other solutions have struggled to deliver:

- Centralizing critical data and applications in a secure location
- Eliminating the need for workstation users to be in inhospitable areas
- Enabling high-performance clustering using GPGPUs (General Purpose GPUs)
- Enabling flexible resource allocation (24-hour usage models)²
- Enabling faster moves and changes as project teams are reassigned—retaining benefits of a standards-based workstation
- Addressing the distance limitations of traditional wired KVM solutions with optional Dell FX100 remote access device

Feature	Dell Precision R5400 Rack Workstation Technical Specifications																													
Processors	Dual-Core (6MB L2 cache) & Quad-Core (2X 6MB L2 cache) Intel® Xeon® Processors																													
Operating System	<ul style="list-style-type: none"> Genuine Windows® 7 Ultimate 32-Bit; Genuine Windows 7 Ultimate 64-Bit Genuine Windows® 7 Professional 32-Bit; Genuine Windows 7 Professional 64-Bit Genuine Windows Vista® Business 32-bit; Genuine Windows Vista® Business 64-bit Red Hat® Enterprise Linux WS v.5.3 (Also certified to run Red Hat Enterprise Linux Version 4 64-bit) 																													
Chipset	Intel 5400																													
Memory	Up to 32GB ³ quad-channel architecture fully buffered DIMM 667MHz ECC memory; in 4 DIMM slots																													
Flash BIOS	BIOS 8MB flash memory for system BIOS; SMBIOS 2.5 support																													
Graphics ⁴	<p>Support for 2 PCI Express x16 graphics cards up to 150 watts (in 2 x16 Gen1 PCI-e slots). All graphics cards support dual monitors configurations</p> <table> <thead> <tr> <th>High End 3D</th> <th>Mid-range 3D</th> <th>Entry 3D</th> <th>Professional 2D</th> </tr> </thead> <tbody> <tr> <td>NVIDIA® Quadro® 6000</td> <td>ATI FirePro V7800</td> <td>ATI FirePro V4800</td> <td>ATI FireMV™ V2260</td> </tr> <tr> <td>NVIDIA Quadro 5000</td> <td>ATI FirePro V5800</td> <td>NVIDIA Quadro 600</td> <td>NVIDIA Quadro NVS 420</td> </tr> <tr> <td>NVIDIA Quadro 4000</td> <td>NVIDIA Quadro FX 3800</td> <td>NVIDIA Quadro FX 580</td> <td>NVIDIA Quadro NVS 295</td> </tr> <tr> <td>NVIDIA Quadro FX 5800</td> <td>NVIDIA Quadro 2000</td> <td></td> <td></td> </tr> <tr> <td>NVIDIA Quadro FX 4800</td> <td>NVIDIA Quadro FX 1800</td> <td></td> <td></td> </tr> </tbody> </table>						High End 3D	Mid-range 3D	Entry 3D	Professional 2D	NVIDIA® Quadro® 6000	ATI FirePro V7800	ATI FirePro V4800	ATI FireMV™ V2260	NVIDIA Quadro 5000	ATI FirePro V5800	NVIDIA Quadro 600	NVIDIA Quadro NVS 420	NVIDIA Quadro 4000	NVIDIA Quadro FX 3800	NVIDIA Quadro FX 580	NVIDIA Quadro NVS 295	NVIDIA Quadro FX 5800	NVIDIA Quadro 2000			NVIDIA Quadro FX 4800	NVIDIA Quadro FX 1800		
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NVIDIA Quadro FX 5800	NVIDIA Quadro 2000																													
NVIDIA Quadro FX 4800	NVIDIA Quadro FX 1800																													
GPU	NVIDIA Tesla C1060 GPU; NVIDIA Tesla S1070 1U GPU (Graphics Processing Unit for High-Performance Computing, no graphics output)																													
Hard Drives	<p>Up to 2 SATA hard drives with optional RAID 0 or 1.</p> <ul style="list-style-type: none"> Up to 2.0TB⁵; SATA 3.0GB/s 7200 RPM with 16MB DataBurst Cache™ Up to 250GB⁶; SATA 3.0GB/s 7200 RPM with 8MB DataBurst Cache Up to 300GB⁶; SATA 3.0GB/s 10K RPM with 8MB DataBurst Cache 																													
Hard Drive Controller	Integrated SATA 3.0GB/s controller that supports host-based (software) RAID 0, 1																													
Communications	Integrated: Dual Broadcom® NetXtreme 10/100/1000 Gigabit Ethernet controllers Optional: IEEE 1394a card; Broadcom® NetXtreme 10/100/1000 Gigabit Ethernet controller PCI Express® card																													
Audio	Integrated high-definition audio (Rev 1.0 Specification) with Sigmatel STAC9200 High-Definition Audio CODEC and Intel ESB2's integrated AC97/high-definition digital controller.																													
Standard I/O	Six USB 2.0: two on front panel, three on back panel, and one internal; two serial; two PS/2; two RJ-45; stereo line-in and line-out on back panel																													
Bays	Two internal 3.5" hard disk drive bays; one external 5.25" slim-line optical bay																													
Slots	<p>All full height and full length slots accommodated in two risers:</p> <ul style="list-style-type: none"> Riser 1: two standard PCIe x16 Gen 1 full length graphics slots each with 150W (300W total) Riser 2: either: (1) PCIX 64-bit @ 100MHz; (1) PCIe x16, wired as x8 (default) Or (1) PCIX 64-bit @ 100MHz; (1) PCI 32-bit; 5V 																													
Chassis (2U Rack)																														
Dimensions	27" (68.5cm) D x 17.5" (44.4cm) W x 3.4" (8.6cm) H without bezel attached																													
Peripherals																														
Monitors	Performance flat-panel displays, Dell UltraSharp™ widescreen and standard flat-panel displays from 17" viewable to 30" viewable																													
Keyboard	Dell Enhanced Quietkey™ USB; Enhanced Multimedia USB; Smart Card keyboard USB																													
Mouse	Dell USB two-button mouse and Dell USB optical two-button scroll mouse																													
Optional Speakers	Internal chassis speaker; Dell two- and three-piece stereo system; Dell sound bar for all flat-panel displays																													
Storage Devices																														
Optional Removable Storage	CD-RW/DVD Combo; DVD-ROM; DVD+/-RW; USB external floppy drive																													
Security																														
Software	Trusted Platform Module 1.2 (TPM 1.2); chassis intrusion switch; Setup/BIOS password; I/O interface security																													
Hardware	Front bezel key lock, top chassis cover lock																													
Environmental & Regulatory																														
	You can find additional safety best practices information on the Regulatory Compliance homepage on www.dell.com at the following location: www.dell.com/regulatory_compliance																													
Service & Support																														
Base	3-Year Limited Warranty ⁶ with 3-year standard Next-Business-Day (NBD) on-site ⁷ parts replacement and 3-year NBD on-site service ⁷																													
Recommended	Dell ProSupport is designed to rapidly respond to your business' needs, protect your investment and sensitive data, and provide enhanced proactive support services to help reduce risk and complexity within your IT environment																													

Simplify your workstation at dell.com/Precision

¹ VMware View™ 4 PCoIP® Hardware zero client support on the Dell FX100 requires PCoIP firmware release 3.X.

² Microsoft may require a Remote Desktop license for the Dell FX100 under certain serial usage models. Please consult with Microsoft for details.

³ Up to 1GB may not be available with 32-bit operating systems due to system resource requirements.

⁴ Significant system memory may be used to support graphics, depending on system memory size and other factors.

⁵ GB means 1 billion bytes and TB equals 1 trillion bytes; actual capacity varies with preloaded material and operating environment and will be less.

⁶ For a complete copy of our guarantees and limited warranties, please write Dell U.S.A. L.P., Attention: Warranties, One Dell Way, Round Rock, TX 78682. For more information visit www.dell.com/warranty

⁷ May be provided by third-party. Technician dispatched, if necessary, following phone-based troubleshooting. Availability varies. See dell.com/service contracts for details.

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**MARKETING NAME***: Dell Precision™ R5400**REGULATORY MODEL**: WMTE01**REGULATORY TYPE**: 08107**EFFECTIVE DATE**: November 11, 2010**Dell Inc.**
www.dell.com**TABLE OF CONTENTS FOR PRODUCT SAFETY, EMC & ENVIRONMENTAL DATASHEET****Regulatory**

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I. PRODUCT SAFETY¹

The product has been certified and bears the Mark, as applicable, of the Product Safety authorities as indicated below.

Country/Region	Authority or Mark
Argentina	IRAM
Belarus	BELLIS
Cambodia	ISC
Canada	SCC
China	CNCA or CCC
Croatia	KONCAR
European Union	CE
Germany	TUV
IECEE	IECEE CB
Israel	SII
Kazakhstan	OTAN – CKT
Kenya	KEBS
Mexico	NYCE or NOM
Moldova	INSM
Nigeria	SONCAP
Norway	NEMKO
Russia	GOST
Saudi Arabia	KSA ICCP
Singapore	Safety Registration Scheme
South Africa	NRCS
Taiwan	BSMI
Ukraine	UKRTEST or UKRSERTCOMPUTER
United States	NRTL
Uzbekistan	STZ

* Notice: This product has been assigned a unique regulatory model and regulatory type that is imprinted on the product shipping invoice and product labeling to provide traceability to the regulatory approvals noted on this datasheet. This datasheet applies to any product that utilizes the assigned regulatory model and type including marketing names other than those listed on this datasheet. Requests for specific information on product regulatory approvals should reference the assigned product regulatory model and type.

¹ The above-listed Product Safety certifications may vary depending upon the location of the Dell factory and specific product configuration. Certification marks may not be applied on products for countries outside the purchaser's country.



II. ELECTROMAGNETIC COMPATIBILITY²

The product has been certified and bears the Mark, as applicable, of the EMC authorities as indicated below.

Country/Region	Authority or Mark	Class
Australia / New Zealand	ACMA or C-Tick	Class A
Belarus	BELLIS	Class A
Bosnia & Herzegovina, Montenegro, Serbia	KVALITET	Class A
Canada	ICES	Class A
China	CNCA or CCC	Class A
Croatia	KONCAR	Class A
European Union	CE	Class A
Israel	SII	Class A
Japan	VCCI	Class A
Kazakhstan	OTAN – CKT	Class A
Moldova	INSM	Class A
Norway	NEMKO	Class A
Russia	GOST	Class A
South Africa	SABS	Class A
South Korea	KCC	Class A
Taiwan	BSMI	Class A
Ukraine	UKRTEST or UKRSERTCOMPUTER	Class A
United States	FCC	Class A
Uzbekistan	STZ	Class A
Vietnam	ICT	Class A

III. ERGONOMICS, ACOUSTICS AND HYGIENICS³

The product has been certified and bears the Mark, as applicable, of the Ergonomics, Acoustics and Hygienics authorities as indicated below.

Country/Region	Authority or Mark
Germany	GS
Russia	GOST

IV. POWER CORDS AND USER DOCUMENTATION

Dell products are provided with the power cord and user documentation suitable for the intended country of delivery. Products that are relocated to other countries should use nationally certified power cords and plugs to ensure safe operation of the product. Contact Dell to determine if alternate power cords or user documentation in other languages is available for your market.

² The above-listed EMC certifications may vary depending upon the location of the Dell factory and specific product configuration. Certification marks may not be applied on products for countries outside the purchaser's country.

³ The above-listed Ergonomics, Acoustics and Hygienics certifications may vary depending upon the location of the Dell factory and specific product configuration. Certification marks may not be applied on products for countries outside the purchaser's country.



V. DATASHEET RESPONSIBLE PARTY NAME AND ADDRESS

Dell Inc.
Department: Global Regulations and Standards
MS: PS4-30
Round Rock, Texas 78682, USA
512-338-4400
Regulatory_Compliance@Dell.com

VI. TRADE (IMPORT/EXPORT) COMPLIANCE DATA

System US Harmonized Tariff System (USHTS) Number	8471.50.0150
System US Export Control Classification Number (ECCN)	4A994

For additional questions regarding importing & exporting classification of Dell products, please send an e-mail to:
US_Export_Classification@Dell.com

VII. PRODUCT MATERIALS INFORMATION⁴

Dell's vision is to avoid the use of substances in its products that could seriously harm the environment or human health and to ensure that we act responsibly and with caution. Dell's material restrictions are based on consideration for world-wide legal requirements, international treaties and conventions, and specific market requirements. These restrictions apply to use in Dell products and in the manufacture of Dell products and their components within specified thresholds. Dell enforces these restrictions through robust compliance assurance processes throughout the entire supply chain.

Material Declarations and Certifications

The list of world-wide legal and market requirements is constantly changing and too lengthy to list in this data sheet. However, here are several of the more commonly requested declarations and certifications.

EU RoHS: The Restriction of Hazardous Substances Directive is a European Union directive. Dell has voluntarily adopted the requirements of the directive globally to help eliminate waste, conserve energy and reduce environmentally sensitive materials. Through internal design controls and supply chain declarations, this system⁵ has been verified to comply with the EU RoHS Directive⁶. For more details, please see [RoHS Guidance](#).

China RoHS: China RoHS restricts the same six substances as the EU version. In addition, producers must also properly label and disclose RoHS information for applicable EIP (Electronic and Information Products) and parts sold in China. All Dell products shipping directly into China which were manufactured on or after March 1st, 2007, are China RoHS compliant.

REACH (Registration, Evaluation, Authorization and Restriction of Chemicals, EC 1907/2006) is the European Union's (EU) chemical substances regulatory framework. Dell complies with the Reach directive. For more details, please see www.dell.com/REACH

⁴ **Waste Handling.** Local regulations should be observed when disposing of this product due to the presence of the materials and substances as listed above.

⁵ Options from Dell Custom Factory Integration (CFI), Software and Peripherals (S&P), and Customer Kits may not be RoHS compliant.

⁶ EU Directive on the Restriction of the use of certain Hazardous Substances in electrical and electronic equipment (2002/95/EC) dated January 27, 2003.



Restricted Substances

Dell provides a detailed restricted materials guidance document at: [Restricted Materials Guide](#). Below is a subset of those materials. Dell products do not contain any of the following substances (in concentrations exceeding legal threshold limits):

- Asbestos
- Azo dyes/colorants in components that come into direct contact with human skin
- Cadmium and its compounds (except for use in applications exempted by the EU RoHS Directive)
- Class I and Class II CFCs (chlorofluorocarbons) and HCFCs (hydrofluorocarbons)
- Chloroparaffins, short chained (10-13 carbon chain)
- Chromium VI and its compounds (except for use in applications exempted by the EU RoHS Directive)
- Halogenated dioxins or furans (i.e. polychlorinated dibenzodioxines, polychlorinated dibenzofurans)
- Lead and its compounds (except for use in applications exempted by the EU RoHS Directive)
- Mercury (except for use in applications exempted by the EU RoHS Directive)
- Nickel and its compounds in components that are likely to result in prolonged skin exposure
- PCBs (polychlorobiphenyls) or PCTs (polychlorotriphenyls)
- PBBs (polybromobiphenyls) or PBDEs (polybrominated diphenylethers)
- PVC (polyvinyl chloride) in plastic parts greater than 25 grams
- Polychlorinated naphthalenes (PCNs)
- Tributyl tin (TBT) and triphenyl tin (TPT) compounds

Flame Retardants

Flame retardants are occasionally needed to meet strict fire safety codes. Dell avoids the use of Brominated Flame Retardants (BFRs) when possible by using plastics that can be flame retarded with non-halogenated compounds and by using design strategies that reduce the need to use flame retarded plastics all together. Through industry partnerships Dell is actively working to evaluate the viability of halogen-free alternatives and to help establish supply chain capability and capacity.

- Dell currently prohibits the use of PBBs and PBDEs (including DecabDE) for all applications.
- Dell currently prohibits the use of all other BFRs (including TBBP-A and HBCD) in plastics parts for many products including desktops, notebooks, and servers.
- Power and signal electrical cable may use PVC as an insulating material to ensure product safety.
- All cover/housing plastics > 25 grams are halogen free.
- Printed circuit boards with components are not all halogen free.
- Plastic parts > 25 grams are free from flame retardant substances/preparations above 0.1% classified as R45/46, R50/51/53, and R60/61.
- More information can be viewed at: [Halogen Position](#).

Part	Flame Retardant	ISO 1043-4
Motherboard	TBBPA	FR16
Mechanical Plastic Parts > 25 grams PC+ABS	Triaryl Phosphate Ester	FR40
Mechanical Plastic Parts >25 grams PC-GF	Triaryl Phosphate Ester	



VIII. ENERGY DATA

System Configuration

The Energy Consumption and Declared Noise Emissions data is based on a configuration including:

Processor/Memory	1 Intel® 2.66Ghz Quad Core / 4Gb
Hard Drive(s)	2 x 160 GB SATA
CD-ROM	CDRW/DVD
FDD	No
Power Supply(ies)	Qty 1 Wattage 750 Efficiency 80+% EPA

Energy Consumption⁷

Service Level	Energy Consumption (Wattage)	BTU Calculation	Description of Service Level
*Maximum	310.6	1062.25	The data provided is the highest wattage reading while running an Industry Benchmark suite of tests.
Idle	148.32	507.25	As specified by the EPA Computer spec 4.0 or system is sitting at the main Windows screen.
ACPI-S3 "Standby" Mode	13.77	47.1	Suspend-to-RAM (Low Power Mode).
Off Low Power Mode Disabled	11.7	40.01	System is turned off with the Low power Mode feature disabled via the BIOS.

*Maximum **Energy Consumption** results are based solely upon the laboratory testing of the **System Configuration** listed above.

Energy consumption is tested at 230 Volts / 50 Hz. Heat dissipation is calculated based on the measured watts, assuming the service level is attained for one hour. Off data is not meant to show compliance to US Executive Order 13221. When applicable, Dell product information related to US Executive Order 13221 may be obtained at: <http://oahu.lbl.gov/index.html>.

Declared Noise Emissions in accordance with ISO 9296 (tested in accordance with ISO 7779) for a typical/common configuration.

Service Level	Sound Power (LWAd, bels) (1 bel=10 decibels, re 10-12 Watts)
CD Drive Accessing	5.5
Hard Drive Accessing	5.4
Idle	5.4

⁷ This document is informational only and reflects laboratory performance. Your product may perform differently, depending on the software, components and peripherals you ordered. Accordingly, the customer should not rely upon this information in making decisions about electrical tolerances or otherwise. No warranty as to accuracy or completeness is expressed or implied.



IX. PACKAGING AND PRINTING

No CFCs (chlorofluorocarbons), HCFCs (hydrofluorocarbons) or other ozone depleting substances are used in packaging material. Chromium, lead, mercury, or cadmium are not intentionally added to packaging materials and are not present in a cumulative concentration greater than 100 ppm as incidental impurities. Halogenated plastics and/or polymers may be used for packaging material. Dell complies with the EU Directive 94/62/EEC.

Packaging Materials	Weight, kg
PE	0.54
Corrugated Cardboard	5.28

User and product documentation do not contain chlorine bleached paper (Europe Only). Some packaging does contain at least 25% post consumer recycled content.

X. BATTERIES

Batteries in this product are not based on mercury, lead or cadmium technologies. The batteries used in this product are in compliance with EU Directive 91/ 157/ EEC, EU Directive 93/ 86/ EEC, EU Directive 98/ 101/ EEC, and EU Battery Directive 2006/66/EC.

The product documentation includes instructional information on the proper removal and disposal of the batteries used in this product. Below is a listing of batteries present in the product:

Battery Description – Internal Batteries	Battery Type
3-V CR2032 Coin Cell	Lithium Ion
4.1-V RAID Battery (optional)	Lithium Ion

** Other batteries may be delivered in this system, depending on customer options. The optional internal batteries are either Lithium or Nickel Metal Hydride.

XI. DESIGN FOR ENVIRONMENT

Longevity and Upgrading

To extend the life of your system, you can install or upgrade certain system components (e.g., microprocessor, memory, expansion cards, and storage devices). Upgrading can be done with commonly available tools. Spare parts are available after the end of production for up to **five** years, or otherwise through the warranty period.

Design for Recyclability

- Minimal use of composite structure material.
- Minimal use of non-separable connections, such as gluing and welding between different materials.
- Plastic materials in covers/housing have no surface coating.
- Plastic parts > 25 grams have materials codes according to ISO 11469 referring ISO 1043.
- Plastic parts are free from metal inlays or have inlays that can be removed with commonly available tools.
- Labels are easily separable.



XII. RECYCLING/ END-OF-LIFE SERVICE INFORMATION

Take back and recycling services are offered for this product in certain countries. If you want to dispose of system components, visit www.dell.com/recyclingworldwide and select the relevant country.

EU WEEE: Dell is dedicated to meeting the requirements of the European Union's WEEE (Waste from Electrical and Electronic Equipment) Directive and is engaged in the development of country-specific implementation schemes to comply with the national WEEE laws. The directive aims to reduce the waste arising from electrical and electronic equipment, and improve the environmental performance of everything involved in the life cycle of electrical and electronic equipment. The EU WEEE mark is applied to products sold in Europe and many products world wide. EU recycling information can be found at www.euro.dell.com/recycling.

XIII. DELL CORPORATE ENVIRONMENTAL INFORMATION

Information on Dell's Environmental initiatives, policies, programs and goals can be found at www.dell.com/environment.

Product Safety, EMC and Environmental Datasheets for Dell products are located at: www.dell.com/regulatory_compliance_datasheets

R Series Expansion Chassis for C Series I/O

NI 9151

- High-performance industrial I/O for any R Series device
- Converts FPGA digital port into multifunction I/O port with plug-in modules for ± 80 mV to 250 V_{rms}
- Provides additional I/O hardware for desktop, PXI/CompactPCI, and industrial PC systems
- Combine with plug-in data acquisition, motion control, vision, or CAN devices to complete your application
- Add multiple 4-slot expansion chassis to a single R Series device
- Automatically synthesize an optimized high-performance electrical circuit implementation of your application using the NI LabVIEW FPGA Module



Overview

The NI 9151 R Series expansion chassis for NI C Series I/O modules connects directly to any R Series intelligent data acquisition (DAQ) device such as an NI 781xR, NI 783xR, NI 784xR, and NI 785xR. In this configuration, the field-programmable gate array (FPGA) resides on the R Series device, and the C Series I/O modules supply industrial I/O, isolation, and signal conditioning. You can use a Windows host CPU or real-time controller to provide high-performance processing for analog control, analysis, or hardware-in-the-loop (HIL) simulations. An R Series intelligent DAQ device combined with the R Series expansion chassis for C Series I/O offers high-speed signal-conditioned input, output, communication, and control capabilities with unprecedented flexibility and optimization.

With multifunction R Series devices (NI 783xR, NI 784xR, NI 785xR), you can connect up to two R Series expansion chassis for a maximum of eight I/O modules per R Series device. With digital R Series devices (NI 781xR), you can connect up to four R Series expansion chassis for a maximum of 16 I/O modules per R Series device.



C Series Compatibility

All C Series I/O modules are compatible with the NI 9151 R Series expansion chassis. Modules that have delta-sigma analog-to-digital converters (NI 9233, NI 9234, NI 9237, NI 9229, NI 9239, NI 9225, NI 9235, NI 9236) cannot share timebases between modules when used in the expansion chassis. Additionally, some modules may have speed limitations when used in the expansion chassis. Check the individual module user manual for specific details.

Visit ni.com/fpga for up-to-date information on FPGA hardware targets, example programs, application notes, and other developer tools.



Ordering Information

- NI 9151 779008-01
- SHC68-68-RDIO 191667-01

Note: Use only the SHC68-68-RDIO digital cable with the NI 9151 chassis.

BUY NOW!

For complete product specifications, pricing, and accessory information, call 800 813 3693 (U.S.) or go to ni.com/rseries.

NI Services and Support



NI has the services and support to meet your needs around the globe and through the application life cycle – from planning and development through deployment and ongoing maintenance. We offer services and service levels to meet customer requirements in research, design, validation, and manufacturing. Visit ni.com/services.

Training and Certification

NI training is the fastest, most certain route to productivity with our products. NI training can shorten your learning curve, save development time, and reduce maintenance costs over the application life cycle. We schedule instructor-led courses in cities worldwide, or we can hold a course at your facility. We also offer a professional certification program that identifies individuals who have high levels of skill and knowledge on using NI products. Visit ni.com/training.

Professional Services

Our NI Professional Services team is composed of NI applications and systems engineers and a worldwide National Instruments Alliance Partner program of more than 600 independent consultants and integrators. Services



range from start-up assistance to turnkey system integration. Visit ni.com/alliance.

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We also offer service programs that provide automatic upgrades to your application development environment and higher levels of technical support. Visit ni.com/ssp.

Hardware Services

System Assurance Programs

NI system assurance programs are designed to make it even easier for you to own an NI system. These programs include configuration and deployment services for your NI PXI, CompactRIO, or Compact FieldPoint system. The NI Basic System Assurance Program provides a simple integration test and ensures that your system is delivered completely assembled in one box. When you configure your system with the NI Standard System Assurance Program, you can select from available NI system driver sets and application development environments to create customized, reorderable software configurations. Your system arrives fully assembled and tested in one box with your software preinstalled. When you order your system with the standard program, you also receive system-specific documentation including a bill of materials, an integration test report, a recommended maintenance plan, and frequently asked question documents. Finally, the standard program reduces the total cost of owning an NI system by providing three years of warranty coverage and calibration service. Use the online product advisors at ni.com/advisor to find a system assurance program to meet your needs.

Calibration Services

NI recognizes the need to maintain properly calibrated devices for high-accuracy measurements. We provide manual calibration procedures, services to recalibrate your products, and automated calibration software specifically designed for use by metrology laboratories. Visit ni.com/calibration.

Repair and Extended Warranty

NI provides complete repair services for our products. Express repair and advance replacement services are also available. We offer extended warranties to help you meet project life-cycle requirements. Visit ni.com/services.

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[Requirements and Compatibility](#) | [Detailed Specifications](#) | [Pinouts/Front Panel Connections](#)

For user manuals and dimensional drawings, visit the product page resources tab on ni.com

Last Revised: 2009-07-17 10:57:48.0

NI R Series Multifunction RIO

Integrated Analog and Digital I/O with FPGA Technology



Onboard FPGA chip, programmable with the LabVIEW FPGA Module

User-defined triggering, timing, and decision making in hardware with 25 ns resolution

Up to 8 analog inputs, independent sampling rates up to 750 kHz, 16-bit resolution

Up to 8 analog outputs, independent update rates up to 1 MHz, 16-bit resolution

Up to 160 digital lines configurable as inputs, outputs, counters, or custom logic at rates up to 40 MHz

Direct memory access (DMA) channels for high-speed data streaming

Implement custom control logic, inline signal processing, and digital communication protocols

Overview

National Instruments reconfigurable I/O (RIO) technology gives you the ability to define your own custom measurement hardware circuitry using reconfigurable field-programmable gate array (FPGA) chips and NI LabVIEW graphical development tools. NI R Series multifunction RIO devices offer the best combination of value and performance by integrating this FPGA technology with eight analog inputs, eight analog outputs, and 96 digital I/O lines, all into a single device that is offered on standard PC form factors such as PCI, PCI Express, and PXI/CompactPCI. Using the LabVIEW FPGA Module, you can create your own hardware personalities for custom data acquisition, high-speed control, digital communications protocols, sensor simulation, hardware-in-the-loop test, and onboard signal processing without in-depth knowledge of hardware description languages.

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Requirements and Compatibility

OS Information

 Windows 2000/XP
 Windows Vista x64/x86

Driver Information

NI-RIO

Software Compatibility

LabVIEW FPGA Module

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Comparison Tables

Product	Bus/Form Factor	FPGA	Analog Inputs (16-bit)	Max Sampling Rate per Channel (kS/s)	Analog Outputs (16-bit)	Max Update Rate per Channel (MS/s)	Digital I/O
Multifunction R Series							
NI 7851R	PCI Express, PCI	Virtex-5 LX30	8	750	8	1	96

NI 7852R	PCI Express, PXI	Virtex-5 LX50	8	750	8	1	96
NI 7853R	PXI	Virtex-5 LX85	8	750	8	1	96
NI 7854R	PXI	Virtex-5 LX110	8	750	8	1	96
NI 7841R	PCI Express, PXI	Virtex-5 LX30	8	200	8	1	96
NI 7842R	PCI Express, PXI	Virtex-5 LX50	8	200	8	1	96
NI 7830R	PCI, PXI	Virtex-II 1M Gates	4	200	4	1	56
NI 7831R	PCI, PXI	Virtex-II 1M Gates	8	200	8	1	96
NI 7833R	PCI, PXI	Virtex-II 3M Gates	8	200	8	1	96
Digital R Series							
NI 7811R	PCI, PXI	Virtex-II 1M Gates	-	-	-	-	160
NI 7813R	PCI, PXI	Virtex-II 3M Gates	-	-	-	-	160

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Application and Technology

Graphical Programming with LabVIEW FPGA

The LabVIEW FPGA Module uses LabVIEW embedded technology to extend LabVIEW graphical development and target FPGAs on NI RIO hardware. LabVIEW is distinctly suited for FPGA programming because it clearly represents parallelism and data flow. With LabVIEW FPGA, you can create custom measurement and control hardware without low-level hardware description languages or board-level design. You can use this custom hardware for unique timing and triggering routines, ultrahigh-speed control, interfacing to digital protocols, digital signal processing (DSP), and many other applications requiring high-speed hardware reliability and tight determinism.

Low-Cost Signal Conditioning and Channel Expansion

The NI 9151 R Series expansion chassis connects directly to any digital connector on R Series devices and houses up to four C Series I/O modules for industrial signal conditioning, I/O channel expansion, and direct sensor connectivity.

New Virtex-5 FPGAs

The new NI 784xR and NI 785xR devices use new Virtex-5 FPGAs with improved optimization capabilities that provide faster code execution and increased code capacity. These Virtex-5 FPGAs feature a new six-input lookup table (LUT) architecture for substantially improved resource utilization as well as DSP48 slices that make it possible for you to implement more complex digital signal processing at faster rates. Previous-generation Virtex-II FPGAs use four-input LUTs for up to 16 combinations of digital logic values. The new Virtex-5 FPGAs use six-input LUTs for up to 64 combinations, increasing the amount of logic that you can implement per slice. In addition, the slices themselves are placed in closer proximity to each other to reduce the propagation delay of electrons and increase overall execution rates. The single-cycle timed loop structure in LabVIEW FPGA takes full advantage of six-input LUTs for substantially improved resource utilization. This means you can optimize more LabVIEW FPGA code to fit within Virtex-5 FPGAs and perform more operations per clock cycle.

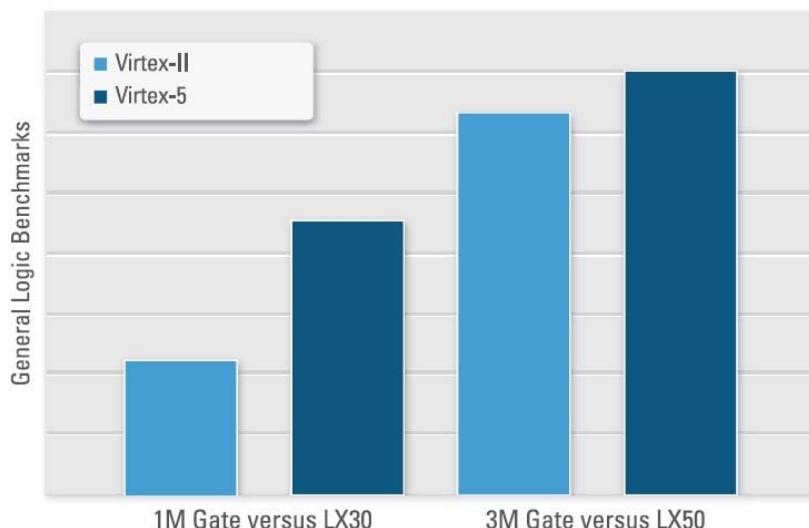


Figure 1. General logic benchmarks show that Virtex-5 FPGAs offer larger sizes when compared to Virtex-II FPGAs.

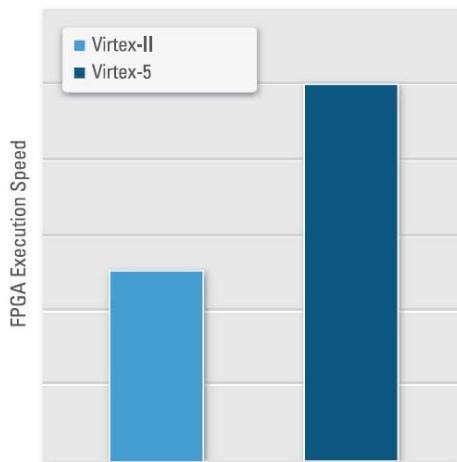


Figure 2. Execution speed benchmarks show that Virtex-5 FPGAs feature faster processing capabilities when compared to Virtex-II FPGAs.

For more information on LabVIEW FPGA benchmarks for Virtex-5 FPGAs, visit ni.com/info and enter **lvfgabenchmarks**.

Required Software for R Series Multifunction RIO

NI 781xR and 783xR devices require the LabVIEW FPGA Module 7.1 or later and NI-RIO 1.3 or later driver software.

PXI-7841R/42R/51R/52R modules require the LabVIEW FPGA Module 8.5.1 or later and NI-RIO 2.4 or later.

PXI-7853R/54R modules require the LabVIEW FPGA Module 8.6 or later and NI-RIO 3.0 or later.

NI PCIe-7841R/42R/51R/52R boards require the LabVIEW FPGA Module 8.5.1 or later and NI-RIO 3.1 or later.

Recommended Accessories

High Performance

SHC68-68-RMIO - High-performance shielded 68-conductor cable terminated with a VHDCI 68-pin male connector at one end and a 68-pin female 0.050 D-type connector at the other end that has been specifically designed for the multifunction I/O connector on R Series multifunction RIO devices.

1 m189588-01
2 m189588-02

SHC68-68-RDIO - High-performance shielded 68-conductor cable terminated with a VHDCI 68-pin male connector at one end and a 68-pin female 0.050 D-type connector at the other end that has been specifically designed for the digital I/O connector on R Series multifunction RIO devices.

1 m191667-01
-----------	------------

SCB-68 - Shielded I/O connector block for rugged, very low-noise signal termination for connecting to 68-pin devices. The SCB-68 also includes two general-purpose breadboard areas.

Dimensions - 19.5 by 15.2 by 4.5 cm (7.7 by 6.0 by 1.8 in.)

SCB-68776844-01
--------------	------------

Low Cost

SH68-C68-S - General-purpose shielded cable that connects any type of R Series connector to 68-pin connector blocks.

0.5 m186381-0R5
1 m186381-01
2 m186381-02

Custom Cabling

SHC68-NT-S - Shielded 68-conductor cable terminated with a 68-pin male VHDCI connector at one end and unterminated bare wires at the other. Use this cable, ideal for OEM applications, to create custom cabling solutions for R Series devices.

2 m189041-02
-----------	------------

NSC68-262650 - Shielded cable terminated with a VHDCI 68-pin male connector at one end and two 26-pin ribbon connectors and one 50-pin ribbon connector on the other; designed to connect the R Series RMIO connector to standard ribbon cable accessories.

1 m189151-01
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NSC68-5050 - Shielded cable terminated with a VHDCI 68-pin male connector at one end and two 50-pin ribbon connectors on the other; designed to connect R Series RDIO connectors to standard ribbon cable accessories.

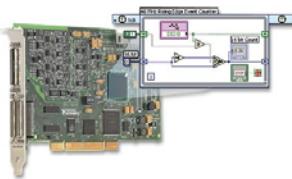
1 m189152-01
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Software Recommendations

NI LabVIEW FPGA Module

Define your own control algorithms with loop rates up to 40 MHz



Execute multiple tasks simultaneously and deterministically
 Create your own I/O hardware without VHDL coding or board design
 Implement custom timing and triggering logic with 25 ns resolution
 Graphically configure FPGAs on NI reconfigurable I/O (RIO) hardware targets

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Support and Services

System Assurance Programs

NI system assurance programs are designed to make it even easier for you to own an NI system. These programs include configuration and deployment services for your NI PXI, CompactRIO, or Compact FieldPoint system. The NI Basic System Assurance Program provides a simple integration test and ensures that your system is delivered completely assembled in one box. When you configure your system with the NI Standard System Assurance Program, you can select from available NI system driver sets and application development environments to create customized, reorderable software configurations. Your system arrives fully assembled and tested in one box with your software preinstalled. When you order your system with the standard program, you also receive system-specific documentation including a bill of materials, an integration test report, a recommended maintenance plan, and frequently asked question documents. Finally, the standard program reduces the total cost of owning an NI system by providing three years of warranty coverage and calibration service. Use the online product advisors at ni.com/advisor to find a system assurance program to meet your needs.

Calibration

NI measurement hardware is calibrated to ensure measurement accuracy and verify that the device meets its published specifications. NI offers a number of calibration services to help maintain the ongoing accuracy of your measurement hardware. These services allow you to be completely confident in your measurements, and help you maintain compliance to standards like ISO 9001, ANSI/NCSL Z540-1 and ISO/IEC 17025. To learn more about NI calibration services or to locate a qualified service center near you, contact your local sales office or visit ni.com/calibration.

Technical Support

Get answers to your technical questions using the following National Instruments resources.

Support - Visit ni.com/support to access the NI KnowledgeBase, example programs, and tutorials or to contact our applications engineers who are located in NI sales offices around the world and speak the local language.

Discussion Forums - Visit forums.ni.com for a diverse set of discussion boards on topics you care about.

Online Community - Visit community.ni.com to find, contribute, or collaborate on customer-contributed technical content with users like you.

Repair

While you may never need your hardware repaired, NI understands that unexpected events may lead to necessary repairs. NI offers repair services performed by highly trained technicians who quickly return your device with the guarantee that it will perform to factory specifications. For more information, visit ni.com/repair.

Training and Certifications

The NI training and certification program delivers the fastest, most certain route to increased proficiency and productivity using NI software and hardware. Training builds the skills to more efficiently develop robust, maintainable applications, while certification validates your knowledge and ability.

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Online instructor-led training - lower-cost, remote training if classroom or on-site courses are not possible.

Course kits - lowest-cost, self-paced training that you can use as reference guides.

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Extended Warranty

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Detailed Specifications

[View Detailed Specifications](#) [Table of Contents](#)

This document lists the specifications of the NI 781xR/783xR/784xR/785xR. These specifications are typical at 25 °C unless otherwise noted.

Analog Input (NI 783x R/784x R/785x R Only)

Input Characteristics

Number of channels

NI 7830R	4
NI 7831R/7833R/7841R/7842R/7851R/7852R/7853R/7854R	8
Input modes	DIFF, RSE, NRSE (software-selectable; selection applies to all channels)
Type of ADC	Successive approximation
Resolution	16 bits, 1 in 65,536
Conversion time	
NI 783xR/NI 784xR	4 µs
NI 785xR	1 µs
Maximum sampling rate	
NI 783xR/784xR	200 kS/s (per channel)
NI 785xR	750 kS/s (per channel)
Input impedance	
Powered on	10 GΩ in parallel with 100 pF
Powered off/overload	4.0 kΩ min
Input signal range	±10 V
Input bias current	
NI 783xR	±2 nA
NI 784xR/785xR	±5 nA
Input offset current	
NI 783xR	±1 nA
NI 784xR/785xR	±5 nA
Input coupling	DC
Maximum working voltage (signal + common mode)	Inputs should remain within ±12 V of ground
Overvoltage protection	
Powered on	±42 V
Powered off	±35 V

Accuracy Information

NI 783xR										
Nominal Range (V)		Absolute Accuracy							Relative Accuracy	
		% of Reading		Offset (µV)	Noise + Quantization (µV)		Temp Drift (%/ °C)	Absolute Accuracy at Full Scale (±mV)	Resolution (µV)	
Positive Full Scale	Negative Full Scale	24 Hours	1 Year		Single Point	Averaged			Single Point	Averaged
10.0	-10.0	0.0496	0.0507	2,542	1,779	165	0.0005	7.78	2,170	217
Note Accuracies are valid for measurements following an internal calibration. Averaged numbers assume dithering and averaging of 100 single-channel readings. Measurement accuracies are listed for operational temperatures within ±1 °C of internal calibration temperature and ±10 °C of external or factory-calibration temperature.										

NI 784xR/NI 785xR										
Nominal Range (V)		Absolute Accuracy							Relative Accuracy	
		% of Reading		Offset (μ V)	Noise + Quantization (μ V)		Temp Drift (%/ $^{\circ}$ C)	Absolute Accuracy at Full Scale (\pm mV)	Resolution (μ V)	
Positive Full Scale	Negative Full Scale	24 Hours	1 Year		Single Point	Averaged			Single Point	Averaged
10.0	-10.0	0.0186	0.0228	1,591	1,029	91.6	0.0005	3.97	1,205	121
<p>Note Accuracies are valid for measurements following an internal calibration. Averaged numbers assume dithering and averaging of 100 single-channel readings. Measurement accuracies are listed for operational temperatures within $\pm 1^{\circ}$C of internal calibration temperature and $\pm 10^{\circ}$C of external or factory-calibration temperature.</p>										

DC Transfer Characteristics

INL

NI 783xR	± 3 LSB typ, ± 6 LSB max
----------	----------------------------------

NI 784xR/785xR	± 1 LSB typ, ± 3 LSB max
----------------	----------------------------------

DNL

NI 783xR	± 1.0 to ± 2.0 LSB max
----------	--------------------------------

NI 784xR/785xR	± 0.4 LSB typ, ± 0.9 LSB max
----------------	--------------------------------------

No missing codes

NI 783xR	16 bits typ, 15 bits min
----------	--------------------------

NI 784xR/785xR	16 bits guaranteed
----------------	--------------------

CMRR, DC to 60 Hz

-86 dB

Dynamic Characteristics

Bandwidth

NI 783xR

Small signal (-3 dB)	650 kHz
----------------------	---------

Large signal (1% of THD)	55 kHz
--------------------------	--------

NI 784xR/NI 785xR

Small signal (-3 dB)	1 MHz
----------------------	-------

Large signal (1% of THD)	500 kHz
--------------------------	---------

Settling Time

Device	Step Size	Accuracy		
		± 16 LSB	± 4 LSB	± 2 LSB
NI 783xR	± 20.0 V	7.5 μ s	10.3 μ s	40 μ s
	± 2.0 V	2.7 μ s	4.1 μ s	5.1 μ s
	± 0.2 V	1.7 μ s	2.9 μ s	3.6 μ s
NI 784xR/785xR	± 20.0 V	2.1 μ s	4.2 μ s	8 μ s
	± 2.0 V	1.3 μ s	1.6 μ s	1.8 μ s
	± 0.2 V	0.8 μ s	1.1 μ s	1.2 μ s

Crosstalk

-80 dB, DC to 100 kHz

Analog Output (NI 783x R/784x R/785x R Only)[Back to Detailed Specs](#)**Output Characteristics**

Output type	Single-ended, voltage output
-------------	------------------------------

Number of channels

NI 7831R/7833R/7841R/7842R/7851R/7852R/7853R/7854R

8

Resolution

16 bits, 1 in 65,536

Update time

1.0 μ s

Maximum update rate

1 MS/s

Type of DAC

Enhanced R-2R

Accuracy Information

Nominal Range (V)		Absolute Accuracy			Absolute Accuracy at Full Scale (\pm mV)
		% of Reading		Offset (μ V)	
Positive Full Scale	Negative Full Scale	24 Hours	1 Year		
10.0	-10.0	0.0335	0.0351	2366	0.0005
Note Accuracies are valid for analog output following an internal calibration. Analog output accuracies are listed for operation temperatures within ± 1 $^{\circ}$ C of internal calibration temperature and ± 10 $^{\circ}$ C of external or factory calibration temperature. Temp Drift applies only if ambient is greater than ± 10 $^{\circ}$ C of previous external calibration.					

DC Transfer Characteristics

INL	± 0.5 LSB typ, ± 4.0 LSB max
DNL	± 0.5 LSB typ, ± 1 LSB max
Monotonicity	16 bits, guaranteed
Voltage Output	
Range	± 10 V
Output coupling	DC
Output impedance	
NI 783xR	1.25 Ω
NI 784xR/785xR	0.5 Ω
Current drive	± 2.5 mA
Protection	Short-circuit to ground
Power-on state	User configurable

Dynamic Characteristics

Settling time			
Step Size	Accuracy		
	± 16 LSB	± 4 LSB	± 2 LSB
± 20.0 V	6.0 μ s	6.2 μ s	7.2 μ s
± 2.0 V	2.2 μ s	2.9 μ s	3.8 μ s
± 0.2 V	1.5 μ s	2.6 μ s	3.6 μ s

Slew rate	10 V/ μ s
Noise	150 μ V _{rms} , DC to 1 MHz
Glitch energy at midscale transition	± 200 mV for 3 μ s

Digital I/O[Back to Detailed Specs](#)

Number of channels	
NI 781xR	160
NI 7830R	56
NI 7831R/7833R/7841R/7842R/7851R/7852R/7853R/7854R	96

Compatibility

TTL

Digital logic levels		
Level	Min	Max
Input low voltage (V_{IL})	0.0 V	0.8 V
Input high voltage (V_{IH})	2.0 V	5.5 V
Output low voltage (V_{OL}), where $I_{OUT} = -4 \text{ mA}$	0 V	0.4 V
Output high voltage (V_{OH}), where $I_{OUT} = 4 \text{ mA}$	2.4 V	3.3 V

Output current

Source	4.0 mA
Sink	4.0 mA
Input leakage current	$\pm 10 \mu\text{A}$
Power-on state	Programmable, by line
Protection	
Input	
NI 781xR/783xR	-0.5 to 7.0 V, single line
NI 784xR/785xR	-20.0 to 20.0 V, single line
Output	Short-circuit (up to eight lines may be shorted at a time)
Minimum pulse width	
Input	25 ns
Output	12.5 ns
Minimum sampling period	5 ns

Reconfigurable FPGA

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NI 7811R/7830R/7831R

FPGA type	Virtex-II V1000
Number of flip-flops	10,240
Number of 4-input LUTs	10,240
Number of 18 × 18 multipliers	40
Embedded block RAM	720 kbits

NI 7813R/7833R

FPGA type	Virtex-II V3000
Number of flip-flops	28,672
Number of 4-input LUTs	28,672
Number of 18 × 18 multipliers	96
Embedded block RAM	1,728 kbits

NI 7841R/7851R

FPGA type	Virtex-5 LX30
Number of flip-flops	19,200
Number of 6-input LUTs	19,200
Number of DSP48 slices (25 × 18 multipliers)	32
Embedded block RAM	1,152 kbits

FPGA type	Virtex-5 LX50
Number of flip-flops	28,800
Number of 6-input LUTs	28,800
Number of DSP48 slices (25 × 18 multipliers)	48
Embedded block RAM	1,728 kbits
NI 7853R	
FPGA type	Virtex-5 LX85
Number of flip-flops	51,840
Number of 6-input LUTs	51,840
Number of DSP48 slices (25 × 18 multipliers)	48
Embedded block RAM	3,456 kbits
NI 7854R	
FPGA type	Virtex-5 LX110
Number of flip-flops	69,120
Number of 6-input LUTs	69,120
Number of DSP48 slices (25 × 18 multipliers)	64
Embedded block RAM	4,608 kbits
Timebase	40, 80, 120, 160, or 200 MHz
Timebase reference sources	
NI PCI-781xR/783xR	Onboard clock only
NI PCIe-784xR/785xR	Onboard clock only
NI PXI-78xxR	Onboard clock, phase-locked to PXI 10 MHz clock
Timebase accuracy, onboard clock	±100 ppm, 250 ps peak-to-peak jitter
Phase locked to PXI 10 MHz Clock (NI PXI-78xxR only)	Adds 350 ps peak-to-peak jitter
Additional frequency-dependent peak-to-peak jitter	
NI 781xR/783xR	
40 MHz	None
80 MHz	400 ps
120 MHz	720 ps
160 MHz	710 ps
200 MHz	700 ps
NI 784xR/785xR	
40 MHz	None
80 MHz	460 ps
120 MHz	172 ps
160 MHz	172 ps
200 MHz	152 ps

Calibration (NI 783x R/784x R/785x R Only)[Back to Detailed Specs](#)

Recommended warm-up time	15 minutes
Calibration interval	1 year
Onboard calibration reference	
DC level	5.000 V (±3.5 mV) (actual value stored in Flash memory)
Temperature coefficient	±5 ppm/°C max

Long-term stability

 $\pm 20 \text{ ppm}/\sqrt{\text{1,000 h}}$ Note Refer to [Calibration Certificates](#) at [ni.com/calibration](#) to generate a calibration certificate for the NI 78xxR.**Bus Interface**[Back to Detailed Specs](#)

PCI/PCIe/PXI	Master, slave
Data transfers	DMA, interrupts, programmed I/O
Number of DMA channels	3

Power Requirement[Back to Detailed Specs](#)

+5 VDC ($\pm 5\%$) ¹	
NI 781xR	9 mA typ
NI 7830R/7831R	330 mA typ
NI 7833R	364 mA typ
NI PXI-7841R/7851R	125 mA typ
NI PXI-7842R/7852R	136 mA typ
NI 7853R	460 mA typ
NI 7854R	484 mA typ
+3.3 VDC ($\pm 5\%$) ²	
NI 7811R	650 mA typ
NI 7813R	850 mA typ
NI 7830R/7831R	462 mA typ
NI 7833R	727 mA typ
NI PCIe-7841R/7851R	847 mA typ
NI PCIe-7842R/7852R	984 mA typ
NI PXI-7841R/7851R	525 mA typ
NI PXI-7842R/7852R	604 mA typ
NI 7853R	640 mA typ
NI 7854R	843 mA typ
+12 V	
NI 784xR/785xR	0.5 A
-12 V	
NI PXI-784xR/785xR	0.25 A
+5V terminal	
Connector 0	0.5 A max ³
Connector 1	0.5 A max ³
Connector 2	0.5 A max ³
All connectors	1.5 A max ^{3, 4}

To calculate the total current sourced by the digital outputs, use the following equation:

$$\sum_{i=1}^j \text{current sourced on channel } i$$

Power available at I/O connectors

4.50 to 5.25 VDC at 1 A total, 250 mA per I/O connector pin

Physical[Back to Detailed Specs](#)

Dimensions (not including connectors)

12/2/2010

NI PCI-781xR/783xR

NI R Series Multifunction RIO - Data Sh...

17 cm by 11 cm (6.7 in. by 4.3 in.)

NI PCIe-784xR/785xR

17 cm by 11 cm (6.7 in. by 4.3 in.)

NI PXI-78xxR

16 cm by 10 cm (6.3 in. by 3.9 in.)

Weight

NI PCI-781xR/783xR

112 g

NI PCIe-784xR/785xR

127 g

NI PXI-78xxR

152 g

I/O connectors

NI 781xR

Four 68-pin female high-density VHDCI type

NI 7830R

Two 68-pin female high-density VHDCI type

NI 783xR/784xR/785xR

Three 68-pin female high-density VHDCI type

Disk drive power connector (PCIe devices)

Standard ATX peripheral connector (not serial ATA)

Maximum Working Voltage (NI 783xR/784xR/785xR Only)[Back to Detailed Specs](#)

Maximum working voltage refers to the signal voltage plus the common-mode voltage.

Channel-to-earth

±12 V, Measurement Category I

Channel-to-channel

±24 V, Measurement Category I

Caution Do not use the NI 783xR/784xR/785xR for connection to signals in Measurement Categories II, III, or IV.**Environmental**[Back to Detailed Specs](#)

The NI 78xxR is intended for indoor use only.

Operating Environment

NI 781xR

0 °C to 55 °C, tested in accordance with IEC-60068-2-1 and IEC-60068-2-2.

NI 7830R, NI 7831R

40 MHz or 80 MHz timebase

0 °C to 55 °C, tested in accordance with IEC-60068-2-1 and IEC-60068-2-2.

NI PCI/PXI-7833R

40 MHz timebase

0 °C to 55 °C, tested in accordance with IEC-60068-2-1 and IEC-60068-2-2.

80 MHz timebase

0 °C to 55 °C except the following: 0 °C to 45 °C when installed in an NI PXI-1000/B or NI PXI-101X, tested in accordance with IEC-60068-2-1 and IEC-60068-2-2.

NI PXI-7841R/7842R/7851R/7852R/7853R/7854R

40 MHz timebase

0 °C to 55 °C, tested in accordance with IEC-60068-2-1 and IEC-60068-2-2.

80 MHz timebase

0 °C to 55 °C except the following: 0 °C to 45 °C when installed in an NI PXI-1000/B or NI PXI-101X, tested in accordance with IEC-60068-2-1 and IEC-60068-2-2.

NI PCIe-7841R/7842R/7851R/7852R

40 MHz or 80 MHz timebase

0 °C to 40 °C, tested in accordance with IEC-60068-2-1 and IEC-60068-2-2.

Relative humidity range

10% to 90%, noncondensing, tested in accordance with IEC-60068-2-56.

Altitude

2,000 m at 25 °C ambient temperature

Storage Environment

NI PCI/PXI-781xR/783xR

-20 °C to 70 °C, tested in accordance with IEC-60068-2-1 and IEC-60068-2-2.

-20 °C to 70 °C, tested in accordance with IEC-60068-2-1 and IEC-60068-2-2.

-40 °C to 70 °C, tested in accordance with IEC-60068-2-1 and IEC-60068-2-2.

-20 °C to 70 °C, tested in accordance with IEC-60068-2-1 and IEC-60068-2-2.

Ambient temperature range

5% to 95%, noncondensing, tested in accordance with IEC-60068-2-56.

Relative humidity range

Note Clean the device with a soft, non-metallic brush. Make sure that the device is completely dry and free from contaminants before returning it to service.**Shock and Vibration (for NI PXI-78xxR Only)**

Operational shock

30 g peak, half-sine, 11 ms pulse; tested in accordance with IEC-60068-2-27.

Test profile developed in accordance with MIL-PRF-28800F.

Random vibration

Operating	5 Hz to 500 Hz, 0.3 g _{rms}
Nonoperating	5 Hz to 500 Hz, 2.4 g _{rms} , tested in accordance with IEC-60068-2-64. Nonoperating test profile exceeds the requirements of MIL-PRF-28800F, Class 3.

Safety[Back to Detailed Specs](#)

This product is designed to meet the requirements of the following standards of safety for electrical equipment for measurement, control, and laboratory use:

IEC 61010-1, EN 61010-1

UL 61010-1, CSA61010-1

Note For UL and other safety certifications, refer to the product label or the *Online Product Certification* section.

Electromagnetic Compatibility[Back to Detailed Specs](#)

This product is designed to meet the requirements of the following standards of EMC for electrical equipment for measurement, control, and laboratory use:

EN 61326 (IEC 61326): Class A emissions; Basic immunity

EN 55011 (CISPR 11): Group 1, Class A emissions

AS/NZS CISPR 11: Group 1, Class A emissions

FCC 47 CFR Part 15B: Class A emissions

ICES-001: Class A emissions

Note For the standards applied to assess the EMC of this product, refer to the [Electromagnetic Compatibility](#) section.

Note For EMC compliance, operate this device with shielded cabling.

CE Compliance[Back to Detailed Specs](#)

This product meets the essential requirements of applicable European Directives, as amended for CE marking, as follows:

2006/95/EC; Low-Voltage Directive (safety)

2004/108/EC; Electromagnetic Compatibility Directive (EMC)

Note For the standards applied to assess the EMC of this product, refer to the *Online Product Certification* section.

Online Product Certification[Back to Detailed Specs](#)

Refer to the product Declaration of Conformity (DoC) for additional regulatory compliance information. To obtain product certifications and the DoC for this product, visit ni.com/certification, search by module number or product line, and click the appropriate link in the Certification column.

Environmental Management[Back to Detailed Specs](#)

National Instruments is committed to designing and manufacturing products in an environmentally responsible manner. NI recognizes that eliminating certain hazardous substances from our products is beneficial not only to the environment but also to NI customers.

For additional environmental information, refer to the *NI and the Environment* Web page at ni.com/environment. This page contains the environmental regulations and directives with which NI complies, as well as other environmental information not included in this document.

Waste Electrical and Electronic Equipment (WEEE)[Back to Detailed Specs](#)

EU Customers At the end of their life cycle, all products *must* be sent to a WEEE recycling center. For more information about WEEE recycling centers and National Instruments WEEE initiatives, visit ni.com/environment/weee.htm.



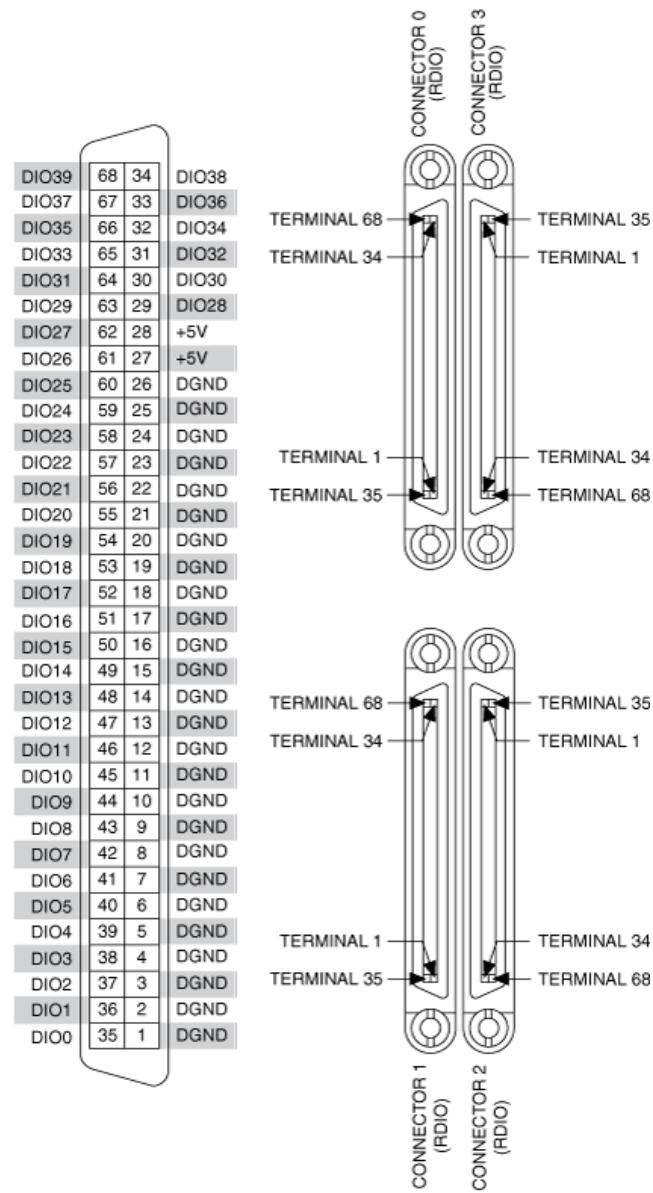
¹ Does not include current drawn from the +5 Vline on the I/O connectors.

² Does not include current sourced by the digital outputs.

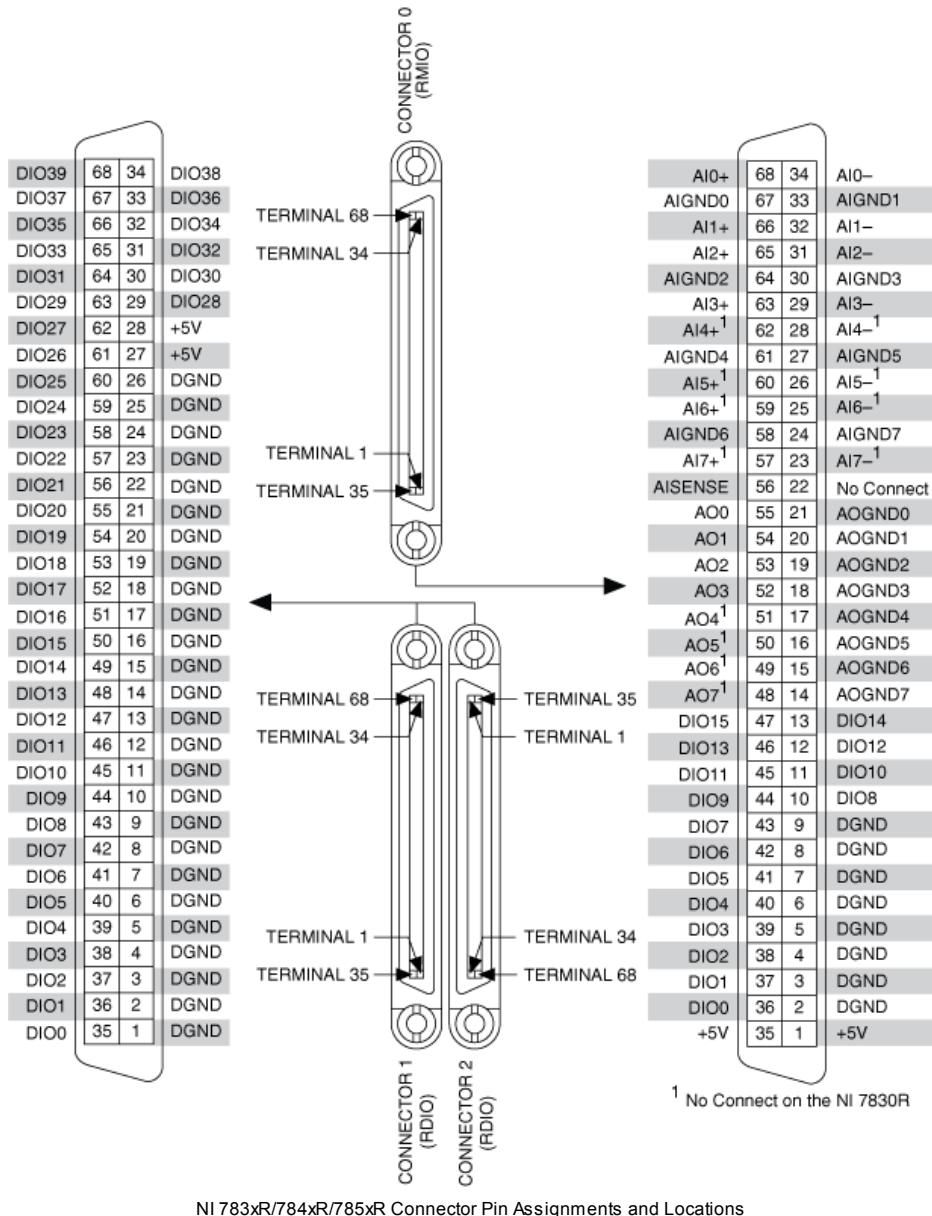
³ (**NI PCIe-78xxR only**) Total maximum terminal current for all connectors is 100 mA unless disk drive connector is attached.

⁴ (**NI 784xR/785xR only**) The NI 784xR/785xR has a user-replaceable socketed fuse that opens when current exceeds the current specification. Refer to the *NI R Series Multifunction RIO User Manual*, available at ni.com/manuals, for information about fuse replacement.

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Pinouts/Front Panel Connections

NI 781xR Connector Pin Assignments and Locations

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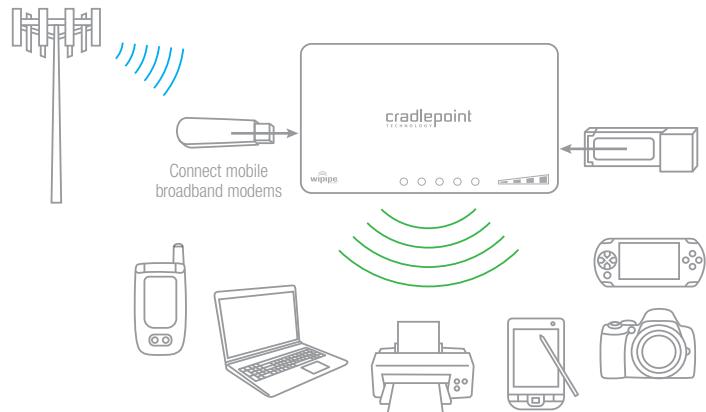
CTR500

3G/4G Mobile Broadband Travel Router

Create WiFi from Broadband USB, ExpressCard or Ethernet

SIMPLE TO USE

The CradlePoint CTR500 Mobile Broadband Travel Router was developed to be a plug-n-play solution. Simply connect an activated USB or ExpressCard modem and turn the unit on. Within seconds, you will have a secure WiFi network of up to 150 feet and the ability to connect up to 32 WiFi-enabled devices. It's that easy.



SMALL SIZE - POWERFUL RANGE

Small enough to fit into your back pocket, the CTR500 can go anywhere with you. Complete with signal strength indicator and external antenna port, the CTR500 can be positioned wherever your modem gets its best signal. And with Failover/Fallback redundancy, should your primary service be interrupted, the CTR500 will automatically discover another connected data network so you're never offline. When your primary service is restored, it will automatically re-connect.

SECURE AND RELIABLE

Powered by WiPipe™ technology, CTR500 requires minimal setup and maintenance, including pre-installed software for right-out-of-the-box simplicity. Standard in the CTR500 are security features like multiple WiFi-encryption modes like WEP and WPA/WPA2 (Personal & Enterprise) and built-in firewall, which prevent unauthorized use of your connection. With no additional software to load, you'll be up and running in minutes.

Connects with any WiFi-enabled device:



CTR500
FEATURES

- **Create A Secure WiFi Network Instantly**
- **Portable, Shareable with up to 32 Devices**
- **No Software or Drivers To Install**
- **Failover / Fallback Redundancy**
- **Security Is Simple To Set Up**
- **Plug 'n' Play - Zero Hassle**

CTR500

3G/4G Mobile Broadband Travel Router



SPECIFICATIONS

MODEL NAME:	CTR500 3G/4G Mobile Broadband Travel Router
WiFi Standards:	IEEE 802.11 b/g
NETWORK CONNECTIONS AND PORTS:	Switchable LAN/WAN Ethernet (10/100), One (1) USB Modem, One (1) ExpressCard
BUTTONS/SWITCHES:	Wireless On/Off Switch, Reset, Signal Strength
LED INDICATORS:	Power, USB Modem Activity, ExpressCard Modem Activity, WLAN, Ethernet WAN, Signal Strength LEDs
POWER:	5V DC, 2.5-3.0A; 100-240V AC
DIMENSIONS:	4.8-in x 2.9-in x 0.75-in (122mm x 73mm x 18.5mm)
WEIGHT:	3.5 oz. (128g)
TEMPERATURE:	0°C to 50°C (32°F to 120°F) Operating -20°C to 70°C (-4°F to 158°F) Storage
RELATIVE HUMIDITY:	10% - 85% Operating / 5% - 90% Storage
CERTIFICATIONS:	FCC, WiFi Alliance

DETAILS

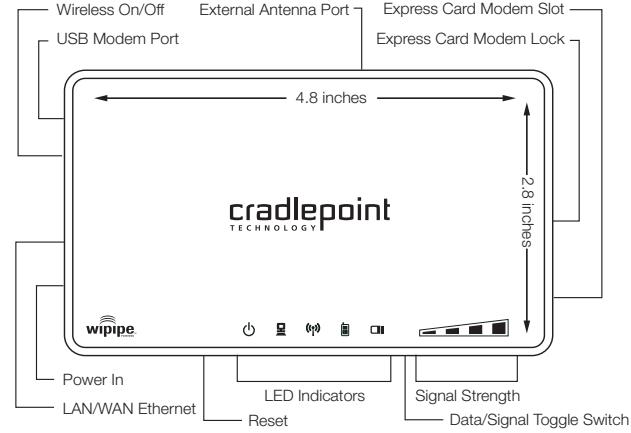
Use with ExpressCard Modems, USB Data Modems, or Phones with Data Tethering Capability
Compatible with HSPA and EVDO Cellular Network Devices
Universal Plug-n-Play and ALGs support for Internet Applications: Email, FTP, Gaming, Remote Desktop, NetMeeting, Telnet, SSH, And SCP
Connector supports optional external WiFi antenna for increased signal
Flash Memory for Firmware Upgrade, Save/Restore Settings and Easy Management via HTTP
Networking Compliance with IEEE 802.11 b/g Standards
Compliant with Windows 98SE/NT/2000/XP/Vista/Server 2003/Linux/Mac OS

SECURITY

Access control available in encrypted and open modes, password-protected access to prevent unauthorized usage. (WEP, WPA, WPA2, WPA2 Enterprise)
Provides additional security of Enable/Disable Network Name Broadcast and Internet Access Control (Services, URL, and MAC Filtering)
Firewall features Network Address Translation (NAT) and Stateful Packet Inspection (SPI) which protects against DoS Attacks
Multiple Concurrent IPSec, L2TP and PPTP VPN Pass-Through Sessions

* Requires Activated USB and/or ExpressCard Modem with a Mobile Broadband Carrier.
Over 100 Modems and Handsets are Supported.

** Based on Mobile Broadband Coverage



RECOMMENDED ACCESSORIES



Travel Pouch



Car Adapter Power Supply



Secure, Manage &
Maintain The Edge
of 3G/4G Network



Wall Power Supply

MINIMUM REQUIREMENTS

Mobile Broadband Data Card with Active Subscription (USB or ExpressCard), or Supported Phone with Active Tethered Data Plan Suggested*

Management Interface Requires an Internet Browser:
Internet Explorer v6.0, Firefox v2.0, or Safari v1.0 Minimum

IN THE BOX

- CTR500 3G/4G Mobile Broadband Travel Router
- Worldwide AC Power Adapter
- Quickstart Guide

Part Number: TTL-485_422-2



■ INTRODUCTION

The TTL-485_422-2 is an industrial grade (wide temperature range with surge & static protection) port-powered bi-directional RS-485/422 to 5VDC TTL/COMS converter, which can be used to convert RS-485 or RS-422 to 5VDC TTL/COMS compatible levels and vice versa. The unit is powered from an external 5VDC power supply. It supports data direction auto-turnaround, no flow control is required.

■ FEATURES

- Industrial grade with wide temperature range, surge and static protection.
- Plug and play, data direction auto-turnaround, no flow control is required.
- Built-in 120Ω end-of-line terminator for easy installation.
- CE certified / 5-year manufacturer's warranty.

■ SPECIFICATIONS

Compatibility:	EIA/TIA RS-485/422 standard and TTL/COMS 5VDC level	
Power Source:	+5VDC ($\pm 5\%$) Regulated Power Supply (not included)	
Current Consumption:	Less than 30mA	
Baud Rates:	300 to 115,200bps (auto-sensing and self-adjusting)	
Distance:	TTL side: 10ft (3m); RS-485/422 side: Up to 4000ft (1.2km) at 19,200bps;	
Connectors:	TTL side: DB-9 Male; RS-485/422 side: DB-9 Male; Termination Board (TTL): DB-9 Female and a 3-way Terminal Block; Termination Board (RS-485/422): DB-9 Female and a 6-Way Terminal Block	
Maximum number of drops:	64	
End-of-Line Terminator:	120Ω (Built-in)	
Surge Protection:	600W	
Static Protection (ESD):	Up to 15kV	
Dimensions (H x W x D):	0.63 x 1.3 x 4.6 in (16 x 32 x 118 mm) (with termination boards)	
Weight:	1.8 oz (51 g) (with termination boards)	
Operating Temperature:	-40°F to 185°F (-40°C to 85°C)	
Operating Humidity:	Up to 90% RH (no condensation)	

■ PIN ASSIGNMENT

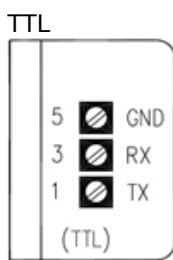
TTL Side (DB-9 Male Connector / Terminal Block):

DB-9 Male Connector:	1	3	5
Terminal Block:	TX	RX	GND
Function:	TTL OUT	TTL IN	GND

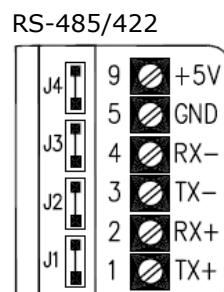
RS-485/RS-422 Side (DB-9 Male Connector / Termination Board):

Pin:	1	2	3	4	5	6	7	8	4	9
Jumper:	J2 (default: ON)		J3 (default: ON)			J1 (default: ON)		J4 (default: ON)		+5V
RS-485:	A+ (J2 ON)		B- (J3 ON)		GND		(J1 ON)			
RS-422:	(J2 OFF)		(J3 OFF)		GND		(J1 OFF)		Terminate/remove J4 to turn ON/OFF the 120Ω ¹ end-of-line terminator	+5V input
	TX+	RX+	TX-	RX-						

Termination Boards:



- Numbers on the left indicate the pin assignment of DB-9 Connectors (TTL side).
- TX is the TTL Output, RX is the TTL Input.



- Numbers on the left indicate the pin assignment of DB-9 Connectors.
- Connect an external +5VDC regulated power supply to +5V and GND.
- Turn ON the 120Ω end-of-line terminator only when the RS-485/422's distance is over 660ft (200m).

■ TTL SIGNAL LEVELS

TTL Input	TTL Output
High (>2.0V)	High (>3.5V)
Low (<0.8V)	Low (<0.6V)

■ CONNECTIONS

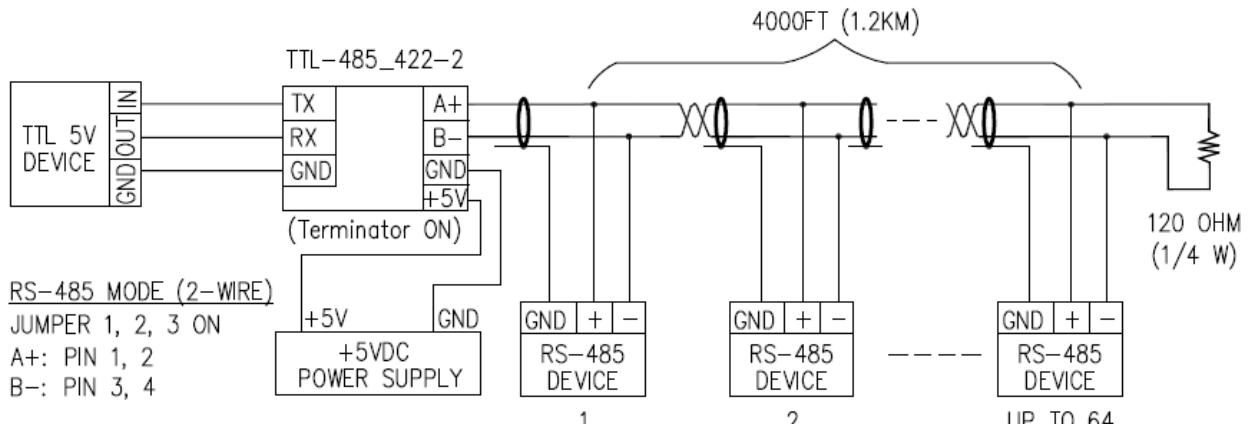


FIGURE 1: MASTER-SLAVE MULTI-DROP CONNECTIONS (RS-485)

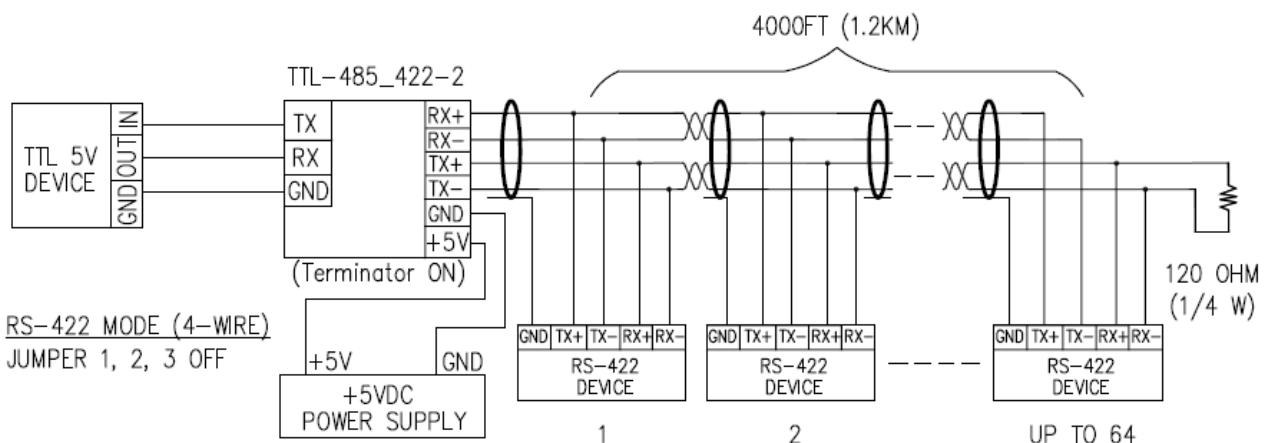


FIGURE 2: MASTER-SLAVE MULTI-DROP CONNECTIONS (RS-422)

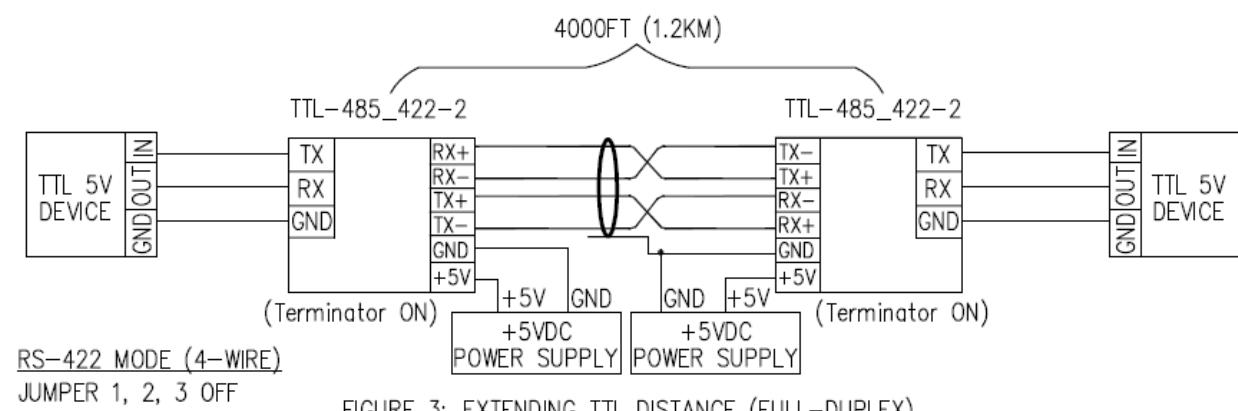


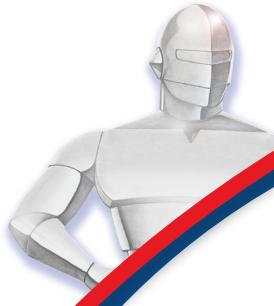
FIGURE 3: EXTENDING TTL DISTANCE (FULL-DUPLEX)

■ INSTALLATION NOTES

- CAUTION: Be sure that the DC power applied to pin +5V and GND is within the range of +4.75V to +5.25V (5V ±5%). Excessive input voltage or incorrect polarity connection could damage the converter.**
- The 120Ω end-of-line terminator adds heavy DC loading to a system; connect it only when the RS-485/422's distance is over 660ft (200m).

■ TROUBLESHOOTING

- Perform a loopback test by using CommFront's 232Analyzer software: Short TX and RX on the TTL side, connect your PC's RS-485 or RS-422 port to the RS485/422 side, and then send commands from the 232Analyzer software. You should receive an echo of the commands sent. By performing a simple loopback test like this, you can test both the transmitter and receiver of the RS-485/422 to TTL converter. This is very helpful when you are in doubt about the performance of your converter.



EN400 - 400VA/200W | EN750 - 750VA/400W
 EN600 - 600VA/300W | EN900 - 900VA/500W

EnSpire EN600 - 600VA/300W
 Standby UPS



The Minuteman® EnSpire™ Series UPS is a low-cost high performance UPS line that provides the features needed to protect your valuable equipment.

The EN400 and EN600 units each have six outlets, three provide battery support along with spike and surge protection and three with spike and surge protection only. The EN750 and EN900 have four each of the outlets described above for total protection of up to eight connected devices. In addition, all units have outlets which are specifically spaced to support transformer blocks.

The EnSpire UPS has a small footprint and is uniquely designed with outlets on the top for placement on or under a desk or table and all models can be wall mounted.

For over 25 years, Para Systems, Inc. has provided quality power products and excellent personalized service with direct human response to all service and support calls. EnSpire products pass extensive quality testing before being shipped to our end users.

Applications

- Small capacity equipment loads
- Desktop/laptop workstations
- Small phone systems
- VoIP handsets
- Home entertainment/theater systems
- Security systems (cameras, DVRs, access control devices)
- Low-power network devices

EnSpire EN900 - 900VA/500W
 Standby UPS



EnSpire Features

- **Minuteman SentryPlus Software** – SentryPlus auto-shutdown and monitoring software is included with every unit. No special downloads or coupons are required.
- **USB Communications** – EnSpire UPS USB connections are automatically recognized by Microsoft Windows® software. No special USB drivers are required. The EnSpire Series automatically recognizes USB connections with its HID-compliant USB communications.
- **Telephone/Fax/Modem Line Protection** - The EnSpire UPS provides a low-cost means of protecting telephone/fax/modem lines.
- **RoHS Compliant** – All EnSpire products are manufactured using non-hazardous* materials making them safer for the environment.
- **Warranty** - The UPS is covered by a three-year parts and labor warranty and \$50,000 Minuteman Platinum Protection Plan® (U.S.A. and Canada only). The battery is covered by a two-year warranty.

Additional features on EN750/EN900 models:

- **Coax Cable Protection** - Surge and spike protection for a coax cable line.
- **Backlit LCD Display** - LCD display that shows UPS information including estimated runtime, battery status and more.

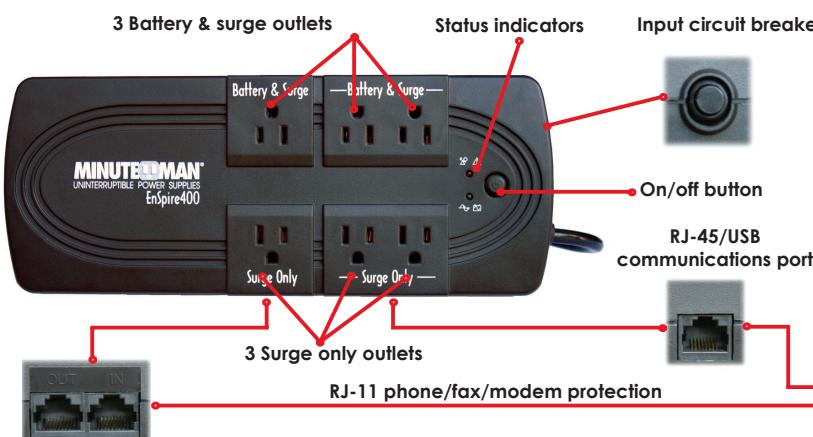
* Excludes batteries

Minuteman® EnSpire™ Series Standby UPS Specifications

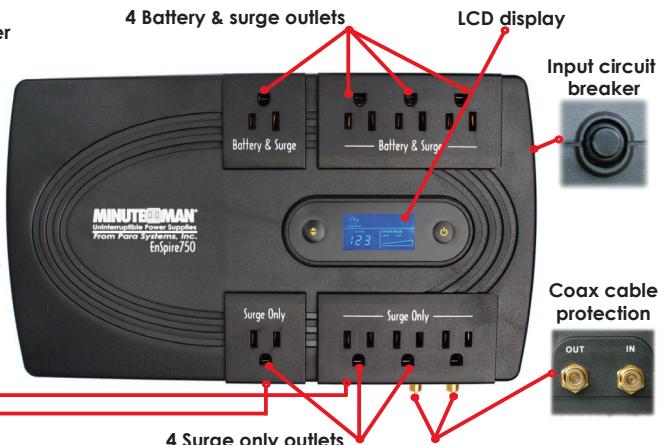
System Specifications

Model Number	EN400	EN600	EN750	EN900		
Maximum Power Capacity	400VA / 200W	600VA / 300W	750VA / 400W	900VA / 500W		
Topology	Standby UPS					
Input						
Nominal Frequency	50 or 60Hz, ±5Hz, autosensing					
Voltage Range	100 - 140VAC					
Low Voltage Transfer Point	96V (± 3%) resets to utility power at 101V (± 3%) or higher					
High Voltage Transfer Point	146V (± 3%) resets to utility power at 140V (± 3%) or lower					
Surge Energy Rating	320 J					
Input Protection	Resettable circuit breaker					
Output Non-Battery Operation						
Voltage Range	120VAC: 100 - 140VAC					
Frequency Range	60Hz: 55 - 65Hz or 50Hz: 45 - 55Hz					
Output Battery Operation						
Waveform Type	Simulated sine wave					
Nominal Voltage	120VAC					
Voltage Regulation	Nominal ±5% (until Low Battery Warning)		Nominal +2%/-9% (until Low Battery Warning)			
Frequency	50/60Hz, ±0.5Hz (unless synchronized to utility)					
Transfer Time	6-8 ms Typical					
Overload Capacity	105% for 10-seconds, 115% Shutdown Immediately		105% for 10-seconds, 120% Shutdown Immediately			
Protection	Over-Current, Short-Circuit Protected and Latching Shutdown					
Physical						
Size - Net L x W x H	11.97 x 4.84 x 3.35 in (304 x 123 x 85 mm)		12.40 x 7.20 x 3.30 in (314 x 183 x 83 mm)			
Weight - Net	6.44 lb (2.92 kg)	7.05 lb (3.20 kg)	9.40 lb (4.30 kg)	9.70 lb (4.40 kg)		
Size - Shipping L x W x H	15.00 x 8.20 x 5.43 in (380 x 208 x 138 mm)		14.40 x 10.20 x 5.60 in (367 x 260 x 143 mm)			
Weight - Shipping	7.30 lb (3.30 kg)	8.00 lb (3.60 kg)	10.60 lb (4.80 kg)	11.02 lb (5.00 kg)		
Regulatory Compliance						
Safety Approvals, EMC	UL1778, cUL (CSA 22.2 no. 107.1), FCC Class B		cTUVus (Conforms to UL1778, CSA 22.2 standards), FCC Class B			

EnSpire EN400/EN600 Top View



EnSpire EN750/EN900 Top View



Para Systems, Inc./Minuteman UPS
1455 LeMay Drive, Carrollton, TX 75007 U.S.A.
Phone 800.238.7272 +1 972.446.7363 Fax +1 972.446.9011



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www.minutemanups.com • www.sizemyups.com • www.sizemypdu.com • www.comparemyups.com

Description

The 30A20AC PWM servo drive is designed to drive brush type DC motors at a high switching frequency. A single red/green LED indicates operating status. The drive is fully protected against over-voltage, under voltage, over-current, over-heating and short-circuits across motor, ground and power leads. Furthermore, the drive can interface with digital controllers or be used as a stand-alone system. The drive requires only a single AC power supply. Loop gain, current limit, input gain and offset can be adjusted using 14-turn potentiometers. The offset adjusting potentiometer can also be used as an on-board input signal for testing purposes.

See Part Numbering Information on last page of datasheet for additional ordering options.

Power Range

Peak Current	30 A
Continuous Current	15 A
Supply Voltage	45 - 140 VAC

**Features**

- ▲ Optical Isolation Between High & Low Power Signals
- ▲ Four Quadrant Regenerative Operation
- ▲ DIP Switch Selectable Modes
- ▲ Adjustable Current Limits
- ▲ High Switching Frequency
- ▲ Differential Input Command
- ▲ Built in Shunt Regulator Circuit
- ▲ On-Board Test Potentiometer
- ▲ Offset Adjustment Potentiometer
- ▲ Adjustable Input Gain
- ▲ Drive Status LED
- ▲ Directional Inhibit Inputs for Limit Switches
- ▲ Built-in brake/shunt regulator
- ▲ Internal brake/shunt resistor

MODES OF OPERATION

- Current
- Voltage
- IR Compensation
- Velocity

COMMAND SOURCE

- ±10 V Analog

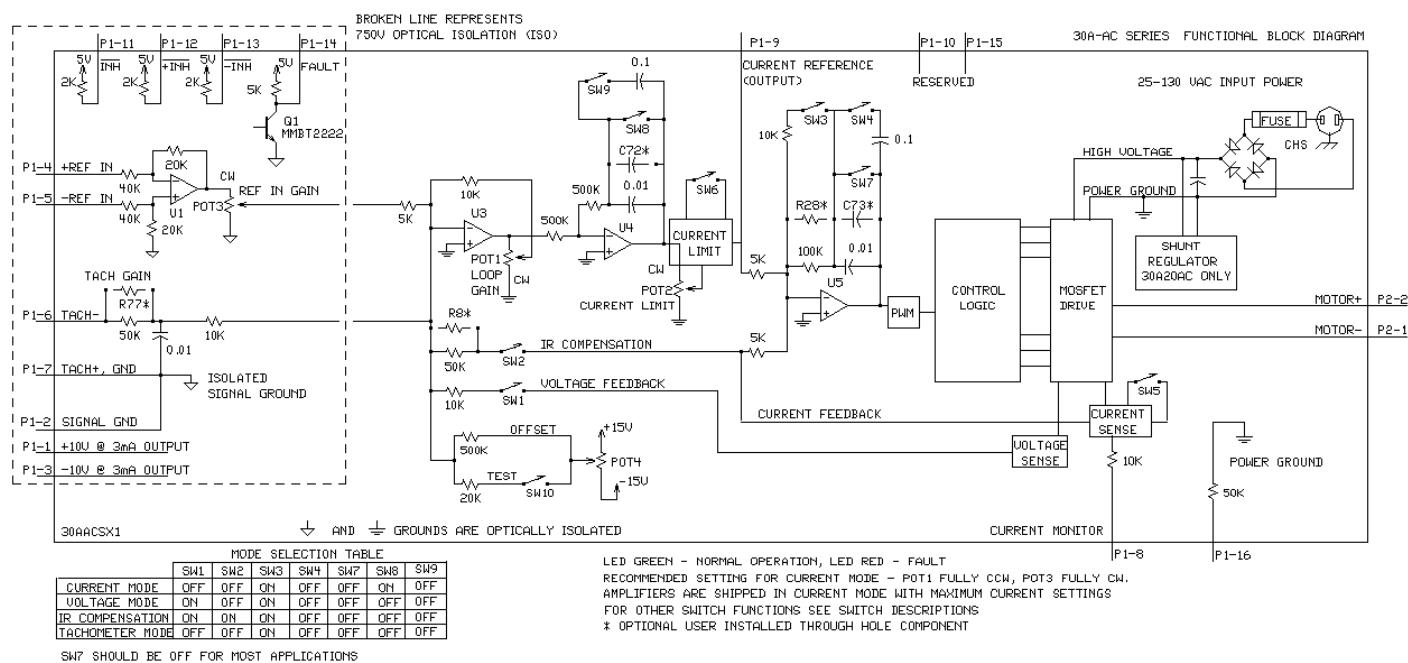
FEEDBACK SUPPORTED

- Tachometer (± 60 VDC)
- ± 10 VDC Position

COMPLIANCES & AGENCY APPROVALS

- UL
- cUL
- CE Class A (LVD)
- CE Class A (EMC)
- RoHS

BLOCK DIAGRAM



Information on Approvals and Compliances

	US and Canadian safety compliance with UL 508c, the industrial standard for power conversion electronics. UL registered under file number E140173. Note that machine components compliant with UL are considered UL registered as opposed to UL listed as would be the case for commercial products.
	Compliant with European CE for both the Class A EMC Directive 2004/108/EC on Electromagnetic Compatibility (specifically EN 61000-6-4:2001, EN 61000-6-2:2001, EN 61000-3-2:2000, and EN 61000-3-3:1995/A1:2001) and LVD requirements of directive 2006/95/EC (specifically EN 60204-1), a low voltage directive to protect users from electrical shock.
	RoHS (Reduction of Hazardous Substances) is intended to prevent hazardous substances such as lead from being manufactured in electrical and electronic equipment.

SPECIFICATIONS

Description		Power Specifications	
		Units	Value
AC Supply Voltage Range	VAC	45 - 140	
DC Supply Voltage Range	VDC	40 - 190	
DC Bus Over Voltage Limit	VDC	195	
Maximum Peak Output Current ¹	A	30	
Maximum Continuous Output Current	A	15	
Maximum Continuous Output Power	W	2707	
Maximum Power Dissipation at Continuous Current	W	143	
Internal Bus Capacitance	µF	3600	
Internal Shunt Resistance	Ω	10	
Internal Shunt Resistor Power Rating	W	50	
Internal Shunt Resistor Turn-on Voltage	VDC	185	
Minimum Load Inductance (Line-To-Line) ²	µH	250	
Low Voltage Supply Outputs	-	±10 VDC (3 mA)	
Switching Frequency	kHz	22	
Shunt Fuse	A	3	
Bus Fuse	A	16	
Description		Control Specifications	
		Units	Value
Command Sources	-	±10 V Analog	
Feedback Supported	-	±10 VDC Position, Tachometer (±60 VDC)	
Commutation Methods	-	Brush Type	
Modes of Operation	-	Current, IR Compensation, Velocity, Voltage	
Motors Supported	-	Single Phase (Brushed, Voice Coil, Inductive Load)	
Hardware Protection	-	Over Current, Over Temperature, Over Voltage, Short Circuit (Phase-Phase & Phase-Ground)	
Primary I/O Logic Level	-	5V TTL	
Internal Shunt Regulator	-	Yes	
Internal Shunt Resistor	-	Yes	
Description		Mechanical Specifications	
		Units	Value
Agency Approvals	-	CE Class A (EMC), CE Class A (LVD), cUL, RoHS, UL	
Size (H x W x D)	mm (in)	186.7 x 107.4 x 62.2 (7.4 x 4.2 x 2.4)	
Weight	g (oz)	1140 (40.2)	
Heatsink (Base) Temperature Range ³	°C (°F)	0 - 65 (32 - 149)	
Storage Temperature Range	°C (°F)	-40 - 85 (-40 - 185)	
Form Factor	-	Panel Mount	
P1 Connector	-	16-pin, 2.54 mm spaced, friction lock header	
P2 Connector	-	2-contact, 11.10 mm spaced, tri-barrier terminal block	

Notes

1. Maximum duration of peak current is ~2 seconds.
2. Lower inductance is acceptable for bus voltages well below maximum. Use external inductance to meet requirements.
3. Additional cooling and/or heatsink may be required to achieve rated performance.

PIN FUNCTIONS

P1 - Signal Connector			
Pin	Name	Description / Notes	I/O
1	+10V 3mA OUT		O
2	SIGNAL GND		SGND
3	-10V 3mA OUT	±10 V @ 3 mA low power supply for customer use. Short circuit protected. Reference ground common with signal ground.	O
4	+REF IN	Differential Reference Input (±10 V Operating Range, ±15 V Maximum Input)	I
5	-REF IN		I
6	-TACH IN	Negative Tachometer Input (Maximum ±60 V). Use signal ground for positive input.	I
7	+TACH / GND	Positive Tachometer Input and Signal Ground	SGND
8	CURR MONITOR OUT	Current Monitor. Analog output signal proportional to the actual current output. Scaling is 7.7 A/V by default but may be reduced to half this value by setting DIP switch SW-5 to OFF (see Hardware Settings section below). Measure relative to power ground.	O
9	CURRENT REF OUT	Measures the command signal to the internal current-loop. This pin has a maximum output of ±7.25 V when the drive outputs maximum peak current. Measure relative to signal ground.	O
10	NC	Not Connected (Reserved)	-
11	<u>INHIBIT IN</u>	TTL level (+5 V) inhibit/enable input. Leave open to enable drive. Pull to ground to inhibit drive. Inhibit turns off all power devices.	I
12	<u>+INHIBIT IN</u>	Positive Direction Inhibit (Does Not Cause A Fault Condition)	I
13	<u>-INHIBIT IN</u>	Negative Direction Inhibit (Does Not Cause A Fault Condition)	I
14	FAULT OUT	TTL level (+5 V) output becomes high when power devices are disabled due to at least one of the following conditions: inhibit, output short circuit, over voltage, over temperature, power-up reset.	O
15	NC	Not Connected (Reserved)	-
16	NON-ISO GND	Connected to power ground and can be used as a reference point for P1-8 and P1-9.	PGND

P2 - Motor Power Connector			
Pin	Name	Description / Notes	I/O
1	-MOT	Negative Motor Output	O
2	+MOT	Positive Motor Output	O

HARDWARE SETTINGS

Switch Functions

Switch	Description	Setting	
		On	Off
1	Voltage feedback. Mode dependent (see mode selection table below).	On	Off
2	IR compensation. Activates or deactivates IR feedback. ON for IR compensation mode and OFF for other modes.	On	Off
3	Current loop proportional gain adjustment. ON by default.	Decrease	Increase
4	Inner (current) loop integral gain adjustment. OFF by default.	Decrease	Increase
5	Current scaling. When OFF, increases sensitivity of current sense thus reducing both peak and continuous current limit by 50%. The scaling of the current monitor output signal becomes $\frac{1}{2}$ its ordinary value when this switch is OFF.	Full-current	Half-current
6	Current limit ratio. Used to set continuous-to-peak current limit ratio. Default is OFF.	Cont./Peak Ratio = 25%	Cont./Peak Ratio = 50%
7	Current loop integral gain. Activates or deactivates integration. OFF by default.	Inactive	Active
8	Outer loop integration. Activates or deactivates integration. ON, by default, for current mode and OFF for other modes.	Inactive	Active
9	Outer loop integral gain adjustment. It is recommended to leave this switch OFF for most applications.	Decrease	Increase
10	Test/Offset. Switches the function of the Test/Offset pot between an on-board command input for testing or a command offset adjustment. OFF by default.	Test	Offset

Mode Selection Table

	SW1	SW2	SW3	SW4	SW7	SW8	SW9
CURRENT	OFF	OFF	ON	OFF	OFF	ON	OFF
VOLTAGE	ON	OFF	ON	OFF	OFF	OFF	OFF
IR COMPENSATION	ON	ON	ON	OFF	OFF	OFF	OFF
TACHOMETER	OFF	OFF	ON	OFF	OFF	OFF	OFF

Note: SW7 should be off for most applications

Potentiometer Functions

Potentiometer	Description	Turning CW
1	Loop gain adjustment for voltage/velocity modes. Turn this pot fully CCW in current mode.	Increases gain
2	Current limit. It adjusts both continuous and peak current limit while maintaining their ratio.	Increases limit
3	Reference gain. Adjusts the ratio between input signal and output variables (voltage, current, or velocity).	Increases gain
4	Offset / Test. Used to adjust any imbalance in the input signal or in the amplifier. Can also be used as an on-board signal source for testing purposes.	Adjusts offset in negative direction

Note: Potentiometers are approximately linear and have 12 active turns with 1 inactive turn on each end.

Through-hole Components[†]

Location	Description
C72*	Velocity Loop Integrator. Through-hole capacitor that can be added for more precise velocity loop tuning. See section below on Tuning with Through-hole components for more details.
C73*	Current Loop Integrator. Through-hole capacitor that can be added for more precise current loop tuning. See section below on Tuning with Through-hole components for more details.
R28*	Current Loop Proportional Gain. Through-hole resistor that can be added for more precise current loop tuning. See section below on Tuning with Through-hole components for more details.
R77*	Tachometer Input Scaling. Through-hole resistor that can be added to change the gain of the tachometer input. See section below on Tachometer Gain for more details.
R8*	IR Compensation Scaling. Through-hole resistor that can be added to configure the amplifier for IR Compensation mode. See section below on IR Compensation Notes for more details.

Tuning With Through-hole Components

In general, the drive will not need to be further tuned with through-hole components. However, for applications requiring more precise tuning than what is offered by the potentiometers and dipswitches, the drive can be manually modified with through-hole resistors and capacitors as denoted in the above table. By default, the through-hole locations are not populated when the drive is shipped. Before attempting to add through-hole components to the board, consult the section on loop tuning in the installation notes on the manufacturer's website. Some general rules of thumb to follow when adding through-hole components are:

- A larger resistor value will increase the proportional gain, and therefore create a faster response time.
- A larger capacitor value will increase the integration time, and therefore create a slower response time.

Proper tuning using the through-hole components will require careful observation of the loop response on a digital oscilloscope to find the optimal through-hole component values for the specific application.

Tachometer Gain

Some applications may require an increase in the gain of the tachometer input signal. This occurrence will be most common in designs where the tachometer input has a low voltage to RPM scaling ratio. The drive offers a through-hole location listed in the above table where a resistor can be added to increase the tachometer gain. Use the drive's block diagram to determine an appropriate resistor value.

IR Compensation Notes

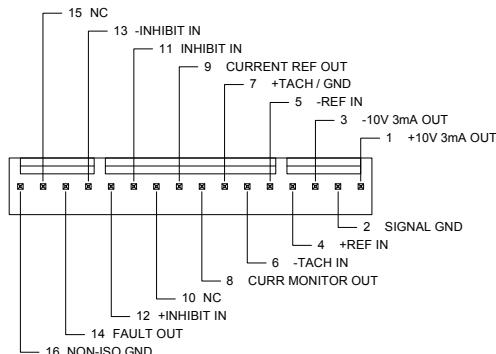
For applications that will use IR Compensation mode, a resistor can be added to the location named in the table above. The combination of the added resistor and correct dipswitch settings will configure the amplifier for IR Compensation mode. While in IR Compensation mode, the amplifier will adjust the duty cycle to compensate for changes in the output current. Consult the amplifier's functional block diagram and the manufacturer's website for more information.

[†]Note: Damage done to the drive while performing these modifications will void the warranty.

MECHANICAL INFORMATION

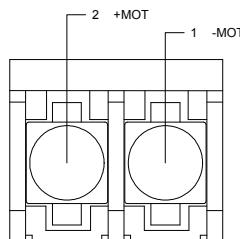
P1 - Signal Connector

Connector Information		16-pin, 2.54 mm spaced, friction lock header
Mating Connector	Details	Molex: P/N 22-01-3167 (connector) and P/N 08-50-0114 (insert terminals)
	Included with Drive	Yes

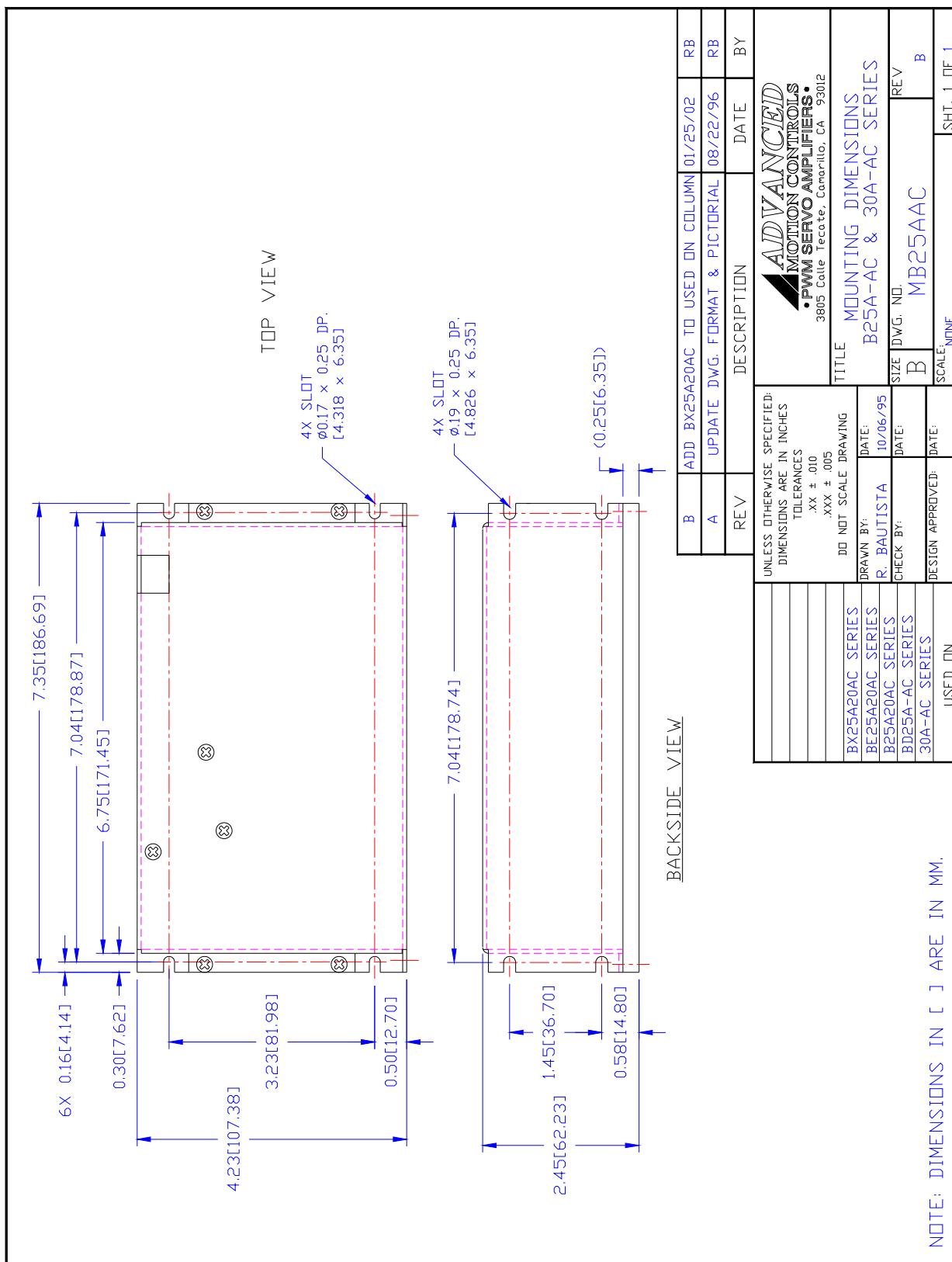


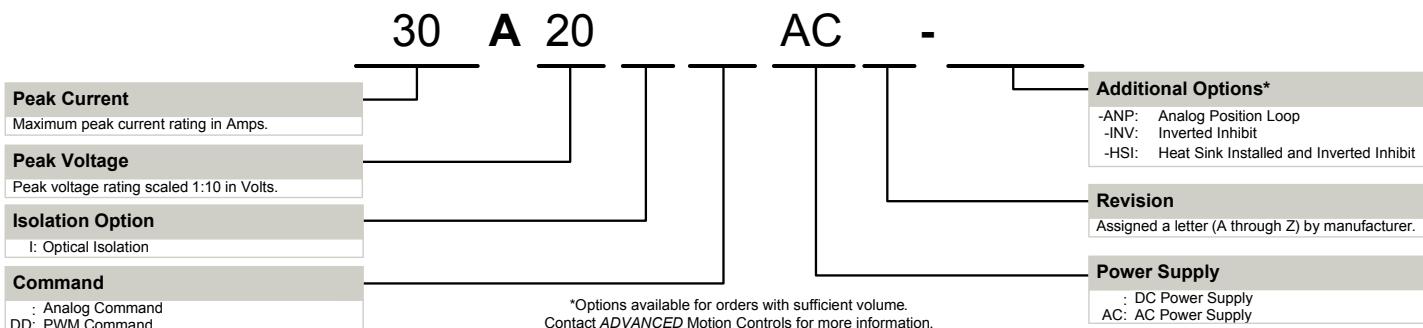
P2 - Motor Power Connector

Connector Information		2-contact, 11.10 mm spaced, tri-barrier terminal block
Mating Connector	Details	Not applicable
	Included with Drive	Not applicable



MOUNTING DIMENSIONS



PART NUMBERING INFORMATION


ADVANCED Motion Controls analog series of servo drives are available in many configurations. All models listed in the selection tables of the website are readily available, standard product offerings.

ADVANCED Motion Controls also has the capability to promptly develop and deliver specified products for OEMs with volume requests. Our Applications and Engineering Departments will work closely with your design team through all stages of development in order to provide the best servo drive solution for your system. Equipped with on-site manufacturing for quick-turn customs capabilities, ADVANCED Motion Controls utilizes our years of engineering and manufacturing expertise to decrease your costs and time-to-market while increasing system quality and reliability.

Examples of Modifications and Customized Products

- Integration of Drive into Motor Housing
- Mount OEM PCB onto Drive Without Cables
- Multi-axis Configuration for Compact System
- Custom PCB and Baseplate for Optimized Footprint
- RTV/Epoxy Components for High Vibration
- OEM Specified Connectors for Instant Compatibility
- OEM Specified Silkscreen for Custom Appearance
- Increased Thermal Limits for High Temp. Operation
- Integrate OEM Circuitry onto Drive PCB
- Custom Control Loop Tuned to Motor Characteristics
- Custom I/O Interface for System Compatibility
- Preset Switches and Pots to Reduce User Setup
- Optimized Switching Frequency
- Ramped Velocity Command for Smooth Acceleration
- Remove Unused Features to Reduce OEM Cost
- Application Specific Current and Voltage Limits

Feel free to contact Applications Engineering for further information and details.

Available Accessories

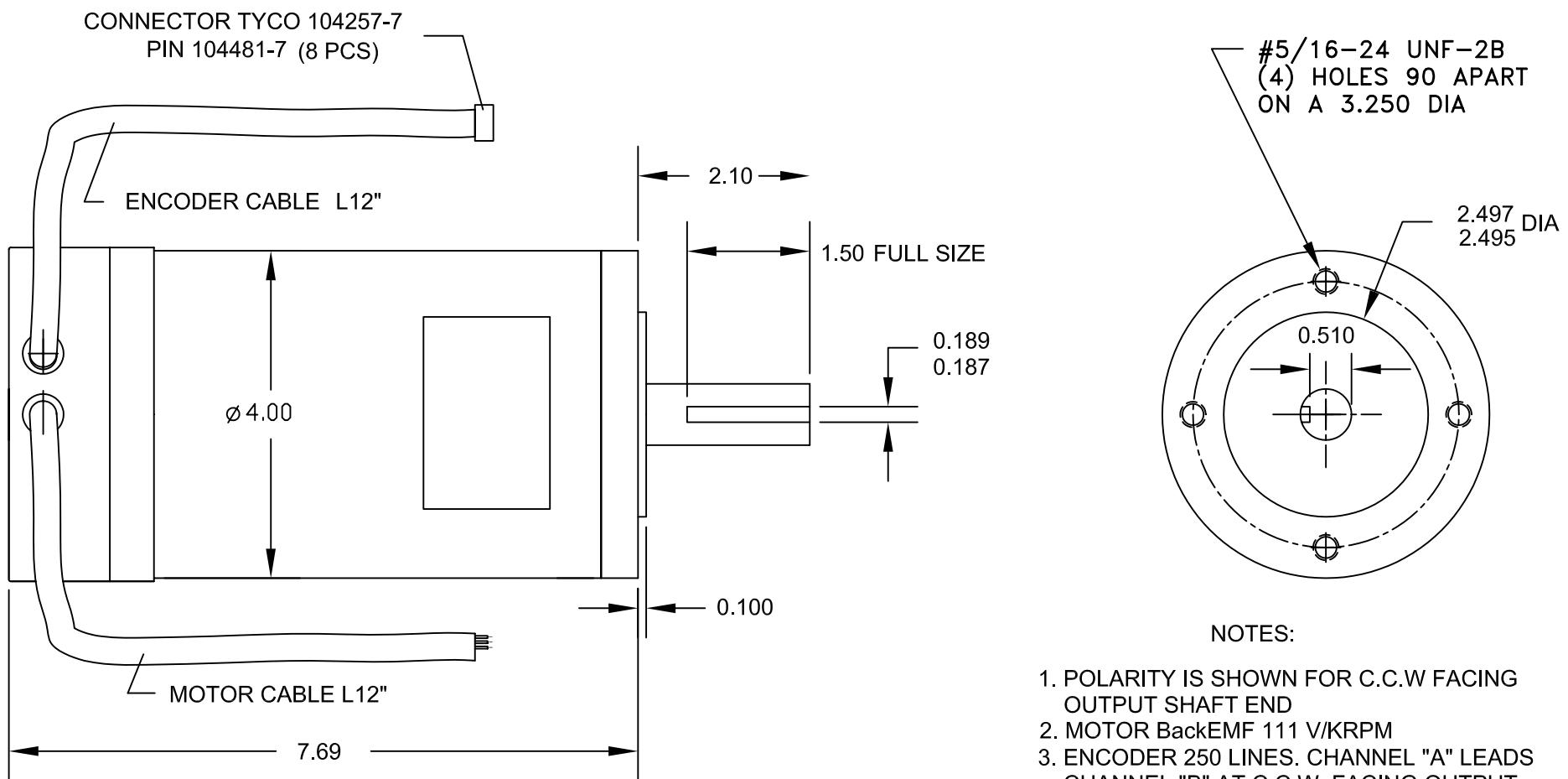
ADVANCED Motion Controls offers a variety of accessories designed to facilitate drive integration into a servo system. Visit www.a-m-c.com to see which accessories will assist with your application design and implementation.



All specifications in this document are subject to change without written notice. Actual product may differ from pictures provided in this document.

REVISIONS

REV.	DESCRIPTION	DATE	APPROVED



CONNECTOR DIAGRAM:

- | | |
|----------------|-----------|
| 1 - INDEX- | (BRN) |
| 2 - Vcc | (RED) |
| 3 - GRND | (BLK) |
| 4 - CHANNEL B | (GRN) |
| 5 - CHANNEL A | (YEL/WHT) |
| 6 - INDEX | (ORN) |
| 7 - CHANNEL B- | (BLU) |
| 8 - CHANNEL A- | (YEL) |

UNLESS OTHERWISE
SPECIFIED DIMENSIONS
ARE IN INCHES
TOLERANCES:
ANGLES 1/2°
XXX DEC +/- .005
XX DEC +/- .01

DRAWN	VM	DATE	11.12.09	POTOMAC ELECTRIC CORP.		
CHK				TITLE		
APVD	LC			SERVOMOTOR, DC		
				SIZE		
CONTRACT	OLIN COLLEGE	DWG	MXE4252.MX	REV.		
		A				
		SCALE	0.5:1			SHEET 1 OF 1

REVISION: A
DATE: 04.03.2008

MOTOR MXE4252.MX

DATA SHEET

SYM	PARAMETER	UNITS	NOMIN	MIN	MAX
T _{pk}	Torque, peak rated	oz.in.	2500	-	-
T _C	Torque, continuous	oz.in.	-	400	-
K _T	Torque sensitivity	oz.in./AMP	162	178	145
R _a	Resistance of armature at 25°C	ohms	TBD		
L _a	Inductance of armature at 1000 Hz	millihenrys	TBD		
I _p	Amps at peak torque	amps	38	-	-
E _p	Maximum terminal voltage	volts	160	-	-
K _V	Volts back EMF	volts/KRMP	120	133	108
F _I	Viscous friction coefficient	oz.in./KRMP	16		
T _f	Static friction torque	oz.in.	15		
T _R	Cogging torque at zero excitation	oz.in.	+/- 5%		
J _m	Moment of inertia - motor/tach	oz.in.sec ²	0.17	-	-
□ _m	Time constant, mechanical -	millisec	4.91		
□ _e	Time constant, electrical	millisec	1.42		
R _{th}	Thermal resistance, mounted	deg C/watt	1.2		
□ _{th}	Thermal time constant	minutes	30		
□ _a	Armature temp., max allowable	deg C	150°		
K _{vt}	Tachometer sensitivity	N/A			
R _t	Tachometer resistance	N/A			
	Tachometer ripple volts	N/A			
	Tachometer test filter & R.P.M.				
	Motor/tach torsional res. freq.				
W	Weight, lb		15		

LCL Series



- Single Output Industrial Supplies
- High Efficiency
- Low Cost
- 150 W Convection Cooled
- 300 W & 500 W with Internal Fans
- Outputs from 12 V to 48 V
- 3 Year Warranty

Specification

Input

Input Voltage	• 85-264 VAC (127-370 VDC) see note 1
Input Frequency	• 47-63 Hz
Input Current	• 2.1 A max for LCL150, 4.5 A max for LCL300, 6.6 A max for LCL500
Inrush Current	• 40 A max for LCL150, 60 A max for LCL300 & 500 25 °C cold start
Power Factor	• Meets EN61000-3-2 class A
Earth Leakage Current	• <2mA at 264 VAC, 60 Hz
Input Protection	• LCL150: T3.15 A/250 V, LCL300: T6.3A/250 V, LCL500: T10A/250 V, internal fuse fitted in line

Output

Output Voltage	• See tables
Output Voltage Trim	• See tables
Initial Set Accuracy	• ±100 mV at 50% load
Minimum Load	• None required
Start Up Delay	• 2 s max for LCL150, 1.5 s max for LCL300, 0.8 s max for LCL500
Start Up Rise Time	• 50 ms max for LCL150, 35 ms max for LCL300 & LCL500
Hold Up Time	• 10 ms min at 115 VAC and full load
Line Regulation	• ±0.5% max for LCL150, ±0.3% for LCL300 & LCL500
Load Regulation	• ±1% max
Transient Response	• 4% max deviation returning to within 1% within 500 µs for a 50% load change
Ripple & Noise	• See tables
Oversupply Protection	• 115-135%, recycle input to reset
Overtemperature Protection	• Output turns off when OTP triggered, measured internally, auto Recovery
Overload Protection	• 110-130% of rated output power. Delayed by 1 s min to allow for peak loads.
Short Circuit Protection	• Trip and restart (hiccup mode), auto recovery
Remote Sense	• Fitted to LCL500 only, compensates for 0.25 V max each line
Remote On/Off	• Fitted on LCL300 & 500 only, On = logic low or open circuit, Off = logic high

General

Efficiency	• 85% min at full load & 230 VAC
Isolation	• 3000 VAC Input to Output 1500 VAC Input to Ground 500 VAC Output to Ground
Switching Frequency	• 90-110 kHz main switch & 45-190 kHz PFC for LCL150, 80-190 kHz main switch & 62-65 kHz PFC for LCL300 & 500
Power Density	• 2.7 W/in³ LCL150, 4.4 W/in³ LCL300, 4.9 W/in³ LCL500
MTBF	• 200 kHrs according to MIL-HDBK-217F at 25 °C, GB

Environmental

Operating Temperature	• -10 °C to +70 °C, derate from 100% load at 50 °C to 50% load at 70 °C
Cooling	• LCL150 convection cooled, LCL300 & LCL500 have internal fans
Operating Humidity	• 5% to 90% non condensing
Storage Temperature	• -40 °C to +85 °C
Operating Altitude	• 3000 m
Vibration	• 10-500 Hz, 2g, 10 mins per cycle on 3 axes

EMC & Safety

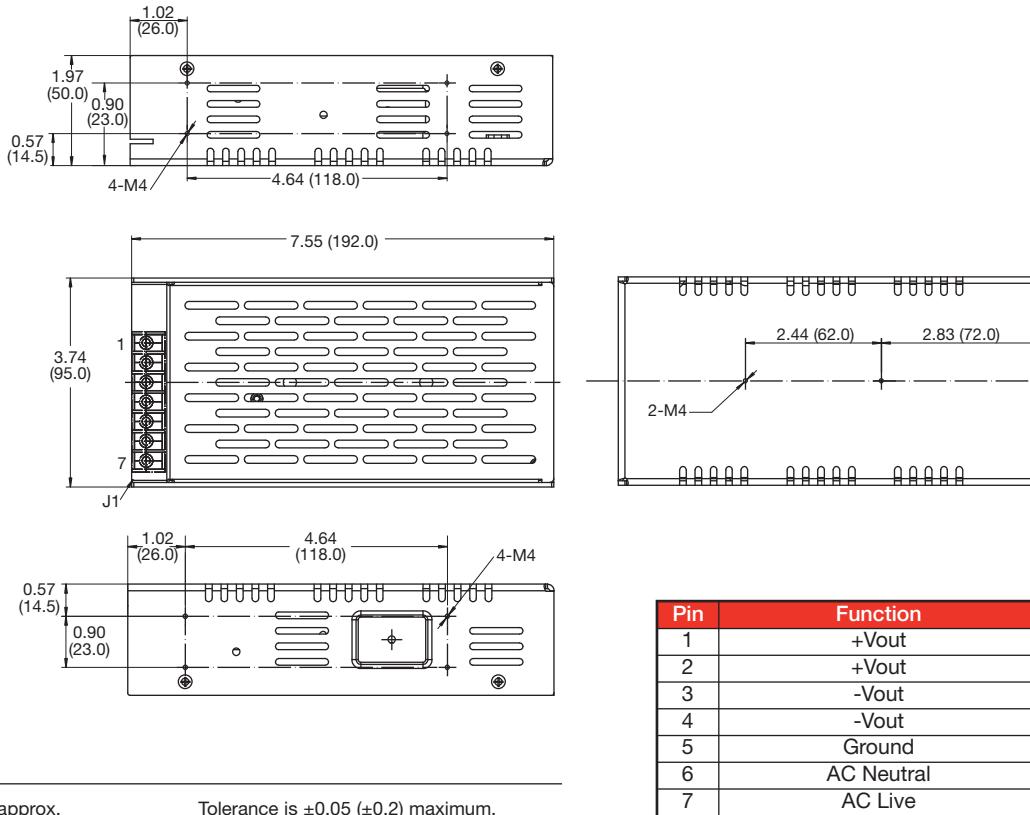
Emissions	• EN55022 level B conducted, level A radiated
Harmonic Currents	• EN61000-3-2 class A
Voltage Flicker	• EN61000-3-3
ESD Immunity	• EN61000-4-2, ±4 kV contact, ±8 kV air discharge, Performance Criteria A
Radiated Immunity	• EN61000-4-3, level 2 Perf Criteria A
EFT/Burst	• EN61000-4-4, level 2 Perf Criteria A
Surge	• EN61000-4-5, level 2 Perf Criteria A
Conducted Immunity	• EN61000-4-6, level 2 Perf Criteria A
Magnetic Field	• EN61000-4-8, 1 A/m Perf Criteria A
Dips & Interruptions	• EN61000-4-11, 70% U _r for 10 ms, 40% U _r for 100 ms, <5% U _r for 5000 ms, Perf Criteria ABB
Safety Approvals	• EN60950-1, UL60950-1, CSA60950 No 22.2

Model and Ratings**LCL150 XP**

Output Power ⁽¹⁾	Output Voltage	Trim Range	Output Current	Ripple & Noise ⁽²⁾	Model Number
150 W	12.0 V	11.0-13.0 V	12.5 A	100 mV pk-pk	LCL150PS12
	13.5 V	12.5-14.5 V	11.1 A	100 mV pk-pk	LCL150PS13
	15.0 V	14.0-16.0 V	10.0 A	100 mV pk-pk	LCL150PS15
	24.0 V	23.0-25.0 V	6.3 A	150 mV pk-pk	LCL150PS24
	27.0 V	26.0-28.0 V	5.6 A	150 mV pk-pk	LCL150PS27
	48.0 V	47.0-49.0 V	3.1 A	250 mV pk-pk	LCL150PS48

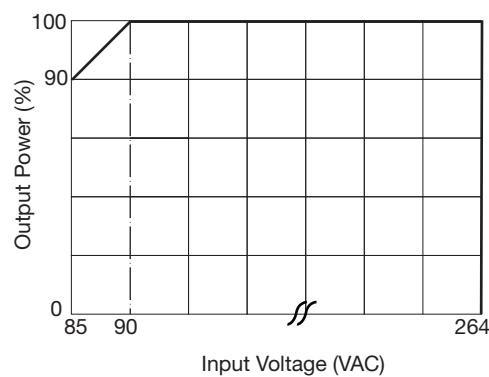
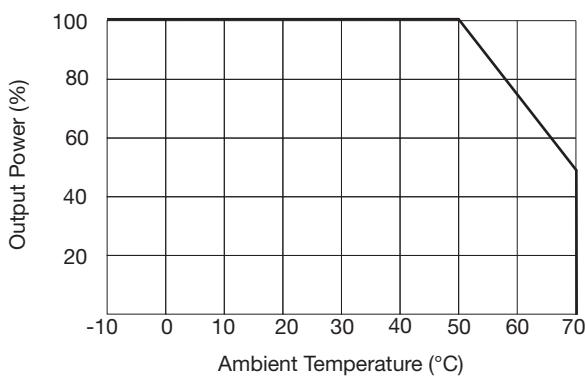
Notes

1. Output power derates linearly from 100% at 90 VAC to 90% at 85 VAC.
 2. Measured with 20 MHz bandwidth.

Mechanical Details**Notes**

Weight: 1.39 lbs (630g) approx.
 Dimensions shown in inches (mm).

Tolerance is ± 0.05 (± 0.2) maximum.

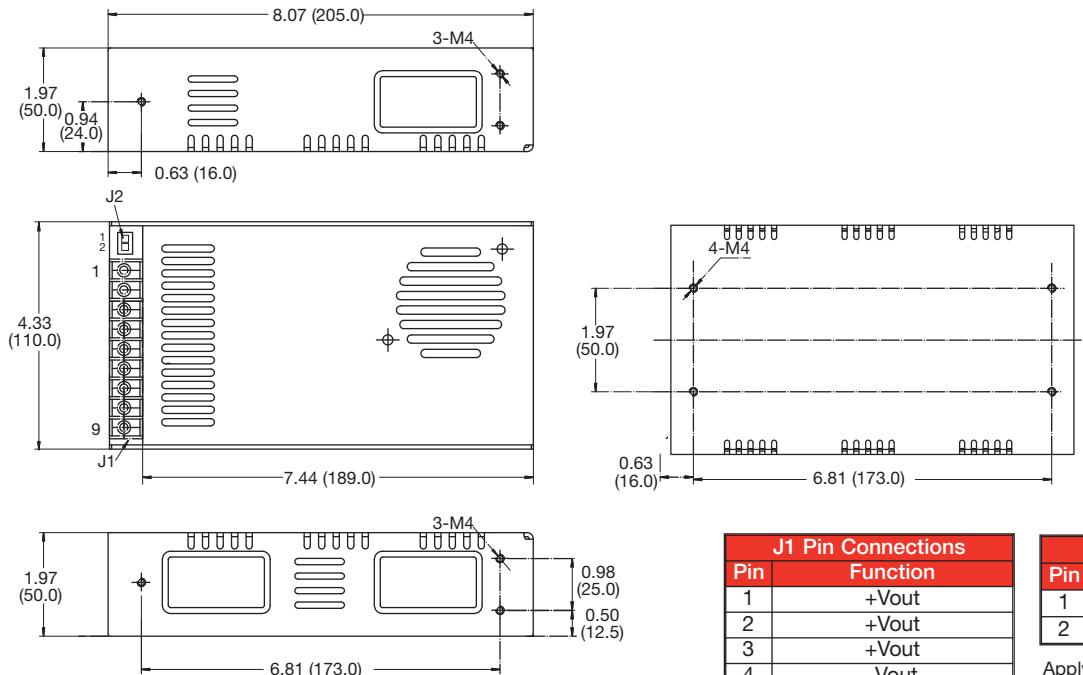
Derating Curves

Model and Ratings**LCL300 XP**

Output Power ⁽¹⁾	Output Voltage	Trim Range	Output Current	Ripple & Noise ⁽²⁾	Model Number
300 W	12.0 V	11.0-13.0 V	25.0 A	150 mV pk-pk	LCL300PS12
	13.5 V	12.5-14.5 V	22.0 A	150 mV pk-pk	LCL300PS13
	15.0 V	14.0-16.0 V	20.0 A	150 mV pk-pk	LCL300PS15
310 W	24.0 V	23.0-25.0 V	13.0 A	150 mV pk-pk	LCL300PS24
315 W	27.0 V	26.0-28.0 V	11.7 A	200 mV pk-pk	LCL300PS27
320 W	48.0 V	47.0-49.0 V	6.70 A	240 mV pk-pk	LCL300PS48

Notes

1. Operation at 85 VAC is possible, but output power derates linearly from 100% at 90 VAC to 90% at 85 VAC.
2. Measured with 20 MHz bandwidth.

Mechanical Details**Notes**

Weight: 1.94 lbs (880g) approx.
Dimensions shown in inches (mm).

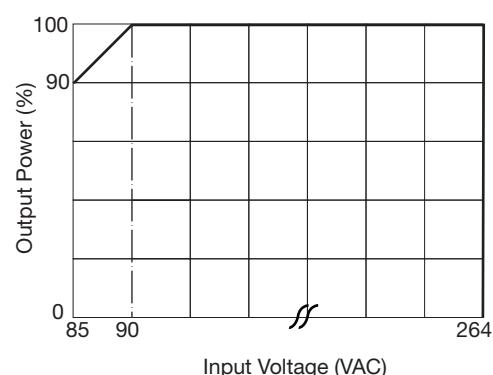
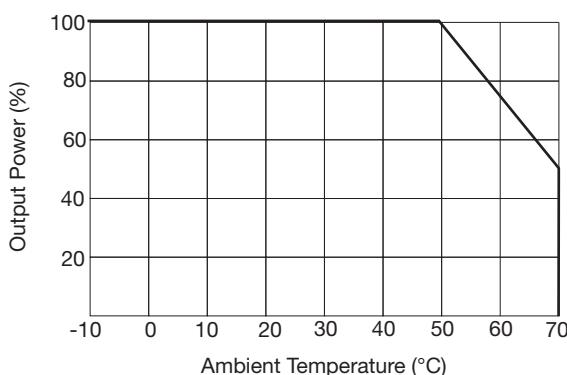
Tolerance is ± 0.05 (± 0.2) maximum.

J1 Pin Connections	
Pin	Function
1	+Vout
2	+Vout
3	+Vout
4	-Vout
5	-Vout
6	-Vout
7	Ground
8	AC Neutral
9	AC Live

J2 Pin Connections	
Pin	Function
1	Remote Control -
2	Remote Control +

Applying >4.5 V to Pin 2 with respect to Pin 1 turns output off. Applying <0.8 V to Pin 2 with respect to Pin 1 or open circuit turns output on.

Mating Connectors (J2):
Molex KK type 2695 housing
Molex 2695-2759 contacts

Derating Curves

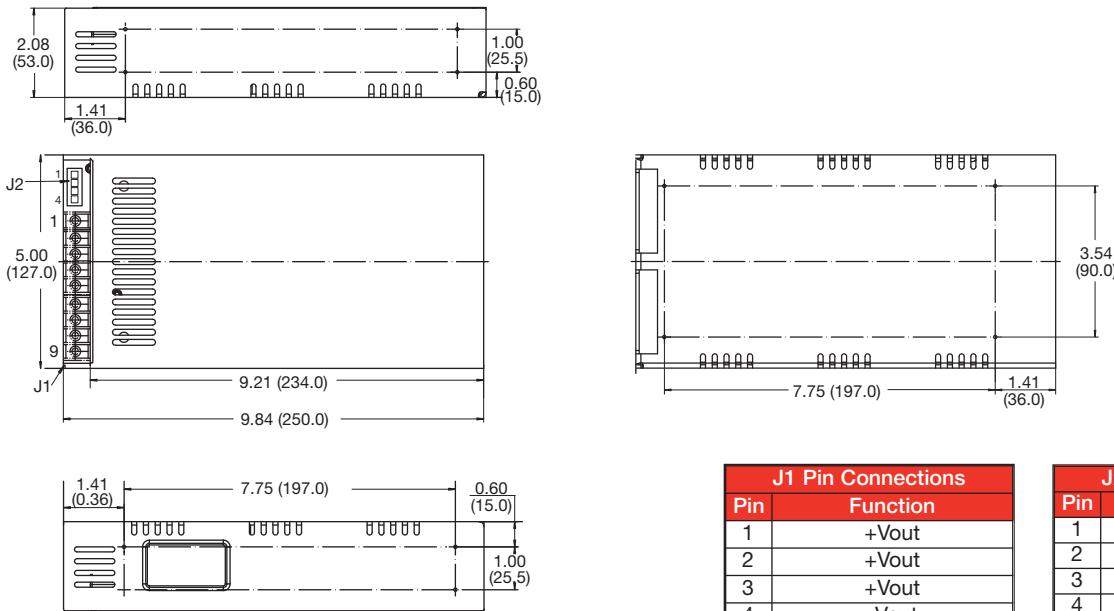
Model and Ratings

Output Power ⁽¹⁾	Output Voltage	Trim Range	Output Current	Ripple & Noise ⁽²⁾	Model Number
500 W	12.0 V	11.0-13.0 V	42.0 A	120 mV pk-pk	LCL500PS12
	13.5 V	12.5-14.5 V	37.0 A	150 mV pk-pk	LCL500PS13
	15.0 V	14.0-16.0 V	34.0 A	150 mV pk-pk	LCL500PS15
	24.0 V	23.0-25.0 V	21.0 A	150 mV pk-pk	LCL500PS24
	27.0 V	26.0-28.0 V	18.5 A	150 mV pk-pk	LCL500PS27
	48.0 V	47.0-49.0 V	10.5 A	240 mV pk-pk	LCL500PS48

Notes

1. Output power derates linearly from 100% at 90 VAC to 90% at 85 VAC.
2. Measured with 20 MHz bandwidth.

Mechanical Details



J1 Pin Connections	
Pin	Function
1	+Vout
2	+Vout
3	+Vout
4	-Vout
5	-Vout
6	-Vout
7	Ground
8	AC Neutral
9	AC Live

J2 Pin Connections	
Pin	Function
1	Remote Control -
2	Remote Control +
3	Sense -
4	Sense +

Applying >4.5 V to Pin 2 with respect to Pin 1 turns output off. Applying <0.8 V to Pin 2 with respect to Pin 1 or open circuit turns output on.

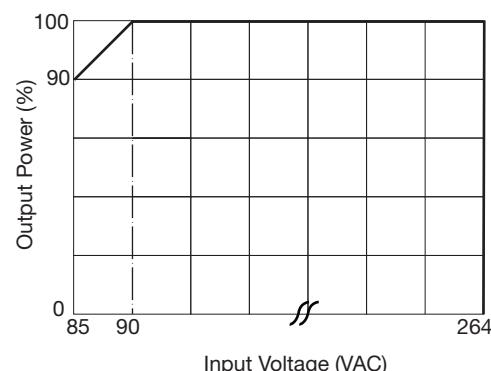
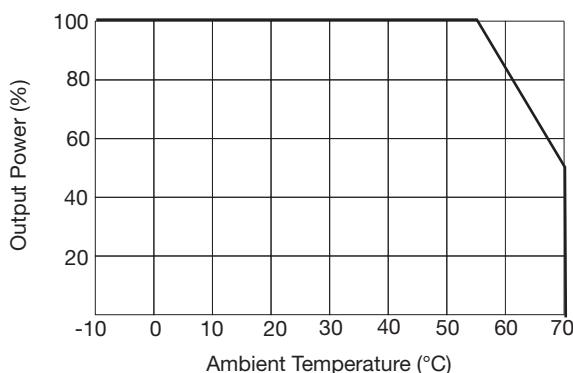
Mating Connectors (J2):
WST P4-I25002 housing
WST I25002BS contacts

Notes

Weight: 3.2 lbs (1.45 kg) approx.
Dimensions shown in inches (mm).

Tolerance is ± 0.05 (± 0.2) maximum.

Derating Curves




■ Features :

- Universal AC input / Full range
- Built-in active PFC function, PF>0.95
- High efficiency up to 89% (typ.)
- Withstand 300VAC surge input for 5 seconds
- Protections: Short circuit / Overload / Over voltage / Over temperature
- Cooling by free air convection
- Built-in constant current limiting circuit
- 1U low profile 38mm
- Built-in remote sense function
- 5 years warranty

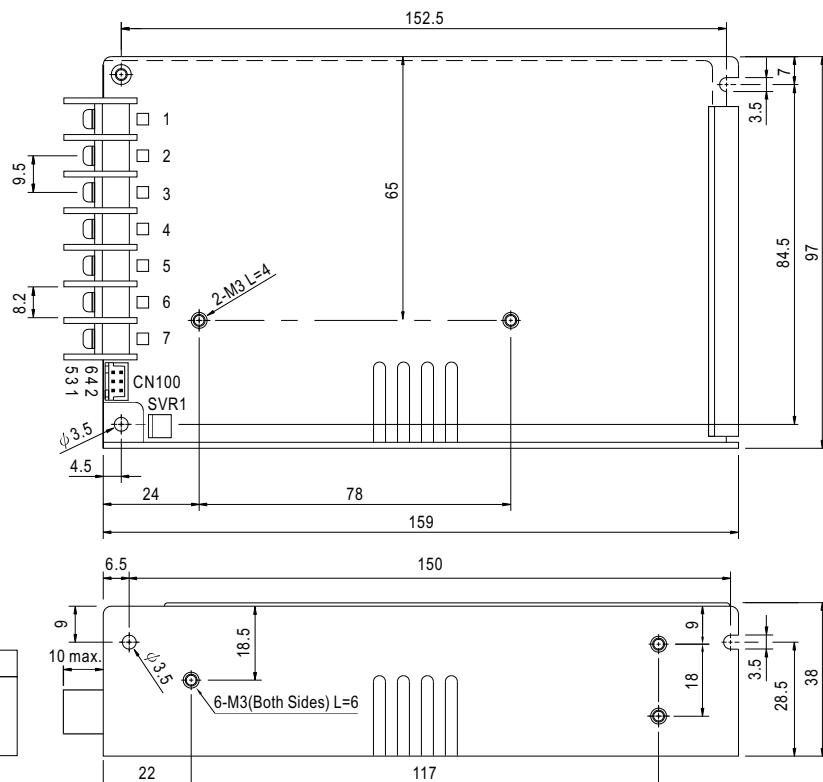

SPECIFICATION

MODEL	HRP-150-3.3	HRP-150-5	HRP-150-7.5	HRP-150-12	HRP-150-15	HRP-150-24	HRP-150-36	HRP-150-48
OUTPUT	DC VOLTAGE	3.3V	5V	7.5V	12V	15V	24V	36V
	RATED CURRENT	30A	26A	20A	13A	10A	6.5A	4.3A
	CURRENT RANGE	0 ~ 30A	0 ~ 26A	0 ~ 20A	0 ~ 13A	0 ~ 10A	0 ~ 6.5A	0 ~ 4.3A
	RATED POWER	99W	130W	150W	156W	150W	156W	154.8W
	RIPLINE & NOISE (max.) Note.2	80mVp-p	80mVp-p	100mVp-p	120mVp-p	150mVp-p	150mVp-p	200mVp-p
	VOLTAGE ADJ. RANGE	2.8 ~ 3.8V	4.3 ~ 5.8V	6.8 ~ 9V	10.2 ~ 13.8V	13.5 ~ 18V	21.6 ~ 28.8V	28.8 ~ 39.6V
	VOLTAGE TOLERANCE Note.3	±2.5%	±2.5%	±2.5%	±1.5%	±1.5%	±1.5%	±1.5%
	LINE REGULATION	±0.5%	±0.5%	±0.5%	±0.3%	±0.3%	±0.2%	±0.2%
	LOAD REGULATION	±1.0%	±1.0%	±1.0%	±0.5%	±0.5%	±0.5%	±0.5%
	SETUP, RISE TIME	1000ms, 50ms/230VAC		2500ms, 50ms/115VAC at full load				
INPUT	HOLD UP TIME (Typ.)	16ms/230VAC		16ms/115VAC at full load				
	VOLTAGE RANGE Note.5	85 ~ 264VAC		120 ~ 370VDC				
	FREQUENCY RANGE	47 ~ 63Hz						
	POWER FACTOR (Typ.)	PF>0.95/230VAC		PF>0.99/115VAC at full load				
	EFFICIENCY (Typ.)	80%	85%	87%	88%	88%	88%	89%
	AC CURRENT (Typ.)	2.3A/115VAC		1.3A/230VAC				
	INRUSH CURRENT (Typ.)	35A/115VAC		65A/230VAC				
PROTECTION	LEAKAGE CURRENT	<1mA / 240VAC						
	OVERLOAD	105 ~ 135% rated output power						
		Protection type : Constant current limiting, recovers automatically after fault condition is removed						
	OVER VOLTAGE	3.96 ~ 4.62V	6 ~ 7V	9.4 ~ 10.9V	14.4 ~ 16.8V	18.8 ~ 21.8V	30 ~ 34.8V	41.4 ~ 48.6V
		Protection type : Shut down o/p voltage, re-power on to recover						57.6 ~ 67.2V
ENVIRONMENT	OVER TEMPERATURE	95°C (3.3V ~ 7.5V), 85°C (12V ~ 48V) (TSW1 : detect on heatsink Q1 of power transistor)						
		105°C (3.3V ~ 7.5V), 100°C (12V ~ 48V) (TSW2 : detect on heatsink HS4 of power transistor)						
		Protection type : Shut down o/p voltage, recovers automatically after temperature goes down						
	WORKING TEMP.	-30 ~ +70°C (Refer to output load derating curve)						
	WORKING HUMIDITY	20 ~ 90% RH non-condensing						
SAFETY & EMC (Note 4)	STORAGE TEMP., HUMIDITY	-40 ~ +85°C, 10 ~ 95% RH						
	TEMP. COEFFICIENT	±0.04%/°C (0 ~ 50°C)						
	VIBRATION	10 ~ 500Hz, 5G 10min./1cycle, 60min. each along X, Y, Z axes						
	SAFETY STANDARDS	UL60950-1, TUV EN60950-1 approved						
	WITHSTAND VOLTAGE	I/P-O/P:3KVAC I/P-FG:1.5KVAC O/P-FG:0.5KVAC						
OTHERS	ISOLATION RESISTANCE	I/P-O/P, I/P-FG, O/P-FG:100M Ohms / 500VDC / 25°C / 70% RH						
	EMI CONDUCTION & RADIATION	Compliance to EN55022 (CISPR22) Class B						
	HARMONIC CURRENT	Compliance to EN61000-3-2, -3						
	EMS IMMUNITY	Compliance to EN61000-4-2,3,4,5,6,8,11; ENV50204, EN55024, EN61000-6-2, heavy industry level, criteria A						
	MTBF	238.8K hrs min. MIL-HDBK-217F (25°C)						
NOTE	DIMENSION	159*97*38mm (L*W*H)						
	PACKING	0.61Kg; 24pcs/15.6Kg/0.76CUFT						
1. All parameters NOT specially mentioned are measured at 230VAC input, rated load and 25°C of ambient temperature. 2. Ripple & noise are measured at 20MHz of bandwidth by using a 12" twisted pair-wire terminated with a 0.1uf & 47uf parallel capacitor. 3. Tolerance : includes set up tolerance, line regulation and load regulation. 4. The power supply is considered a component which will be installed into a final equipment. The final equipment must be re-confirmed that it still meets EMC directives. 5. Derating may be needed under low input voltages. Please check the derating curve for more details.								

File Name: HRP-150-SPEC 2008-12-10

Mechanical Specification

Case No.901I Unit:mm

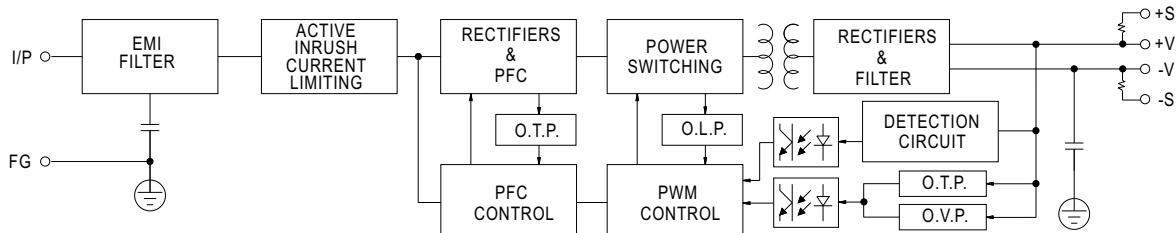
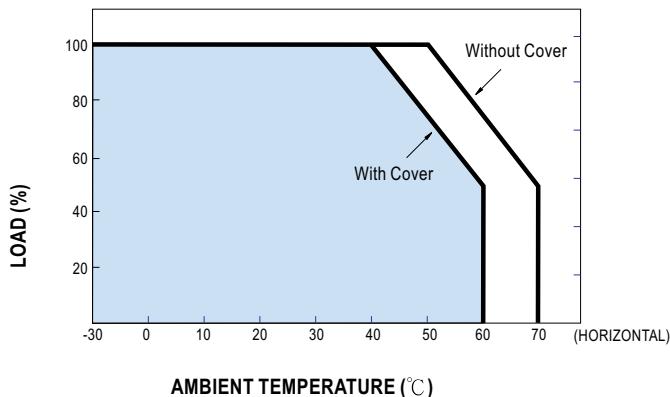
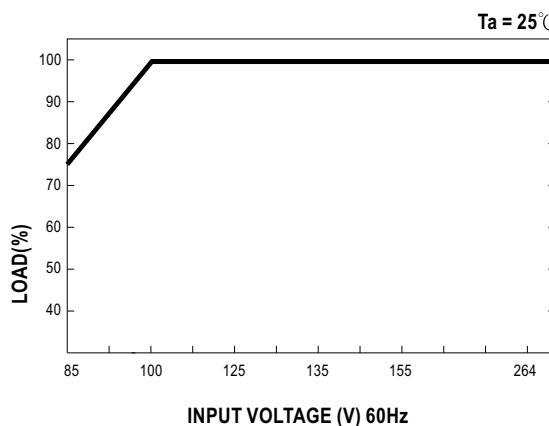

Terminal Pin No. Assignment:

Pin No.	Assignment	Pin No.	Assignment
1	AC/L	4,5	DC OUTPUT -V
2	AC/N	6,7	DC OUTPUT +V
3	FG \pm		

Connector Pin No. Assignment (CN100) :

HRS DF11-6DP-2DS or equivalent

Pin No.	Assignment	Mating Housing	Terminal
1	-S		
2	+S	HRS DF11-6DS or equivalent	HRS DF11-**SC or equivalent
3~6	NC		

 fosc : 100KHz(3.3~7.5V)
 70KHz(12~48V)

Derating Curve

Output Derating VS Input Voltage




300W Single Output with PFC Function



HRP-300 series



■ Features :

- Universal AC input / Full range
- Built-in active PFC function, PF>0.95
- High efficiency up to 89% (typ.)
- Withstand 300VAC surge input for 5 seconds
- Protections: Short circuit / Overload / Over voltage / Over temperature
- Built-in constant current limiting circuit
- 1U low profile 41mm
- Built-in cooling Fan ON-OFF control (load)
- With DC OK signal output
- Built-in remote sense function
- 5 years warranty

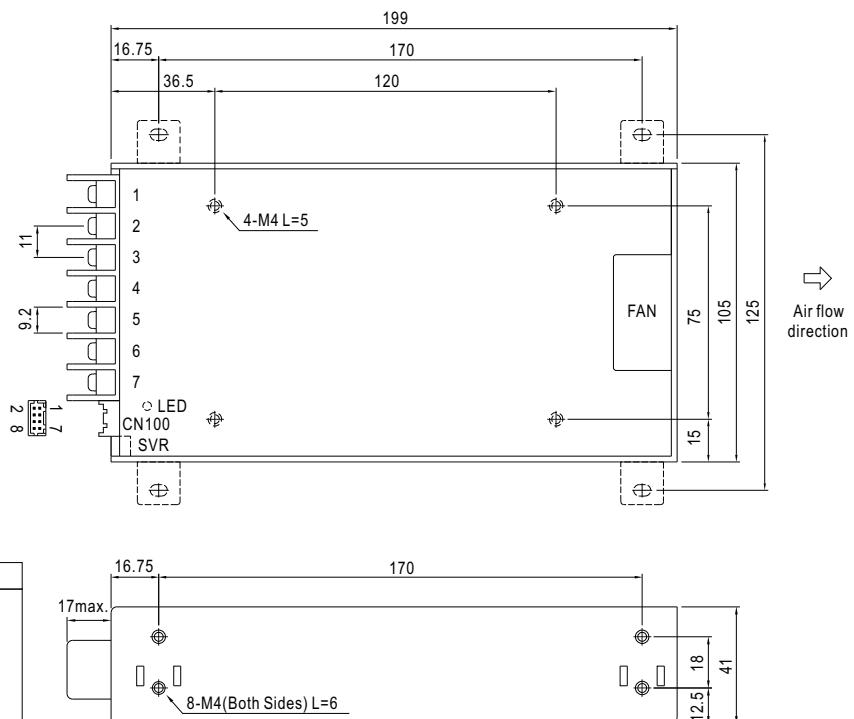


SPECIFICATION

MODEL	HRP-300-3.3	HRP-300-5	HRP-300-7.5	HRP-300-12	HRP-300-15	HRP-300-24	HRP-300-36	HRP-300-48
OUTPUT	DC VOLTAGE	3.3V	5V	7.5V	12V	15V	24V	36V
	RATED CURRENT	60A	60A	40A	27A	22A	14A	9A
	CURRENT RANGE	0 ~ 60A	0 ~ 60A	0 ~ 40A	0 ~ 27A	0 ~ 22A	0 ~ 14A	0 ~ 9A
	RATED POWER	198W	300W	300W	324W	330W	336W	336W
	RIPLPE & NOISE (max.) Note.2	80mVp-p	90mVp-p	100mVp-p	120mVp-p	150mVp-p	150mVp-p	250mVp-p
	VOLTAGE ADJ. RANGE	2.8 ~ 3.8V	4.3 ~ 5.8V	6.8 ~ 9V	10.2 ~ 13.8V	13.5 ~ 18V	21.6 ~ 28.8V	28.8 ~ 39.6V
	VOLTAGE TOLERANCE Note.3	±2.5%	±2.0%	±2.0%	±1.0%	±1.0%	±1.0%	±1.0%
	LINE REGULATION	±0.5%	±0.5%	±0.5%	±0.3%	±0.3%	±0.2%	±0.2%
	LOAD REGULATION	±1.0%	±1.0%	±1.0%	±0.5%	±0.5%	±0.5%	±0.5%
	SETUP, RISE TIME	1000ms, 50ms/230VAC		2500ms, 50ms/115VAC at full load				
INPUT	HOLD UP TIME (Typ.)	16ms/230VAC		16ms/115VAC at full load				
	VOLTAGE RANGE Note.5	85 ~ 264VAC		120 ~ 370VDC				
	FREQUENCY RANGE	47 ~ 63Hz						
	POWER FACTOR (Typ.)	PF>0.95/230VAC		PF>0.99/115VAC at full load				
	EFFICIENCY (Typ.)	79%	82%	86%	88%	88%	87%	88%
	AC CURRENT (Typ.)	5A/115VAC	2.5A/230VAC					
	INRUSH CURRENT (Typ.)	35A/115VAC	70A/230VAC					
PROTECTION	LEAKAGE CURRENT	<1mA / 240VAC						
	OVERLOAD	105 ~ 135% rated output power						
		Protection type : Constant current limiting, recovers automatically after fault condition is removed						
	OVER VOLTAGE	3.96 ~ 4.62V	6 ~ 7V	9.4 ~ 10.9V	14.4 ~ 16.8V	18.8 ~ 21.8V	30 ~ 34.8V	41.4 ~ 48.6V
		Protection type : Shut down o/p voltage, re-power on to recover						57.6 ~ 67.2V
FUNCTION	OVER TEMPERATURE	90°C ±5°C (TSW1: detect on heatsink of power transistor)						
		100°C ±5°C for 3.3V, 5V, 7.5V ; 95°C ±5°C for others (TSW2: detect on heatsink of power diode)						
		Protection type : Shut down o/p voltage, recovers automatically after temperature goes down						
ENVIRONMENT	DC OK SIGNAL	PSU turn on : 3.3 ~ 5.6V ; PSU turn off : 0 ~ 1V						
	WORKING TEMP.	-30 ~ +70°C (Refer to output load derating curve)						
	WORKING HUMIDITY	20 ~ 90% RH non-condensing						
	STORAGE TEMP., HUMIDITY	-40 ~ +85°C, 10 ~ 95% RH						
	TEMP. COEFFICIENT	±0.03%/°C (0 ~ 50°C)						
SAFETY & EMC (Note 4)	VIBRATION	10 ~ 500Hz, 5G 10min./cycle, 60min. each along X, Y, Z axes						
	SAFETY STANDARDS	UL60950-1, TUV EN60950-1 approved						
	WITHSTAND VOLTAGE	I/P-O/P:3KVAC I/P-FG:1.5KVAC O/P-FG:0.5KVAC						
	ISOLATION RESISTANCE	I/P-O/P, I/P-FG, O/P-FG:100M Ohms / 500VDC / 25°C / 70% RH						
	EMI CONDUCTION & RADIATION	Compliance to EN55022 (CISPR22) Class B						
OTHERS	HARMONIC CURRENT	Compliance to EN61000-3-2, -3						
	EMS IMMUNITY	Compliance to EN61000-4-2, 3, 4, 5, 6, 8, 11, ENV50204, EN55024, EN61000-6-2, heavy industry level, criteria A						
	MTBF	176K hrs min. MIL-HDBK-217F (25°C)						
NOTE	DIMENSION	199*105*41mm (L*W*H)						
	PACKING	0.95Kg; 15pcs/15.3Kg/0.69CUFT						
	1. All parameters NOT specially mentioned are measured at 230VAC input, rated load and 25°C of ambient temperature.							
	2. Ripple & noise are measured at 20MHz of bandwidth by using a 12" twisted pair-wire terminated with a 0.1uf & 47uf parallel capacitor.							
	3. Tolerance : includes set up tolerance, line regulation and load regulation.							
	4. The power supply is considered a component which will be installed into a final equipment. The final equipment must be re-confirmed that it still meets EMC directives.							
	5. Derating may be needed under low input voltages. Please check the derating curve for more details.							

Mechanical Specification

Case No.980A Unit:mm

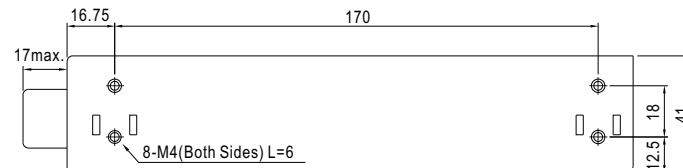

Terminal Pin No. Assignment

Pin No.	Assignment	Pin No.	Assignment
1	AC/L	4,5	DC OUTPUT-V
2	AC/N	6,7	DC OUTPUT+V
3	FG \pm		

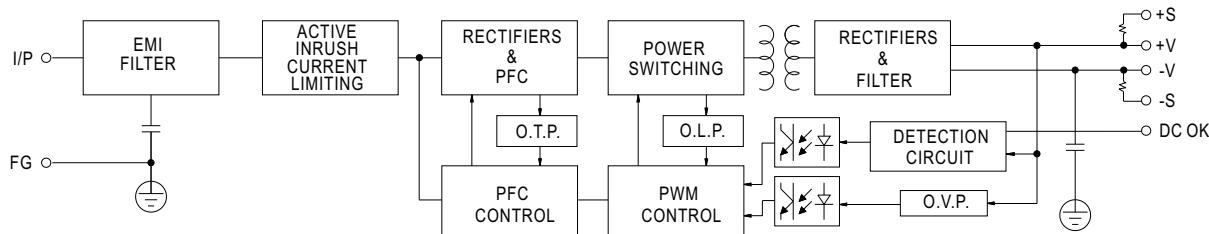
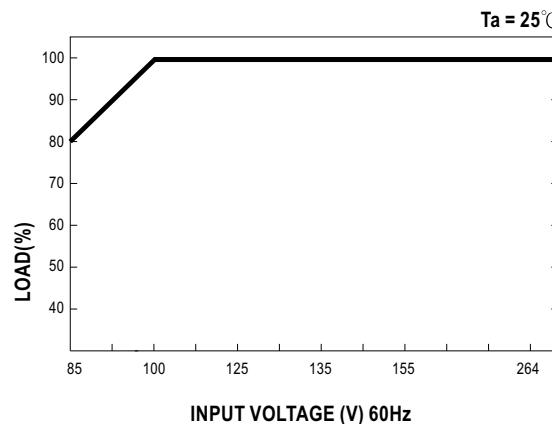
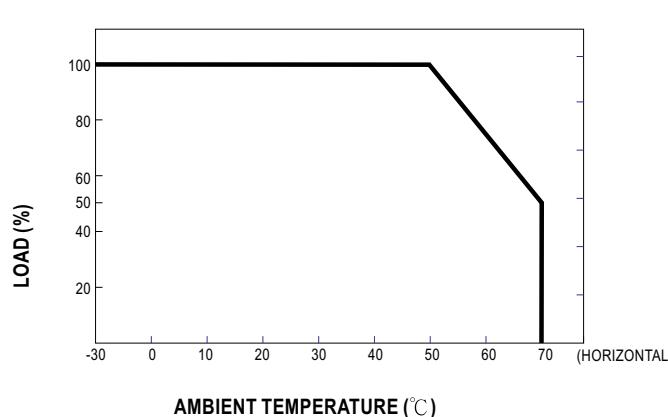
Connector Pin No. Assignment (CN100) :

HRS DF11-08DP-2DS or equivalent

Pin No.	Assignment	Mating Housing	Terminal
1,2,4,6	NC		
3	DC-OK	HRS DF11-8DS or equivalent	
5	GND		HRS DF11-**SC or equivalent
7	+S		
8	-S		


Block Diagram

fosc : 70KHz


Derating Curve
Output Derating VS Input Voltage



■ Features :

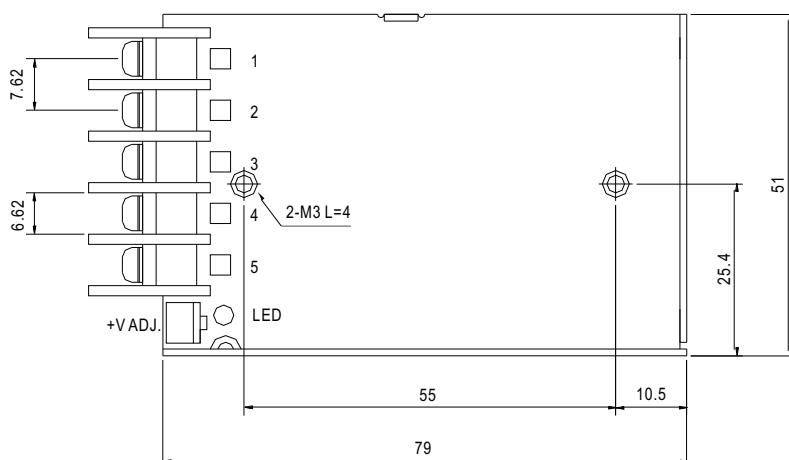
- 2:1 wide input range
- Protections: Short circuit/Over load /voltage
- Built-in EMI filter, low ripple noise
- 100% full load burn-in test
- Low cost
- High reliability
- 1 year warranty

SPECIFICATION

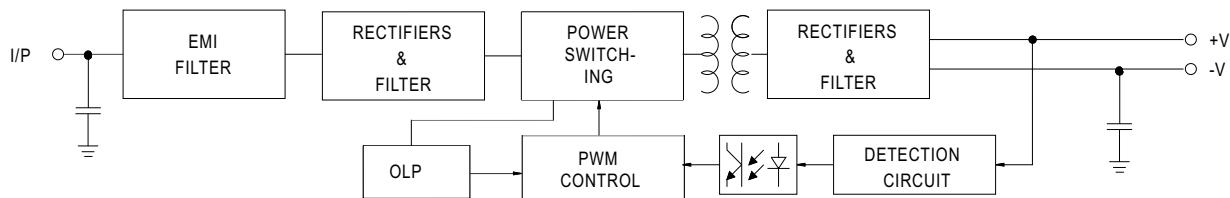

MODEL	SD-15A-05	SD-15B-05	SD-15C-05	SD-15A-12	SD-15B-12	SD-15C-12	SD-15A-24	SD-15B-24	SD-15C-24						
OUTPUT	DC VOLTAGE	5V		12V			24V								
	RATED CURRENT	3A		1.25A			0.625A								
	CURRENT RANGE	0 ~ 3A		0 ~ 1.25A			0 ~ 0.625A								
	RATED POWER	15W		15W			15W								
	ripple & noise (max.) Note.2	100mVp-p		120mVp-p			150mVp-p								
	VOLTAGE ADJ.RANGE	4.75~5.5VDC		10.8~13.2VDC			21.6~26.4VDC								
	VOLTAGE TOLERANCE Note.3	± 2.0%		± 1.0%			± 1.0%								
	LINE REGULATION	±0.5%		±0.3%			±0.2%								
	LOAD REGULATION	±0.5%		±0.3%			±0.2%								
SETUP, RISE ,HOLD UP TIME		2.5s, 25ms,... 12VDC/24VDC/48VDC at full load													
INPUT	VOLTAGE RANGE	A: 9.2 ~18VDC	B: 18 ~ 36VDC	C: 36 ~ 72VDC											
	EFFICIENCY(Typ.)	68%	76%	75%	72%	76%	79%	70%	77%						
	DC CURRENT(Typ.)	1.9A/12VDC	0.9A/24VDC	0.45A/48VDC											
PROTECTION	OVER LOAD	105% -160% rated output power Protection type : hiccup mode , recovers automatically after fault condition is removed													
	OVER VOLTAGE	5.75 ~ 6.75V		13.8~ 16.2V			27.6 ~ 32.4V								
ENVIRONMENT	WORKING TEMP.	-10~+60°C (Refer to output load derating curve)													
	WORKING HUMIDITY	20 ~ 90% RH non-condensing													
	STORAGE TEMP., HUMIDITY	-20 ~ +85°C, 10 ~ 95% RH													
	TEMP. COEFFICIENT	±0.03%/°C (0 ~ 50°C)													
	VIBRATION	10 ~ 500Hz, 2G 10min./1cycle, 60min.each along X, Y, Z axes													
SAFETY & EMC	WITHSTAND VOLTAGE	I/P-O/P:3KVDC I/P-FG:1.5KVDC O/P-FG:0.8KVDC													
	ISOLATION RESISTANCE	I/P-O/P,I/P-FG,O/P-FG:100M Ohms/500VDC													
	EMI CONDUCTION&RADIATION	Compliance to EN55022(CISPR22) CLASS B													
OTHERS	EMS IMMUNITY	Compliance to EN61000-4-2,3,4,6,8;ENV50204,EN55024,light industry level,criteria A													
	DIMENSION	79*51*28mm (L*W*H)													
	PACKING	0.18kg,60 PCS/11.8kg													
NOTE	1. All parameters NOT specially mentioned are measured at normal input, rated load and 25°C of ambient temperature. 2. Ripple & noise are measured at 20MHz of bandwidth by using a 12" twisted pair-wire terminated with a 0.1uf & 47uf parallel capacitor. 3. Tolerance : includes set up tolerance, line regulation and load regulation. 4. The power supply is considered a component which will be installed into a final equipment. The final equipment must be re-confirmed that it still meets EMC directives.														

■ Mechanical Specification

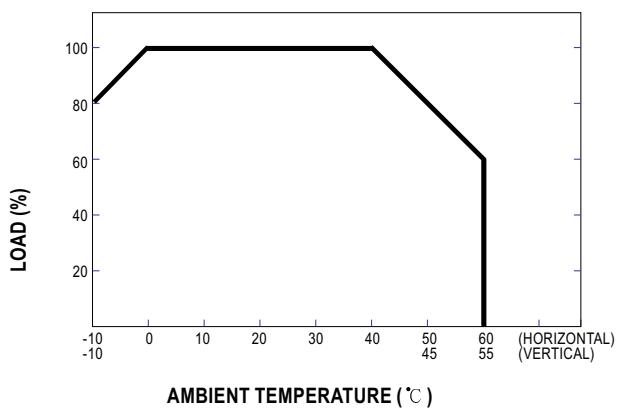
Case No.931 Unit:mm


Terminal Pin No Assignment

Pin No.	Assignment	Pin No.	Assignment
1	DC INPUT V+	4	DC OUTPUT +V
2	DC INPUT V-	5	DC OUTPUT -V
3	FG \pm		


■ Block Diagram


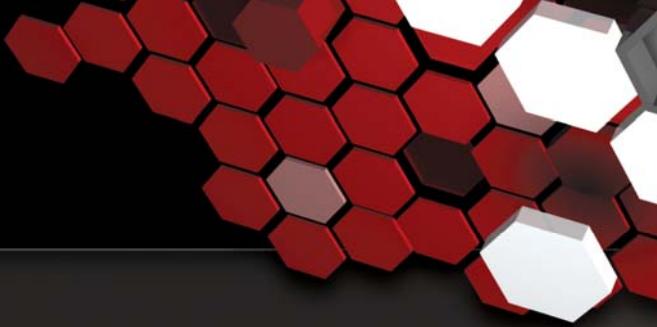
fosc : 96KHz

■ Output Derating
■ Static Characteristics




SAFESTOP™

Wireless Emergency Stop System



SAFESTOP™ Key Features

Multi-level Control

Pause and Stop switches on the transmitter control independent contacts and serial messages.

Convenient Design

The rechargeable transmitter battery provides up to 30 hours of untethered use. Both the handheld transmitter and receiver are approximately 4"x4"x2".

Operator Feedback

Indicator lights on the transmitter and receiver display the states of the SafeStop. An audible alarm on the transmitter sounds if a link is lost and warns of a low battery.

Long Range

A spread spectrum radio resists interference and allows communications up to 6 miles LOS*.



ES-220 Transmitter Unit



ES-220 Reciever Unit

SAFESTOP™

Wireless Emergency Stop System

SAFESTOP™ confidently used by...

- Ford/Honeywell DARPA Urban Challenge Team
- University of Louisiana DARPA Urban Challenge Team
- Kairos Autonomi DARPA Urban Challenge Team



ES-220 Specs

Performance

Operating Distance:	6 mi. (line-of-sight)*
Update Rate:	25 Hz

Wireless Link

Link Frequency Band:	902 -928 MHz
Transmit Power:	1W
Modulation:	FHSS FSK
Channels:	32
Encryption:	56-bit DES Key
FCC Approved:	Yes

Electrical

ES-220T Battery Life:	30 hours*
ES-220R Input Voltage:	9-32 VDC
ES-220R Power Consumption:	9 Watts

Vehicle Interface / Contact Ratings

Digital Communications:	RS-232
Data Rate:	9,600 baud
Run/Stop Contact Rating:	24VDC, 5A
Run/Pause Contact Rating:	24VDC, 5A

* Range and performance data based on optimal conditions.

Audible Alarm

Link Lost:	Continuous Tone
Low Battery:	Three Beeps

Visual Indicators

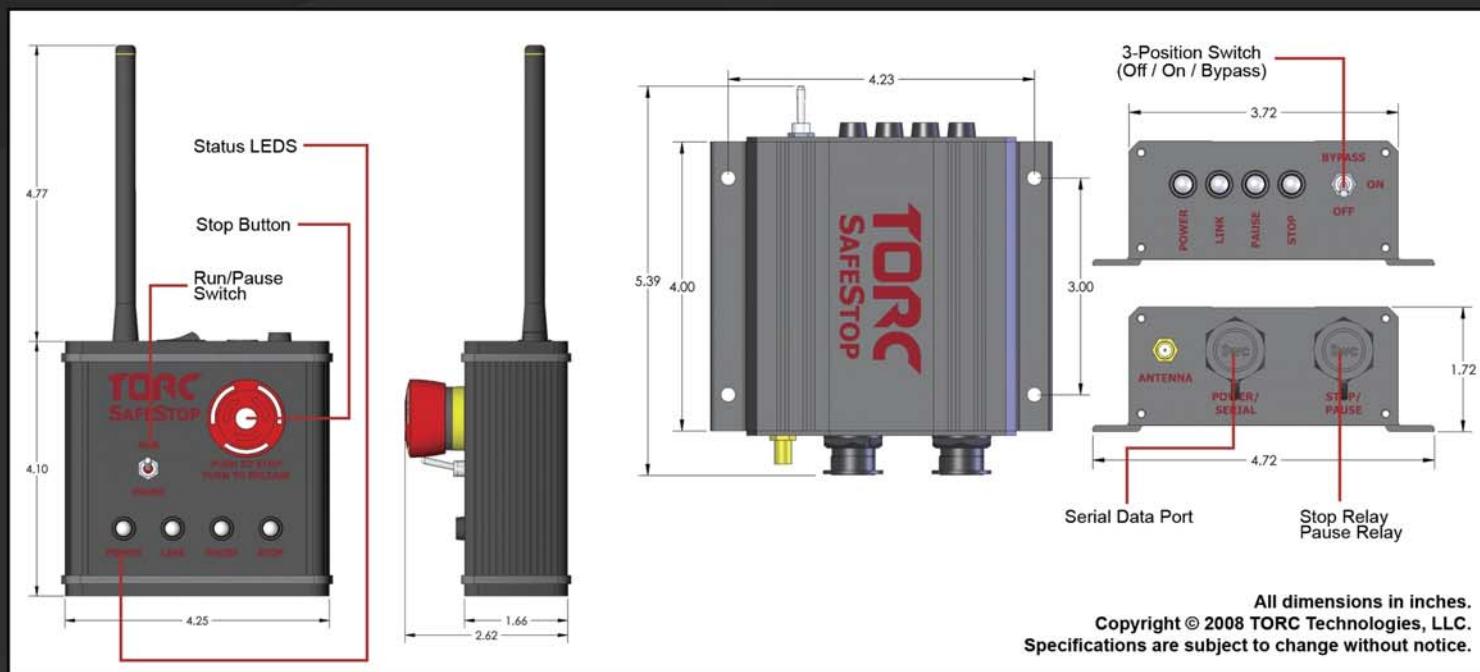
Power:	Bicolor LED
Link Status:	Bicolor LED
Pause Relay:	Bicolor LED
Stop Relay:	Bicolor LED
Charging (ES-220T):	Bicolor LED

Environmental

Dust / Water Resistance:	IP50
Operating Temperature:	0°C -70°C
Operational Shock Rating:	10 g

Optional Accessories

ES-220T Transmitter Unit	
-ES-220T-RDA Flexible Antenna	
-ES-220T-ACC 100 -240 VAC Charger	
-ES-220T-DCC 12 VDC Automotive Charger	
ES-220R Receiver Unit	
-ES-220R-MMA Magnetic Mount Antenna	
-ES-220R-PWC Power / Serial Cable	
-ES-220R-RLC Pause / Stop Relay Cable	



All dimensions in inches.
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JOHN DEERE

GATOR™

UTILITY VEHICLES

XUV SERIES

CAMOUFLAGE LIMITED EDITION

620i Camo 4X4 | 850D Camo 4X4



The Limited Edition Gator™ XUV Camo 4x4

Get one before they disappear.

- REALTREE HARDWOODS HD® Camo pattern is professionally applied through advanced hydrographics and 3M® film for a long-lasting and realistic appearance
- Independent rear suspension for a superior ride on the roughest terrain
- 30 mph (48 km/h) top speed, fast acceleration and quick-starting EFI engines on gas models

- Exclusive electronic governor and throttle for more power under load
- On-demand, true 4WD for superior terrain capability
- Over 100 available attachments and accessories for enhanced versatility

See local dealer to learn more.

Gator 620i XUV Camo 4x4		Gator 850D XUV Camo 4x4
Engine and Electrical		
Engine	23 hp** (617 cc), 2-cylinder, 4-cycle OHV gas, EFI	24.6 hp** (854 cc), 3-cylinder, 4-cycle OHV diesel
Maximum Torque	34.6 ft.-lb. torque (46.9 Nm) @2,100 rpm	36.9 ft.-lb. torque (50 Nm) @2,400 rpm
Ignition	Solid state 12V	Compression ignition
Lubrication	Full pressure	Full pressure
Cooling System	Liquid	Liquid
Air Cleaner	Intake	Intake
Battery	340 CCA	480 CCA
Alternator	25.5 amp @ 3,200 rpm, regulated, 306 watts	40 amp @ 3,200 rpm regulated
Headlights	Two 37.5-watt halogen	Two 37.5-watt halogen
Fuel Capacity	5.3 U.S. gal. (20.1 L)	5.3 U.S. gal. (20.1 L)
Transmission		
Type	Continuously Variable Transmission (CVT)	Continuously Variable Transmission (CVT)
4WD	On-demand true four-wheel-drive system	On-demand true four-wheel-drive system
Drive Belt	Spun top cog, 31 mm wide	Spun top cog, 31 mm wide
Ground Speed, Forward	0–30 mph (0–48 km/h) hi 0–17 mph (0–27 km/h) low 0–20 mph (0–32 km/h)	0–30 mph (0–48 km/h) hi 0–15 mph (0–24 km/h) low 0–17 mph (0–27 km/h)
Ground Speed, Reverse	Two speed; oil bath	Two speed; oil bath
Transaxle	Forward (hi-lo), neutral, reverse	Forward (hi-lo), neutral, reverse
Gear Selection	Front and rear hydraulic disk	Front and rear hydraulic disk
Brakes	Driveline mechanical disk, hand operated	Driveline mechanical disk, hand operated
Parking Brake	Sealed, double-row ball	Sealed, double-row ball
Bearings		
Axle	27 mm dia. forged CV-shaft w/double offset joint	27 mm dia. forged CV-shaft w/double offset joint
Suspension and Steering		
Suspension, Front	Independent with McPherson Strut	Independent with McPherson Strut
Front Suspension Travel (Total)	5.15 in. (131 mm)	5.2 in. (131 mm)
Suspension, Rear	Independent with coil over shock	Independent with coil over shock
Rear Suspension Travel (Total)	7 in. (170 mm)	7 in. (170 mm)
Steering	Rack and pinion	Rack and pinion
Occupant Protective System (OPS)	SAE J2194 and OSHA ROPS standards steel tubular structure with 3-pt. belts and multiple handholds	SAE J2194 and OSHA ROPS standards steel tubular structure with 3-pt. belts and multiple handholds
Dimensions		
Length/Width/Height (w/Bumper and OPS)	113-in. L x 59.3-in. W x 74-in. H (2870 mm L x 1506 mm W x 1880 mm H)	113-in. L x 59.3-in. W x 74-in. H (2870 mm L x 1506 mm W x 1880 mm H)
Front-Tread Centers	44.8 in. (1137 mm)	44.8 in. (1137 mm)
Rear-Tread Centers	47.9 in. (1216 mm)	47.9 in. (1216 mm)
Wheelbase	79 in. (2007 mm)	79 in. (2007 mm)
Weight (Including Fuel/Fluids)	1,383 lb. (627 kg)	1,532 lb. (695 kg)
Seating Capacity/Type	2/Professional high back, bucket (tilt forward)	2/Professional high back, bucket (tilt forward)
Towing Capacity*	1,300 lb. (590 kg)	1,300 lb. (590 kg)
Payload Capacity*	1,400 lb. (635 kg)	1,400 lb. (635 kg)
Ground Clearance	11 in. (267 mm)	11 in. (267 mm)
Cargo Box	Heavy-duty steel	Heavy-duty steel
Volume	11.2 cu. ft. (0.32 m³)	11.2 cu. ft. (0.32 m³)
Weight (On Level Terrain)	1,000 lb. (554 kg)	1,000 lb. (554 kg)
Length/Width/Depth	43.9-in. L x 49-in. W x 9-in. D 1116 mm L x 1244 mm W x 229 mm D	43.9-in. L x 49-in. W x 9-in. D 1116 mm L x 1244 mm W x 229 mm D
Tailgate	Removable; hinged at bottom	Removable; hinged at bottom
Front Tires	AT489 = 25x10-12	AT489 = 25x10-12
	All Trail II = 25x9-12	All Trail II = 25x9-12
Rear Tires	AT489 = 25x11-12	AT489 = 25x11-12
	All Trail II = 25x11-12	All Trail II = 25x11-12
Available Tread Types	Standard (All Trail II), Aggressive (AT489)	Standard (All Trail II), Aggressive (AT489)
Available Colors	REALTREE HARDWOODS HD® Camouflage	REALTREE HARDWOODS HD® Camouflage
Rear Receiver Hitch	2-inch, standard	2-inch, standard

*Includes 200-lb. (91 kg) operator and 200-lb. (91 kg) passenger and maximum box capacity. **The engine horsepower information is provided by the engine manufacturer to be used for comparison purposes only.

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3DM-GX1®

Gyro Enhanced Orientation Sensor



Introduction

3DM-GX1® combines three angular rate gyros with three orthogonal DC accelerometers, three orthogonal magnetometers, multiplexer, 16 bit A/D converter, and embedded microcontroller to output its orientation in dynamic and static environments.

Operating over the full 360 degrees of angular motion on all three axes, 3DM-GX1® provides orientation in matrix, quaternion, and Euler formats. The digital serial output can also provide temperature compensated, calibrated data from all nine orthogonal sensors at update rates of 350 Hz.

Networks of 3DM-GX1® nodes can be deployed by using the built-in RS-485 network protocol. Embedded microcontrollers relieve the host system from the burden of orientation calculations, allowing deployment of dozens of 3DM-GX1® nodes with no significant decrease in system throughput.

Output modes and software filter parameters are user programmable. Programmed parameters and calibration data are stored in nonvolatile memory.

Features & Benefits

- on-board processing/filtering of accelerometer, gyro and magnetometer output
- fully compensated over wide temperature range
- calibrated for sensor misalignment and gyro G-sensitivity
- supports hard-iron field calibration
- outputs Euler angles, quaternion, orientation matrix, attitude and heading (azimuth/yaw) or raw sensor data
- standard RS-232, RS-485 outputs, optional analog output
- small, lightweight and low power
- AHRS, IMU and vertical gyro modes

Applications

- unmanned aerial / underwater vehicles, robotics – navigation, artificial horizon
- computer science, biomedical – animation, linkage free tracking/control
- mobile cameras, sonar scanners – image reconstruction
- mobile radio antennas – aiming optimization, dynamic correction, antenna shaping
- manufacturing – container handling, hydraulic lift systems, machine tools

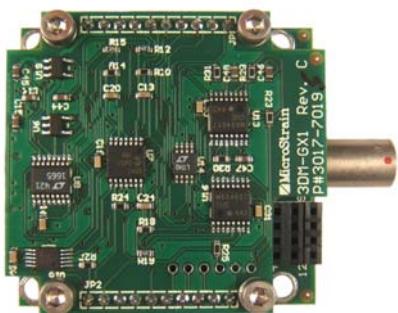


3DM-GX1® Gyro Enhanced Orientation Sensor

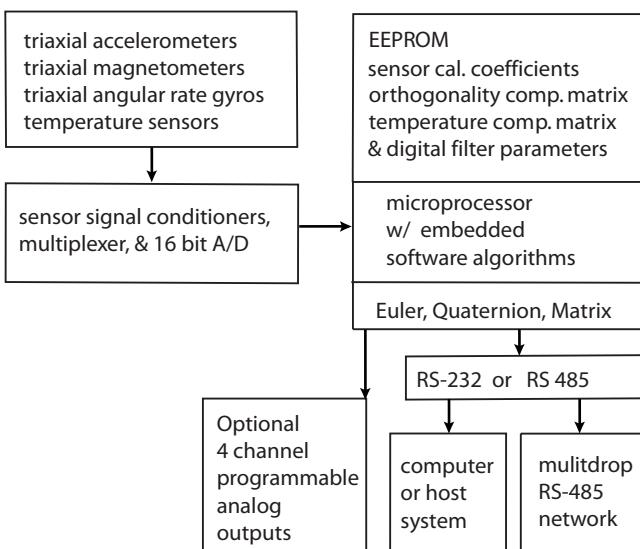
3DM-GX1® utilizes the triaxial gyros to track dynamic orientation and the triaxial DC accelerometers along with the triaxial magnetometers to track static orientation. The embedded microprocessor contains a unique programmable filter algorithm, which blends these static & dynamic responses in real time.

This provides a fast response in the face of vibration and rapid movement while eliminating drift. The stabilized output is provided in an easy-to-use digital format. Analog output voltages proportional to the Euler angles can be ordered as an option.

Full temperature compensation is provided for all nine orthogonal sensors to insure performance over a wide operating temperature range.



3DM-GX1's® small size is ideal for OEM applications.



Specifications

Orientation range (pitch, roll, yaw)	360° all axes (orientation matrix, quaternion) ± 90°, ± 180°, ± 180° (Euler angles)
Sensor range	gyros: ± 300°/sec FS accelerometers: ± 5 g FS magnetometers: ± 1.2 Gauss FS
A/D resolution	16 bits
Accelerometer nonlinearity	0.2%
Accelerometer bias stability*	0.010 g
Gyro nonlinearity	0.2%
Gyro bias stability*	0.7°/sec
Magnetometer nonlinearity	0.4%
Magnetometer bias stability*	0.010 Gauss
Orientation resolution	<0.1° minimum
Repeatability	0.20°
Accuracy	± 0.5° typical for static test conditions ± 2.0° typical for dynamic (cyclic) test conditions & for arbitrary orientation angles
Output modes	matrix, quaternion, Euler angles, & nine scaled sensors with temperature
Digital outputs	serial RS-232 & RS-485 optional with software programming
Analog output option	4 channel, 0–5 volts full scale programmable analog outputs
Digital output rates	100 Hz for Euler, Matrix, Quaternion 350 Hz for nine orthogonal sensors only
Serial data rate	19.2/38.4/115.2 kbaud, software programmable
Supply voltage	5.2 VDC minimum, 12 VDC maximum
Supply current	65 mA
Connectors	one keyed LEMO, two for RS-485 option
Operating temp.	-40 to +70°C with enclosure -40 to +85°C without enclosure
Enclosure (w/tabs)	64 mm x 90 mm x 25 mm
Weight (grams)	75 grams with enclosure, 30 grams without enclosure
Shock limit	1000 g (unpowered), 500g (powered)

*Accuracy and stability specifications obtained over operating temperatures of -40 to 70°C with known sine and step inputs, including angular rates of ± 300° per second.

For additional information, please refer to "3DM-GX1 - Detailed Specifications", available online at www.microstrain.com.

 **MicroStrain®**

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fax: 802-863-4093
sales@microstrain.com

Patent Pending

MAGNETIC SENSOR

MP1005–MP1007 Series



**Solid state, magnetic proximity sensors
in adjustable, threaded housing.**

Features

- Excellent output stability over operating temperature range
- Regulated power supply not required
- Reverse battery protection to -24VDC
- Meets IEC529 IP67 for dust and water protection
- Wire: 20 AWG, tin plated, polyolefin insulation
- Anodized aluminum housing
- South pole activated

- Open Collector (NPN) output can be used with bipolar or cmos logic circuits with suitable pull up resistor
 - Output switches low (off) when the magnetic field at the sensor exceeds the operate point threshold
 - Output switches high (on) when the magnetic field is reduced to below the release point threshold

Applications

- Limit switch
- Home security
- Door position

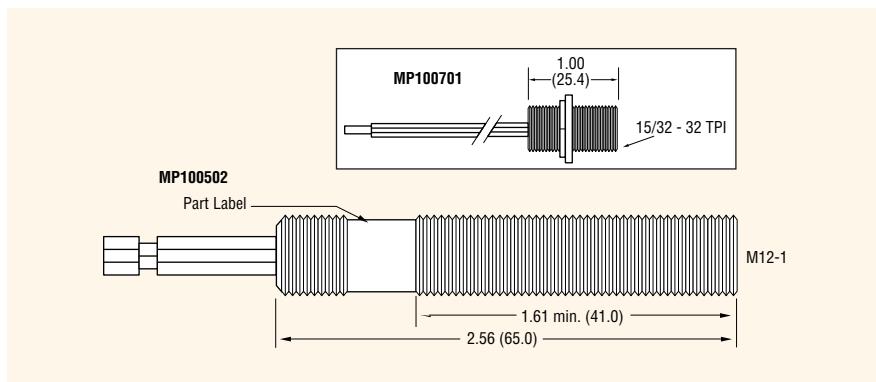
Specifications

Part Number	Operating Voltage Range (VDC)	Supply Current (mA max.)	Output	Output Saturation Voltage (mV max.)	Output Current (mA max.)	Operating Temp Range (°C)	Storage Temp Range (°C)	Operate Point Gauss (max.)	Release Point Gauss (min.)	Housing Color	Wires
MP100502	4.75 – 24	12	3-wire sink	700	25	-40 to 125	-40 to 125	300	60	Red	20 AWG x 1m BBB
MP100701	4.75 – 24	16	3-wire sink	700	25	40 to 105	40 to 125	300	60	Black	20 AWG x 1m BBB

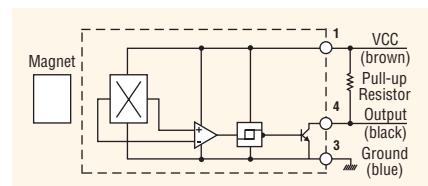
Notes: These sensors require the use of an external pull-up resistor, the value of which is dependent on the supply voltage. See page 18 for recommendations. Pull-up resistor should be connected between output (Black) and Vcc (Brown).

Dimensions inches (mm)

All tolerances ± 0.005 (0.13) unless otherwise noted.



Open Collector Sinking Block Diagram



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[Requirements and Compatibility](#) | [Ordering Information](#) | [Detailed Specifications](#) | [Pinouts/Front Panel Connections](#)

For user manuals and dimensional drawings, visit the product page resources tab on ni.com

Last Revised: 2010-04-07 11:59:12.0

4-Channel, 100 kS/s, 16-Bit, ± 10 V, Analog Output Module

NI 9263


± 10 V and 0 to 20 mA analog output ranges, 16-bit resolution, 100 kS/s simultaneous update rate

4 channels per module

Isolation up to 2,300 Vrms (withstand), up to 250 Vrms (continuous)

Per-channel digital-to-analog converter (DAC) for simultaneous analog output

± 30 V overvoltage protection and short-circuit protection for direct connection to actuators and industrial devices

Excellent relative accuracy optimized for single-point control applications

NIST-traceable calibration certificate

Overview

High-performance analog output modules for NI CompactRIO embedded systems, R Series expansion chassis, and NI CompactDAQ hardware provide accurate signal generations. Each module incorporates built-in signal conditioning and an integrated connector with screw-terminal or cable options for flexible and low-cost signal wiring. All modules feature the NI CompactRIO Extreme Industrial Certifications and Ratings.

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Requirements and Compatibility

OS Information

Real-Time OS
Windows

Driver Information

NI-DAQmx
NI-RIO

Software Compatibility

LabVIEW
LabVIEW SignalExpress
LabWindows/CVI
Measurement Studio
Visual C++
Visual Studio
Visual Studio .NET

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Comparison Tables

Product	NI CompactRIO Compatibility	NI CompactDAQ Compatibility	Signal Type	Channels	Resolution (bits)	Max Update Rate (S/s)	Range	Current Drive	Simultaneous Updating
9263	yes	yes	Voltage	4	16	100 k/ch	± 10 V	1 mA/ch	yes

12/3/2010

			4-Channel, 100 kS/s, 16-Bit, ± 10 V, Ana...							
	9264	yes	yes	Voltage	16	16	25 kS/s	± 10 V	4 mA/ch	yes
9265	yes	no	Current	4	16	100 k/ch	0 to 20 mA	20 mA/ch	yes	
9269	yes	yes	Voltage	4	16	100 k/ch	± 10 V	10 mA/ch	yes	

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Application and Technology

System Compatibility

You can use NI C Series modules in multiple system types depending on the software available. See the table above for CompactRIO and NI CompactDAQ module compatibility because not all modules work with both systems. Many of the advanced features described apply only to reconfigurable I/O systems and not to NI CompactDAQ.

Advanced Features

Advanced features include ± 30 V overvoltage protection and short-circuit protection, simultaneous 16-bit per-channel digital-to-analog converters (DACs), high-speed settling, excellent monotonicity, and NIST-traceable calibration. NI 926x modules include a channel-to-earth ground double isolation barrier for safety and noise immunity.

When used in CompactRIO, C Series analog output modules connect directly to reconfigurable I/O (RIO) field-programmable gate array (FPGA) hardware to create high-performance embedded systems that deliver the optimization and flexibility of a custom electrical circuit completely dedicated to your input/output application. The reconfigurable FPGA hardware within CompactRIO provides a variety of options for timing, triggering, synchronization, change detection, digital pattern matching, or digital communication. For instance, with CompactRIO, you can implement a circuit to generate complex arbitrary waveforms; perform filtering or splining to generate a smooth output signal based on a choppy, low-speed output command; simulate a nonlinear sensor; or implement amplitude/phase modulation.

Key Features

- High-performance analog output signal generation for CompactRIO embedded systems, R Series expansion chassis, or NI CompactDAQ hardware
- Screw terminals, strain relief, high-voltage, and cable options
- NI CompactRIO Extreme Industrial Certifications and Ratings
- Channel-to-earth ground double isolation barrier for safety and noise immunity

Visit ni.com/compactrio or ni.com/compactdaq for up-to-date information on module availability, example programs, application notes, and other developer tools.

Connectivity Accessories

CompactRIO and NI CompactDAQ systems are designed to provide flexible options for low-cost field wiring and cabling. Most C Series modules have a unique connector block option to provide secure and safe connections to your CompactRIO or NI CompactDAQ system. The table below contains all of the connector blocks available for C Series I/O modules.

Accessory	Description
NI 9932	10-position strain relief and high-voltage screw-terminal connector kit
NI 9933	37-pin D-Sub connector kit with strain relief and D-Sub shell
NI 9934	25-pin D-Sub connector kit with strain relief and D-Sub shell
NI 9935	15-pin D-Sub connector kit with strain relief and D-Sub shell
NI 9936	10-position screw-terminal plugs (quantity 10)

Note: To meet shock and vibration requirements, you must affix ferrules to the ends of the wires on all screw-terminal connectors.



Figure 1. cRIO-9937
Power Supply Plugs



Figure 2. cRIO-9932 Strain
Relief and High-Voltage
Connector Kit



Figure 3. cRIO-9936
10-Position Screw-
Terminal Plugs

The table below lists the recommended connector block accessories for each CompactRIO analog output module.

C Series Analog Output Module	Recommended Module Accessory
NI 9263	NI 9932, NI 9936
NI 9264	NI 9940, NI 9974
NI 9265	NI 9932, NI 9936
NI 9269	NI 9971, NI 9976

The NI 9932 kit provides strain relief and operator protection from high-voltage signals for any 10-position screw-terminal module.



Figure 4. NI 9932 10-Position Strain Relief and High-Voltage Screw-Terminal Connector Kit

The NI 9933 includes a screw-terminal connector with strain relief as well as a D-Sub solder-cup backshell for creating custom cable assemblies for any module with a 37-pin D-Sub connector.



Figure 5. NI 9933 37-Pin D-Sub Connector Kit with Strain Relief and D-Sub Shell

The NI 9934 includes a screw-terminal connector with strain relief as well as a D-Sub solder-cup backshell for creating custom cable assemblies for any module with a 25-pin D-Sub connector.



Figure 6. NI 9934 25-Pin D-Sub Connector Kit with Strain Relief and D-Sub Shell

The NI 9935 includes a screw-terminal connector with strain relief as well as a D-Sub solder-cup backshell for creating custom cable assemblies for any module with a 15-pin D-Sub connector.



Figure 7. NI 9935 15-Pin D-Sub Connector Kit with Strain Relief and D-Sub Shell

The NI 9936 consists of 10-position screw-terminal plugs for any 10-position screw-terminal module.



Figure 8. NI 9936 10-Position Screw-Terminal Plugs

Visit ni.com/compactrio or ni.com/compactdaq for up-to-date information on accessory availability.

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Ordering Information

For a complete list of accessories, visit the product page on ni.com.

Products	Part Number	Recommended Accessories	Part Number
NI 9263			
NI 9263 Each NI 9263 requires: 1 Connectivity Accessory	779012-01	Connectivity Accessory: Screw Terminals - NI 9932 Backshell with 10-pos connector block (qty 1)	779017-01

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Software Recommendations

NI LabVIEW Professional Development System for Windows



Easy-to-use graphical development environment
Tight integration with a wide range of measurement hardware
Rapid user interface development for displaying live data
Extensive signal processing, analysis, and math functionality
Source code control integration and code complexity metrics
Support for Windows XP/Vista/7 (32-bit) and Windows Vista/7 (64-bit)

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Support and Services

System Assurance Programs

NI system assurance programs are designed to make it even easier for you to own an NI system. These programs include configuration and deployment services for your NI PXI, CompactRIO, or Compact FieldPoint system. The NI Basic System Assurance Program provides a simple integration test and ensures that your system is delivered completely assembled in one box. When you configure your system with the NI Standard System Assurance Program, you can select from available NI system driver sets and application development environments to create customized, reorderable software configurations. Your system arrives fully assembled and tested in one box with your software preinstalled. When you order your system with the standard program, you also receive system-specific documentation including a bill of materials, an integration test report, a recommended maintenance plan, and frequently asked question documents. Finally, the standard program reduces the total cost of owning an NI system by providing three years of warranty coverage and calibration service. Use the online product advisors at [ni.com/advisor](#) to find a system assurance program to meet your needs.

Calibration

NI measurement hardware is calibrated to ensure measurement accuracy and verify that the device meets its published specifications. NI offers a number of calibration services to help maintain the ongoing accuracy of your measurement hardware. These services allow you to be completely confident in your measurements, and help you maintain compliance to standards like ISO 9001, ANSI/NCSL Z540-1 and ISO/IEC 17025. To learn more about NI calibration services or to locate a qualified service center near you, contact your local sales office or visit [ni.com/calibration](#).

Technical Support

Get answers to your technical questions using the following National Instruments resources.

Support - Visit [ni.com/support](#) to access the NI KnowledgeBase, example programs, and tutorials or to contact our applications engineers who are located in NI sales offices around the world and speak the local language.

Discussion Forums - Visit [forums.ni.com](#) for a diverse set of discussion boards on topics you care about.

Online Community - Visit [community.ni.com](#) to find, contribute, or collaborate on customer-contributed technical content with users like you.

Repair

While you may never need your hardware repaired, NI understands that unexpected events may lead to necessary repairs. NI offers repair services performed by highly trained technicians who quickly return your device with the guarantee that it will perform to factory specifications. For more information, visit [ni.com/repair](#).

Training and Certifications

The NI training and certification program delivers the fastest, most certain route to increased proficiency and productivity using NI software and hardware. Training builds the skills to more efficiently develop robust, maintainable applications, while certification validates your knowledge and ability.

Classroom training in cities worldwide - the most comprehensive hands-on training taught by engineers.

On-site training at your facility - an excellent option to train multiple employees at the same time.

Online instructor-led training - lower-cost, remote training if classroom or on-site courses are not possible.

Course kits - lowest-cost, self-paced training that you can use as reference guides.

Training memberships and training credits - to buy now and schedule training later.

Visit [ni.com/training](#) for more information.

Extended Warranty

NI offers options for extending the standard product warranty to meet the life-cycle requirements of your project. In addition, because NI understands that your requirements may change, the extended warranty is flexible in length and easily renewed. For more information, visit [ni.com/warranty](#).

OEM

NI offers design-in consulting and product integration assistance if you need NI products for OEM applications. For information about special pricing and services for OEM customers, visit [ni.com/oem](#).

Alliance

Our Professional Services Team is comprised of NI applications engineers, NI Consulting Services, and a worldwide National Instruments Alliance Partner program of more than 600 independent consultants and integrators. Services range from start-up assistance to turnkey system integration. Visit [ni.com/alliance](#).

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Detailed Specifications

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The following specifications are typical for the range -40 to 70 °C unless otherwise noted. All voltages are relative to COM unless otherwise noted.

Output Characteristics

Number of channels	4 analog output channels
DAC resolution	16 bits

Type of DAC	String
Power-on output state	Channels off
Startup/power-down voltage	0 V
Output voltage range	
Nominal	± 10 V
Minimum	± 10.3 V
Typical	± 10.7 V
Maximum	± 11 V
Current drive	± 1 mA per channel max
Output impedance	0.1 Ω

Accuracy		
Measurement Conditions	Percent of Reading (Gain Error)	Percent of Range ¹ (Offset Error)
Calibrated, max (-40 to 70 °C)	0.35%	0.75%
Calibrated, typ (25 °C, ± 5 °C)	0.01%	0.1%
Uncalibrated, max (-40 to 70 °C)	2.2%	1.7%
Uncalibrated, typ (25 °C, ± 5 °C)	0.3%	0.25%

Stability	
Gain drift	6 ppm/°C
Offset drift	80 μ V/°C
Protection	
Overvoltage	± 30 V
Short-circuit	Indefinitely

Update time		
Number of Channels	Update Time for cRIO-9151 R Series Expansion Chassis	Update Time for All Other Chassis
1	3.5 μ s	3 μ s
2	6.5 μ s	5 μ s
3	9 μ s	7.5 μ s
4	12 μ s	9.5 μ s

Noise	260 μ V _{rms}
Slew rate	4 V/ μ s
Crosstalk	76 dB
Settling time (100 pF load, to 1 LSB)	
Full-scale step	20 μ s
3 V step	10 μ s
0.1 V step	8 μ s
Glitch energy (256 steps, worst case)	2 mV for 2 μ s
Capacitive drive	1,500 pF min
Monotonicity	16 bits
DNL	-1 to 2 LSBs max
INL (endpoint)	16 LSBs max
MTBF	1,732,619 hours at 25 °C; Bellcore Issue 2, Method 1, Case 3, Limited Part Stress Method

Note Contact NI for Bellcore MTBF specifications at other temperatures or for MIL-HDBK-217F specifications.

Power Requirements

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Power consumption from chassis

Active mode	625 mW max
Sleep mode	25 µW max
Thermal dissipation (at 70 °C)	
Active mode	625 mW max
Sleep mode	25 µW max

Physical Characteristics

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Note For two-dimensional drawings and three-dimensional models of the C Series module and connectors, visit ni.com/dimensions and search by module number.

Screw-terminal wiring	12 to 24 AWG copper conductor wire with 10 mm (0.39 in.) of insulation stripped from the end
Torque for screw terminals	0.5 to 0.6 N · m (4.4 to 5.3 lb · in.)
Ferrules	0.25 mm ² to 2.5 mm ²
Weight	150 g (5.3 oz)

Safety

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If you need to clean the module, wipe it with a dry towel.

Safety Voltages

Connect only voltages that are within the following limits.

Isolation

Channel-to-channel	None
Channel-to-earth ground	
Continuous	250 V _{rms} , Measurement Category II
Withstand	2,300 V _{rms} , verified by a 5 s dielectric withstand test

Measurement Category II is for measurements performed on circuits directly connected to the electrical distribution system. This category refers to local-level electrical distribution, such as that provided by a standard wall outlet (e.g., 115 V for U.S. or 230 V for Europe). Examples of Measurement Category II are measurements performed on household appliances, portable tools, and similar products.

Caution Do not connect the NI 9263 to signals or use for measurements within Measurement Categories III or IV.

Hazardous Locations

U.S. (UL)	Class I, Division 2, Groups A, B, C, D, T4; Class I, Zone 2, AEx nA IIC T4
Canada (C-UL)	Class I, Division 2, Groups A, B, C, D, T4; Class I, Zone 2, Ex nA IIC T4
Europe (DEMKO)	Ex nA IIC T4

Safety Standards

This product is designed to meet the requirements of the following standards of safety for electrical equipment for measurement, control, and laboratory use:

IEC 61010-1, EN 61010-1
UL 61010-1, CSA61010-1

Note For UL and other safety certifications, refer to the product label or the *Online Product Certification* section.

Electromagnetic Compatibility

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This product meets the requirements of the following EMC standards for electrical equipment for measurement, control, and laboratory use:

EN 61326 (IEC 61326): Class A emissions; Industrial Immunity
EN 55011 (CISPR 11): Group 1, Class A emissions
AS/NZS CISPR 11: Group 1, Class A emissions
FCC 47 CFR Part 15B: Class A emissions
ICES-001: Class A emissions

Note For the standards applied to assess the EMC of this product, refer to the *Online Product Certification* section.

Note For EMC compliance, operate this device with shielded cables.

This product meets the essential requirements of applicable European Directives, as amended for CE marking, as follows:

2006/95/EC; Low-Voltage Directive (safety)

2004/108/EC; Electromagnetic Compatibility Directive (EMC)

Note For the standards applied to assess the EMC of this product, refer to the *Online Product Certification* section.

Online Product Certification

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Refer to the product Declaration of Conformity (DoC) for additional regulatory compliance information. To obtain product certifications and the DoC for this product, visit [ni.com/certification](#), search by module number or product line, and click the appropriate link in the Certification column.

Shock and Vibration

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To meet these specifications, you must panel mount the system and either affix ferrules to the ends of the terminal wires or use the NI 9932 backshell kit to protect the connections.

Operating vibration

Random (IEC 60068-2-64)	5 g _{rms} , 10 to 500 Hz
Sinusoidal (IEC 60068-2-6)	5 g, 10 to 500 Hz
Operating shock (IEC 60068-2-27)	30 g, 11 ms half sine, 50 g, 3 ms half sine, 18 shocks at 6 orientations

Environmental

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National Instruments C Series modules are intended for indoor use only but may be used outdoors if installed in a suitable enclosure. Refer to the manual for the chassis you are using for more information about meeting these specifications.

Operating temperature (IEC 60068-2-1, IEC 60068-2-2)	-40 to 70 °C
Storage temperature (IEC 60068-2-1, IEC 60068-2-2)	-40 to 85 °C
Ingress protection	IP 40
Operating humidity (IEC 60068-2-56)	10 to 90% RH, noncondensing
Storage humidity (IEC 60068-2-56)	5 to 95% RH, noncondensing
Maximum altitude	2,000 m
Pollution Degree (IEC 60664)	2

Environmental Management

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National Instruments is committed to designing and manufacturing products in an environmentally responsible manner. NI recognizes that eliminating certain hazardous substances from our products is beneficial not only to the environment but also to NI customers.

For additional environmental information, refer to the *NI and the Environment* Web page at [ni.com/environment](#). This page contains the environmental regulations and directives with which NI complies, as well as other environmental information not included in this document.

Waste Electrical and Electronic Equipment (WEEE)

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EU Customers At the end of their life cycle, all products *must* be sent to a WEEE recycling center. For more information about WEEE recycling centers and National Instruments WEEE initiatives, visit [ni.com/environment/weee.htm](#).

电子信息产品污染控制管理办法（中国 RoHS）



中国客户 National Instruments 符合中国电子信息产品中限制使用某些有害物质指令 (RoHS)。

关于 National Instruments 中国 RoHS 合规性信息, 请登录 [ni.com/environment/rohs_china](#)。
(For information about China RoHS compliance, go to [ni.com/environment/rohs_china](#).)

Calibration

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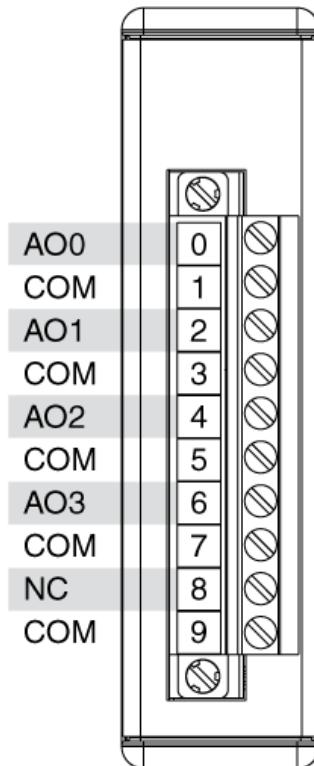
You can obtain the calibration certificate for this device at [ni.com/calibration](#).

Calibration interval

1 year

¹ Range equals ± 10.7 V

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Pinouts/Front Panel Connections

NI 9263 Terminal Assignments

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For user manuals and dimensional drawings, visit the product page resources tab on ni.com

Last Revised: 2010-02-10 17:19:41.0

NI 9401

8 Ch, 5 V/TTL High-Speed Bidirectional C Series Digital I/O Module



8-channel, 100 ns ultrahigh-speed digital I/O

5 V/TTL, sinking/sourcing digital I/O

Bidirectional, configurable by nibble (4 bits)

Industry-standard 25-pin D-Sub connector

Hot-swappable operation

-40 to 70 °C operating range

Overview

The NI 9401 is an eight-channel, 100 ns bidirectional digital input C Series module for any NI CompactDAQ or CompactRIO chassis. You can configure the direction of the digital lines on the NI 9401 for input or output by nibble (four bits). Thus, you can program the NI 9401 for three configurations – eight digital inputs, eight digital outputs, or four digital inputs and four digital outputs. With reconfigurable I/O (RIO) technology (CompactRIO only), you can use the NI LabVIEW FPGA Module to program the NI 9401 for implementing custom, high-speed counter/timers, digital communication protocols, pulse generation, and much more. Each channel is compatible with 5 V/TTL signals and features 1,000 Vrms transient isolation between the I/O channels and the backplane.

The NI 9934 (or other 25-pin D-Sub connector) is required for use with the NI 9401 module. The module includes a screw-terminal connector with strain relief as well as a D-Sub solder cup backshell for creating custom cable assemblies.

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Requirements and Compatibility

OS Information

 Real-Time OS
 Windows

Driver Information

 NI-DAQmx
 NI-RIO

Software Compatibility

 LabVIEW
 LabVIEW SignalExpress
 LabWindows/CVI
 Measurement Studio
 Visual Studio
 Visual Studio .NET

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Comparison Tables

Product Name	Signal Levels	Number of Channels	Connectivity	Speed	Special Features
NI 9401	TTL	8	25-Pin D-Sub	100 ns	Bidirectional, nibble configurable

NI 9402	LV TTL	4	BNC	50 ns	Bidirectional shift on the fly by channel
NI 9403	TTL	32	37-Pin D-Sub	7 µs	Bidirectional, configurable by line

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Application and Technology

High-performance digital output and switching modules for NI CompactDAQ systems, CompactRIO embedded systems, and R Series expansion chassis provide extended voltage ranges and high-current-switching capacity for direct control of a wide array of industrial and automotive actuators. Each module features an integrated connector junction box with screw-terminal or cable options for flexible, low-cost signal wiring. All modules feature CompactRIO extreme industrial certifications and ratings including -40 to 70 °C operating temperatures and 50 g shock.

When used in CompactRIO, NI C Series digital output modules connect directly to reconfigurable I/O (RIO) field-programmable gate array (FPGA) hardware to create high-performance embedded systems. The reconfigurable FPGA hardware within CompactRIO provides a variety of options for timing, triggering, synchronization, digital waveform generation, or digital communication. For instance, with CompactRIO, you can implement a circuit to generate pulse-width modulation (PWM) outputs for controlling motors, heaters, or fans as well as to perform pulse code modulation (PCME) for wireless telemetry applications.

The C Series hardware family features more than 50 measurement modules and several chassis and carriers for deployment. With this variety of modules, you can mix and match measurements such as temperature, acceleration, flow, pressure, strain, acoustic, voltage, current, digital, and more to create a custom system. Install the modules in one of several carriers to create a single module USB, Ethernet, or Wi-Fi system, or combine them in chassis such as NI CompactDAQ and CompactRIO to create a mixed-measurement system with synchronized measurements. You can install up to eight modules in a simple, complete NI CompactDAQ USB data acquisition system to synchronize all of the analog output, analog input, and digital I/O from the modules. For a system without a PC, CompactRIO holds up to eight modules and features a built-in processor, RAM, and storage for an embedded data logger or control unit. For higher-speed control, CompactRIO chassis incorporate a field-programmable gate array (FPGA) that you can program with LabVIEW software to achieve silicone-speed processing on I/O data from C Series modules.

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Ordering Information

For a complete list of accessories, visit the product page on ni.com.

Products	Part Number	Recommended Accessories	Part Number
NI 9401			
NI 9401	779351-01	Connectivity Accessory: Screw Terminals - NI 9934 25pin D-Sub connector kit	779104-01

Each NI 9401 requires: 1 Connectivity Accessory

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Support and Services

System Assurance Programs

NI system assurance programs are designed to make it even easier for you to own an NI system. These programs include configuration and deployment services for your NI PXI, CompactRIO, or Compact FieldPoint system. The NI Basic System Assurance Program provides a simple integration test and ensures that your system is delivered completely assembled in one box. When you configure your system with the NI Standard System Assurance Program, you can select from available NI system driver sets and application development environments to create customized, reorderable software configurations. Your system arrives fully assembled and tested in one box with your software preinstalled. When you order your system with the standard program, you also receive system-specific documentation including a bill of materials, an integration test report, a recommended maintenance plan, and frequently asked question documents. Finally, the standard program reduces the total cost of owning an NI system by providing three years of warranty coverage and calibration service. Use the online product advisors at ni.com/advisor to find a system assurance program to meet your needs.

Calibration

NI measurement hardware is calibrated to ensure measurement accuracy and verify that the device meets its published specifications. NI offers a number of calibration services to help maintain the ongoing accuracy of your measurement hardware. These services allow you to be completely confident in your measurements, and help you maintain compliance to standards like ISO 9001, ANSI/NCSL Z540-1 and ISO/IEC 17025. To learn more about NI calibration services or to locate a qualified service center near you, contact your local sales office or visit ni.com/calibration.

Technical Support

Get answers to your technical questions using the following National Instruments resources.

Support - Visit ni.com/support to access the NI KnowledgeBase, example programs, and tutorials or to contact our applications engineers who are located in NI sales offices around the world and speak the local language.

Discussion Forums - Visit forums.ni.com for a diverse set of discussion boards on topics you care about.

Online Community - Visit community.ni.com to find, contribute, or collaborate on customer-contributed technical content with users like you.

Repair

While you may never need your hardware repaired, NI understands that unexpected events may lead to necessary repairs. NI offers repair services performed by highly trained technicians who quickly return your device with the guarantee that it will perform to factory specifications. For more information, visit ni.com/repair.

Training and Certifications

The NI training and certification program delivers the fastest, most certain route to increased proficiency and productivity using NI software and hardware. Training builds the skills to more efficiently develop robust, maintainable applications, while certification validates your knowledge and ability.

Classroom training in cities worldwide - the most comprehensive hands-on training taught by engineers.

On-site training at your facility - an excellent option to train multiple employees at the same time.

Online instructor-led training - lower-cost, remote training if classroom or on-site courses are not possible.

Course kits - lowest-cost, self-paced training that you can use as reference guides.

Training memberships and training credits - to buy now and schedule training later.

Visit ni.com/training for more information.

Extended Warranty

NI offers options for extending the standard product warranty to meet the life-cycle requirements of your project. In addition, because NI understands that your requirements may change, the extended warranty is flexible in length and easily renewed. For more information, visit ni.com/warranty.

OEM

NI offers design-in consulting and product integration assistance if you need NI products for OEM applications. For information about special pricing and services for OEM customers, visit ni.com/oem.

Alliance

Our Professional Services Team is comprised of NI applications engineers, NI Consulting Services, and a worldwide National Instruments Alliance Partner program of more than 600 independent consultants and integrators. Services range from start-up assistance to turnkey system integration. Visit ni.com/alliance.

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Detailed Specifications

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The following specifications are typical for the range –40 to 70 °C unless otherwise noted. All voltages are relative to COM unless otherwise noted.

Input/Output Characteristics

Number of channels	8 DIO channels
Default power-on line direction	Input
Input/output type	TTL, single-ended
Digital logic levels	
Input	
Voltage	5.25 V max
High, V_{IH}	2 V min
Low, V_{IL}	0.8 V max
Output	
High, V_{OH} , 5.25 V max	
Sourcing 100 μ A	4.7 V min
Sourcing 2 mA	4.3 V min
Low, V_{OL}	
Sinking 100 μ A	0.1 V max
Sinking 2 mA	0.4 V max
Maximum input signal switching frequency by number of input channels, per channel	
8 input channels	9 MHz
4 input channels	16 MHz
2 input channels	30 MHz
Maximum output signal switching frequency by number of output channels with an output load of 1 mA, 50 pF, per channel	
8 output channels	5 MHz

4 output channels	
2 output channels	20 MHz
I/O propagation delay	100 ns max
I/O pulse width distortion	10 ns typ
Input current ($0 \text{ V} \leq V_{in} \leq 4.5 \text{ V}$)	$\pm 250 \mu\text{A}$ typ
Input capacitance	30 pF typ
Input rise/fall time	500 ns max
Overvoltage protection, channel-to-COM	$\pm 30 \text{ V}$ max on one channel at a time; however, continued use at this level will degrade the life of the module.
MTBF	1,244,763 hours at 25°C ; Bellcore Issue 2, Method 1, Case 3, Limited Part Stress Method

Note Contact NI for Bellcore MTBF specifications at other temperatures or for MIL-HDBK-217F specifications.

Power Requirements

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Power consumption from chassis	
Active mode	580 mW max
Sleep mode	1 mW max
Thermal dissipation (at 70°C)	
Active mode	580 mW max
Sleep mode	1 mW max

Physical Characteristics

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Weight	145 g (5.1 oz)
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Safety

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If you need to clean the module, wipe it with a dry towel.	
Maximum Voltage ¹	
Connect only voltages that are within the following limits.	
Channel-to-COM	$\pm 30 \text{ V}$ max on one channel at a time, Measurement Category I
Isolation Voltages	
Channel-to-channel	None
Channel-to-earth ground	
Continuous	60 VDC, Measurement Category I
Withstand	1,000 V _{rms} , verified by a 5 s dielectric withstand test

Measurement Category I is for measurements performed on circuits not directly connected to the electrical distribution system referred to as MAINS ² voltage. This category is for measurements of voltages from specially protected secondary circuits. Such voltage measurements include signal levels, special equipment, limited-energy parts of equipment, circuits powered by regulated low-voltage sources, and electronics.

Caution Do not connect the NI 9401 to signals or use for measurements within Measurement Categories II, III, or IV.

Safety Standards

This product is designed to meet the requirements of the following standards of safety for electrical equipment for measurement, control, and laboratory use:

IEC 61010-1, EN 61010-1
UL 61010-1, CSA 61010-1

Note For UL and other safety certifications, refer to the product label or the *Online Product Certification* section.

Hazardous Locations

U.S. (UL)	Class I, Division 2, Groups A, B, C, D, T4; Class I, Zone 2, AExnC IIC T4
Canada (C-UL)	Class I, Division 2, Groups A, B, C, D, T4; Class I, Zone 2, Ex nC IIC T4
Europe (DEMKO)	EEx nC IIC T4

Environmental

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National Instruments C Series modules are intended for indoor use only but may be used outdoors if installed in a suitable enclosure. Refer to the manual for the chassis you are using for more information about meeting these specifications.

Operating temperature (IEC 60068-2-1, IEC 60068-2-2)	– 40 to 70 °C
Storage temperature (IEC 60068-2-1, IEC 60068-2-2)	– 40 to 85 °C
Ingress protection	IP 40
Operating humidity (IEC 60068-2-56)	10 to 90% RH, noncondensing
Storage humidity (IEC 60068-2-56)	5 to 95% RH, noncondensing
Maximum altitude	2,000 m
Pollution Degree (IEC 60664)	2

Shock and Vibration[Back to Detailed Specs](#)

To meet these specifications, you must panel mount the system.

Operating vibration

Random (IEC 60068-2-64)	5 g _{rms} , 10 to 500 Hz
Sinusoidal (IEC 60068-2-6)	5 g, 10 to 500 Hz
Operating shock (IEC 60068-2-27)	30 g, 11 ms half sine, 50 g, 3 ms half sine, 18 shocks at 6 orientations

Electromagnetic Compatibility[Back to Detailed Specs](#)

This product is designed to meet the requirements of the following standards of EMC for electrical equipment for measurement, control, and laboratory use:

EN 61326 EMC requirements; Industrial Immunity

EN 55011 Emissions; Group 1, Class A

CE, C-Tick, ICES, and FCC Part 15 Emissions; Class A

Note For EMC compliance, operate this device with shielded cables.

CE Compliance[Back to Detailed Specs](#)

This product meets the essential requirements of applicable European Directives, as amended for CE marking, as follows:

2006/95/EC; Low-Voltage Directive (safety)

2004/108/EC; Electromagnetic Compatibility Directive (EMC)

Note For the standards applied to assess the EMC of this product, refer to the *Online Product Certification* section.

Online Product Certification[Back to Detailed Specs](#)

Refer to the product Declaration of Conformity (DoC) for additional regulatory compliance information. To obtain product certifications and the DoC for this product, visit ni.com/certification, search by module number or product line, and click the appropriate link in the Certification column.

Environmental Management[Back to Detailed Specs](#)

National Instruments is committed to designing and manufacturing products in an environmentally responsible manner. NI recognizes that eliminating certain hazardous substances from our products is beneficial not only to the environment but also to NI customers.

For additional environmental information, refer to the *NI and the Environment* Web page at ni.com/environment. This page contains the environmental regulations and directives with which NI complies, as well as other environmental information not included in this document.

Waste Electrical and Electronic Equipment (WEEE)

EU Customers At the end of their life cycle, all products *must* be sent to a WEEE recycling center. For more information about WEEE recycling centers and National Instruments WEEE initiatives, visit ni.com/environment/weee.htm.

电子信息产品污染控制管理办法（中国 RoHS）

中国客户 National Instruments 符合中国电子信息产品中限制使用某些有害物质指令 (RoHS)。

关于 National Instruments 中国 RoHS 合规性信息, 请登录 ni.com/environment/rohs_china。
(For Information about China RoHS compliance, go to ni.com/environment/rohs_china.)

¹ The maximum voltage that can be applied or output between any channel and COM without damaging the module or other devices.

² MAINS is defined as the (hazardous live) electrical supply system to which equipment is designed to be connected for the purpose of powering the equipment. Suitably rated measuring circuits may be connected to the MAINS for measuring purposes.

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12/3/2010

NI 9401 - Data Sheet - National Instru...

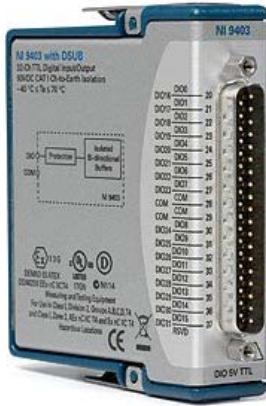
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For user manuals and dimensional drawings, visit the product page resources tab on ni.com
Last Revised: 2010-01-26 16:31:34.0

NI 9403

32 Ch, 5 V/TTL Bidirectional Digital I/O C Series Module



32-channel digital I/O module for NI CompactDAQ or CompactRIO

5 V/TTL, sinking/sourcing digital I/O

Bidirectional, configurable by line

1000 Vrms transient isolation, ±30 V overvoltage protection

Hot-swappable operation

-40 to 70 °C operating range

Overview

The NI 9403 is a 32-channel, 7 µs bidirectional digital input/output module for any NI CompactDAQ or CompactRIO chassis. You can configure the direction of each digital line on the NI 9403 for input or output. Each channel is compatible with 5 V/TTL signals and features 1,000 Vrms transient isolation between the I/O channels and the backplane. The NI 9403 also features ±30 V overvoltage protection and can source up to 2 mA output current per channel. When incorporated in an NI CompactDAQ chassis, the NI 9403 can be used only as a static (software-timed) digital input/output module. With the NI 9403 in a CompactRIO chassis, you can use LabVIEW FPGA to program the NI 9403 for implementing custom counter/timers, pulse generation, and much more. The NI 9933 (or other 37-pin D-Sub connector) is required for use with the NI 9403 module. The NI 9933 includes a screw-terminal connector with strain relief as well as a D-Sub solder cup backshell for creating custom cable assemblies.

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Requirements and Compatibility

OS Information

 PharLap
 Real-Time OS
 Windows

Driver Information

 NI-DAQmx
 NI-RIO

Software Compatibility

 LabVIEW
 LabVIEW FPGA Module
 LabVIEW Real-Time Module
 LabVIEW SignalExpress
 LabWindows/CVI
 Visual Studio
 Visual Studio .NET

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Comparison Tables

Product Name	Signal Levels	Number of Channels	Connectivity	Speed	Special Features
NI 9401	TTL	8	25-pin D-Sub	100 ns	Bidirectional, nibble configurable
NI 9402	LV TTL	4	BNC	50 ns	Bidirectional shift on the fly by channel

Application and Technology

High-performance digital output and switching modules for NI CompactDAQ systems, CompactRIO embedded systems, and R Series expansion chassis provide extended voltage ranges and high-current-switching capacity for direct control of a wide array of industrial and automotive actuators. Each module features an integrated connector junction box with screw-terminal or cable options for flexible, low-cost signal wiring. All modules feature CompactRIO extreme industrial certifications and ratings including -40 to 70 °C operating temperatures and 50 g shock.

When used in CompactRIO, NI C Series digital output modules connect directly to reconfigurable I/O (RIO) field-programmable gate array (FPGA) hardware to create high-performance embedded systems. The reconfigurable FPGA hardware within CompactRIO offers a variety of options for timing, triggering, synchronization, digital waveform generation, or digital communication. For instance, with CompactRIO, you can implement a circuit to generate pulse-width modulation (PWM) outputs for controlling motors, heaters, or fans as well as perform pulse code modulation (PCME) for wireless telemetry applications.

The C Series hardware family features more than 50 measurement modules and several chassis and carriers for deployment. With this variety of modules, you can mix and match measurements such as temperature, acceleration, flow, pressure, strain, acoustic, voltage, current, digital, and more to create a custom system. Install the modules in one of several carriers to create a single module USB, Ethernet, or Wi-Fi system, or combine them in chassis such as NI CompactDAQ and CompactRIO to create a mixed-measurement system with synchronized measurements. You can install up to eight modules in a simple, complete NI CompactDAQ USB data acquisition system to synchronize all of the analog output, analog input, and digital I/O from the modules. For a system without a PC, CompactRIO holds up to eight modules and features a built-in processor, RAM, and storage for an embedded data logger or control unit. For higher-speed control, CompactRIO chassis incorporate an FPGA that you can program with NI LabVIEW software to achieve silicone-speed processing on I/O data from C Series modules.

Ordering Information

For a complete list of accessories, visit the product page on ni.com.

Products	Part Number	Recommended Accessories	Part Number
NI 9403			
NI 9403 with DSub Each NI 9403 with DSub requires: 1 Connectivity Accessory	779787-01	Connectivity Accessory: Screw Terminals - NI 9933 37pin D-Sub connector kit	779103-01
NI 9403 with DSub CC Each NI 9403 with DSub CC requires: 1 Connectivity Accessory	780179-01	Connectivity Accessory: Screw Terminals - NI 9933 37pin D-Sub connector kit	779103-01

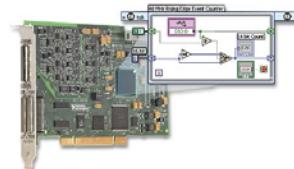
Software Recommendations

NI LabVIEW Professional Development System for Windows



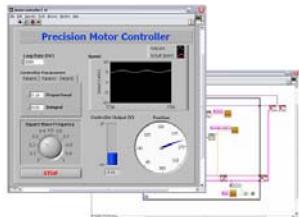
Easy-to-use graphical development environment
Tight integration with a wide range of measurement hardware
Rapid user interface development for displaying live data
Extensive signal processing, analysis, and math functionality
Source code control integration and code complexity metrics
Support for Windows XP/Vista/7 (32-bit) and Windows Vista/7 (64-bit)

NI LabVIEW FPGA Module



Define your own control algorithms with loop rates up to 40 MHz
Execute multiple tasks simultaneously and deterministically
Create your own I/O hardware without VHDL coding or board design
Implement custom timing and triggering logic with 25 ns resolution
Graphically configure FPGAs on NI reconfigurable I/O (RIO) hardware targets

LabVIEW Real-Time Module



Design real-time applications with graphical programming
Download to a dedicated target for reliable, deterministic performance
Deploy as a distributed, stand-alone, or embedded system
Use built-in PID control functions or create your own control algorithms
Purchase individually or as part of the NI Developer Suite

Support and Services

System Assurance Programs

NI system assurance programs are designed to make it even easier for you to own an NI system. These programs include configuration and deployment services for your NI PXI, CompactRIO, or Compact FieldPoint system. The NI Basic System Assurance Program provides a simple integration test and ensures that your system is delivered completely assembled in one box. When you configure your system with the NI Standard System Assurance Program, you can select from available NI system driver sets and application development environments to create customized, reorderable software configurations. Your system arrives fully assembled and tested in one box with your software preinstalled. When you order your system with the standard program, you also receive system-specific documentation including a bill of materials, an integration test report, a recommended maintenance plan, and frequently asked question documents. Finally, the standard program reduces the total cost of owning an NI system by providing three years of warranty coverage and calibration service. Use the online product advisor at ni.com/advisor to find a system assurance program to meet your needs.

Technical Support

Get answers to your technical questions using the following National Instruments resources.

Support - Visit ni.com/support to access the NI KnowledgeBase, example programs, and tutorials or to contact our applications engineers who are located in NI sales offices around the world and speak the local language.

Discussion Forums - Visit forums.ni.com for a diverse set of discussion boards on topics you care about.

Online Community - Visit community.ni.com to find, contribute, or collaborate on customer-contributed technical content with users like you.

Repair

While you may never need your hardware repaired, NI understands that unexpected events may lead to necessary repairs. NI offers repair services performed by highly trained technicians who quickly return your device with the guarantee that it will perform to factory specifications. For more information, visit ni.com/repair.

Training and Certifications

The NI training and certification program delivers the fastest, most certain route to increased proficiency and productivity using NI software and hardware. Training builds the skills to more efficiently develop robust, maintainable applications, while certification validates your knowledge and ability.

Classroom training in cities worldwide - the most comprehensive hands-on training taught by engineers.

On-site training at your facility - an excellent option to train multiple employees at the same time.

Online instructor-led training - lower-cost, remote training if classroom or on-site courses are not possible.

Course kits - lowest-cost, self-paced training that you can use as reference guides.

Training memberships and training credits - to buy now and schedule training later.

Visit ni.com/training for more information.

Extended Warranty

NI offers options for extending the standard product warranty to meet the life-cycle requirements of your project. In addition, because NI understands that your requirements may change, the extended warranty is flexible in length and easily renewed. For more information, visit ni.com/warranty.

OEM

NI offers design-in consulting and product integration assistance if you need NI products for OEM applications. For information about special pricing and services for OEM customers, visit ni.com/oem.

Alliance

Our Professional Services Team is comprised of NI applications engineers, NI Consulting Services, and a worldwide National Instruments Alliance Partner program of more than 600 independent consultants and integrators. Services range from start-up assistance to turnkey system integration. Visit ni.com/alliance.

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Detailed Specifications

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The following specifications are typical for the range –40 to 70 °C unless otherwise noted. All voltages are relative to COM unless otherwise noted.

Input/Output Characteristics

Number of channels	32 DIO channels
Input/output type	TTL, single-ended
Default power-on line direction	Input
Digital logic levels	

Input

Voltage	-0.25 to 5.25 V
High, V_{IH}	2.2 V min
Low, V_{IL}	0.8 V max
Hysteresis, V_H	0.2 V min

Output

High, V_{OH} (5.2 V max)	
Sourcing 100 μ A	4.75 V min
Sourcing 2 mA	4.4 V min
Low, V_{OL}	
Sinking 100 μ A	0.1 V max
Sinking 2 mA	0.26 V max
Input current ($0 \leq V_{in} \leq 4.5$ V)	$\pm 250 \mu$ A max

Module output current ¹	64 mA max
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Input capacitance	30 pF
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Timing	
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Input

Setup time ²	10 ns min
Hold time ³	60 ns min

Output

Propagation delay ⁴	330 ns max
Channel-to-channel skew ⁵	265 ns max

Update/transfer time⁶

cRIO-9151 R Series Expansion chassis	8 μ s max
All other chassis	7 μ s max

Direction change time ⁵	18 μ s max
------------------------------------	----------------

Overvoltage protection Channel-to-COM	± 30 V max on up to 8 channels at a time; however, continued use at this level will degrade the life of the module.
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MTBF	763,325 hours at 25 °C; Bellcore Issue 2, Method 1, Case 3, Limited Part Stress Method
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Note Contact NI for Bellcore MTBF specifications at other temperatures or for MIL-HDBK-217F specifications.

Power Requirements

[Back to Detailed Specs](#)

Power consumption from chassis	
Active mode	1 W max
Sleep mode	25 μ W max
Thermal dissipation (at 70 °C)	
Active mode	1 W max
Sleep mode	25 μ W max

Physical Characteristics

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If you need to clean the module, wipe it with a dry towel.	
Weight	150 g (5.3 oz)

Safety

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Safety Voltages

Connect only voltages that are within the following limits.

Channel-to-COM

± 30 V max on up to 8 channels at a time, Measurement Category I

Isolation

Channel-to-channel

None

Channel-to-earth ground

Continuous

60 VDC, Measurement Category I

Withstand

1,000 V_{rms} verified by a 5 s dielectric withstand test

Measurement Category I is for measurements performed on circuits not directly connected to the electrical distribution system referred to as MAINS ⁷ voltage. This category is for measurements of voltages from specially protected secondary circuits. Such voltage measurements include signal levels, special equipment, limited-energy parts of equipment, circuits powered by regulated low-voltage sources, and electronics.

Caution Do not connect the NI 9403 to signals or use for measurements within Measurement Categories II, III, or IV.

Safety Standards

This product is designed to meet the requirements of the following standards of safety for electrical equipment for measurement, control, and laboratory use:

IEC 61010-1, EN 61010-1

UL 61010-1, CSA 61010-1

Note For UL and other safety certifications, refer to the product label or the *Online Product Certification* section.

Hazardous Locations

U.S. (UL)	Class I, Division 2, Groups A, B, C, D, T4; Class I, Zone 2, AEx nA IIC T4
Canada (C-UL)	Class I, Division 2, Groups A, B, C, D, T4; Class I, Zone 2, Ex nA IIC T4
Europe (DEMKO)	Ex nA IIC T4

Environmental

[Back to Detailed Specs](#)

National Instruments C Series modules are intended for indoor use only but may be used outdoors if installed in a suitable enclosure. Refer to the manual for the chassis you are using for more information about meeting these specifications.

Operating temperature (IEC 60068-2-1, IEC 60068-2-2) -40 to 70 °C

Storage temperature (IEC 60068-2-1, IEC 60068-2-2) -40 to 85 °C

Ingress protection IP 40

Operating humidity (IEC 60068-2-56) 10 to 90% RH, noncondensing

Storage humidity (IEC 60068-2-56) 5 to 95% RH, noncondensing

Maximum altitude 2,000 m

Pollution Degree (IEC 60664) 2

Shock and Vibration

[Back to Detailed Specs](#)

To meet these specifications, you must panel mount the system.

Operating vibration

Random (IEC 60068-2-64) 5 g_{rms}, 10 to 500 Hz

Sinusoidal (IEC 60068-2-6) 5 g, 10 to 500 Hz

Operating shock (IEC 60068-2-27) 30 g, 11 ms half sine, 50 g, 3 ms half sine, 18 shocks at 6 orientations

Electromagnetic Compatibility

[Back to Detailed Specs](#)

This product is designed to meet the requirements of the following standards of EMC for electrical equipment for measurement, control, and laboratory use:

EN 61326 EMC requirements; Industrial Immunity

EN 55011 Emissions; Group 1, Class A

CE, C-Tick, ICES, and FCC Part 15 Emissions; Class A

Note For EMC compliance, operate this device with shielded cables.

CE Compliance

[Back to Detailed Specs](#)

This product meets the essential requirements of applicable European Directives, as amended for CE marking, as follows:

2006/95/EC; Low-Voltage Directive (safety)

2004/108/EC; Electromagnetic Compatibility Directive (EMC)

Note For the standards applied to assess the EMC of this product, refer to the *Online Product Certification* section.

Refer to the product Declaration of Conformity (DoC) for additional regulatory compliance information. To obtain product certifications and the DoC for this product, visit [ni.com/certification](#), search by module number or product line, and click the appropriate link in the Certification column.

Environmental Management

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National Instruments is committed to designing and manufacturing products in an environmentally responsible manner. NI recognizes that eliminating certain hazardous substances from our products is beneficial not only to the environment but also to NI customers.

For additional environmental information, refer to the *NI and the Environment* Web page at [ni.com/environment](#). This page contains the environmental regulations and directives with which NI complies, as well as other environmental information not included in this document.

Waste Electrical and Electronic Equipment (WEEE)

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EU Customers At the end of their life cycle, all products *must* be sent to a WEEE recycling center. For more information about WEEE recycling centers and National Instruments WEEE initiatives, visit [ni.com/environment/weee.htm](#).

电子信息产品污染控制管理办法（中国 RoHS）



中国客户 National Instruments 符合中国电子信息产品中限制使用某些有害物质指令 (RoHS)。
关于 National Instruments 中国 RoHS 合规性信息, 请登录 [ni.com/environment/rohs_china](#)。
(For information about China RoHS compliance, go to [ni.com/environment/rohs_china](#).)

Calibration

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You can obtain the calibration certificate for this device at [ni.com/calibration](#).

Calibration interval

1 year

¹ Module output current is the maximum guaranteed current that the module can drive from all the I/O lines without going into an overcurrent state.

² *Setup time* is the amount of time input signals must be stable before reading from the module.

³ *Hold time* is the amount of time input signals must be stable after initiating a read from the module.

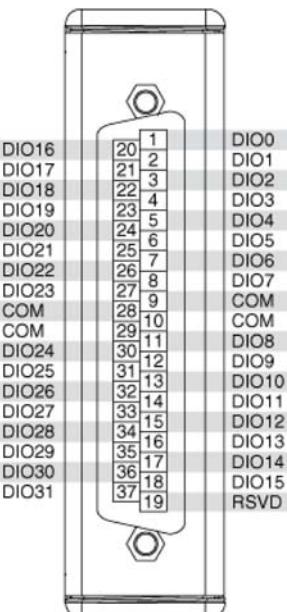
⁴ *Propagation delay* is the amount of time after writing to the module that the output signals become valid.

⁵ *Channel-to-channel skew* is the amount of time between the first output signal updating and the last output signal updating.

⁶ The update/transfer and direction change times are valid when the module is used in a CompactRIO system. When used in other systems, driver software and latencies impact these times.

⁷ MAINS is defined as the (hazardous live) electrical supply system to which equipment is designed to be connected for the purpose of powering the equipment. Suitably rated measuring circuits may be connected to the MAINS for measuring purposes.

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Pinouts/Front Panel Connections

NI 9403 Pin Assignments

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NI C Series Motion Module for CompactRIO

NI 9505

- Full H-bridge brushed servo motor drive with a built-in encoder interface and current sensor
- Continuous current of up to 5 A at 40 °C (or 1 A at 70 °C) at 30 V – for higher-power requirements, attach NI 9931
- Direct connectivity to actuators such as fractional horsepower brushed DC servo motors, relays, lamps, solenoids, and valves
- Create custom current loop algorithm for optimized torque control with LabVIEW FPGA
- Use data from current sensor for flexible sampling time and filtering of the motor current for control loop optimization
- Create powerful custom motion control systems using the NI SoftMotion Development Module for LabVIEW



Overview

The NI 9505 C Series module for NI CompactRIO is a full H-bridge servo motor drive for direct connectivity to actuators such as fractional horsepower brushed DC servo motors, relays, lamps, solenoids, and valves. With its low-power consumption and small form factor, combined with the reconfigurability and performance of the field-programmable gate array (FPGA), you can create intelligent, energy-efficient control systems using the NI LabVIEW graphical system design platform. The NI 9505 delivers continuous current of up to 5 A at 40 °C (or 1 A at 70 °C) at 30 V. To increase the output power of the module, National Instruments offers an additional screw-terminal accessory you can use in place of the standard screw terminal included with the NI 9505 module. With the NI 9931 screw-terminal accessory, the NI 9505 can deliver a maximum current of 7.3 A at 40 °C (or 1 A at 70 °C). The NI 9505 module benefits electronics engineers designing consumer appliances, industrial control engineers designing small-to medium-sized machines, and automotive engineers working on rapid prototyping applications.

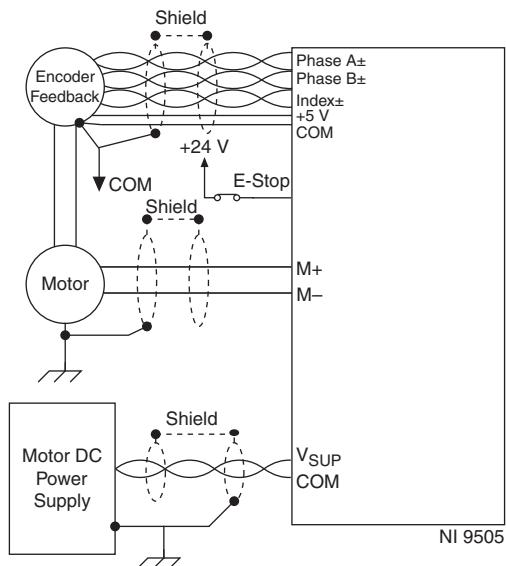
Key Features

This module includes a built-in encoder interface for single-ended or differential inputs for position feedback from a quadrature encoder. It also includes a current sensor you can use to sample the current through the motor, or actuator, and read it through the FPGA in the CompactRIO chassis. You can use real-time data from the current sensor for flexible sampling time and motor current filtering to optimize the control loop. With functions such as trajectory generation, spline

interpolation, and proportional integral derivative (PID) control featured in the NI SoftMotion Development Module for LabVIEW, you can develop a complete reconfigurable motion control and drive system in a compact form factor with CompactRIO and LabVIEW. By customizing FPGA logic on CompactRIO, you can accurately control torque in addition to velocity and position. You also can implement advanced control techniques, such as notch filter use, to avoid exciting the system at resonant frequencies or apply gain scheduling, to adjust for changing load inertia. You can use the real-time embedded processor on CompactRIO to implement functions such as supervisory control and trajectory generation for multiaxis coordination and accurate velocity/acceleration profiles for smooth movements. The NI SoftMotion Development Module for LabVIEW provides the necessary functions and examples to create a custom motion control system using CompactRIO.

The nine-pin D-Sub connector on the NI 9505 offers encoder input for position and velocity feedback in addition to a +5 V connection for encoder power and an emergency stop input. The NI 9505 also has a screw-terminal connector that provides power connection to the motor or actuator. This hot-swappable module has four LEDs to display status information for chassis power, motor power, drive disable, and drive fault. It indicates the presence of a drive fault in cases of overvoltage, undervoltage, short to supply power or ground, or excessive temperatures in the module.

NI C Series Motion Module for CompactRIO



NI 9505 Connections

Applications

The minimal power dissipation and accurate velocity or position control provided by CompactRIO with the NI 9505 is especially important when prototyping control systems for consumer appliances such as printers, copiers, scanners, and fax machines. The ruggedness of the CompactRIO platform makes the NI 9505 attractive for use in automated test equipment, process control systems, programmable machine tools, instrumentation panels, robotics, and pick-and-place machines. CompactRIO with the NI 9505 is also an excellent commercial off-the-shelf platform for developing complex rapid prototyping applications in the automotive industry for subsystems such as engine, transmission, emission control, body and chassis, instrumentation, antilock braking, and electronic fuel injection.

Ordering Information

NI 9505	779126-01
NI 9931 higher-power motor screw-terminal accessory for NI 9505.....	780571-01
NI 9943 9-pin connector kit with strain relief	779570-01
NI 9946 4-pos NI 9505 plugs (quantity 10)	779571-01
NI 9947 4-pos NI 9505 plug with strain relief.....	779580-01

BUY NOW!

For complete product specifications, pricing, and accessory information, call (800) 813 3693 (U.S.) or go to ni.com/compactrio.

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Our NI Professional Services team is composed of NI applications and systems engineers and a worldwide National Instruments Alliance Partner program of more than 600 independent consultants and integrators. Services

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OEM Support

We offer design-in consulting and product integration assistance if you want to use our products for OEM applications. For information about special pricing and services for OEM customers, visit ni.com/oem.



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Hardware Services

System Assurance Programs

NI system assurance programs are designed to make it even easier for you to own an NI system. These programs include configuration and deployment services for your NI PXI, CompactRIO, or Compact FieldPoint system. The NI Basic System Assurance Program provides a simple integration test and ensures that your system is delivered completely assembled in one box. When you configure your system with the NI Standard System Assurance Program, you can select from available NI system driver sets and application development environments to create customized, reorderable software configurations. Your system arrives fully assembled and tested in one box with your software preinstalled. When you order your system with the standard program, you also receive system-specific documentation including a bill of materials, an integration test report, a recommended maintenance plan, and frequently asked question documents. Finally, the standard program reduces the total cost of owning an NI system by providing three years of warranty coverage and calibration service. Use the online product advisors at ni.com/advisor to find a system assurance program to meet your needs.

Calibration Services

NI recognizes the need to maintain properly calibrated devices for high-accuracy measurements. We provide manual calibration procedures, services to recalibrate your products, and automated calibration software specifically designed for use by metrology laboratories. Visit ni.com/calibration.

Repair and Extended Warranty

NI provides complete repair services for our products. Express repair and advance replacement services are also available. We offer extended warranties to help you meet project life-cycle requirements. Visit ni.com/services.

IP68

Never Beaten by Seasons

Buccaneer® For Power

Frozen Winters! Torrential Springs! Blistering Summers! Dusty Autumns!

The Buccaneer range of IP68 waterproof connectors
for power applications up to 32A, 600V.



900 Series Buccaneer®

The 900 series is the power house in Bulgin's range of IP68 rated connectors.

With a maximum voltage rating up to 600V ac/dc, current carrying capacity up to 32A and available from 2 to 10 poles, the 900 Series offers a secure and robust connection for many power applications.

Screw terminals facilitate easy termination in the field without the need for special tooling. Cables up to 22mm overall diameter can be accommodated, with additional strain relief, to give added security for the larger cable diameters.

The 900 series continues the Buccaneer pedigree into higher power applications.



FLEX CABLE CONNECTOR



PX0911

- Flex cable connector
- Mates with in-line flex or panel mounting versions
- PX0 Series 13-15mm cable dia. as standard
- PXA Series 20-22mm cable dia. as standard

IN-LINE FLEX CABLE CONNECTOR



PX0921

- In-line flex cable connector
- Mates with either PX0911 or PXA911 connectors
- PX0 Series 13-15mm cable dia. as standard
- PXA Series 20-22mm cable dia. as standard

PANEL MOUNTING CONNECTOR



PX0931

- Single hole fixing panel mounting connector - PX0931
- Flange mounting connector - PX0941
- Mates with either PX0911 or PXA911
- Supplied with sealing gaskets

ACCESSORIES



Sealing Caps

- Sealing caps to maintain IP68 rating of unmated connectors
- Bulkhead adaptor moulding - PX0950, for use with flange mounting connector PX0941, to give 45° or 90° angle
- Gland packs

APPLICATIONS

- Lighting
- Industrial Pumps
- Welding Equipment
- Sound/Broadcast Systems
- Handling/Lifting Equipment

SPECIFICATION

Poles:	2, 3,	4, 5	7	10*
Current Rating:	32A 30A, CSA	32A 25A, CSA	32A	10A
Voltage Rating:	600V	600V	430V	250V
Operating Temperature:	-40° to +85°C			
Approvals:	UL, CSA, VDE			
Flammability Rating:	UL94V-0			
Sealing:	IP68, EN 60529:1992 tested @ 15lb/sq in (10m depth) for 2 weeks			
Cable Acceptance:	13-22mm O/D			
Diameter over coupling ring:	57.7mm			



Standard Buccaneer®

The original Buccaneer. The Standard Buccaneer was the first in Bulgin's range of IP68 rated connectors.

With a maximum voltage rating of 250V ac/dc, current carrying capacity up to 12A, and available from 2 to 25 poles, the Standard Buccaneer can satisfy most applications for dust and waterproof connections. Available in screw, crimp and solder contact versions, together with BNC inserts, it can be used in many applications. Its simple construction ensures ease of assembly without the need for special tooling.

The Standard Buccaneer has developed a reputation for providing secure connections for harsh environments.



FLEX CABLE CONNECTOR



Flex Mounting

- Flex cable connector
- Mates with in-line flex or panel mounting versions
- Leading earth on 3 pole connectors

IN-LINE FLEX CABLE CONNECTOR



In-Line Flex Mounting

- In-line flex cable connector
- Mates with flex cable connector

PANEL MOUNTING CONNECTOR



Panel Mounting

- Single hole front or rear panel fixing connectors
- Bulkhead flange mounting connector
- Low profile flange mounting connector
- Mates with flex cable connector
- PCB version

ACCESSORIES



Sealing Caps

- Sealing cap assembly tools to maintain IP68 rating of unmated connectors, seals connector and removes inserts
- Insertion and extraction tools for 25 way contacts
- Cable support

FEATURES

- Water and dustproof to IP68 when mated
- IP68 rating tested at 15lb/sq in (10m depth for 2 weeks) and 140lb/sq in (100m for 12 hours)
- Up to 12A, 250V rating
- 2, 3, 4, 6, 7, 9, 12 & 25 poles
- 5 body styles - flex & in-line flex, panel - single hole & flange mounting
- Pin or socket connection in each body style
- 2, 3, 4, 6 & 7 pole screw terminals, 3, 9 & 12 pole crimp contacts, 25 pole crimp or solder contacts, BNC inserts, 3, 4, 6, 9, 12 & 25 pole PCB versions
- Cable range from 3.5 - 9mm overall diameter
- Approvals:

SPECIFICATION

Poles:	2, 3	4	6, 7	9	12	25
Current Rating:						
UL & CSA	10A	6A	3A	5A	5A	1A
VDE	12A	10A	5A	5A	5A	1A
Voltage Rating:	250V	250V	250V	150V	50V	50V
Operating Temperature:	-20° to +70°C					
Approvals:	UL, CSA & VDE					
Flammability Rating:	UL94HB					
Sealing:	IP68, BS 5490:1977 tested @ 15lb/sq in (10m depth) for 2 weeks					
	BSEN 60529:1992 tested @ 140lb/sq in (100m depth) for 12 hours					
Cable Acceptance:	3.5 - 9.0mm					
Diameter over coupling ring:	38.0mm					



APPLICATIONS

- Marine (Commercial & Leisure)
- Traffic Management
- Telecommunications
- Industrial Equipment

Mini Buccaneer®

Dust and waterproof to IP68, the Mini Buccaneer addresses the need for a smaller connector.

With a maximum voltage rating of 380V ac, current carrying capacity up to 10A, and available from 2 to 8 poles, the Mini Buccaneer offers performance similar to the Standard Buccaneer but in a smaller package. Although more compact than the Standard Buccaneer the Mini still boasts screw, crimp and solder contact versions together with BNC inserts. Its modular construction means that the connectors can be configured quickly and easily without the need for special tooling.

The Mini Buccaneer continues to build on the reputation established by the Standard Buccaneer.



FLEX CABLE CONNECTOR



Flex Mounting

- Flex cable connector
- Mates with in-line flex or panel mounting versions

IN-LINE FLEX CABLE CONNECTOR



In-Line Flex Mounting

- In-line flex cable connector
- Mates with flex cable connector

PANEL MOUNTING CONNECTOR



Panel Mounting

- Single hole fixing connector
- Right angle cable entry version
- Mates with flex cable connector
- Supplied with gaskets

FEATURES

- Water and dustproof to IP68 when mated
- IP68 rating tested at 15lb/sq in (10m depth) for 2 weeks
- UL94-V0 flammability rating
- Up to 10A, 250V rating
- 2, 3, 4, & 6 pole screw terminal inserts
- 3 & 8 pole solder or crimp inserts
- 50Ω or 75Ω BNC inserts
- 5 body styles - flex & in-line flex, panel - single hole fixing (3 styles)
- Pin or socket connection in each body style
- Body mouldings and inserts supplied separately
- Cable range from 3.5 - 9mm overall diameter
- Approvals:

SPECIFICATION

Poles:	2, 3	4	6	Crimp/Solder
Current Rating:	10A	6A	3A	5A
Voltage Rating:	250V	250V	250V	380V
Operating Temperature:	-20° to +70°C			
Approvals:	UL			
Flammability Rating:	UL94V-0			
Sealing:	IP68, EN 60529:1992 tested @ 15lb/sq in (10m depth) for 2 weeks			
Cable Acceptance:	3.5 - 9.0mm			
Diameter over coupling ring:	26mm			

ACCESSORIES



Sealing Caps

- Sealing caps to maintain IP68 rating of unmated connectors
- Contact insertion tool

APPLICATIONS

- Water Monitoring Meters
- Portable Equipment
- Test Equipment
- Data Acquisition Equipment



400 Series Buccaneer®

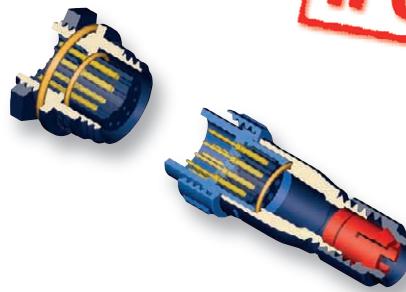
The 400 series, the newest and the smallest in the range of IP68 rated connectors.

With ratings of up to 8A 250V ac/dc, and up to 12 poles, the 400 series offers practical solutions for both signal and mains power applications, but in a very compact space.

Contacts come in crimp and solder versions. They can be inserted and removed easily from the contact inserts and are gold plated for superior conductivity and high reliability.

Overmoulded cable assemblies provide secure and tamperproof connections.

The 400 series Buccaneer follows the long established pedigree of its larger brothers and does not compromise on performance.



IP68

FLEX CABLE CONNECTOR



PX0410/P PX0410/S

- Flex cable connector
- Mates with in-line flex or panel mounting versions (PX0411, PX0412, PX0413 & PX0401)
- Contacts supplied separately

IN-LINE FLEX CABLE CONNECTOR



PX0411/P PX0411/S

- In-line flex cable connector
- Mates with PX0410 & PX0400
- Contacts supplied separately

PRE WIRED CABLE CONNECTORS



PX0400/S PX0400/P

- Overmoulded cable assemblies
- Secure, tamperproof connections
- Single or double ended
- PX0400 mates with PX0401, PX0411, PX0412 & PX0413
- PX0401 mates with PX0400 & PX0410

PANEL MOUNTING CONNECTOR



PX0412/P PX0412/S

- Single hole front or rear of panel fixing
- Mates with PX0410 & PX0400
- Contacts supplied separately
- PCB version - fully loaded
- Supplied with gaskets

ACCESSORIES



Sealing Caps

- Sealing caps to maintain IP68 rating of unmated connectors
- Insertion/extraction tools for contacts
- Gland packs

FEATURES

- Sealed to IP68 when mated
- IP68 rating tested @ 15lb/sq in (10m depth for 2 wks)
- Up to 8A, 250V rating
- UL94-V0 flammability rating
- Overmoulded cable assemblies
- 2, 3, 4, 6, 8, 10 & 12 poles
- Pin or socket connection in each body style
- Crimp & Solder contacts
- Gold plated contacts
- Scoop proof contacts
- PCB Versions
- Cable range from 3 - 9mm overall diameter
- Approvals:

SPECIFICATION

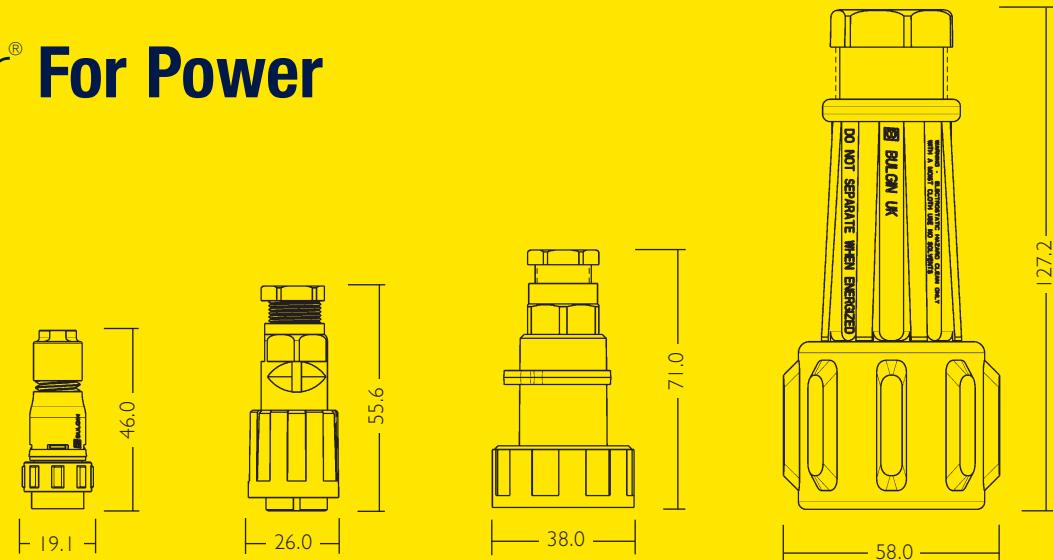
Poles:	2, 3	4, 6, 8	10, 12
Current Rating:	8A	5A	1A
Voltage Rating:	250V	125V	50V
Operating Temperature:	-40° to +80°C		
Approvals:	UL, CSA* & VDE		
Flammability Rating:	UL94V-0		
Sealing:	IP68, EN 60529:1992 tested @ 15lb/sq in (10m depth) for 2 weeks		
Cable Acceptance:	PX0410 & PX0411 PX0400 & PX0401	3.0 - 7.0mm 2.5 - 9.0mm	
Diameter over coupling ring:	19.1mm		

*approval pending



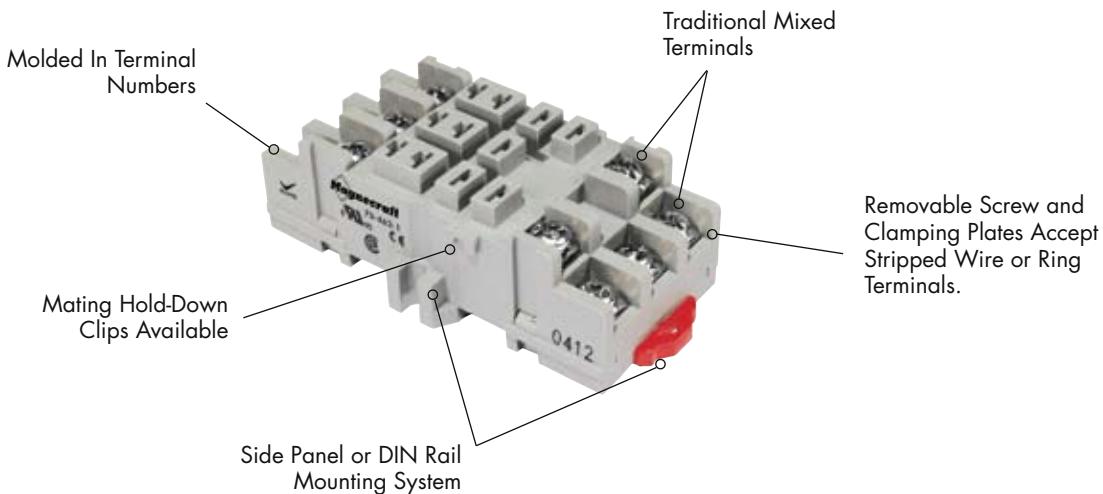
Buccaneer® For Power

Outline drawings shown @ 50%



MECHANICAL		400 SERIES	MINI	STANDARD	900 SERIES
Sealing	IP68, EN60529	IP68, EN60529	IP68, EN60529	IP68, EN60529	IP68, EN60529
Body Material	Polyamide	Polyamide	Glass Filled Polyamide	Glass Filled Polyamide	Polyamide
Flammability Rating	UL94V-0	UL94V-0	UL94V-HB	UL94V-HB	UL94V-0
Contact Material	Copper Alloy	Copper Alloy (crimp/solder), Brass (screw)	Brass (screw), Copper Alloy (Crimp/Solder)	Brass (screw), Copper Alloy (Crimp/Solder)	Brass
Contact Plating	Gold	Gold (crimp/solder), Nickel (screw)	Nickel (screw), Tin, Gold (Crimp/Solder)	Nickel (screw), Tin, Gold (Crimp/Solder)	Nickel
Cable Acceptance (dia.)	3.0-7.0mm	3.5-9mm	3.5-9mm	3.5-9mm	7-22mm
Approvals (see spec for detail)	UL, CSA, VDE	UL	UL, CSA, VDE	UL, CSA, VDE	UL, CSA, VDE
ELECTRICAL		400 SERIES	MINI	STANDARD	900 SERIES
2 pole	Rating Wire accommodation (max) Termination	8A, 250V ac/dc 0.5mm ² , 20AWG Crimp/Solder/PCB	10A, 250V ac 1mm ² , 18AWG Screw	12A, 250V ac/dc (max.) 4mm ² , 12AWG Screw	32A, 600V ac/dc 4mm ² , 10AWG Screw
3 pole	Rating Wire accommodation (max) Termination	8A, 250V ac/dc 0.5mm ² , 20AWG Crimp/Solder/PCB	5A, 380V ac Crimp/Solder; 10A, 250V ac screw 0.5mm ² , 20AWG Crimp/Solder, 1mm ² , 18 AWG screw Crimp/Solder or Screw	12A, 250V ac/dc (max.) 4mm ² , 12AWG Screw/Crimp/PCB	32A, 600V ac/dc 4mm ² , 10AWG Screw
4 pole	Rating Wire accommodation (max) Termination	5A, 125V ac/dc 0.32mm ² , 22AWG Crimp/Solder/PCB	6A, 250V ac 1mm ² , 18AWG Screw	10A, 250V ac/dc (max.) 1.5mm ² , 16AWG Screw/PCB	32A, 600V ac/dc 4mm ² , 10AWG Screw
5 pole	Rating Wire accommodation (max) Termination	— — —	— — —	— — —	32A, 600V ac/dc 4mm ² , 10AWG Screw
6 pole	Rating Wire accommodation (max) Termination	5A, 125V ac/dc 0.32mm ² , 22AWG Crimp/Solder/PCB	3A, 250V ac 1mm ² , 18AWG Screw	5A, 250V ac/dc (max.) 1.5mm ² , 16AWG Screw/PCB	— — —
7 pole	Rating Wire accommodation (max) Termination	— — —	— — —	5A, 250V ac/dc (max.) 1.5mm ² , 16AWG Screw	32A, 430V ac/dc 4mm ² , 10AWG Screw
8 pole	Rating Wire accommodation (max) Termination	5A, 125V ac/dc 0.32mm ² , 22AWG Crimp/Solder/PCB	5A, 380V ac 0.5mm ² , 20AWG Crimp/Solder	— — —	—
9 pole	Rating Wire accommodation (max) Termination	— — —	— — —	5A, 150V ac/dc 0.2mm ² , 24AWG Crimp/PCB	— — —
10 pole	Rating Wire accommodation (max) Termination	1A, 50V ac/dc 0.2mm ² , 24AWG Crimp/Solder/PCB	— — —	— — —	10A, 250V ac/dc 1mm ² , 18AWG Screw
12 pole	Rating Wire accommodation (max) Termination	1A, 50V ac/dc 0.2mm ² , 24AWG Crimp/Solder/PCB	— — —	5A, 50V ac/dc 0.32mm ² , 22AWG Crimp/Solder/PCB	— — —
25 pole	Rating Wire accommodation (max) Termination	— — —	— — —	1A, 50V ac/dc 0.2mm ² , 24AWG Crimp/Solder/PCB	— — —
BNC	RF connector	—	50 and 75Ω	50 and 75Ω	—

70-463-1 Socket/15 Amp Rating, 300 Volts



BOLD-FACED PART NUMBERS ARE NORMALLY STOCKED

Standard Part Number	Description
70-463-1	11-Pin, DIN/Panel Mount with Screw Terminals & Clamping Plates

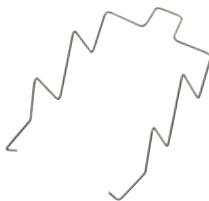
General Specifications (UL 508)

Characteristics	Units	Value
Number of Terminals		11
Electrical Rating		
Nominal Voltage Rating	Volts	300
Nominal Current Rating	Amps	15
Dielectric Strength		
Output to Adjacent Output Terminals	V rms	2000
Output to Input Terminals	V rms	2000
Terminals to Rail / Chassis	V rms	2000
Temperature		
Operating Range:	°C	- 40 to + 80
Storage Range:	°C	- 40 to + 105
Construction		
Internal Metal Tracks		Copper Alloy, Zinc Plated
Screw Terminals		Steel, Zinc Plated
Screw Style		Combination Head,
Screw size	mm	M3.5
Screw Torque 3.5 mm (Maximum)	Lb-in / Nm	9 / 1.0
Miscellaneous		
Socket Mounting:		Din / Panel
Wire Size Capacity (Maximum)	EN 60204-1	AWG mm ²
Solid Cu	AWG, mm ²	14 / 16 (2) 2.5 / 1.5 (2)
Stranded Cu	AWG, mm ²	14 / 16 (2) 2.5 / 1.5 (2)
Wire Connection Method		Screw Clamping
DIN Rail Mounting	EN 60715	35mm
Chassis Mount Screw Torque	Lb-in / Nm	7 / 0.8
Flammability Rating		94V-0
Body Color		Light Gray
DIN Locking Method		Red Plastic Locking Clip
Product Certification		UL, CSA
Conformance		CE, RoHS
Weight	grams	51

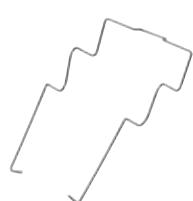
Optional Mating Accessories



788 Relay



16-1351



16-1344

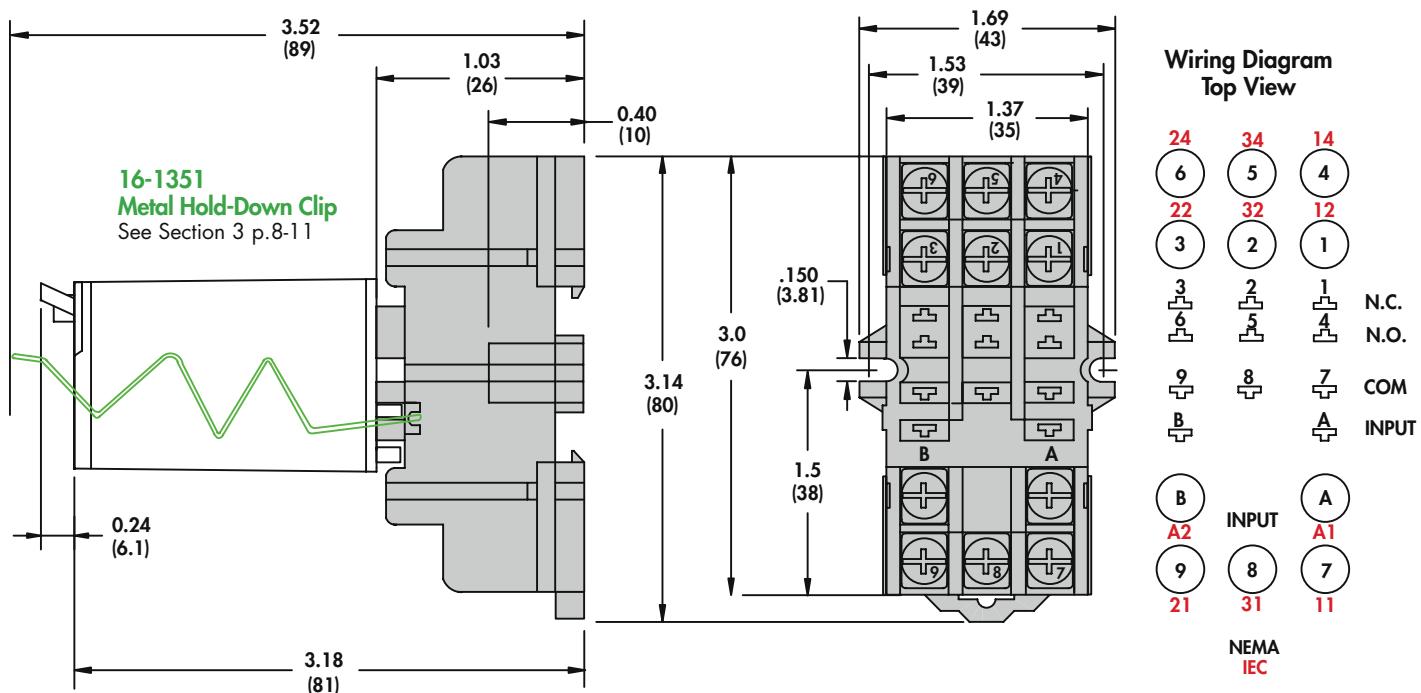


16-700DIN



16-DCLIP-1

Standard Part Number	Description	Catalog Location
788	Relay	Section 1 p.30-38
16-1351	Metal Hold-Down Clip used with 788, 785, 711, 388 Relays	Section 3 p.8-11
16-1344	Metal Hold-Down Clip for TDRSOX/SRX Relays	Section 3 p.8-11
16-700DIN	Metal DIN Rail	Section 3 p.19
16-DCLIP-1	DIN Rail Locking Clip	Section 3 p.19





UL Recognized
File No. E43641



COMPLIES WITH REQUIREMENTS OF
 * IEC STANDARDS 947-4-1 AND
 947-5-1 LOW VOLTAGE DIRECTIVE
 * IEC = INTERNATIONAL
 ELECTROTECHNICAL COMMISSION
 * CE TESTING AND EVALUATION
 PERFORMED BY THE UNDERWRITERS
 LABORATORIES AS A THIRD PARTY
 PARTICIPANT



LISTED 367G
IND. CONT. EQ.

WHEN USED WITH
SOCKET 70-463-1

CURRENT LIMITED TO
 RATING OF RELAY OR
 SOCKET WHICHEVER
 IS LESS



GENERAL SPECIFICATIONS (@ 25°C)

	UNITS	
COIL		
Pull-in Voltage AC (50/60 Hz):≤	% of nominal	85
Pull-in Voltage DC:≤	% of nominal	80
Dropout Voltage AC (50/60 Hz):≥	% of nominal	10
Dropout Voltage DC:≥	% of nominal	10
Maximum Voltage:	% of nominal	110
Resistance:	% ±	10
Coil Power AC (60 Hz):	VA	2.0 - 3.0
Coil Power DC:	W	1.4
Insulation System Per UL Standard 1446:		Class B (130 °C)
Maximum Coil Dissipation, AC (60 Hz):	VA	3.5
Maximum Coil Dissipation, DC:	W	3
Duty:		Continuous
CONTACTS		
Contact Material:		Silver alloy, gold flashed
Contact Rating AC Amperes (AC1):	A	16
Contact Rating AC Voltage:	V	277
Contact Rating DC Amperes (DC1):	A	16 / 0.5
Contact Rating DC Voltage:	V	28 / 220
Horse Power (AC):	HP	1/3 @ 120 V
Horse Power (AC):	HP	1/2 @ 240 V
Pilot Duty (60 Hz):		B300
Utilization Category:	IEC	AC15
VA Rating Make:	VA	3600
VA Rating Break:	VA	360
Minimum Recommended Load:	ma	100 @ 5 VDC or 0.5 W
TIMING		
Operate Time:	ms	20
Release Time:	ms	20

FEATURES

FLAG INDICATOR:
BI - POLAR L.E.D. STATUS LAMP:
COLOR CODED PUSH BUTTON:
LOCK-DOWN DOOR:
FINGER - GRIP COVER:
WHITE PLASTIC I.D. TAG/WRITE LABEL:

SHOWS RELAY STATUS IN MANUAL OR POWERED CONDITION.

ALLOWS FOR REVERSE POLARITY APPLICATIONS,
 SHOWS COIL "ON" OR "OFF" STATUS.
 IDEAL IN LOW LIGHT CONDITIONS.

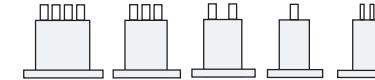
IDENTIFIES AC COILS WITH RED OR DC COILS WITH BLUE
 PUSH BUTTONS. ALLOWS FOR MANUAL OPERATION OF RELAY
 WITHOUT THE NEED FOR COIL POWER. IDEAL FOR FIELD
 SERVICE PERSONNEL TO TEST CONTROL CIRCUITS.

WHEN ACTIVATED, HOLDS PUSH BUTTON AND CONTACTS
 IN THE OPERATE POSITION. EXCELLENT FOR ANALYZING
 CIRCUIT PROBLEMS.

ALLOWS OPERATOR TO REMOVE RELAYS FROM SOCKETS
 MORE EASILY THAN CONVENTIONAL RELAYS.

USED FOR IDENTIFICATION OF RELAYS
 IN MULTI-RELAY CIRCUITS.

MANUFACTURED
 UNDER
 ISO 9002
 & QS 9000



UNITS

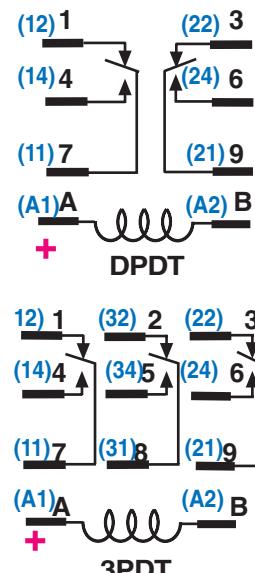
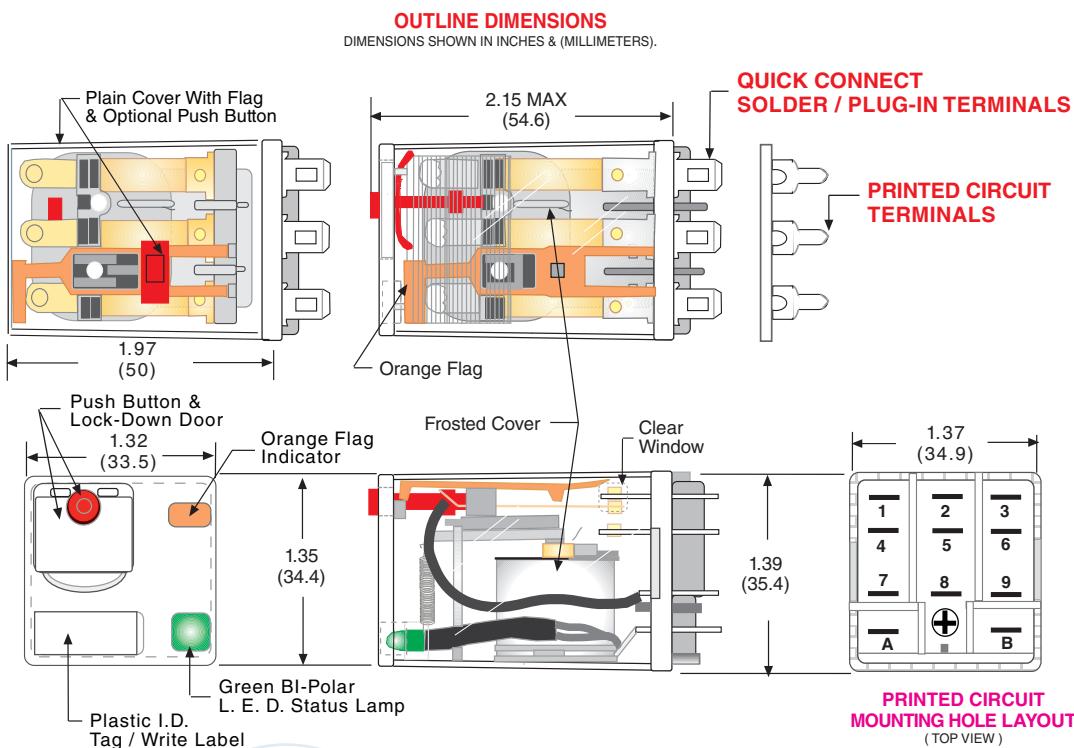
DIELECTRIC STRENGTH	UNITS	
Coil to Contacts:	V rms	2500
Across Open Contacts:	V rms	1500
Pole to Pole:	V rms	2500
Contacts to Frame:	V rms	
Insulation Resistance:	megohms minimum @VDC	1000 @ 500
VIBRATION RESISTANCE		
Functional:	g's	10-55 Hz, 6 g's, 1mm double amplitude
SHOCK RESISTANCE		
Functional:	g's	10
TEMPERATURE		
Operating, AC Lower:	°C	-40
Operating, AC Upper:	°C	+50
Operating, DC Lower:	°C	-40
Operating, DC Upper:	°C	+65
Storage, Lower:	°C	-40
Storage, Upper:	°C	+105
LIFE EXPECTANCY		
Electrical @ Rated Load (AC1):	operations	100,000
Mechanical @ no Load :	operations	5,000,000
MISCELLANEOUS		
Operating Position:		Any
Insulation Material:	94V-0	Molded plastic
Enclosure Material:	94V-0	Polycarbonate
Cover Protection Category:	IP	40
Terminals:	Inch (mm)	0.187, 0.062 x 0.020 (4.74, 1.57 x 0.508)
Weight:	grams	88

788 PLUG-IN POWER RELAY



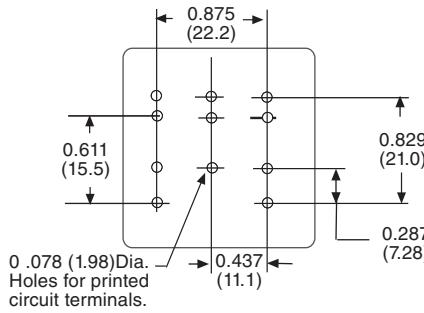
DPDT & 3PDT, 16 AMPS

WIRING DIAGRAM
(VIEWED FROM PIN END)



ALTERNATE NEMA
OR IEC () NUMBERS
VIEWED FROM
PIN SIDE

PRINTED CIRCUIT
MOUNTING HOLE LAYOUT
(TOP VIEW)



Mating Sockets

70-463-1: SCREW/DIN

70-124-1: SOLDER

70-178-1, 70-178-2: PRINTED CIRCUIT

See section 7

ORDERING CODE

788

XBX

M4L

-120A

CLASS: _____

CONTACT CONFIGURATION:
DPDT: XBX, 3PDT: XCX

OPTIONAL PLAIN COVER:
CODE C

TERMINAL STYLE:
SOLDER PLUG-IN TERMINALS: NO CODE
PRINTED CIRCUIT TERMINALS: CODET

FULL FEATURED VERSION:
PUSH BUTTON & LOCK DOWN DOOR: CODE M4
BI - POLAR L.E.D. STATUS LAMP: CODE L

OPTIONAL FULL FEATURED DELETION:
PUSH BUTTON WITHOUT LOCK DOWN DOOR: CODE M

OPTIONAL PLAIN COVER FEATURES:
PUSH BUTTON WITHOUT LOCK-DOWN DOOR: CODE M
POLARIZED L.E.D. STATUS LAMP: CODE L
(OBSERVE POLARITY +)

COIL VOLTAGE:
6, 12, 24, 120, 220 / 240 ADD "A" FOR AC COILS
6, 12, 24, 48, 110 ADD "D" FOR DC COILS

FULL FEATURED	CONTACT CONFIGU- RATION	COIL MEASURED @ 25 °C	
		NOMINAL INPUT VOLTAGE	NOMINAL RESISTANCE (OHMS)
AC OPERATED - SOLDER/PLUG-IN, 16 AMP			
788XBXM4L-24A	DPDT	24 VAC, 50/60Hz	72 Ω
788XBXM4L-120A	DPDT	110/120 VAC, 50/60Hz	1,700 Ω
788XBXM4L-220/240A	DPDT	220/240 VAC, 50/60Hz	7,200 Ω
DC OPERATED - SOLDER/PLUG-IN, 16 AMP			
788XBXM4L-12D	DPDT	12 VDC	120Ω
788XBXM4L-24D	DPDT	24 VDC	470Ω
788XBXM4L-110D	DPDT	110/125 VDC	10,000Ω
AC OPERATED - SOLDER/PLUG-IN, 16 AMP			
788XCXM4L-24A	3PDT	24 VAC, 50/60Hz	72 Ω
788XCXM4L-120A	3PDT	110/120 VAC, 50/60Hz	1,700 Ω
788XCXM4L-220/240A	3PDT	220/240 VAC, 50/60Hz	7,200 Ω
DC OPERATED - SOLDER/PLUG-IN, 16 AMP			
788XCXM4L-12D	3PDT	12 VDC	120 Ω
788XCXM4L-24D	3PDT	24 VDC	470 Ω
788XCXM4L-110D	3PDT	110/125 VDC	10,000 Ω

CADMUM-FREE CONTACTS AVAILABLE,
CONTACT FACTORY FOR DETAILS

Product description

The T11 series of circuit breakers for equipment is a line of small, single pole push to reset, overload protective devices. The trip mechanism is of the superior «latch type». A high contact force can be maintained until the unit trips. This prevents electrical «noise» due to contact bounce and reduces the risk of contact welding which may occur with spring type mechanism.

The overload sensing is done with the aid of a thermal bimetal which has the advantage of being immune to high inrush currents and line transients. All T11-units are «positively trip-free». The contacts will open and will remain open during an overload. Contacts cannot be held in the closed position and they will not close automatically even if the closing command is maintained.

The T11 is specifically designed to protect equipment, wiring, transformers, power supplies, motors and sub-assemblies, such as printed circuit boards. For non-PCB mounting the T11 is connected to wiring with the popular quick connect terminals. Rated currents can be specified from 0,05 A to 16 A. All models are internationally approved.

The Swiss precision design is simple with few moving parts. This results in an extremely reliable CBE with high resistance against shock and vibration.

Available options

- Threaded neck type
- Snap-in type
- Drop-in type with soldering pins for PCB mounting
- Shunt terminal
- Additional position indication of the reset button by white ring

Special features

- Wide rated current range
- Variety of mounting styles
- Compact and reliable design
- Immunity to inrush currents and line transients
- Positively trip-free
- UL, CSA, VDE

Applications

- Electric power tools
- Electric household appliances
- Power supplies
- Battery chargers
- Sport machines
- Transformers

Effect of ambient temperature

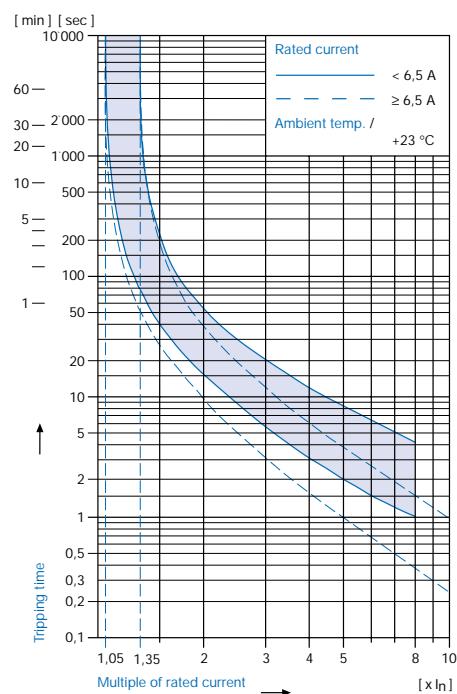
The unit is calibrated for an ambient temperature of +23°C. To determine the rated current for a lower or higher ambient temperature, use a correction factor from the table below:

Ambient temperature [°C]	Correction factor
-5	0,87
0	0,90
+10	0,95
+23	1,00
+30	1,04
+40	1,10
+50	1,15
+60	1,20

Example

Rated current at +23°C 5,0 A
 Ambient temperature +40°C
 Correction factor 1,1
 Chosen rated current at +40°C ambient temperature
 $5,0 \text{ A} \times 1,1 = 5,5 \text{ A}$

Tripping characteristics



Technical data

Rated voltage U_e	See approvals, page 20	AC 120; 240 V DC 24; 32; 48 V
Rated current I_n	See approvals, page 20	AC/DC 0,05 – 16 A
Conditional short circuit current I_{nc}	EN 60934 PC1, AC 240 V	2000 A
Short circuit capacity I_{cn}	AC 240 V with $I_n < 6,5 \text{ A}$ AC 240 V with $I_n \geq 6,5 \text{ A}$	$8 \times I_n$ 96 A
Class of protection	• Between live parts and accessible parts • Other parts	II I
Degree of protection	Accessible range Termination range	IP40 IP00
Dielectric strength	Accessible range	Test voltage AC 4000 V

Technical data (continued)

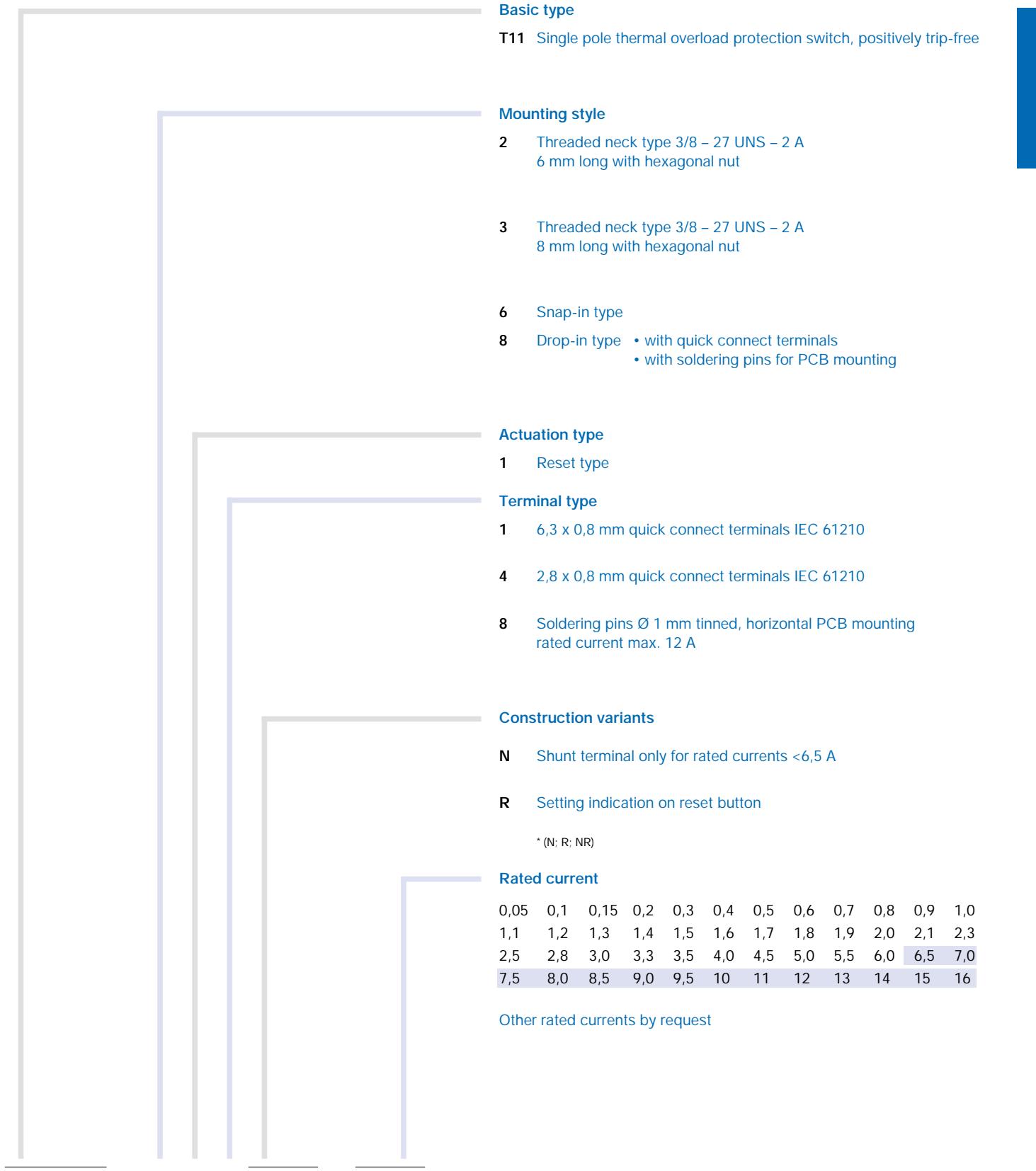
Insulation resistance	DC 500 V	>100 MΩ
Permissible ambient temperature		-5°C to +60°C
Type of actuation	Reset type (manual)	R
Type of tripping	• Thermal • Positively trip-free	TO
Weight		approx. 10 g

Approvals

		Rated current range	Rated voltage AC	Rated voltage DC
 us	UL	UL 1077	0,05 – 16 A	240 V
	UL	CSA C22.2 235	0,05 – 16 A	240 V
	VDE	EN 60934	0,05 – 16 A	240 V

Models 214, 314, 614 and 814 are only available for rated currents $\leq 6 \text{ A } I_{\text{n}}$.
PCB mounting T11-818 by request.

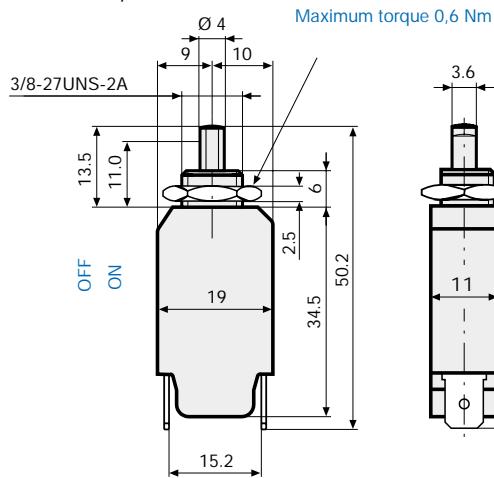
Order code



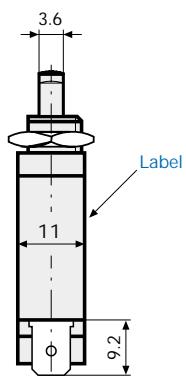
T 1 1 - 2 1 1 N R - 0,15 Order example

Threaded neck type

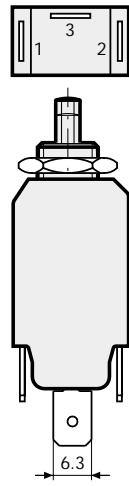
T11-211 ≤7,5 A



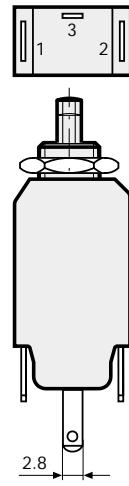
T11-211 >7,5 A



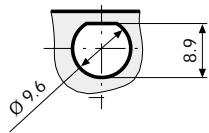
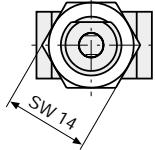
T11-211N



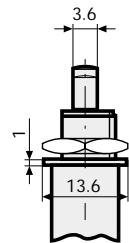
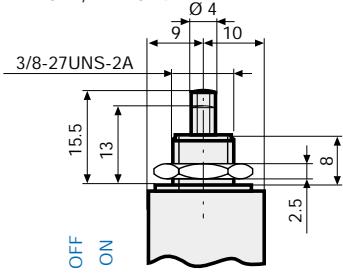
T11-214N



Cut-out

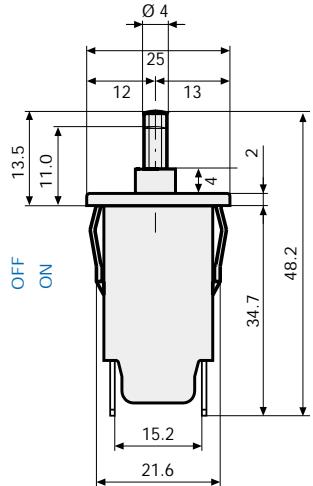


T11-311; T11-314

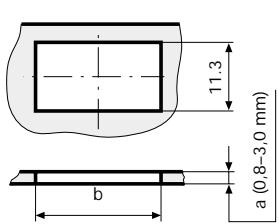
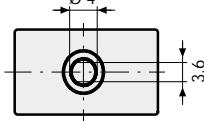


Snap-in type

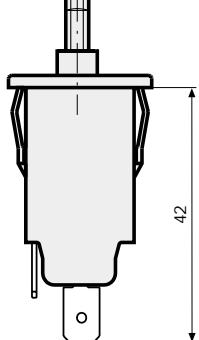
T11-611 ≤7,5 A



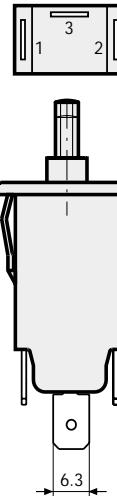
Cut-out



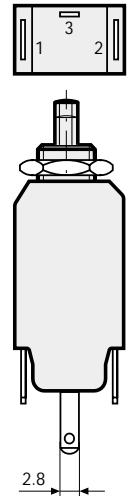
T11-611 >7,5 A



T11-611N

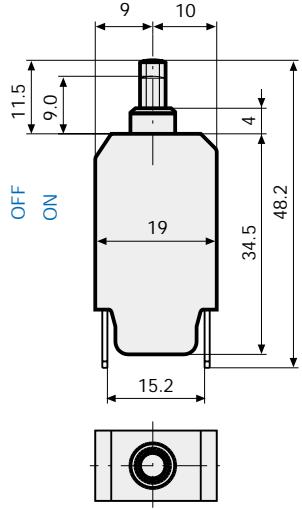
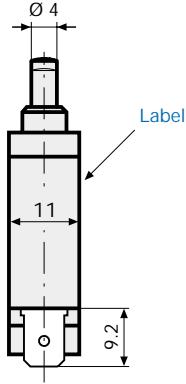


T11-614 N

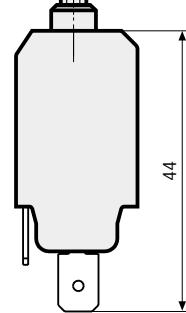


a	b
0,8	21,9
1,0	22,0
1,5	22,1
2,0	22,3
3,0	22,6

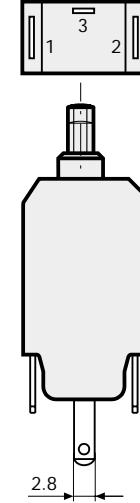
Drop-in type with quick connect terminal

T11-811 $\leq 7,5$ AT11-811 $>7,5$ A

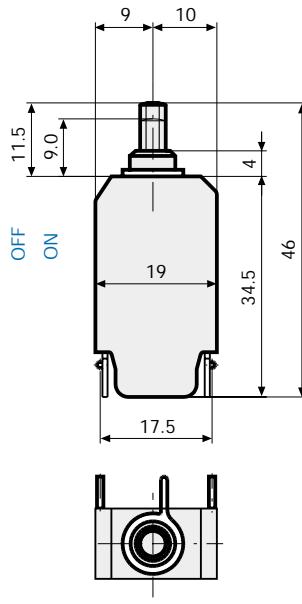
T11-811N



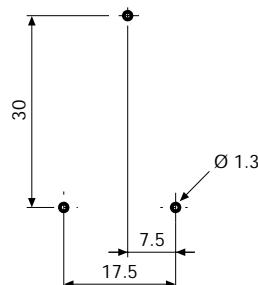
T11-814N



Drop-in type with soldering pins for PCB mounting

T11-818 $\leq 7,5$ A ($>7,5 - 12$ A by request)

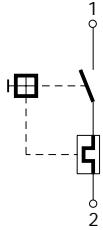
Drilling diagram



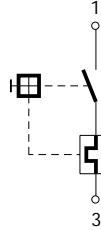
Schematic diagrams – accessories – colours

Schematic diagrams

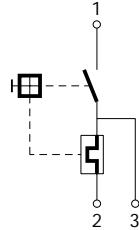
Rated current
 $\leq 7,5 \text{ A}$



Rated current
 $> 7,5 \text{ A}$



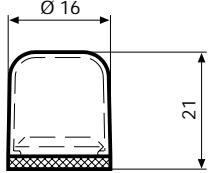
Shunt terminal
T11-...N $\leq 6,5 \text{ A}$



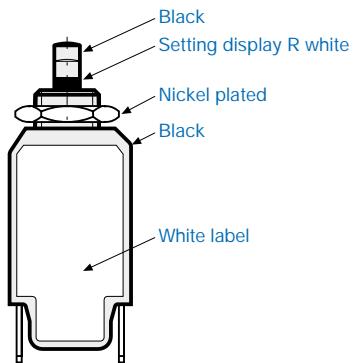
Accessories

Protective transparent cover, degree of protection IP54

TZZ01



Colours



Encoder Technology's HD2.0 Heavy Duty

Industrial Encoder is a compact version of the rugged HD2.5. This robust unit incorporates all the features of the HD2.5 including cast aluminum housing, stainless steel shaft, 100# load rated industrial ball bearings, mil spec sealed connector, all metal code disk, single monolithic phased array opto IC with integrated commutation signals, reverse voltage, ESD and EMI protection, single IR light source, and no internal electrical bias or mechanical adjustments. The HD2.0 is ideally suited for machine tool, process control, robotics, textile, pulp and paper factory automation, elevator control, and many other industrial applications. Covered by a three year warranty (one year for bearings) the HD2.0 provides quality, reliability and value available only through Encoder Technology's proprietary design and manufacturing capabilities.

Technical Specifications

Mechanical

Shaft diameter	As specified
Flat on shaft	0.60 long x 0.018 deep
Shaft loading	Up to 100 lbs axial and radial
Shaft runout	0.0005 TIR at midpoint
Shaft	303 stainless steel (passivated)
Starting torque at 25°C	<i>Without shaft seal:</i> 1.0 in-oz. maximum <i>With optional shaft seal:</i> 2.5 in-oz. maximum
Bearings	5200 ZZ double row
Bearing life	5 x 10 ⁸ revs at rated shaft Loading, 5 x 10 ¹¹ revs at 10% of rated shaft loading. (manufacturers' specs)
Housing and cover	Die Cast Aluminum
Disc material	Metal or mylar
Moment of inertia	1.5 x 10 ⁻⁴ oz-in-sec ²
Weight	11 ounces, typical

Electrical

Code	Incremental
Cycles per Revolution	See "Current Resolutions" list
Supply voltage	See ordering information
Current requirements	50M (no load condition)
Output format	Channels A and B
Output format options	In quadrature ± 15° electrical Index, complementary outputs, and commutation signals on ET7272, ET7273 only
Output IC's	2N2222, ET7272, ET7273
Illumination	LED
Frequency response	125 kHz (data and index)
Output termination	See Table 1
Circuit Protection	Reverse over voltage and output short circuit

Environmental

Operating temp	-40 to 100°C
Operating temp ATEX	-40 to 80°C
Storage temperature	-40 to 100°C
Shock	50G's for 11msec duration
Vibration	5 to 2000Hz @ 20 G's
Humidity	98%RH without condensation
NEMA 4 and 13	When ordered with shaft seal

The above specifications are subject to change without notice.
Dimensions shown in inches.

HD2.0 Heavy Duty Optical Encoder

for Harsh Industrial Environments with Space Limitations



Ordering Information - This model series is available in an intrinsically safe version Certified to ATEX EEx ia IIB T4

Example part number:

HD2.0 [] D [] B [] - 37F [] [] - SS [] 2000 ABZ [] C [] - 72 [] S18 [] 28

1. 2. 3. 4. 5. 6. 7. 8. 9. 10. 11.

1. Housing Configuration

- Square Flange (standard) D
Servo Mount (ø2.00) E

7. Output Channels

- Single A
Dual quadrature AB
Dual with index (standard) ABZ
Commutation signals available.
Contact the factory.

2. Pilot Configuration

- 1.181 in. female(shift seal not available)... A
1.25 in. (standard)..... B

8. Complements

- With Complements C
(available on Outputs 72 and 73 only)
Without complements (blank)

3. Shaft Diameter

- 0.2497/0.2495 25
0.3747/0.3745(standard) 37F
0.3935/0.3942 (10mm)..... 39
"F" = flat on shaft..... i.e. 37F

4. Face Mount

- If not required (blank)
Or specify..... F5, F12, or F28

9. Output ICs

- 2N2222 open collector (5 to 28V) 220C
2N2222 with pull-ups 221K or 222K

Differential line drivers

- ET7272 (5 to 28V) 72
ET7273 open collector (5 to 28V) 73

5. Shaft Seal/Sealed Bearing

- Shaft seal (standard)..... SS
Sealed bearing SB
If not required (shielded)..... (blank)

10. Output Termination

- MS3102R14S-6P (6 pin) S14
MS3102R16S-1P (7pin) S16
MS3102E18-1P (10 pin) S18
Side Cable with seal (18" stdn) SCS18

6. Standard Resolutions

- Many resolutions from 1 to 16384. See
"Current Resolutions" list. Others by special
order. Consult the factory.

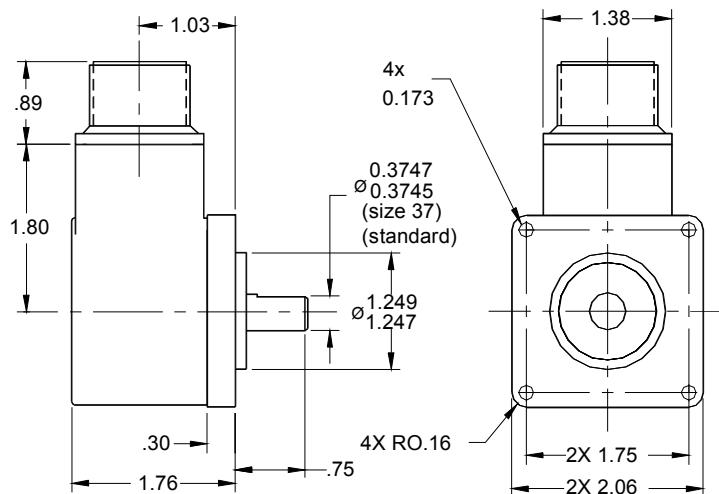
11. Voltage - standard

- 5 to 28Vdc 28
5 to 28Vdc,in, 5Vdc out (ET7272 only).... 28/5

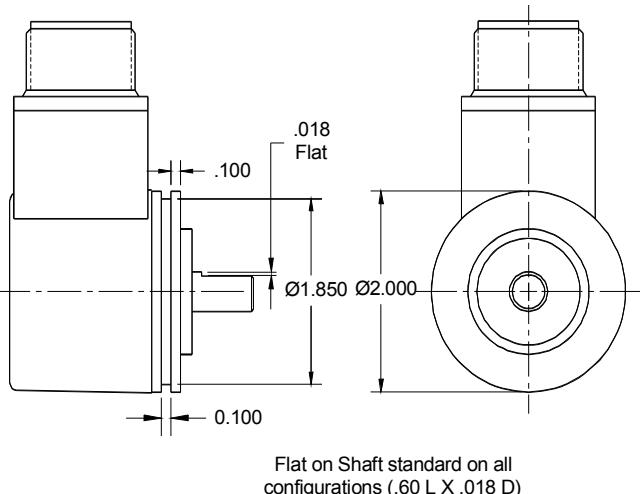
12. Voltage - ATEX

- 5Vdc 5
7 to 28Vdc 28
5 to 28Vdc,in, 5Vdc out (ET7272 only).... 28/5

Outline Dimensions Standard 'D' Housing

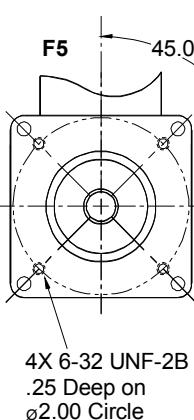


Servo Mount "E" Housing

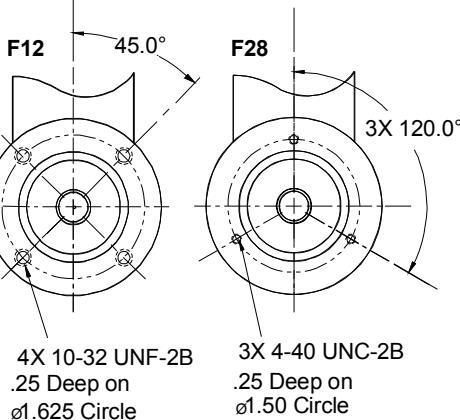


Optional Face Mounts

D Flange only



D or E Flanges



See Shaft Diameter Options

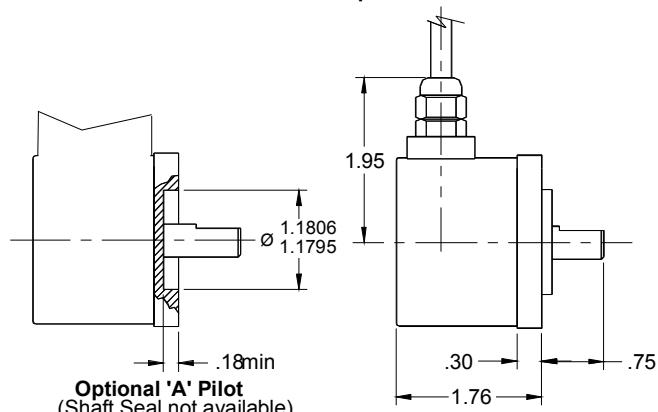
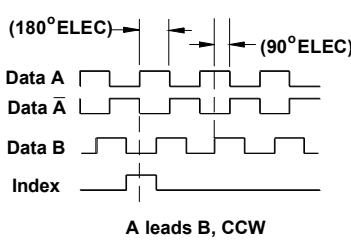


Table 1: Output Terminations (Pinout)

| Connector Pins | | | Output Channels | | | Cable Termination | |
|----------------|-----|-----|-----------------|--------|------|-------------------|----------|
| M14 | M16 | M18 | ABZ | ABC | ABZC | Wire Color | Function |
| E | A | A | A | A | A | Green | A |
| D | B | B | B | B | B | Blue | B |
| C | C | C | Z | A Bar | Z | Orange | Z |
| B | D | D | +V | +V | +V | Red | +Vdc |
| F | E | E | N/C | B Bar | N/C | Black | Ground |
| A | F | F | Circuit | Ground | | Violet | A Bar |
| G | G | | Case Ground | | | Brown | B Bar |
| H | | N/C | N/C | A Bar | | Yellow | Z Bar |
| I | | N/C | N/C | B Bar | | White | Case Gnd |
| J | | N/C | N/C | Z Bar | | | |

Case Ground not available on ATEX Certified Units

DATA AND INDEX
Not all complements shown.
A shown for reference.



(Optional)
COMMUTATION TRACKS
Not all complements shown.
C1 shown for reference.

