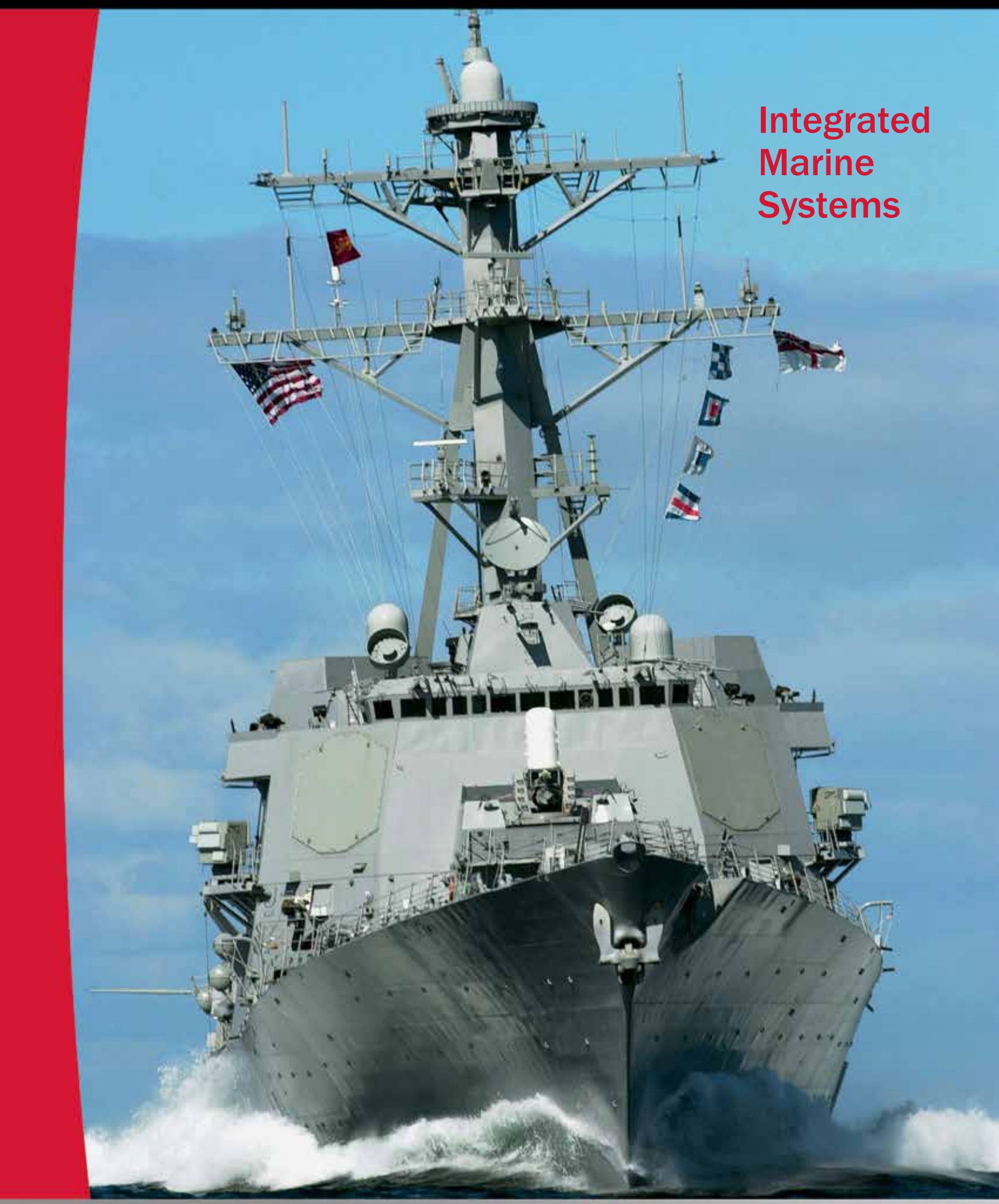


Integrated Marine Systems

LEONARDO DRS

LEONARDO DRS

Thank you for choosing Leonardo DRS to meet your system needs. Our naval and marine offerings are vast and range from core hardware and software products to complete system integration and installation services. This catalog provides an overview of readily available products and services, among them: propulsion system integration, power distribution, power conversion, heating ventilation air conditioning and refrigeration, machinery plant controls, power conditioning, electric motors and turbo machinery.

The offerings in this catalog touch on product and design capabilities at Leonardo DRS. Our full service approach includes a team of product and system experts who are skilled at guiding you through the process of defining, designing and meeting your component or system needs.

This catalog combines the former Ship Systems catalog of DRS Power & Control Technologies (Now DRS Naval Power Systems, Milwaukee) with additional products products and capabilities from DRS NPS and DRS Naval Electronics.

For those familiar with the former Ship Controls Systems Catalog you will find the Motor Controllers & Accessories section to be largely reflective of that catalog, with part numbering and page designs that reflect the history of product presentation for ease of use.

Leonardo DRS is ready to serve with a long history of successfully fielded product and a talented and creative design team.

Contact information by product area is found to the right on this page. To expedite response to your request please provide us with the following upon inquiry:

- *Your name*
- *Your contact telephone number and email address*
- *The name of your organization*
- *The country in which your organization resides*
- *The product description and, if applicable, the catalog page number upon which it appears*

A product specialist will contact you directly within 24 hours of your receipt of your inquiry.

NEW PRODUCTS

DRS Naval Power Systems
4265 N. 30th Street, Milwaukee, WI 53216
Phone: 414.875.2900 **Fax:** 414.875.4319
Email: IMS-BD@drs.com

MOTOR CONTROL AND OPERATOR INTERFACE SPECIFICATION AND DOCUMENTS

DRS Naval Power Systems
4265 N. 30th Street, Milwaukee, WI 53216
Phone: 414.875.2900 **Fax:** 414.875.4764
Email: IMS-BD@drs.com

MOTOR CONTROL AND OPERATOR INTERFACE

DRS Naval Power Systems
4265 N. 30th Street, Milwaukee, WI 53216
Phone: 414.875.2900 **Fax:** 414.875.4764
Email: IMS-BD@drs.com

POWER SOLUTIONS

DRS Naval Electronics - Pivotal Power
150 Bluewater Rd., Bedford, NS B4B 1G9
Phone: 902.835.7268 **Fax:** 902.835.6026
Email: info@pivotalpower.com

HEATING, VENTILATING, AIR CONDITIONING & REFRIGERATION

DRS Naval Power Systems - Marlo Coil
6060 Highway PP, High Ridge, MO 63049-0171
Phone: 636.677.6600 **Fax:** 636.677.1203
Email: marlo.navysales@drs.com

PERMANENT MAGNET MOTORS TURBO MACHINERY

DRS Naval Power Systems
166 Boulder Drive, Suite 201E, Fitchburg, MA 01420
Phone: 978.353.5500 **Fax:** 978.353.5107
Email: powertechnology.info@drs.com

LEONARDO DRS

LEONARDO DRS

Integrated Marine Systems

Propulsion Systems Integration and Power Distribution

Leonardo DRS has extensive marine systems experience showcasing capabilities developed through a century of proudly serving the U.S. Navy and our international allies. Whether it's design and/or selection of a single component or full integration of every aspect of a marine propulsion system, our Integrated Marine Systems (IMS) team is focused on developing and deploying the most advanced power generation, conversion, distribution, and propulsion control technology in the world.

Our products are designed and manufactured to meet stringent standards for reliability, durability and maintainability. Among the standards used are: Military Specifications (MIL-SPEC), American Bureau of Shipping (ABS), Institute of Electrical and Electronics, Engineers (IEEE) standards, ISO Certified - 9001 and 14001.

As customer-centric partners Leonardo DRS listens and delivers solutions through all product offerings. Our commitment to execution excellence, technology innovation and broadly diversified vendor partnerships ensures deployment of superior marine systems.

Our IMS product and services portfolio is broad and adaptable including:

Propulsion System Integration

Our comprehensive approach to propulsion system integration encompasses design, assembly, test, installation and support. Leveraging our significant experience in component design and system deployment, our products and systems can be found on a variety of ship classes ranging in complexity from nuclear submarines to surface combatant support ships.

Power Distribution

Leonardo DRS provides equipment and systems across the full spectrum of shipboard power distribution need including medium and low voltage switchboards and load centers, hardened circuit breakers, and integrated power management systems.

Our Integrated Fight-Through Power (IFTP) system is a redundant power conversion-based zonal power system designed to support requirements for growing power efficiency demands on future navy ships.

Machinery Plant Control and Monitoring Systems

Our innovative solutions for naval machinery control, automation and networking include ruggedized COTS technology qualified for shock, vibration, acoustic and EMI requirements. Existing, fielded, and fully qualified Leonardo DRS products include:

- Server/Network Cabinets
- Logic Processors
- Data Acquisition Units
- Displays/Workstations

Open Architecture Software: *OpenSea™*

Developed by Leonardo DRS for naval and marine applications, OpenSea™ provides the ultimate in open architecture, platform-independent distributed control system (DCS) software. Simple, flexible integration enables improved logistical support, enhanced crew training and reduced manning. Redundant communication assures complete communication among all major systems.

DESIGN | ANALYZE | SELECT | PACKAGE

Motor Controls and Drives

Proudly fielded on every U.S. Naval combatant since WWII, DRS motor control products are proven performers in harsh marine environments. Our rugged variable speed drives (VSDs) can be found wherever variable speed/ frequency is a key operating parameter. We provide a wide range of reliable motor control and drive offerings to our customers by leveraging our strong engineering capabilities, full understanding of applicable MIL-SPECs and experience gained from a history of successful products.

Propulsion and Power Generation

Power-dense Leonardo DRS Permanent Magnet (PM) machines offer innovative solutions for direct drive ship propulsion, hybrid electric drive and power generation for auxiliary systems.

Our unique set of core competencies enables us to develop a wide range of PM machines in radial and axial-field topologies that meet tough standards for military and commercial applications.

PM motors and generators have significant advantages in size, weight and power over conventional motors. They are ideal for dimension and/or weight constrained applications where significant torque, high efficiency and precise control across load and speed variations are essential.

Rotating Machinery Packaging

As a full-service equipment packager we have designed and/ or assembled aero-derivative gas turbine packages using each major engine manufacturers' products. These units are in service in naval and ground power applications around the world.

Whether build-to-print production or more extensive systems packaging is required DRS is ready to meet the needs of any machinery packaging project.

Shipboard Power Conversion and Conditioning

Leonardo DRS power conversion and conditioning systems meet stringent specifications and have been proven to perform in harsh marine environments that can include extreme temperatures, humidity and high shock and vibration. Our products include variable frequency converters; DC rectifiers for helicopter starting; portable multiple-battery chargers and reliable uninterruptible power supply (UPS) systems for powering critical command, control, communication and navigation equipment on-board naval and marine ships.

Heating, Ventilation, Air Conditioning and Refrigeration (HVAC/R)

Shipboard environments require proper control over a wide range of temperatures to support sailors, systems, ships stores and fire suppression. DRS has extensive experience designing and manufacturing rugged HVAC/R equipment specifically for ship applications. Our Naval products are designed to U.S. military specifications and our commercial marine products are designed to U.S. Coast Guard and American Bureau of Shipping regulations. We offer HVAC equipment in many standard sizes and configurations as well as program specific designs for unique applications.

Integrated Logistical Support (ILS)

Leonardo DRS' dedication to ILS requirements assures reliability, availability, maintainability and testability across all product lines, including military, commercial, consumer and industrial customers. Our capabilities enable us to provide life-cycle support for Leonardo DRS manufactured equipment and to tailor specific ILS elements to meet unique requirements. Leonardo DRS staff is experienced and can provide high-quality solutions to meet all logistics requirements.

Life Cycle Support

Leonardo DRS provides unequalled technical and post-delivery support. Our world-wide network of professionals enable us to have qualified personnel on-location, to any location worldwide within 36 hours.

We stand ready to meet your system, component or service needs. Contact us at LeonardoDRS.com for more information.

NEW PRODUCTS

Leonardo DRS drives success through innovation and excellence, with a century of tradition and performance providing power and control onboard every Navy combatant since World War II.

At the heart of Leonardo DRS success is our evolutionary design process, utilizing, integrating and improving the very best innovations across product lines and through successive iterations.

Our products and services are found in fully integrated marine systems, ship propulsion and power generation, power distribution conversion and conditioning, as well as motor controls and drives, auxiliary motors and generators and shipboard HVAC.

For our customers, our depth of experience and breadth of knowledge means battle-hardened dependability of parts, components and systems that meet all applicable specifications and our own stringent quality requirements.

MIL-SPEC Process Controllers (MSPC)

Leonardo DRS is the leader in providing MIL-SPEC solutions for the demanding maritime market. The latest technology is used in our innovative designs. The self contained Process Controller integrates military off the shelf equipment with a MIL-SPEC motor controller to provide a small, lightweight, and cost effective solution. Utilized on the latest U.S. Navy ships for pump controls, the MIL-SPEC qualified Process Controller is designed to withstand rugged maritime conditions for the life of the ship.

Whether for new shipbuilding or modernization programs MSPC is ideal for integrated control, condition based maintenance, power monitoring, and interfacing with ship network communications.

Controls and indicators are functionally grouped on the controller to optimize the human interface, visibility, and ease of use.

From power distribution and electrical control products to ship control automation, Leonardo DRS offers advanced product development, world-class manufacturing and global engineering services and support. That is why our products are found on all U. S. Navy ships since WWII.

Highlights

- Distributed system architecture control
- Efficient and robust operation
- Autonomous control
- Expandable analog and discrete I/O
- Expandable LED display
- Analog readout displays
- System diagnostics
- Remote PROFIBUS communication
- Navy electronic motor operator
    - Custom thermal overload trip curves
    - Full load current sensing from 0.5 to 150 Amps
    - Voltage sensing from 50 to 550 Volts

Military Specifications

MIL-STD-461
MIL-S-901, Grade A
MIL-STD-167-1, 4-50 Hz

Monitors

- Current
- Voltage
- Line frequency
- Apparent power
- Real power
- Reactive power
- Power factor
- Percent FLA
- Percent nominal RMS voltage
- Elapsed run time
- Start count
- Run time since start

Protective Feature

(Can be set as a trip or alarm)

- Under current
- Over current
- Motor JAM trip level
- Current imbalance
- Under voltage
- Over voltage
- Voltage imbalance
- Single phasing current trip level
- Single phasing voltage trip level

Navy Electronic Motor Operator (NEMO)

NEMO is a product enhancement of our existing N2000 and N2001 products.

The Leonardo DRS Navy Electronic Motor Operator answers the call for modern ship specifications requiring small, simplistic, cost effective and flexible control and communications. Utilized on the latest U.S. Navy ships for motor control, HVAC control, and ABT control, the MIL-SPEC qualified Navy Electronic Motor Operator is designed to withstand rugged maritime conditions for the life of the ship.

The Navy Electronic Motor Operator (NEMO) is comprised of an Electronic Control Module, an Overload Application Module, and a solid state Switch module. NEMO integrates control, motor protection, power monitoring, network communications and local network I/O into a single unit in accordance with MIL-DTL-2212. NEMO supplies 24VDC for safe operator control. Configurable discrete inputs and outputs are provided to satisfy most control applications. An LED display provides operating status, diagnostic and fault information. Two sets of parameters allow one module to protect fast and slow speed windings of a motor or to energize/de-energize two separate loads. All interfaces to the main power are galvanically isolated to ensure integrity of the main bus. The network connection design is modular and adaptable to meet current and future Navy machinery control network protocols.

Features

- Configurable control via mini USB port
- Adapatble network communication
- Local CAN network for I/O expansion
- Four character LED display for status
- Field upgradeable firmware
- Operator safe 24VDC I/O
- 5 inputs for control/monitor
- 4 outputs for control/timing/alarm
- MTBF – 188,000 Hrs at 40° C
- Pluggable control terminals
- Stud terminals for main power
- Galvanic isolation to power lines
- Dual parameter sets for fast and slow motor winding protection

Specifications

MIL-DTL-2212, including

- MIL-STD-461, Surface / Submarine
- MIL-S-901, Grade A
- MIL-STD-167-1, 33 Hz
- MIL-STD-1399, Section 300A

Environmental Performance

Operating temperature	-20 to 65° C
Operating humidity	95% Non-condensing
Storage temperature	-40 to 85° C

Functional Ratings

(Ratings are nominal unless stated)

Power Characteristics

Supply voltage	440 VAC
Optional	115 VAC
Supply frequency	60 Hz
Supply isolation (1 minute)	2500 VAC
Current sensing	0.5 to 30 Arms
Optional	1.2 to 150 Arms

Control Characteristics

I/O power supply voltage	24 VDC
I/O power supply capacity	20 W
Input on state voltage	17 to 36 VDC
Input on state burden	17 mADC
Input isolation to chassis	500 VDC
Output voltage	36 VDC maximum
Output load current	100 mA maximum
Output leakage current	0.1 mA
Voltage drop	0.15 VDC Max
Output isolation to chassis	500 VDC

Physical Characteristics

Four corner mounting holes	0.3 inch (0.8 cm) thick base
Weight	7.7 lbs. (3498 g)

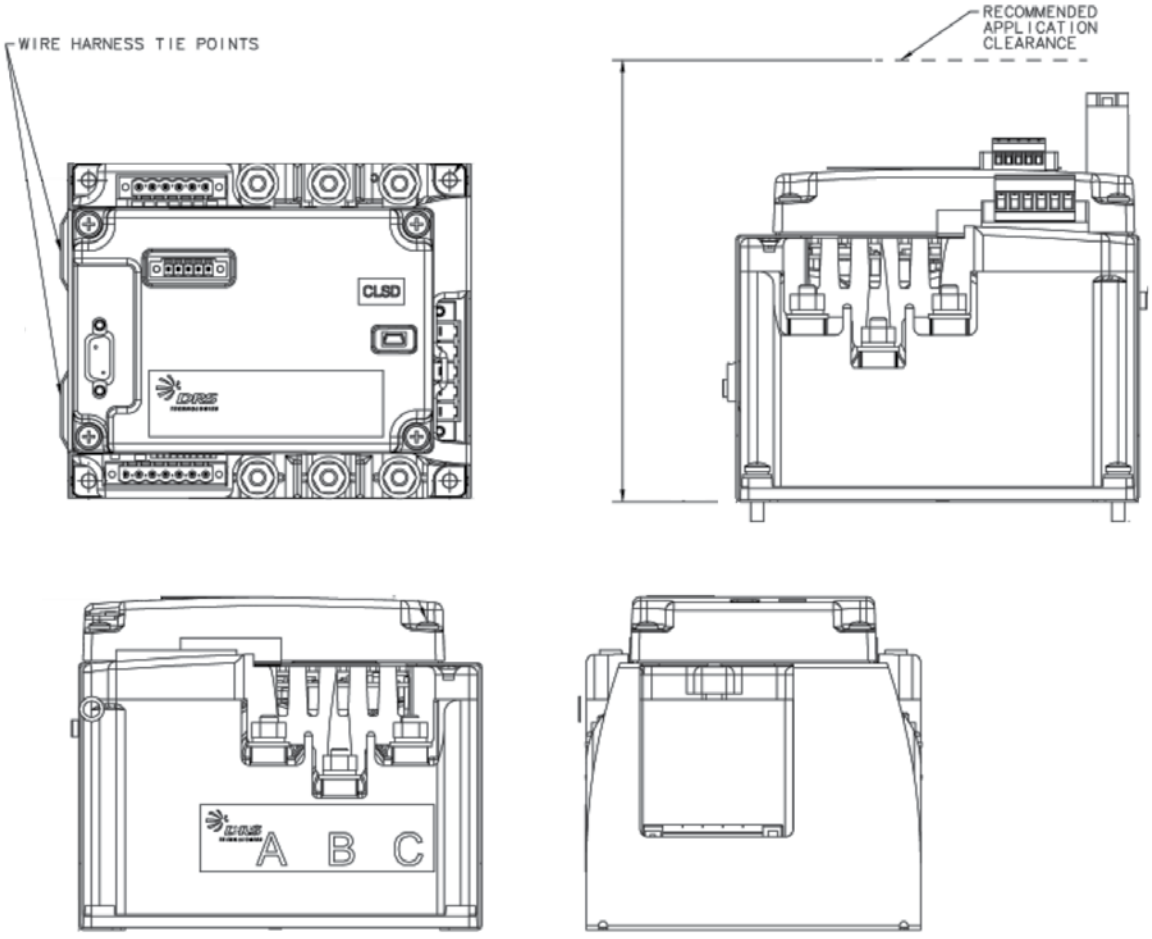
Related Documentation

NEMO operation manual	MC-007067/01
NEMO engineering configuration tool manual	MC-002410/23
Switch module application manual	MC-007055

Navy Electronic Motor Operator (NEMO)

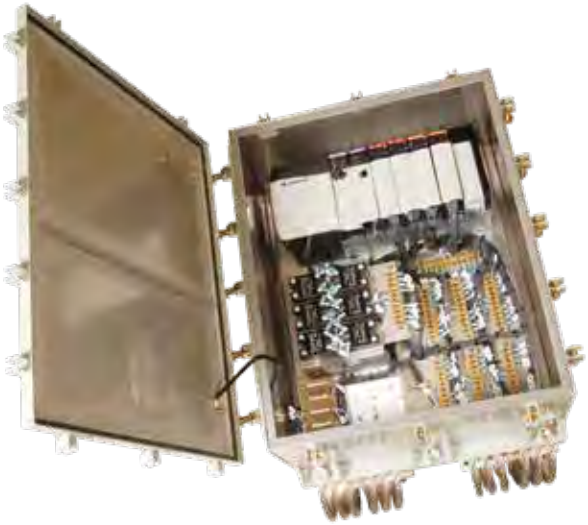
Navy Electronic Motor Operator Models

Application	Current	Sensing	Control Voltage	Assembly
Overload	0.5-30	Internal	440	MC-009557-01
		External	440	MC-009557-07
			115	MC-009557-05
	1.2-150	Internal	440	MC-009557-04
		External	440	MC-009557-08
			115	MC-009557-06
HVAC control	0.5-30	Internal	440	MC-009557-02
HVAC monitoring				MC-009557-03
Bus transfer switch	0.5-30	External	115	MC-009557-09
Automatic bus transfer				MC-009557-10



Type ENG-DAU-1
Data Acquisition Unit

Engineered Systems
Small Remote Terminal Unit – Single Chassis



When ordering specify
- Power requirements
- I/O type
- Fieldbus type
- Network and fieldbus media type
- Redundancy requirements
- Ethernet requirements
- Number and type of analog I/O
- Number and type of digital I/O
- Number and type of specialty I/O
- Number and type of communication I/O
- Visual display/Human Machine Interface requirements
- Required environmental qualifications
- Required IMO certifications

General
A small, application flexible, MIL-SPEC grade I/O enclosure for engineered naval and marine machinery control applications. Supports both Rockwell Automation and Siemens Hardware.

Specifications

Parameter	Description
Enclosure Dimensions	Enclosure: H 22.82" x W 17.5" X D 10.6"
	Mountings: H 28.39" x W 20.0" X D 15.94"
	Door Open: H 28.39" x W 21.7" X D 32.42"
Enclosure Weight	Unpopulated
	Populated
Enclosure Type	Drip-proof type
Power Supply	120V/220V AC
	24V DC

Parameter	Description	
Max # of I/O Cards Capacity	(2) x 10 Slot Chassis	
Type and Capacity I/O	Typical I/O Is a combo of those below:	
	Max Discrete AC Input – 192	
	Max Discrete AC Output – 96	
	Max Discrete DC Input – 192	
	Max Discrete DC Output – 192	
	Max Analog Input – 48	
	Max RTD/Thermo Input - 36	
	Max Analog Output - 48	
Vendor I/O Supported	Rockwell Automation	1756
		1756 XT
		1794
		1794 XT
		1734
	Siemens	S7-300
		ET200M
Field Bus	Rockwell Automation:	ControlNet
		DeviceNet
		Ethernet/IP
		ProfiBus
		Modbus
		Modbus/TCP
	Siemens	Profibus
		CanBus
		ProfiNet
		Modbus
		Modbus/TCP
	Redundancy	Optional
	Media	Optional
Ethernet	Protocols	TCP/IP, UDP
	# of Ports	Optional
	Redundancy	Optional
	Media	Optional
MIL-SPEC	*MIL-STD 901D	
	*MIL-STD 167-1	
	*MIL-STD 461	
	*MIL-STD 1399	
	*MIL-STD 810	
Temperature	0-60°C Operating	
	-20-70°C Operating with Extreme Temperature I/O Modules	
Humidity	5-95% Noncondensing	

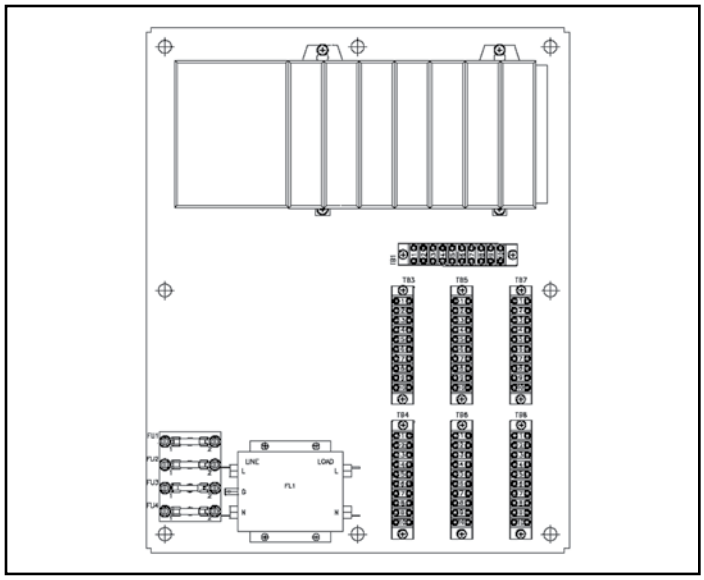
* Designed to specifications

Type ENG-DAU-1
Data Acquisition Unit

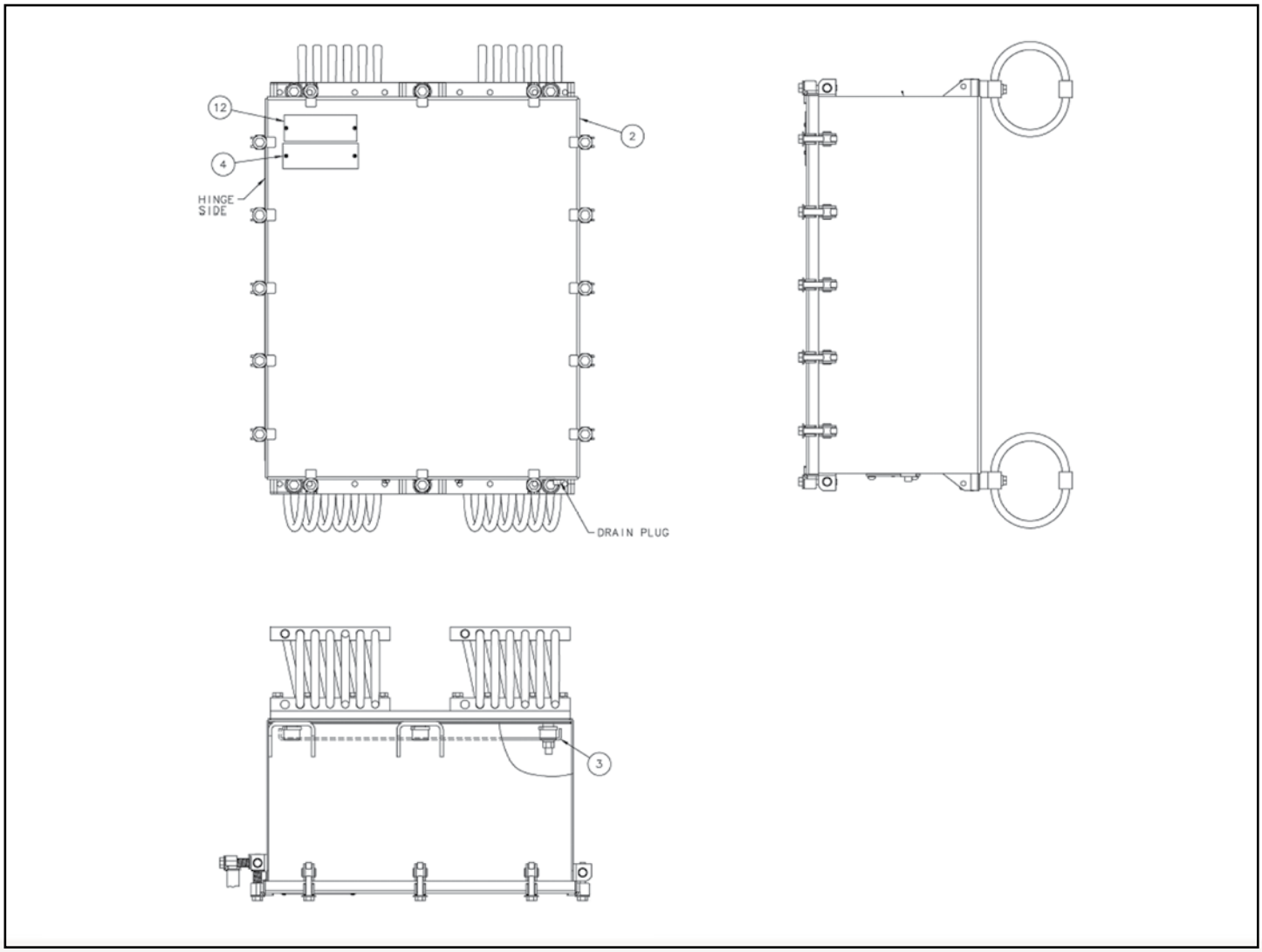
Features

- Power supply
- Optional processor
- Fieldbus communications
- (1) I/O chassis
- Industry standard I/O modules
- Internal terminal blocks for field wiring
- External power connection with fusing and filtering
- Optional signal conditioning
- Optional local ethernet switch with downlink and local ports
- Optional field bus and ethernet redundancy
- Optional fiber optic field bus
- Optional in chassis industrial PC
- Optional panel mounted LCD display
- Optional OpenSea™ control software

Typical Writing Diagram



Dimensional Diagram



Type ENG-DAU-2
Data Acquisition Unit

Engineered Systems
Large Remote Terminal Unit – Three Chassis

When ordering specify
- Power requirements
- I/O Type
- Field bus type
- Media
- Redundancy requirements
- Ethernet requirements
- Number and type of analog I/O
- Number and type of digital I/O
- Number and type of specialty I/O
- Number and type of communication I/O
- Required environmental qualifications
- Required IMO certifications

General
A large, application flexible, MIL-SPEC grade I/O enclosure for engineered naval and marine machinery control applications. Supports both Rockwell Automation and Siemens Hardware.

Specifications

Parameter	Description
Enclosure Dimensions	Enclosure: H 48.0" x W 27.0" X D 12.24"
	Mountings: H 48.0 x W 27.0" x D 17.99
	Door Open: H 48.0" x W 53.0" X D 17.99"
Enclosure Weight	Unpopulated
	Populated
Enclosure Type	Drip-proof type
Power Supply	120V/220V AC
	24V DC

Parameter	Description	
Max # of I/O Cards Capacity	(3) x 10 Slot Chassis	
Type and Capacity I/O	Typical I/O Is a combo of those below:	
	Max Discrete AC Input – 864	
	Max Discrete AC Output – 432	
	Max Discrete DC Input – 864	
	Max Discrete DC Output – 864	
	Max Analog Input – 432	
	Max RTD/Thermo Input - 162	
	Max Analog Output - 216	
Vendor I/O Supported	Rockwell Automation	1756
		1756 XT
		1794
		1794 XT
		1734
	Siemens	S7-300
		ET200M
Field Bus	Rockwell Automation:	ControlNet
		DeviceNet
		Ethernet/IP
		ProfiBus
		Modbus
		Modbus/TCP
	Siemens	Profibus
		CanBus
		ProfiNet
		Modbus
		Modbus/TCP
	Redundancy	Optional
	Media	Optional
Ethernet	Protocols	TCP/IP, UDP
	# of Ports	Optional
	Redundancy	Optional
	Media	Optional
MIL-SPEC	*MIL-STD 901D	
	*MIL-STD 167-1	
	*MIL-STD 461	
	*MIL-STD 1399	
	*MIL-STD 810	
Temperature	0-60°C Operating	
	-20-70°C Operating with Extreme Temperature I/O Modules	
Humidity	5-95% Noncondensing	

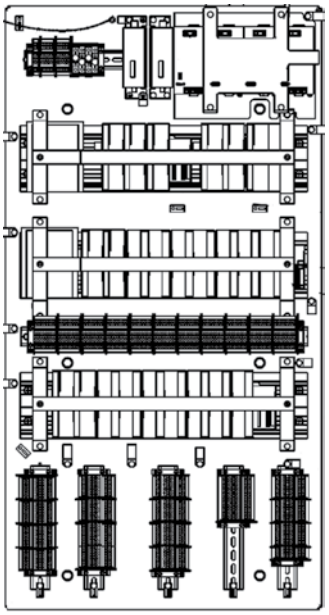
* Designed to specifications

Type ENG-DAU-2
Data Acquisition Unit

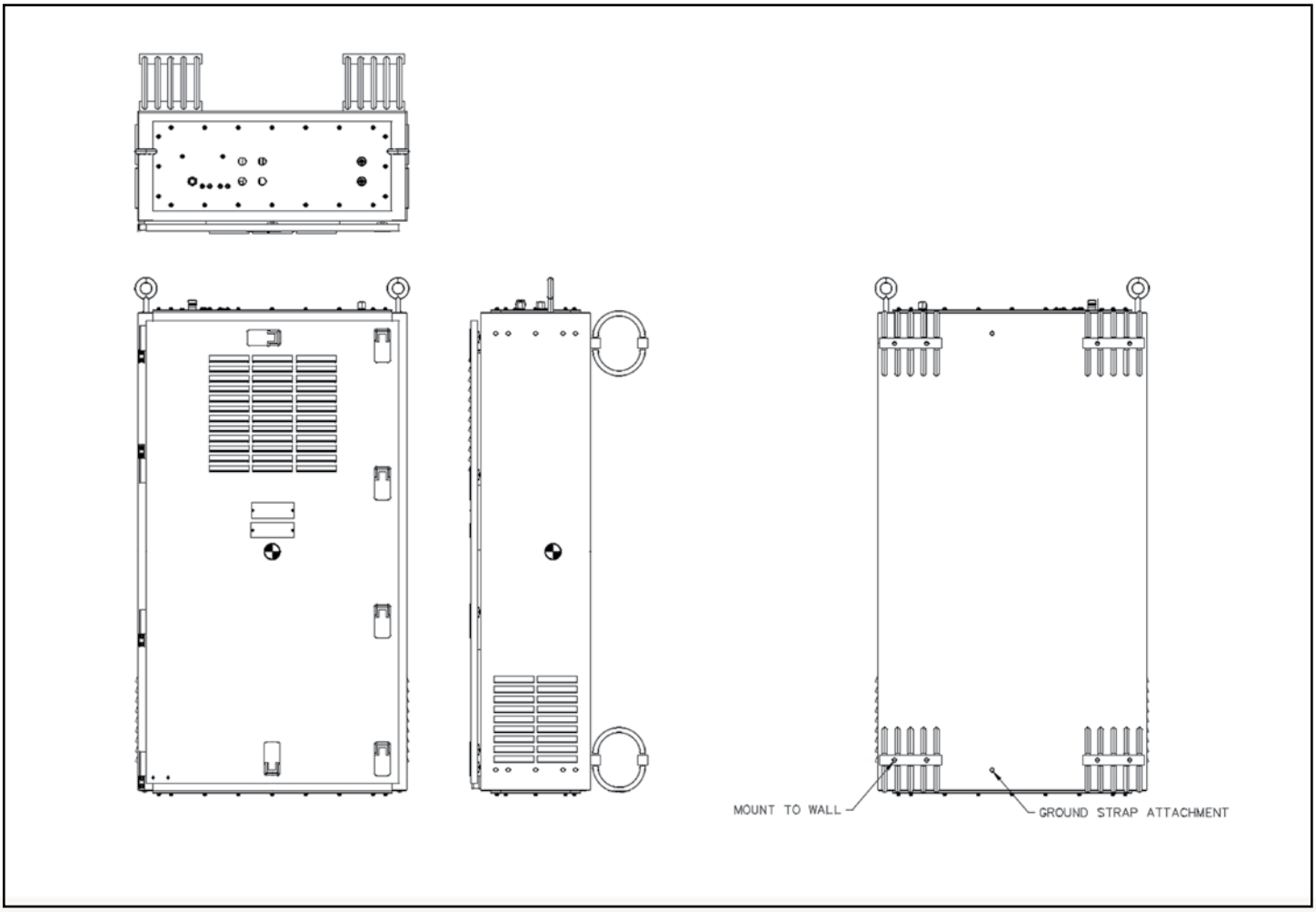
Features

- Power supply
- Optional processor
- Fieldbus communications
- (3) I/O chassis's
- Industry standard I/O modules
- Internal terminal blocks for field wiring
- External power connection with fusing and filtering
- Optional signal conditioning
- Optional local ethernet switch with downlink and local ports
- Optional field bus and ethernet redundancy
- Optional fiber optic field bus
- Optional in chassis industrial PC
- Optional panel mounted LCD display
- Optional OpenSea™ control software

Typical Writing Diagram



Dimensional Diagram



DRS 15kV VCB
Vacuum Circuit Breaker (VCB)

The Leonardo DRS 15kV VCB is a 1600 A medium voltage Vacuum Circuit Breaker (VCB). This circuit breaker is based on a COTS breaker that is militarized by DRS providing a small, lightweight, and cost effective solution. Utilized on the latest U.S. Navy ships for power distribution, the military hardened VCB is designed to withstand rugged maritime conditions for the life of the ship.

This is the Navy's first and only Vacuum Interrupter-Based Circuit Breaker qualified for military use. The Vacuum Interrupter design significantly reduces breaker size and weight as arc chutes are not needed. Maintenance is reduced since no contact adjustments are required, only a periodic check of the integral wear indicator is needed. The VCB is drawout (removable) for ease of inspection and replacement.

From power distribution and electrical control products to ship control automation, Leonardo DRS offers advanced product development, world-class manufacturing and global engineering services and support. That is why our products are found on all U. S. Navy ships since WWII.

Highlights

- Maintenance free vacuum interrupter
- Trip free operation
- Interlocks for proper and safe operation
- Built-in contact erosion indicator
- Operations counter
- Mechanical position indicator
- Closing springs charged indicator
- Mechanical and electric close capability
- Mechanical and electric open capability

Military Specifications

MIL-S-901, Grade A
MIL-STD-167-1, 4-21 Hz
MIL-STD-461
MIL-STD-1399-300A

Physical Characteristics

Circuit breaker:

Width	27.6 inches (70.1 cm)
Height	32.2 inches (81.8 cm)
Depth	25.1 inches (63.8 cm)
Weight	430 lbs. (195.0 kg)

Environmental Performance

Operating temperature	-30 to +65° C
Operating humidity	95% Non-condensing

Functional Ratings

(Ratings are nominal unless stated)

Power characteristics

Max. continuous current	1600A
Max. voltage and frequency	15,000VAC, 60Hz
Max. short circuit interrupting current	40,000A symmetrical
Short circuit duration	3 seconds
Max. short circuit making current	103,000A peak
Max. trip time	3 cycles
Max. close time	5 cycles
Mechanical endurance	10,000 cycles
Number of poles	3

Voltage characteristics

Dielectric withstand	36,000 V for 1 second
Basic Impulse Level (BIL)	95,000V
Corona extinction voltage level	17,500V

Attachments

Electrical closing device	Standard
Shunt trip device	Standard
Charging motor protection	Standard
Grounding contacts	Standard
Auxiliary switches – quantity	15
Auxiliary switches – ratings	120VAC, 15A / 125VDC, 10A
Secondary disconnect pins	50

DRS LV - PEMS
Low Voltage Power Electronic Modules

Drive PEM

Power Converter PEM

The Leonardo DRS LV - PEMS is a complete series of Low Voltage Power Electronic Modules. This next generation of power conversion equipment is based on DRS' experience in 3 level power converters for Drive, DC/AC Inverter and DC/DC converter applications. This next generation of PEMS offers a significant increase in power density and decrease in cost over the previous generation.

Potential applications include VFD's, soft starters, frequency converters, point of use power conversion (AC/DC, DC/AC, DC/DC, AC/AC), propulsion drives or power conversion based power systems.

From power distribution and electrical control products to ship control automation, Leonardo DRS offers advanced product development, world-class manufacturing and global engineering services and support.

Highlights

- High efficiency
- Fault tolerance
- Excellent power quality
- High power density
- Modular (drawer mounted)
- Scalable systems (multiple units in parallel)
- Liquid cooled
- 4th generation IGBT's
- Low voltage distortion for direct connect drive applications
- Communication interfaces include fiber optic, ethernet, and CAN
- All applications are capable of bidirectional power flow

Military Specifications

MIL-S-901, Grade A (mitigated enclosure)
MIL-STD-167-1
MIL-STD-461
MIL-STD-1399

Physical Characteristics

Drive only:

Width	16.5 inches (70.1 cm)
Height	14.6 inches (81.8 cm)
Depth	32 inches (63.8 cm)
Weight	300 lbs. (195.0 kg)

Power converter (with output filtering):

Width	16.5 inches (70.1 cm)
Height	29.6 inches (81.8 cm)
Depth	32 inches (63.8 cm)
Weight	800 lbs. (195.0 kg)

Environmental Performance

Operating air temperature	-40 to +70° C
Operating humidity	95% non-condensing
Operating water temperature	1 to +43° C

Functional Ratings

(Ratings are nominal unless stated)
Power characteristics

Max. continuous current	750A/phase (drive), 600A/phase (inverter), 900A (converter)
Max. output voltage and frequency	690 VAC 60hz (400hz option), 1200VDC
Number of output poles	4 (drive), 3 (inverter), 2 (converter)

Voltage characteristics

dielectric withstand	5,000 VDC for 60 second

ACB-2020
Low Voltage Air Circuit Breaker

Navy Type ACB-2020 is an 800-2000A low voltage Air Circuit Breaker utilizing the latest technology electronic trip unit. This circuit breaker is based on a COTS breaker that is militarized by Leonardo DRS providing a small, lightweight, and cost effective solution. Utilized on the latest U.S. Navy ships for power distribution, the MIL-SPEC qualified air circuit breaker is designed to withstand rugged maritime conditions for the life of the ship.

Whether for new shipbuilding or modernization programs the ACB-2020 is ideal for integrated control, condition based maintenance, power monitoring, and interfacing with ship network communications. The built-in electronic trip unit can be remotely accessed for diagnostics, breaker status, ampere, voltage and power monitoring.

Controls and indicators are functionally grouped on the breaker faceplate to optimize the human interface, visibility, and ease of use. For maximum safety, a modern, through-the-door design permits access to the breaker levering system, trip unit, controls and indicators with the door closed.

Highlights

- Electronic trip unit with long, short, and instantaneous trip curve settings
- 24 character LED display for status
- System diagnostics:
  - Cause of trip
  - Trip log
  - Waveform capture
  - Breaker health monitor
  - Remote signal contacts
  - Programmable contacts
  - Electronic operations counter

Military Specifications

MIL-C-17587
MIL-S-901, Grade A
MIL-STD-167-1, 4-50 Hz

Physical Characteristics

Circuit breaker:
- Width ..... 16.5 inches (41.9 cm)
- Height ..... 18.2 inches (46.2 cm)
- Depth ..... 16.8 inches (42.7 cm)
- Weight ..... 200 lbs. (90.7 kg)

Cassette:
- Width ..... 18.3 inches (46.5 cm)
- Height ..... 20.8 inches (52.8 cm)
- Depth ..... 17.7 inches (45.0 cm)
- Weight ..... 120 lbs. (54.4 kg)

Environmental Performance

Operating temperature ..... -20 to +70° C
Operating humidity ..... 95% non-condensing

Functional Ratings

(Ratings are nominal unless stated)

Power characteristics
- Max. continuous current 2000A
- Max. voltage and frequency 500VAC, 60Hz
- Max. interrupting rating ..... 85,000 A symmetrical
- Rated short time current 85,000A
- Rated short time current duration ..... 0.5 Sec
- Number of poles 3

Attachments
- Electrical closing mechanism ..... Standard
- Shunt trip device ..... Standard
- Remote close function ..... Optional
- Vertical bus stab adapters ..... Optional
- Auxiliary switches – quantity 8
- Auxiliary switches – ratings .. 120VAC, 15A / 480VAC, 5A
- Mechanical lockout device ..... Standard
- Mechanical position indicator ..... Standard
- Secondary disconnect ..... 8 @ 15A and 4 @ 10A
- Cell switch 120VAC, 15A

Protective features
(Can be set as a trip or alarm)
- Time over current
- Ground fault
- Over voltage
- Over frequency
- Reverse power
- Zonal interlocking
- Under voltage
- Under frequency
- Voltage unbalance
- Phase rotation

DRS-4040
Low Voltage Air Circuit Breaker

The Leonardo DRS 4040 is a 2400-4000A low voltage Air Circuit Breaker utilizing the latest technology electronic trip unit. This circuit breaker is based on a COTS breaker that is militarized by DRS providing a small, lightweight, and cost effective solution. Utilized on the latest U.S. Navy ships for power distribution, the military hardened air circuit breaker is designed to withstand rugged maritime conditions for the life of the ship.

Whether for new shipbuilding or modernization programs the 4040 is ideal for integrated control, condition based maintenance, power monitoring, and interfacing with ship network communications. The built-in electronic trip unit can be remotely accessed for diagnostics, breaker status, ampere, voltage and power monitoring.

Controls and indicators are functionally grouped on the breaker faceplate to optimize the human interface, visibility, and ease of use. For maximum safety, a modern, through-the-door design permits access to the breaker levering system, trip unit, controls and indicators with the door closed.

Highlights

- Electronic trip unit with long, short, and instantaneous trip curve settings
- 24 character LED display for status
- System diagnostics:
  - Cause of trip
  - Trip log
  - Waveform capture
  - Breaker health monitor
  - Remote signal contacts
  - Programmable contacts
  - Electronic operations counter
- Remote communications (Modbus, Profibus, Incom, PowerNet, TripLink)
- Metering: Amps, Volts, Hz, kW, kVA, kVAr, THD, IHD, Power Factor, Crest Factor
- Pad-lockable levering device shutter
- Optional remote close module
- Optional remote communications module

Military Specifications

Designed to MIL-C-17587
MIL-S-901, Grade A

Physical Characteristics

Circuit breaker:

Width	35.3 inches (89.7 cm)
Height	18.2 inches (46.2 cm)
Depth	16.8 inches (42.7 cm)
Weight	365 lbs. (165.6 kg)

Cassette:

Width	37.0 inches (94.0 cm)
Height	20.8 inches (52.8 cm)
Depth	17.7 inches (45.0 cm)
Weight	120 lbs. (54.4 kg)

Environmental Performance

Operating temperature	-20 to +70° C
Operating humidity	95% non-condensing

Functional Ratings

(Ratings are nominal unless stated)

Power characteristics

Max. continuous current	4000A
Max. voltage and frequency	500VAC, 60Hz
Max. interrupting rating	85,000 A symmetrical
Rated short time current	85,000A
Rated short time current duration	0.5 Sec
Number of poles	6

Attachments

Electrical closing mechanism	Standard
Shunt trip device	Standard
Remote close function	Optional
Vertical bus stab adapters	Optional
Auxiliary switches – quantity	8
Auxiliary switches – ratings	120VAC, 15A / 480VAC, 5A
Mechanical lockout device	Standard
Mechanical position indicator	Standard
Secondary disconnect	8 @ 15A and 4 @ 10A
Cell switch	120VAC, 15A

Protective Features

(Can be set as a trip or alarm)

- Time over current
- Ground fault
- Over voltage
- Over frequency
- Reverse power
- Zonal interlocking
- Under voltage
- Under frequency
- Voltage unbalance
- Phase rotation

Variable Speed/Frequency Drives

Leonardo DRS is a leader in providing Variable Frequency Drives to military or marine grade specifications. Our rugged Variable Speed Drives can be found wherever speed/frequency is a key operating parameter. We provide a wide range of drive offerings to our customers by leveraging our strong engineering capabilities, full understanding of applicable MIL-SPEC's or Commercial requirements gained from a history of successfully deployed products.

From power distribution and electrical control products to ship control automation, Leonardo DRS offers advanced product development, world-class manufacturing and global engineering services and support. That is why our products are found on all U. S. Navy ships since WWII.

15HP Variable Frequency Drive (VFD)

The 15HP VFD utilizes a Commercial-Off-The-Shelf (COTS) solution that provides low cost, induction motor control. This 15HP drive takes advantage of DRS designed filter components to meet strict EMI requirements for conducted and radiated emissions. Using a unique COTS drive allows for future and back-fit applications where the existing motor is not inverter grade. This VFD is best suited for pump and fan applications where variable speed control and high efficiency power electronics can save energy. Network capabilities allow flexibility of control from automated systems to local manual user control.

Highlights

- Variable speed control of induction motors
- 440VAC, 3 phase input
- 460VAC, 3 phase output
- Motor protection
- Meets:
    - MIL-STD-461
    - MIL-STD-1399, 300
    - MIL-STD-901
    - MIL-STD-167
- 15HP @ 50°C
- Bulkhead mount design
- Ethernet and profibus network capability
- Digital and analog I/O for local and remote user stations
- Fan cooled
- Drip proof

250HP Variable Frequency Drive

The 250HP VFD utilizes a Commercial-Off-The-Shelf (COTS) solution that provides low cost, induction motor control. This 250HP drive takes advantage of DRS designed filter components to meet strict EMI requirements for conducted and radiated emissions. Using a unique COTS drive allows for future and back-fit applications where the existing motor is not inverter grade. This VFD is best suited for pump and fan applications where variable speed control and high efficiency power electronics can save energy. Network capabilities allow flexibility of control from automated systems to local manual user control.

Highlights

- Variable speed control of induction motors
- 650VDC input
- 460VAC, 3 phase output
- Motor protection
- Meets:
    - MIL-STD-461
    - MIL-STD-1399, 300
    - MIL-STD-901
    - MIL-STD-167
- 250HP @ 50°C
- Floor & bulkhead mount design
- Ethernet and profibus network capability
- Digital and analog I/O for local and remote user stations
- Fan cooled
- Drip proof

High Frequency Drive

The High Frequency Drive (HFD) utilizes Leonardo DRS drive technology. The HFD utilizes an active, power factor corrected front end combined with a buck topology that yields the ability to control standard 460VAC motors as well as lower voltage machines. A high switching frequency reduces the size of filter components creating a highly power dense package. Plug-in option cards provide options for resolver, hall-effect or encoder position feedback as well as network cards and I/O expansion. The HFD is capable of driving induction and brushless DC (BLDC) permanent magnet motors increasing its capability for applications such as pumps, blowers, valve actuators and chillers.

Highlights

- Variable frequency control of induction and brushless DC (BLDC) permanent magnet motors
- 440VAC, 3 phase input
- 110VAC – 460VAC, 3 phase output
- Embedded web server for drive configuration and monitoring / diagnostics
- Motor protection
- Meets:
    - MIL-STD-461
    - MIL-STD-1399, 300
    - MIL-STD-901
    - MIL-STD-167
- 20HP @ 50°C, fan cooled
- 5HP @ 50°C, convection cooled
- Bulkhead, hard-mount design
- Networks: Ethernet, Profibus, CAN/DeviceNet, USB
- Digital and analog I/O for local and remote user stations
- Splash proof

Steering Gear Actuation System (SGAS)

The Steering Gear Actuation System (SGAS) drive has been designed using innovative power electronics and packaging techniques. Three drive sections along with an integral dynamic braking section are provided in the cabinet along with redundant control and monitoring of drive, motor and cabinet status and faults. The drive has been designed to control permanent magnet AC motors and has provision to accept resolver feedback but could be modified to interface with induction machines. It is well suited to provide high performance in position, velocity or torque control types of applications.

Highlights

- Control of three (3) individual PM AC motors
- 650 VDC input
- Maximum of 460 VAC, 3 phase variable voltage / frequency output
- 3 drive sections @ 50ºC
- Integral dynamic brake for regenerative applications
- Redundant drive control and system monitoring
- Chilled water cooled with condensation management system
- Rugged compact design
- Cabinet IP54 rated
- Redundant ethernet connectivity
- Meets:
    - MIL-STD-461
    - MIL-STD-1399, 300
    - MIL-STD-901
    - MIL-STD-167

These are just some examples of our drive offerings. To discuss your particular drive applications please contact our factory directly.

Low Voltage Switchgear

Leonardo DRS is a leader in providing Low Voltage Switchboards and load centers to military or marine grade specifications. Utilized on the latest U.S. Navy ships for power distribution, the military hardened switchgear is designed to withstand rugged maritime conditions for the life of the ship.

Leonardo DRS has supplied switchgear with an unprecedented level of automation for ship applications. This includes generator controls, synchronization, load shedding, and protective features. The switchgear can also provide custom HMI screens for power monitoring, control, diagnostics, condition based maintenance, and interfacing with ship network communications.

From power distribution and electrical control products to ship control automation, Leonardo DRS offers advanced product development, world-class manufacturing and global engineering services and support. That is why our products are found on all U. S. Navy ships since WWII.

Highlights

- Drip proof or spray tight enclosures
- Wide range of standard distribution units
- AC or DC switchgear
- Arc fault detection
- Optional insulated bus bars
- Remote monitoring and control to SCADA
- Modbus/Profibus communications

Military Specifications

ABS NVR
MIL-S-901, Grade A
MIL-STD-167-1
MIL-STD-461
MIL-STD-1399 Section 300

Commercial Marine Specifications

ABS SVR
IEEE 45

Integrated Generator Controls

- Start and automatically parallel generators to the bus
- Automatically parallel to and from shore power
- Automatically recover from a dark ship condition
- Automatically start or stop generators based on load demands via the power management system
- Automatically perform load sharing among generators (KW and VAR) in a split or monolithic bus
- Provide digital under voltage and over current protection
- Two stage load shed capability

Medium Voltage Switchgear

Leonardo DRS is a leader in providing Medium Voltage Switchgear to military requirements. Leonardo DRS can provide switchgear up to 15kV, in a compact and rugged enclosure that is a 40% reduction in volume over typical commercial switchgear. Utilized on the latest U.S. Navy ships for power distribution, the military hardened switchgear is designed to withstand rugged maritime conditions for the life of the ship.

The switchboards provide custom HMI screens for power monitoring, control, diagnostics, condition based maintenance, and interfacing with ship network communications. Built-in safety features are provided to keep the operator out of harms way while operating the circuit breakers.

Highlights

- Metal clad construction for operator safety
- Meets 95kV BIL rating
- Two-high breaker arrangement is standard
- Vacuum circuit breakers provide low maintenance, long life
- Fluidized bed epoxy coated bus bar
- Silicone (non-PVC) insulating boots
- Remote communications (Modbus, Profibus)
- HMI for metering, control, and diagnostics
- Circuit breaker condition-based monitoring

Military Specifications

MIL-S-901, Grade A
MIL-STD-167-1
MIL-STD-461
MIL-STD-1399 Section 300

Protective Relaying Features

(Can be set as a trip or alarm)

- Current differential
- Time over current
- Zonal interlocking
- Ground fault
- Under voltage
- Over voltage
- Under frequency
- Over frequency
- Voltage unbalance
- Reverse power
- Phase rotation
- Loss of field
- Negative phase sequence
- Volts per Hertz

Supplemental Devices

- Compact foldable lifting cart
- Manual ground and test device
- VCB electrical test box

MOTOR CONTROL & OPERATOR INTERFACE SPECIFICATION AND DOCUMENTS

Our customer's mantra is our mantra - Pride, Purpose, Performance.

Pride - Leonardo DRS has a rich history of providing robust equipment to the U.S. Navy and its international allies. In recent history, Leonardo DRS has become the largest hull, mechanical, and electrical provider for the CVN 78 Class Aircraft Carrier, the DDG 1000 Destroyer, and the Lockheed Martin Freedom Class of Littoral Combat Ships.

Purpose - Our heritage of products reaches back to 1904, when it delivered its first motor controller products. This heritage continues today into the U.S. Navy's new platforms including key positions on the DDG 51 restart efforts (motor controllers, hybrid-electric drives, next generation power distribution and conversion programs) support of the Columbia Class Program, the Lockheed Martin Littoral Combat Ship, and the LHA 7 Amphibious Assault Ship design.

Performance - Leonardo DRS has demonstrated that it has the design capabilities and bench depth to meet the demanding needs of today's Navy. Our extensive field service support and shipyard interaction has provided a unique perspective on product design. Our newest motor controller designs include a next generation overload and a revolutionary lightweight enclosure. The designers of this enclosure dismissed conventional thought on motor controller design while incorporating customer needs for installation. The result is a new cabinet with open corners and an integral back panel that significantly reduces in-house production costs and shipyard/shipboard installation time and materials.

Pride, Purpose, Performance at Leonardo DRS we live it everyday.

Controlling Standards/Specifications

MIL-DTL-2212 is the controlling specification for motor control equipment used on Naval vessels. It invokes 24 other Military Specifications and Standards. Some of these are:

MIL-E-917	Electric Power Equipment, Basic Requirements
MIL-S-901	Shock Tests, High Impact; Shipboard Machinery, Equipment and Systems, Requirements for
MIL-STD-167-1	Mechanical Vibrations of Shipboard Equipment (I – Environmental and II – Internally Excited)
DOD-STD-1399	Interface Standard for Shipboard Systems Section 300– Electric Power, Alternating Current

Protective Enclosures

The controlling specifications for Navy motor control equipment require dripproof enclosures as a general minimum. Other types of enclosures may be required depending on the application. These include splashproof, submersible and explosion proof.

The Navy definitions of these enclosure types are shown below.

Dripproof

An enclosure constructed so that enclosed equipment operates satisfactorily in the presences of falling drops of liquid or solid particles. This protection must be provided for up to 45° of inclination from the vertical.

Explosion Proof

Enclosed equipment operates safely in the presence of any concentration of a specified gas or vapor. The enclosure must be constructed to withstand the explosion of the gas or vapor within it and show no distortion or significant damage as a result. It shall contain the explosion and other sparks and flashes so that the gas or vapor surrounding the enclosure is not ignited. Class I, Group D, MIL-E-2036.

Splashproof

An enclosure constructed so that equipment within it operates satisfactorily in the presence of a coarse spray of liquid or solid particles. The spray is to be directed at all exposed surfaces and the surface to which the controller is mounted. The test duration is five minutes at a water flow rate of 15 gallons per minute.

Submersible

An enclosure constructed so that equipment within operates satisfactorily when submerged in water up to a specified depth. Water leakage is not permitted. The most common test is 15 feet for 24 hours.

Watertight

An enclosure constructed to prevent entry of water from a solid stream striking it on any surface and at any angle. The test required a solid stream of water from a one inch nozzle, sprayed from a 10 foot distance, with a flow rate of 65 gallons per minute. The test duration is 60 minutes. An alternative test method is submersion in water so the enclosure is covered, the test duration is five minutes. Entry of water during the test shall be cause for rejection.

The Navy definition of dripproof and splashproof permit the entry of some liquid or solid particulate into the enclosure cavity. The entering contaminant, however, may not affect the operation of the equipment within the enclosure.

A comparison of similar Navy and NEMA enclosure grades follows:

Navy Classification	NEMA Type	Navy Requirement	NEMA Requirement
Dripproof	12	Protection to 45 ° inclination	No inclination requirement
Watertight	4	60 minute hose test at 65 gallons per minute	5 minute hose test at 65 gallons per minute
Submersible	6	Minimum -15 ft of submersion for 24 hours	6 ft of submersion for 30 minutes

Corrosion protection is an obvious necessity for motor control equipment in a seagoing environment. Leonardo DRS provides corrosion protection for its Navy motor control equipment through the use of corrosion-resistant materials and high quality finishes. All enclosures are designed and tested to pass a standard 200 hour salt spray test.

Features

Leonardo DRS AC controllers, components and pilot devices are designed and built to meet the requirements of MIL-DTL-2212.

Additional features include:

- **Temperature Rating** – 50°C as required by MIL-DTL-2212.
- **Compensation** – Overload relays are insensitive to variations in Ambient temperature.
- **Diagram** – Heat resistant, durable copy of controller diagram is attached to inside of controller.
- **Voltage** – 440V and 115V; other voltages available upon request.
- **High Shock** – MIL-S-901, Grade A, Class 1, Type A requirements.
- **Vibration** – MIL-STD-167-1 to 33 Hz as standard
- **Operational** – Equipment will operate at inclinations up to 45° from the normal mounting orientation.

Documentation and Other Information

Equipment documentation is an important consideration for motor control equipment to be used at sea. Leonardo DRS provides extensive documentation configured to support the end-user.

For example, standard plans provide the physical and electrical information necessary to install and maintain a controller. Certification Data Sheets provide important reference information for identifying the application, manufacturer, applicable drawing numbers, and quantities involved. Tech manuals support repair and maintenance activities by providing disassembly and adjustment information, repair parts data and electrical diagrams useful for troubleshooting.

The documentation that are available from Leonardo DRS to support Navy Motor control equipment is described in the following sections:

Testing

The prices for motor controllers and accessories include the standard inspections and routine tests required by MIL-DTL-2212. They do not include First Article Testing or factory provided installation supervision.

AC Controllers, components and pilot devices are designed and built to meet the requirements of MIL-DTL-2212. IAW with MIL-DTL-2212 a representative sample of controllers, components and pilot devices are periodically subjected to Conformance Testing. The tested and related types of controller, component and pilot devices are placed on QPL-2212 for general use in Naval applications.

DC Controllers and components were last qualified to meet the QPL requirements of MIL-C-2212F. Representative samples of these devices are subjected to periodic non-witnessed Conformance Testing IAW MIL-C-2212F which precludes inclusion on the current QPL-2212 listing.

Leonardo DRS does not imply a full suite of QPL testing is completed for every variation of controller, component and pilot device manufactured. If additional individual qualification testing is required, Leonardo DRS will provide a separate quote for those specifically requested tests. If qualification testing is required, Leonardo DRS must be notified prior to the placement of a Purchase Order.

In addition, pricing for any special inspections, or installation support can be provided upon request.

Drawings

Drawings and certification data are normally provided for approval purposes or when required by a purchase specification.

The information included in these documents follow.

Standard Plan

The Standard Navy Plan provided for Leonardo DRS Navy motor control equipment conforms to the requirements of MIL-DTL-2212. Included are the following (minimum):

1. Manufacturer's name and Cat. I.D. of apparatus.
2. Applicable specifications.
3. Weight of controller.
4. Outline drawing and dimensions of enclosure, location of mounting holes, center of gravity.
5. Description of operation, adjustments.
6. List of repair parts.
7. Connection and schematic diagrams.
8. List of material, overload heater table.
9. Descriptive data of controller, i.e. enclosure, rating, operation, type, etc.
10. Descriptive and electrical design data of coils, resistors, transformers, etc.
11. Approval status.

Certification Data (CD Sheets)

Certification Data Sheets provided conform to the requirements of DOD-STD-100C. The standard form is an 8-1/2" x 11". Information provided is as follows:

1. Navy Contract No. of Shipbuilder's Order No.
2. Manufacturer's Number
3. Subcontractor's Order Number
4. Applications:
   a. Auxiliary
   b. No. of controls per vessel
   c. Motor hp rating
   d. Full load amps.
   e. Volts
   f. Heater Coil Cat. No.
5. Number of controllers involved
6. Number of controllers per vessel
7. Number of sets of repair parts per vessel contract
8. Number of vessels involved
9. Vessel of hull numbers
10. Drawing numbers of associated equipment

Copies of Standard Plans and CD Sheets

The plan price includes one full size reproducible (vellum) plus additional paper copies when ordered with the control. Other requirements are priced by request and in accordance with the following table.

Paper, Vellum or Electronic Reproduction of controller and accessory plans, ordered separately.
Paper or Electronic Reproductions of Certification Data (CD) sheets.
Reduced size copies of standard plans – First 50 or fewer copies. Each additional 50 copies.
35 mm Aperture cards, in accordance with MIL-M-9868/1.

Packaging

Packaging and packing of Controllers and Components

A. Commercial (Level C).....No Charge
B. Military – Per any military standard of specification or "Packaging Requirement Code"
   1. Enclosed controllers and accessories: 5% or minimum of $188. Per order
   2. Open controllers, components or accessories: 12% or minimum of $188. per order

Packaging and Packing of Repair Parts

A. Commercial (bulk) – Package marking only – No Preservation..... No Charge
B. Military – Per any military standard or specification or "Packaging Requirement Code"..... 12% Minimum $188. per order

Bar Code Marking

$295 per order plus $20 per item and each additional destination.
FCA Destination 12%

Provisioning Technical Documentation

Provisioning Technical Documentation (PTDs) can recommend on-board and stock repair part levels. These recommendations are normally made on NAVSHIPS forms 4786 and 4786A in accordance with MIL-P-15137. Alternatively, Short Form Provisioning data (SFPPL) can be provided on NAVSEA forms 4423/3 and 4423/3A in accordance with MIL-STD-1552 and MIL STD 1561.

Price: Forms 4786 & 4786A – included if requested at time of order, if not $250 fee will apply.
Forms 4432/3 & 4423/3A - $550.

Repair Parts

Repair Parts are normally an optional and unpriced item on an initial contract or order. When such an option is exercised, the required parts are added to the contract or order based on the Government's selection of items and quantities from the standard Provisioning Technical Documentation (PTD) forms. Consult the factory for current pricing.

Non-magnetic Construction

Special situations require the use of motor control equipment that presents a low "magnetic profile." One example is a mine sweeper. Reducing the magnetic profile requires the use of non-ferrous (i.e. non-magnetic) materials where feasible. Additional steps may be necessary to counteract the impact of ferrous materials and magnetic structures that cannot be eliminated.

Navy qualified non-magnetic control will be provided when required. Contact the factory for price information.

Quality Assurance

The DRS Naval Power Systems Milwaukee facility (with the legal entity name of DRS Power & Control Technologies) is ISO 9000 certified and quality programs exceed the requirements of MIL-I-45208A - "Inspection System Requirements". Leonardo DRS motor controllers, components, and accessories are designed and manufactured in conformance with MIL-C-2212 and MIL-DTL-2212 and applicable subtier Military Specifications, as indicated in this catalog. Most DRS Naval Power Systems products are listed on the Qualified products list (QPL) of the specification indicated in this catalog.

The Quality Assurance documentation normally provided includes Government Source Inspections, Certificate of Compliance, Certificate of Identicality, and a copy of the final test report. Applicable pricing can be provided upon request.

Quiet Control (MIL-STD-740)

MIL-STD-740 defines acceptable levels for airborne and structure borne noise when "Quiet" operation is required. Airborne noise is undesired sound carried through the air. Structure borne noise is an undesired vibration carried through a solid medium such as the ship's hull.

Navy motor control equipment and components can be provided to meet the requirements of MIL-STD-740B. Special manufacturing methods, parts selection and verification test are necessary to guarantee compliance. Prices for quiet components, controls and noise testing are gladly provided upon request.

Technical Manuals

Standard Tech Manual Inserts conforming to MIL-DTL-2212 will be supplied when ordered. These provide ample information for the installation, maintenance and repair of our Navy qualified motor control equipment. Included are the following:

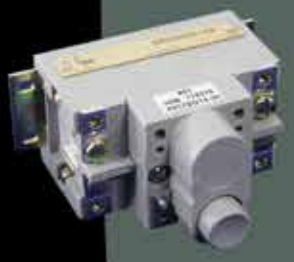
1. Title Page
2. Table of Contents
3. Copies of applicable CD Sheets
4. Reduced size copies of applicable Navy Plans
5. Applicable component Technical Publications

Preliminary copies will be supplied for approval. The final copies will consist of black and white reproducibles.

Standard Tech Manual Inserts	Price
First 5 copies or part thereof when ordered with control	No Charge
Each additional 50 copies	Provided by request

Complete Tech Manuals conforming to MIL-M-15071 or similar specifications can be provided if required. Please contact the factory.

MOTOR CONTROL AND OPERATOR INTERFACE



Exceptional engineering, proven solutions

Leonardo DRS marries exceptional engineering capability with a long history of successfully fielded products to deliver proven solutions. Our motor controllers, variable frequency drives, electronic motor operators, starters and UPS units are the natural choice for critical applications specified for the U.S. Navy and other Maritime applications. MIL-STD Naval specifications are only the start. Leonardo DRS products are battle-tested and hardened, having proven themselves time and again, providing continuous, flawless operations in the harshest environments.

Leonardo DRS commands a 60-year service record other providers can only envy: building and supporting motor controllers, starters and accessory products since World War II.

Leonardo DRS products are also ever evolving as our company looks to future Navy needs, with innovative products including our Navy Electronic Motor Operators (NEMO).

Leonardo DRS delivers. As we develop innovations and improvements, we incorporate the very best ideas across product lines and through successive product iterations.

Type 6922
AC/DC Manual Across-the-Line Starter

Starter in watertight enclosure

Specifications

- MIL-SPEC.....MIL-DTL-2212
- Enclosure .....Dripproof or watertight
- Operation .....Manual
- Type .....Across-the-line
- Function .....Motor starting
- Duty .....Continuous
- Protection.....Low voltage release effect -
  Overload protection - thermal type relay
  Compensation - Change in rating does not exceed 5% for each 10°C change in ambient between 20°C and 70°C
  Adjustability - Adjustable from 90 to 110% of relay rating
  Type of reset - Hand from STOP button
- Performance ..... Manual
- Ambient temp ..... 50°C
- Insulation ..... Class B
- Emergency Run ... By holding START button depressed

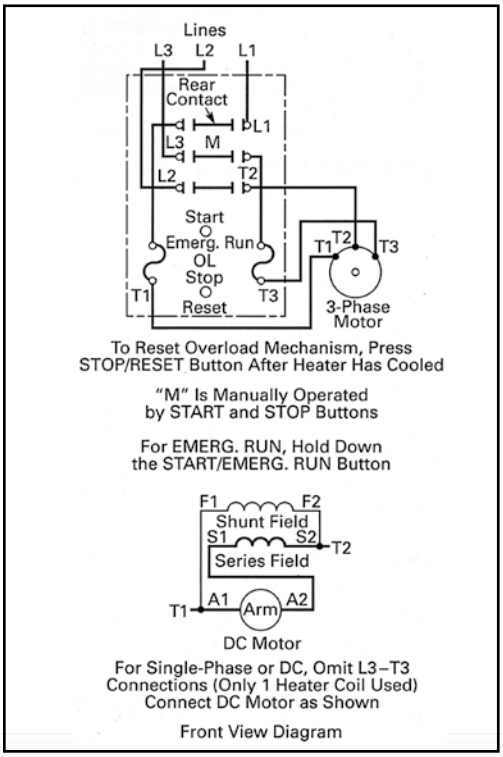
When ordering specify

Catalog number
- Horsepower
- Voltage
- Full load motor current
- Type of motor with which starter is to be used
- Application

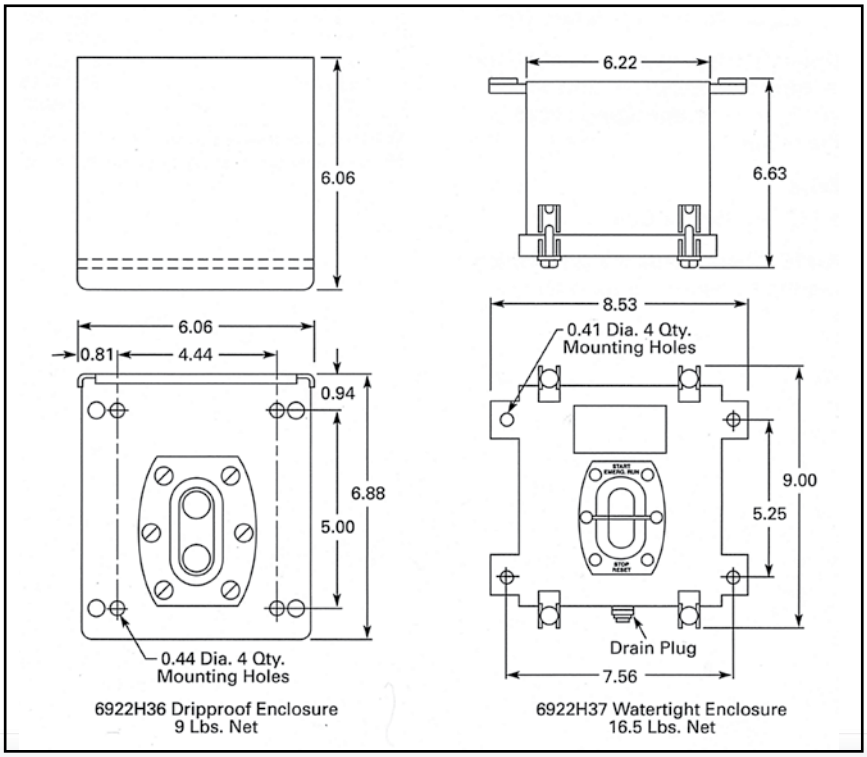
Max. hp	Starter			
440V 3-Phase	Dripproof		Watertight	
	Cat. No.	Lbs. Net	Cat. No.	Lbs. Net
7 1/2	6922H36B	9.5	6922H37D	16.5

Starter price does not include heater coils. Select Heater Coils from table on following page.

Typical Wiring Diagram



Approximate Dimensions in Inches and Shipping Weights



AC Manual Across-the-Line Starter Overload Heater Coil Selection

General

The 9104 Heater Coils listed at right are for use on Type 6922 Manual Starters.

Heater Selection

Select Heater Coils based on motor nameplate full load current.

Heater coils are rated to protect 40°C motors. Open and dripproof motors have a **service factor of 1.15** where the motor and the controller are at the same Ambient temperature.

For other conditions:

A. For 50°C, 55°C, 75°C rise motors and **enclosed motors having a service factor of 1.0, select a heater coil two sizes smaller.**
B. Ambient temperature of controller lower than the motor by 26°C, use one size smaller heater coil.
C. Ambient temperature of controller higher than the motor by 26°C, use on size larger coil.

Ultimate tripping current of heater is approximately 1.20 times the minimum current rating listed in the tables.

NOTE: There are some coils which require minimum order quantity.

Motor Amperes ❶		Catalog Number	Motor Amperes ❶		Catalog Number
Min.	Max.		Min.	Max.	
0.320	0.343	**9104H3812**	3.01	3.23	**9104H3771**
0.344	0.370	**9104H3813**	3.24	3.55	**9104H3772**
0.371	0.397	**9104H3814**	3.56	3.83	**9104H3773**
0.398	0.424	**9104H3815**	3.84	4.16	**9104H3774**
0.425	0.461	**9104H3816**	4.17	4.50	**9104H3775**
0.462	0.500	**9104H3817**	4.51	4.94	**9104H3776**
0.501	0.540	**9104H3818**	4.95	5.29	**9104H3777**
0.541	0.583	**9104H3819**	5.30	5.79	**9104H3778**
0.584	0.629	**9104H3820**	5.80	6.25	**9104H3779**
0.630	0.671	**9104H3821**	6.26	6.79	**9104H3780**
0.672	0.730	**9104H3822**	6.80	7.29	**9104H3781**
0.731	0.789	**9104H3823**	7.30	7.99	**9104H3782**
0.790	0.859	**9104H3754**	8.00	8.74	**9104H3783**
0.860	0.917	**9104H3755**	8.75	9.59	**9104H3784**
0.918	1.00	**9104H3756**	9.60	10.4	**9104H3785**
1.01	1.07	**9104H3757**	10.5	11.3	**9104H3786**
1.08	1.15	**9104H3758**	11.4	12.2	**9104H3787**
1.16	1.26	**9104H3759**	12.3	13.2	**9104H3788**
1.27	1.35	**9104H3760**	13.3	14.3	**9104H3789**
1.36	1.46	**9104H3761**	14.4	15.3	**9104H3790**
1.47	1.57	**9104H3762**	15.4	16.3	**9104H3791** ❷
1.58	1.68	**9104H3763**	16.4	17.9	**9104H3792** ❷
1.69	1.82	**9104H3764**	18.0	19.2	**9104H3793** ❷
1.83	1.96	**9104H3765**	19.3	20.7	**9104H3794** ❷
1.97	2.16	**9104H3766**	20.8	22.1	**9104H3795** ❷
2.17	2.31	**9104H3767**	22.2	24.0	**9104H3796** ❷
2.32	2.53	**9104H3768**	24.1	26.3	**9104H3797** ❷
2.54	2.74	**9104H3769**	26.4	28.8	**9104H3798** ❷
2.75	3.00	**9104H3770**			

❶ Based on starter in a maximum 50°C ambient.
❷ These coils are quantity sensitive and have minimum order size of five (5) pieces.

Type 6956
AC Magnetic Contactors - Enclosed

Contactor Only – No Overload Relay

6956ED

When ordering specify

- Type number
- Ampere rating
- Voltage
- Frequency
- Type of enclosure
- LVR or LVP (type of pilot device)
- Application
- Type and number of interlocks required

Specifications

- MIL-SPEC MIL-DTL-2212
- Enclosure . . . . . Dripproof type
- Poles . . . . . Three poles
- Operation . . . . . Magnetic
- Duty . . . . . Continuous
- Protection . . . . . Low voltage release or low voltage protection (depending upon type of master)
- Performance . . . . Non-automatic or automatic (depending on type of master)
- Ambient temp. . . 50°C .
- Insulation. . . . . Class B, except coils, Class A

AC Magnetic Contactors

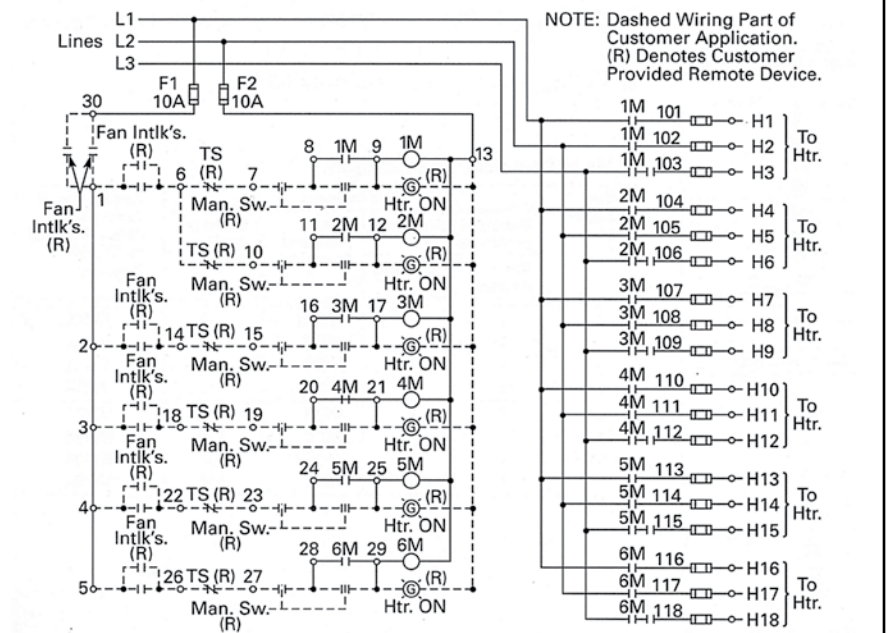
For open panels or watertight enclosures, refer to factory

Size	Max. Amps Enclosed
0	18
1	27
2	45
3	90
4	135
5	270
5 SP	420

Heater Loads (kW)

Size	110V	440V	
		Single-Phase	Three-Phase
0	1.9	7.9	13
1	2.9	11	20
2	4.9	19	34
3	9.9	39	68
4	14.8	58	100
5	29.7	118	205
5 SP	46.2	184	320

Sample Wiring Diagram



Approximate❶ Dimensions and Weights

Size	Dimension in Inches			Wt. Lbs.
	Wide A	Wide B	Wide C	
0/1	8.25	11.25	6.50	18
2	9.38	13.13	7.88	25
3	11.38	15.75	8.75	36
4	11.38	15.75	8.75	37
5	18.13	23.13	11.50	100

❶ Design variables will affect size and/or weight.

AC Magnetic Starters
General Data

6962ED

When ordering specify

- Catalog or type number
- Specifications applying
- Voltage
- Horsepower rating
- Frequency
- Type of enclosure
- Full load motor current
- Local or remote master switch
- Scheme of operation (LVP or LVR)
- Non-automatic or automatic
- Application
- Type of motor with which starter will be used
- Any special contract requirements involving operation,construction, plans, packing, etc.

Maximum Horsepower Ratings – 60 Hertz

Navy Starter Size	Maximum Horsepower	
	115V, 1-Phase	440V, 3-Phase
Types 6962 and 6963 Single Speed Across-the-Line		
0	–	5
1	2	10
2	3	25
3	7-1/2	50
4	–	100
5	–	200
5SP	–	375
6	–	400

	440V, 3-Phase	
	Constant or Variable Torque	Constant Horsepower
Types 6967 and 6968 Two Speed Across-the-Line		
1	10	7-1/2
2	25	20
3	50	40
4	100	75

	110V	440V
Type 6966 Reduced Voltage Autotransformer		
2	7-1/2	25
3	15	50
4	25	100
5	50	200
5 SP	–	375
6	–	400

Specifications

- MIL-SPEC..... MIL-DTL-2212
- Enclosure ..... Dripproof, watertight (other types available, contact factory)
- Operation ..... Magnetic
- Type ..... Electromagnetic
- Function
  - Type 6962 ..... Motor starting
  - Type 6963 ..... Motor starting and reversing
  - Type 6966 ..... Reduced voltage motor starting
  - Type 6967 ..... Motor starting and speed selection
  - Type 6968 ..... Motor starting, reversing and speed selection
  - Type 6969 ..... Special
- Duty ..... Continuous
- Protection ..... Low voltage protection and low voltage release types
- Overload
  - Protection ..... Eutectic thermal type relay (N750) **See Page 54**
  - Compensation..... Less than 3% change for each 10° variation in ambient between 20° and 70°C
  - Adjustability ..... -10%, +10% of heater rating
  - Reset ..... Hand (local) or electrical (remote)
- Performance ..... Non-automatic or automatic (depending on type of master switch used)
- Ambient temp ..... 50°C
- Insulation ..... Class B, except contactor coils, Class A
- Emergency Run Optional, by separate emergency RUN button
- Rating ..... AC only 60 Hz

Table of Contactor Type Numbers

Navy Starter Size	Main Contactor				Type number of Control Relay (When Furnished for Special Purposes)
	Number of Contactors per Starter		Type number of Contactor	Enclosed Ampere Rating	
	Non-reversing	Reversing			
0	1	–	**N1291**	18	**N1154**
1	1	2	**N850**	27	**N1154**
2	1	2	**N894**	45	**N1154**
3	1	2	**N846**	90	**N1154**
4	1	2	**N862**	135	**N1154**
5	1	2	**N878**	270	**N1154**
5 SP	1	2	**N1178**	420	**N1154**
6	1	2	**N630**	540	**N1154**

Type 6962H Non-Reversing
Standard (Non-engineered) AC Motor Starters

Across-the-Line, Single Speed

When ordering specify

- Catalog number
- Horsepower rating
- Full load motor current

Specifications

- MIL-SPEC. MIL-DTL-2212
- Enclosure . . . . . .Dripproof with wraparound cover
- Voltage. . . . . 440V AC, 60 Hz, 3-phase only
- Operation. . . . . Magnetic

Remote Control – With Provision for Remote START/STOP Pushbutton (LVP) or ON/OFF Selector Switch (LVR)

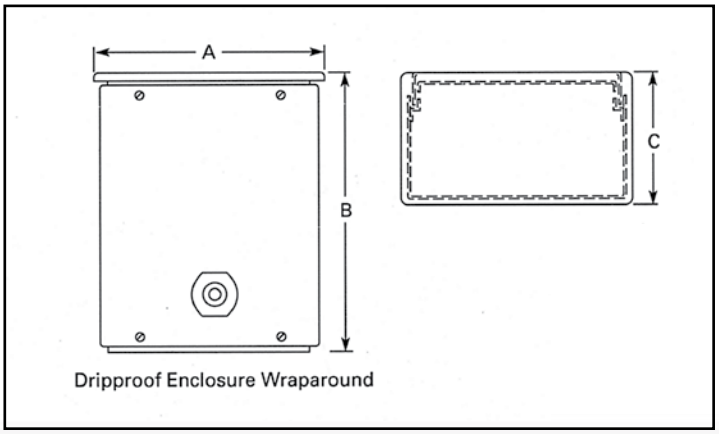
Size	Remote START/STOP Pushbutton (LVP)			Remote ON/OFF Selector Switch (LVR)			Dim. Table Reference
	Catalog number			Catalog number			
	Without Additional Features	With Provisions for		Without Additional Features	With Provisions for		
		Remote Protective Device	Remote Emergency Run		Remote Protective Device	Remote Emergency Run	
Without Indicating Light (1 Pilot Circuit Fuse)							
1	**6962H154A2**	**6962H154A6**	**6962H154A3**	**6962H154A4**	–	**6962H154A5**	B
2	**6962H161A2**	**6962H161A4**	**6962H161A3**	**6962H161A7**	–	**6962H161A8**	E
3	**6962H170A2**	**6962H170A4**	**6962H170A3**	**6962H171A2**	–	**6962H171A3**	G
4	**6962H178A2**	**6962H178A4**	**6962H178A3**	**6962H179A2**	–	**6962H179A3**	H
With Provision for Indicating Light (3 Pilot Circuit Fuses)							
1	**6962H155A2**	–	**6962H155A3**	**6962H155A4**	–	**6962H155A5**	B
2	**6962H163A2**	–	**6962H163A3**	**6962H163A4**	–	**6962H163A5**	E
3	**6962H172A2**	–	**6962H172A3**	**6962H173A2**	–	**6962H173A3**	G
4	**6962H180A2**	–	**6962H180A3**	**6962H181A2**	–	**6962H181A3**	H

Local Control – With START/STOP Pushbutton (LVP) or ON/OFF Selector Switch (LVR) – 440A – 60 Hz

Size	START/STOP Pushbutton in Cover (LVP)								ON/OFF Selector Switch in Cover (LVR) with Local Emergency Run		START/STOP Pushbutton and MAN/AUTO Selector Switch in Cover (LVP) with Provisions for Remote 2-Wire Automatic Device	
	Without Additional Features		With Local Emergency Run		With Provisions for							
					Remote Pushbuttons (1 Pilot Fuse)		Remote Safety Switch (1 Pilot Fuse)					
	Catalog number	Dim. Ref.	Catalog number	Dim. Ref.	Catalog number	Dim. Ref.	Catalog number	Dim. Ref.	Catalog number	Dim. Ref.	Catalog number	Dim. Ref.
Without Indicating Light												
1	**6962H156A2**	A	**6962H157A2**	A	**6962H159A2**	B	**6962H159A3**	B	**6962H158A2**	B	**6962H160A2**	C
2	**6962H165A2**	D	**6962H166A2**	D	**6962H168A2**	E	**6962H168A3**	E	**6962H167A2**	E	**6962H169A2**	J
3	**6962H174A2**	F	**6962H175A2**	F	**6962H177A2**	G	**6962H177A3**	G	**6962H176A2**	G	–	–
4	**6962H182A2**	H	**6962H183A2**	H	**6962H185A2**	H	**6962H185A3**	H	**6962H184A2**	H	–	–

Prices of starters do not include overload heater coils. Two required per controller. Heater Coil Selection, **Page 58.**

Approximate Dimensions and Weights



Reference Letter	Dimensions in Inches			Weight Lbs.
	Wide A	High B	Deep C	
A	8.38	11.30	6.68	20
B	8.24	15.56	6.68	25
C	11.74	15.30	6.44	35
D	9.38	12.80	8.06	30
E	9.38	17.30	8.06	35
F	11.38	15.30	8.94	40
G	11.38	19.80	8.94	45
H	11.38	19.80	8.94	47
J	13.74	16.80	8.06	40

Type 6967H Non-Reversing Standard (Non-engineered) AC Motor Starters

When ordering specify

- Catalog number
- Horsepower rating
- Full load motor current

Specifications

- MIL-SPEC..... MIL-DTL-2212
- Enclosure ..... Dripproof with wraparound cover
- Voltage ..... 440V AC, 60 Hz, 3-phase only
- Operation ..... Magnetic. Two speed, Two-Winding LVP

Local Control — FAST/SLOW/STOP

Size	Maximum Horsepower	Catalog number		
			With Provisions for	
		Local FAST/SLOW/STOP Only	Remote FAST/SLOW/STOP	Remote FAST/SLOW/STOP and MOTOR RUN Lights ❶ and Remote EM-START/EM-STOP
1 2	10 25	**6967H21A2** **6967H28A2**	– **6967H26A2**	– **6967H27A2**

Remote Control Only

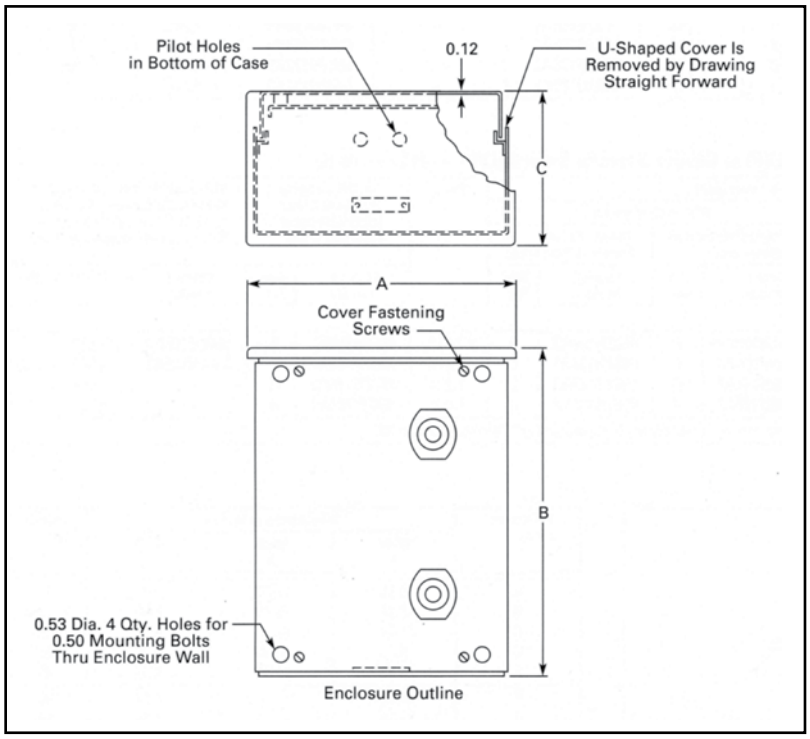
Size	Maximum Horsepower	Catalog number	
		With Provisions for	
		Remote FAST/SLOW/STOP	Remote FAST/SLOW/STOP and MOTOR RUN Lights ❶ and Remote EM-START/EM-STOP
1 2	10 25	**6967H21A2** **6967H28A2**	– **6967H29A2**

Prices of Starters do not include overload heater coils. Four required per controller. Heater Coil Selection, **Page 58.**

❶ Motor run light for each speed.

Size	Dimensions in Inches			Weight Lbs.
	Wide A	High B	Deep C	
1 2	11.8 13.8	15.3 16.8	6.5 8.1	32 47

Approximate Dimensions and Weights



Type 6962 Non-Reversing and Type 6963 Reversing Engineered AC Magnetic Starters

Across-the-Line, Single Speed

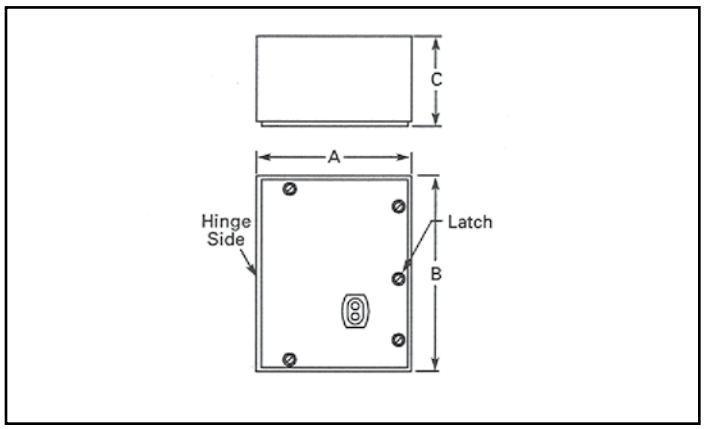
When ordering specify

- Base type number. Example 6962-3
- Voltage and frequency
- Type of enclosure
- Full load motor current
- Low voltage protection or low voltage release
- Features required
- Desired circuit operation
- Description of application
- Any special instructions

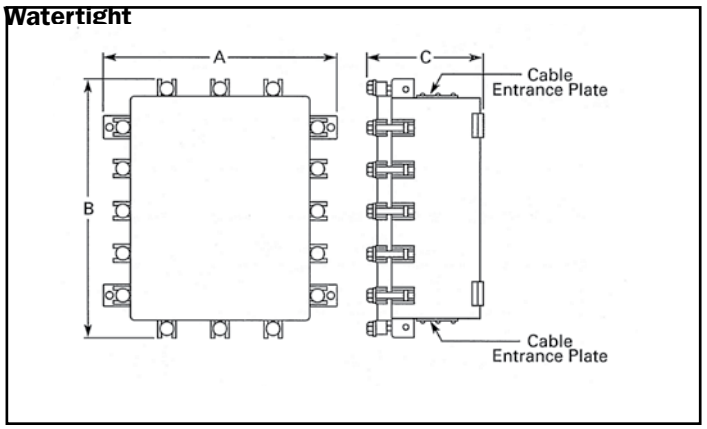
Specifications

- MIL-SPEC..... MIL-DTL-2212
- Enclosure ..... Dripproof or watertight
- Operation ..... Magnetic
- Rating ..... 440V AC, 60 Hz, 3-Phase
  other voltages available

Approximate Dimensions and Shipping Weights - Dripproof



Approximate Dimensions and Shipping Weights - Watertight



Controller Size	Dripproof Enclosure ❶			
	Dimensions in Inches			Shipping Weight Lbs.
	Wide A	High B	Deep C	
Type 6962 Non-reversing				
0	12.0	18.0	9.5	35
1	12.0	18.0	9.5	35
2	12.0	18.0	9.5	35
3	12.0	18.0	9.5	45
4	14.0	18.0	9.5	51
5	22.13	28.13	11.5	120
5 SP	22.13	28.13	11.5	120
6	35.5	60.0	24.0	790
Type 6963 Reversing				
1	12.0	18.0	9.5	35
2	14.0	20.0	9.5	47
3	Contact Factory			
4				

Controller Size	Watertight Enclosure ❶			
	Dimensions in Inches			Shipping Weight Lbs.
	Wide A	High B	Deep C	
Type 6962 Non-reversing				
0	9.5	19.0	7	34
1	9.5	19.0	7	35
2	13.5	19.0	9	52
3	Contact Factory			
4				
5				
5 SP				
6				
Type 6963 Reversing				
1	13.28	21.13	9	50
2	15.38	21.13	9	60
3	Contact Factory			
4				

❶ Dimensions and weights shown are for the base controller only. The addition of optional features will affect the size and weight.

Type 6967 Non-Reversing and Type 6968 Reversing Engineered AC Magnetic Starters

Two Speed, Across-the-Line

When ordering specify

- Type number
- Applicable specifications
- Two-winding or single-winding reconnected
- Horsepower rating at high and low speeds
- Full load motor current at high and low speeds
- Voltage and frequency
- Low voltage release or low voltage protection
- Non-automatic or automatic
- Local or remote master
- Type of enclosure
- Application

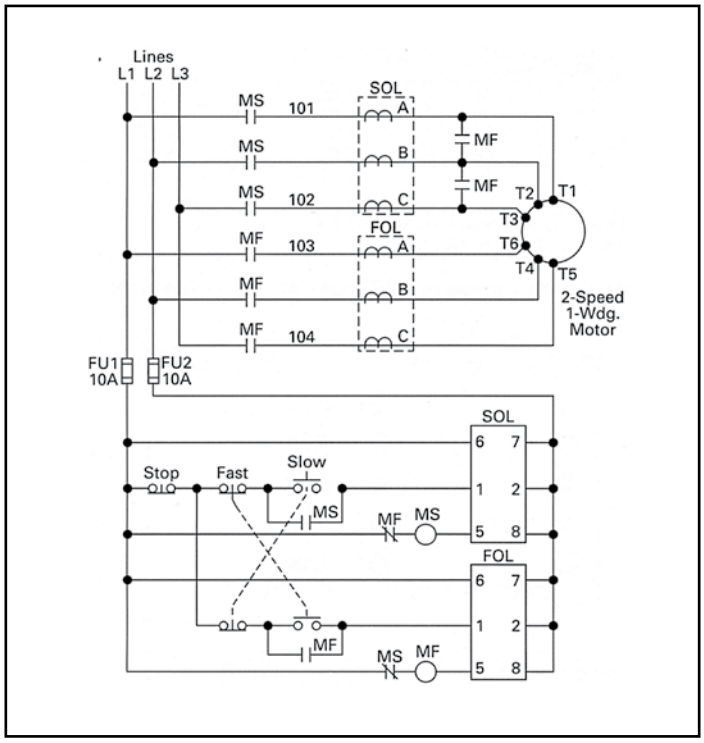
Specifications

- MIL-SPEC..... MIL-DTL-2212
- Enclosure ..... Dripproof or watertight
- Operation ..... Magnetic
- Rating ..... 440V AC, 60 Hz, 3-Phase
  other voltages available

Maximum Horsepower Ratings

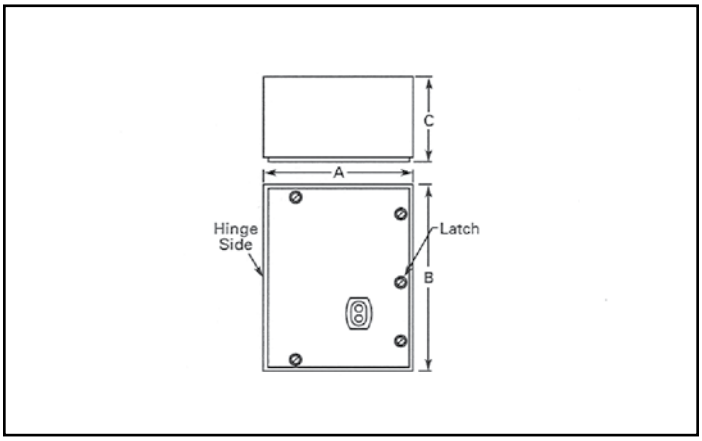
Size	Maximum Horsepower 3-Phase, 60 Hz	
	Constant or Variable Torque	Constant Horsepower
	440V	440V
1	10	7-1/2
2	25	20
3	50	40
4	100	75

Diagram



Approximate Dimensions and Weights –

Watertight enclosure dimensions on application. Design variables prevent accurate dimensions.



Size	Dimensions in Inches			Weight Lbs.
	Wide A	High B	Deep C	
Non-reversing - Dripproof				
1	14.13	18.13	9.38	45
2	14.13	20.13	9.38	55
3	16.13	22.13	9.38	73
4	16.13	22.13	9.38	85
Reversing - Dripproof				
1	16.13	20.13	9.38	60
2	16.13	24.13	9.38	79
3	22.13	28.13	9.38	132
4	22.13	32.13	9.38	141

Type 6966
Engineered AC Magnetic Starters

Autotransformer, Reduced Voltage Type

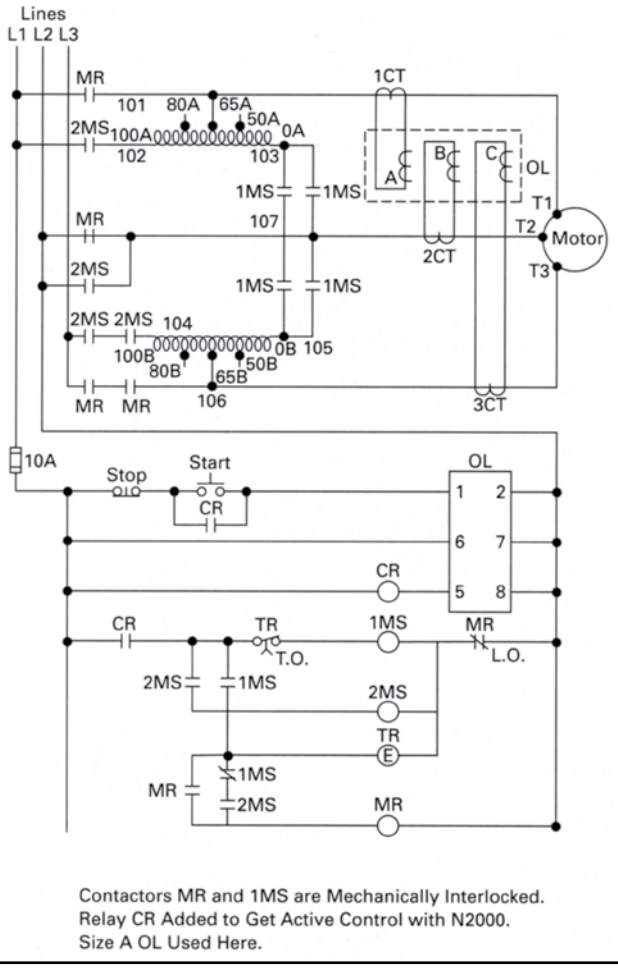
When ordering specify

- Type number
- Application specifications
- Horsepower
- Voltage and frequency
- Full load motor current
- Type of enclosure
- Local or remote control
- Low voltage protection or low voltage release
- Non-automatic or automatic
- Application

Specifications

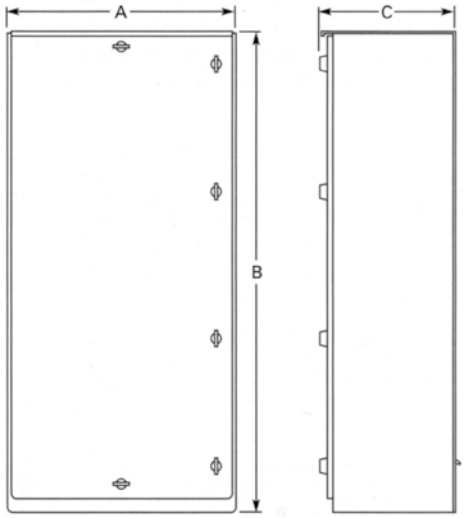
- MIL-SPEC..... MIL-DTL-2212
- Enclosure ..... Dripproof
- Operation ..... Magnetic
- Rating ..... 440V AC, 60 Hz, 3-Phase
  Other voltages available

Typical Wiring Diagram



Contactors MR and 1MS are Mechanically Interlocked.
Relay CR Added to Get Active Control with N2000.
Size A OL Used Here.

Approximate Dimensions in Inches and Weights – Type 6966❶



Size 4, 5 and 6 Deck Mounted
(Bottom Open for Cable Entry)

Size	Dimensions in Inches			Weight Lbs.
	Wide A	High B	Deep C	
Dripproof Enclosure				
1	20	42	14	190
2	20	42	14	200
3	20	42	14	300
4	26	60	24	700
5	32.50	84	28.25	1275
6	34.25	90	30.25	1700

❶ Design variables prevent accurate dimensions.

Type 6999
Engineered AC Magnetic Starters and Controls

Other Configurations

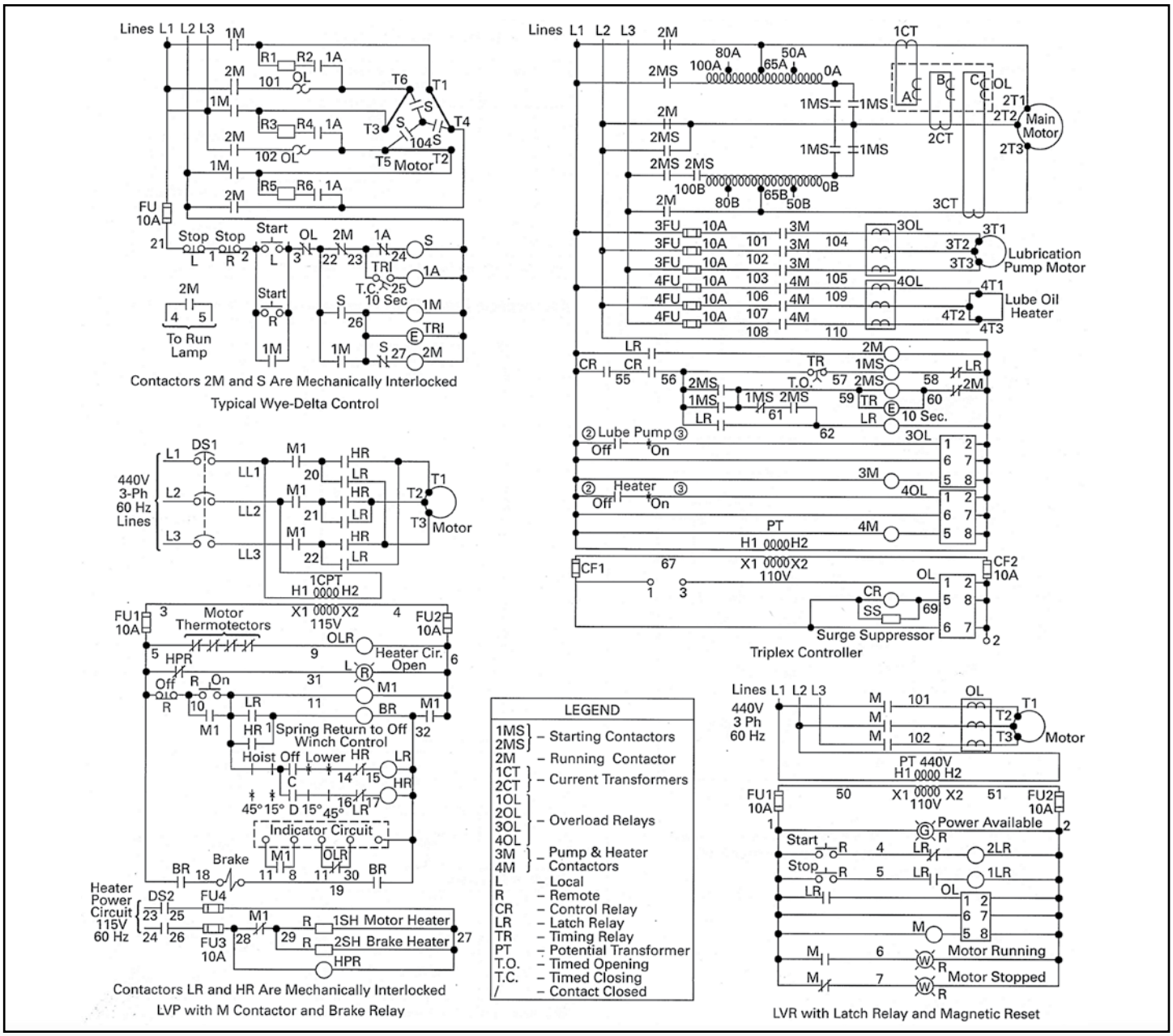
When ordering specify

- Application specifications
- Function description
- Circuit configuration
- Horsepower rating
- Full load amperes
- Voltage and frequency
- Operation – LVP or LVR
- Local or remote master
- Enclosure type
- Application description

Possible Configurations

- Reversing autotransformer
- Wye-Delta reduced voltage
- Part-winding
- Wound rotor
- Special control needs

Example Diagrams



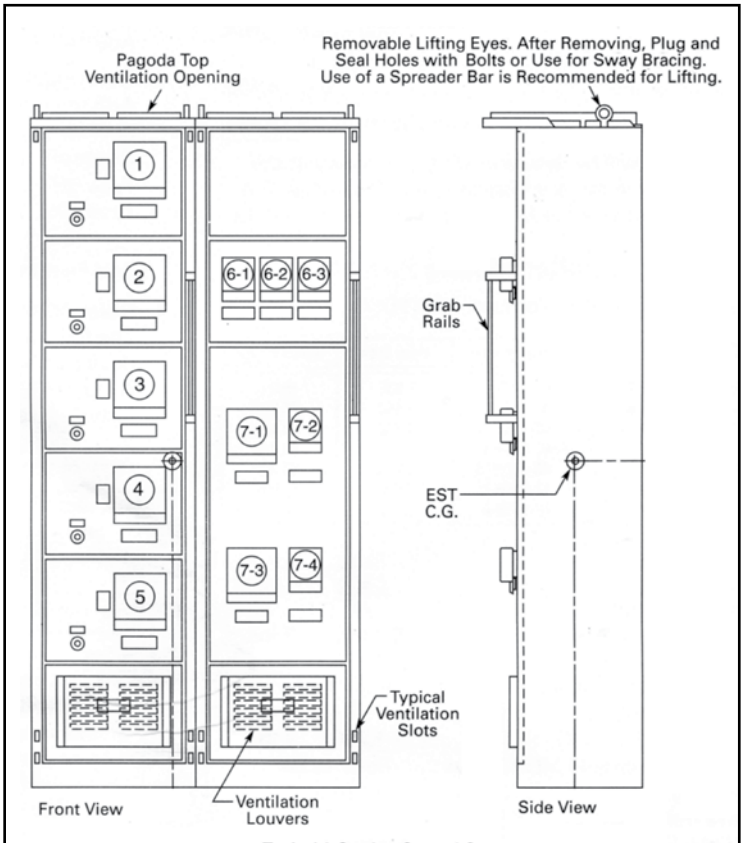
Type 6976
Navy Underdeck Control Centers

When ordering specify

- Type number
- Applicable specifications
- Control center layout and individual cell application
- Type number of individuals cells - specify voltage, frequency, horsepower and full load motor current for each cell.

Specifications

- MIL-SPEC..... MIL-C-23742
- Enclosure Splash proof (meets “Water Spray Protected” requirement)
- Operation ..... Magnetic
- Function Motor starting, speed selection and power distribution. Variable voltage control.
- Duty ..... Continuous
- Protection ..... Low voltage release or low voltage protection Overload protection - thermal type, adjustable overload relay
- Performance ..... Non-automatic or automatic
- Ambient temp. .... 50°C
- Insulation Class B - except magnet coils which have Class A insulation
- Emergency Run ... Included
- Ratings..... 440V, 3-Phase, 60 Hz



Typical 2-Section Control Center

Type 6962

Across-the-Line – 20 Inch Wide

Size	Maximum Horsepower	Circuit Breaker Ampere Rating	Space
0	5	100	1-13 Inch
1	10	100	1-13 Inch
2	25	100	1-13 Inch
3	50	100	1-13 Inch
4	75	100	1-13 Inch

Type 6967

2 Speed – 20 Inch Wide

Size	Maximum Horsepower	Circuit Breaker Ampere Rating	Space
1	10	100	1-26 Inch
2	25	100	1-26 Inch

Circuit Breaker Distribution Section

22-1/4 Inch Wide

Circuit Breaker Type	Space
1 to 4 AQB-A-101	1-13 Inch
1 to 2 AQB-LF-250	1-13 Inch

Variable Voltage Static Control

20 Inch Wide

Horsepower Rating	Speed Range	Space
10-20	3:1	1-13 Inch
50	5:1	1-13 Inch

Optional Features Available

- Pushbuttons, selector switches and indicating lights.
- Control relays and timers.
- Space only for future or special control.

Type 6957
AC Navy Contactors

N850-N851 – Size 1 and N1291 – Size 0

6957ED25-1C

Specifications

- MIL-SPEC..... MIL-DTL-2212
- Operation ..... Magnetic
- Duty ..... Continuous
- Ambient temp ..... 50°C
- Insulation ..... Class B, except coils, Class A

Electrical Data (Enclosed)

	N850	N851	N1291
Number of Poles	4	5	3
Ampere Rating – Enclosed	27	27/13.5	18
Horsepower Rating – 440V, 3-Phase, 60 Hz	10	10	5
Maximum Break – Amperes at 484V, 40%	162	162	108
PF	2	2	1
No. of Interlocks – Hi-Shock NO	2	1	-
NC			

Interlock Contact

	Amperes		
	Make	Break	Continuous
440V AC	6	1	15
110V AC	15	1	15

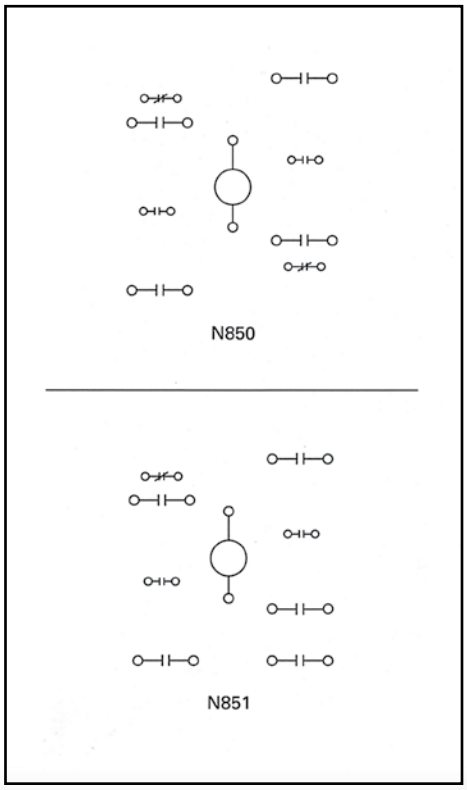
Coil Data – 60 Hertz (All Devices)

		440V	110V
Inrush	Amperes	0.46	1.84
	Watts	170	170
	VA	200	200
Sealed	Amperes	0.04	0.16
	Watts	5.4	5.4
	VA	17.8	17.8

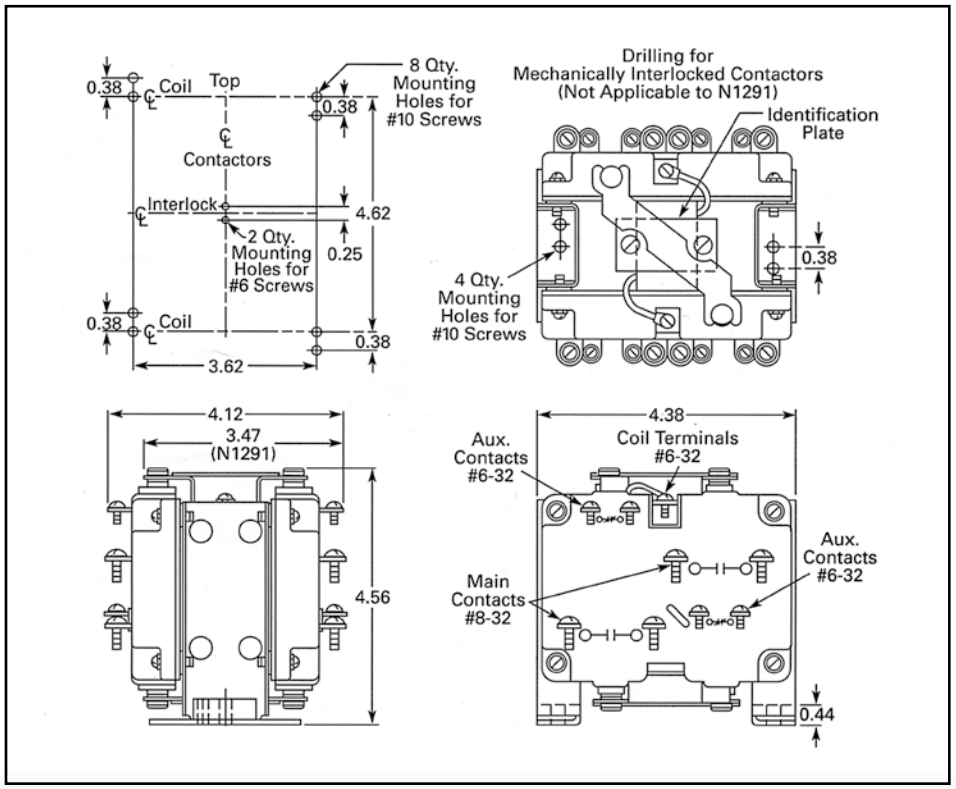
Contactor Weight

	N850	N851	N1291
Pounds	3.1	3.1	3.0

Diagram Symbols



Approximate Dimensions in Inches



Type 6957
AC Navy Contactors

N894-N895 – Size 2

6957ED29-2A

Specifications

- MIL-SPEC..... MIL-DTL-2212
- Operation ..... Magnetic
- Duty ..... Continuous
- Ambient temp ..... 50°C
- Insulation ..... Class B, except coils, Class A

Electrical Data (Enclosed)

	N894	N895
Number of Poles	4	5
Ampere Rating – Enclosed	45	45/22.5
Horsepower Rating – 440V, 3-Phase, 60 Hz	25	25
Maximum Break – Amperes at 484V, 40% PF	270	270
No. of Interlocks – Hi-Shock NO	2	1
NC	2	2

Interlock Contact

	Amperes		
	Make	Break	Continuous
440V AC	6	1	15
110V AC	15	1	15

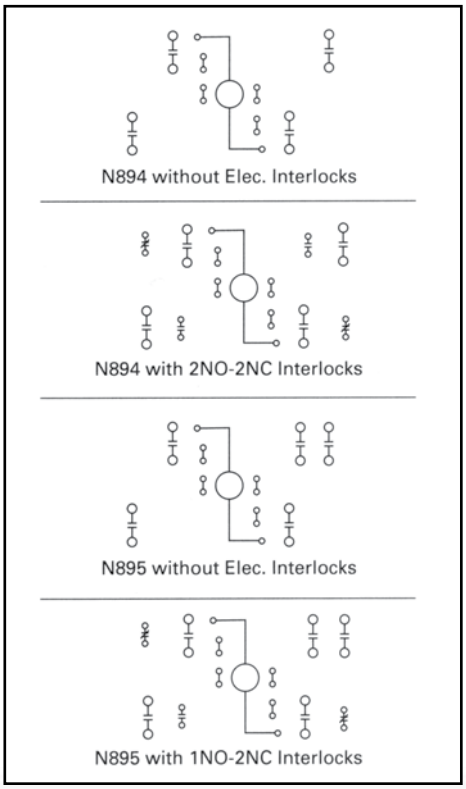
Coil Data – 60 Hertz (All Devices)

		440V	110V
Inrush	Amperes	0.56	2.24
	Watts	220	220
	VA	245	245
Sealed	Amperes	0.03	0.12
	Watts	5.6	5.6
	VA	13.1	13.1

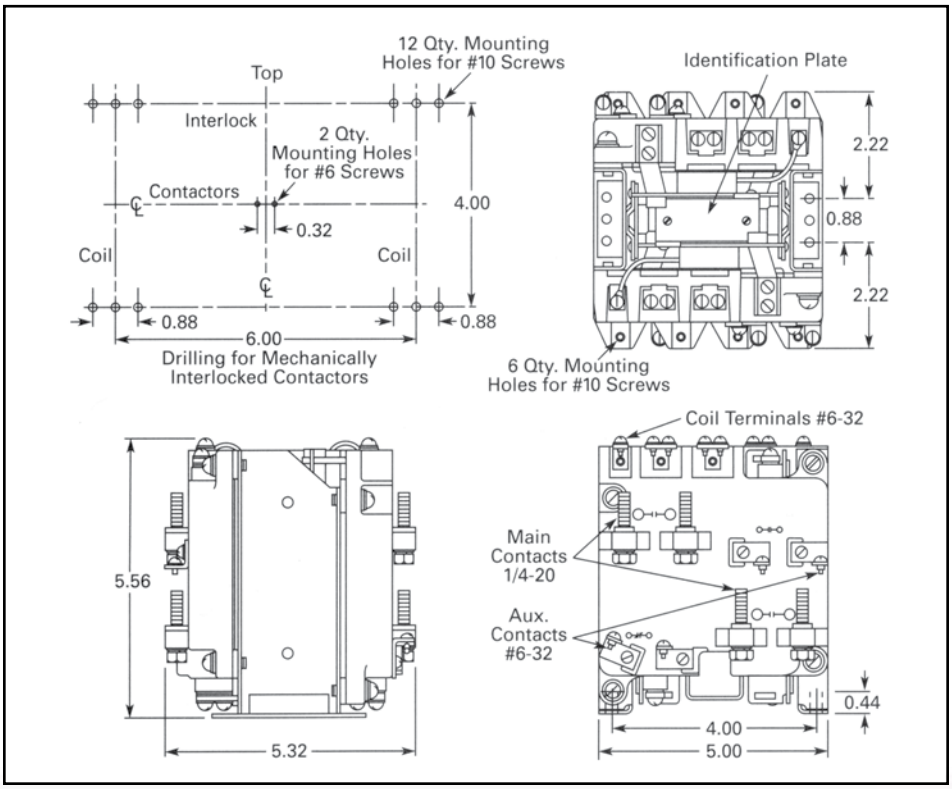
Contactor Weight

	N894	N895
Pounds	5.25	5.40

Diagram Symbols



Approximate Dimensions in Inches



Type 6957
AC Navy Contactors

N846/N847 – Size 3

6957ED31-2C

Specifications

- MIL-SPEC..... MIL-DTL-2212
- Operation ..... Magnetic
- Duty ..... Continuous
- Ambient temp ..... 50°C
- Insulation ..... Class B, except coils, Class A

Electrical Data (Enclosed)

	N846	N847
Number of Poles	4	5
Ampere Rating – Enclosed	90	90/45
Horsepower Rating – 440V, 3-Phase, 60 Hz	50	50
Maximum Break – Amperes at 484V, 40% PF	540	540
No. of Interlocks – Hi-Shock NO	4	3
NC	4	3

Interlock Contact

	Amperes		
	Make	Break	Continuous
440V AC	6	1	15
110V AC	15	1	15

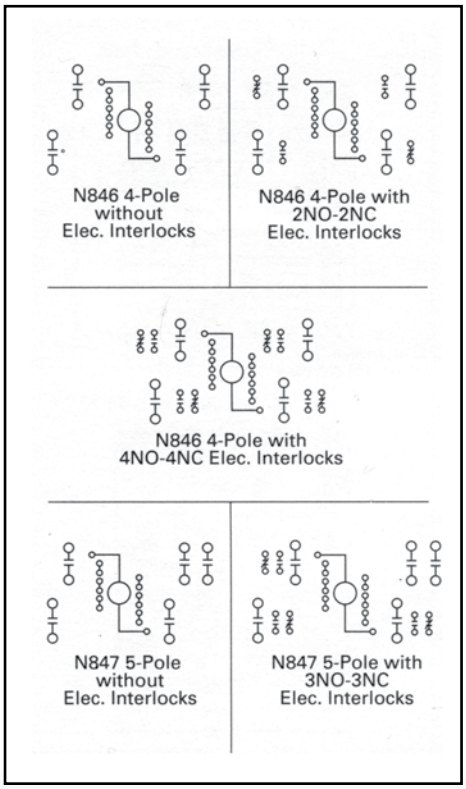
Coil Data – 60 Hertz (All Devices)

		440V	110V
Inrush	Amperes	1.3	5.20
	Watts	309	309
	VA	570	570
Sealed	Amperes	0.044	0.18
	Watts	8.8	8.8
	VA	19.5	19.5

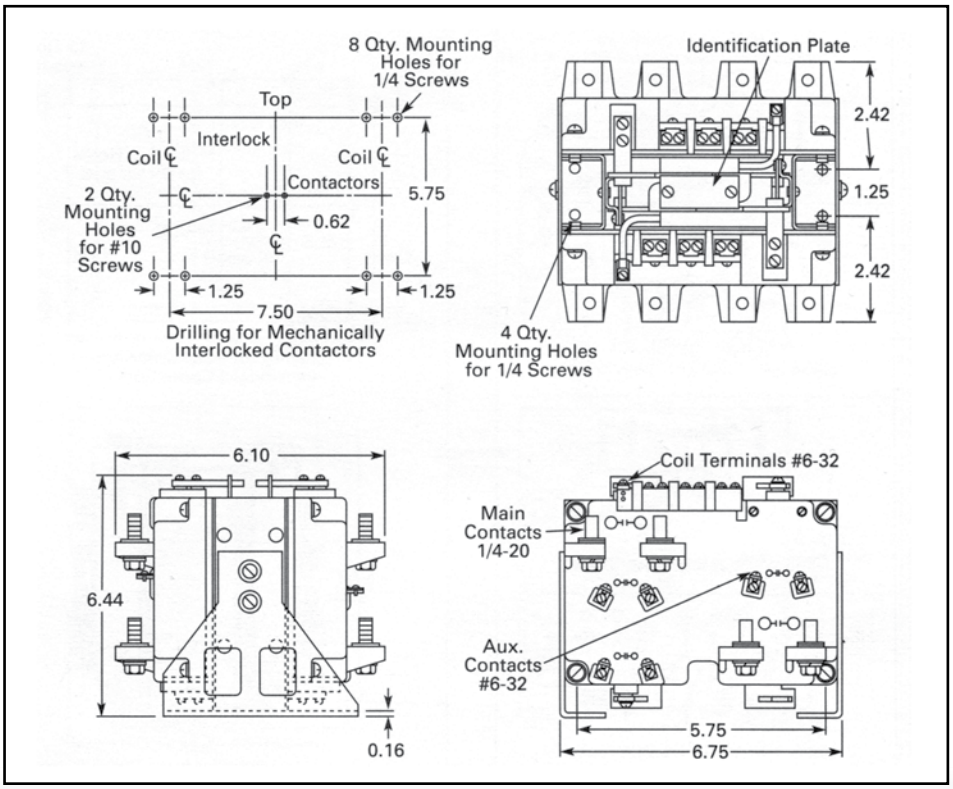
Contactor Weight

	N846	N847
Pounds	9.6	10.0

Diagram Symbols

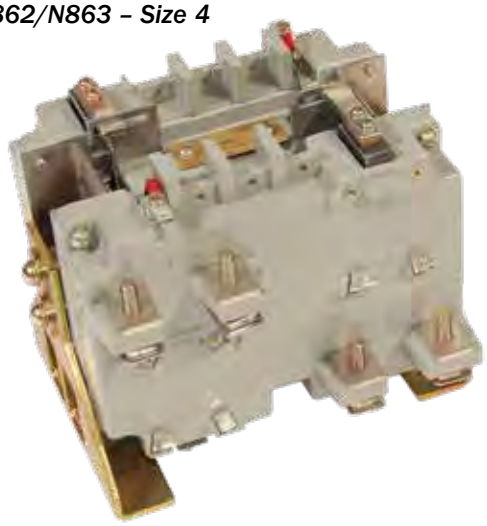


Approximate Dimensions in Inches



Type 6957
AC Navy Contactors

N862/N863 – Size 4



6957ED33-2CA

Specifications

- MIL-SPEC..... MIL-DTL-2212
- Operation ..... Magnetic
- Duty ..... Continuous
- Ambient temp ..... 50°C
- Insulation ..... Class B, except coils, Class A

Electrical Data (Enclosed)

	N862	N863
Number of Poles	4	5
Ampere Rating – Enclosed	135	135/67.5
Horsepower Rating – 440V, 3-Phase, 60 Hz	100	100
Maximum Break – Amperes at 484V, 40%	810	810
PF	4	3
No. of Interlocks – Hi-Shock NO	4	3
NC		

Interlock Contact

	Amperes		
	Make	Break	Continuous
440V AC	6	1	15
110V AC	15	1	15

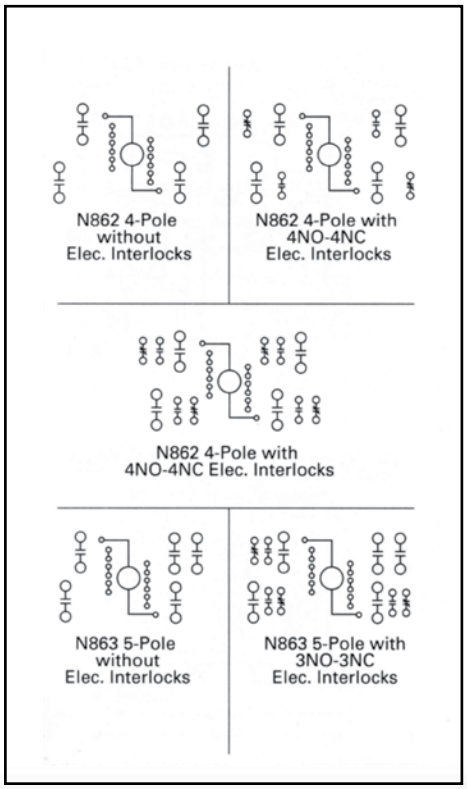
Coil Data – 60 Hertz (All Devices)

		440V	110V
Inrush	Amperes	1.3	5.20
	Watts	309	309
	VA	570	570
Sealed	Amperes	0.044	0.18
	Watts	8.8	8.8
	VA	19.5	19.5

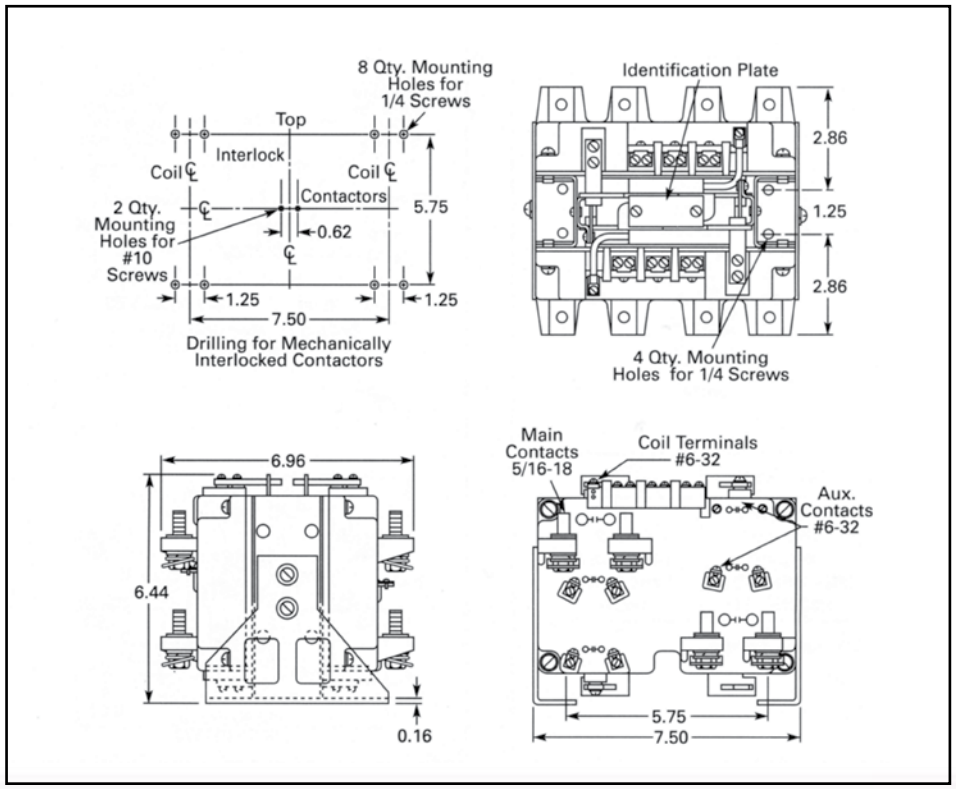
Contactor Weight

	N862	N863
Pounds	12.5	12.9

Diagram Symbols



Approximate Dimensions in Inches



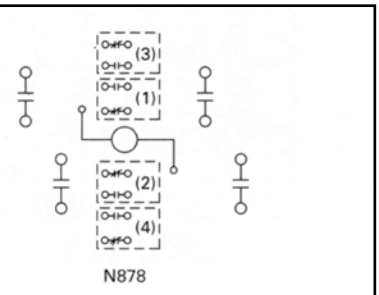
Type 6957
AC Navy Contactors

N878-Size 5 and N1178-Size 5 SP

Specifications

- MIL-SPEC..... MIL-DTL-2212
- Operation ..... Magnetic
- Duty ..... Continuous
- Ambient temp ..... 50°C
- Insulation ..... Class B, except coils, Class A

Diagram Symbols



N878

Interlocks	Use Position
1NO-2NC	1
2N0-2NC	1 and 2
4NO-4NC	1-2-3 amd 4
2NO-1NC-1NC LO	1 and 2 (LO)
1NO-1NC LO	1 (LO)

LO - Late Opening

Electrical Data (Enclosed)

	N878	N1178
Number of Poles	4	3
Ampere Rating – Enclosed	270	420
Horsepower Rating – 440V, 3-Phase, 60 Hz	200	375
Maximum Break – Amperes at 484V, 40%	1620	2520
PF	1, 2, 4	1, 2, 4
No. of Interlocks – HI-Shock NO	1, 2, 4	1, 2, 4
NC		

Interlock Contact

	Amperes		
	Make	Break	Continuous
440V AC	6	1	15
110V AC	15	1	15

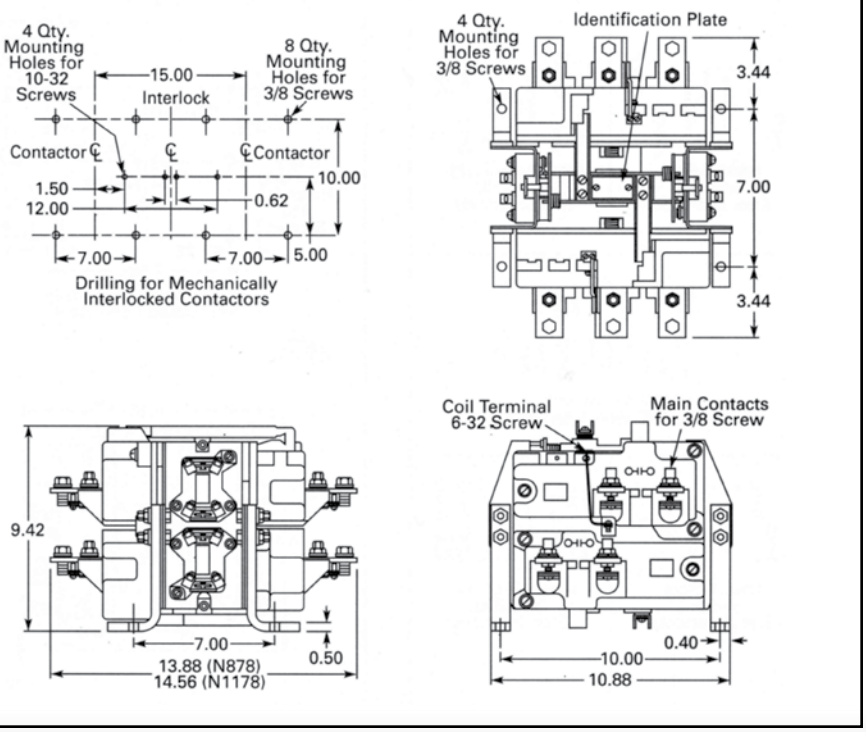
Coil Data – 60 Hertz (All Devices)

		440V	110V
Inrush	Amperes	4.1	16.4
	Watts	210	210
	VA	1750	1750
Sealed	Amperes	0.2	0.8
	Watts	36	36
	VA	88	88

Contactor Weight

	N878	N1178
Pounds	40	41

Approximate Dimensions in Inches



Type 6957
AC Magnetic Contactors

AC Magnetic Contactors

Size	Device Number	Main Contacts		Auxiliary Contacts	Standard	"Quiet" ❷
		Rating (Amperes)	Numbers		Catalog number ❶	Catalog number ❶
0	N1291	18	3NO	1NO	**6957ED58-1_**	**6957ED58-1_Q**
1	N850	27	4NO 3NO	2NO-2NC 2NO-1NC	**6957ED25-1_** **6957ED25-4_**	**6957ED25-1_Q** **6957ED25-4_Q**
	N851	27	5NO ❸	2NO-1NC	**6957ED26-4_**	**6957ED26-4_Q**
2	N894	45	4NO 4NO 3NO	- 2NO-2NC 2NO-2NC	**6957ED29-1_** **6957ED29-2_** **6957ED29-4_**	**6957ED29-1_Q** **6957ED29-2_Q** **6957ED29-4_Q**
	N895	45	5NO ❸ 5NO ❸	- 1NO-2NC	**6957ED30-1_** **6957ED30-2_**	**6957ED30-1_Q** **6957ED30-2_Q**
3 ❺	N846	90	4NO 4NO 4NO 3NO 3NO	- 2NO-2NC 4NO-4NC 2NO-1NC 3NO-3NC	**6957ED31-1_** **6957ED31-2_** **6957ED31-3_** **6957ED31-7_** **6957ED31-8_**	**6957ED31-1_Q** **6957ED31-2_Q** **6957ED31-3_Q** **6957ED31-7_Q** **6957ED31-8_Q**
	N847	90	5NO ❸ 5NO ❸	- 3NO-3NC	**6957ED32-1_** **6957ED32-2_**	**6957ED32-1_Q** **6957ED32-2_Q**
4 ❺	N862	135	4NO 4NO 4NO 3NO 3NO	- 2NO-2NC 4NO-4NC 2NO-1NC 3NO-3NC	**6957ED33-1_** **6957ED33-2_** **6957ED33-3_** **6957ED33-7_** **6957ED33-8_**	**6957ED33-1_Q** **6957ED33-2_Q** **6957ED33-3_Q** **6957ED33-7_Q** **6957ED33-8_Q**
	N863	135	5NO ❸ 5NO ❸	- 3NO-3NC	**6957ED34-1_** **6957ED34-2_**	**6957ED34-1_Q** **6957ED34-2_Q**
5 ❺	N878	270	4NO 4NO 4NO	1NO-1NC 2NO-2NC 4NO-4NC	**6957ED39-1_** **6957ED39-2_** **6957ED39-3_**	**6957ED39-1_Q** **6957ED39-2_Q** **6957ED39-3_Q**
5 SP ❺	N1178	420	3NO 3NO 3NO	1NO-1NC 2NO-2NC 4NO-4NC	**6957ED53-1_** **6957ED53-2_** **6957ED53-3_**	**6957ED53-1_Q** **6957ED53-2_Q** **6957ED53-3_Q**
6	N630	540	3NO	1NO	**6957ED6-__** ❹	-

Magnetic Coil Suffix

Contact factory for other volts and hertz

Coil Voltage (60Hz)	Suffix Letter	
	Size 0 and 1 thru 5 SP	Size 6 Only
440	A	C
220	B	B
110	C	A

High Temperature (65ºC Ambient) and Very Quiet (MIL-STD-740-2) Magnetic Contactors

The high temperature, very quiet magnetic contactor (HTVQ) is qualified to operate in a 65°C Ambient temperature and meets the noise limits of MIL-STD-740-2.

Replacement Type 6957 AC Magnetic Contactors

Size	Device Number	Catalog number ❻
Relay	N841	**6957ED24**
1	N892	**6957ED27**
1	N893	**6957ED28**
Timer	N867	**6957ED35**

❶Add or insert Magnet Coil Suffix letter from table at left. Examples: 6957ED58-1A. 6957ED58-1AQ.
❷"Quiet" devices are qualified to MIL-STD-740B.
❸One pole has half rating.
❹Contactor factory mounted to a plywood panel. Latching relay not included.
❺No-NC auxiliary contacts in the same cavity (adjacent to each other) must be wired with the same voltage and polarity.
❻These are replacement devices only. Obtain complete Part Number from existing controller bill of material.

Type 6957
AC Magnetic Pneumatic Timing Relay – N907

When ordering specify
- Catalog number

General
The relay must be adjusted to provide timing in the range of 0.05 seconds to three minutes.

Minimum time between successive operations – 0.2 seconds – Specification – DTL-2212-H.

AC Pneumatic Timing Relay

Type	Contacts		Catalog No. ❹	Suffix Letter	
	Main	Timing		440V 60Hz	110V 60Hz
Timer (ON Delay)	1NO-1NC	Timed	**6957ED41-1**	A	B
	1NO-1NC 1NO-1NC	Timed Inst.	**6957ED41-3** **6957ED41-3**	A A	B B
	1NO-1NC 2NO-2NC	Timed Inst.	**6957ED41-5** **6957ED41-5**	A A	B B
Timer (OFF Delay)	1NO-1NC	Timed	**6957ED41-2**	A	B
	1NO-1NC 1NO-1NC	Timed Inst.	**6957ED41-4** **6957ED41-4**	A A	B B
	1NO-1NC 2NO-2NC	Timed Inst.	**6957ED41-6** **6957ED41-6**	A A	B B

❹ Complete Catalog number consists of the Basic Number, plus the Suffix Letter. Example: 6957ED41-1A.

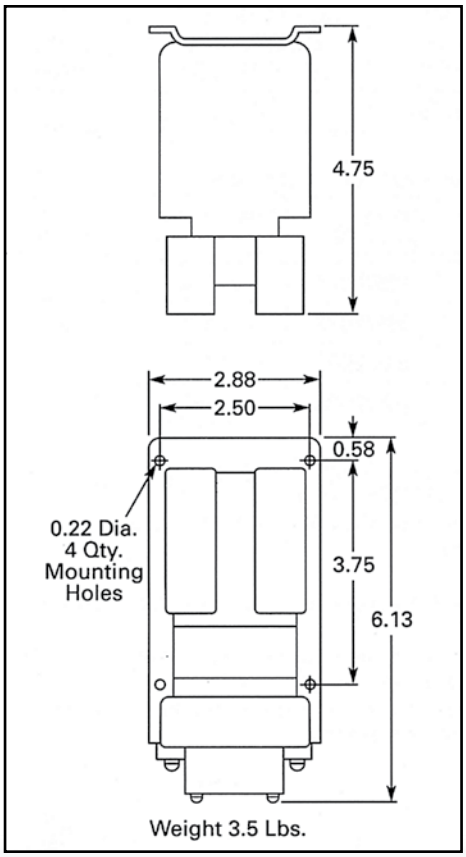
This timing relay can be supplied for either On Delay or OFF Delay timing, but is not convertible from one to the other.

NOTE: Solenoid plunger may move during shock and cause contacts to operate. An energized timing relay may even recycle.

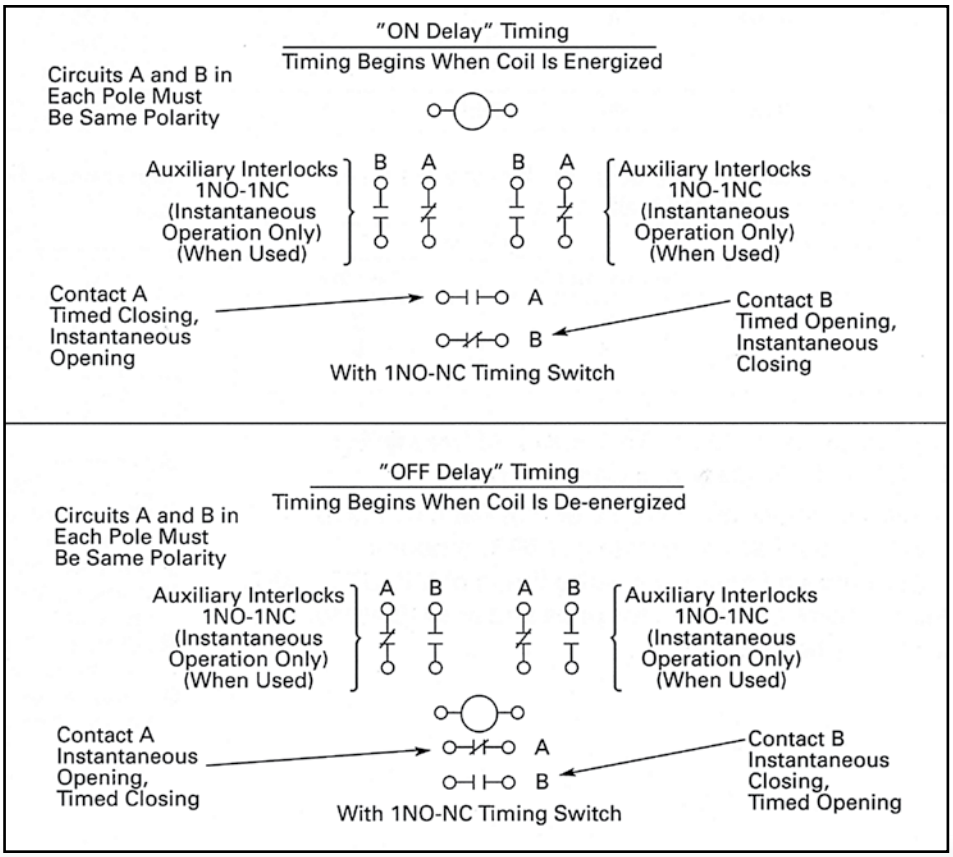
Ampere Rating – AC Pilot Duty

	AC Volts	
	440	110
Continuous	15	15
Maximum Interrupting	6	15
Maximum Inrush	10	40

Approximate Dimensions in Inches



Connection Diagrams



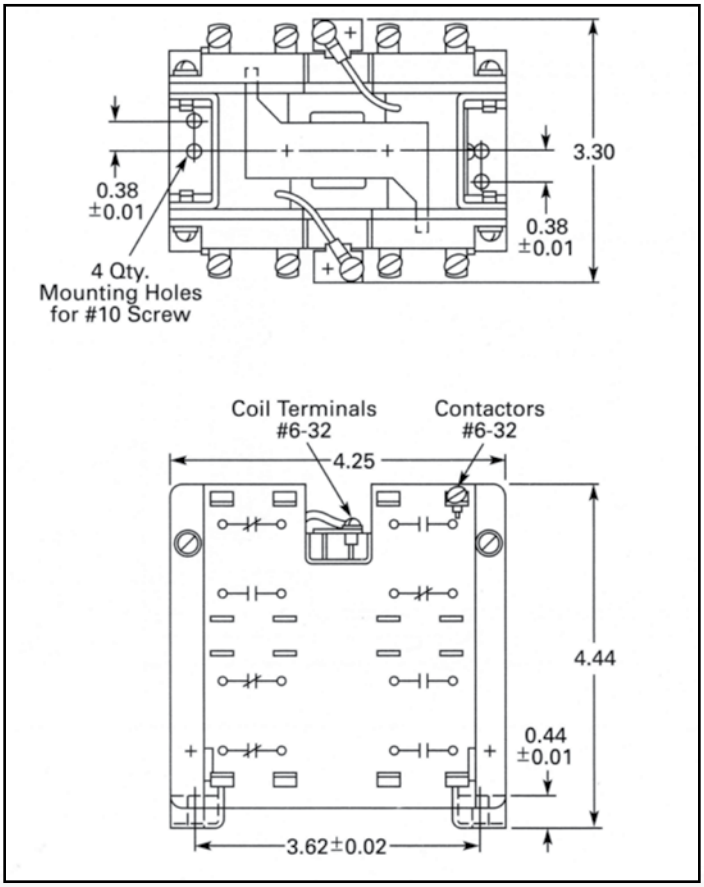
Type 6957
AC Multi-Pole General Purpose Relay – N1154

6957ED59-10C
8-Pole

When ordering specify
- Catalog number

Features
- Replaceable contacts fully rated to 440V.
- Easy installation and wiring.
- Repair part commonality with widely used Size 1 N850 device.
- Low Noise (Quiet) version available.

Approximate Dimensions in Inches



Specifications
- MIL-SPEC MIL-DTL-2212
- Number of poles . . . . . .8 maximum

Interlock Contact

	Amperes		
	Make	Break	Continuous
440V AC	6	1	15
110V AC	15	1	15

- Contact bounce... 4 milliseconds – Equivalent to Class II shockproofness as defined in MIL-R-19523A
- Contact weight .... 2.4 Pounds

Coil Data – 60 Hertz (All Devices)

		440V	110V
Inrush	Amperes Watts VA	0.46 170 200	1.84 170 200
Sealed	Amperes Watts VA	0.04 5.4 17.8	0.16 5.4 17.8

Coil Data – 60 Hertz (All Devices)

Catalog number ❶ ❷	Poles	
	NO	NC
6957ED59-1	4	0
6957ED59-2	3	1
6957ED59-3	2	2
6957ED59-4	1	3
6957ED59-5	0	4
6957ED59-6	8	0
6957ED59-7	7	1
6957ED59-8	6	2
6957ED59-9	5	3
6957ED59-10	4	4
6957ED59-11	3	5
6957ED59-12	2	6
6957ED59-13	1	7
6957ED59-14	0	8

❶ Add Magnet coil Suffix to Part Number for appropriate coil voltage. Example: 6957ED59-2A for 440V AC coil.
❷ Add "Q" suffix to part number for "Quiet" version. Example: 6957ED59-2AQ. Quiet devices meet MIL-STD-740B.

Suffix	Coil Voltage
A	440V
B	220V
C	110V

Type 6957ED104
Navy Electronic Overload Relay – N2000

A more capable and upgraded product is the NEMO found on page 8.

N2000

General

The N2000 Overload Relay is a solid-state overload relay designed to protect a motor against excessive heavy loads.

The N2000 is available in five current ranges:

- Size A..... (0.25 to 18A)
- Size B ..... (9 to 32A)
- Size C ..... (16 to 72A)
- Size D ..... (31 to 135A)
- Size E..... (135A and above – requires external CTs)

Features

- Motor trip current selected by program function (no heater coils required)
- Separate trip curves available for standard, high efficiency and high inertia motors
- Phase-loss protection
- Phase-unbalance protection
- JAM protection
- Auto-rest
- Undercurrent trip
- Emergency run

Programmability

The N2000 can be programmed with the Hand Held Programmer shown on page 50.

Catalog number Format — N2000 Overload Relay

6957ED104 – A 1 A T N

Overload Ampere Rating
A – 19 Amperes
B – 32 Amperes
C – 72 Amperes
D – 135 Amperes
E – 19 Amperes ❶

Control Voltage
1 – 110 Volts AC
2 – 440 Volts AC

Operation
A – 1 Button (RESET/EMER. RUN)
B – 1 Button (STOP/RESET)
C – 2 Button (STOP – RESET/EMER. RUN)
D – 2 Button (START – RESET/EMER. RUN)
E – 2 Button (START – STOP/RESET)

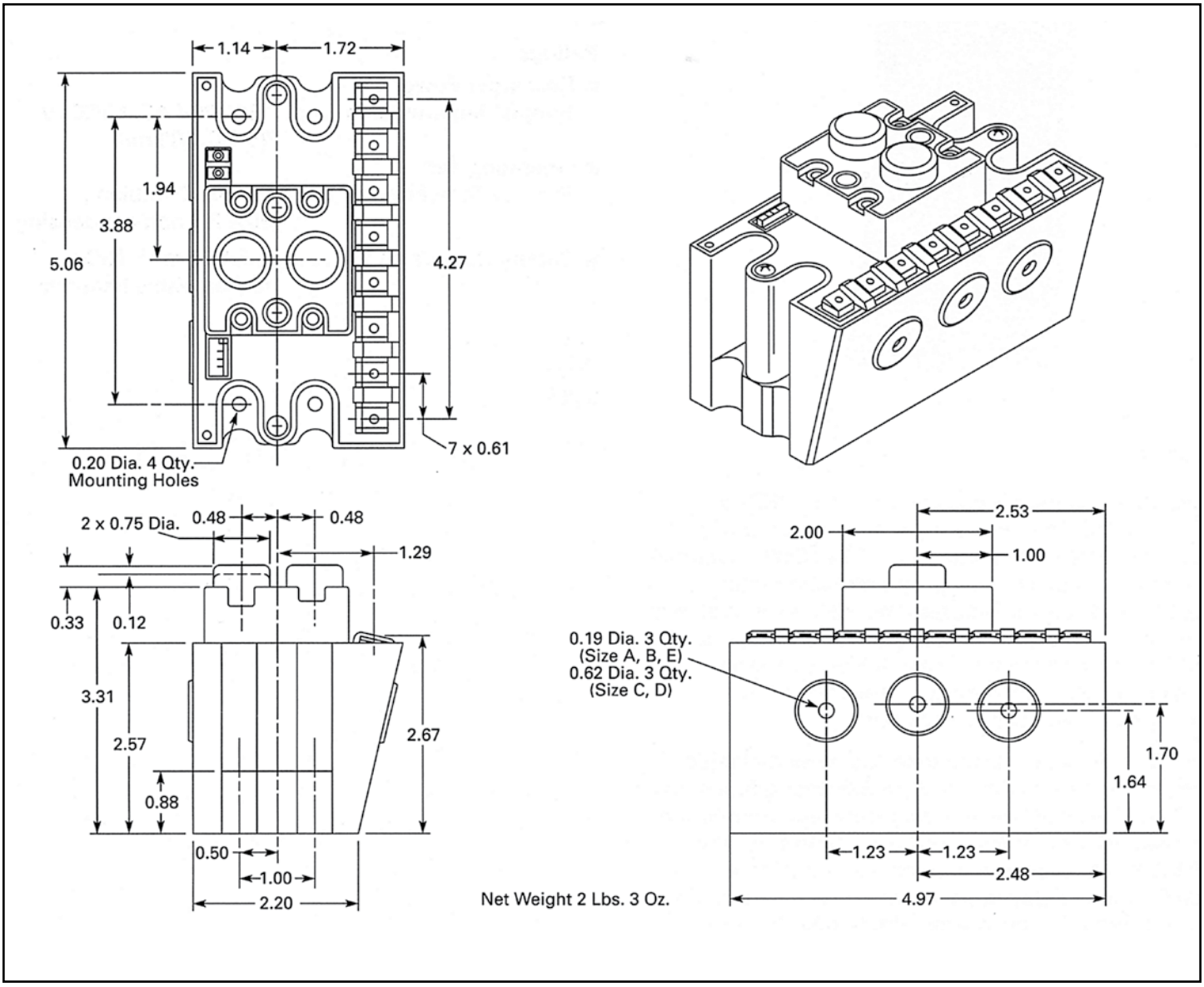
Control Terminals
T – Top (Standard)
B – Bottom

N – Non-reversing
R – Reversing

❶ Used with external 500:5 current transformers for Size 5 and 5S applications.
NOTE: This Size E device will not drive a Size 5 or 5S coil at 110 volts.
Use only with 440 volt contactor coils.

Type 6957ED104
Navy Electronic Overload Relay – N2000

Approximate Dimensions in Inches



Type 6991ED27
Navy Communication Module – N2001

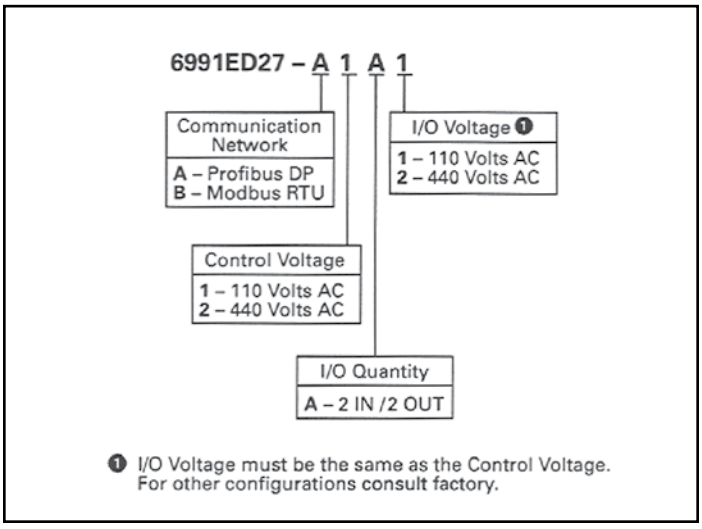
A more capable and upgraded product is the NEMO found on page 8.

N2001

General

The N2001 Navy Communication Module (NCM) connects the N2000 Navy Electronic Overload Relay (NEOLR) to a Profibus or Modbus-RTU communication network. The NCM is designed to mount under the NEOLR on a controller panel. A receptacle on the top of the NCM connects directly into a plug on the bottom of the NEOLR. The NCM and NEOLR provide users with the ability to control and monitor the controller operation. The NCM also includes independent discrete inputs and outputs that can be monitored and controlled over the network.)

Catalog number Format — N2001 Communication Module



Specifications MIL-DTL-2212H

Ratings

- **Environmental**
  - Enclosure .....General
  - Operating temp .....-40°C to +50°C
  - Storage temp.....-40°C to +80°C
  - Humidity.....95% non-condensing

- **Input Power**
  - Voltage.....115V AC or 440V AC, +10% -20% (model dependent)
  - Frequency.....60 Hz ±3%
  - Burden .....10 VA

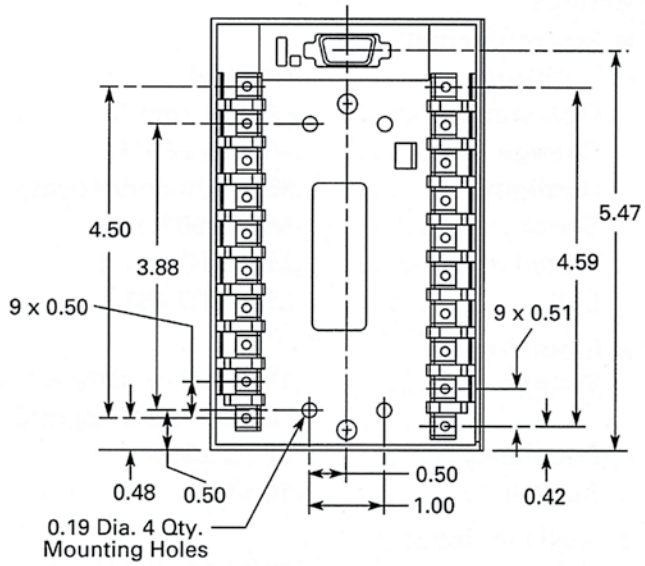
- **Auxiliary Input**
  - Voltage.....115V AC or 440V AC, +10% -20% (model dependent)
  - Frequency.....60 Hz ±3%
  - Burden .....2.7 mA @115V AC, 5 mA @ 440V AC
  - Turn ON delay.....32 milliseconds
  - Turn OFF delay.....32 milliseconds
  - Turn ON level .....92V AC minimum for 115V AC 352V AC minimum for 440V AC
  - Turn OFF level .....12V AC maximum for 115V AC 44V AC maximum for 440V AC
  - Withstand voltage.....1880V AC for 1 minute

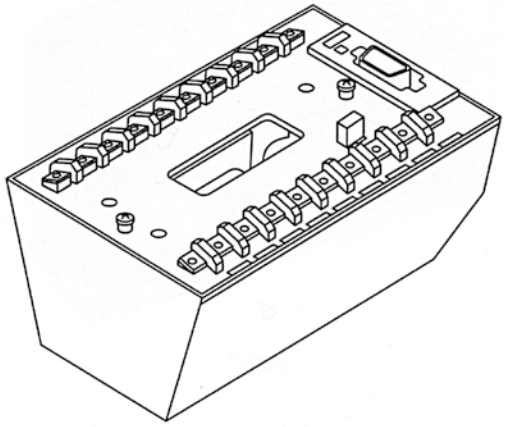
- **Auxiliary Output**

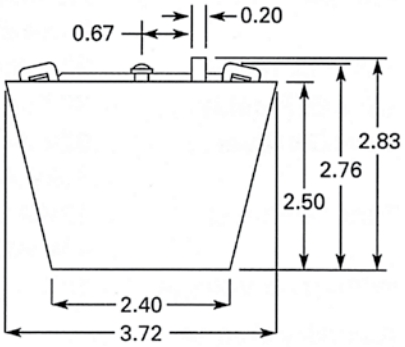
  Output circuit has two triacs in series.
  - Voltage.....115V AC or 440V AC, +10% -20% (model dependent)
  - Frequency.....60 Hz ±3%
  - Continuous rating.....200 mA
  - Holding current .....20 mA minimum
  - OFF leakage current.....5 mA maximum
  - Inrush ratin.....14A for 100 ms
  - Turn ON delay.....32 milliseconds
  - Turn OFF delay.....32 milliseconds
  - Withstand voltage.....1880V AC for 1 minute

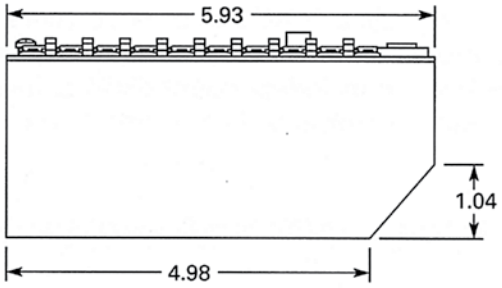
Type 6991ED27
Navy Communication Module

Approximate Dimensions in Inches and Weight









Net Weight 2 Lbs. 14 oz.

Type N2000HHP
N2000 Hand Held Programmer

A more capable and upgraded product is the NEMO found on page 8. The NEMO does not require a special external programming device.

N2000HHP

General

The N2000 Hand Held Programmer (N2000HHP) is designed to facilitate the setup of any of the various styles of the N2000 Overload Relay. The N2000 Overload Relay family contains many programmable motor protection and control features. The N2000HHP is able to access and modify all of the programmable features of the N2000 Overload Relay. These features may be accessed directly via the function select keys, or indirectly by means of stored setups.

The N2000HHP supports multiple customer definable setups. In addition to the direct programming functions, the N2000HHP also supports diagnostic and monitoring functions such as start/stop and current display. The N2000HHP is designed to provide enough voltage to the N2000 Overload Relay to power its logic circuits, and to allow programming even when the N2000 Overload Relay is not energized.

Specifications

Ratings

- Recharger power supply requirements.....110/220V AC, 50/60 Hz 9V DC, 300 mA
- Operating and storage temperature.....0-50°C ambient, 90% RH non-condensing
- Battery requirements.....4 AA 60 mAH NiCd rechargeable batteries

Type 6957
AC Navy Overload Relay – N750

6957ED14-3A

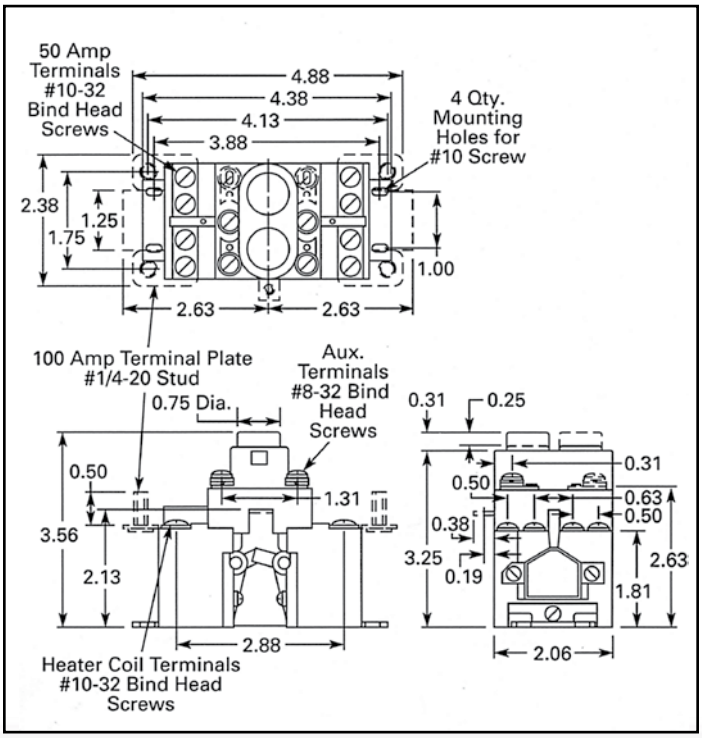
When ordering specify

- Catalog number

Specifications

- MIL-SPEC.....MIL-DTL-2212
- Compensation.....Insensitive to variations in temperature – Less than 3% change in trip current for each 10°C change in ambient
- Trip Mechanism.....Eutectic alloy
- Number of Heaters...2 (phase)
- Motor Current Range 0.5 to 126 Amps ❷
- Relay Weigh .....1.0 Pounds ❸

Approximate Dimensions in Inches



Overload Relays

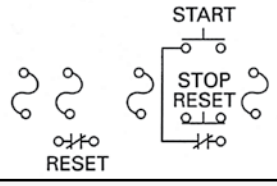
Number of Buttons	Terminal Rating Amperes	Markings	Catalog Number
Standard Devices			
1	50 100	RESET	**6957ED14-1A** **6957ED14-6A**
	50 100	RESET ❹	**6957ED14-26A** **6957ED14-36A**
	50 100	RESET ❸	**6957ED14-24A** **6957ED14-25A**
	50 100	STOP — RESET	**6957ED14-27A** **6957ED14-34A**
2	50 100	START — STOP/RESET	**6957ED14-2A** **6957ED14-7A**
	50 100	EM. RUN — STOP/RESET	**6957ED14-4A** **6957ED14-9A**
	50 100	START — RESET	**6957ED14-5A** **6957ED14-10A**
3	50 100	EM RUN — START — STOP/RESET	**6957ED14-3A** **6957ED14-8A**
With Remote (Solenoid) Reset ❶			
1	50 100	RESET	**6957ED14-11_** **6957ED14-16_**
	50 100	RESET ❸	**6957ED14-15_** **6957ED14-20_**
	50 100	RESET ❹	**6957ED14-38_** **6957ED14-37_**
2	50	START — STOP/RESET	**6957ED14-12**
	50 100	EM RUN — STOP/RESET	**6957ED14-14_** **6957ED14-19_**
	100	START — RESET	**6957ED14-17_**
3	50 100	EM RUN — START — STOP/RESET	**6957ED14-13_** **6957ED14-18_**
For Heater Coil selection, see Page 60.			

❶ Add Suffix Letter for solenoid coil voltage.
Example: 6957ED14-19F. Contact factory for information.
❷ For current limiting reactors or current transformers, contact the factory.
❸ Device supplied with extra terminals.
❹ Device has a Form C contact alarm circuit. Consult factory for application.

Replacement Operator Boots

Number of Buttons	Boot Part Number
1 2 3	**32-17** **32-251** **32-20**

Diagram Symbols

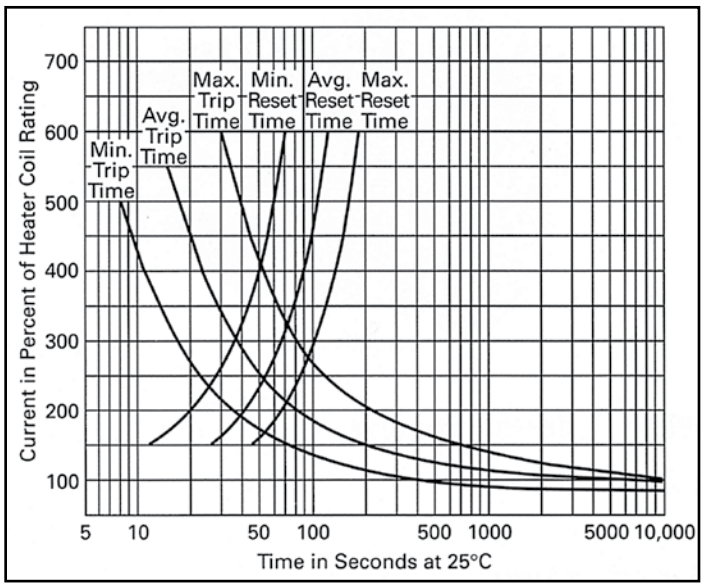


Type 6957
AC Navy Overload Relay – N750

Trip Adjustability

The relay may be adjusted to trip at a value between 90 and 110 percent of the rated coil current. Loosening the binding screws that hold the relay heater coil and moving the heater coil out away from the relay will increase the value of current required to trip the relay. Moving the heater coil assembly in will decrease the value of current required to trip the relay. Serrations on the terminal plates and on the underside of the slotted brackets of the heater coil assembly securely lock the heater coil in position when the binding head screws are tightened.

Trip Curves



Type 9104
AC Heater Coils

Overload Heater Coils for N750

Heater Coil

General

The 9104 Heater Coils listed at right are for use on the following AC magnetic Starters with the N750 Overload Relay:

6262.....6963
6966.....6967
6968.....6999

Heater Selection

Select the Heater based on motor nameplate full load current.

Heater Coils are rated to protect 40°C motors, and open and dripproof motors having a **service factor of 1.15** where the motor and the controller are at the same Ambient temperature.

For other conditions:

A. For 50°C, 55°C, 75°C rise motors and **enclosed motors having a service factor of 1.0,** select a heater coil two sizes smaller.

B. Ambient temperature of controller lower than motor by 26°C, use one size smaller heater coil.

C. Ambient temperature of controller higher than motor by 26°C, use one size larger heater coil.

Ultimate tripping current of heater is approximately 1.20 times the minimum current listed in the tables.

For Size 1-4 Controller

Motor Amperes ❶		Catalog Number ❷	Motor Amperes ❶		Catalog Number ❷	Motor Amperes ❶		Catalog Number ❷
Min.	Max.		Min.	Max.		Min.	Max.	
0.5	0.53	**H3815**	3.53	3.79	**H3934**	22.5	24.1	**H3958**
0.54	0.57	**H3816**	3.8	4.06	**H3935**	24.2	26.1	**H3959**
0.59	0.63	**H3817**	4.07	4.36	**H3936**	26.2	28.4	**H3960**
0.66	0.69	**H3818**	4.37	4.74	**H3937**	28.5	30.7	**H3961**
0.7	0.74	**H3819**	4.75	5.14	**H3938**	30.8	33.1	**H3962**
0.817	0.866	**H3915**	5.15	5.56	**H3939**	33.2	35.9	**H3963**
0.867	0.941	**H3916**	5.57	6.04	**H3940**	36	38.7	**H3964**
0.942	1.01	**H3917**	6.05	6.51	**H3941**	38.8	42.2	**H3965**
1.02	1.1	**H3918**	6.52	6.99	**H3942**	42.3	45.8	**H3966**
1.11	1.17	**H3919**	7	7.55	**H3943**	45.9	49.2	**H3967**
1.18	1.28	**H3920**	7.56	8.15	**H3944**	49.3	53	**H3968**
1.29	1.39	**H3921**	8.16	8.74	**H3945**	53.1	57.6	**H3969**
1.4	1.51	**H3922**	8.75	9.57	**H3946**	57.7	61.8	**H3970**
1.52	1.6	**H3923**	9.58	10.2	**H3947**	61.9	67.3	**H3971**
1.61	1.75	**H3924**	10.3	11.2	**H3948**	67.4	724	**H3972**
1.76	1.88	**H3925**	11.3	12.1	**H3949**	72.5	78.7	**H3973**
1.89	2.05	**H3926**	12.2	13	**H3950**	78.8	84.9	**H3974**
2.06	2.21	**H3927**	13.1	14	**H3951**	85	91.6	**H4078**
2.22	2.38	**H3928**	14.1	15.1	**H3952**	91.7	99.9	**H4079**
2.39	2.59	**H3929**	15.2	16.3	**H3953**	100	107	**H4080**
2.6	2.77	**H3930**	16.4	17.8	**H3954**	108	116	**H4081**
2.78	2.96	**H3931**	17.9	19.2	**H3955**	117	126	**H4082**
2.97	3.24	**H3932**	19.3	20.8	**H3956**			
3.25	3.52	**H3933**	20.9	224	**H3957**			

For Controller with Current Transformers

Size 3 and 4 For use with 30.9:1 Transformer			Sizes 5 and 5 SP For Use With 62:1 Transformer			Size 6 For use with 120:1 Transformer		
Motor Amperes ❶		Catalog Number ❷	Motor Amperes ❶		Catalog Number ❷	Motor Amperes ❶		Catalog Number ❶
Min.	Max.		Min.	Max.		Min.	Max.	
53.2	57.1	**H3925**	84.3	91.5	**H3922**	227	246	**H3926**
57.2	62.1	**H3926**	91.6	97.4	**H3923**	247	265	**H3927**
62.2	66.9	**H3927**	97.5	105	**H3924**	266	285	**H3928**
67	72.2	**H3928**	106	113	**H3925**	286	311	**H3929**
72.3	78.4	**H3929**	114	123	**H3926**	312	332	**H3930**
78.5	83.1	**H3930**	124	135	**H3927**	333	355	**H3931**
83.2	89.1	**H3931**	136	145	**H3928**	356	389	**H3932**
89.2	97.4	**H3932**	146	156	**H3929**	390	422	**H3933**
97.5	105	**H3933**	157	167	**H3930**	423	455	**H3934**
106	113	**H3934**	168	177	**H3931**	456	487	**H3935**
114	121	**H3935**	178	193	**H3932**	488	523	**H3936**
122	130	**H3936**	194	203	**H3933**	524	569	**H3937**
131	141	**H3937**	204	223	**H3934**			
142	153	**H3938**	224	240	**H3935**			
			241	257	**H3936**			
			258	279	**H3937**			
			280	303	**H3938**			
			304	328	**H3939**			
			329	362	**H3940**			
			363	390	**H3941**			
			391	419	**H3942**			
			420	453	**H3943**			

❶ Based on relay inside a controller and all in a 50°C ambient.

❶ Catalog number must have a 9104 prefix to be complete. Example: 9104H3945. Each catalog Number above covers one heater coil only. Two are required for a three-phase application.

Type 6957
Reactor Coils for AC Navy Overload Relay – N750

General

The N750 overload relay with parallel reactor is intended to provide a slower time response to motor inrush currents than the standard N750 overload. This is done to eliminate nuisance overload tripping during long duration motor acceleration currents as required by a particular mechanical system.

The underlying principle states that as a reactor becomes saturated, its inductive impedance becomes very small in comparison to the heater coil impedance and consequently the reactor will handle the largest part of the inrush current, avoiding premature tripping. As the inrush current subsides to normal full load and the reactor comes out of saturation, the reactor impedance increases to become very large in comparison to the heater coil impedance. The heater coil then carries most of the full load current and standard overload protection is then provided. Each specific heater coil has its own matching reactor that will provide the time delay required.

- Contact factory for application guidance.
- When reactors are used, two are required for each N750 overload relay.

Heater and Reactor Coils

Motor Amperes		Heater Coil Number	Reactor Coil Number
Min.	Max.		
0.817	0.866	**9104H3915**	**9-1584-1**
0.867	0.941	**9104H3916**	**9-1584-2**
0.942	1.01	**9104H3917**	**9-1584-3**
1.02	1.1	**9104H3918**	**9-1584-4**
1.11	1.17	**9104H3919**	**9-1584-4**
1.18	1.28	**9104H3920**	**9-1584-4**
1.29	1.39	**9104H3921**	**9-1584-5**
1.4	1.51	**9104H3922**	**9-1584-5**
1.52	1.6	**9104H3923**	**9-1584-6**
1.61	1.75	**9104H3924**	**9-1584-7**
1.76	1.88	**9104H3925**	**9-1584-8**
1.89	2.05	**9104H3926**	**9-1584-9**
2.06	2.21	**9104H3927**	**9-1584-9**
2.22	2.38	**9104H3928**	**9-1584-10**
2.39	2.59	**9104H3929**	**9-1584-10**
2.6	2.77	**9104H3930**	**9-1584-11**
2.78	2.96	**9104H3931**	**9-1584-12**
2.97	3.24	**9104H3932**	**9-1584-12**
3.25	3.52	**9104H3933**	**9-1584-13**
3.53	3.79	**9104H3934**	**9-1584-14**
3.8	4.06	**9104H3935**	**9-1584-14**

Motor Amperes		Heater Coil Number	Reactor Coil Number
Min.	Max.		
4.07	4.36	**9104H3936**	**9-1584-14**
4.37	4.74	**9104H3937**	**9-1584-15**
4.75	5.14	**9104H3938**	**9-1584-15**
5.15	5.56	**9104H3939**	**9-1584-16**
5.57	6.04	**9104H3940**	**9-1584-17**
6.05	6.51	**9104H3941**	**9-1584-17**
6.52	6.99	**9104H3942**	**9-1584-17**
7	7.55	**9104H3943**	**9-1584-18**
7.56	8.15	**9104H3944**	**9-1584-19**
8.16	8.74	**9104H3945**	**9-1584-19**
8.75	9.57	**9104H3946**	**9-1584-20**
9.58	10.2	**9104H3947**	**9-1584-21**
10.3	11.2	**9104H3948**	**9-1584-21**
11.3	12.1	**9104H3949**	**9-1584-22**
12.2	13	**9104H3950**	**9-1584-22**
13.1	14	**9104H3951**	**9-1584-23**
14.1	15.1	**9104H3952**	**9-1584-23**
15.2	16.3	**9104H3953**	**9-1584-23**
16.4	17.8	**9104H3954**	**9-1584-24**
17.9	19.2	**9104H3955**	**9-1584-24**
19.3	20.8	**9104H3956**	**9-1584-24**

Type 6956
Size “0” Reverser Assembly

When ordering specify

- Catalog number

General

The Size “0” Reverser Assembly is a special purpose control panel consisting of two N1310 contactors, which are electrically and mechanically interlocked. The assembly is completely qualified to MIL-DTL-2212 and is ideally suited for reversing applications that have severe space limitations.

Size	Catalog number	Suffix Letter		
		440V	220V	110V
0	**6956ED464-1**	A	B	C

Electrical Data (Enclosed)

	N1310
Number of Poles Ampere Rating – Enclosed Horsepower Rating – 440V, 3-Phase, 60 Hz	3 18 5
Maximum Break – Amperes at 484V, 40% PF No. of Interlocks – Hi Shock NO NC ❶	108 1 1

Interlock Contact

	Amperes		
	Make	Break	Continuous
440V AC	6	1	15
110V AC	15	1	15

Coil Data – 60 Hertz (All Devices)

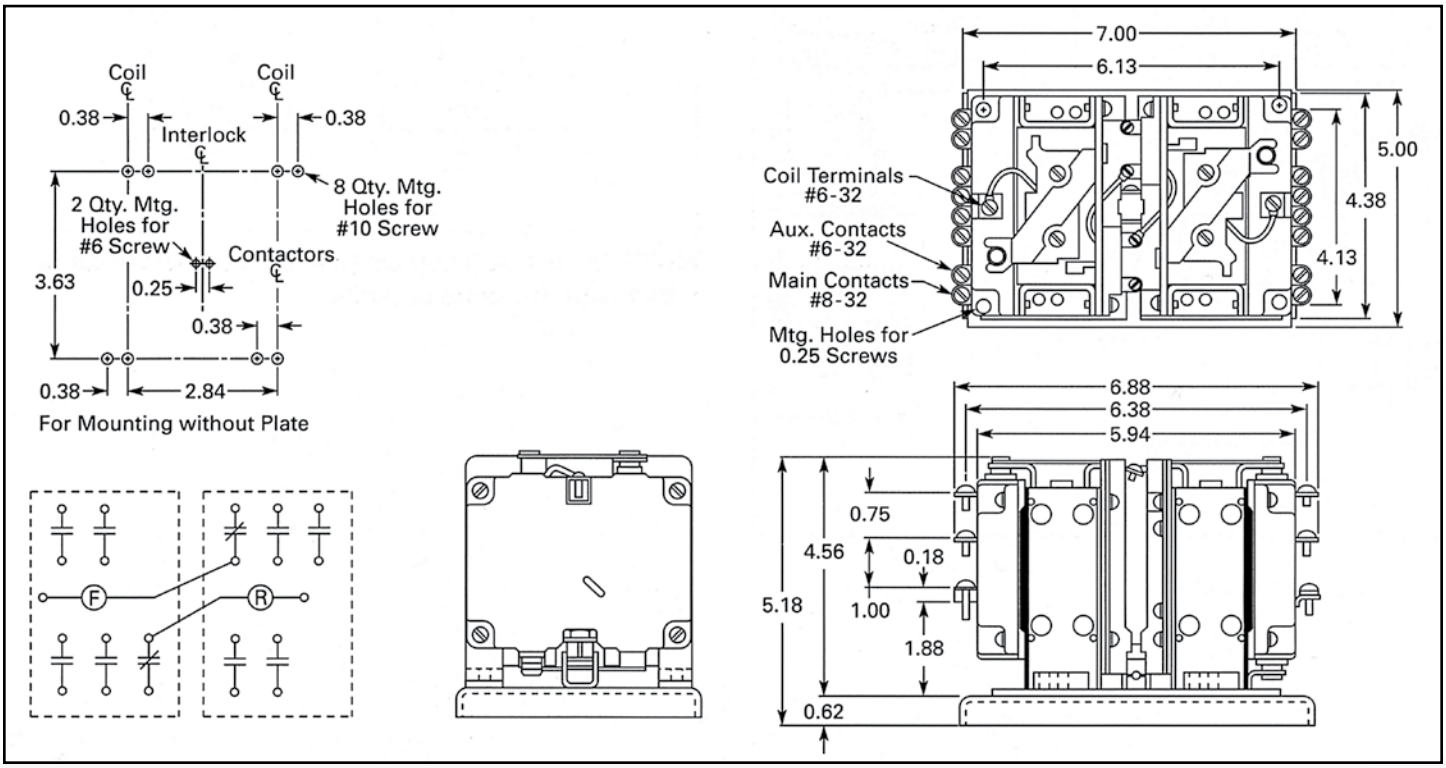
		440V	110V
Inrush	Amperes Watts VA	0.46 170 200	1.84 170 200
Sealed	Amperes Watts VA	0.04 5.4 17.8	0.16 5.4 17.8

❶ This NC contact is factory wired for electrical interlocking. It cannot be used in other circuits.

Reverser Weight

	N1310
Pounds	7

Approximate Dimensions in Inches



Type 6957
AC Magnetic Latch Relay – N639

6957ED12-5B

General

The contact setting on this relay is retained or latched with a two-position toggle mechanism. No permanent latching magnets are used.

The set of contacts marked “A” are designed for control of the coil circuits and is not adaptable for other circuits. The set of contacts marked “B” are available for control of external circuits.

The coils are energized momentarily to position the switch and are de-energized by the opening of the corresponding “A” contacts on the switch.

When ordering specify

- Catalog number

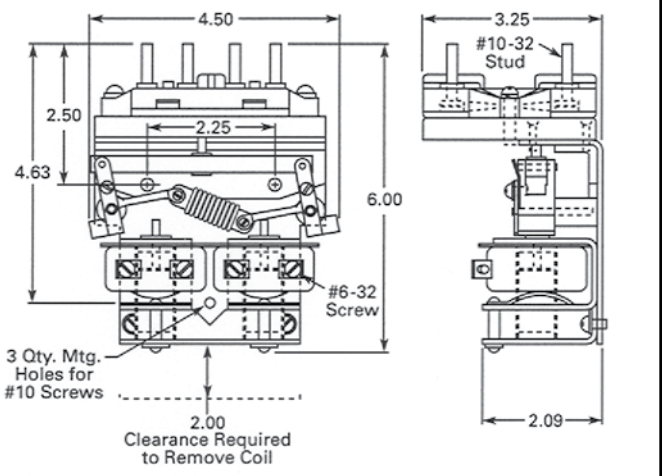
Type	Contacts	Catalog number ❶	Suffix Letter	
			440V 60 Hz	110V 60 Hz
Latch	1NO-1NC	**6957ED12-5**	B	C

❶ Complete Catalog number consists of the Basic Number, plus the suffix.
Example: 6957ED12-5B.
Weight: 2 Lbs.
QPL Test reference: NY 4456-A-39A

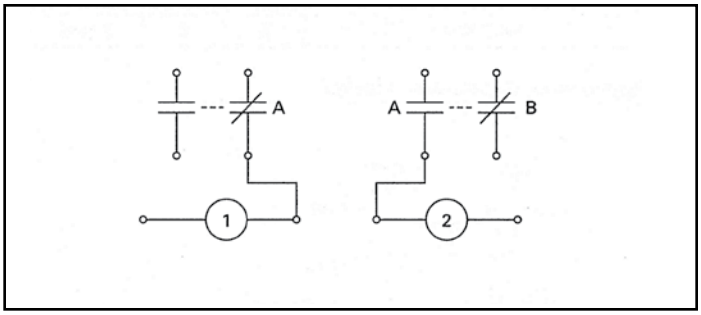
Ampere Rating AC Pilot Duty

	AC Volts	
	440V 60 Hz	110V 60 Hz
Continuous	15	15
Maximum Interrupting	6	15
Maximum Inrush	10	40

Approximate Dimensions in Inches



Typical Wiring Diagram



NOTE: In each A-B contact pair, the contacts must be wired with the same polarity.

Type 6922
DC Manual Across-the-Line Starter

Starter in watertight enclosure

When ordering specify

- Catalog number
- Horsepower
- Voltage
- Full load motor current
- Motor inrush current
- Type of motor with which starter is to be used
- Application

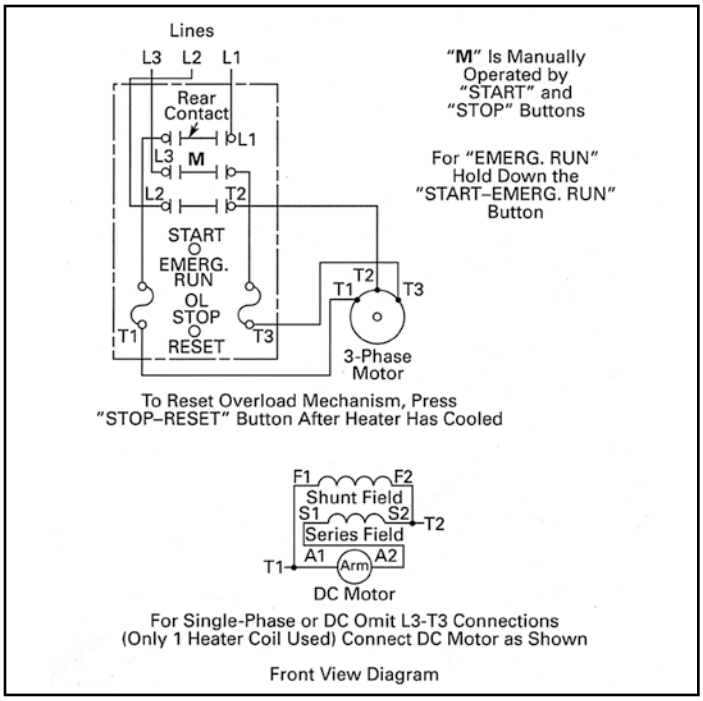
Specifications

- MIL-SPEC.....MIL-DTL-2212
- Enclosure .....Dripproof or watertight
- Operation .....Manual
- Type .....Across-the-line
- Function .....Motor starting
- Duty .....Continuous
- Protection.....Low voltage release effect
- Overload protection Thermal type relay
- Compensation.....Change in rating does not exceed 5% for each 10°C change in ambient between 20°C and 70°C
- Adjustability .....Adjustable from 90 to 110% of relay rating
- Type of reset.....Hand from STOP button
- Performance .....Manual
- Ambient temp .....50°C
- Insulation .....Class B
- Emergency Run .....By holding START button depressed

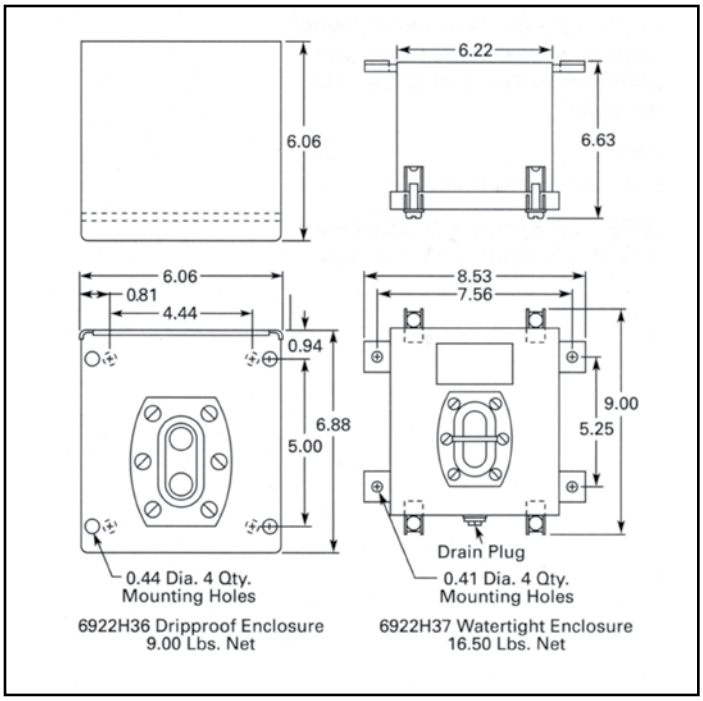
Max. hp	Starter			
115V or 230V DC	Dripproof		Watertight	
	Cat. No.	Lbs. Net	Cat. No.	Lbs. Net
½	**6922H36B**	9.5	**6922H37D**	16.5

Select heaters from table on Page 58.

Typical Wiring Diagram



Approximate Dimensions in Inches



DC Manual Across-the-Line Starter Overload Heater Coil Selection

General

The 9104 Heater Coils listed at right are for use on Type 6922 Manual Starters.

Heater Selection

Select Heater Coils based on motor nameplate full load current.

Heater coils are rated to protect 40°C motors. Open and dripproof motors have a **service factor of 1.15** where the motor and the controller are at the same Ambient temperature.

For other conditions:

A. For 50°C, 55°C, 75°C rise motors and **enclosed motors having a service factor of 1.0, select a heater coil two sizes smaller.**

B. Ambient temperature of controller lower than the motor by 26°C, use one size smaller heater coil.

C. Ambient temperature of controller higher than the motor by 26°C, use on size larger coil.

Ultimate tripping current of heater is approximately 1.20 times the minimum current rating listed in the tables.

NOTE: There are some coils that require minimum order quantity.

Motor Amperes ❶		Catalog number	Motor Amperes ❶		Catalog number
Min.	Max.		Min.	Max	
0.32	0.343	**9104H3812**	3.01	3.23	**9104H3771**
0.344	0.37	**9104H3813**	3.24	3.55	**9104H3772**
0.371	0.397	**9104H3814**	3.56	3.83	**9104H3773**
0.398	0.424	**9104H3815**	3.84	4.16	**9104H3774**
0.425	0.461	**9104H3816**	4.17	4.5	**9104H3775**
0.462	0.5	**9104H3817**	4.51	4.94	**9104H3776**
0.501	0.54	**9104H3818**	4.95	5.29	**9104H3777**
0.541	0.583	**9104H3819**	5.3	5.79	**9104H3778**
0.584	0.629	**9104H3820**	5.8	6.25	**9104H3779**
0.63	0.671	**9104H3821**	6.26	6.79	**9104H3780**
0.672	0.73	**9104H3822**	6.8	7.29	**9104H3781**
0.731	0.789	**9104H3823**	7.3	7.99	**9104H3782**
0.79	0.859	**9104H3754**	8	8.74	**9104H3783**
0.86	0.917	**9104H3755**	8.75	9.59	**9104H3784**
0.918	1	**9104H3756**	9.6	10.4	**9104H3785**
1.01	1.07	**9104H3757**	10.5	11.3	**9104H3786**
1.08	1.15	**9104H3758**	11.4	12.2	**9104H3787**
1.16	1.26	**9104H3759**	12.3	13.2	**9104H3788**
1.27	1.35	**9104H3760**	13.3	14.3	**9104H3789**
1.36	1.46	**9104H3761**	14.4	15.3	**9104H3790**
1.47	1.57	**9104H3762**	15.4	16.3	**9104H3791** ❷
1.58	1.68	**9104H3763**	16.4	17.9	**9104H3792** ❷
1.69	1.82	**9104H3764**	18	19.2	**9104H3793** ❷
1.83	1.96	**9104H3765**	19.3	20.7	**9104H3794** ❷
1.97	2.16	**9104H3766**	20.8	22.1	**9104H3795** ❷
2.17	2.31	**9104H3767**	22.2	24	**9104H3796** ❷
2.32	2.53	**9104H3768**	24.1	26.3	**9104H3797** ❷
2.54	2.74	**9104H3769**	26.4	28.8	**9104H3798** ❷
2.75	3	**9104H3770**			

❶ Based on starter in a maximum 50°C ambient.
❷ These coils are quantity sensitive and have minimum order size of five (5) pieces.

Type 6942
Engineered DC Magnetic Control

When ordering specify

- Type number
- Specifications applying
- Voltage
- Horsepower rating
- Full load motor current
- Local or remote master switch
- Scheme of operation (LVP or LVR)
- Semi-automatic or automatic operation
- For adjustable speed motor - speed range by field control, shunt field resistance, field current at weakened field speed, and horsepower rating at full speed
- Application - nature of load, Example: fan, MG set
- Any special contract requirements involving operation, construction, plans, packing, etc.
- Shockproofness

Specifications

- MIL-SPEC.....MIL-C-2212
- Enclosure .....Dripproof; for watertight enclosed controllers, contact factory
- Operation .....Magnetic
- Type .....Sizes 1 to 7 – Resistor
- Function -
- Non-reversing type...Motor starting; motor starting and speed regulation by field control
- Reversing type .....Refer to factory
- Duty .....Continuous
- Protection .....Low voltage protection and low voltage release types
- Shockproofness .....Timer is mechanically shockproof only.
- Overload Protection .Thermal or magnetic (based on application)
- Performance .....Non-automatic or automatic (depending upon type of master switch used)

Standard controller design will permit accelerating timer and contactors to recycle under shock. To eliminate recycling (if system prohibits this), additional components and circuitry will be required. Refer to factory for pricing with complete details.

- Ambient temp .....50°C
- Insulation .....Class B, except for contactor coils Class A

Size	Maximum Horsepower 230V	Number of Accelerators	Dimension References ❶
1	5	1	A
2	10	1	B
3	25	2	C
4	40	2	D
5	75	2	E
6	150	3	F

Approximate Dimensions in Inches and Weights

Dimension Reference Letter ❷	Dimensions in Inches			Weight Lbs.
	Wide	High	Deep	
A	16	22	10	80
B	18	24	10	100
C	18	26	12	125
D	24	32	13	200
E	34	50	17	500
F	Contact Factory			

❶ See Approximate Dimensions and Weights table.
❷ From Specifications table above.

Type 6942
Engineered DC Magnetic Control

Adding Features / Modifying / Sample Circuit Diagrams

Optional Features

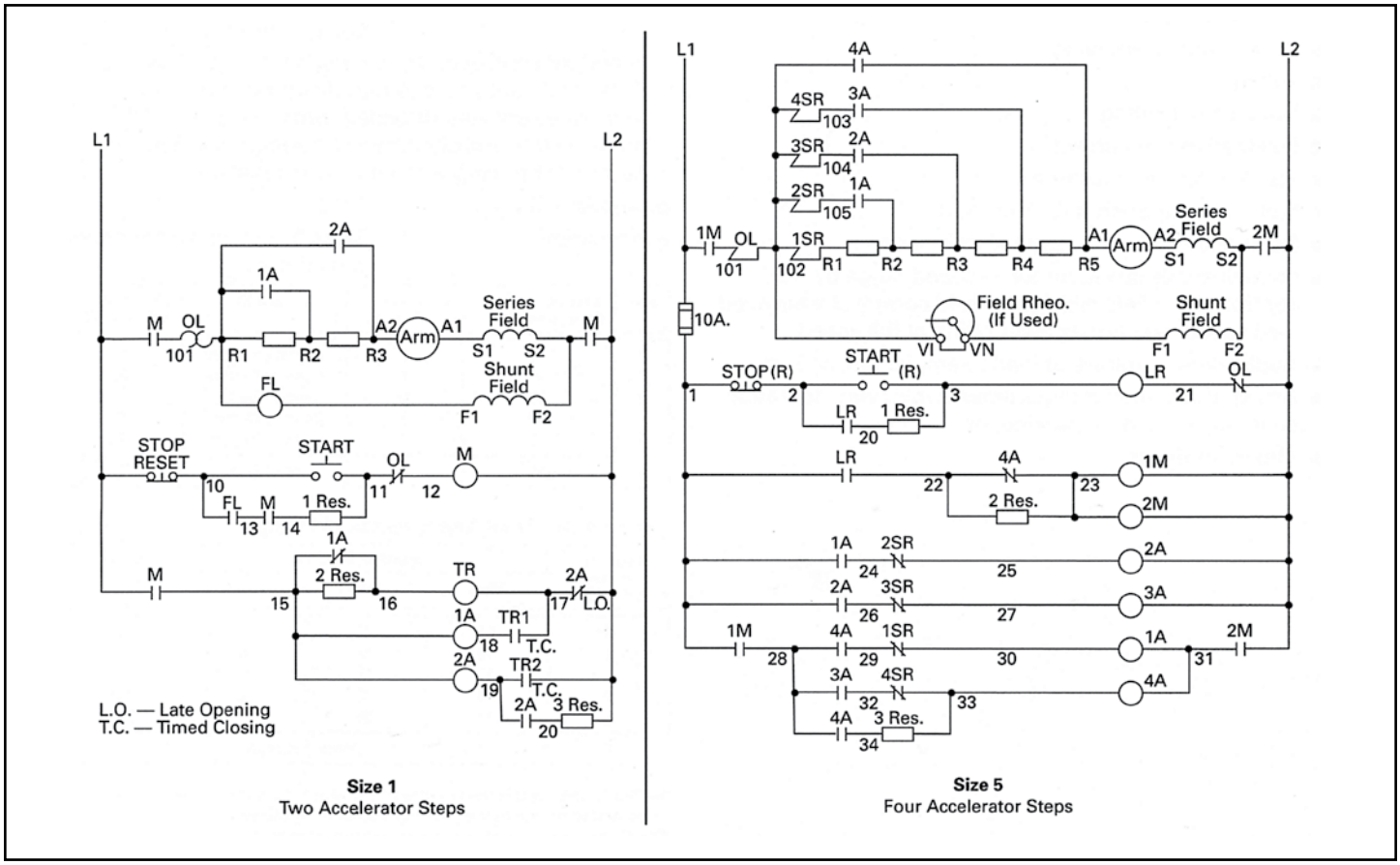
1. Relays –	Added Weight
Field failure	8 lbs.
Series (for current limit acceleration) (N175)	8 lbs.
Control (N617)	7 lbs.
Timer, N907 – DC (for timed acceleration)	4 lbs.
Accelerator, size 2	7 lbs.
Accelerator, size 4	8 lbs.
Overload Relay, N709 (Magnetic)	
Overload Relay, N750 (up to 126 Amperes)❶	4 lbs. 1 lb.

2. Pilot Devices –	Added Weight
Momentary Pushbutton	5 oz.
Indicator Light (includes resistors)	24 oz.
Selector Switch	8 oz.
Rotary Switches – 4 finger	12 oz.
7 finger	24 oz.

3. Other Additions –	
Additional Control	
Circuit Fuse	8 oz.
Wired Interlock	8 oz.
Anti-Condensate Heaters	
Size 1, 2	–
Size 3, 4	–
Size 5	–
Size 6	–

❶ The N750 Overload Relay requires one Heater Coil for DC operation. Use the Controller, Size 1-4, table on Page 60 for Heater Coil selection.

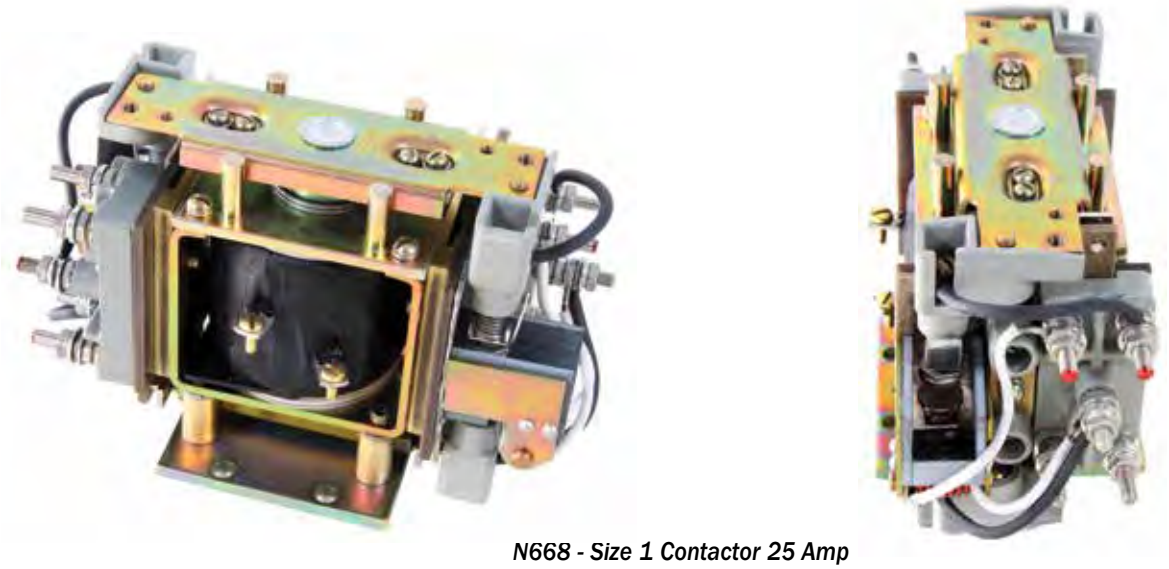
Sample Circuit Diagrams



Size 1
Two Accelerator Steps

Size 5
Four Accelerator Steps

Type 6938
DC Magnetic Contactors and Relays



N668 - Size 1 Contactor 25 Amp

When ordering specify❶

- Base catalog number
- Application
- Contact amperes
- Blow-out coil amperes❷
- Coil voltage
- Auxiliary contact needs
- Thickness of mounting panel, if appropriate❸

- Example: 6938ED20, 75 Amp contacts,
  75 Amp blow-out coil,
  230V DC operating coil,
  1NO-1NC auxiliary contact,
  0.75 inch thick mounting panel.

❶ Refer to selection table on **Page 62**.
❷ A blow-out coil is required to minimize arcing on DC power contactors. To work properly, they must be sized correctly.
❸ Melamine mounted contactors are shipped mounted to a plywood base of the stated thickness. This configures the parts in a correct relationship and provides mounting hardware of the proper length for your application.

Specifications

- MIL-SPEC.....MIL-C-2212
- Operation .....Magnetic
- Ambient temp .....50°C
- Insulation .....Class B, except coils, Class A
- Mounting .....Designed and shipped for mounting to a melamine panel if appropriate. Standard thickness is 0.63 inch, other thicknesses are available. Some devices can mount directly to a steel panel. **See Page 62**, Dimension Reference Table.

Type 6938
DC Magnetic Contactors and Relays

Contactors - Include Blow-Out Coils

Size	Device Number	Main Contacts		Available ❶ Aux. Contacts	Available Coil Voltage (DC)	Base Catalog ❷ ❸ Number	Dim. Ref.
		Rating	Poles				
1	N668	25A	2NO	1NO-1NC	115, 230, 250	**6938ED18**	A
2	N669	50A	2NO	2NO-2NC	115, 230, 250	**6938ED19**	B
3	N700	100A	2NO	2NO-2NC	115, 230, 250	**6938ED20**	C
4	N701	150A	2NO	2NO-2NC	115, 230, 250	**6938ED21**	D
5	N542 ❹	300A	1NO	1NO-1NC	115, 230, 250	**6938ED7**	E
6	N545 ❹	600A	1NO	2NO-1NC	115, 230, 250	**6938ED8**	F
-	N546 ❹	1200A	1NO	1NO	115, 230	**6938ED9**	G

Contactors - No Blow-Out Coils

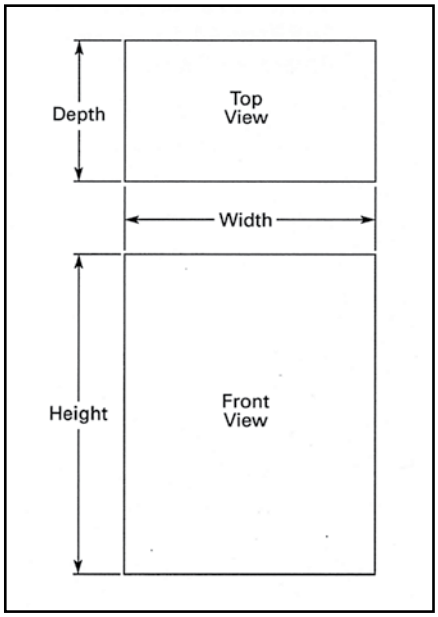
Size	Device Number	Main Contacts		Available ❶ Aux. Contacts	Available Coil Voltage (DC)	Base Catalog ❷ ❸ Number	Dim. Ref.
		Rating	Poles				
2	N912	50A	1NO	1NO-1NC	115, 230, 250	**6938ED38**	H
4	N913	150A	1NO	1NO-1NC	115, 230, 250	**6938ED39**	J

Relays - No Blow-Out Coils

Type	Device Number	Description	Contacts	Available Coil Voltages (DC)	Base Catalog ❷ ❸ Number	Dim. Ref.
Control	N617	Control Circuit	4NO-4NC	115, 230, 250	**6938ED16**	K
Timer	N867	Duplex Timer	2NO-2NC	115, 230, 250	**6938ED37**	L
Timer	N907	ON/OFF Delay	1NO-1NC	115, 230, 250	**6938ED46**	M
Overload	N709	Magnetic Operation	1NC	115, 230, 250	**6938ED22** ❺	N
Series	N175	Current Sensitive	1NC	Not Applicable	**6938ED3**	P
Latch ❹	N621	Special Purpose	2NO-2NC	115, 230, 250	**6938ED17**	R

❶ Some devices offer various auxiliary contact configurations. Data shown is maximum available.
❷ **Catalog numbers shown are not complete.** A suffix is required to identify coil voltage, auxiliary contact configuration and panel thickness. Contact factory for assistance.
❸ The Catalog number do not include economizing resistors. Contact factory for assistance.
❹ For two-pole (main contact) applications, use of N621 is required. Contact factory for assistance.
❺ Need motor full load rating.

Approximate Dimensions in Inches



Dimension Reference Table

Ref.	Panel Space (Inches			Weight Lbs.	Mount to Steel Panel
	Footprint		Depth Required		
	Width	Height			
A	4.5	6.5	4.5	5	Yes
B	5.5	6	6	10	Yes
C	7	8	6.5	16	Yes
D	8	8.5	7.5	25	No
E	7.5	14	8.5	28	No
F	8	23	8.5	42	No
G	10.5	12.5	14.5	137	No
H	7.5	11	5.5	7	Yes
J	4.5	12.5	8	8	Yes
K	4	6.5	6	7	No
L	4.5	7.5	5.5	8	Yes
M	4	6.5	5	4	Yes
N	4.5	9.5	5.5	4	No
P	3.8	4.5	5	2	Yes
R	3.8	6.5	5.8	7	No

Type 6901
Standard Dripproof Enclosures

Wraparound

Hinged

General

Enclosures listed below are supplied with all panel and enclosure mounting holes pre-drilled. Other sizes and classes (e.g. Watertight, Non-magnetic, Spraytight) are available. Contact the factory for price and availability.

Specifications

MIL-SPEC.....MIL-DTL-2212, MIL-E-2036
Class .....Dripproof
Venting.....None

When ordering specify

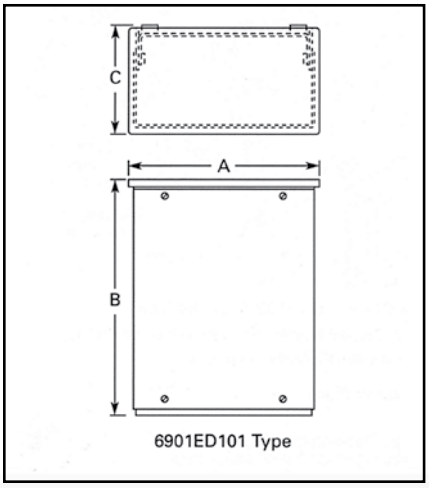
- Catalog number

Type 6901 Dripproof Enclosures

Enclosure Dimensions in Inches						Interior Panel Dimensions in Inches						Weight Lbs.	Catalog number
Wide A	High B	Deep C	Mounting ❶			Width	Height	Panel Mounting			Door to Panel		
			D	E	Holes			Width	Height	Holes			
Wraparound Cover Style ❷													
8.24	11.3	6.68	4.75	9.38	4	6.5	8	4.75	6	4	5.24	17	**6901ED101-1A**
8.24	15.56	6.68	4.75	13.62	4	6.5	12.25	4.75	10.25	6	5.24	21	**6901ED101-2A**
9.38	17.3	8.06	6	14.5	4	7.75	13	6	11	6	6.63	26	**6901ED101-3A**
11.38	19.8	8.94	8	17	4	9.75	15.25	8	13	6	7.45	35	**6901ED101-4A**
13.74	16.8	8.06	10.24	14.88	4	12	13.5	10.25	11.75	6	6.63	36	**6901ED101-5A**
Hinged Door with Diamond Latch Style													
12.12	18.12	9.76	8.5	16	4	10	14.5	8.5	13	4	8.12	33	**6901ED102-1A**
14.12	18.12	9.76	10.5	16	4	12	14.5	10.5	13	4	8.12	36	**6901ED102-2A**
14.12	20.12	9.76	10.5	18	4	12	16.5	10.5	15	6	8.12	40	**6901ED102-3A**
16.12	20.12	9.76	12.5	18	4	14	16.5	12.5	15	6	8.12	43	**6901ED102-4A**
16.12	22.12	9.76	12.5	20	4	14	18.5	12.5	17	6	8.12	47	**6901ED102-5A**
16.12	24.12	9.76	12.5	22	4	14	20.5	12.5	19	6	8.12	50	**6901ED102-6A**
18.12	26.12	9.76	14.5	24	6	16	22.5	14.5	21	9	8.12	64	**6901ED102-7A**
22.12	28.12	9.76	18.5	26	6	20	24.5	18.5	23	9	8.12	78	**6901ED102-5A**

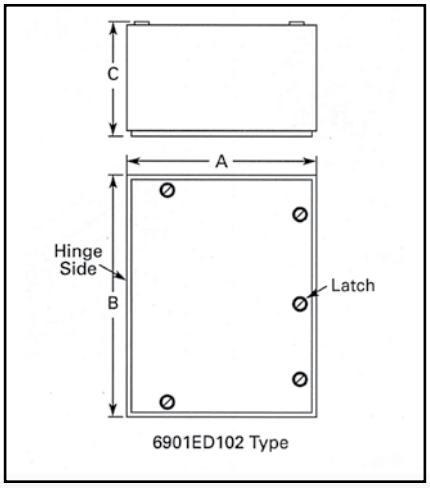
❶ Enclosures are designed for 0.50" diameter mounting bolts.
❷ Wraparound style enclosures are not suitable for cover mounted control elements.

Wraparound Cover Style



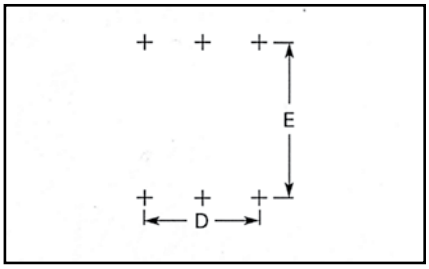
6901ED101 Type

Hinged Door Style



6901ED102 Type

Enclosure Mounting Reference



Type 6981ED165 and 6981ED166
Separate Flush Mounting Pushbuttons and Indicating Lights

When ordering specify

Units by catalog number - Examples table at right

- Catalog number and complete description

Unlisted Units – See **Page 65**

General

Each single element unit consists of either a contact block or an indicating light element, brackets for behind the panel mounting, and the gasket and mounting plate for the front of the panel. On the indicating light, a lens is sandwiched between the gasket and the mounting plate. Mounting hardware is supplied for panel thicknesses as shown in sketches below.

Indicating light elements are of the double lamp type. AC indicating lights have self-contained 440/1.8-1.8V or 117/1.8-1.8V transformers. Indicating light current draw is 1.6 mA @ 440V and 6.4 mA @110V. DC indicating lights require a separate series resistor for each bulb at any supply voltage above 24 volts. Resistors are not included in the price.

Specifications

- MIL-SPEC..... MIL-DTL-2212
- Duty ..... Continuous
- Ambient temp ..... 50°C
- Insulation ..... Class B
- Enclosure ..... Open type for watertight mounting (3 ft. head – 5 min.)

Rating (Pushbutton)

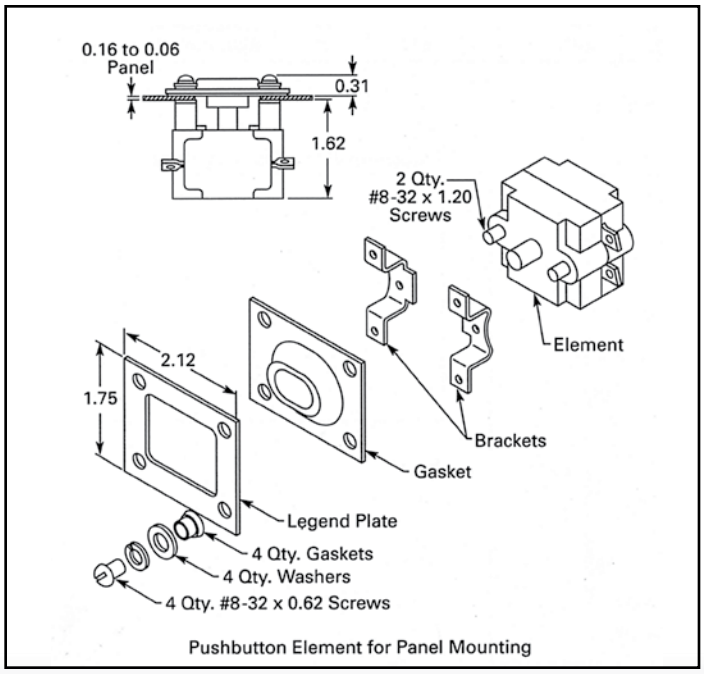
Inductive Rating	AC 60 Hertz			DC		
	100V	220V	440V	115V	230V	355V
Make	60	50	50	2	0.75	0.5
Break	6	5	5	2	0.75	0.5

Examples of Common Catalog numbers

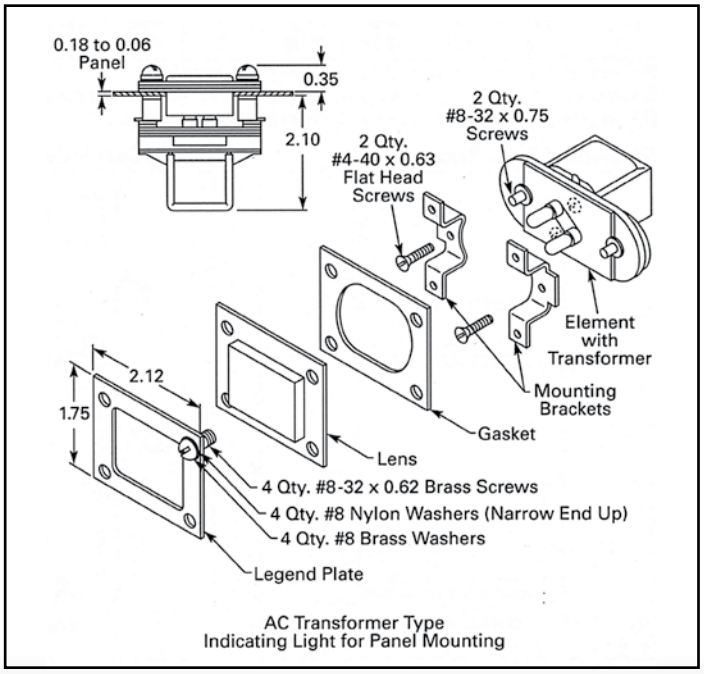
To Order by Description See **Page 65**

Element Identification Code ❶	Marking ❷	Catalog number
Pushbuttons		
C	FAST	**6981ED165-1**
C	SLOW	**6981ED165-2**
A	L.P. BYPASS	**6981ED165-3**
C	FORWARD	**6981ED165-4**
C	REVERSE	**6981ED165-5**
C	START	**6981ED165-6**
C	STOP	**6981ED165-7**
Indicating Lights		
B1	MOTOR RUNNING	**6981ED166-1**
A2	MOTOR RUNNING	**6981ED166-2**
C5	POWER ON	**6981ED166-3**

❶ For description of Element Identification Code, see Page 67.
❷ Pushbutton legend stamped on legend plate. Indicating light legend engraved on lens.



Pushbutton Element for Panel Mounting



AC Transformer Type
Indicating Light for Panel Mounting

Type 6981ED165 and 6981ED166
Separate Flush Mounting Pushbuttons and Indicating Lights

When ordering specify

Order by complete description –

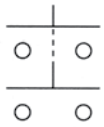
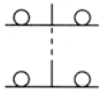
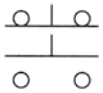
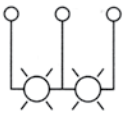
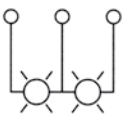
- Basic catalog number
- Element Identification Code
- Required Legend

Example:
6981ED166- with element B5, marked POWER AVAILABLE

Legend Data

- Pushbutton legend may consist of one or two lines, each with a maximum of eight characters.
- Light legend may consist of one, two or three lines, each with a maximum of eight characters.
- Use of the letter "I" in a line will permit one additional character.

Information Table for Ordering by Description

Basic Catalog number	Element Identification Code		Circuit Symbol	Description	Weight – Oz.
6981ED165-	A			Pushbutton – 2NO Contacts	5
6981ED165-	B			Pushbutton – 2NC Contacts	5
6981ED165-	C			Pushbutton – 1NO-1NC Contacts	5
	Lens Color				
6981ED166-	Red	**A1**		Indicating Light – 115V 60Hz ❷	7
6981ED166-	Green	**A2**			
6981ED166-	Amber	**A3**			
6981ED166-	Blue	**A4**			
6981ED166-	White	**A5**			
6981ED166-	Red	**B1**		Indicating Light – 440V 60Hz ❷	7
6981ED166-	Green	**B2**			
6981ED166-	Amber	**B3**			
6981ED166-	Blue	**B4**			
6981ED166-	White	**B5**			
6981ED166-	Red	**C1**		Indicating Light – 24V DC ❶❸	4
6981ED166-	Green	**C2**			
6981ED166-	Amber	**C3**			
6981ED166-	Blue	**C4**			
6981ED166-	White	**C5**			
6981ED166-	Red	**D1**		Indicating Light – 10V DC ❹	4
6981ED166-	Green	**D2**			
6981ED166-	Amber	**D3**			
6981ED166-	Blue	**D4**			
6981ED166-	White	**D5**			

❶ These are Resistor Type indicating lights. Each lamp requires the following series resistance depending on the voltage used. Resistors must be separately mounted and are not included.

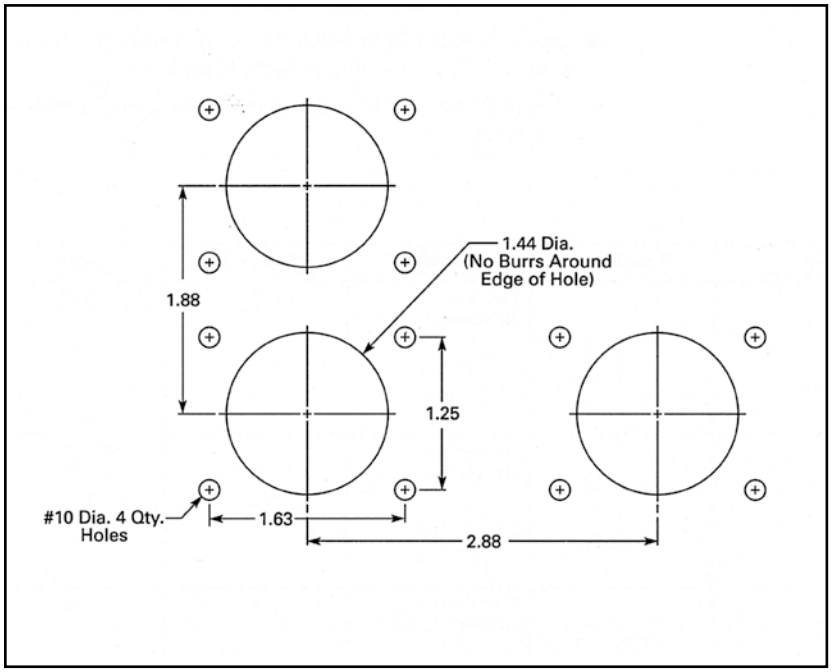
24V DC – None	120V DC – 2800 Ohms, 5 Watts
48V DC – 710 Ohms, 2 Watts	240V DC – 6300 Ohms, 10 Watts
Resistor not included in above price.	250V DC – 8000 Ohms, 10 Watts (Nominal submarine voltage 180-355V range)

❷ Lamp type: No. 1769, T1-3/4 Midget Screw Base.
❸ Lamp type: No. 335, T1-3/4 Midget Screw Base.
❹ Lamp type: No. 373, T1-3/4 Midget Screw Base.

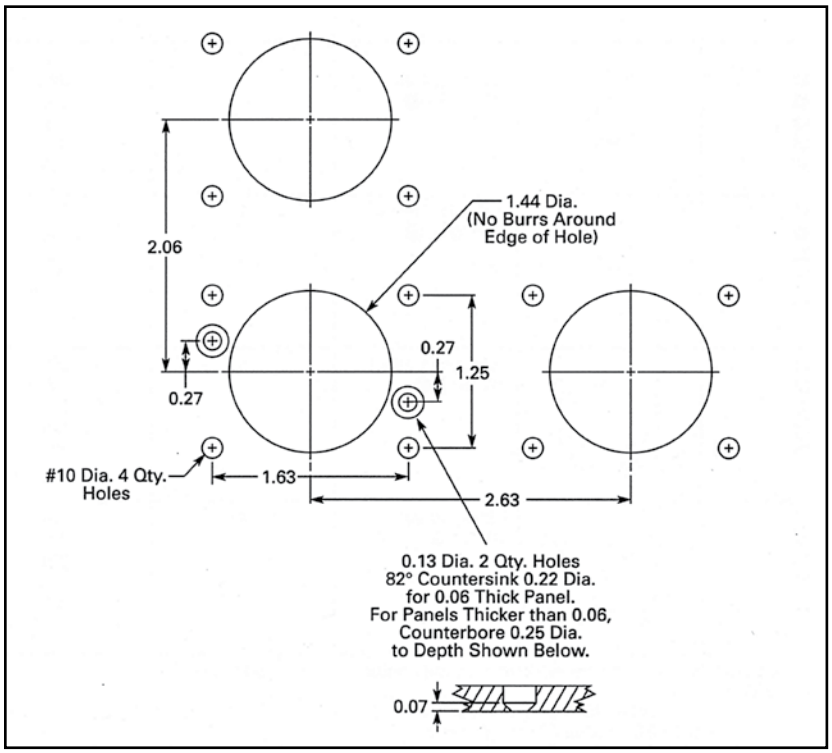
Type 6981ED165 and 6981ED166
Separate Flush Mounting Pushbuttons and Indicating Lights

Drilling and Spacing Dimensions (in Inches)

Flush Mounting Pushbutton



Flush Mounting Indicating Light - Front View of Door



Replacement Indicating Light Transformers

General

When installed in the flush mounted configuration or in a remote control station enclosure, the transformers meet the shock, vibration and temperature requirements of MIL-DTL-2212.

Lamps are included with the transformer.

Description	Catalog number
115V AC to 2V AC Type B-41A	**42-1091**
440V AC to 2V AC Type B-41B	**42-1091-2**
Replacement Lamp, Midget Screw Base #1769 2.5V	**28-651**

Specifications

Manufactured to BUSHIPS DWG 9000 S6202 F 73919.

Type 6981ED200
Separate Flush Mounting Selector Switches

When ordering specify

Units by Catalog number - Examples table at right

- Catalog Number

Unlisted Units – Order by complete description, including:

- Type number – 6981ED200
- Element Identification Code – Consists for a number from Table 1 on this page and a letter from Table 2 on **Page 69**. Example: **1A**
- Legend required
  Example: 6981ED200 switch with element 5P, marked MAN-OFF-AUTO ❷

General

Selector switches for watertight mounting are available in two- or three-position configurations, self-centering or non self-centering.

Self-centering two-position switches may be spring return from either side to center. Three-position self-centering switches may be spring return fro m either or both sides to center.

The basic selector switch element has a maximum of 8 stationary contacts/terminals, 4 in each of two planes. Movable contacts consist of shaft mounted segments, available in several shapes to provide various circuit combinations for each of the two planes. Segments in the front and rear plane can be electrically connected by use of a jumper through the shaft assembly.

Segments can be assembled to the shaft in any of four positions at 90° displacement. Further variation is available though 45° displacement of the shaft when the starwheel is assembled to the shaft.

Ordering Instructions for Unlisted Units

Order switch by Type Number and Element Identification from Table 1 on this page and Table 2 on **Page 69**. Select basic operating characteristics from Table 1, and circuit from Table 2. Specify legend.

Specifications

- MIL-SPEC..... MIL-DTL-2212
- Enclosure ..... Open, for watertight mounting
- Duty ..... Continuous
- Operation ..... Manual
- Ambient temp ..... 50°C
- Insulation ..... Class B

Rating

Operation	Inductive Load (Amperes)					
	AC 60 Hz			DC		
	115V	220V	440V	115V	230V	355V
Make	30	15	7.5	1.1	0.55	0.4
Break	3	1.5	.75	1.1	0.55	0.4
Carry	10	10	10	10	10	10

Examples of Some Common Catalog numbers and Their Descriptions

Element Identification Code	Marking	Catalog number
1C	(Blank)	**6981ED200-1**
1B	ON/OFF	**6981ED200-2**
1C	MAN/AUTO	**6981ED200-3**
1C	OPEN/CLOSE	**6981ED200-10**
5P	HAND/OFF/AUTO	**6981ED200-11**
1C	ON/OFF	**6981ED200-15**
6E	STOP/START	**6981ED200-54**
7A	HAND/OFF/AUTO	**6981ED200-63**
8E	STOP/RUN/START	**6981ED200-92**

Table 1 –
Selector Switch Configurations

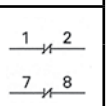
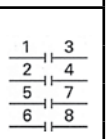
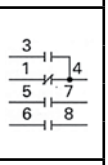
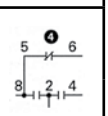
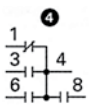
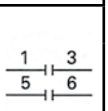
Partial Element ❶ Identification Code ❷	Basic Configuration	
	No. of Positions	Operation
1	2	Maintained Contact, Center and CW
2	2	Maintained Contact, Center and CCW
3	2	Spring Return from CW to Center
4	2	Spring Return from CCW to Center
5	3	Maintained Contact
6	3	Spring Return from CW & CCW to Center
7	3	Spring Return from CCW to Center
8	3	Spring Return from CW to Center

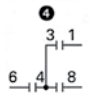
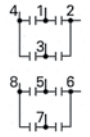
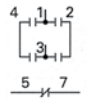
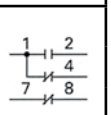
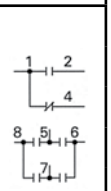
❶ Element Identification consists of this number plus letter from Table 2 on **Page 69**.

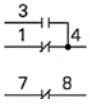
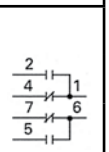
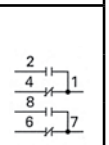
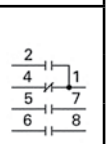
❷ **Do not use Element Identification Code as Suffix to Catalog Number.**

Type 6981ED200
Separate Flush Mounting Selector Switches

Table 2 – Selector Switch Circuits

Partial Element I.D. Code ❶	Contact	Position CCW	Position C	Position CW	Schematic Symbol ❷
A	1-4	X			
	1-2			X	
	7-6	X			
	7-8			X	
B	1-2		X		
	7-8		X		
C	1-2		X		
	3-4		X		
	5-6			X	
	5-8	X			
D	1-3			X	
	2-4	X			
	5-7			X	
	6-8	X			
E	1-4		X	X	
	3-4	X			
	5-7	X			
	6-8			X	
F	2-4-5-8			X	
	5-6-8		X		
G	1-4		X		
	1-4-6-8			X	
	3-4	X			
H	1-2-4	X			
	1-2-3			X	
J	1-3	X			
	5-6	X		X	

Partial Element I.D. Code ❶	Contact	Position CCW	Position C	Position CW	Schematic Symbol ❷
K	1-3-4	X			
	3-4-6-8			X	
L	1-2-5-6	X			
	2-3			X	
	6-7			X	
M	1-2			X	
	3-4			X	
	5-6			X	
	7-8			X	
	1-4	X			
	2-3	X			
	5-8	X			
	6-7	X			
N	1-2			X	
	3-4			X	
	5-7		X		
	1-4	X			
	2-3	X			
P	1-2	X			
	2-3			X	
Q	1-2			X	
	1-4	X	X		
	7-8		X		
R	1-2			X	
	1-4	X	X		
	5-6			X	
	7-8			X	
	5-8	X			
	6-7	X			

Partial Element I.D. Code ❶	Contact	Position CCW	Position C	Position CW	Schematic Symbol ❷
S	1-4		X	X	
	3-4	X			
	7-8		X		
T	1-2-4	X			
	1-2-3			X	
	5-6		X		
U	1-4	X	X		
	1-2			X	
	5-6	X			
	6-7		X	X	
W	1-4	X	X		
	1-2			X	
	6-7	X	X		
	7-8			X	
X	1-2	X			
	2-3		X	X	
	5-8		X	X	
	7-8	X			
Y	1-4	X	X		
	1-2			X	
	5-7	X			
	6-8			X	
Z	1-4	X	X		
	1-2			X	
	5-6-8			X	
	5-7-8	X			

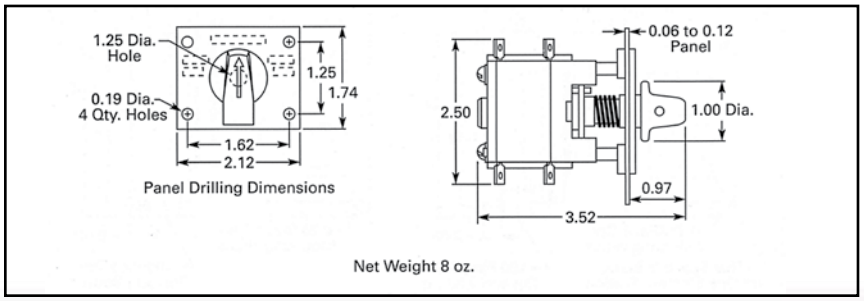
❶ Element Identification Code consists of number from Table 1 on **Page 68** plus letter from this Table. Example: 1A.

❷ Numbers adjacent to circuit diagrams represent terminals.

❸ X = Contact closed, all circuits shown with switch in center position.

❹ Element with internal jumper between front and rear elements.

Approximate Dimensions in Inches and Weights



Type 6981
Watertight Remote Control Stations

Using Pushbuttons, Indicating Lights and Selector Switches

Three Element Station

Five Element Station

Two Element Station

When ordering specify

- Catalog number (if known)
- Number of elements
- Element identification code
- Type of each element
- Enclosure
- For indicating light elements, color of lens
- Legend required for each element
- Voltage
- Application

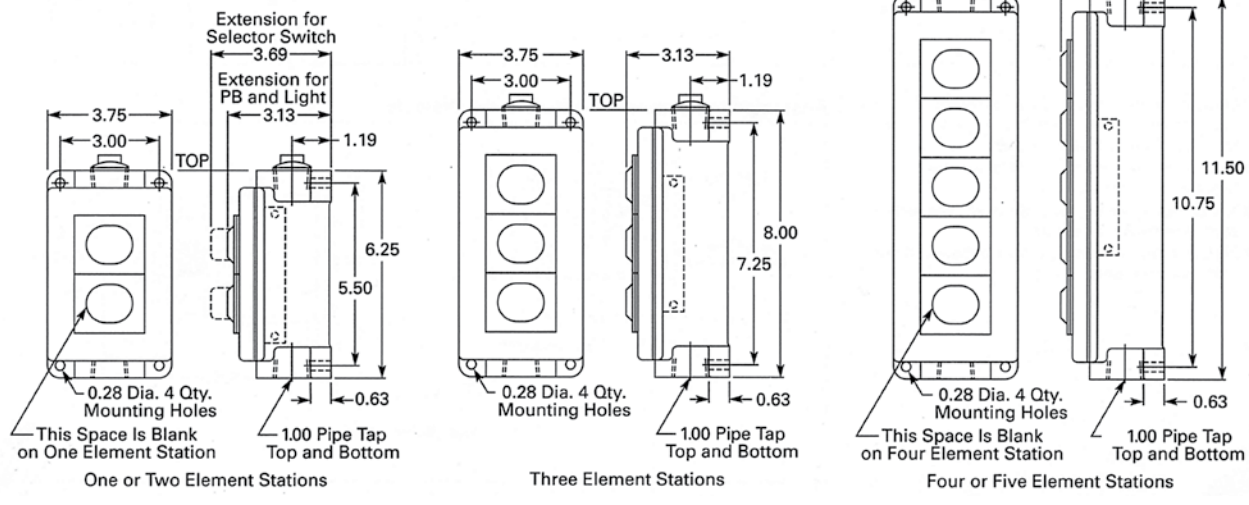
Specifications

- MIL-SPEC MIL-DTL-2212
- Enclosure ..... Watertight – below
  Explosion-proof – **Page 77**
  Cast brass – **Page 79**
- Operation ..... Manual
- Ambient temp ..... 50°C
- Insulation ..... Class B
- Rating ..... Pilot circuits only

Type of Element	Continous Capacity Amps.	Inductive ratings				
		AC (60 Hz)			DC	
		Volts	Amps Make	Amps Break	Volts	Amps Break
Heavy-Duty Pushbutton	10 10 10	440 220 110	50 50 60	5 ❶ 5 6	250 ❶ 230 115	0.5 0.75 2.0
Selector Switch	10 10 10	440 220 110	7.5 15 30	0.75 1.5 3.0	250 ❶ 230 115	0.4 0.55 1.1

❶ Nominal submarine voltage (355 volts maximum).

Approximate Dimensions in Inches, Watertight



Type 6981
Watertight Remote Control Stations

When ordering specify

- Enclosure Catalog number
- Element Identification Code(s) – For Selector Switch Elements on **Pages 72** and **73**, Element Identification Code consists of a number from Table 1 and a letter from Table 2. Example: **1A**
- Location of Elements
- Legend required for each Element

General

Whenever possible, select a typical pushbutton or indicating light station from the tables on Page 76. For example, Catalog number 6981ED172-1 covers a two element station with two Type "C" pushbuttons marked START and STOP respectively.

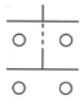
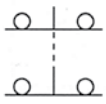
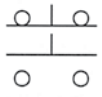
If required station cannot be found in the Typical listings, then select a station from this and the following pages.

Selector switch elements are listed on the following pages.

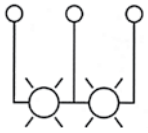
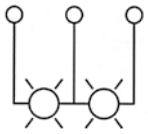
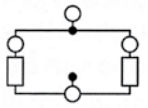
Basic Element Selection Table (Surface Mounting, WT)

Number of Units	Incomplete Catalog number	Weight
1	**6981ED171**	2 lbs., 3 oz.
2	**6981ED172**	2 lbs., 2 oz.
3	**6981ED173**	2 lbs., 6 oz.
4	**6981ED174**	3 lbs., 5 oz.
5	**6981ED175**	3 lbs., 4 oz.

Pushbutton Elements

Element Identification Code	Circuit Symbol	Description	Weight
A		Pushbutton 2NO Contacts	4 oz.
B		Pushbutton 2NC Contacts	4 oz.
C		Pushbutton 1NO-1NC Contacts	4 oz.

Indicating Light Elements

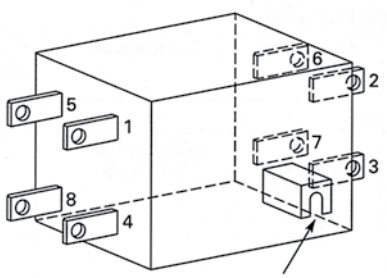
Element Identification Code	Circuit Symbol	Description	Weight
D1 – Red D2 – Green D3 – Amber D4 – Blue D5 – White		Indicating Light – 115V 60Hz ❶	6 oz.
E1 – Red E2 – Green E3 – Amber E4 – Blue E5 – White		Indicating Light – 440V 60Hz ❶	6 oz.
F1 – Red F2 – Green F3 – Amber F4 – Blue F5 – White		Indicating Light – 24V DC ❷❸	3 oz.
G1 – Red G2 – Green G3 – Amber G4 – Blue G5 – White		Indicating Light – 10V DC ❹	3 oz.
H1 – Red H2 – Green H3 – Amber H4 – Blue H5 – White		Indicating Light – 48V DC ❸	3 oz.

❶ Lamp Type: No. 1769, T1-3/4 Midget Screw Base.
❷ These are resistor type indicating lights. Each lamp requires the following series resistance, depending on the voltage used. Resistors must be separately mounted and are not included.

Voltage	Resistance
24V DC	None
120V DC	2800 ohms – 5 watts
240V DC	6300 ohms – 10 watts
250V DC	8000 ohms – 10 watts (Nominal submarine voltage, 180-355V range)

❸ Lamp Type: No. 335, T1-3/4 Midget Screw Base.
❹ Complete assembly including resistors. Lamp Type: No. 373, T1-3/4 Midget Screw Base.

Type 6981
Watertight Remote Control Stations



Basic Element Showing Orientation of Terminals

Selector Switch Elements

Selector switches are available in two- or three-position configurations, self-centering or non self-centering.

Self-centering two-position switches may be spring return from either side of center. Three-position self-centering switches may be spring return form either or both sides of center.

The basic selector switch element has a maximum of eight stationary contact/terminals, four in each of two planes. Moveable contacts consist of shaft mounted segments, available in several shapes to provide various circuit combinations for each of the two planes. Segments in the front and rear plane can be electrically connected by use of a jumper through the shaft assembly.

Segments can be assembled to the shaft in any one of four positions at 90° displacement. Further variation is available through 45° displacement of the shaft when the starwheel is assembled to the shaft.

The circuits shown in Table 2, on **Page 73**, are intended for use with either the two- or three-position selector switch. A portion of the contacts, or circuit, as shown may not be used with a particular basic configuration.

Circuits shown are designed to accommodate the majority of standard control requirements. Other combinations are available and can be set up as required.

Table 1 – Selector Switch Configurations

Partial Element Identification Code ❶	Basic Configuration		Weight
	No. of Positions	Operation	
1	2	Maintained Contact, Center and CW	8 oz.
2	2	Maintained Contact, Center and CCW	8 oz.
3	2	Spring Return fro CW to Center	8 oz.
4	2	Spring Return form CCW to Center	8 oz.
5	3	Maintained Contact	8 oz.
6	3	Spring Return from CW & CCW to Center	8 oz.
7	3	Spring Return from CCW to Center	8 oz.
8	3	Spring Return from CW to Center	8 oz.

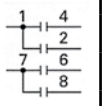
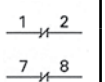
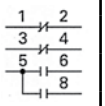
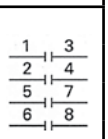
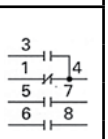
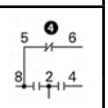
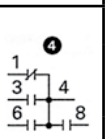
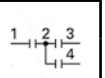
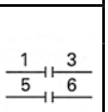
❶ Element identification consists of this number plus letter from Table 2 on **Page 73**.

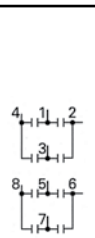
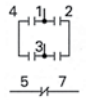
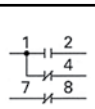
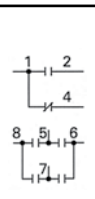
Table 2 is shown on following page.

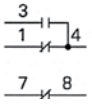
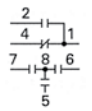
Type 6981
Watertight Remote Control Stations

Selector Switch Elements (Continued)

Table 2 – Selector Switch Circuits

Partial Element I.D. Code ❶	Contact	Position CCW	Position C	Position CW	Schematic Symbol ❷
A	1-4	X			
	1-2			X	
	7-6	X			
	7-8			X	
B	1-2		X		
	7-8		X		
C	1-2		X		
	3-4		X		
	5-6			X	
	5-8	X			
D	1-3			X	
	2-4	X			
	5-7			X	
	6-8	X			
E	1-4		X	X	
	3-4	X			
	5-7	X			
	6-8			X	
F	2-4-5-8			X	
	5-6-8		X		
G	1-4		X		
	1-4-6-8			X	
	3-4	X			
H	1-2-4	X			
	1-2-3			X	
J	1-3	X			
	5-6	X		X	

Partial Element I.D. Code ❶	Contact	Position CCW	Position C	Position CW	Schematic Symbol ❷
K	1-3-4	X			
	3-4-6-8			X	
L	1-2-5-6	X			
	2-3			X	
	6-7			X	
M	1-2			X	
	3-4			X	
	5-6			X	
	7-8			X	
	1-4	X			
	2-3	X			
	5-8	X			
	6-7	X			
N	1-2			X	
	3-4			X	
	5-7		X		
	1-4	X			
	2-3	X			
P	1-2	X			
	2-3			X	
Q	1-2			X	
	1-4	X	X		
	7-8		X		
R	1-2			X	
	1-4	X	X		
	5-6			X	
	7-8			X	
	5-8	X			
	6-7	X			

Partial Element I.D. Code ❶	Contact	Position CCW	Position C	Position CW	Schematic Symbol ❷
S	1-4		X	X	
	3-4	X			
	7-8		X		
T	1-2-4	X			
	1-2-3			X	
	5-6		X		
U	1-4	X	X		
	1-2			X	
	5-6	X			
	6-7		X	X	
W	1-4	X	X		
	1-2			X	
	6-7	X	X		
	7-8			X	
X	1-2	X			
	2-3		X	X	
	5-8		X	X	
	7-8	X			
Y	1-4	X	X		
	1-2			X	
	5-7	X			
	6-8			X	
Z	1-4	X	X		
	1-2			X	
	5-6-8			X	
	5-7-8	X			

❶ Element Identification Code consists of number from Table 1 on **Page 72** plus letter from this Table. Example: 1A.

❷ Numbers adjacent to circuit diagrams represent terminals.

❸ X = Contact closed, all circuits shown with switch in center position.

❹ Element with internal jumper between front and rear elements.

Optional Features for Watertight Remote Control Stations –

- Hinged Protective Covers
- Warning Plate
- Special Message Plate
- Special Ink Color on Legend Plate
- Special Character Size on Legend Plate
- Blank Station
- Space Heater (not available in a 5 element station)
- Non-magnetic Configuration
- Red Legend Plate
- Dim Out Unit on Indicator Light

Type 6981
Watertight Remote Control Stations

Examples of Some Common Catalog numbers and Their Descriptions

Element Identification Code and Marking ❶					Catalog number	Weight Lbs.-Oz.
Position 1 (Top)	Position 2	Position 3	Position 4	Position 5		
One Element Stations						
C - STOP	-	-	-	-	**6981ED171-1**	2-7
C - START	-	-	-	-	**6981ED171-2**	2-7
C - EM. RUN	-	-	-	-	**6981ED171-3**	2-7
C - EM. STOP	-	-	-	-	**6981ED171-4**	2-7
E4 - CLOSED	-	-	-	-	**6981ED171-8**	2-9
Two Element Stations						
C - START	C - STOP	-	-	-	**6981ED172-1**	2-10
C - OPEN	C - CLOSE	-	-	-	**6981ED172-2**	2-10
C - HOIST	C - LOWER	-	-	-	**6981ED172-3**	2-10
C - EM. START	C - EM. STOP	-	-	-	**6981ED172-4**	2-10
E2 - FAST	E2 - SLOW	-	-	-	**6981ED172-5**	2-14
E3 - OPEN	E4 - CLOSED	-	-	-	**6981ED172-6**	2-14
E5 - POWER ON	A - START	-	-	-	**6981ED172-7**	2-12
E5 - FAST	E5 - SLOW	-	-	-	**6981ED172-14**	2-14
A - START	C - STOP	-	-	-	**6981ED172-20**	2-10
Three Element Stations						
C - FORWARD	C - REVERSE	C - STOP	-	-	**6981ED173-1**	3-0
C - FAST	C - SLOW	C - STOP	-	-	**6981ED173-2**	3-0
C - HOIST	C - LOWER	C - STOP	-	-	**6981ED173-3**	3-0
D2 - MOTOR RUN	C - START	C - STOP	-	-	**6981ED173-4**	3-2
E2 - MOTOR RUN	C - START	C - STOP	-	-	**6981ED173-19**	3-2
C - EM. RUN	C - START	C - STOP	-	-	**6981ED173-6**	3-0
E5 - ON	C - ON	C - OFF	-	-	**6981ED173-9**	3-2
C - UP	C - DOWN	C - JOG	-	-	**6981ED173-11**	3-0
C - TEST	C - START	C - STOP	-	-	**6981ED173-14**	3-0
Four Element Stations						
C - E.M RUN	C - FORWARD	C - REVERSE	C - STOP	-	**6981ED174-1**	4-5
E2 - MOTOR RUN	C - EM. RUN	C - START	C - STOP	-	**6981ED174-2**	4-7
E3 - OPEN	E4 - CLOSED	C - OPEN	C - CLOSE	-	**6981ED174-3**	4-9
E5 - POWER ON	E2 - HEATER ON	C - START	C - STOP	-	**6981ED174-4**	4-9
C - HOIST	C - LOWER	C - FORWARD	C - REVERSE	-	**6981ED174-9**	4-5
Five Element Stations						
E2 - FAST	E2 - SLOW	C - FAST	C - SLOW	C - STOP	**6981ED175-1**	4-12
E3 - OPEN	E4 - CLOSED	C - OPEN	C - CLOSE	C - STOP	**6981ED175-2**	4-12

❶ For description of Element Identification codes, see table below.

Element Symbol Identification

Pushbuttons	Indicating Lights ❷	Indicating Lights Lens Color
A - 2ND Contact Pushbutton	D - 110V, 60 Hz Indicating Light	(Suffix Number to Base Light)
B - 2NC Contact Pushbutton	E - 440V, 60 Hz Indicating Light	1 - Red Lens
C - 1 NO-I NC Contact Pushbutton	F - 24V DC Indicating Light	2 - Green Lens
	G - 10V DC Indicating Light	3 - Amber Lens
	H - 48V DC Indicating Light	4 - Blue Lens
		5 - White Lens

❷ Requires Suffix Number to designate lens color. Example: D1-110V, 60 Hz indicating light with red lens.

Type 6981
Explosion-Proof Remote Control Stations

When ordering specify

- Complete description of Explosion-Proof Station from table following. Listed prices include required elements.
- Element Identification Code for each element required. Select from the tables on **Pages 71** thru **73**. For Selector Switch elements on **Page 72**, the Element Identification Code consists of a number from Table 1 on **Page 72** and a letter from Table 2 on **Page 73**. Example: 1A.
- Location of Elements.
- Legend required for each Element.

General

Select pushbutton, indicating light or selector switch station from table following. The prices as listed cover the complete stations including the required elements. Pushbutton and selector switch elements may be intermixed within a single, two or three-element enclosure. **Indicating lights may not be combined with other type elements.** Consult the factory for indicating light elements.

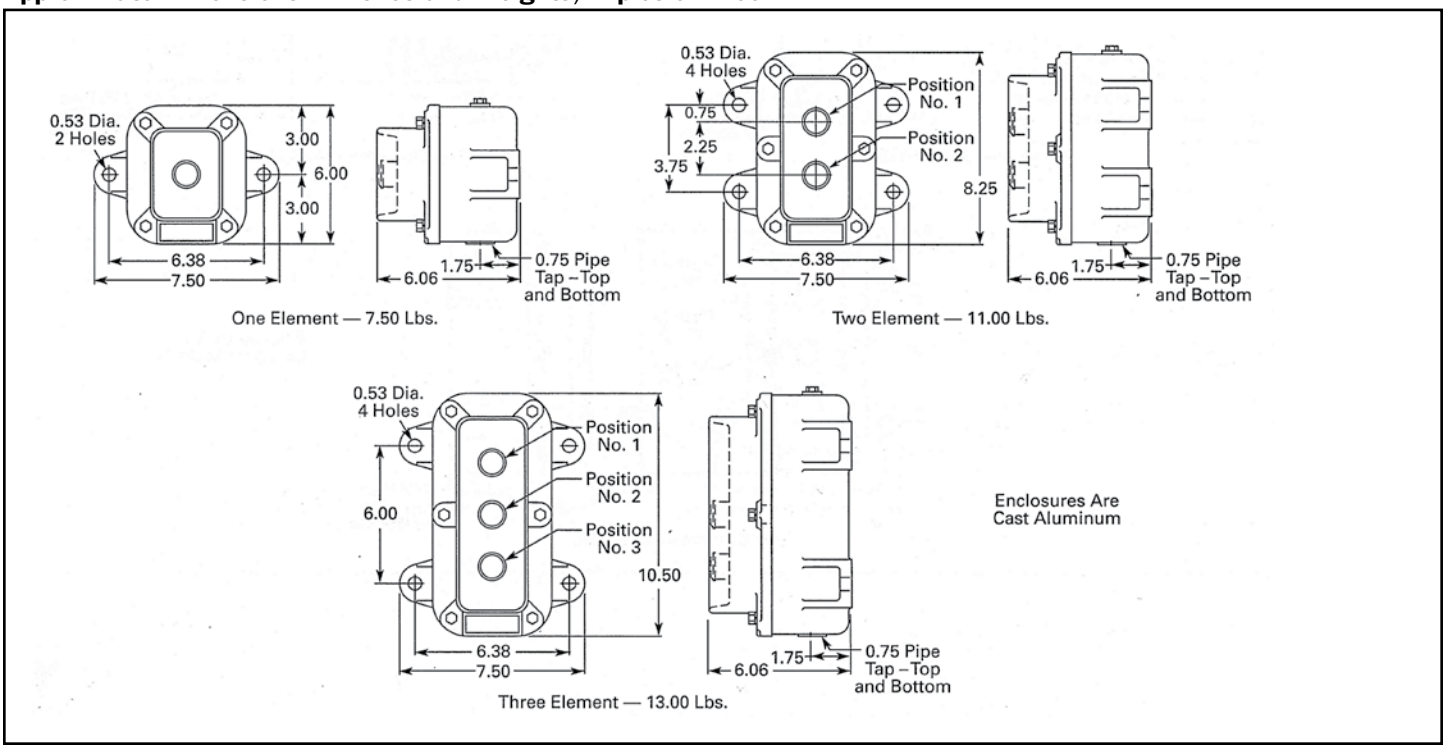
Explosion-Proof Stations - NEMA 7 ❶

Number of Elements	Pushbutton. Selector Switch and/or Indicating Light Elements ❷
1	Pushbutton, Selector Switch Indicating Light, AC or DC
2	2 - Pushbuttons
3	3 - Pushbuttons

❶ Class 1, Group D, unless specifically defined otherwise.
❷ Contact factory for other options

Order by complete description with Element Identification from Pages 71 thru 73, plus required legend(s).

Approximate Dimensions in Inches and Weights, Explosion-Proof



Type 6981
Explosion-Proof Remote Control Stations

When ordering specify

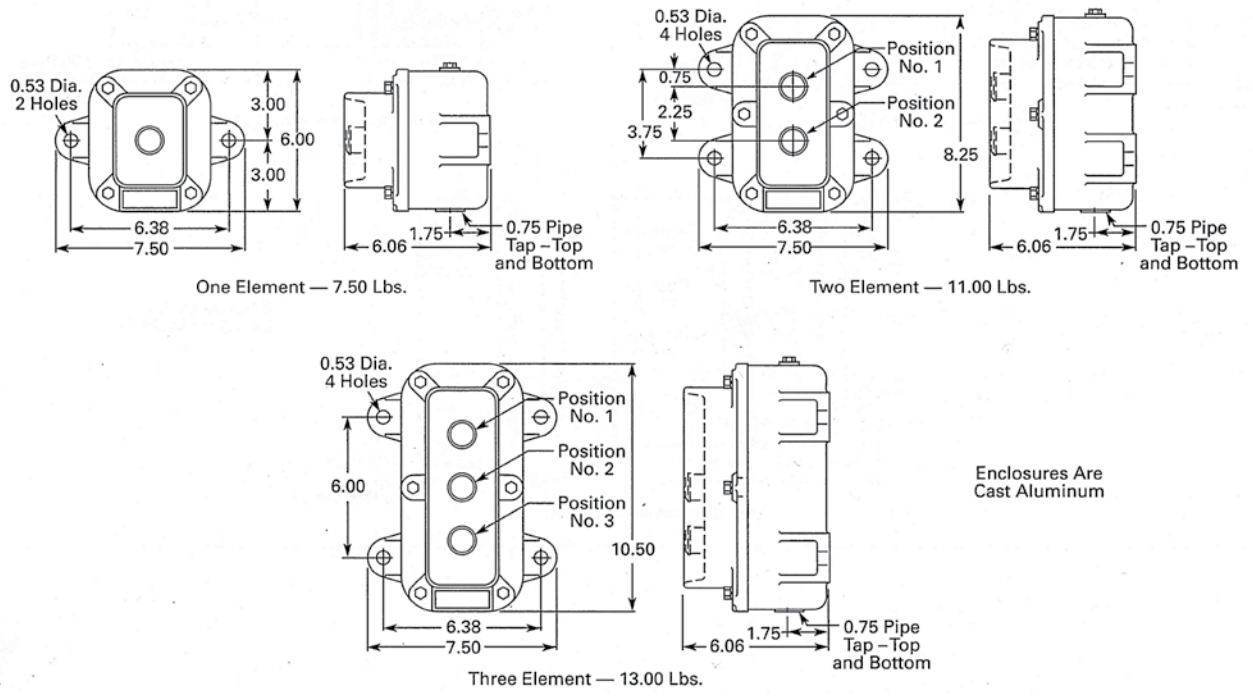
- Complete Catalog number

Examples of Some Common Catalog numbers and Their Descriptions

Element Identification Code and Marking ❶			Catalog number
Position 1 (Top)	Position 2	Position 3	
One Element Station			
C – STOP	-	-	**6981ED202-1**
C – START	-	-	**6981ED202-2**
C – EMERG. RUN	-	-	**6981ED202-3**
5A – MAN/OFF/AUTO	-	-	**6981ED202-6**
1P – ON/OFF	-	-	**6981ED202-8**
Two Element Station			
C – START	C – STOP	-	**6981ED203-1**
C – OPER.	C – CLOSE	-	**6981ED203-2**
C – HOIST	C – LOWER	-	**6981ED203-3**
A – START	B – STOP	-	**6981ED203-24**
A – OPER.	A – CLOSE	-	**6981ED203-25**
C – UP	C – DOWN	-	**6981ED203-36**
Three Element Station			
C – FORWARD	C – REVERSE	C – STOP	**6981ED204-1**
C – FAST	C – SLOW	C – STOP	**6981ED204-2**
C – HOIST	C – LOWER	C – STOP	**6981ED204-3**
A – UP	B – DOWN	B – STOP	**6981ED204-23**

❶ For description of Element Identification codes, see table on **Page 76.**

Approximate Dimensions in Inches and Weights, Explosion-Proof



Type 6981
Cast Brass Watertight Remote Control Stations

When ordering specify

- One, Two, or Three Element Station
- Element Identification Code for each element required. Select from the tables on **Pages 71** thru **73**. For Selector Switch elements on **Page 72**, the Element Identification Code consists of a number from Table 1 on **Page 72** and a letter from Table 2 on **Page 73**. Example: 1A.
- Location of Elements.
- Legend required for each Element.

Number of Elements	Incomplete Catalog number ❶
1	**6981ED241**
2	**6981ED242**
3	**6981ED243**

❶ Enclosure size the same for all three stations.

Specifications

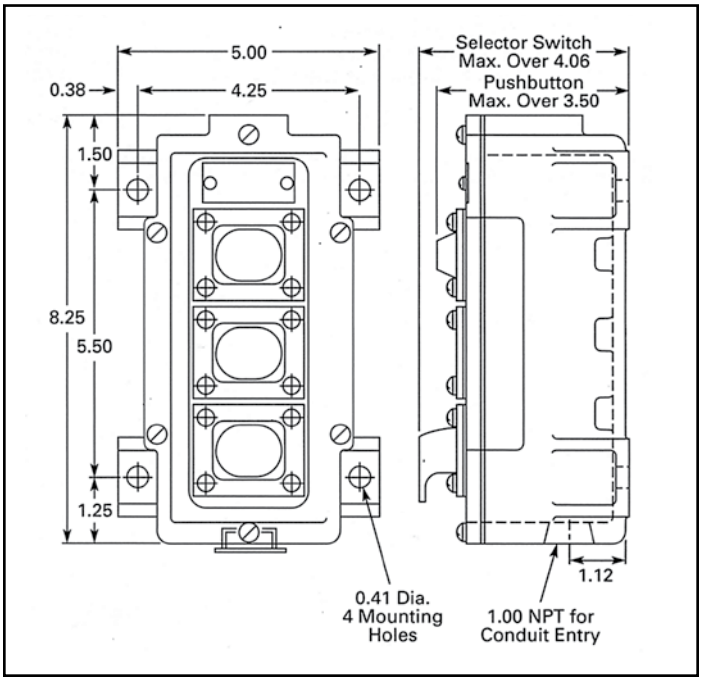
- MIL-SPEC.....MIL-DTL-2212
- Enclosure .....Cast Brass, Watertight
- Operation .....Manual
- Ambient temp .....50°C
- Insulation .....Class B

Ratings

Type of Element	Continuous Capacity Amps	Inductive Rating				
		AC (60 Hz)			DC	
		Volts	Amperes		Volts	Amperes
			Make	Break		Break
Two Element Station						
Heavy Duty Pushbutton	10	440	50	5	250❸	0.5
	10	220	50	5	230	0.75
	10	110	60	6	115	2
Selector Switch	10	440	7.5	0.75	250❸	0.4
	10	220	15	1.5	230	0.55
	10	110	30	3	115	1.1

❸ Nominal submarine voltage (355V maximum).

Approximate Dimensions in Inches, Cast Brass



Type 6981
Typical Cast Brass Watertight Remote Control Stations

When ordering specify

- Catalog number

Examples of Some Common Catalog numbers and Their Descriptions

Element Identification Code and Marking ❶			Catalog number
Position 1 (Top)	Position 2	Position 3	
One Element Station			
A – START	-	-	**6981ED241-1**
C – EMERG RUN	-	-	**6981ED241-2**
A – ON	-	-	**6981ED241-3**
Two Element Station			
C – OPEN	C – CLOSE	-	**6981ED242-3**
A – START	A – STOP	-	**6981ED242-4**
A – ON	A – OFF	-	**6981ED242-6**
A – HOIST	A – LOWER	-	**6981ED242-7**
Three Element Station			
C – START	C – STOP	C – EMERG RUN	**6981ED243-1**
A – START	B – STOP	A – EMERG RUN	**6981ED243-4**
D3 – POWER ON	C – START	C – STOP	**6981ED243-5**
E2 – MOTOR RUNNING	8E – START/STOP	C – EMERG RUN	**6981ED243-6**

❶ For Description of Element Identification Codes, see table below.

Element Symbol Identification

Pushbuttons	Indicating Lights ❷	Indicating Lights Lens Color
A - 2ND Contact Pushbutton	D - 110V, 60 Hz Indicating Light	(Suffix Number to Base Light)
B - 2NC Contact Pushbutton	E - 440V, 60 Hz Indicating Light	1 - Red Lens
C - 1 NO-I NC Contact Pushbutton	F - 24V DC Indicating Light	2 - Green Lens
	G - 10V DC Indicating Light	3 - Amber Lens
	H - 48V DC Indicating Light	4 - Blue Lens
		5 - White Lens

❷ Requires Suffix Number to designate lens color. Example: D1-110V, 60 Hz indicating light with red lens.

Type 6981
"Emergency Stop" Pushbutton Stations

Specifications

- MIL-SPEC..... MIL-DTL-2212
- Enclosure ..... Watertight or Explosion-Proof
- Duty ..... Continuous
- Operation ..... Manual
- Ambient temp ..... 50°C
- Insulation ..... Class B

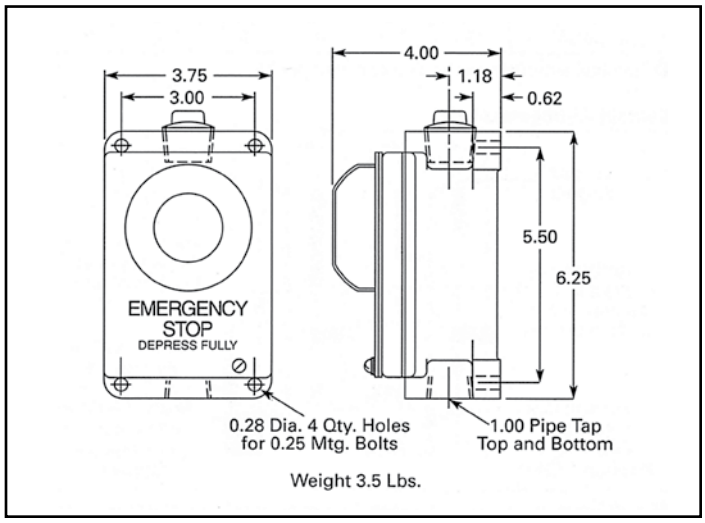
Ratings

Inductive Rating	Maximum Amperes					
	AC 60 Hz			DC		
	110V	220V	440V	115V	230V	355V
Make	60	50	50	2	0.75	0.5
Break	6	5	5	2	0.75	0.5

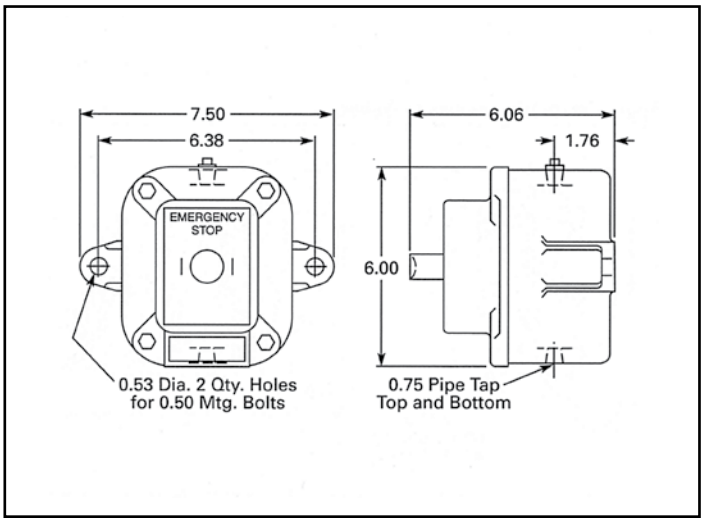
When ordering specify

- Complete catalog number

Approximate Dimensions in Inches and Weight - Watertight



Approximate Dimensions in Inches and Weight - Explosion-Proof



Catalog number	Pushbutton Contacts
Watertight Enclosure	
6981ED236-1	2NO
6981ED236-2	2NC
6981ED236-3	1NO-1NC
6981ED236-4NM ❶	2NO
6981ED236-5NM ❶	2NC
6981ED236-6NM ❶	1NO-1NC

❶ Non-magnetic construction.

Catalog number	Pushbutton Contacts
Explosion-Proof Enclosure ❷	
6981ED239-1	2NO
6981ED239-2	2NC
6981ED239-3	1NO-1NC

❷ Class 1, Group D, unless specifically defined otherwise.

Type 6982-T5
Flush Mounting Drum Type Transfer or Selector Switch

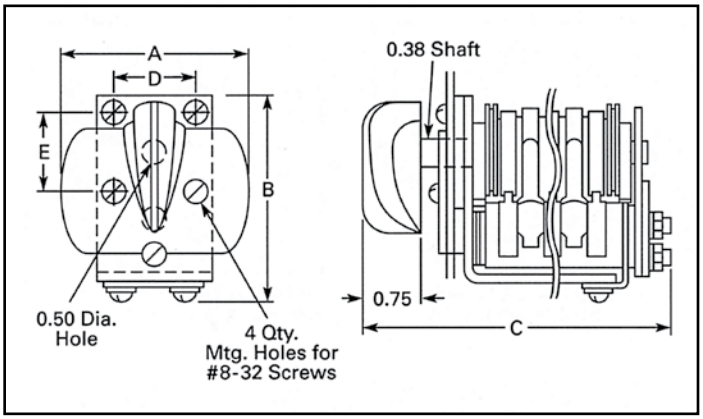
When ordering specify

- Type number – 6982-T5
- Voltage, AC or DC
- Number of fingers and circuit arrangements
- Number of positions
- Self-centering or no-self-centering
- Legend required
- Application

Prices

Description	Type of Enclosure
4 Finger (Max.) – Flush Mounting	
2-, 3-, 4- or 5-Position	Open
7 Finger (Max.) – Flush Mounting	
2-, 3-, 4- or 5-Position	Open

Approximate Dimensions in Inches



Open Type

Type	Dimensions in Inches					Weight Lbs.
	Wide	High	Deep	Mounting		
	A	B	C	D	E	
4 Finger	2.5	2.875	5.19	1.06	1.06	0.75
7 Finger	2.5	2.875	6.875	1.06	1.06	1.5

Specifications

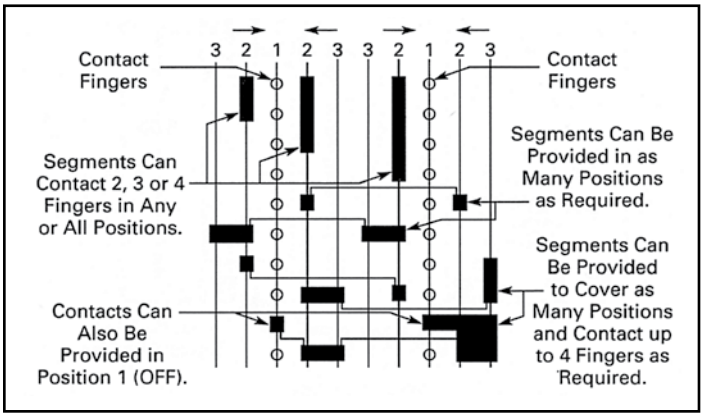
- MIL-SPEC.....MIL-DTL-2212
- Enclosure .....Open types for watertight mounting
- Operation .....Manual, self-centering and non-self-centering types
- Type .....6982-T5 – 2-, 3-, 4- or 5- position, including OFF position
- Function .....Pilot circuit transfer or selector switch
- Duty .....Continuous
- Ambient temp .....50°C
- Insulation .....Class B

Ratings – Pilot Circuits Only

Inductive Rating	Maximum Amperes					
	AC 60 Hz			DC		
	110V	220V	440V	115V	230V	250V❶
Make	40	25	12	2	2	2
Break	4	2	1	1.5	0.75	0.2
Carry	15	15	15	15	15	15
(cont.)						

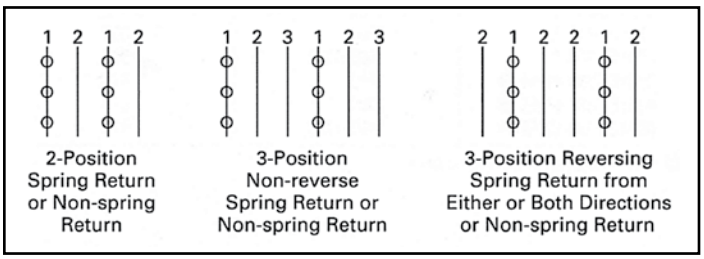
❶ Nominal submarine voltage (355V maximum)

Contact Arrangement ❷ ❸



❷ A 10 Finger long device is shown to display capability. The maximum length available in a flush mount is 7 Fingers.

❸ Diagram for 5-position reversing selector switch showing typical contact segment combinations which are available.



4 Fingers Long – Total 8 fingers (maximum). Can be supplied 2-, 3-, 4- or 5-position. Spring return can be supplied but unit is limited to 3 Fingers maximum length.

7 Fingers Long – Total 14 fingers (maximum). Can be supplied 2-, 3-, 4- or 5-position. Spring return can be supplied but unit is limited of 6 Fingers maximum length.

Type 6982-T5
Drum Type Transfer or Selector Switch

When ordering specify

- Type number – 6982-T5
- Voltage, AC or DC
- Number of fingers and circuit arrangements
- Number of positions
- Self-centering or non-self-centering
- Type of enclosure
- Application and legends required
- Type of handle (counterbalanced lever, round knob or teardrop knob)
- Bulkhead or surface mounting

Specifications

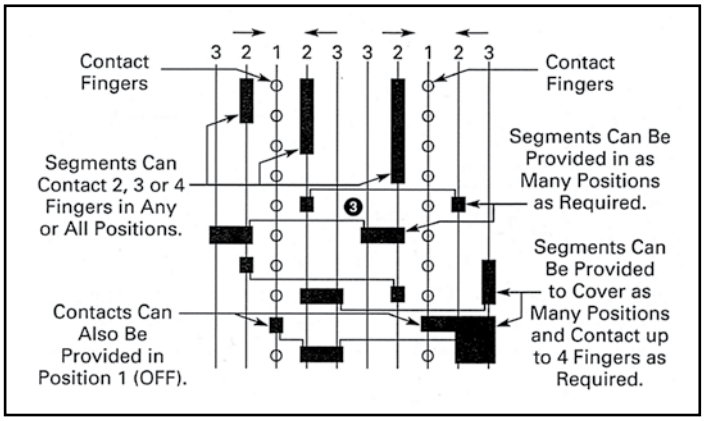
- MIL-SPEC.....MIL-DTL-2212
- Enclosure .....Watertight or dripproof
- Operation .....Manual, self-centering and non-self-centering types
- Type .....6982-T5 – 2-, 3-, 4- or 5-position, including OFF position
- Function .....Pilot circuit transfer or selector switch
- Duty .....Continuous
- Ambient temp .....50°C
- Insulation .....Class B

Ratings – Pilot Circuits Only

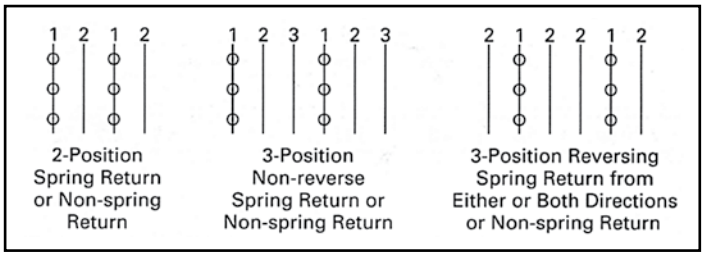
Inductive Rating	Maximum Amperes				
	AC 60 Hz		DC		
	110V	440V	115V	230V	250V❶
Make	40	12	2	2	2
Break	4	1	1.5	0.75	0.2
Carry (cont.)	15	15	15	15	15

❶ Nominal submarine voltage (355V maximum)

Contact Arrangement ❷



❷ Diagram for 5-position reversing selector switch showing typical contact segment combinations which are available.



7 Fingers Long – Total 14 fingers (maximum). Can be supplied 2-, 3-, 4- or 5-position. Spring return can be supplied but unit is limited to 6 Fingers maximum length.

10 Fingers Long – Total 20 fingers (maximum). Can be supplied 2-, 3-, 4- or 5-position. Spring return can be supplied but unit is limited to 9 Fingers maximum length.

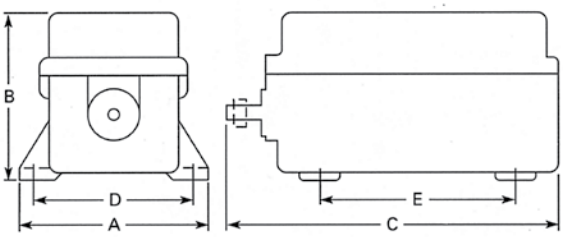
Type 6982-T5
Drum Type Transfer or Selector Switch

Master Transfer Switches – Types T8 and T5

Type	Description	Type of Enclosure
Cam Type Masters ❶		
6982T8	Surface or Pedestal Mounting Two-Speed Reversing	Watertight
Optional Features – Cam Type		
	ON/OFF or ON/OFF/EMERG. RUN Selector Switch	
Drum Type Pilot Circuit Transfer Switches		
6982T5	2-, 3-, 4-, or 5-position – 7 fingers maximum	Dripproof
6982T5	2-, 3-, 4-, or 5-position – 10 fingers maximum	Dripproof
6982T5	2-, 3-, 4-, or 5-position – 7 fingers maximum	Watertight

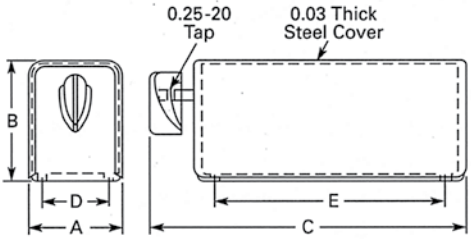
❶ Non-closing on Hi-shock

Approximate Dimensions in Inches and Weights — Watertight Type T5



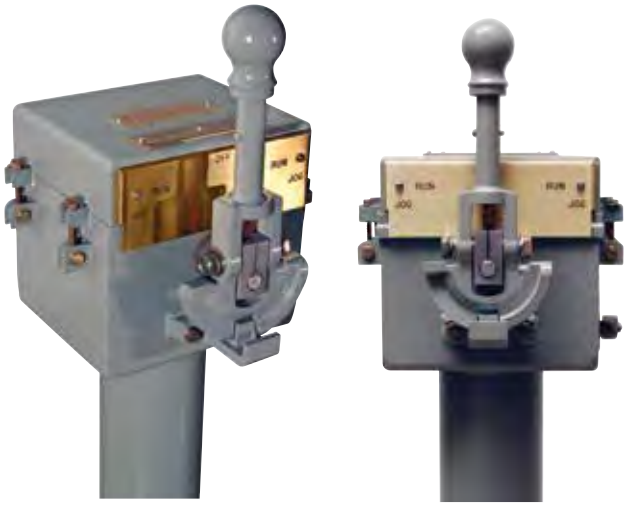
Type	Dimensions in Inches					Weight Lbs.
	Wide A	High B	Deep C	Mounting D	Mounting E	
7 Finger	5	4.8	9.12	4.25	5.5	17.5

Approximate Dimensions in Inches and Weights — Dripproof Type T5



Type	Dimensions in Inches					Weight Lbs.
	Wide A	High B	Deep C	Mounting D	Mounting E	
7 Finger	2.38	3.25	8.13	1.75	5.88	1.5
10 Finger	2.38	3.25	9.88	1.75	7.88	2.25

Type 6982-T8
Cam Type Master Switch



When ordering specify

- Type number – 6982-T8
- Voltage, AC or DC
- Circuit arrangement
- Self-centering or non-self-centering
- Applications and legends
- Non-plugging or counterbalanced lever

Specifications

- MIL-SPEC.....MIL-DTL-2212
  Master switch contacts are non-closing on Class HI-Shock. Contacts may momentarily bounce open on Class HI-Shock.
- Enclosure .....Watertight
- Operation .....Manual, self-centering and non-self-centering types
- Location .....Remote
- Type .....2-speed reversing (6 circuits)
- Duty .....Continuous
- Ambient temp .....50°C
- Insulation .....Class B

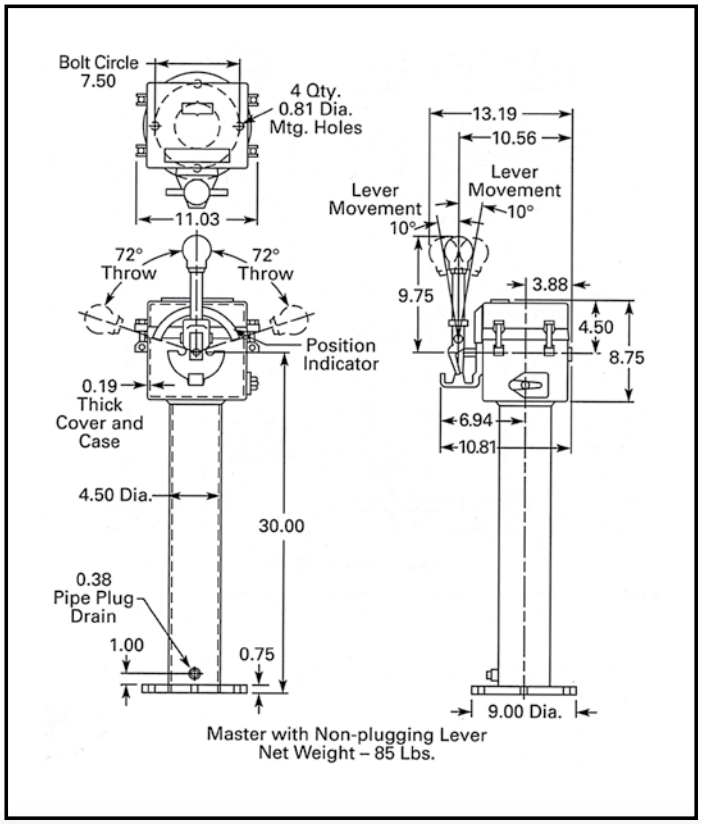
Ratings – Pilot Circuits Only

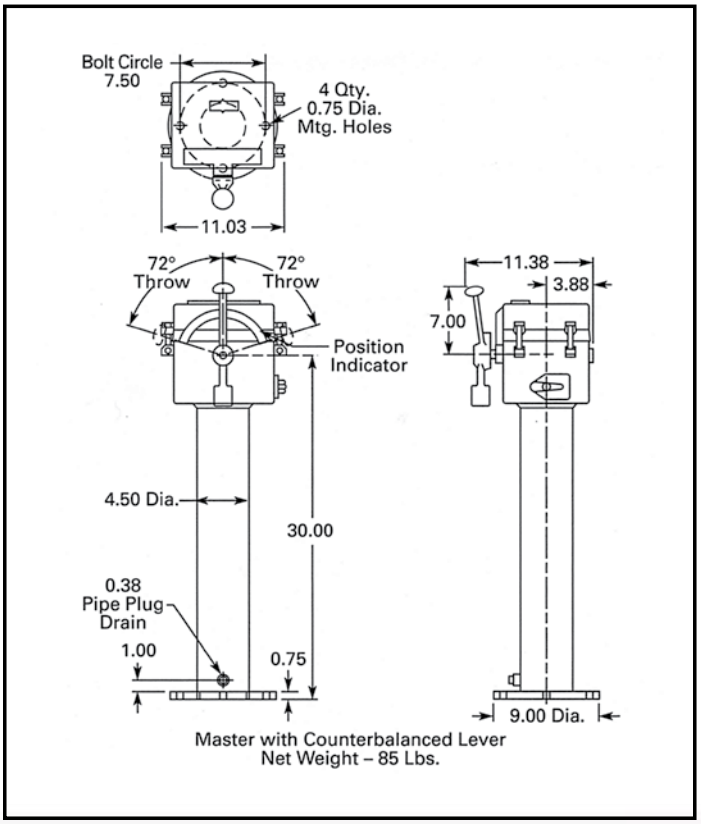
Inductive Rating	Maximum Amperes			
	AC 60 Hz		DC	
	110V	440V	115V	230V
Make	40	10	3	1.5
Break	10	2.5	3	1.5
Carry (cont.)	10	10	10	10

When Ordering Renewal Parts –

For a master switch in service, be sure to give nameplate data and description of parts required.

Approximate Dimensions in Inches and Weights





Type 6982-T9
Pedestal Mounted Cam Type Master Switch

When ordering specify

- Type number – 6982-T9
- Voltage, AC or DC
- Circuit Arrangement
- Application and legends
- Non-plugging or counterbalanced lever

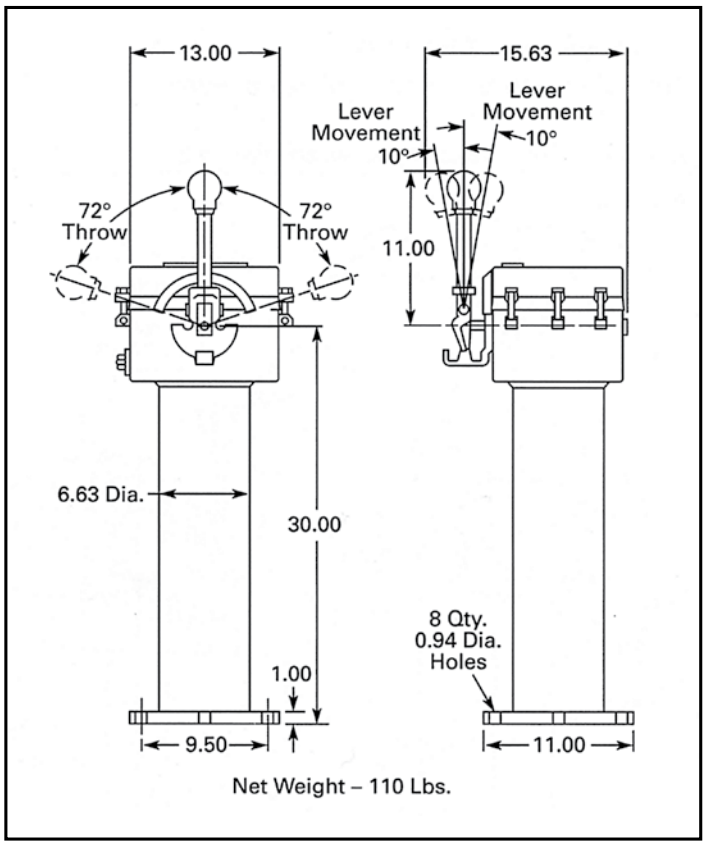
When Ordering Renewal Parts –

For a master switch in service, be sure to give nameplate data and description of parts required.

Specifications

- MIL-SPEC.....MIL-DTL-2212
  Master switch contacts are non-closing on Class HI-Shock. Contact may momentarily bounce open on Class HI-Shock.
- Enclosure .....Watertight
- Operation .....Manual, self-centering and non-self-centering types
- Location .....Remote
- Type .....Cam Type – 5 positions each direction
- Duty .....Continuous
- Ambient temp .....50°C

Approximate Dimensions in Inches and Weight



Ratings – Pilot Circuits Only

Inductive Rating	Maximum Amperes			
	AC 60 Hz		DC	
	110V	440V	115V	230V
Make	40	10	3	1.5
Break	10	2.5	3	1.5
Carry (cont.)	10	10	10	10

Type 6984NL
Snap Action Limit Switches

Counterbalanced Roller Lever

Adjustable Roller Lever

Adjustable Rod Actuator

Top Pushbutton Roller

Specifications

- MIL-SPEC.....MIL-DTL-2212
- Enclosure .....Watertight, zinc alloy die casting with corrosion resistant finish
- Type .....Snap action precision type, single-pole double-throw (NO-NC), or double-pole single-throw (2NO-2NC)
- Operation .....5 types of operating heads available; in addition to four-position, 90° operating head rotation, all rotary lever type limit switches offer 360° lever adjustability. Spring return to normal.
- Duty .....Continuous
- Ambient temp .....50°C
- Insulation .....Navy molding material, removable as complete unit
- Weight.....1.25 Lbs.

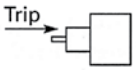
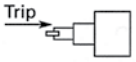
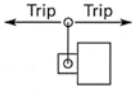
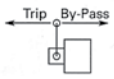
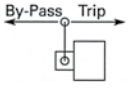
When ordering specify

- Catalog number
- Voltage
- Type of operating head
- For roller lever, adjustable lever or adjustable rod, specify if bypass is required in either direction of operation.

Ratings – Pilot Duty AC or DC

Contacts	Current Amperes	AC		DC		
		110V	440V	115V	230V	355V
NO-NC	Max. Inrush	40	10	-	-	-
	Max. Continuous	15	6	0.5	0.2	0.1
2NO or 2NC	Max. Inrush	17	4.5	-	-	-
	Max. Continuous	3	0.75	0.1	0.05	-

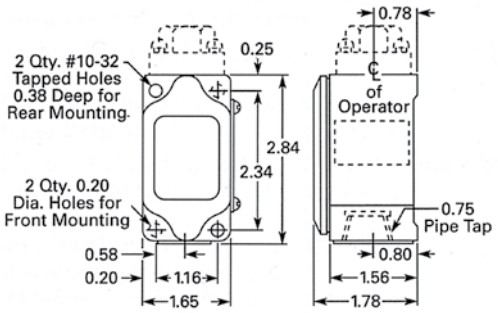
Type NL

Description		1NO-1NC ❸	2NO	2NC
Type of Operator	Function	Cat. No.	Cat. No.	Cat. No.
Pushbutton		**6984H42A**	**6984H79A**	**6984H80A**
Push Roller		**6984H43A**	**6984H81A**	**6984H82A**
Adjustable Rod Lever		**6984H50A**	**6984H95A**	**6984H98A**
Adjustable Roller Lever		**6984H47A**	**6984H89A**	**6984H92A**
1.5" Counterbalance Roller Lever ❷		**6984H53A ❶**	**6984H83A**	**6984H86A**
Adjustable Rod Lever		**6984H51A**	**6984H96A**	**6984H99A**
Adjustable Roller Lever		**6984H48A**	**6984H90A**	**6984H93A**
1.5" Counterbalance Roller Lever ❷		**6984H54A ❶**	**6984H84A**	**6984H87A**
Adjustable Rod Lever		**6984H52A**	**6984H97A**	**6984H100A**
Adjustable Roller Lever		**6984H49A**	**6984H91A**	**6984H94A**
1.5" Counterbalance Roller Lever ❸		**6984H55A ❶**	**6984H85A**	**6984H88A**

❶ These switches are electrically "HI-Shock." All others are mechanical "HI-Shock" only.
❷ Switch with 2.5" counterbalance roller lever is available. Information and price based on application.
❸ Must be same polarity

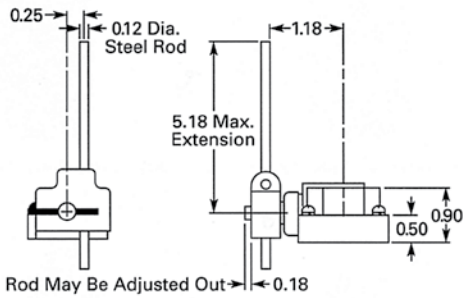
Type 6984NL
Snap Action Limit Switches

Approximate Dimensions in Inches and Operating Data
Without Operating Head



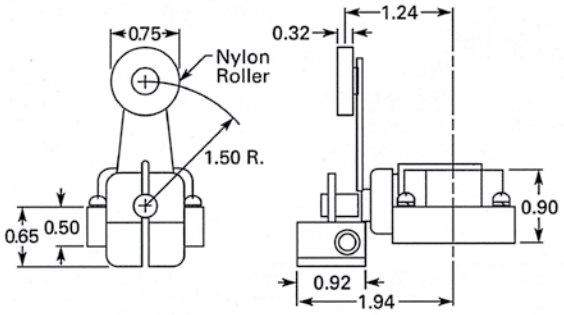
Travel to Close Contacts ..... 10°
Pounds Force to Trip @ 1.5" Radius 2
Total Travel ..... 50°
Travel to Reset from Trip Point ..... 4°

Adjustable Rod Actuator



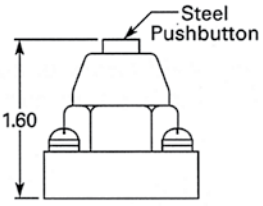
Travel to Close Contacts ..... 10°
Pounds Force to Trip @ 1.5" Radius 2
Total Travel ..... 50°
Travel to Reset from Trip Point ..... 4°

Counterbalanced Roller Lever



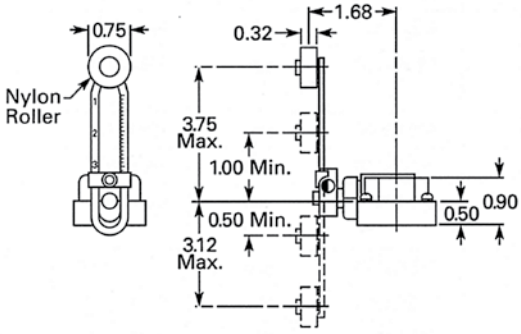
Travel to Close Contacts ..... 10°
Pounds Force to Trip @ 1.5" Radius 2
Total Travel ..... 50°
Travel to Reset from Trip Point ..... 4°

Top Pushbutton



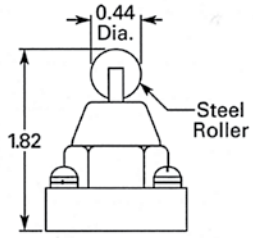
Travel to Close Contacts ..... 0.05"
Pounds Force to Trip Contacts 4.0
Total Travel ..... 0.28"
Travel to Reset ..... 0.02"

Adjustable Roller Lever



Travel to Close Contacts ..... 10°
Pounds Force to Trip @ 1.5" Radius 2
Total Travel ..... 50°
Travel to Reset from Trip Point ..... 4°

Top Push Roller



Travel to Close Contacts ..... 0.04"
Pounds Force to Trip Contacts 4.0
Total Travel ..... 0.28"
Travel to Reset ..... 0.02"

Type 6984NL X–W
Explosion–Proof❶/Watertight Limit Switches

Specifications

- MIL-SPEC.....MIL-DTL-2212
- Enclosure .....Watertight (hose test) and explosion-proof ❶. Completely corrosion-proof switch. All metallic external parts are silicon bronze.
- Type .....Snap action precision type: NO-NC, 2NO or 2 NC
- Operation .....Top pushbutton, top push roller and roller lever types available. In addition to four-position, 90° operating head rotation, all rotary lever type limit switches offer 360° lever adjustability. Spring return to normal.
- Duty .....Continuous
- Ambient temp .....50°C

Ratings – Pilot Duty AC or DC

Contacts	Current Amperes	AC		DC		
		110V	440V	115V	230V	355V
NO-NC	Max. Inrush	40	10	-	-	-
	Max. Continuous	15	6	0.5	0.2	0.1
2NO or 2NC	Max. Inrush	17	4.5	-	-	-
	Max. Continuous	3	0.75	0.1	0.05	-

When ordering specify

- Catalog number

Type NLXW Silicon Bronze Limit Switches

Contacts	Rotation	Operator Type ❷ – Catalog number				Weight Lbs.
		Top Pushbutton	Top Roller	1.5" Counterbalanced Roller Lever	2.5" Counterbalanced Roller Lever	
NO-NC ❹	-	**6984ED64-21**	**6984ED64-24**	-	-	6.25
	CW and CCW	-	-	**6984ED64-27** ❸	**6984ED64-36** ❸	
	CCW	-	-	**6984ED64-28** ❸	**6984ED64-40** ❸	
	CW	-	-	**6984ED64-29** ❸	**6984ED64-41** ❸	
2NO	-	**6984ED64-22**	**6984ED64-25**	-	-	6.25
	CW and CCW	-	-	**6984ED64-30**	**6984ED64-37**	
	CCW	-	-	**6984ED64-31**	-	
	CW	-	-	**6984ED64-32**	-	
2NC	-	**6984ED64-23**	**6984ED64-26**	-	-	6.25
	CW and CCW	-	-	**6984ED64-33**	**6984ED64-38**	
	CCW	-	-	**6984ED64-34**	-	
	CW	-	-	**6984ED64-35**	-	

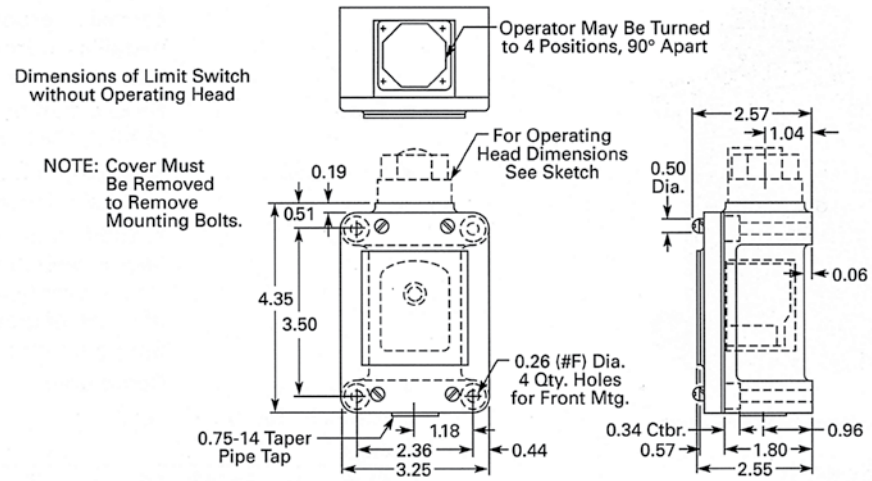
❶ Class I, Group D, unless specifically defined otherwise.
❷ For dimensions and operating characteristics, see dimension drawings on **Page 84**.
❸ Only these switches are electrically and mechanically "HI-Shock." All others are mechanically "HI-Shock" only.
❹ Both contacts must be the same polarity.

Type 6984NLX-W
Explosion-Proof❶ / Watertight Limit Switches

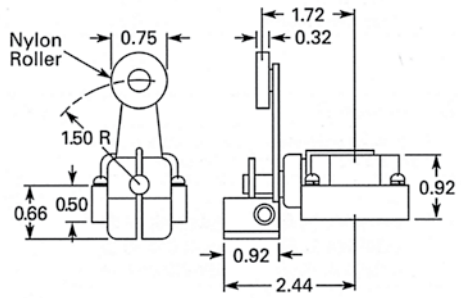
Silicon Bronze

Approximate Dimensions in Inches and Operating Data

Silicon Bronze Limit Switch without Operating Head

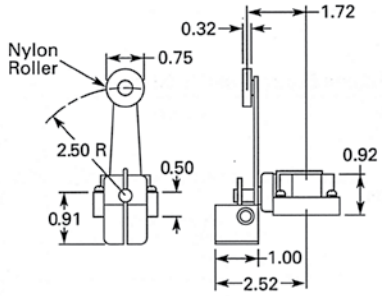


1.5" Counterbalanced Roller Lever with Nylon Roller



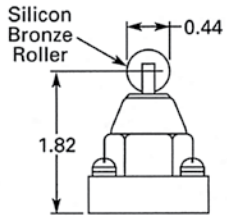
Travel to Trip ..... 10°
Pounds Force to Trip @ 1.5" Radius 2
Total Travel ..... 50°
Travel to Reset ..... 4°

2.5" Counterbalanced Lever with Nylon Roller



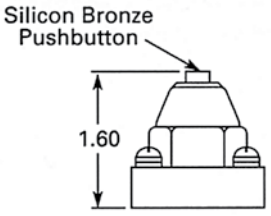
Travel to Trip ..... 10°
Pounds Force to Trip @ 2.5" Radius 1.2
Total Travel ..... 50°
Travel to Reset ..... 4°

Top Push Roller



Travel to Close Contacts (maximum) ..... 0.05"
Pounds Force to Trip Contacts 5.75
Total Travel (minimum) ..... 0.27"
Travel to Reset (maximum) ..... 0.05"

Top Pushbutton



Travel to Close Contacts (maximum) ..... 0.05"
Pounds Force to Trip Contacts 5.75
Total Travel (minimum) ..... 0.27"
Travel to Reset (maximum) ..... 0.05"

❶ Class I, Group D, unless Specifically defined otherwise.

NOTE: Dimensions are approximate and are not to be used for construction.

Type 6984-T11 and T12
Snap Action Limit Switch

Type T11 – Watertight with 3.5 Inch Lever and Large Nylon Roller

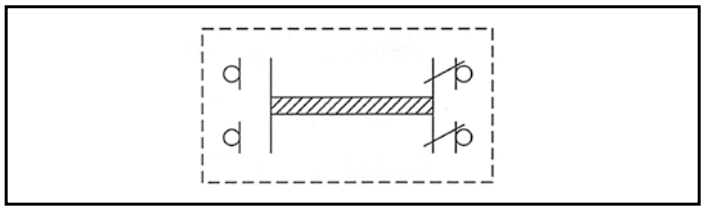
When ordering specify

- Catalog number
- Voltage
- Type of operating head
- For roller lever type operator, specify if bypass is required in either direction of operation.

Arrangement of Contacts

Type T11

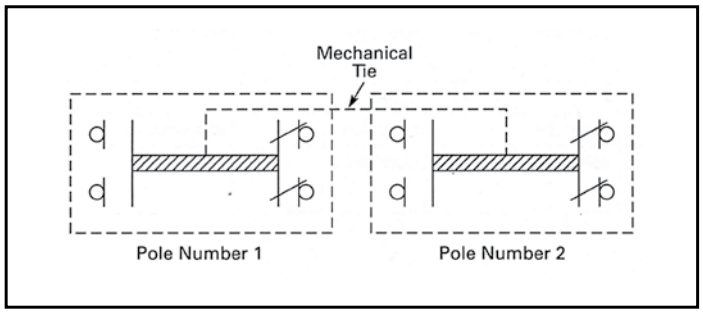
Single-Pole, Double-Throw Switch — Normal Position



Normally open and normally closed contacts should be on the same side of the line.

Type T12

Double-Pole, Double-Throw Switch — Normal Position



The poles can be used on opposite sides of the line. Normally open and normally closed contacts on each pole must be on the same side of the line.

Specifications

- MIL-SPEC.....MIL-DTL-2212
- Enclosure .....Watertight or explosion-proof ❶.
- Type .....Snap action limit switch
  C-H Type T11 -
  Single-Pole, Double-Throw
  C-H Type T12 -
  Double-Pole, Double-Throw
- Operation .....Three types of operating head available: Roller lever operator
  Push roller operator
  Pushbutton operator
  Spring return to normal position
- Duty .....Continuous
- Ambient temp .....50°C
- Insulation .....Class B

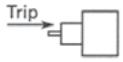
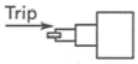
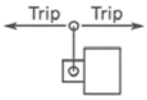
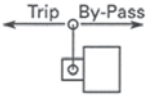
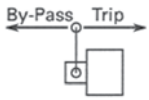
Ratings – Pilot Circuits Only

Inductive Rating	Maximum Amperes					
	AC 60 Hertz			DC		
	110V	220V	440V	115V	230V	250V❷
Make	60	30	20	10	10	10
Break	6	3	1.5	2.2	1.1	0.5
Carry (Cont.)	10	10	10	10	10	10

❶ Class I, Group D, unless specifically defined otherwise.
❷ Nominal submarine voltage (355V maximum).

Type 6984-T11 and T12
Snap Action Limit Switch

Types T11 and T12 – Watertight or Explosion Proof ❶

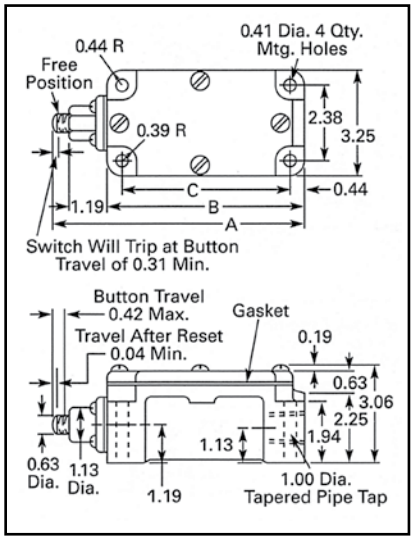
Description		Type T11 – 1NO-1NC		Type T12 – 2NO-2NC	
Type of Operator	Function	Watertight	Explosion-Proof ❶	Watertight	Explosion-Proof ❶
		Catalog number	Catalog number	Catalog number	Catalog number
Pushbutton		6984H5C	6984H21B	6984ED89-1	6984ED86-1
Push Roller		6984H6C	6984H22B	6984ED89-2	6984ED86-2
1.19” Long Roller Lever, Steel Roller		6984ED5-2	6984ED39-2	6984ED92-1	-
2.5” Long Roller Lever, Steel Roller		6984H27A	6984H24A	6984ED90-1	6984ED87-1
3.5” Long Roller Lever, Nylon Roller ❷		6984H36A	6984H33A	6984ED91-1	6984ED88-1
1.19” Long Roller Lever, Steel Roller		6984ED6-2	6984ED39	6984ED92-2	-
2.5” Long Roller Lever, Steel Roller		6984H28A	6984H25A	6984E90-2	6984ED87-3
3.5” Long Roller Lever, Nylon Roller ❷		6984H37A	6984H34A	6984ED91-2	6984ED88-2
1.19” Long Roller Lever, Steel Roller		6984ED7	-	6984ED92-3	-
2.5” Long Roller Lever, Steel Roller		6984H29A	6984H26A	6984ED90-3	6984ED87-4
3.5” Long Roller Lever, Nylon Roller ❷		6984H38A	6984H35A	6984ED91-3	6984ED88-3

❶ Class I, Group D, unless specifically defined otherwise.
❷ Nylon roller is 1.5” diameter.

Type 6984-T11 and T12
Snap Action Limit Switches

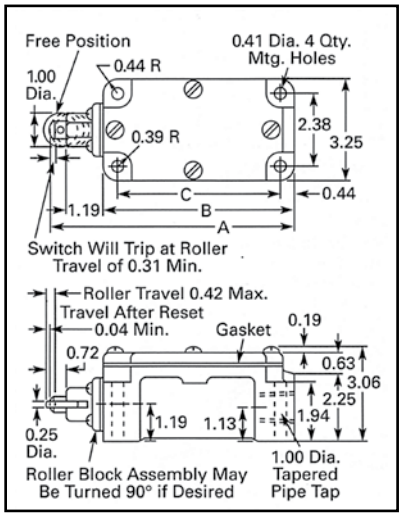
Approximate Dimensions in Inches and Weights – Watertight Enclosures

Snap Action Limit Switch with Pushbutton Operator



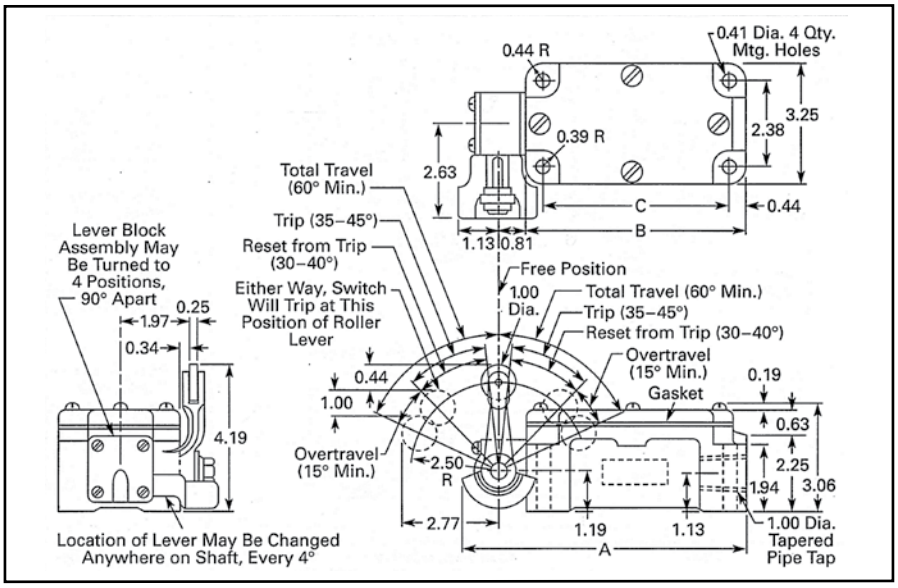
Type	Dimensions in Inches			Weight Lbs.
	A	B	C	
T11-Single-Pole, Double Throw	7.91	6.13	5.25	4
T12 – Double-Pole, Double Throw	11.03	9.25	8.38	5

Snap Action Limit Switch with Push Roller Operator



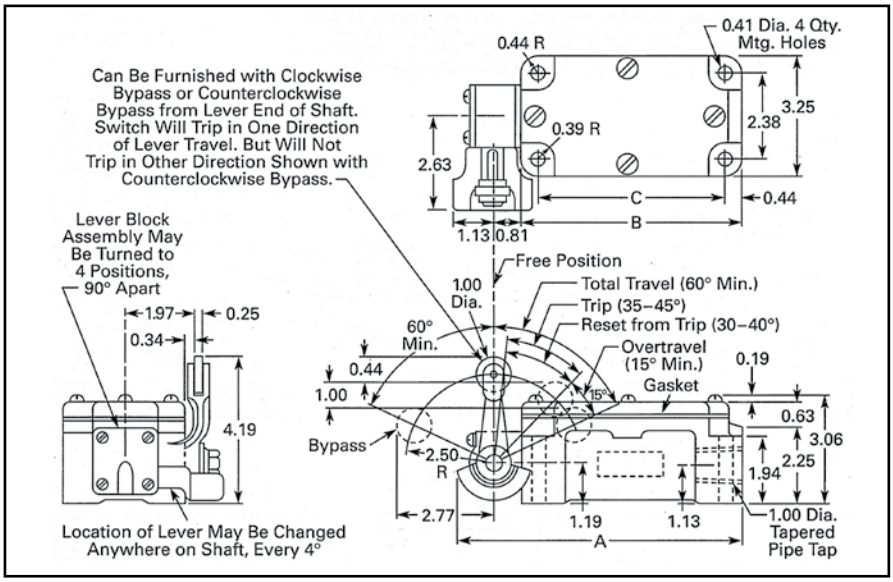
Type	Dimensions in Inches			Weight Lbs.
	A	B	C	
T11-Single-Pole, Double Throw	8.03	6.13	5.25	4
T12 – Double-Pole, Double Throw	11.16	9.25	8.38	5

Snap Action Limit Switch with Roller Lever Operator, Clockwise and Counterclockwise Trip



Type	Dimensions in Inches			Weight Lbs.
	A	B	C	
T11-Single-Pole, Double Throw	8	6.13	5.25	4
T12 – Double-Pole, Double Throw	11.25	9.25	8.38	5

Snap Action Limit Switch with Roller Lever Operator, Clockwise Trip and Counterclockwise Bypass - or Counterclockwise Trip and CLockwise Bypass



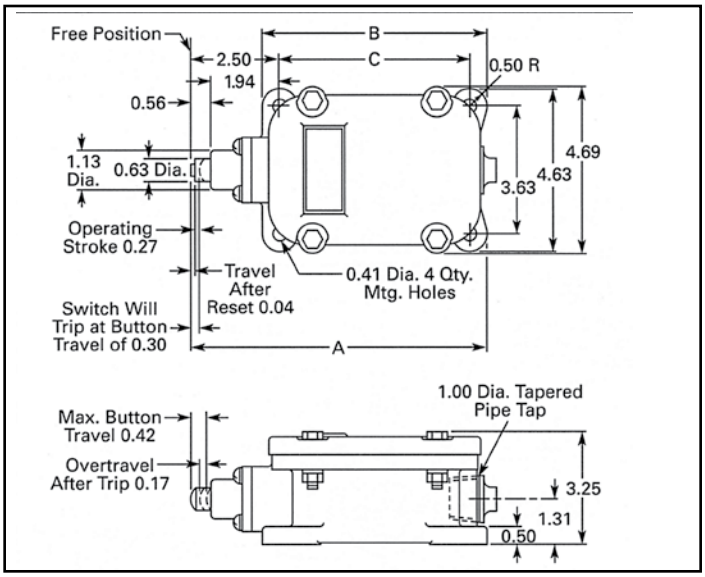
Type	Dimensions in Inches ❶			Weight Lbs.
	A	B	C	
T11-Single-Pole, Double Throw	8.06	6.13	5.25	4
T12 – Double-Pole, Double Throw	11.19	9.25	8.38	5

❶ Nylon Roller is 1.5" diameter.

Type 6984-T11 and T12
Snap Action Limit Switch

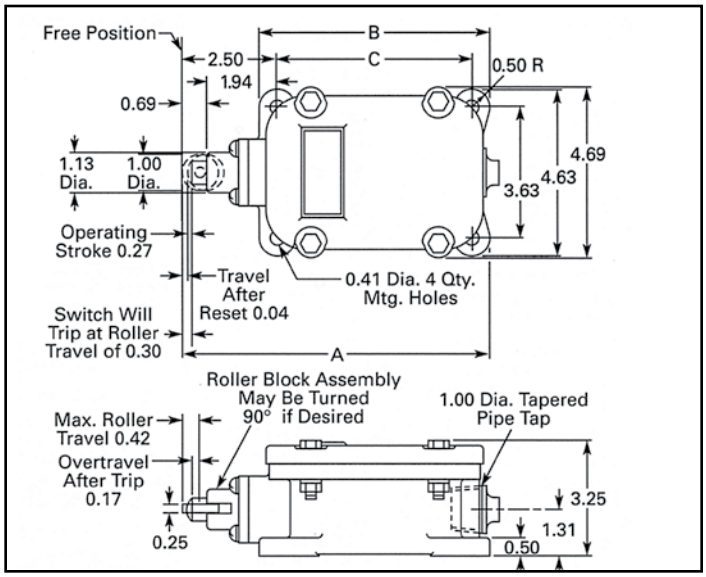
Approximate Dimensions in Inches and Weights – Explosion-Proof Enclosures ❶ (Cast Brass)

Snap Action Limit Switch with Pushbutton Operator



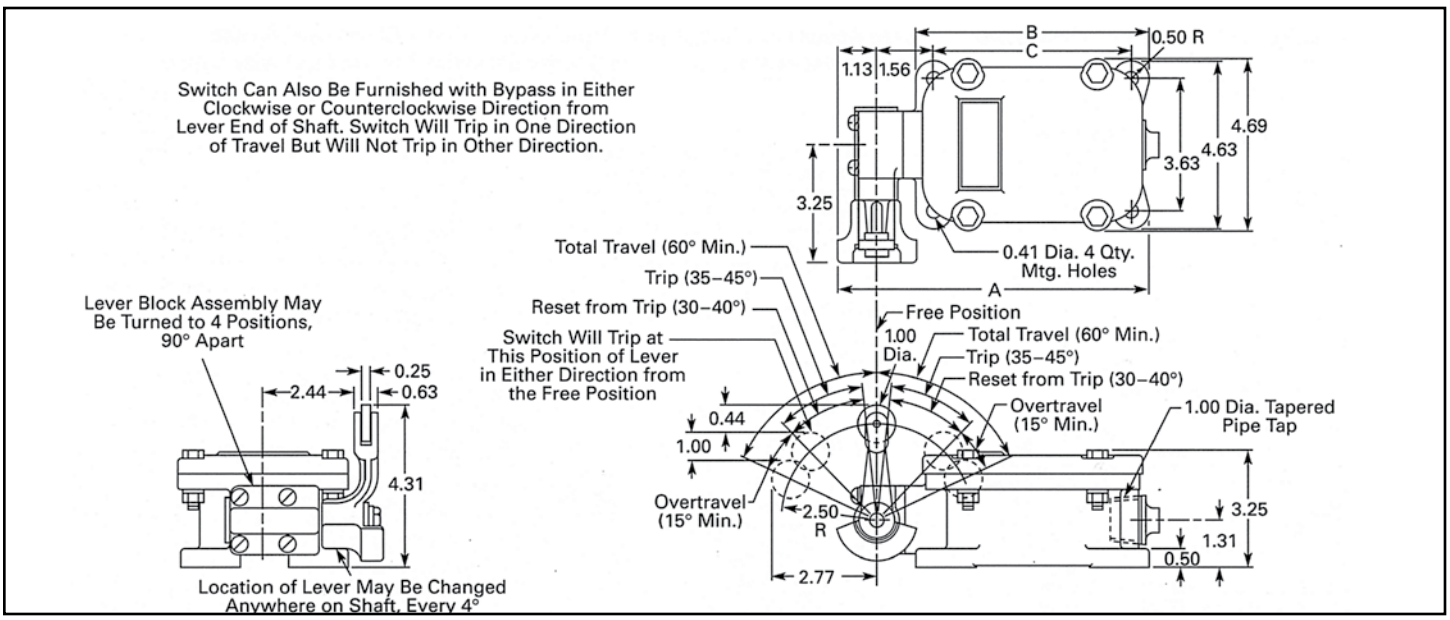
Type	Dimensions in Inches			Weight Lbs.
	A	B	C	
T11-Single-Pole, Double Throw	8.38	6.38	5.38	14
T12 – Double-Pole, Double Throw	11.5	9.5	8.5	20

Snap Action Limit Switch with Push Roller Operator



Type	Dimensions in Inches			Weight Lbs.
	A	B	C	
T11-Single-Pole, Double Throw	8.5	6.38	5.38	14
T12 – Double-Pole, Double Throw	11.63	9.5	8.5	20

Snap Action Limit Switch with Roller Lever Operator



Type	Dimensions in Inches ❷			Weight Lbs.
	A	B	C	
T11-Single-Pole, Double Throw	9	6.38	5.38	14
T12 – Double-Pole, Double Throw	11.69	9.5	8.5	20

❶ Class I, Group D, unless specifically defined otherwise.
❷ Nylon roller is 1.5" diameter.

Type 6984
Geared Type Limit Switch

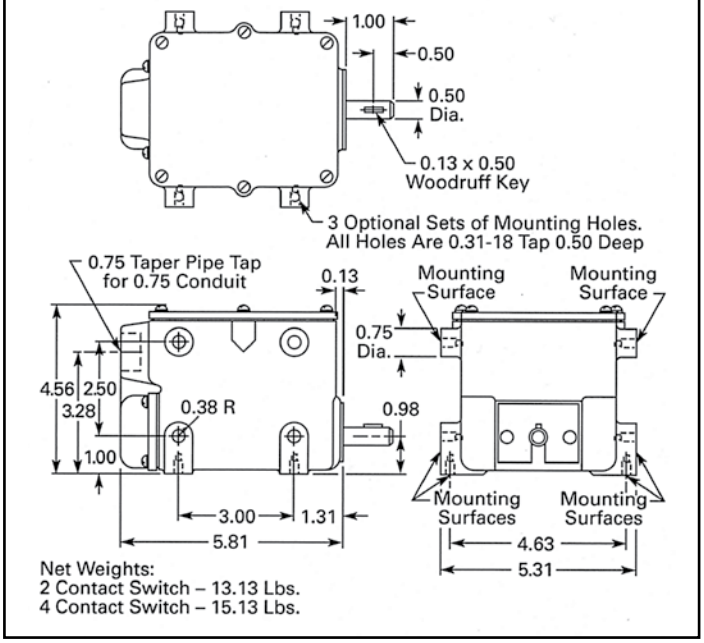
When ordering specify

- Type number
- Voltage
- 2 contact or 4 contact
- Shaft speed
- Settings

Geared Limit Switch - Watertight

Description	Catalog No.
Rotating Shaft – 2 Contact (A&B)	**6984H133A-NM**
Rotating Shaft – 4 Contact (A-D)	**6984ED84NM**

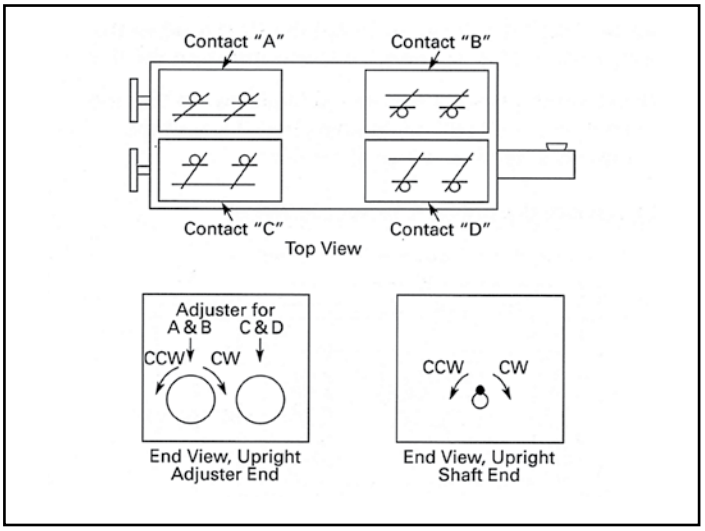
Approximate Dimensions in Inches and Weights



Specifications

- MIL-SPEC.....MIL-DTL-2212
  Contact may open or close momentarily on Class HI-Shock
- Enclosure .....Watertight – brass case and cover
- Type .....Geared Type, 2 contact or 4 contact
- Operation .....Shaft driven, tripping points are adjustable between ½ and 100 turns of operating shaft in increments of 1/20th of a shaft turn. For shaft speeds of 600 rpm (max.), 10 rpm (min.)
- Duty .....Continuous
- Ambient temp .....50°C
- Insulation .....Class B

Operation



All contacts are closed between limits, the switch construction is such that contact "A" and "D" are normally open before they are mounted in the switch, and contacts "B" and "C" are normally closed before mounting in switch.

Contacts "A" and "C" are opened by clockwise rotation of the adjuster, and clockwise rotation of the shaft. Contact "A" and "C" are set by driving the machine to its end of travel in the direction that turns the adjuster clockwise, and then opening the contacts with the adjuster.

Contacts "B" and "D" are opened by counterclockwise rotation of the adjuster, and the counterclockwise rotation of the shaft. Contacts "B" and "D" are set by driving the machine to its end of travel in the direction that turns the adjuster counterclockwise, and then opening the contacts with the adjuster.

One turn of the adjuster corresponds to 1-1/3 turns of the main shaft.

Type 6991
Overtemperature Monitor

When ordering specify

- Catalog number of Overtemperature Monitor
- Resistance value of installed thermistors

Type 6991 Overtemperature Monitor

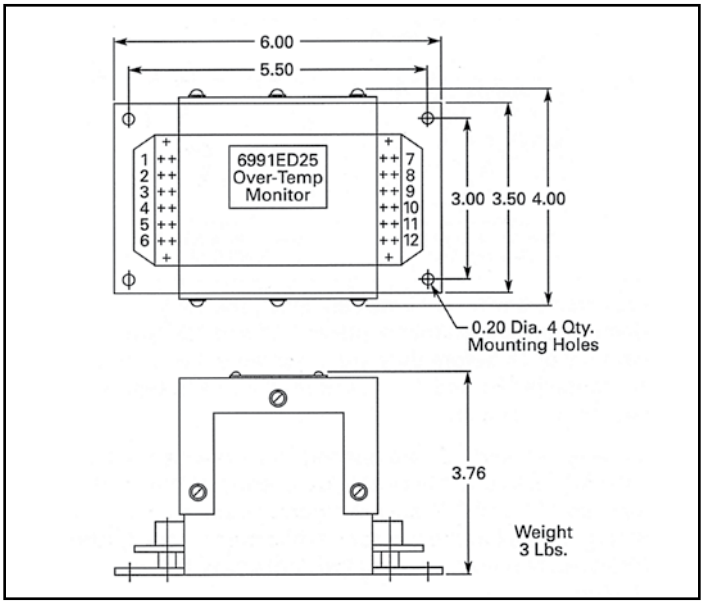
Description	Catalog No.
Overtemperature Monitor	**6991ED25**

General

The Overtemperature Monitor measures the individual resistance of up to three thermistors which are attached to or imbedded in the motor windings. When one or more of the thermistors reaches its trip temperature (a resistance of 450 ohms), a control circuit relay (not supplied) is de-energized. The contacts of the control relay (not supplied) are wired in series with the motor starter magnet coil and drop out the starter when the relay opens. This disconnects the motor from the line.

The Overtemperature Monitor is "failsafe" in that the control relay coil will be de-energized if any of the thermistors open circuit or short out.

Approximate Dimensions in Inches and Weights



Catalog No. 6991ED25 supersedes and is interchangeable with Overtemperature Monitor Catalog No. 6999ED207C2.

Specifications

- MIL-SPEC.....MIL-E-917 and MIL-S-901
- Duty .....Continuous
- Ambient temp .....50°C
- Rating .....110V AC pilot duty

Three thermistors with the following characteristics are required:

- Type .....Negative Temperature Coefficient
- Max. resistance .....4000 ohms at 20°C
- "Trip" resistance 450 ohms at desired "Trip" temperature

NEMA Insulation Classes

Motor Insulation Class	Trip Temperatures
A	100° C
B	130° C
F	155° C
H	180° C

Type 6999
Overspeed Trip Drive

When ordering specify

- Catalog number

Type 6999 Overspeed Trip Device

Description	Tachometer Voltage	Catalog number
Overspeed Trip Device	0 - 40V 0 - 60V	**6999ED203A4** **6999ED203A5**

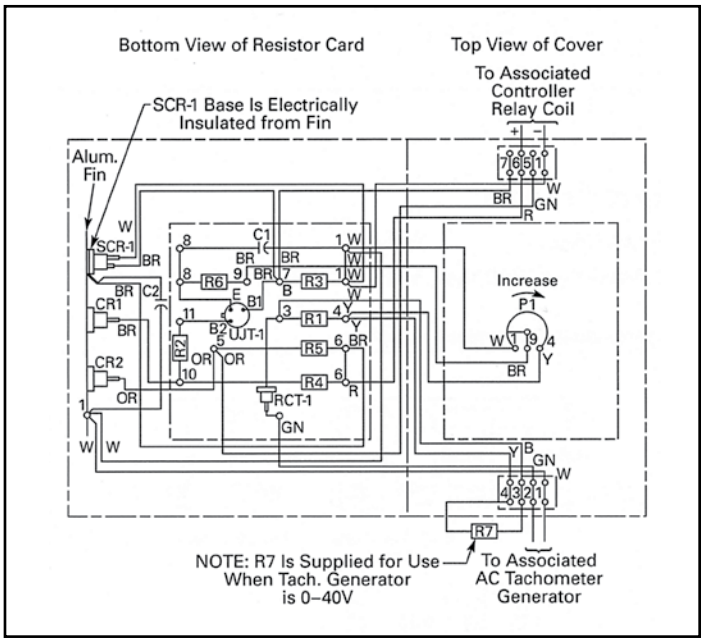
General

The Overspeed Trip Device is designed to prevent overspeeding on DC driven M-G sets, centrifugal pumps, etc.,
by measuring tachometer voltage of the driven machine and stopping the motor at a predetermined voltage. Stopping is accomplished by de-energizing the coil of a DC control relay (not included), which then opens the main motor controller contactor.

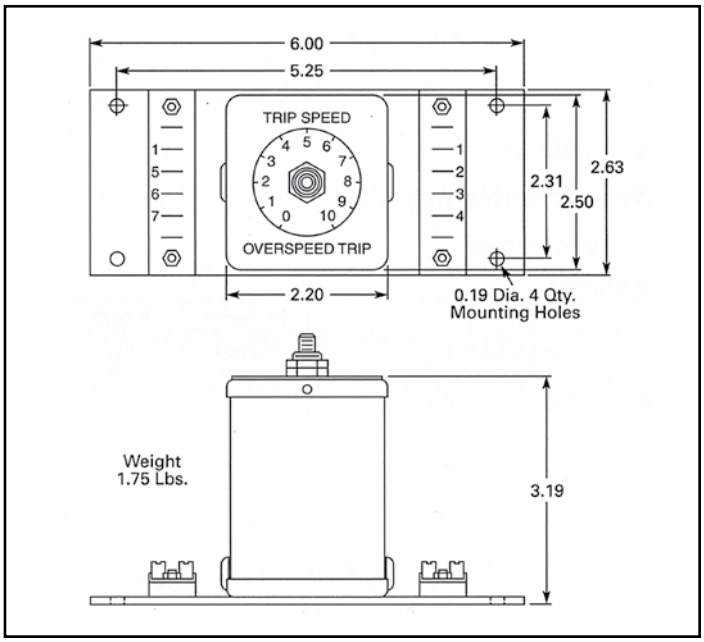
Specifications

- MIL-SPEC.....MIL-E-917 and MIL-S-901
- Duty .....Continuous
- Ambient temp .....50°C
- Repair parts.....Complete unit is supplied
- Ratings.....Tachometer input 0-40V or 0-60V AC. Maximum voltage on terminals 1 through 6, 100V DC. Maximum application voltage with control relay, 250V DC nominal (180V - 355V submarine)

Typical Wiring Diagram



Approximate Dimensions in Inches and Weights



Navy Control Circuit Wiring
Terminal Boards / Fuse Blocks

Terminal Boards

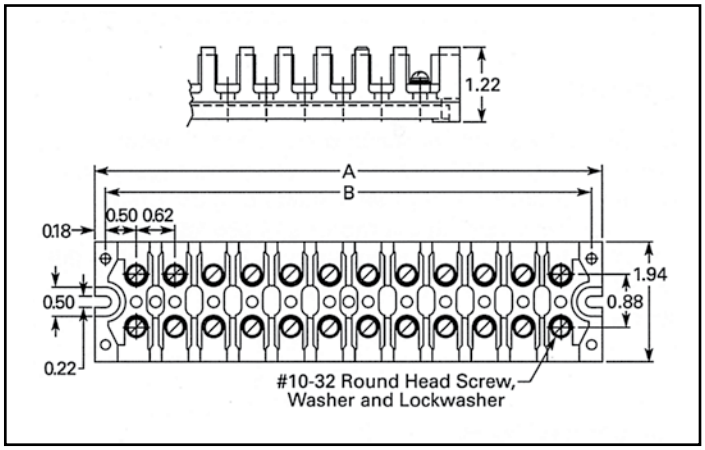
When ordering specify
- Catalog number

Terminal Boards

Tie Points	Dimensions In Inches		Part Number
	A	B	
4	**3.25**	**2.88**	**80-958-4**
8	**5.75**	**5.38**	**80-958-5**
12	**8.25**	**7.88**	**80-958-6**

Specifications
- MIL-SPEC.....MIL-DTL-2212
- Ratings.....440V AC, 30A continuous

Approximate Dimensions in Inches



Fuse Blocks

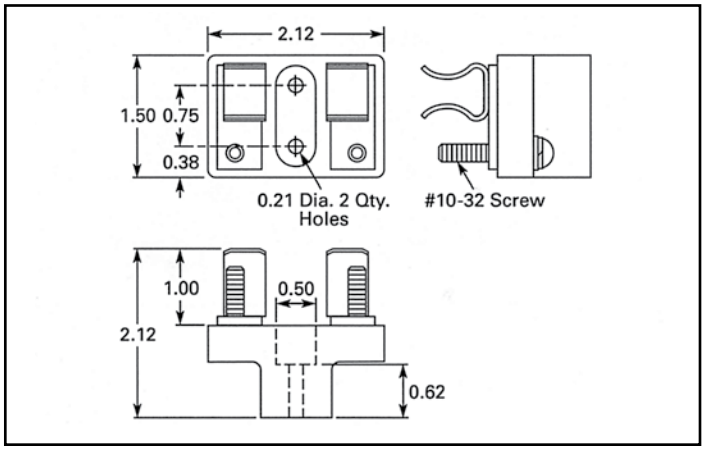
When ordering specify
- Catalog number

Terminal Boards

Fuse Type	Part Number
F60 (MIL-F-15160/60)	**44-1804A**
F61 (MIL-F-15160/61)	**44-647-5**

Specifications
- MIL-SPEC.....MIL-DTL-2212
- Maximum Ratings.....500V AC, 30A continuous

Approximate Dimensions in Inches



Navy Power Terminal Blocks 100, 150 and 300 Amperes

When ordering specify

- Catalog number

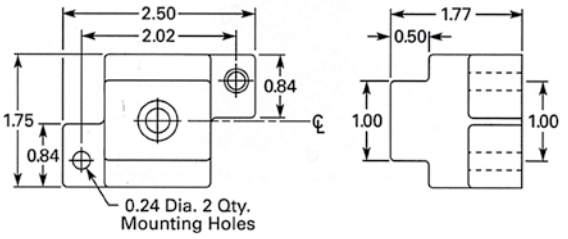
Specifications

- MIL-SPEC.....MIL-DTL-2212
- Maximum ratings.....600V

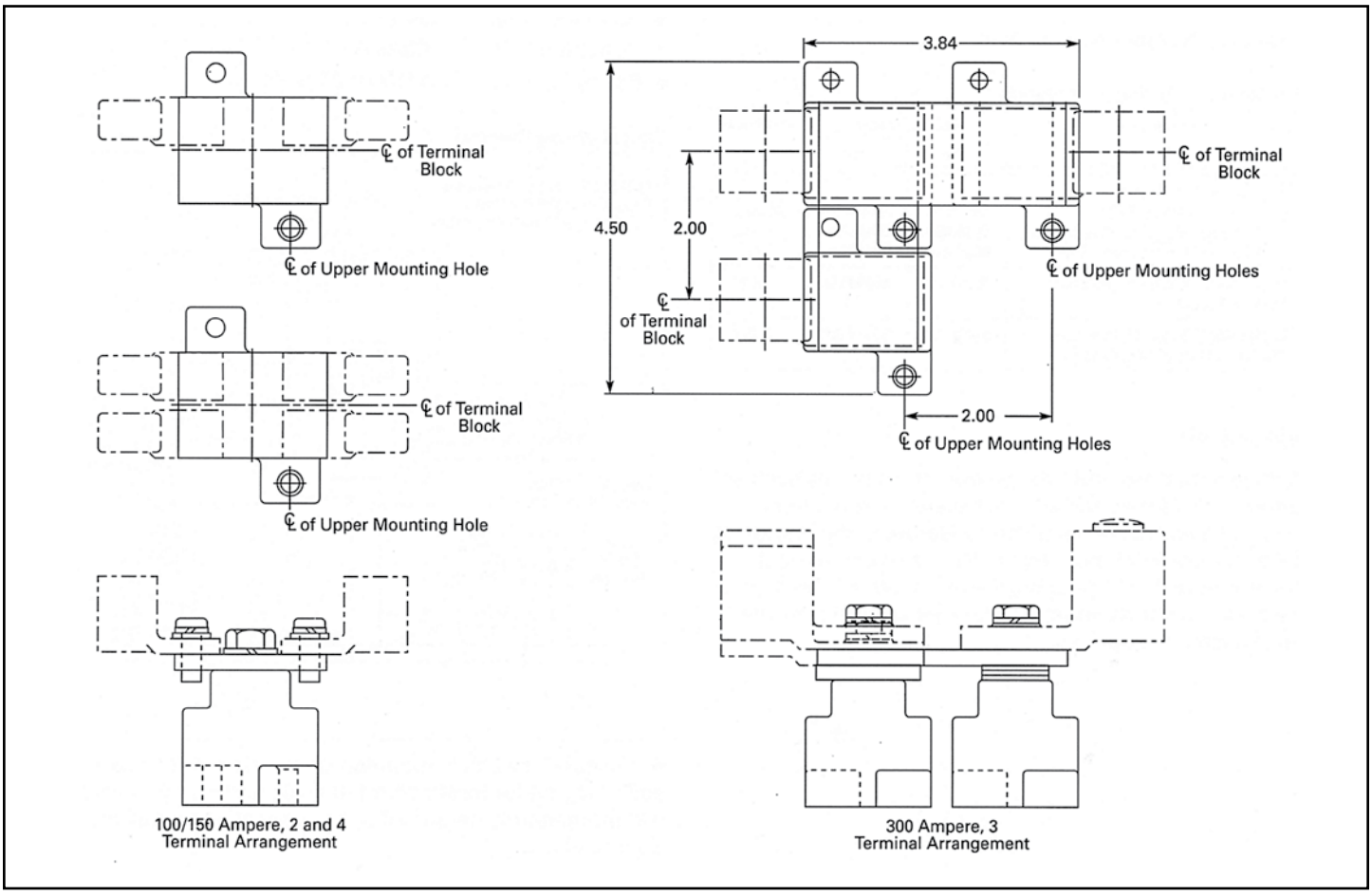
Power Terminal Blocks

Ampere Rating	Tie Points	Part Number
100	2	**81-7712**
100	4	**81-7712-2**
150	2	**81-7712-5**
150	4	**81-7712-6**
300	2	**81-7712-3**
300	3	**81-7712-4**

Basic Block Dimensions in Inches



Terminal Arrangements, Approximate Dimensions in Inches



POWER CONDITIONING

The Solution Leader - 100W - 200kW

Leonardo DRS is a proven leader in the design, development and manufacturer of high reliability power generation and power conversion equipment from 100W to 200kW. Our combined capabilities provide an unmatched customer relationship commitment to fully understanding and providing your power requirements.

With over two decades of customer satisfaction and success, Leonardo DRS delivers products to Navy operations world-wide, consistently exceeding expectations and bolstering our reputation for high reliability in power conversion equipment including UPS systems, rectifiers, vehicle starters, battery chargers and frequency converters. Units are available with hard mounting for bulkhead or deck, hard-mounted or isolated rack mounting, single- or three-phase ship power input and are all full MIL-SPEC qualified. We also offer affordable COTS systems.

In-house tests include environmental screening, EMI/EMC confidence and vibration.

Engineered Center of Excellence

Leonardo DRS has created a “Center of Excellence”, staffed by a dedicated and experienced engineering team for second-to-none capability and a thorough understanding of maritime needs.

0.8 KW DC UPS

841-01

General

Leonardo DRS Uninterruptible Power Supply (UPS) systems are intended for use on board naval combat ships to power critical command, control, communications and navigation equipment.

Features

- Mean Time Between Failures (MTBF) – 40,000 hours
- Isolation switches for input, output and battery
- SNMP communications and control options
- Draw-out sub-assemblies and printed wiring boards
- Built-In Test (BIT) capability
- On-line maintenance of batteries and battery charger
- 841-01 offers 30 minutes of backup*

  * Battery enclosures are sold separately

Electrical Characteristics	
Input voltage	440VAC, 3-Phase, 60Hz conforming to Type 1 of MIL-STD-1399, Section 300 A
Output	
Voltage nominal	28 VDC
Voltage regulation	± 2%
Power rating	800W
Overload capacity	125% for 1 minute
Short circuit current	200% rated load current for 1 second
Maximum transient voltage for 50% load step	10%
Maximum transient voltage recovery time for 50% load step	100 ms
Ripple and noise	200 mV p-p
Efficiency at rated load	80% minimum
Remote signal communications	Multiple options available
Battery charging time	6 hours for 40% capacity to 80% capacity

Environmental Characteristics	
Operating temperature	0°C to 50°C / 32°F to 122°F
Storage temperature	-40°C to +70°C / -40°F to +158°F
Electromagnetic compatibility / Electromagnetic interference	MIL-STD-461D, CE101, CE102, CS101, CS114, CS116, RE101, RE102, RS101, RS103
Vibration	MIL-STD-167/1, Type I, 4-33Hz
Shock	MIL-S-901D, Grade A, Class I
Airborne noise	MIL-STD-740-1, Class A12

Reliability and Maintainability	
Mean time between failures (MTBF)	40,000 hours
Mean time to repair	20 minutes
Maximum time to repair	45 minutes

Physical Characteristics (Please refer to the power unit interface control drawing for detailed dimensions)		
Enclosure protection	Drip proof protected as per MIL-STD-108E (45°)	
Cooling method	Forced air	
Approximate Dimensions / Mounting	**Bulkhead**	**Rack**
Width (mm / inches)	513 / 20.5	483 / 19.3
Depth (mm / inches)	231 / 9.1	725 / 28.6
Height (mm / inches)	640 / 25.2	222 / 8.9 (5U)
Weight (kg / pounds)	47 / 114	47 / 114

2.4 KW DC UPS

843-01

General

Leonardo DRS Uninterruptible Power Supply (UPS) systems are intended for use on board naval combat ships to power critical command, control, communications and navigation equipment.

Features

- Mean Time Between Failures (MTBF) – 40,000 hours
- Isolation switches for input, output and battery
- SNMP communications and control options
- Draw-out sub-assemblies and printed wiring boards
- Built-In Test (BIT) capability
- On-line maintenance of batteries and battery charger
- Key system LED status indicators, LCD status display
- 843-01 offers 30 minutes of backup*
  * Battery enclosures are sold separately

Electrical Characteristics	
Input voltage	440VAC, 3-Phase, 60Hz conforming to Type 1 of MIL-STD-1399, Section 300 A
Output	
Voltage nominal	28 VDC
Voltage regulation	± 2%
Power rating	2.4 kW
Overload capacity	125% for 1 minute
Short circuit current	200% rated load current for 1 second
Maximum transient voltage for 50% load step	10%
Maximum transient voltage recovery time for 50% load step	100ms
Ripple and noise	200 mV p-p
Efficiency at rated load	80% minimum
Remote signal communications	Multiple options available
Battery charging time	6 hours for 40% capacity to 80% capacity

Environmental Characteristics	
Operating temperature	0°C to 50°C / 32°F to 122°F
Storage temperature	-40°C to +70°C / -40°F to +158°F
Electromagnetic compatibility / Electromagnetic interference	MIL-STD-461D, CE101, CE102, CS101, CS114, CS116, RE101, RE102, RS101, RS103
Vibration	MIL-STD-167/1, Type I, 4-33Hz
Shock	MIL-S-901D, Grade A, Class I
Airborne noise	MIL-STD-740-1, Class A12

Reliability and Maintainability	
Mean time between failures (MTBF)	40,000 hours
Mean time to repair	20 minutes
Maximum time to repair	45 minutes

Physical Characteristics (Please refer to the power unit interface control drawing for detailed dimensions)		
Enclosure protection	Drip proof protected as per MIL-STD-108E (45°)	
Cooling method	Forced air	
Approximate Dimensions / Mounting	**Bulkhead**	**Rack**
Width (mm / inches)	513 / 20.5	483 / 19.3
Depth (mm / inches)	260 / 10.2	725 / 28.6
Height (mm / inches)	710 / 28.0	262 / 10.3 (6U)
Weight (kg / pounds)	74 / 163	74 / 163

1.0 KW DC Rectifier

841-01-14

General

Leonardo DRS rectifier systems are intended for use on board naval combat ships to provide regulated power to critical command, control, communications and navigation equipment.

Features

- Mean Time Between Failures (MTBF) – 40,000 hours
- Isolation switches for input and output
- SNMP communications and control options
- Draw-out sub-assemblies and printed wiring boards
- Built-In Test (BIT) capability
- Available with Manually Adjustable Output Voltage and Line Loss Compensation Option (per MIL-P-15736)
- Also available in 2.4 KW Power Level

Electrical Characteristics	
Input voltage	440VAC, 3-Phase, 60Hz conforming to Type 1 of MIL-STD-1399, Section 300 A
Output	
Voltage nominal	28 VDC
Voltage regulation	± 2%
Power rating	800W
Overload current, 125%	44 A, shutdown in 80 sec.
Short circuit current	80 A, shutdown in 2.5 sec.
Ripple and noise	200 mV p-p
Efficiency at rated load	80% minimum
Remote signal communications	Multiple options available

Environmental Characteristics	
Operating temperature	0°C to 50°C / 32°F to 122°F
Storage temperature	-40°C to +70°C / -40°F to +158°F
Electromagnetic compatibility / Electromagnetic interference	MIL-STD-461D, CE101, CE102, CS101, CS114, CS116, RE101, RE102, RS101, RS103
Vibration	MIL-STD-167/1, Type I, 4-33Hz
Shock	MIL-S-901D, Grade A, Class I
Airborne noise	MIL-STD-740-1, Class A12

Reliability and Maintainability	
Mean time between failures (MTBF)	40,000 hours
Mean time to repair	20 minutes
Maximum time to repair	45 minutes

Physical Characteristics (Please refer to the power unit interface control drawing for detailed dimensions)		
Enclosure protection	Drip proof protected as per MIL-STD-108E (45°)	
Cooling method	Forced air	
Approximate Dimensions / Mounting	**Bulkhead**	**Rack**
Width (mm / inches)	513 / 20.5	483 / 19.3
Depth (mm / inches)	231 / 9.1	725 / 28.6
Height (mm / inches)	640 / 25.2	222 / 8.9 (5U)
Weight (kg / pounds)	47 / 114	43 / 95

2 KVA AC UPS

832-01A

General

Leonardo DRS Uninterruptible Power Supply (UPS) systems are intended for use on board naval combat ships to power critical command, control, communications and navigation equipment.

Features

- Mean Time Between Failures (MTBF) – 40,000 hours
- Isolation switches for input, output and battery
- SNMP communications and control options
- Draw-out sub-assemblies and printed wiring boards
- Built-In Test (BIT) capability
- On-line maintenance of batteries and battery charger
- Key system LED status indicators, LCD status display
- 832-01A offers 30 Minutes of battery back up
  * Battery enclosures are sold separately

Electrical Characteristics	
Input voltage	440VAC, 3-Phase, 60Hz conforming to Type 1 of MIL-STD-1399, Section 300 A
Output	
Voltage	115 VAC
Frequency	60 Hz
Number of phases	1
Voltage regulation	± 2 %
Frequency regulation	± 0.5 %
Power rating	2 kVA
Overload capacity	125% for 1 minute
Short circuit current	200% rated load current for 1 second
Maximum transient voltage for 50% load step	10%
Maximum transient voltage recovery time for 50% load step	100 ms
Linear load	< 3 %
Nonlinear load	< 5 %
Maximum deviation factor for linear load	1 %
Current crest factor capacity	2.5
Efficiency at rated load	80% minimum
Remote signal communications	Multiple options available
Battery charging time	6 hours for 40% capacity to 80% capacity

Environmental Characteristics	
Operating temperature	0°C to 50°C / 32°F to 122°F
Storage temperature	-40°C to +70°C / -40°F to +158°F
Electromagnetic compatibility / Electromagnetic interference	MIL-STD-461D, CE101, CE102, CS101, CS114, CS116, RE101, RE102, RS101, RS103
Vibration	MIL-STD-167/1, Type I, 4-33Hz
Shock	MIL-S-901D, Grade A, Class I
Airborne noise	MIL-STD-740-1, Class A12

Reliability and Maintainability	
Mean time between failures (MTBF)	40,000 hours
Mean time to repair	20 minutes
Maximum time to repair	45 minutes

Physical Characteristics (Please refer to the power unit interface control drawing for detailed dimensions)		
Enclosure protection	Drip proof protected as per MIL-STD-108E (45°)	
Cooling method	Forced air	
Approximate Dimensions / Mounting	**Bulkhead**	**Rack**
Width (mm / inches)	445 / 17.8	483 / 19.3
Depth (mm / inches)	262 / 10.5	725 / 28.6
Height (mm / inches)	715 / 28.6	222 / 8.9 (5U)
Weight (kg / pounds)	81 / 178	81 / 178

3 KVA AC UPS

833-01A

General

Leonardo DRS Uninterruptible Power Supply (UPS) systems are intended for use on board naval combat ships to power critical command, control, communications and navigation equipment.

Features

- Mean Time Between Failures (MTBF) – 40,000 hours
- Isolation switches for input, output and battery
- SNMP communications and control options
- Draw-out sub-assemblies and printed wiring boards
- Built-In Test (BIT) capability
- On-line maintenance of batteries and battery charger
- Key system LED status indicators, LCD status display
- 833-01 offers 10 or 30 minutes of backup*
  * Battery enclosures are sold separately

Electrical Characteristics	
Input voltage	440VAC, 3-Phase, 60Hz conforming to Type 1 of MIL-STD-1399, Section 300 A
Output	
Voltage	115 VAC
Frequency	60 Hz
Number of phases	1
Voltage regulation	± 2 %
Frequency regulation	± 0.5 %
Power rating	3 kVA
Overload capacity	125% for 1 minute
Short circuit current	200% rated load current for 1 second
Maximum transient voltage for 50% load step	10%
Maximum transient voltage recovery time for 50% load step	100ms
Linear load	< 3 %
Nonlinear load	< 5 %
Maximum deviation factor for linear load	1%
Current crest factor capacity	2.5
Efficiency at rated load	80% minimum
Remote signal communications	Multiple options available
Battery charging time	6 hours for 40% capacity to 80% capacity

Environmental Characteristics	
Operating temperature	0°C to 50°C / 32°F to 122°F
Storage temperature	-40°C to +70°C / -40°F to +158°F
Electromagnetic compatibility / Electromagnetic interference	MIL-STD-461D, CE101, CE102, CS101, CS114, CS116, RE101, RE102, RS101, RS103
Vibration	MIL-STD-167/1, Type I, 4-33Hz
Shock	MIL-S-901D, Grade A, Class I
Airborne noise	MIL-STD-740-1, Class A12

Reliability and Maintainability	
Mean time between failures (MTBF)	40,000 hours
Mean time to repair	20 minutes
Maximum time to repair	45 minutes

Physical Characteristics (Please refer to the power unit interface control drawing for detailed dimensions)		
Enclosure protection	Drip proof protected as per MIL-STD-108E (45°)	
Cooling method	Forced air	
Approximate Dimensions / Mounting	Bulkhead	Rack
Width (mm / inches)	513 / 20.5	483 / 19.3
Depth (mm / inches)	262 / 10.5	715 / 28.6
Height (mm / inches)	715 / 28.6	222 / 8.9 (5U)
Weight (kg / pounds)	81 / 178	81 / 178

6 KVA AC UPS

836-01A

General

Leonardo DRS Uninterruptible Power Supply (UPS) systems are intended for use on board naval combat ships to power critical command, control, communications and navigation equipment.

Features

- Mean Time Between Failures (MTBF) – 40,000 hours
- Isolation switches for input, output and battery
- SNMP communications and control options
- Draw-out sub-assemblies and printed wiring boards
- Built-In Test (BIT) capability
- On-line maintenance of batteries and battery charger
- Key system LED status indicators, LCD status display
- 836-01 offers 10 or 30 minutes of backup*
  * Battery enclosures are sold separately

Electrical Characteristics	
Input voltage	440VAC, 3-Phase, 60Hz conforming to Type 1 of MIL-STD-1399, Section 300 A
Output	
Voltage	115 VAC
Frequency	60 Hz
Number of phases	1
Voltage regulation	± 2 %
Frequency regulation	± 0.5 %
Power rating	6 kVA
Overload capacity	125% for 1 minute
Short circuit current	200% rated load current for 1 second
Maximum transient voltage for 50% load step	10%
Maximum transient voltage recovery time for 50% load step	100ms
Linear load	< 3 %
Nonlinear load	< 5 %
Maximum deviation factor for linear load	1 %
Current crest factor capacity	2.5
Efficiency at rated load	80% minimum
Remote signal communications	Multiple options available
Battery charging time	6 hours for 40% capacity to 80% capacity

Environmental Characteristics	
Operating temperature	0°C to 50°C / 32°F to 122°F
Storage temperature	-40°C to +70°C / -40°F to +158°F
Electromagnetic compatibility / Electromagnetic interference	MIL-STD-461D, CE101, CE102, CS101, CS114, CS116, RE101, RE102, RS101, RS103
Vibration	MIL-STD-167/1, Type I, 4-33Hz
Shock	MIL-S-901D, Grade A, Class I
Airborne noise	MIL-STD-740-1, Class A12

Reliability and Maintainability	
Mean time between failures (MTBF)	40,000 hours
Mean time to repair	30 minutes
Maximum time to repair	60 minutes

Physical Characteristics (Please refer to the power unit interface control drawing for detailed dimensions)		
Enclosure protection	Drip proof protected as per MIL-STD-108E (45°)	
Cooling method	Forced air	
Approximate Dimensions/Mounting	Bulkhead	Rack
Width (mm / inches)	513 / 20.5	483 / 19.3
Depth (mm / inches)	400 / 16.0	710 / 28.4
Height (mm / inches)	710 / 28.4	355 / 14.2
Weight (kg / pounds)	151 / 332	151 / 332

Helicopter Starter

137-01B

General

The DC rectifier power supply (RPS) is intended for use on board combat ships. The RPS is capable of providing up to 1000 A short term high starting currents.

Features

- Mean Time Between Failures (MTBF) – 60,000 hours
- Remote sensing capability
- Programmable battery charging algorithm
- UPS functionality
- Two output channels
- Use of Insulated Gate Bipolar Transistors (IGBT) as power switching devices
- Parallellable, up to three units

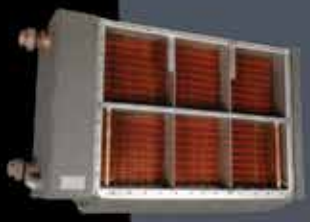
Input Specifications	
Voltage	440 VAC, 3 phase, 3 wire, 60 Hz
Current	Nominal 18 A – Maximum 30 A Full Load Output
Output Specifications	
Applicable standards	MIL-P-15736/1D
Output voltage	26 to 32 VDC adjustable Line drop compensated for up to 3.5V cable drop with 1000A output current
Voltage regulation	± 2%
Rated output current	350A
Short-term output current	1000A for 1 sec
	750A for 4 sec
	500A for 15 sec
	350A for 30 sec
	(Four consecutive cycles repeatable with 5 minute rest time)
Short circuit capacity	1100A for 2 seconds
Ripple and noise	2Vpp
Efficiency at rated load	80%
Parallel operation	Up to 3 units can be paralleled to provide up to 1000A continuous output.

Environmental Qualifications	
Electromagnetic	440 VAC, 3 phase, 3 wire, 60 Hz
Interference/Electromagnetic Compatibility (EMI/EMC)	MIL-STD-461D Surface Ships CE101, CE102, CS101, CS114, CS116, RE101, RE102, RS101, RS103
Vibration	MIL-STD-167/1, Type I, 4-33 Hz
Noise	MIL-STD-740-1, Class A12, Grade B
Shock	MIL-STD-901D, Grade A, Type A, Class I
Ambient temperature	0 to 50 degrees Celsius
Relative Humidity	Up to 95%

Reliability	
Mean time between failures (MTBF)	40,000 hours
Mean time to repair	20 min
Maximum time to repair	45 min

Physical Characteristics	
Weight	290 kg / 638 lbs
Width	565 mm / 22.6 in
Depth	603 mm / 24.1 in
Height	921 mm / 36.8 in

HEATING, VENTILATION, AIR CONDITIONING AND REFRIGERATION



Leonardo DRS is the leader in custom engineered heating, ventilating, air conditioning and refrigeration (HVAC&R) and is an NQA certified ISO 9001 Registered Company.

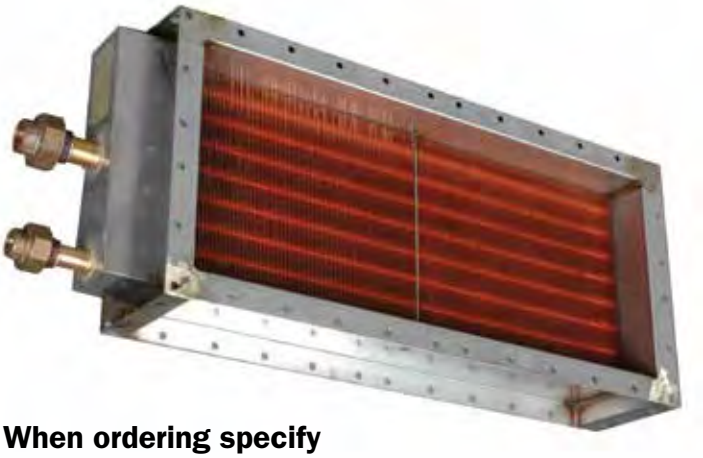
Leonardo DRS is the U.S. Navy's largest supplier of heating and cooling coils, air handling units, product coolers and refrigeration plants. Our customer base also includes the Military Sealift Command, the U.S. Coast Guard and international governments.

Leonardo DRS has developed and qualified virtually all U.S. Navy shipboard HVAC&R cooling and heating coils, fan coil units and fan coil assemblies since the 1940s. An unwavering commitment to quality, customer service and product flexibility continues to this day.

In addition to providing high quality custom engineered equipment for Navy and marine applications, Leonardo DRS also regularly provides custom engineered equipment for pharmaceuticals, clean rooms, hospitals and other applications requiring quality levels higher than commercial grade equipment.

We design our equipment around your project. At Leonardo DRS, we continue a 7-decade record of providing unparalleled design, test, manufacture and support for military, commercial, industrial and critical process HVAC&R applications.

Type S21X-T38X Ventilation Heaters



General

Navy Ventilation Heaters are duct type steam ventilation heaters for use in heating, ventilating and air conditioning systems aboard ship.

Specifications

- MIL-SPEC.....MIL-H-16235
- Qualified products list.....QPL-16235
- Shock qualification MIL-S-901
- Vibration qualification MIL-STD-167

When ordering specify

- Type I standard construction
- Type II 304 stainless steel non-magnetic construction
- Size (21-38)
- Fin spacing (L/M/H)
- Optional welded header box
- Hull number for replacement applications

Approximate Dimensions in Inches and Weights

Model X = L, M or H	Weight (Lbs) L / M / H	CFM @ 600 FPM	Coil Face Size L" x W"	Frame Size L" x W" x D"
S21X (L / M / H)	9/10/10	81	6 x 3-3/4	9 x 6-1/4 x 5
S22X (L / M / H)	10/10/11	122	9 x 3-3/4	12 x 6-1/4 x 5
S23X (L / M / H)	12/12/13	190	14 x 3-3/4	17 x 6-1/4 x 5
S24X (L / M / H)	12/13/14	234	9 x 6-3/4	12 x 9-1/4 x 5
S25X (L / M / H)	18 / 19 / 21	364	14 x 6-3/4	17 x 9-1/4 x 5
T26X (L / M / H)	35 / 38 / 40	572	22 x 7	25 x 9-1/4 x 7
T27X (L / M / H)	42 / 45 / 48	848	22 x 10	25 x 12-1/4 x 7
T28X (L / M / H)	51 / 55 / 60	1,160	30 x 10	33 x 12-1/4 x 7
T29X (L / M / H)	59 / 65 / 76	1,534	30 x 13	33 x 15-1/4 x 7
T30X (L / M / H)	67 / 74 / 83	1,910	30 x 16	33 x 18-1/4 x 7
T31X (L / M / H)	72 / 79 / 88	2,140	42 x 13	45 x 15-1/4 x 7
T32X (L / M / H)	76 / 84 / 94	2,280	30 x 19	33 x 21-1/4 x 7
T33X (L / M / H)	90 / 101 / 114	2,940	42 x 17-1/2	45 x 19-3/4 x 7
T34X (L / M / H)	104 / 117 / 133	3,560	56 x 16	59 x 18-1/4 x 7
T35X (L / M / H)	116 / 132 / 153	4,240	42 x 25	45 x 27-1/4 x 7
T36X (L / M / H)	128 / 147 / 171	4,960	56 x 22	59 x 24-1/4 x 7
T37X (L / M / H)	153 / 178 / 208	6,350	42 x 37	45 x 39-1/4 x 7
T38X (L / M / H)	178 / 208 / 245	7,750	56 x 34	59 x 36-1/4 x 7

Type UW51-55
Unit Coolers

General

Unit Coolers consist of a vaneaxial fan and motor, a DW type duct cooling coil, with air filtersand directional louvers built as a single unit foroverhead mounting.

Specifications

- MIL-SPEC.....MIL-C-2939-E
- Qualified products list.....QPL-2939
- Shock qualification MIL-S-901
- Vibration qualification MIL-STD-167

When ordering specify

- Size (51-55)
- Class
  - UW - Chilled water, gravity
- Composition:
  - M – Magnetic
  - N – Nonmagnetic
- Hand:
  - Left or right hand
  - (Left if not specified)
- Hull number for replacement applications

Approximate Dimensions in Inches and Weights

Model	Flowrate GPM	Capacity BTU/Hr	Frame Size L" x W" x D"	Air Flow CFM	Weight (Lbs)	
					Dry	Wet
UW51	4	11,500	23 x 12-1/8 x 38-7/8	215	202	207
UW52	7	22,200	25-1/4 x 14-3/8 x 38-5/8	340	236	239
UW53	10	33,500	32-1/4 x 14-3/8 x 40-3/8	510	315	326
UW54	15	49,300	374 x 16-5/8 x 40-7/8	750	411	427
UW55	19	62,400	43-1/2 x 18-7/8 x 43-7/8	1120	510	534

Type DW51-58
Cooling Coils (50 Series)

When ordering specify

- Size (51-58)
- Class
  - Class 1 – Chilled water, DW duct mounted
  - Class 2 – seawater (DWS), duct mounted
- Composition:
  - M – Magnetic
  - N – Nonmagnetic
- Hand:
  - Left or right hand
  - (Left if not specified)
- Hull number for replacement applications

General

Navy Duct Water Coils (50 Series) use chilled water for the cooling and dehumidification of air. The cooling coils are built as a single unit consisting of supporting framework, cooling element and removable drain pan. Each cooling coil is built ready for installation and connection to the appropriate water supply, return lines and condensate drainage piping.

Specifications

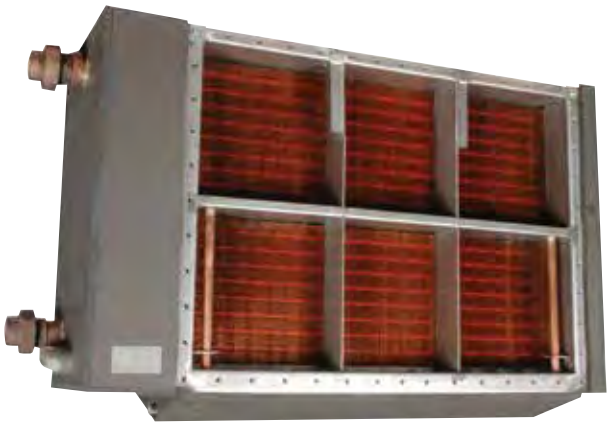
- MIL-SPEC.....MIL-C-2939-E
- Qualified products list.....QPL-2939
- Shock qualification MIL-S-901
- Vibration qualification MIL-STD-167
- Refrigerant.....R-12

Approximate Dimensions in Inches and Weights

Model DW Series	Weight (Lbs)		Airflow		Capacity MBH/Hr[1]	Coil Face Size		Outside Dimensions W" x H" x D"
	Dry	Wet	CFM	Ft/Min		W" x H"	Ft^2	
51	152	157	280	491	14,000	11-3/4 x 7	0.57	26-1/2 x 12-1/8 x 15
52	176	183	450	500	23,000	14 x 9-1/4	0.90	28-3/4 x 14-3/8 x 15
53	225	236	670	496	34,000	21 x 9-1/4	1.35	35-3/4 x 14-3/8 x 15
54	301	317	975	488	50,000	25 x 11-1/2	2.00	40-1/2 x 16-7/8 x 15
55	390	414	1500	483	65,000	31-1/2 x 13-3/4	3.00	47 x 18-7/8 x 15
56	562	602	2500	500	121,000	39-1/2 x 18-1/4	5.00	55 x 23-3/8 x 15
57	975	1040	3750	507	190,000	39-1/2 x 28-7/16	7.50	56-3/8 x 36-7/8 x 17-5/8
58	1225	1310	5000	500	234,000	39-1/2 x 37-7/16	10.00	56-3/8 x 45-7/8 x 17-5/8

[1] MBH rating based on the following conditions:
Entering air: 80°F DB, 67F WB
Entering water: 45F
Water flowrate: 3.6 GPM per Ton

Type DW61-68
Cooling Coils (60 Series)



When ordering specify

- Size (61-68)
- Class 1 – Chilled water,
  DW duct mounted
- Composition:
  - M – Magnetic
  - N – Nonmagnetic
- Hull number for replacement applications

General

Navy Duct Water Coils (60 Series) use chilled water for the cooling and dehumidification of air. The cooling coils are built as a single unit consisting of supporting framework, cooling element and integral drain pan. Each cooling coil is built ready for installation and connection to the appropriate water supply, return lines and condensate drainage piping.

Specifications

- MIL-SPEC.....MIL-C-2939-F
- Qualified products list.....QPL-2939
- Shock qualification MIL-S-901
- Vibration qualification MIL-STD-167

Approximate Dimensions in Inches and Weights

Model DW Series	Weight (Lbs)		Airflow		Capacity MBH/Hr ❶	Coil Face Size		Outside Dimensions W" x H" x D"
	Dry	Wet	CFM	Ft/Min		W" x H"	Ft2	
61	106	111	280	491	9,020	11-3/4 x 7	0.57	26-5/8 x 12-3/4 x 16-1/4
62	125	132	450	500	16,470	14 x 9-1/4	0.90	28-15/16 x 15 x 16-1/4
63	157	163	670	496	27,260	21 x 9-1/4	1.35	35-15/16 x 14-3/8 x 16-1/4
64	203	218	975	488	39,970	25 x 11-1/2	2.0	40-5/8 x 17-1/4 x 16-1/4
65	278	302	1500	483	63,440	31-1/2 x 13-3/4	3.0	47-1/8 x 19-1/2 x 16-1/4
66	416	454	2500	500	112,200	39-1/2 x 18-1/4	5.0	55-1/8 x24 x 16-1/4
67	688	752	3750	507	183,600	39-1/2 x 28-7/16	7.5	55-7/16 x 34-7/8 x 18-7/8
68	838	923	5000	500	240,700	39-1/2 x 37-7/16	10.0	55-7/16 x 43-7/8 x 18-7/8

❶ MBH rating based on the following conditions:
Entering air: 80°F DB, 67F WB
Entering water: 45F
Water flowrate: 3.6 GPM per Ton

Type FCA
Fan Coil Assemblies

General

HVAC Fan Coil Assemblies (FCAs) are designed for floor mounting, used in conjunction with a chilled water system, a drainage system, an air distribution system and a power source for air conditioning spaces onboard surface ships.

Features

Type II FCAs are used when no duct sections are to be attached to the unit when it is placed in service.

Type III FCAs should be specified when one or more duct sections are to be attached to the air inlet or to the air outlet of the FCA when it is placed in service.

When ordering specify

- Size (21 - 25)
- Type:
  - Type II – Three section unit: cooling coil, fan-motor, and air distribution plenum
  - Type III – Two section unit: cooling coil and fan-motor section
- Grade:
  - High impact shock
  - Type X – (Non-hi shock)
- Composition:
  - M – Magnetic
- Hand:
  - Left or right hand
  - (Right if not specified)
- Motor
  - Sealed
  - Non-Sis (Not sealed)
  - 1EEE45 MARINE DUTY
- Grille requirements
  - Inlet
  - Outlet
- Cover plate requirements
  - Inlet
  - Outlet
- Hull number for replacement Applications

Specifications

- MIL-SPEC.....MIL-A-23798
- Shock qualification MIL-S-901
- Vibration qualification MIL-STD-167
- Cooling Media .....Chilled water

Approximate Dimensions in Inches and Weights

	Model	Capacity BTU/Hr ❶	Cabinet Size L" x W" x D"	Air Flow CFM	Weight (Lbs)	
					Dry	Wet
Type II	FCA 21	36,700	44 x 28 x 75	760	1190	1203
	FCA 22	59,900	44 x 28 x 75	1260	1260	1289
	FCA 23	90,900	48 x 32 x 75	1880	1429	1472
	FCA 24	117,700	51 x 37 x 75	2550	1546	1590
	FCA 25	178,400	56 x 37 x 75	3800	1770	1836
Type III	FCA 21	36,700	44 x 28 x 50	760	990	1003
	FCA 22	59,900	44 x 28 x 50	1260	1060	1089
	FCA 23	90,900	48 x 32 x 75	1880	1210	1253
	FCA 24	117,700	51 x 37 x 50	2550	1305	1349
	FCA 25	178,400	56 x 37 x 50	3800	1520	1586

❶ BTU rating based on the following conditions:
Entering air: 80°F DB, 67F WB
Entering water: 45F
Water flowrate: 3.6 GPM per Ton

Type FCU H/V
Fan Coil Units

General

HVAC Fan Coil Units (FCU) are used as an alternative to built-up air conditioning recirculation systems of a ship's heating, ventilating and air conditioning (HVAC) system. They provide heating, cooling, and air recirulation required to satisfy compartment environmental design conditions with a savings in space and wight over built-up systems.

The units consist of fans and two speed motors, air filters, operational controls, thermostat, cooling coil, thermal and acoustical insulation and optional electric heaters.

When ordering specify

- Size (1-8)
- Type:
  - H: Horizontal – Overhead mounting
  - V: Vertical – Bulkhead mounting
- Composition:
  - M – Magnetic
  - N – Nonmagnetic
- Chilled water (CHW) connections:
  - Left or right hand (Right if not specified)
- Heater options:
  - Heating in Kilowatts (kW) as listed in table on the right
- Grade:
  - High impact shock
  - Type X – (Non-hi shock)
- Motor
  - Sealed
  - Non-SIS (Not sealed)
- Motor protection
  - LVP – Low voltage protection
  - LVR – Low voltage release
- Hull number for replacement applications

Specifications

- MIL-SPEC.....MIL-A-24775
- Shock qualification MIL-S-901
- Vibration qualification MIL-STD-167

Approximate Dimensions in Inches and Weights

Model H or V	Capacity BTU/ Hr ❶	Heat Options kW Option1 /Option2 / Option3...	Cabinet Size L" x W" x D"	Air Flow CFM	Weight (Lbs)	
					Dry	Wet
FCU H1 / V1	5850	0 / 1.2 / 2.2 / 3.3	50 x 25 x 10	145	261	264
FCU H2 / V2	9690	0 / 1.2 / 2.2 / 3.3	50 x 25 x 10	240	268	271
FCU H3 / V3	15,280	0 / 1.75 / 3.5 / 5.25	52 x 27 x 14	350	343	348
FCU H4 / V4	22,890	0 / 2.0 / 4.0 / 6.0	52 x 36 x 14	530	393	401
FCU H5 / V5	30,500	0 / 2.0 / 4.0 / 6.0	52 x 44 x 14	690	478	488
FCU H6 / V6	39,910	0 / 3.0 / 6.0 / 9.0	52 x 39 x 17	950	513	524
FCU H7 / V7	45,560	0 / 3.0 / 6.0 / 9.0	52 x 52 x 17	1100	652	664
FCU H8 / V8	72,920	0 / 3.0 / 6.0 / 9.0	52 x 62 x 17	1650	774	793

❶ BTU rating based on the following conditions:
Entering air: 80°F DB, 67F WB
Entering water: 45F
Water flowrate: 3.6 GPM per Ton

Type FCU 1-9
Spruance Class Fan Coil Units

When ordering specify

- Size (1-9)
- Class:
  - Left or right hand (Right if not specified)
- Heater options:
  - Heating in Kilowatt (kW) as listed in table below
- Hull number for replacement applications

General

Spruance Class HVAC Fan Coil Units sizes 1-5 are designed for overhead mounting, sizes 6-9 are designed for either overhead or bulkhead mounting.

The units consist of direct drive fans and single speed motors, cleanable air filters, thermostat, cooling coil, thermal and acoustical insulation and optional electric heaters with high temperature thermal cut-out switch.

This series of HVAC Fan Coil Units have been supplied for use on the Spruance Class Destroyers (DD-963 to 992 & 997) and Kidd Class Destroyers (DD-993 to 996).

Features

- Designed as a replacement for Spruance and Kidd Destroyer fan coil units
- Cleanable aluminum air filters
- Coper tube and fin coil
- Designed for chilled water service
- Coil connections interchangeable from let to right hand
- Optional electric heater
- Complete specification and selection data available

Specifications

- MIL-SPEC (Heater) MIL-H-22577
- Shock qualification MIL-S-901
- Vibration qualification MIL-STD-167

Approximate Dimensions in Inches and Weights

Model	Capacity BTU/Hr ❶	Heat Options (kW) Option1 / Option2 / Option3...	Cabinet Size L" x W" x D"	Air Flow CFM	Weight (Lbs)	
					Dry	Wet
FCU-1	6000	0 / 1.0 / 1.5 / 2.5	42 x 21 x 10	214	170	175
FCU-2	8500	0 / 0.6 / 1.0 / 1.5 / 2.0 / 2.5	42 x 28-1/2 x 8-1/4	305	205	210
FCU-3	12,300	0 / 0.6 / 1.0 / 1.5 / 2.0 / 2.5 / 3.0	42 x 35-1/2 x 8-1/4	358	238	243
FCU-4	17,900	0 / 0.6 / 1.0 / 1.5 / 2.0 / 2.5 / 3.0 / 3.5	42 x 49-1/2 x 8-1/4	472	306	311
FCU-5	22,200	0 / 0.5 / 1.0 / 1.5 / 2.0 / 2.5 / 3.5	42 x 62-1/2 x 8-1/4	565	348	453
FCU-6	21,500	0 / 1.65 / 2.5 / 6.0	61 x 22-1/2 x 17	976	360	365
FCU-7	34,000	0 / 1.0 / 1.5 / 2.0 / 2.5 / 3.0 / 4.0	61 x 30-1/2 x 17	1236	395	400
FCU-8	45,000	0 / 0.5 / 1.0 / 3.5 / 5.0 / 7.5	61 x 38-1/2 x 17	1764	515	520
FCU-9	56,500	0 / 0.5 / 1.0 / 1.5 / 2.5 / 4.0 / 4.5	61 x 49-1/2 x 17	1988	575	580

❶ BTU rating based on the following conditions:
Entering air: 80°F DB, 67F WB
Entering water: 45F
Water flowrate: 3.6 GPM per Ton

Type 11-16
Unit Heaters

General

Unit Heaters are designed for overhead mounting. The units consist of a fan and motor, steam/hot water heating coil, fan guard and directional louvers built as a single unit. Electric heating elements are available in lieu of the standard steam/hot water coil.

Specifications

- MIL-SPEC.....MIL-U-17293
- Shock qualification MIL-S-901
- Vibration qualification MIL-STD-167

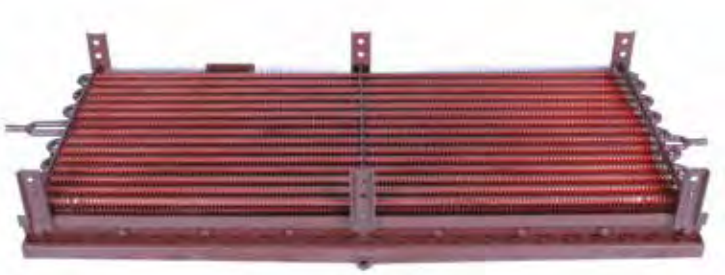
When ordering specify

- Size (11-16)
- Hull number for replacement applications

Approximate Dimensions in Inches and Weights

Model	Power (AC) Volts / Ph	Capacity BTU/Hr	Cabinet Size L" x W" x D"	Air Flow CFM	Weight (Lbs)
Size 11	**115 / 1**	18,000	23 x 15.5 x 29	300	98
Size 12	**115 / 1**	30,000	25 x 18.5 x 29	500	112
Size 13	**115 / 1**	46,000	28 x 21.5 x 30	790	127
Size 14	**115 / 1**	74,500	34 x 23.5 x 30	1330	167
Size 15	**440 / 3**	116,000	28 x 22 x 31	2060	183
Size 16	**440 / 3**	186,500	36 x 22 x 31	3310	250

Type GW/GF 1, 3 & 5
Gravity Cooling Coils



General

Navy Gravity Water / Refrigerant Coils (GW/GF Series) use chilled water or refrigerant for the cooling and dehumidification of air. The gravity coils shall be built as a single unit consisting of supporting framework, drain pans, and cooling element. Each gravity coil is ready for installation and connection to the appropriate water/refrigerant supply and return lines and condensate drainage piping.

When ordering specify

- Size (1, 3 or 5)
- Class
  - GW - Chilled water, gravity
  - GF – Refrigerant, gravity
- Composition:
  - Standard ASTM A569 steel construction
  - Copper fin, copper tube core available with either paintedcarbon steel frame or SST frame
  - ASTM A240 316 corrosion resistent stainless steel

Specifications

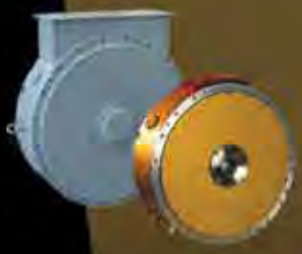
- MIL-SPEC.....MIL-C-2939
- Qualified products list.....QPL-2939
- Shock qualification MIL-S-901
- Vibration qualification MIL-STD-167

Approximate Dimensions in Inches and Weights

Model Water / R-12	Weight (Lbs)		Capacity BTU/Hr ❶	Coil Face Size L" x W"	Frame Size L" x W" x D"
	Dry	Wet			
GW1 / GF1	42	96	1,000 - 1,100	22 x 11-5/8	26 x 14-5/8 x 10
GW3 / GF3	98	108	2,800 - 3,300	44 x 17-5/8	48 x 20-5/8 x 10
GW5 / GF5	146	162	4,500 - 5,500	54 x 23-5/8	58 x 26-5/8 x 10

❶ BTU rating based on the following conditions:
Entering air: 80°F DB, 67F WB
Entering water: 45F
Water flowrate: 3.6 GPM per Ton

PERMANENT MAGNET MOTORS



Efficient Motor/Generator Solutions Wherever Variable Speed is Needed

Turn to Leonardo DRS Permanent Magnet (PM) motors and generators for dimension and/or weight constrained applications where significant torque, high efficiency and precise control across load and speed variations are essential. They provide reliable solutions for pumps, fans, portable generators, electro-mechanical actuators and other shipboard auxiliaries.

At Leonardo DRS our customer-focused approach and our unique set of core competencies enable us to develop PM machines in a range of radial and axial-field topologies that meet tough standards for military and commercial applications. Our motors, generators and drives can support the electrification of the naval and marine forces of today and tomorrow.

Electric Ship Propulsion Motors

Specifications: 36.5 MW PM Machine for Electric Ship Propulsion

Performance	
Output	50,000 HP (36.5 MW)
Speed	1-127 RPM
Torque	>2 M ft. lbs. (2.7M Nm)
Motor Efficiency	97.5%
Mechanical	
Motor Length	202 inches (5.1 meters)
Motor Width	214 inches (5.4 meters)
Motor Height	209 inches (5.3 meters)
Motor Weight	280,000 lbs. (127 tonnes, 127,000 kg)
Cooling Method	Fresh water
Electrical	
Voltage	1450 VAC
Phases	Doubly-fed, 3-phase
Insulation Class	R (220° C)
Temperature Rise	H (180° C)

Content Approved for Public Release, Dept. of the Navy 1-8-2009

General

Supporting requirements for electric propulsion and growing power efficiency demands on future ships.

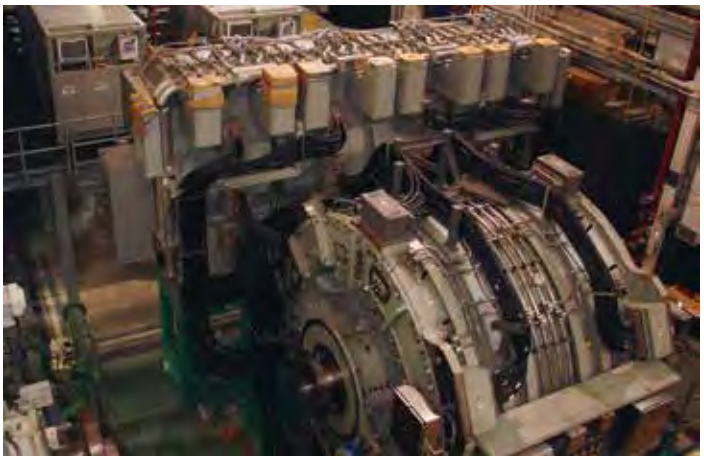
Leonardo DRS Technologies offers a superior direct drive ship propulsion solution using Permanent Magnet (PM) motor technology. PM motors have significant advantages in size, weight and power over conventional motors. Because the high-strength magnets provide the rotor flux instead of wire-wound rotor poles PM motors produce more torque with the same amount of supplied current.

The smaller footprint of our propulsion PM motors allows more flexibility in engine room design and increased cargo space, and the simpler construction results in increased reliability and durability.

Our 35.6 MW PM machine illustrated here is an example of the advantages this technology offers for electric ship propulsion. Ongoing developments in permanent magnet propulsion motor design offer greater power density, increased energy efficiency, and reduced manufacturing cost.

Highlights

- Space & Weight limits – Offers high torque in a compact package and minimal engine room impact
- Fuel Savings – High efficiency performance at full and part load
- Life Cycle Costs – Reduced maintenance costs



The DRS 36.5 MW Permanent Magnet Motor System (PMMS) at the U.S. Navy Land Based Test Site (LBTS) in Philadelphia, PA

Hybrid Electric Ship Propulsion Motors/Generators

General

Supporting initiatives for increased energy efficiency on today's naval and marine platforms.

The combination of high fuel costs and inefficient propulsion make gas turbine driven ships an ideal candidate for hybrid propulsion. The hybrid system allows the propulsion gas turbines to be shut down for low speeds, driving the ship with a variable speed hybrid electric PM propulsion motor instead. The PM machine can either be directly mounted to the propulsion shaft or mounted to a reduction gear.

On a ship with a diesel propulsion system using a hybrid electric drive system to propel ship at low speeds reduces the accumulation of coking deposits over time. This can significantly reduce the mean time between repairs, lowering the risk of damage to the diesel and expense of repairs.

Our 1.5 MW machine illustrated here is an example of the advantages this technology offers for hybrid electric ship propulsion.

For existing ships or those under development the adaptation of an innovative Leonardo DRS hybrid electric drive using power-dense permanent magnet (PM) technology can significantly reduce total ownership costs.

Highlights

- Space & weight benefits –High torque in a compact package means minimal engine room impact
- Fuel savings – Using PM power at low speeds can save thousands of barrels of fuel
- Life cycle costs – Reduced gas turbine or diesel motor operation time saves on maintenance costs
- Easy integration and minimum impact to engine room
- Leonardo DRS PM machines provide a mature technology: evolved from a lineage of fielded permanent magnet motors with a history of performance in extreme operating conditions

Specifications: 1.5MW PM Machine for Hybrid Electric Ship Propulsion

Performance	
Output	2,010 HP (1.5 MW)
Speed	498 RPM
Motor Efficiency	98%

DDG 51 Main Reduction Gear (MRG)

Leonardo DRS Permanent Magnet (PM) Motor

Permanent-Magnet Axial Air Core (PAAC) Motors and Generators

This 10 HP PAAC motor is 1/3 the size and weight of a comparable induction motor.

Highlights

- Space and weight limits - PAAC machines are among the most power dense in the world - 30-50% more power dense than induction motors
- Critical applications - Ideal for applications requiring high precision and/or high torque
- Life cycle costs - Compact and simple design provides superior reliability & low production costs
- Acoustic advantages - Few moving parts and sinusoidal BEMF make the PAAC inherently quiet

General

A light-weight, rugged, acoustically superior solution for applications ranging from fans, to portable generators, to throttle and other electro-mechanical actuators.

The PAAC series Permanent Magnet (PM) brushless motors and generators for military applications are designed to provide exceptional versatility at low cost. PM machines feature high-strength magnets mounted to the rotor to provide the magnetic field that interacts with the electrical windings. Since the magnets have no electrical losses, more electrical power is converted to mechanical torque, increasing both power density and efficiency.

The PAAC series takes the advantages of PM technology one step further by using Printed Circuit Board (PCB) technology to increase power density and efficiency in the stator as well. The result is an extremely power dense, efficient, and versatile machine that can be utilized across a vast array of applications requiring variable speed control.

Specifications

Performance	
Output	Ranges from 1/3HP (0.25KW) to 1000HP (746KW)
Speed	Depending on application
Motor Efficiency	Depending upon size and application

Permanent-Magnet Axial (PA) Series PM Motors and Generators

General

Combining rugged construction, high torque and precise control for demanding applications where reliability is key and downtime is not an option.

The Leonardo DRS PA series Permanent Magnet (PM) motors and generators are built to last under the world's most demanding applications. Lightweight and compact , the PA design delivers more power per pound than other electric motors and continuous high torque, even at stall. Since the PA rotor uses permanent magnets it works equally well as a generator, making it the ideal choice for mobile generator sets, traction systems, cranes, elevators and lifts.

Highlights

- Space and weight – Power density of existing models greater than 1 horsepower/lb
- Critical applications - Ideal for applications requiring high precision and/or high torque
- Reliability – Proven to survive four times longer than conventional motors in demanding applications

The Leonardo DRS PA series motors/generators have been developed for use in oil and gas drilling, transit, marine and other applications.

Specifications: PA44-450

Performance	
Rated Power	450 HP (336KW)
Rated Speed	3600 RPM
Rated Torque	1,475 ft. lbs. (2,000 Nm)
Efficiency at Rated Speed	95%
Mechanical	
Length	8.8 inches (224 mm)
Diameter	25.5 inches (648 mm)
Mounting	24.6 inches (625mm) bolt circle
Standard Shaft Type	DIN 5480 Spline (W60 x 2 x 30 x 28 x 9g)
Motor Weight	395 lbs (195 kg)
Cooling Method	Liquid (water/glycol)
Electrical	
Rated Current	425 A rms
Voltage Constant	800 V peak

Specifications: PA57-1000

Performance	
Rated Power	1,000 HP (746 kW)
Rated Speed	4,000 rpm
Rated Torque	2,712 Nm (2,000 lb-ft)
Efficiency at Rated Speed	96%
Mechanical	
Length	10.20 inches (259.1 mm)
Diameter	31 inches (787 mm)
Mounting	30 inches (762 mm) bolt circle
Standard Shaft Type	ANSI 5480 Spline (W60 x 2 x 30 x 28 x 9g)
Motor Weight	750 lbs. (340 kg)
Cooling Method	Liquid (water/glycol)
Electrical	
Rated Current	335 A rms
Voltage Constant	0.24 V/rpm (240 V amplitude @1,000 rpm)

Permanent-Magnet Radial Field Embedded Magnet (PRE) Series Motors

General

Designed for superior performance in severe environments.

The rugged Leonardo DRS Permanent Magnet, Radial field, Embedded Magnet (PRE) series of brushless motors delivers more torque per pound than other electric motors in its class.

In addition to impressive power density the simpler construction of PM machines versus induction machines means they are highly reliable and durable. Leonardo DRS PRE PM motors are designed to operate in harsh duty cycles and with most commercially available variable frequency drives.

Highlights

- Retrofit – PRE machines built to industry standard frames
- Critical applications – Ideal for harsh duty applications where reliability is important
- Life cycle costs – 3 year warranty
- High efficiency – Superior performance at full and part load

Specifications: PRE34-600

Performance	
Rated Power	600 HP (447KW)
Rated Speed	1200 RPM
Rated Torque	1,475 ft. lbs. (2,000 Nm)
Efficiency at Rated Speed	97%
Mechanical	
Length	52.9 inches (1343 mm)
Vertical Mounting	24.4 inches (621 mm) bolt circle diameter using 4 x 1 inch (25.4 mm) bolts
Horizontal Mounting	NEMA 5011
Standard Drive Options	Customizable (up to 4 inch, 100 mm, diameter) Example: SAE External
Shaft Side Load	5000 lbs. (22.2KN) lateral
Motor Weight	3500 lbs. (1588 kg) with blower 3300 lbs. (1497 KG) without blower
Cooling Method	External blower
Electrical	
Rated Current	732 Arms
Voltage Constant (line to line)	0.31 Vrms/RPM
Connections	Stator: 3 Phase Wye, floating ground Interface Box: NEMA IP 54

ROTATING MACHINERY PACKAGING — STEAM TURBINE DESIGN, ASSEMBLY AND REPAIR

Rotating Machinery Packaging

As a full-service equipment packager we have designed and/or assembled aero-derivative gas turbine packages using each major engine manufacturers' products. These units are in service in naval and ground power applications around the world. Many were specifically designed for extreme environments. In other applications, stringent specifications required the use of skilled design techniques to minimize noise and vibration while enhancing the unit's robustness and survivability.

Our extensive capabilities include developing composite enclosures, performing system shock analyses (applying design adjustments if needed), precision assembly of large equipment, and obtaining full naval qualification to MIL-SPEC or ABS NVR standards.

Whether you require build-to-print production or more extensive systems packaging Leonardo DRS is ready to meet the needs of any machinery packaging project.

Steam Turbine Design, Assembly and Repair

Evolving from our GE heritage, Leonardo DRS is one of the foremost steam turbine design companies. Our exceptional steam turbine team supports commercial power producers, steam turbine OEMs and the U.S. Navy by developing new turbine designs and redesigning and upgrading old equipment to meet today's efficiency and reliability standards.

With a full array of engineering and design capabilities, including computational fluid dynamics (CFD), rotor dynamics, acoustics, shock and vibrations analysis, and heat balance assessment, Leonardo DRS is ready and able to solve your most challenging steam turbine design and repair problems.

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