

FAIRBANKS MORSE  
**DEFENSE**

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Ward Leonard

# MOTORS & CONTROLLERS

## Product Catalog

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# MOTORS & CONTROLLERS PRODUCT CATALOG

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# Ward Leonard Overview

An industry-leading provider of motors, control components, and systems integration solutions for surface, subsurface, and land-based naval applications. For more than 120 years, the company has been supplying the U.S. Navy with high-reliability products and comprehensive services.




## FMD – Overview

Stacking the decks with best-in-class marine technologies and service solutions. Fairbanks Morse Defense has mastered that balance over more than a century, configuring the delivery of every customer engagement to meet the needs of the moment. We deliver an advantage to the U.S. Fleet with a growing array of best-in-class marine technologies, OEM parts, and turnkey services – all from a single, trusted source.



# Our Locations



-  Service Centers
-  Manufacturing Facilities
-  International Service Partners

## Fairbanks Morse Defense

701 White Avenue  
Beloit, WI 53511  
Phone: 1-800-356-6955

[www.FairbanksMorseDefense.com](http://www.FairbanksMorseDefense.com)

## American Fan

Phone: 1-866-771-6266

## Federal Equipment Co.

Phone: 1-877-435-4723

## Hunt Valve Company

Phone: 1-800-321-2757

## Maxim Watermakers

Phone: 1-318-629-2460

## Research Tool & Die Works

Phone: 1-310-639-5722

## Ward Leonard

Phone: 1-860-283-5801

## Welin Lambie

Phone: +44 1384-78294

**MOTORS**





# NOVO<sup>1</sup> MOTOR

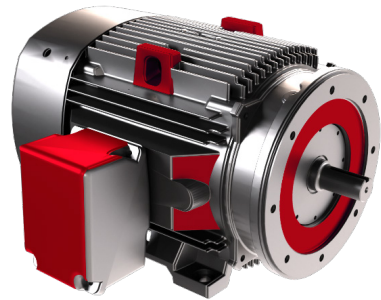
The Fairbanks Morse Defense commitment to technology innovation within maritime defenses is demonstrated through our newest AC Induction motor line for Surface Navy Vessels; the Ward Leonard Novo1 Motor line. This new motor line offers 12 frame sizes with a wide variety of configurations allowing for a very customizable and economical motor. They are designed to withstand the most destructive of impacts, manufactured under ISO-9001 certification and meets the requirements of MIL-DTL-17060.

## Key Features

- Modular design allows for customization making it the only motor you need
- Commonality of parts
- Variety of mounting configurations, speeds and enclosures to meet shipboard requirements
- Built to latest Navy mil-spec standards: MIL-DTL-17060 Revision G Amendment 1
- CBM+ ready
- VFD Compatible

## Advantages

- High reliability
- Cost effective & economical



# NOVO<sup>1</sup> MOTOR

## Specifications

HP	3600 RPM		1800 RPM		1200 RPM		900 RPM	
	DPP	TEFC	DPP	TEFC	DPP	TEFC	DPP	TEFC
<b>1</b>	182TN	182TN	182TN	182TN	182TN	182TN	182TN	184TN
<b>1 1/2</b>	182TN	182TN	182TN	182TN	182TN	184TN	184TN	213TN
<b>2</b>	182TN	182TN	182TN	182TN	184TN	213TN	213TN	215TN
<b>3</b>	182TN	184TN	182TN	184TN	213TN	215TN	215TN	254TN
<b>5</b>	182TN	213TN	184TN	213TN	215TN	254TN	254TN	256TN
<b>7 1/2</b>	184TN	215TN	213TN	215TN	254TN	256TN	256TN	256TN
<b>10</b>	213TN	254TN	215TN	254TN	256TN	256TN	286TN	286TN
<b>15</b>	215TN	256TN	254TN	256TN	286TN	286TN	286TN	326TN
<b>20</b>	254TN	286TN	256TN	286TN	286TN	326TN	326TN	326TN
<b>25</b>	256TN	286TN	286TN	286TN	326TN	326TN	326TN	365TN
<b>30</b>	286TN	326TN	286TN	326TN	326TN	365TN	365TN	365TN
<b>40</b>	286TN	326TN	326TN	326TN	365TN	365TN	365TN	405TN
<b>50</b>	326TN	365TN	326TN	365TN	365TN	405TN	405TN	405TN
<b>60</b>	326TN	365TN	365TN	365TN	405TN	405TN	405TN	445TN
<b>75</b>	365TN	405TN	365TN	405TN	405TN	445TN	445TN	445TN
<b>100</b>	365TN	445TN	405TN	445TN	445TN	445TN	445TN	505TN
<b>125</b>	405TN	445TN	405TN	445TN	445TN	445TN	505TN	505TN
<b>150</b>	445TN	445TN	445TN	445TN	505TN	505TN	505TN	505TN
<b>200</b>	445TN	505TN	445TN	505TN	505TN	—	—	—
<b>250</b>	445TN	505TN	505TN	505TN	505TN	—	—	—

# COMPRESSOR MOTOR

Built to MIL-Spec requirements, Ward Leonard compressor motors are designed for decades of use in the toughest environments. Ward Leonard compressor motors provide duty-cycle performance to withstand the demanding requirements of Naval compressors while providing efficient power at constant speeds without fluctuation.

## Key Performance Ratings

- 1/16 to 350 HP
- 2 - 16 Pole Speeds
- 440V/3/60Hz
- Open and Closed Motor Enclosures
- Service A and C Applications
- Grade A and B Shock & Vibration Capable



## Key Features

- Class F Sealed Insulation System
- Vacuum Pressure Impregnation
- Nodular Iron Frame Construction
- Precision Bearings
- Low Structure Borne Vibration Performance
- Single and Multiple Stator Winding Designs

## Specifications

- MIL-M-17060/MIL-DTL-17060, Alternating Current Motors
- MIL-M-17059, Fractional Horsepower Motors
- MIL-S-901, Shock Testing
- MIL-STD-167, Vibration Testing
- MIL-STD-740, Noise Testing
- MIL-STD-2037, Vacuum Pressure Impregnation

# NOISE QUIET MOTOR

Navy Noise Quiet Motors manufactured by Ward Leonard assist in contributing to the U.S. Navy's ability to operate anywhere in the world. These motors power critical pump and compressor applications on Los Angeles, Ohio, and Virginia Class subsurface fleets.

Ward Leonard's low-structure-borne noise performance motors are used extensively on U.S. Navy submarines. These shock-and-vibration-proof motors are also able to fit in tight spaces – an absolute premium requirement on a military submarine – while reducing the vessel's signature and detectability.

## Key Performance Ratings

- 1/16 to 350 HP
- 2 - 16 Pole Speeds
- 440V/3/60Hz
- Service A and C Applications
- Grade A and B Shock & Vibration Capable

## Key Features

- Class F Sealed Insulation System
- Vacuum Pressure Impregnation
- Nodular Iron Frame Construction
- Precision Bearings
- Low Structure Borne Vibration Performance
- Single and Multiple Stator Winding Designs

## Specifications

- MIL-M-17060/MIL-DTL-17060, Alternating Current Motors
- MIL-M-17059, Fractional Horsepower Motors
- MIL-S-901, Shock Testing
- MIL-STD-167, Vibration Testing
- MIL-STD-740, Noise Testing
- MIL-STD-2037, Vacuum Pressure Impregnation



# PUMP MOTOR

Ward Leonard motors are built to accommodate the severe duty requirements of Navy pump applications in the hazardous environments encountered by combat vessels.

Ward Leonard pump motors are built to withstand harsh environments and provide reliable service in demanding Naval pump applications including brine, graywater, ground food waste, cooling, bilge, firefighting, and others.

## Key Performance Ratings

- 1/16 to 350 HP
- 2 - 16 Pole Speeds
- 440V/3/60Hz
- Open and Closed Motor Enclosures
- Service A and C Applications
- Grade A and B Shock & Vibration Capable



## Key Features

- Class F Sealed Insulation System
- Vacuum Pressure Impregnation
- Nodular Iron Frame Construction
- Precision Bearings
- Low Structure Borne Vibration Performance
- Single and Multiple Stator Winding Designs

## Specifications

- MIL-M-17060/MIL-DTL-17060, Alternating Current Motors
- MIL-M-17059, Fractional Horsepower Motors
- MIL-S-901, Shock Testing
- MIL-STD-167, Vibration Testing
- MIL-STD-740, Noise Testing
- MIL-STD-2037, Vacuum Pressure Impregnation

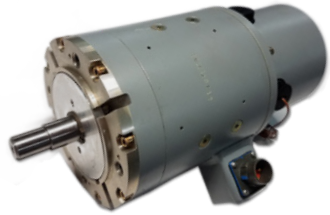
# SERVO MOTOR

Ward Leonard MIL-Spec servo motors offer wide-ranging designs to support all fan applications in the fractional to integral horsepower range.

Our servo motors are designed to support fan applications including aero foil, mixed-flow, Type-A, centrifugal, CPS, and others. Ward Leonard servo motors are built to last for decades of use in the harsh environments of life at sea.

## Key Performance Ratings

- 1/16 to 350 HP
- 2 - 16 Pole Speeds
- 440V/3/60Hz
- Open and Closed Motor Enclosures
- Service A and C Applications
- Grade A and B Shock & Vibration Capable



## Key Features

- Class F Sealed Insulation System
- Vacuum Pressure Impregnation
- Nodular Iron Frame Construction
- Precision Bearings
- Low Structure Borne Vibration Performance
- Single and Multiple Stator Winding Designs

## Specifications

- MIL-M-17060/MIL-DTL-17060, Alternating Current Motors
- MIL-M-17059, Fractional Horsepower Motors
- MIL-S-901, Shock Testing
- MIL-STD-167, Vibration Testing
- MIL-STD-740, Noise Testing
- MIL-STD-2037, Vacuum Pressure Impregnation

# WINCH MOTOR

Ward Leonard has a long history of providing MIL-Spec motors to drive winches on U.S. Navy aircraft carriers and other vessels deployed throughout the world.

Ward Leonard 440 Volt AC MIL-Spec induction motors feature high starting torque and multiple speeds to provide optimal power to drive gypsy, span wire, saddle winches, and capstans.

## Key Performance Ratings

- 1/16 to 350 HP
- 2 - 16 Pole Speeds
- 440V/3/60Hz
- Open and Closed Motor Enclosures
- Service A and C Applications
- Grade A and B Shock & Vibration Capable



## Key Features

- Class F Sealed Insulation System
- Vacuum Pressure Impregnation
- Nodular Iron Frame Construction
- Precision Bearings
- Low Structure Borne Vibration Performance
- Single and Multiple Stator Winding Designs

## Specifications

- MIL-M-17060/MIL-DTL-17060, Alternating Current Motors
- MIL-M-17059, Fractional Horsepower Motors
- MIL-S-901, Shock Testing
- MIL-STD-167, Vibration Testing
- MIL-STD-740, Noise Testing
- MIL-STD-2037, Vacuum Pressure Impregnation





# **MOTOR AND HEATER CONTROLLERS**



# MOTOR AND HEATER CONTROLLERS

With more than 2,000 designs available, Fairbanks Morse Defense and Ward Leonard offer a controller to fit every application. Known for their durability and longevity, our controllers are the dependable solution maritime vessels can rely on.

Our controllers are built to serve in dedicated high-shock, high vibration, high-abuse environments and last for decades. We are uncompromising on quality control and assurance, so we manufacture each of the individual components on all of our controls. We build and test them to meet the DoD's most stringent specs.

## Key Features

- Performance ratings: size 0 to size 7
- Over 2,000 designs available
- 3D modeling allows for custom design to meet your specific application
- MIL-DTL-2212 specification



# CONTROLLER PART NUMBERING MATRIX

1234-567890-ABCDE

<b>1 Product Type</b>	<b>7, 8 HP rating</b>
(4) Motor Starter	(01) One winding Non HP specific
(5) Heater Controller	(02) 2 winding Non HP specific
(6) Control Panel	(05) 5 HP
<b>2 Power Configuration</b>	(06) 10 HP
(0) Single speed Non Reversing	(07) 25 HP
(2) Single Speed Reversing	(08) 50 HP
(3) 2 Speed, Non Reversing	(09) 75 HP
(5) Wye-Delta	(10) 100 HP
(6) Reduced Voltage Autotransformer	(20) 200 HP
(7) Special	(25) 250 HP
(9) Two Speed, Reversing	(30) 300 HP
<b>3 Style</b>	(40) 400 HP
(0) IC518 Series	(50) 500 HP
(1) N160 Series	(60) 600 HP
(2) N461 Series	(99) Special
(3) IEC Series	<b>9 Control Voltage</b>
<b>4 Output contactor size</b>	(0) Customer Supplied Control Voltage
(1) thru (9)	(1) 115VAC Coil Voltage
<b>5 Output Configuration</b>	(2) 220 AC Coil Voltage
(1) 2 Speed, 1 winding	(4) 440 AC Coil Voltage
(2) 2 speed, 2 winding	(6) 24VAC
(3) Single speed	(7) 24VDC
(4) Multiple Outputs	(9) Special
(5) 2 Stage Starting, Voltage Regulated 400 Hz	
(9) Special* (Older designs only)	
* Older special designs are indicated by a '9' followed by a 3 digit sequential identifier.	
<b>6 Enclosure Type</b>	<b>O Motor Protection</b>
(1) GE Drip-proof	(0) None
(2) WL Take apart	(1) Thermal Overload
(3) GE Wrap around	(2) Fused Main
(4) Watertight enclosure	(3) Electronic Overload
(5) Explosion proof	(9) Special
(6) Submersible	
(7) Saddle	
(8) WI Drip-proof Enclosure	
(9) Special (Frame Construction, etc)	
(0) Open	
<b>ABCDE Masterplan number</b>	

Example:

4010-380111-24184, Ward Leonard Motor Starter

Single Speed, Non Reversing, Size 0, Drip-proof enclosure, 115 VAC Control, Master plan 24184

# **AUTOMATIC BUS TRANSFERS**



# AUTOMATIC BUS TRANSFERS

The Fairbanks Morse Defense and Ward Leonard Automatic Bus Transfers (ABT) allow for the flow of uninterrupted power supply to your emergency power source. Our ABT Switches are the trusted name in reliability, providing the necessary power when needed most.

Our Automatic Bus Transfer (ABT) Switches provide for automatic or manual transfer of three-phase AC loads in cases where a low voltage or no voltage event occurs on a power supply. Our ABTs transfer the load from the emergency bus to the normal bus automatically or manually, depending on your unique requirements.

## Key Performance Ratings

- 25-Amp to 400-Amp loads
- Switching time as fast as 50 msec

## Key Features

- A1, A2, or A3 configurations
- Modular architectures
- MIL-PRF-17773 specification



# DECODING THE WARD LEONARD ABT CATALOG NUMBERING SYSTEM

Reference: W/L Spec G-103.33 Rev A dated 7/30/85, Updated 11/30/17, HHP, Rev 1.1

The ABT Catalog Number is an 11 position descriptor, in the form NYYY-XXXXXX. The “N” in position 1 is common to all catalog numbers. (The dash is one of the positions and is position 5)

Number “YYY” in positions 2, 3, and 4 have the following meaning:

TYPE	AMP RATING	CATALOG NUMBER
A1	25	N296-XXXXXX
A1	50	N297-XXXXXX
A1	100	N294-XXXXXX
A1	150	N298-XXXXXX
A1	250	N292-XXXXXX
A1	300	N299-XXXXXX
A1	400	N295-XXXXXX
A1	600	N293-XXXXXX
A2	25	N286-XXXXXX
A2	50	N287-XXXXXX
A2	100	N284-XXXXXX
A2	150	N288-XXXXXX
A2	250	N282-XXXXXX
A2	300	N289-XXXXXX
A2	400	N285-XXXXXX
A2	600	N283-XXXXXX
A3	25	N276-XXXXXX
A3	50	N277-XXXXXX
A3	100	N274-XXXXXX
A3	150	N278-XXXXXX
A3	250	N272-XXXXXX
A3 or A11	300	N279-XXXXXX
A3	400	N275-XXXXXX
A3	600	N273-XXXXXX

- Notes:** a) For special types “S” and “A11” see examples end of page 2  
 b) 600 amp ABT’s not currently being manufactured. Not on QPL.



# DECODING THE WARD LEONARD ABT CATALOG NUMBERING SYSTEM

**Position 5 (dash): General Info/Type:**

- (-) Standard, steel, as in chart above
- A Non-magnetic (Stainless Steel)
- E Steel, Trapezoid Extended Housing
- F Stainless Steel, Trapezoid Extended Housing

**Number "XXXXXX" in positions 6, 7, 8, 9, 10, and 11 have the following meaning:**

**Position 6:**

- 1 Single phase
- 3 3 phase
- 9 special design, positions 7,8,9 do not conform to descriptions below. Selected as needed. See examples at end of listing.

**Position 7:**

**Enclosure**

- 0 Open (no enclosure)
- 1 Watertight Stainless Steel
- 4 Watertight Steel
- 6 Dripproof Stainless Steel
- 8 Dripproof Steel

**Position 8:**

**ABT built to Navy Specification**

- 0 DOD-17773B(SH) (old ABT spec – obsolete - not fused)
- 1 MIL-PRF-17773D(SH) (current ABT spec - fused)

**Position 9:**

**Frequency**

- 4 400 Hz
- 6 60 Hz

**Positions 10 & 11: Operating Voltage**

- 11 120 VAC
- 41 450 VAC

# DECODING THE WARD LEONARD ABT CATALOG NUMBERING SYSTEM

## EXAMPLES OF CATALOG NUMBERS,

N274-380641: A3, 100amp, 3phase, dripproof steel enclosure, DOD spec, 60Hz, 450V

N289-341611: A2, 300amp, 3phase, watertight steel enclosure, MIL-PRF spec, 60Hz, 120V

N277A361641: A3, 50amp, 3phase, dripproof stainless steel encl., MIL-PRF spec, 60Hz, 450V

N276-381411: F3, 25amp, 3phase, dripproof steel enclosure, MIL-PRF spec, 400Hz, 120V

N287E381611: A2, 50amp, 3phase, dripproof extended steel encl., MIL-PRF spec, 60Hz, 120V

## “SPECIAL” DESIGNS: (900000 numbers)

**Position 7:** Navy Specification    **Positions 8 & 9:** Assigned to a specific design

## Variable switching time delay (RFPS) (Most common “non-standard” ABT’s)

N279-900241: A3S, 300 amp, 3 phase, dripproof steel, DOD spec, 60Hz, 450V

N279-900341: A3S, 300 amp, 3 phase, watertight steel, DOD spec, 60Hz, 450V

N279-910241: A3S, 300 amp, 3 phase, dripproof steel, MIL-PRF spec, 60Hz, 450V

N279-910341: A3S, 300 amp, 3 phase, watertight steel, MIL-PRF spec, 60Hz, 450V

N274-900241: A3S, 100 amp, 3 phase, dripproof steel, DOD spec, 60Hz, 450V

## Non-selective – Power Seeking (type A11)

N279-910441: A11, 300 amp, 3 phase, dripproof steel, MIL-PRF spec, 60 Hz, 450 Volts

Assign positions 8,9 in sequence as new special variations occur ....05, 06, .....  
Example: Watertight A11 300 amp 450 volt MIL-PRF would be N279-910541

# **CONTACTORS**



# CONTACTORS

As the only manufacturer that offers the 3 Navy QPL contactor designs, Fairbanks Morse Defense and Ward Leonard provide the solution to meet your required specifications.

Meeting MIL-Standard qualification MIL-DTL-2212, our portfolio of electrical contactors includes:

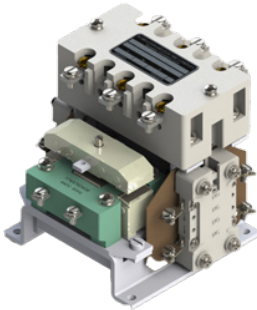
- Proprietary-designed contactors
- GE-design contactors
- Navy-standard designs

## Key Performance Ratings

- Sizes 0 - 7

## Key Features

- Operation: magnetic solenoid
- Multiple configuration types to address a wide range of applications – different form factors of contactor families fit into customer required spaces
- MIL-DTL-2212 specification AC Control





# RELAYS





# OVERLOAD RELAYS

Fairbanks Morse Defense and Ward Leonard overload relays are ideal for critical applications in the toughest environments. These durable relays are able to withstand high shock and vibration to perform in the harshest conditions.

We design and manufacture solid-state motor overload protection relays that adhere to NAVSEA's stringent MIL-R-2033 standards. These state-of-the-art products:

- Are available in thermal, AC and DC magnetic and reset versions
- Are designed to increase monitoring capability and performance, while decreasing controller size and weight
- Support Modbus, Profibus, and Ethernet protocols on multiple products

Built to MIL-Spec requirements, our compressor motors are designed for decades of use in the toughest environments and provide duty-cycle performance to meet the requirements of Naval compressors while providing efficient power at constant speeds without fluctuation.

## Key Performance Ratings

- Thermal compensation for more predictable overload exposure
- N154 tested up to 100°C

## Key Features

- Function: motor overload protection
- Thermal, AC, and DC magnetic set and reset versions
- Operation: magnetic inverse time delay type, self-repeat
- MIL-R-2033 specification
- MIL-DTL-2212 specification



# MAGNETIC RELAYS

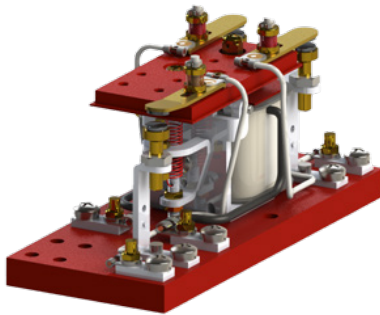
Series N130 Magnetic Relays are recommended for applications where the pilot or control circuit must be established and interrupted repeatedly. These auxiliary control relays in one, two, three and four pole combinations are available for operation on A.C. (480 volts max.) and D.C. (250 volts max.) circuits.

## Key Performance Ratings

- 1, 2, 3, or 4, poles
- AC up to 480V and DC up to 250V Max
- With or without magnetic blowouts
- Continuous duty

## Key Features

- Arc blowout available
- Relays from all 3 QPL manufacturer designs (Ward Leonard, GE, Cutler Hammer)



# ROTARY/MDR RELAYS

Fairbanks Morse Defense and Ward Leonard MDR Rotary Relay Series provides increased contact ratings compared to similar relays used in military and heavy-industrial applications. The increased contact rating enables the MDR Rotary Relay Series to be used in situations beyond the current-carrying capability of similar relays.

Unlike other relay models that use two contacts in series to achieve this increased rating, our MDR rotary relay design frees contact terminals to control additional circuitry and simplify control wiring.

Engineered to MIL-R-19523B (SH) and QPL for vibration, shock, and endurance testing, exceeding 500,000 operations, the MDR Rotary Relay Series are backwards compatible with models from other manufacturers. High reliability, high performance and increased contact ratings make the durable MDR Rotary Relay ideal for the most demanding applications.

## Key Performance Ratings

- High current capacity on contacts

## Key Features

- Contact arrangements 4 PDT-12 PDT
- Increased contact ratings eliminates need to have connect in series
- Standard and low noise options
- Standard meets requirement of MIL-R-19523B (SH)





# **INDICATING LAMPS/BULBS**



# INDICATING LAMPS/BULBS

Our indicator lights are incandescent or light-emitting diode (LED) and handle voltages from 117V to 440V AC or 2V – 120V DC. They're available with red, green, amber, blue, white, and clear color lenses as well as flashing lamps and watertight units.

The Dual Amp Indicator Light revolutionized the single lamp concept. Dual Amp Indicator Light features include:

- 2.5 volts alternating current (VAC) lamps in parallel
- Independently supplied by a 1.8 VAC closely regulated transformer for long lamp life
- Voltages such as 117 or 450 VAC
- Availability of direct current voltages (VDC) Included hardware (O-ring, hex nut, cup washer) Midget screw base lamps & lenses (purchased separately)

Additionally, FMD can build light unit assemblies for watertight indicator lights.

Indicating lights to be integrated into panels, controllers or other products with a variety of configurations to maximize available space behind the mounting panel.

## Key Performance Ratings

- 1.8 to 28V AC or DC
- LED or incandescent

## Key Features

- Dual amp indicator lights
- Application with DC 50, 60, or 400 Hz AC systems
- 90° and straight line configurations
- Shock, vibe, moisture resistance, dielectric withstanding voltage and voltage insulation tested



# INDICATING LIGHT KITS

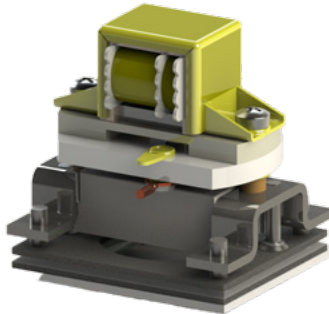
Configured kits including lamp, gaskets, lenses, name plates and light holder.

## Key Performance Ratings

- Low amperage draw

## Key Features

- Dual amp indicator lights
- Application with DC 50, 60, or 400 Hz AC systems
- 90° and straight line configurations
- Shock, vibrate, moisture resistance, dielectric withstanding voltage and voltage insulation tested
- LED or incandescent bulbs
- Variety of mounting configurations to maximize available space on a panel





# INDICATOR LIGHT HOLDERS

This light is to be used on alternating current where space behind the panel is limited and where a light with the built-in transformers which can be mounted elsewhere on the panel and can be connected to the LH 97 to obtain the required voltages. The lamp screw shells are grounded to the case so that when the lamps are removed, there is no shock hazard to personnel.

Application with 50, 60, or 400 Hz A.C. systems.

Lamp Accommodation – W-L-00111/56 (#1769; MS15612-3)

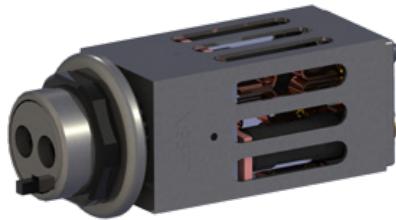
Lenses Available – LC38 thru 45

## Key Performance Ratings

- 50,60, or 400 Hz
- Up to 2 bulbs
- LED or Incandescent bulbs
- 12 - 440VAC
- 2 - 240 VDC

## Key Features

- Dual amp indicator lights
- Application with DC 50, 60, or 400 Hz AC systems
- 90° and straight line configurations
- Shock, vibrate, moisture resistance, dielectric withstanding voltage and voltage insulation tested



# LIGHT LENSES

These panel mounted lenses are in accordance with MIL-L-3661/55 thru 59. Any engraving must be specified along with color since these lenses are specially engraved to your order.

## Key Performance Ratings

- Flat and bubble lenses in variety of colors
- Plexiglass, nylon/plastic or glass

## Key Features

- Bubble Caps
- Flat Flush
- Dimmable
- Text within flat lens available
- MIL-L-3661/55 thru 59



# **STARTERS AND PUSH BUTTON STATIONS**



# MANUAL STARTERS

Built to be reliable, our starters are designed for continuous duty and general-purpose service to provide decades of use.

Manual starters are flush mounted for panel installation, feature drip-proof enclosures for surface mounting, thermostatic bimetal overload protection, with a low-voltage release effect, where contacts remain closed on low voltage, allowing motor to restart upon return of power.

Our starters are built to serve in dedicated high-shock, high vibration, high-abuse environments, and last for decades. We are uncompromising on quality control and assurance, so we manufacture each individual component on all our controls. We build and test them to meet the DoD's most stringent specs.

## Key Performance Ratings

- Size 0
- Dripproof
- Continuous and general purpose service
- Embedded overload protection
- 115, 220 or 440V
- Lockable
- Up to 15A continuous current

## Key Features

- Thermo static bimetal overload protection
- Low voltage release
- Cable entrance from top or bottom
- Basic motor starter/protection in condensed package
- MIL-DTL-2212 compliant



# PANEL MOUNTED PUSH BUTTONS

Designed for continuous duty, our Panel Mounted Push Buttons are watertight, and built to serve in dedicated high-shock, high vibration, high-abuse environments while lasting for decades.

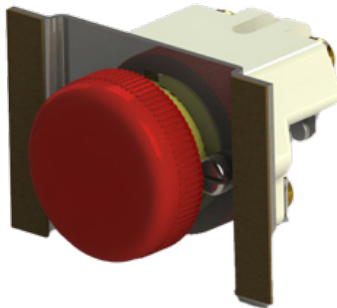
Our Panel Mounted Push Buttons featured up to Water or Oil proof momentary closure/open for use in panels, remote stations, motor controllers.

## Key Performance Ratings

- Standard, Oiltight or Watertight forms
- Up to 2 contacts
- Black or red caps available

## Key Features

- Momentary Closure/Open
- Normally Open/Normally Closed
- Up to 2 poles



# REMOTE PUSH BUTTON STATIONS

Our Pushbutton Stations are designed for shipboard control applications requiring heavy duty watertight master switches.

Ward Leonard push button stations adhere to MIL-DTL-2212 standards, and are built to serve in dedicated high-shock, high vibration, high-abuse environments while lasting for decades. Stations are available with up to 7 elements equipped with maintained or momentary contacts, as well as indicating lights. For panel or switchboard mounting, individual N.O., N.C. or D.T. elements can be supplied.

We are uncompromising on quality control and assurance, so we manufacture each individual component on all our controls. We build and test them to meet the DoD's most stringent specs.

## Key Performance Ratings

- Switches, up to 2-deck pushbuttons and indicating lights in a compact, user defined configuration
- Available with dimmable lights, protective covers and tamper proof covers.

## Key Features

- 1 – 7 remote functions per device
- Dimmable Light Covers
- Tamper Proof Covers
- LED bulbs available
- Ward Leonard will design to your application
- MIL-DTL-2212 standards







# MASTER SWITCHES



# MASTER SWITCHES

Our master switches are MIL-DTL-2212 compliant and allow for remote control of magnetic starters.

Master switches are utilized for remote control of magnetic starter applications, and are available in either 8 or 20 circuits, each with 4 positions maximum, and 10 amps carry.

## Key Performance Ratings

- Single switch remote station

## Key Features

- Master, limit, pushbutton, and rotary selector variants
- Spring returning or maintaining contacts
- Watertight and non-watertight options
- MIL-DTL-2212 compliant



# PANEL MOUNTED SWITCHES

Wherever maintained contact switching of control circuits is required, our panel mounted switches are the reliable and durable solution.

## Key Performance Ratings

- 1SR to 3SR configurations, momentary or holding positions, up to 6 positions
- Up to 30A, 500V, 60Hz

## Key Features

- Master, limit, pushbutton, and rotary selector variants
- Spring returning or maintaining contacts
- Watertight and non-watertight options
- MIL-DTL-2212 compliant



**COMPONENTS  
ACCESSORIES**



# CONTROL POWER TRANSFORMERS

Series 106.531 Transformers reduce supply voltage to 115 volts A.C. in control circuits of motor starters, controllers and other equipment.

## Key Performance Ratings

- Voltage step down
- Ambient 50° C
- Continuous duty
- Class B Insulation



# FUSE BLOCKS

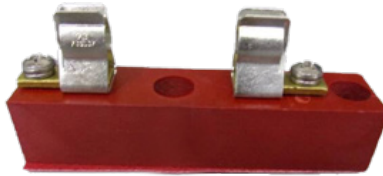
Use fuse blocks for holding cartridge-type fuses through 30 amps. Designed for use with style F61 fuses of Specification MIL-F-15160.

## Key Performance Ratings

- 30 amps
- 600 volts (max.)
- Single pole

## Key Features

- MIL-E-917
- MIL-S-901 (for shock)
- Fuse clips meet MIL-F-21346





# POWER TERMINAL BOARDS

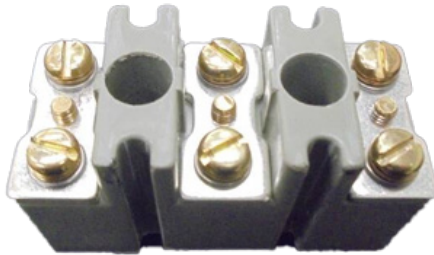
These one-piece terminal boards are for use in power circuits 50 through 600 amps.

## Key Performance Ratings

- 50 through 600 amps
- 600 volts (max.)
- Number of points - three

## Key Features

- MIL-C-2212
- MIL-E-917



# SWITCHBOXES

Our switchboxes provide a voice powered telephone system in a Grade A shock and vibration qualified enclosure.

## Key Performance Ratings

- Voice Powered
- Grade A Shock and Vibe
- Water tight
- Non-magnetic (less than 2.0 mu)

## Key Features

- Shock per MIL-S-901
- Vibration MIL-STD-167
- Watertight MIL-STD-108E
- Dielectric Test
- Insulation resistance
- Electrical continuity
- Non-magnetic (less than 2.0 mu)

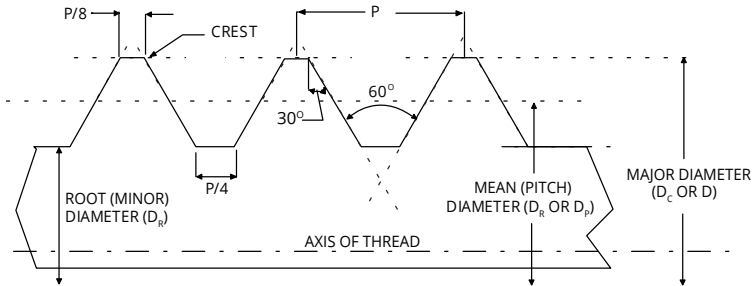


# RESOURCES



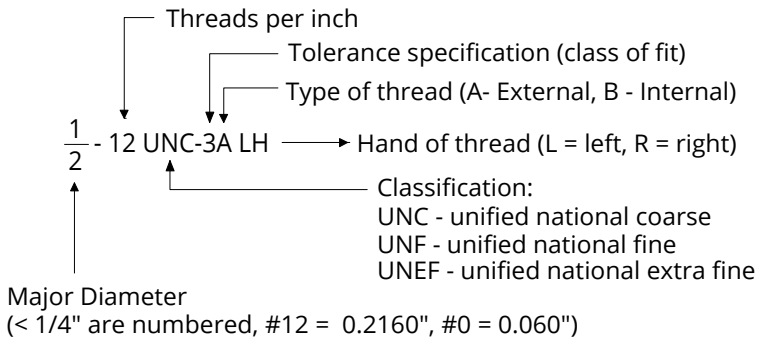
# THREAD STANDARDS

## UNIFIED AND ISO THREAD GEOMETRY

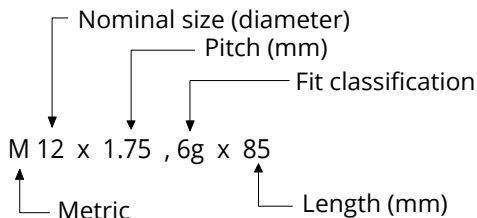


CLASS	UNIFIED		METRIC	
	EXTERNAL THREAD	INTERNAL THREAD	EXTERNAL THREAD	INTERNAL THREAD
LOOSE	1A	1B	8G	7H
STANDARD	2A	2B	6G	6H
CLOSE	3A	3B	4G	5H

### UNIFIED NATIONAL:



### METRIC:



# THREAD DIMENSIONS

## AND TAP DRILL SIZES

Size	Threads Per Inch		Outside Diameter Inches	Pitch Diameter Inches	Root Diameter Inches	Tap Drill Approx. 75% Full Thread	Decimal Equiv. Of Tap Drill
	NC UNC	NF UNF					
0	—	80	.0600	.0519	.0438	3/64"	.0469
1	64	—	.0730	.0629	.0527	53	.0595
1	—	72	.0730	.0640	.0550	53	.0595
2	56	—	.0860	.0744	.0628	50	.0700
2	—	64	.0860	.0759	.0657	50	.0700
3	48	—	.0990	.0855	.0719	47	.0785
3	—	56	.0990	.0874	.0758	46	.0810
4	40	—	.1120	.0958	.0795	43	.0890
4	—	48	.1120	.0985	.0849	42	.0935
5	40	—	.1250	.1088	.0925	38	.1015
5	—	44	.1250	.1102	.0955	37	.1040
6	32	—	.1380	.1177	.0974	36	.1065
6	—	40	.1380	.1218	.1055	33	.1130
8	32	—	.1640	.1437	.1234	29	.1360
8	—	36	.1640	.1460	.1279	29	.1360
10	24	—	.1900	.1629	.1359	26	.1470
10	—	32	.1900	.1697	.1494	21	.1590
12	24	—	.2160	.1889	.1619	16	.1770
12	—	28	.2160	.1928	.1696	15	.1800
1/4"	20	—	.2500	.2175	.1850	7	.2010
1/4"	—	28	.2500	.2268	.2036	3	.2130
5/16"	18	—	.3125	.2764	.2403	F	.2570
5/16"	—	24	.3125	.2854	.2584	I	.2720
3/8"	16	—	.3750	.3344	.2938	5/16"	.3125
3/8"	—	24	.3750	.3479	.3209	Q	.3320
7/16"	14	—	.4375	.3911	.3447	U	.3680
7/16"	—	20	.4375	.4050	.3726	25/64"	.3906
1/2"	13	—	.5000	.4500	.4001	27/64"	.4219
1/2"	—	20	.5000	.4675	.4351	29/64"	.4531
9/16"	12	—	.5625	.5084	.4542	31/64"	.4844
9/16"	—	18	.5625	.5264	.4903	33/64"	.5156
5/8"	11	—	.6250	.5660	.5069	17/32"	.5312
5/8"	—	18	.6250	.5889	.5528	37/64"	.5781
3/4"	10	—	.7500	.6850	.6201	21/32"	.6562
3/4"	—	16	.7500	.7094	.6688	11/16"	.6875
7/8"	9	—	.8750	.8028	.7307	49/64"	.7656
7/8"	—	14	.8750	.8286	.7822	13/16"	.8125
1"	8	—	1.0000	.9188	.8376	7/8"	.8750
1"	—	12	1.0000	.9459	.8917	59/64"	.9219
1 1/8"	7	—	1.1250	1.0322	.9394	63/64"	.9844
1 1/8"	—	12	1.1250	1.0709	1.0168	1 3/64"	1.0469
1 1/4"	7	—	1.2500	1.1572	1.0644	1 7/64"	1.1094
1 1/4"	—	12	1.2500	1.1959	1.1418	1 11/64"	1.1719
1 3/8"	6	—	1.3750	1.2667	1.1585	1 7/32"	1.2187
1 3/8"	—	12	1.3750	1.3209	1.2668	1 19/64"	1.2969
1 1/2"	6	—	1.5000	1.3917	1.2835	1 11/32"	1.3437
1 1/2"	—	12	1.5000	1.4459	1.3918	1 27/64"	1.4219
1 3/4"	5	—	1.7500	1.6201	1.4902	1 9/16"	1.5625
2"	4 1/2	—	2.0000	1.8557	1.7113	1 25/32"	1.7812
2 1/4"	4 1/2	—	2.2500	2.1057	1.9613	2 1/32"	2.0313
2 1/2"	4 1/2	—	2.5000	2.3376	2.1752	2 1/4"	2.2500
2 3/4"	4	—	2.7500	2.5876	2.4252	2 1/2"	2.5000
3"	4	—	3.0000	2.8376	2.6752	2 3/4"	2.7500
3 1/4"	4	—	3.2500	3.0876	2.9252	3"	3.0000
3 1/2"	4	—	3.5000	3.3376	3.1752	3 1/4"	3.2500
3 3/4"	4	—	3.7500	3.5876	3.4252	3 1/2"	3.5000
4"	4	—	4.0000	3.3786	3.6752	3 3/4"	3.7500

# PIPE DIMENSIONS

## US AND METRIC

NOMINAL PIPE SIZE	OD	SCHEDULE DESIGNATIONS			WALL THICKNESS		WEIGHT		ID	
		IN. MM	IN. MM	ASME	IN.	MM	LBS/FOOT	KG/METER	IN.	MM
1/8 6	0.405 10.3	10	10S		0.049	1.24	0.19	0.28	0.307	7.82
		STD 40	40S		0.068	1.73	0.24	0.37	0.269	6.84
		XS 80	80S		0.095	2.41	0.31	0.47	0.215	5.84
1/4 8	0.540 13.7	10	10S		0.065	1.65	0.33	0.49	0.410	10.40
		STD 40	40S		0.088	2.24	0.43	0.63	0.364	9.22
		XS 80	80S		0.119	3.02	0.54	0.80	0.302	7.66
3/8 10	0.675 17.1	10	10S		0.065	1.65	0.42	0.63	0.545	13.80
		STD 40	40S		0.091	2.31	0.57	0.84	0.493	12.48
		XS 80	80S		0.126	3.20	0.74	1.10	0.423	10.70
1/2 15	0.840 21.3	5	5S		0.065	1.65	0.54	0.80	0.710	18.00
		10	10S		0.083	2.11	0.67	1.00	0.674	17.08
		STD 40	40S		0.109	2.77	0.85	1.27	0.622	15.76
		XS 80	80S		0.147	3.73	1.09	1.62	0.546	13.84
		160			0.188	4.78	1.31	1.95	0.464	11.74
3/4 20	1.050 26.7	XX			0.294	7.47	1.72	2.55	0.252	6.36
		5	5S		0.065	1.65	0.69	1.03	0.920	23.40
		10	10S		0.083	2.11	0.86	1.28	0.884	22.48
		STD 40	40S		0.113	2.87	1.13	1.69	0.824	20.96
		XS 80	80S		0.154	3.91	1.48	2.20	0.742	18.88
1 25	1.315 33.4	160			0.219	5.56	1.95	2.90	0.612	15.58
		XX			0.308	7.82	2.44	3.64	0.434	11.06
		5	5S		0.065	1.65	0.87	1.29	1.185	30.10
		10	10S		0.109	2.77	1.41	2.09	1.097	27.86
		STD 40	40S		0.133	3.38	1.68	2.50	1.049	26.64
1-1/4 32	1.660 42.2	XS 80	80S		0.179	4.55	2.17	3.24	0.957	24.30
		160			0.250	6.35	2.85	4.24	0.815	20.70
		XX			0.358	9.09	3.66	5.45	0.599	15.22
		5	5S		0.065	1.65	1.11	1.65	1.530	38.90
		10	10S		0.109	2.77	1.81	2.69	1.442	36.66
1-1/2 40	1.900 48.3	STD 40	40S		0.140	3.56	2.27	3.39	1.380	35.08
		XS 80	80S		0.191	4.85	3.00	4.47	1.278	32.50
		160			0.250	6.35	3.77	5.61	1.160	29.50
		XX			0.382	9.70	5.22	7.77	0.896	22.80
		5	5S		0.065	1.65	1.28	1.90	1.770	45.00
2 50	2.375 60.3	10	10S		0.109	2.77	2.09	3.11	1.682	42.76
		STD 40	40S		0.145	3.68	2.72	4.05	1.610	40.94
		XS 80	80S		0.200	5.08	3.63	5.41	1.500	38.14
		160			0.281	7.14	4.86	7.25	1.338	34.02
		XX			0.400	10.15	6.41	9.55	1.100	28.00
2-1/2 65	2.875 73.0	5	5S		0.065	1.65	1.61	2.39	2.245	57.00
		10	10S		0.109	2.77	2.64	3.93	2.157	54.76
		STD 40	40S		0.154	3.91	3.66	5.44	2.067	52.48
		XS 80	80S		0.218	5.54	5.03	7.48	1.939	49.22
		160			0.344	8.74	7.47	11.11	1.687	42.82
3 80	3.500 88.9	XX			0.436	11.07	9.04	13.44	1.503	38.16
		5	5S		0.083	2.11	2.48	3.69	2.709	68.78
		10	10S		0.120	3.05	3.53	5.26	2.635	66.90
		STD 40	40S		0.203	5.16	5.80	8.63	2.469	62.68
		XS 80	80S		0.276	7.01	7.67	11.41	2.323	58.98
3-1/2 90	4.000 101.6	160			0.375	9.53	10.02	14.92	2.125	53.94
		XX			0.552	14.02	13.71	20.39	1.771	44.96
		5	5S		0.083	2.11	3.03	4.52	3.334	84.68
		10	10S		0.120	3.05	4.34	6.46	3.260	82.80
		STD 40	40S		0.216	5.49	7.58	11.29	3.068	77.92
4 100	4.500 114.3	XS 80	80S		0.300	7.62	10.26	15.27	2.900	73.66
		160			0.438	11.13	14.34	21.35	2.624	66.64
		XX			0.600	15.24	18.60	27.68	2.300	58.42
		5	5S		0.083	2.11	3.48	5.18	3.834	97.38
		10	10S		0.120	3.05	4.98	7.41	3.760	95.50
4-1/2 115	5.000 127.0	STD 40	40S		0.226	5.74	9.12	13.57	3.548	90.12
		XS 80	80S		0.318	8.08	12.52	18.64	3.364	85.44
		XX			0.636	16.15	22.87	34.03	2.728	69.30
		5	5S		0.083	2.11	3.92	5.84	4.334	110.08
		10	10S		0.120	3.05	5.62	8.37	4.260	108.20
4-1/2 115	5.000 127.0	156			0.156	3.96	7.24	10.78	4.188	106.38
		188			0.188	4.78	8.67	12.91	4.124	104.74
		STD 40	40S		0.237	6.02	10.80	16.08	4.026	102.26
		XS 80	80S		0.337	8.56	15.00	22.32	3.826	97.18
		120			0.438	11.13	19.02	28.32	3.624	92.04
		160			0.531	13.49	22.53	33.54	3.438	87.32
		XX			0.674	17.12	27.57	41.03	3.152	80.06
4-1/2 115	5.000 127.0	STD 40	40S		0.247	6.27	12.55	18.67	4.506	114.46
XS 80	80S		0.355	9.02	17.63	26.24	4.290	108.96		
XX			0.710	18.03	32.56	48.45	3.580	90.94		

# AMERICAN WIRE GAUGE

## CONDUCTOR SIZE TABLE

AWG	Diameter [inches]	Diameter [mm]	Area [mm <sup>2</sup> ]	Resistance [Ohms/1000 ft]	Resistance [Ohms / km]	Max Current [Amperes]	Max Frequency
0000 (4/0)	0.46	11.684	107	0.049	0.16072	302	125 Hz
000 (3/0)	0.4096	10.40384	85	0.0618	0.202704	239	160 Hz
00 (2/0)	0.3648	9.26592	67.4	0.0779	0.255512	190	200 Hz
0 (1/0)	0.3249	8.25246	53.5	0.0983	0.322424	150	250 Hz
1	0.2893	7.34822	42.4	0.1239	0.406392	119	325 Hz
2	0.2576	6.54304	33.6	0.1563	0.512664	94	410 Hz
3	0.2294	5.82676	26.7	0.197	0.64616	75	500 Hz
4	0.2043	5.18922	21.2	0.2485	0.81508	60	650 Hz
5	0.1819	4.62026	16.8	0.3133	1.027624	47	810 Hz
6	0.162	4.1148	13.3	0.3951	1.295928	37	1100 Hz
7	0.1443	3.66522	10.5	0.4982	1.634096	30	1300 Hz
8	0.1285	3.2639	8.37	0.6282	2.060496	24	1650 Hz
9	0.1144	2.90576	6.63	0.7921	2.598088	19	2050 Hz
10	0.1019	2.58826	5.26	0.9989	3.276392	15	2600 Hz
11	0.0907	2.30378	4.17	1.26	4.1328	12	3200 Hz
12	0.0808	2.05232	3.31	1.588	5.20864	9.3	4150 Hz
13	0.072	1.8288	2.62	2.003	6.56984	7.4	5300 Hz
14	0.0641	1.62814	2.08	2.525	8.282	5.9	6700 Hz
15	0.0571	1.45034	1.65	3.184	10.44352	4.7	8250 Hz
16	0.0508	1.29032	1.31	4.016	13.17248	3.7	11 k Hz
17	0.0453	1.15062	1.04	5.064	16.60992	2.9	13 k Hz
18	0.0403	1.02362	0.823	6.385	20.9428	2.3	17 kHz
19	0.0359	0.91186	0.653	8.051	26.40728	1.8	21 kHz
20	0.032	0.8128	0.518	10.15	33.292	1.5	27 kHz
21	0.0285	0.7239	0.41	12.8	41.984	1.2	33 kHz
22	0.0254	0.64516	0.326	16.14	52.9392	0.92	42 kHz
23	0.0226	0.57404	0.258	20.36	66.7808	0.729	53 kHz
24	0.0201	0.51054	0.205	25.67	84.1976	0.577	68 kHz
25	0.0179	0.45466	0.162	32.37	106.1736	0.457	85 kHz
26	0.0159	0.40386	0.129	40.81	133.8568	0.361	107 kHz
27	0.0142	0.36068	0.102	51.47	168.8216	0.288	130 kHz
28	0.0126	0.32004	0.081	64.9	212.872	0.226	170 kHz
29	0.0113	0.28702	0.0642	81.83	268.4024	0.182	210 kHz
30	0.01	0.254	0.0509	103.2	338.496	0.142	270 kHz
31	0.0089	0.22606	0.0404	130.1	426.728	0.113	340 kHz
32	0.008	0.2032	0.032	164.1	538.248	0.091	430 kHz
33	0.0071	0.18034	0.0254	206.9	678.632	0.072	540 kHz
34	0.0063	0.16002	0.0201	260.9	855.752	0.056	690 kHz
35	0.0056	0.14224	0.016	329	1079.12	0.044	870 kHz
36	0.005	0.127	0.0127	414.8	1360	0.035	1100 kHz
37	0.0045	0.1143	0.01	523.1	1715	0.0289	1350 kHz
38	0.004	0.1016	0.00797	659.6	2163	0.0228	1750 kHz
39	0.0035	0.0889	0.00632	831.8	2728	0.0175	2250 kHz
40	0.0031	0.07874	0.00501	1049	3440	0.0137	2900 kHz

**Current (ampacity) Notes:** The current ratings shown in the table are for power transmission and have been determined using the rule of 1 amp per 700 circular mils, which is a very conservative rating



# FRACTION - DECIMAL

## CONVERSION CHART

	IN	MM
	$\frac{1}{64}$	.015625 .3969
$\frac{1}{32}$	$\frac{2}{64}$	.03125 .7938
	$\frac{3}{64}$	.046875 1.1906
$\frac{1}{16}$	$\frac{5}{64}$	.0625 1.5875
	$\frac{7}{64}$	.078125 1.9844
$\frac{3}{32}$	$\frac{9}{64}$	.09375 2.3813
	$\frac{11}{64}$	.109375 2.7781
$\frac{1}{8}$	$\frac{13}{64}$	.125 3.1750
	$\frac{15}{64}$	.140625 3.5719
$\frac{5}{32}$	$\frac{17}{64}$	.15625 3.9688
	$\frac{19}{64}$	.171875 4.3656
$\frac{3}{16}$	$\frac{21}{64}$	.1875 4.7625
	$\frac{23}{64}$	.203125 5.1594
$\frac{7}{32}$	$\frac{25}{64}$	.21875 5.5563
	$\frac{27}{64}$	.234375 5.9531
$\frac{1}{4}$	$\frac{29}{64}$	.250 6.3500
	$\frac{31}{64}$	.265625 6.7469
$\frac{9}{32}$		.28125 7.1438
		.296875 7.5406
$\frac{5}{16}$		.3125 7.9375
		.328125 8.3344
$\frac{11}{32}$		.34375 8.7313
		.359375 9.1282
$\frac{3}{8}$		.375 9.5250
		.390625 9.9219
$\frac{13}{32}$		.40625 10.3188
		.421875 10.7157
$\frac{7}{16}$		.4375 11.1125
		.453125 11.5094
$\frac{15}{32}$		.46875 11.9063
		.484375 12.3032
$\frac{1}{2}$		.500 12.7001

	IN	MM
	$\frac{33}{64}$	.515625 13.096
$\frac{17}{32}$	$\frac{35}{64}$	.53125 13.493
	$\frac{37}{64}$	.546875 13.890
$\frac{9}{16}$	$\frac{39}{64}$	.5625 14.287
	$\frac{41}{64}$	.578125 14.684
$\frac{19}{32}$	$\frac{43}{64}$	.59375 15.081
	$\frac{45}{64}$	.609375 15.478
$\frac{5}{8}$	$\frac{47}{64}$	.625 15.875
	$\frac{49}{64}$	.640625 16.271
$\frac{21}{32}$	$\frac{51}{64}$	.65625 16.668
	$\frac{53}{64}$	.671875 17.065
$\frac{11}{16}$	$\frac{55}{64}$	.6875 17.462
	$\frac{57}{64}$	.703125 17.859
$\frac{23}{32}$	$\frac{59}{64}$	.71875 18.256
	$\frac{61}{64}$	.734375 18.653
$\frac{3}{4}$		.750 19.050
		.765625 19.447
$\frac{25}{32}$		.78125 19.843
		.796875 20.240
$\frac{13}{16}$		.8125 20.6375
		.828125 21.0345
$\frac{27}{32}$		.84375 21.431
		.859375 21.8282
$\frac{7}{8}$		.875 22.2251
		.890625 22.6220
$\frac{29}{32}$		.90625 23.0188
		.921875 23.4157
$\frac{15}{16}$		.9375 23.8126
		.953125 24.2095
$\frac{31}{32}$		.96875 24.6063
		.984375 25.0032
1		1.000 25.4001

# SHEET METAL GAUGE CHART

Gauge	Steel	Galvanized Steel	Stainless Steel	Aluminium	Electrical Steel
	in (mm)	in (mm)	in (mm)	in (mm)	in (mm)
3	0.2391 (6.07)	—	—	—	—
4	0.2242 (5.69)	—	—	—	—
5	0.2092 (5.31)	—	—	—	—
6	0.1943 (4.94)	—	—	0.162 (4.1)	—
7	0.1793 (4.55)	—	0.1875 (4.76)	0.1443 (3.67)	—
8	0.1644 (4.18)	0.1681 (4.27)	0.1719 (4.37)	0.1285 (3.26)	—
9	0.1495 (3.80)	0.1532 (3.89)	0.1563 (3.97)	0.1144 (2.91)	—
10	0.1345 (3.42)	0.1382 (3.51)	0.1406 (3.57)	0.1019 (2.59)	—
11	0.1196 (3.04)	0.1233 (3.13)	0.1250 (3.18)	0.0907 (2.30)	—
12	0.1046 (2.66)	0.1084 (2.75)	0.1094 (2.78)	0.0808 (2.05)	—
13	0.0897 (2.28)	0.0934 (2.37)	0.094 (2.4)	0.072 (1.8)	—
14	0.0747 (1.90)	0.0785 (1.99)	0.0781 (1.98)	0.0641 (1.63)	—
15	0.0673 (1.71)	0.0710 (1.80)	0.07 (1.8)	0.057 (1.4)	—
16	0.0598 (1.52)	0.0635 (1.61)	0.0625 (1.59)	0.0508 (1.29)	0.0625 (1.59)
17	0.0538 (1.37)	0.0575 (1.46)	0.056 (1.4)	0.045 (1.1)	0.0560 (1.42)
18	0.0478 (1.21)	0.0516 (1.31)	0.0500 (1.27)	0.0403 (1.02)	0.0500 (1.27)
19	0.0418 (1.06)	0.0456 (1.16)	0.044 (1.1)	0.036 (0.91)	0.0453 (1.15)
20	0.0359 (0.91)	0.0396 (1.01)	0.0375 (0.95)	0.0320 (0.81)	0.0375 (0.952)
21	0.0329 (0.84)	0.0366 (0.93)	0.034 (0.86)	0.028 (0.71)	0.0340 (0.860)
22	0.0299 (0.76)	0.0336 (0.85)	0.031 (0.79)	0.025 (0.64)	0.0310 (0.787)
23	0.0269 (0.68)	0.0306 (0.78)	0.028 (0.71)	0.023 (0.58)	0.0280 (0.711)
24	0.0239 (0.61)	0.0276 (0.70)	0.025 (0.64)	0.02 (0.51)	0.0250 (0.635)
25	0.0209 (0.53)	0.0247 (0.63)	0.022 (0.56)	0.018 (0.46)	0.0220 (0.559)
26	0.0179 (0.45)	0.0217 (0.55)	0.019 (0.48)	0.017 (0.43)	0.0185 (0.470)
27	0.0164 (0.42)	0.0202 (0.51)	0.017 (0.43)	0.014 (0.36)	0.0170 (0.432)
28	0.0149 (0.38)	0.0187 (0.47)	0.016 (0.41)	0.0126 (0.32)	0.0155 (0.394)
29	0.0135 (0.34)	0.0172 (0.44)	0.014 (0.36)	0.0113 (0.29)	0.0140 (0.356)
30	0.0120 (0.30)	0.0157 (0.40)	0.013 (0.33)	0.0100 (0.25)	0.0125 (0.318)
31	0.0105 (0.27)	0.0142 (0.36)	0.011 (0.28)	0.0089 (0.23)	0.0100 (0.254)
32	0.0097 (0.25)	—	—	—	—
33	0.0090 (0.23)	—	—	—	—
34	0.0082 (0.21)	—	—	—	—
35	0.0075 (0.19)	—	—	—	—
36	0.0067 (0.17)	—	—	—	—
37	0.0064 (0.16)	—	—	—	—
38	0.0060 (0.15)	—	—	—	—
33	0.0071	0.18034	0.0254	206.9	678.632
34	0.0063	0.16002	0.0201	260.9	855.752
35	0.0056	0.14224	0.016	329	1079.12
36	0.005	0.127	0.0127	414.8	1360
37	0.0045	0.1143	0.01	523.1	1715
38	0.004	0.1016	0.00797	659.6	2163
39	0.0035	0.0889	0.00632	831.8	2728
40	0.0031	0.07874	0.00501	1049	3440

# ELECTRICAL DESIGN RULES

Wire sizes for a given contact size (using 125 °C MIL-DTL-16878/15 wire at 50 °C ambient).

AWG	MAX Amperage	MAX Contact Size
18	10 A	N/A
16	12 A	N/A
14	15 A	N/A
12	20 A	0
10	30 A	1
8	65 A	2
6	86 A	2
4	114 A	3
2	155 A	4
1/0	213 A	4
2/0	246 A	4
3/0	287 A	5
4/0	332 A	5
250	373 A	5
400	504 A	5
500	574 A	6
1000	865 A	7

Ratings for multi-speed, magnetic controllers for nonplugging and nonjogging duty for constant-horsepower motors.

Size of controller	Continuous current rating (amperes)	Three-phase hp at		Three-phase power at	
		115 V	440 V	115 V	440 V
0	18	2	5	3.6 kW	13.7 kW
1	27	3	10	5.4 kW	20.6 kW
2	45	7½	25	9 kW	34.3 kW
3	90	15	50	18 kW	68.6 kW
4	135	30	100	26.9 kW	102.9 kW
5	270	--	200	53.7 kW	205.8 kW
6	540	--	400	107.4 kW	411.5 kW
7	810	--	600	161.1 kW	617.3 kW

Ratings for multi-speed, magnetic controllers for nonplugging and nonjogging duty for constant-horsepower motors

Size of controller	Continuous current rating (amperes)	Three-phase hp at	
		115 V	440 V
0	18	1	3
1	27	2	7½
2	45	—	20
3	90	—	40
4	135	—	75
5	270	—	150
6	540	—	300
7	810	—	450



**Ward Leonard**

Powered by **FAIRBANKS MORSE  
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