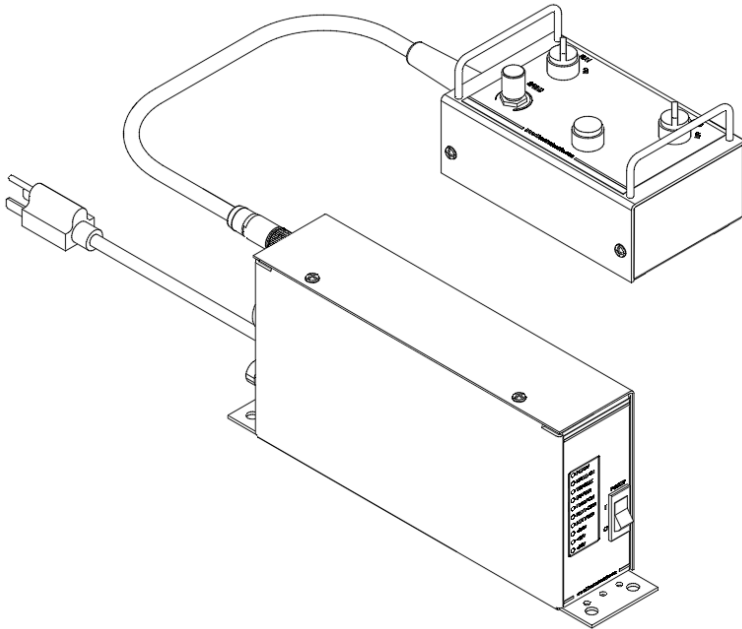


Operator's Manual

CWT[™] WFD-3



For use with machines having Numbers:

S0A5147



Register your machine:

www.lincolnelectric.com/register

Authorized Service and Distributor Locator:

www.lincolnelectric.com/locator

Save for future reference

Date Purchased

Code: (ex: 10859)

Serial: (ex: U1060512345)

THANK YOU FOR SELECTING A QUALITY PRODUCT BY LINCOLN ELECTRIC.

PLEASE EXAMINE CARTON AND EQUIPMENT FOR DAMAGE IMMEDIATELY

When this equipment is shipped, title passes to the purchaser upon receipt by the carrier. Consequently, claims for material damaged in shipment must be made by the purchaser against the transportation company at the time the shipment is received.

SAFETY DEPENDS ON YOU

Lincoln arc welding and cutting equipment is designed and built with safety in mind. However, your overall safety can be increased by proper installation ... and thoughtful operation on your part. **DO NOT INSTALL, OPERATE OR REPAIR THIS EQUIPMENT WITHOUT READING THIS MANUAL AND THE SAFETY PRECAUTIONS CONTAINED THROUGHOUT.** And, most importantly, think before you act and be careful.

WARNING

This statement appears where the information must be followed exactly to avoid serious personal injury or loss of life.

CAUTION

This statement appears where the information must be followed to avoid minor personal injury or damage to this equipment.



KEEP YOUR HEAD OUT OF THE FUMES.

DON'T get too close to the arc. Use corrective lenses if necessary to stay a reasonable distance away from the arc.

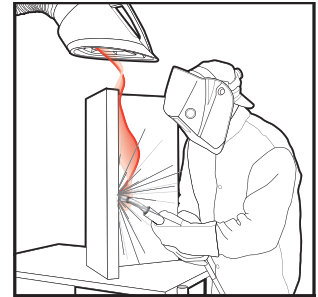
READ and obey the Safety Data Sheet (SDS) and the warning label that appears on all containers of welding materials.

USE ENOUGH VENTILATION or exhaust at the arc, or both, to keep the fumes and gases from your breathing zone and the general area.

IN A LARGE ROOM OR OUTDOORS, natural ventilation may be adequate if you keep your head out of the fumes (See below).

USE NATURAL DRAFTS or fans to keep the fumes away from your face.

If you develop unusual symptoms, see your supervisor. Perhaps the welding atmosphere and ventilation system should be checked.



WEAR CORRECT EYE, EAR & BODY PROTECTION

PROTECT your eyes and face with welding helmet properly fitted and with proper grade of filter plate (See ANSI Z49.1).

PROTECT your body from welding spatter and arc flash with protective clothing including woolen clothing, flame-proof apron and gloves, leather leggings, and high boots.

PROTECT others from splatter, flash, and glare with protective screens or barriers.

IN SOME AREAS, protection from noise may be appropriate.

BE SURE protective equipment is in good condition.

Also, wear safety glasses in work area **AT ALL TIMES.**



SPECIAL SITUATIONS

DO NOT WELD OR CUT containers or materials which previously had been in contact with hazardous substances unless they are properly cleaned. This is extremely dangerous.

DO NOT WELD OR CUT painted or plated parts unless special precautions with ventilation have been taken. They can release highly toxic fumes or gases.

Additional precautionary measures

PROTECT compressed gas cylinders from excessive heat, mechanical shocks, and arcs; fasten cylinders so they cannot fall.

BE SURE cylinders are never grounded or part of an electrical circuit.

REMOVE all potential fire hazards from welding area.

ALWAYS HAVE FIRE FIGHTING EQUIPMENT READY FOR IMMEDIATE USE AND KNOW HOW TO USE IT.



SECTION A: WARNINGS



CALIFORNIA PROPOSITION 65 WARNINGS



WARNING: Breathing diesel engine exhaust exposes you to chemicals known to the State of California to cause cancer and birth defects, or other reproductive harm.

- Always start and operate the engine in a well-ventilated area.
- If in an exposed area, vent the exhaust to the outside.
- Do not modify or tamper with the exhaust system.
- Do not idle the engine except as necessary.

For more information go to
www.P65warnings.ca.gov/diesel

WARNING: This product, when used for welding or cutting, produces fumes or gases which contain chemicals known to the State of California to cause birth defects and, in some cases, cancer. (California Health & Safety Code § 25249.5 *et seq.*)



WARNING: Cancer and Reproductive Harm
www.P65warnings.ca.gov

ARC WELDING CAN BE HAZARDOUS. PROTECT YOURSELF AND OTHERS FROM POSSIBLE SERIOUS INJURY OR DEATH. KEEP CHILDREN AWAY. PACEMAKER WEARERS SHOULD CONSULT WITH THEIR DOCTOR BEFORE OPERATING.

Read and understand the following safety highlights. For additional safety information, it is strongly recommended that you purchase a copy of "Safety in Welding & Cutting - ANSI Standard Z49.1" from the American Welding Society, P.O. Box 351040, Miami, Florida 33135 or CSA Standard W117.2-1974. A Free copy of "Arc Welding Safety" booklet E205 is available from the Lincoln Electric Company, 22801 St. Clair Avenue, Cleveland, Ohio 44117-1199.

BE SURE THAT ALL INSTALLATION, OPERATION, MAINTENANCE AND REPAIR PROCEDURES ARE PERFORMED ONLY BY QUALIFIED INDIVIDUALS.



FOR ENGINE POWERED EQUIPMENT.

- 1.a. Turn the engine off before troubleshooting and maintenance work unless the maintenance work requires it to be running.
- 1.b. Operate engines in open, well-ventilated areas or vent the engine exhaust fumes outdoors.
- 1.c. Do not add the fuel near an open flame welding arc or when the engine is running. Stop the engine and allow it to cool before refueling to prevent spilled fuel from vaporizing on contact



with hot engine parts and igniting. Do not spill fuel when filling tank. If fuel is spilled, wipe it up and do not start engine until fumes have been eliminated.

- 1.d. Keep all equipment safety guards, covers and devices in position and in good repair. Keep hands, hair, clothing and tools away from V-belts, gears, fans and all other moving parts when starting, operating or repairing equipment.
- 1.e. In some cases it may be necessary to remove safety guards to perform required maintenance. Remove guards only when necessary and replace them when the maintenance requiring their removal is complete. Always use the greatest care when working near moving parts.
- 1.f. Do not put your hands near the engine fan. Do not attempt to override the governor or idler by pushing on the throttle control rods while the engine is running.
- 1.g. To prevent accidentally starting gasoline engines while turning the engine or welding generator during maintenance work, disconnect the spark plug wires, distributor cap or magneto wire as appropriate.
- 1.h. To avoid scalding, do not remove the radiator pressure cap when the engine is hot.



ELECTRIC AND MAGNETIC FIELDS MAY BE DANGEROUS



- 2.a. Electric current flowing through any conductor causes localized Electric and Magnetic Fields (EMF). Welding current creates EMF fields around welding cables and welding machines
- 2.b. EMF fields may interfere with some pacemakers, and welders having a pacemaker should consult their physician before welding.
- 2.c. Exposure to EMF fields in welding may have other health effects which are now not known.
- 2.d. All welders should use the following procedures in order to minimize exposure to EMF fields from the welding circuit:
 - 2.d.1. Route the electrode and work cables together - Secure them with tape when possible.
 - 2.d.2. Never coil the electrode lead around your body.
 - 2.d.3. Do not place your body between the electrode and work cables. If the electrode cable is on your right side, the work cable should also be on your right side.
 - 2.d.4. Connect the work cable to the workpiece as close as possible to the area being welded.
 - 2.d.5. Do not work next to welding power source.



ELECTRIC SHOCK CAN KILL.



- 3.a. The electrode and work (or ground) circuits are electrically “hot” when the welder is on. Do not touch these “hot” parts with your bare skin or wet clothing. Wear dry, hole-free gloves to insulate hands.
- 3.b. Insulate yourself from work and ground using dry insulation. Make certain the insulation is large enough to cover your full area of physical contact with work and ground.

In addition to the normal safety precautions, if welding must be performed under electrically hazardous conditions (in damp locations or while wearing wet clothing; on metal structures such as floors, gratings or scaffolds; when in cramped positions such as sitting, kneeling or lying, if there is a high risk of unavoidable or accidental contact with the workpiece or ground) use the following equipment:

- Semiautomatic DC Constant Voltage (Wire) Welder.
 - DC Manual (Stick) Welder.
 - AC Welder with Reduced Voltage Control.
- 3.c. In semiautomatic or automatic wire welding, the electrode, electrode reel, welding head, nozzle or semiautomatic welding gun are also electrically “hot”.
 - 3.d. Always be sure the work cable makes a good electrical connection with the metal being welded. The connection should be as close as possible to the area being welded.
 - 3.e. Ground the work or metal to be welded to a good electrical (earth) ground.
 - 3.f. Maintain the electrode holder, work clamp, welding cable and welding machine in good, safe operating condition. Replace damaged insulation.
 - 3.g. Never dip the electrode in water for cooling.
 - 3.h. Never simultaneously touch electrically “hot” parts of electrode holders connected to two welders because voltage between the two can be the total of the open circuit voltage of both welders.
 - 3.i. When working above floor level, use a safety belt to protect yourself from a fall should you get a shock.
 - 3.j. Also see Items 6.c. and 8.



ARC RAYS CAN BURN.



- 4.a. Use a shield with the proper filter and cover plates to protect your eyes from sparks and the rays of the arc when welding or observing open arc welding. Headshield and filter lens should conform to ANSI Z87.1 standards.
- 4.b. Use suitable clothing made from durable flame-resistant material to protect your skin and that of your helpers from the arc rays.
- 4.c. Protect other nearby personnel with suitable, non-flammable screening and/or warn them not to watch the arc nor expose themselves to the arc rays or to hot spatter or metal.



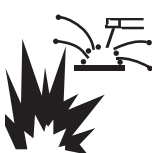
FUMES AND GASES CAN BE DANGEROUS.



- 5.a. Welding may produce fumes and gases hazardous to health. Avoid breathing these fumes and gases. When welding, keep your head out of the fume. Use enough ventilation and/or exhaust at the arc to keep fumes and gases away from the breathing zone. **When welding hardfacing (see instructions on container or SDS) or on lead or cadmium plated steel and other metals or coatings which produce highly toxic fumes, keep exposure as low as possible and within applicable OSHA PEL and ACGIH TLV limits using local exhaust or mechanical ventilation unless exposure assessments indicate otherwise. In confined spaces or in some circumstances, outdoors, a respirator may also be required. Additional precautions are also required when welding on galvanized steel.**
- 5.b. The operation of welding fume control equipment is affected by various factors including proper use and positioning of the equipment, maintenance of the equipment and the specific welding procedure and application involved. Worker exposure level should be checked upon installation and periodically thereafter to be certain it is within applicable OSHA PEL and ACGIH TLV limits.
- 5.c. Do not weld in locations near chlorinated hydrocarbon vapors coming from degreasing, cleaning or spraying operations. The heat and rays of the arc can react with solvent vapors to form phosgene, a highly toxic gas, and other irritating products.
- 5.d. Shielding gases used for arc welding can displace air and cause injury or death. Always use enough ventilation, especially in confined areas, to insure breathing air is safe.
- 5.e. Read and understand the manufacturer's instructions for this equipment and the consumables to be used, including the Safety Data Sheet (SDS) and follow your employer's safety practices. SDS forms are available from your welding distributor or from the manufacturer.
- 5.f. Also see item 1.b.



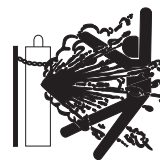
WELDING AND CUTTING SPARKS CAN CAUSE FIRE OR EXPLOSION.



- 6.a. Remove fire hazards from the welding area. If this is not possible, cover them to prevent the welding sparks from starting a fire. Remember that welding sparks and hot materials from welding can easily go through small cracks and openings to adjacent areas. Avoid welding near hydraulic lines. Have a fire extinguisher readily available.
- 6.b. Where compressed gases are to be used at the job site, special precautions should be used to prevent hazardous situations. Refer to "Safety in Welding and Cutting" (ANSI Standard Z49.1) and the operating information for the equipment being used.
- 6.c. When not welding, make certain no part of the electrode circuit is touching the work or ground. Accidental contact can cause overheating and create a fire hazard.
- 6.d. Do not heat, cut or weld tanks, drums or containers until the proper steps have been taken to insure that such procedures will not cause flammable or toxic vapors from substances inside. They can cause an explosion even though they have been "cleaned". For information, purchase "Recommended Safe Practices for the Preparation for Welding and Cutting of Containers and Piping That Have Held Hazardous Substances", AWS F4.1 from the American Welding Society (see address above).
- 6.e. Vent hollow castings or containers before heating, cutting or welding. They may explode.
- 6.f. Sparks and spatter are thrown from the welding arc. Wear oil free protective garments such as leather gloves, heavy shirt, cuffless trousers, high shoes and a cap over your hair. Wear ear plugs when welding out of position or in confined places. Always wear safety glasses with side shields when in a welding area.
- 6.g. Connect the work cable to the work as close to the welding area as practical. Work cables connected to the building framework or other locations away from the welding area increase the possibility of the welding current passing through lifting chains, crane cables or other alternate circuits. This can create fire hazards or overheat lifting chains or cables until they fail.
- 6.h. Also see item 1.c.
- 6.i. Read and follow NFPA 51B "Standard for Fire Prevention During Welding, Cutting and Other Hot Work", available from NFPA, 1 Batterymarch Park, PO box 9101, Quincy, MA 022690-9101.
- 6.j. Do not use a welding power source for pipe thawing.



CYLINDER MAY EXPLODE IF DAMAGED.



- 7.a. Use only compressed gas cylinders containing the correct shielding gas for the process used and properly operating regulators designed for the gas and pressure used. All hoses, fittings, etc. should be suitable for the application and maintained in good condition.
- 7.b. Always keep cylinders in an upright position securely chained to an undercarriage or fixed support.
- 7.c. Cylinders should be located:
 - Away from areas where they may be struck or subjected to physical damage.
 - A safe distance from arc welding or cutting operations and any other source of heat, sparks, or flame.
- 7.d. Never allow the electrode, electrode holder or any other electrically "hot" parts to touch a cylinder.
- 7.e. Keep your head and face away from the cylinder valve outlet when opening the cylinder valve.
- 7.f. Valve protection caps should always be in place and hand tight except when the cylinder is in use or connected for use.
- 7.g. Read and follow the instructions on compressed gas cylinders, associated equipment, and CGA publication P-1, "Precautions for Safe Handling of Compressed Gases in Cylinders," available from the Compressed Gas Association, 14501 George Carter Way Chantilly, VA 20151.



FOR ELECTRICALLY POWERED EQUIPMENT.



- 8.a. Turn off input power using the disconnect switch at the fuse box before working on the equipment.
- 8.b. Install equipment in accordance with the U.S. National Electrical Code, all local codes and the manufacturer's recommendations.
- 8.c. Ground the equipment in accordance with the U.S. National Electrical Code and the manufacturer's recommendations.

Refer to
<http://www.lincolnelectric.com/safety>
for additional safety information.

ELECTROMAGNETIC COMPATIBILITY (EMC)

CONFORMANCE

Products displaying the CE mark are in conformity with European Community Council Directive. It was manufactured in conformity with a national standard that implements a harmonized standard: EN 60974-10 Electromagnetic Compatibility (EMC) Product Standard for Arc Welding Equipment. It is for use with other Lincoln Electric equipment. It is designed for industrial and professional use.

INTRODUCTION

All electrical equipment generates small amounts of electromagnetic emission. Electrical emission may be transmitted through power lines or radiated through space, similar to a radio transmitter. When emissions are received by other equipment, electrical interference may result. Electrical emissions may affect many kinds of electrical equipment; other nearby welding equipment, radio and TV reception, numerical controlled machines, telephone systems, computers, etc.

WARNING: This Class A equipment is not intended for use in residential locations where the electrical power is provided by the public low-voltage supply system. There may be potential difficulties in ensuring electro-magnetic compatibility in those locations, due to conducted as well as radiated disturbances.

INSTALLATION AND USE

The user is responsible for installing and using the welding equipment according to the manufacturer's instructions.

If electromagnetic disturbances are detected then it shall be the responsibility of the user of the welding equipment to resolve the situation with the technical assistance of the manufacturer. In some cases this remedial action may be as simple as earthing (grounding) the welding circuit, see Note. In other cases it could involve constructing an electromagnetic screen enclosing the power source and the work complete with associated input filters. In all cases electromagnetic disturbances must be reduced to the point where they are no longer troublesome.

NOTE: The welding circuit may or may not be earthed for safety reasons. Follow your local and national standards for installation and use. Changing the earthing arrangements should only be authorized by a person who is competent to assess whether the changes will increase the risk of injury, e.g., by allowing parallel welding current return paths which may damage the earth circuits of other equipment.

ASSESSMENT OF AREA

Before installing welding equipment the user shall make an assessment of potential electromagnetic problems in the surrounding area. The following shall be taken into account:

- a) other supply cables, control cables, signaling and telephone cables; above, below and adjacent to the welding equipment;
- b) radio and television transmitters and receivers;
- c) computer and other control equipment;
- d) safety critical equipment, e.g., guarding of industrial equipment;
- e) the health of the people around, e.g., the use of pacemakers and hearing aids;
- f) equipment used for calibration or measurement;
- g) the immunity of other equipment in the environment. The user shall ensure that other equipment being used in the

environment is compatible. This may require additional protection measures;

- h) the time of day that welding or other activities are to be carried out.

The size of the surrounding area to be considered will depend on the structure of the building and other activities that are taking place. The surrounding area may extend beyond the boundaries of the premises.

METHODS OF REDUCING EMISSIONS

Public Supply System

Welding equipment should be connected to the public supply system according to the manufacturer's recommendations. If interference occurs, it may be necessary to take additional precautions such as filtering of the system. Consideration should be given to shielding the supply cable of permanently installed welding equipment, in metallic conduit or equivalent. Shielding should be electrically continuous throughout its length. The shielding should be connected to the welding power source so that good electrical contact is maintained between the conduit and the welding power source enclosure.

Maintenance of the Welding Equipment

The welding equipment should be routinely maintained according to the manufacturer's recommendations. All access and service doors and covers should be closed and properly fastened when the welding equipment is in operation. The welding equipment should not be modified in any way except for those changes and adjustments covered in the manufacturer's instructions. In particular, the spark gaps of arc striking and stabilizing devices should be adjusted and maintained according to the manufacturer's recommendations.

Welding Cables

The welding cables should be kept as short as possible and should be positioned close together, running at or close to the floor level.

Equipotential Bonding

Bonding of all metallic components in the welding installation and adjacent to it should be considered. However, metallic components bonded to the work piece will increase the risk that the operator could receive a shock by touching these metallic components and the electrode at the same time. The operator should be insulated from all such bonded metallic components.

Earthing of the Workpiece

Where the workpiece is not bonded to earth for electrical safety, nor connected to earth because of its size and position, e.g., ship's hull or building steelwork, a connection bonding the workpiece to earth may reduce emissions in some, but not all instances. Care should be taken to prevent the earthing of the workpiece increasing the risk of injury to users, or damage to other electrical equipment. Where necessary, the connection of the workpiece to earth should be made by a direct connection to the workpiece, but in some countries where direct connection is not permitted, the bonding should be achieved by suitable capacitance, selected according to national regulations.

Screening and Shielding

Selective screening and shielding of other cables and equipment in the surrounding area may alleviate problems of interference. Screening of the entire welding installation may be considered for special applications.¹

¹ Portions of the preceding text are contained in EN 60974-10 "Electromagnetic Compatibility (EMC) product standard for arc welding equipment."

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1.0 GENERAL DESCRIPTION

1.1 Functional Description

The WFD-3 Wire Feed Drive Control is a PWM motor speed controller using an embedded micro controller to provide motor speed regulation and torque compensation. The WFD-3 is a general purpose GMAW/GTAW wire feed system using the CWT Capstan Wire Feeder. The system is designed to be used with automated welding fixtures and robotic welding systems. The Capstan wire drive is designed specifically for automation. The Capstan's small size and light weight (less than 6 lbs without torch - less than 8 lbs with 350 amp water cooled torch) allows the wire feeder to be placed directly on the automated fixture or robot wrist, eliminating the wire guide liners normally associated with conventional wire drive systems. The Capstan also provides an increase in wire drive contact area by wrapping the wire around a wire drive wheel. This wire drive method has four major benefits:

- Plastic deforms the filler wire, virtually eliminating existing wire cast.
- Increased drive force eliminates wire slip and flattening or damage to wire surface.
- Integral wire straightener on the discharge side of the wire allows the wire drive to precisely locate the filler wire independent of wire cast.
- Locate the filler wire independent of wire cast.

The WFD-3 also provides a RS-485 serial port configured to support Modbus RTU protocol. This port can be used to Operate and configure various features of the WFD-3.

The WFD-3 is used to control linear DC drive motors for wire feed and or travel speed functions. The WFD-3 provides speed and torque regulation using an optical encoder or phase sampled Back EMF. The embedded controller provides precise motor braking and anti-plugging features to extend motor life.

1.2 Remote I/O Control

The WFD-3 provides remote speed control using a 0-10 VDC input signal. Two 24 VDC inputs provide remote direction control. The control provides an optional isolated encoder output signal. A remote I/O connector located on the rear of the enclosure provides all user control connections.

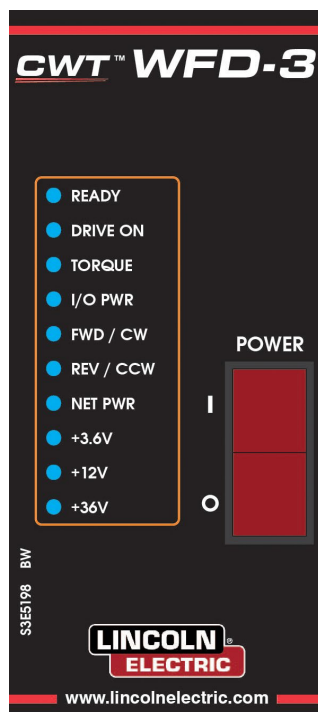
1.3 Motor Output

The standard WFD-3 can be used with 24 VDC permanent magnet motors up to 150 watts. A motor connector located on the rear of the enclosure provides all user motor connections. The control can be used with or without an optical tachometer. The control uses a 100 line optical tachometer input and can provide a 5 VDC or 15 VDC output for the tachometer. The tachometer input mode is automatically enabled when an encoder signal is active. If the encoder is not used the control will switch to the back EMF sample mode for speed regulation.

1.4 Operational Status

The operational status of the WFD-3 is displayed using 9 LED's located on the front panel. The following is a description of the LED functions:

- **READY** – Indicates when the controller is ready to respond to input commands.
- **DRIVE ON** – Illuminates when the Motor drive output is active.
- **TORQUE** – Illuminates when the motor controller detects max current output.
- **I/O PWR** – Illuminates when power is applied to the isolated I/O.
- **FWD/CW** – Illuminates when the control has a FWD/CW input applied to the remote I/O.
- **REV/CW** – Illuminates when the control has a REV/CCW input applied to the remote I/O.
- **NET PWR** – Illuminates when power is applied to the isolate RS-485 serial Com port.
- **+3.6V** – Illuminates when the 3.6 volt power supply is active.
- **+12V** – Illuminates when the 12 volt power supply is active.
- **+36V** – Illuminates when the main motor power supply is active.

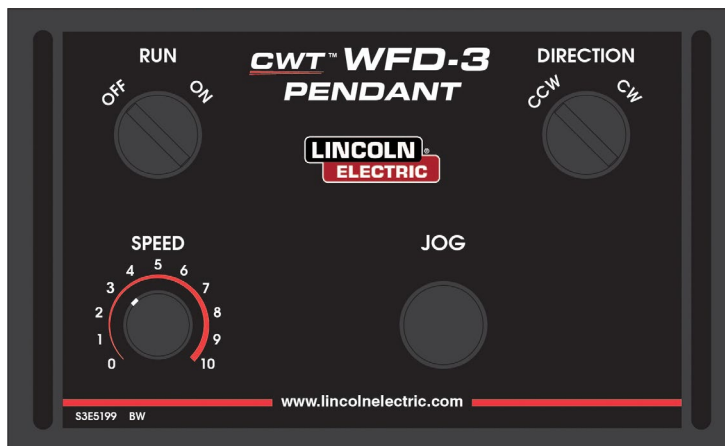


1.5 Operator Pendant

The WFD-3 wire drive control provides all of the required wire feed drive control functions and a tach-less Tachometer feedback Pulse Width Modulated (PWM) motor drive control. The PWM control provides auto tachometer sensing and will use the tachometer for feedback regulation if available. The following operator pendant controls are provided:

- **RUN** - This switch is used to start and stop the wire feed drive. Setting the switch to the "ON" position will start the wire feed drive motor. Setting the switch to the "OFF" position will terminate the wire feed drive motor.

- **DIRECTION** – This switch is used select the direction to feed the wire. When the switch is set to the “CCW” position slide will be move in the CCW direction. When the switch is set to the “CW” position the slide will be moved in the CW direction.
- **SPEED** – The speed pot is used to control the speed of the wire drive.
- **JOG** – The switch used to manually control the wire feed.



1.6 Control Specification

The following are the mechanical specifications for the WFD-3 Control:

Dimension	4.75"h x 2.0"w x 11.0"l (120.6mm x 50.8mm x 279.4mm)
Mounting Dimension	1.25" wide x 10.25" long, four 0.25" diameter hole
Weight	5 lbs (2.27 kgms)
Operating Temperature	-10°F (-23°C) to +140°F (+60°C)

The following are the electrical specifications for the WFD-3 Control:

Power Input	120 vac \pm 10% @ 2.5amps
Armature Current	0.5 – 6.5 amps
Armature Voltage	0 – 24 vdc
Encoder Input	5 or 15 vdc 100 lines/rev max frequency 25.0khz
Forward Input	24 vdc @ 20ma (Active High)
Reverse Input	24 vdc @ 20ma (Active High)
Speed Reference Input	0-10 vdc @ 0.1 ma

The following are the mechanical specifications for the WFD-3 Pendant:

Control Dimension	2.0"H x 3.5"W x 5.75"L (50mm x 89mm x 147 mm)
Mounting Dimension	Hand Held
Weight	1 lbs (1.18 kgms)
Power Input	24 VDC @ 0.2 amps
Operating Temperature	-10°F (-23°C) to +140°F (+60°C)

2.0 INSTALLATION

2.1 Location

The WFD-3 controller should be located near the drive motor it is controlling. The maximum motor drive cable length is 75 ft. Mount the WFD-3 controller in a location that allows easy access to the front and rear panel. Figure 2-1 shows the WOC-2 System Diagram. Figure 2-2 and 2-3 shows the dimensions for the control enclosure and operator pendant.

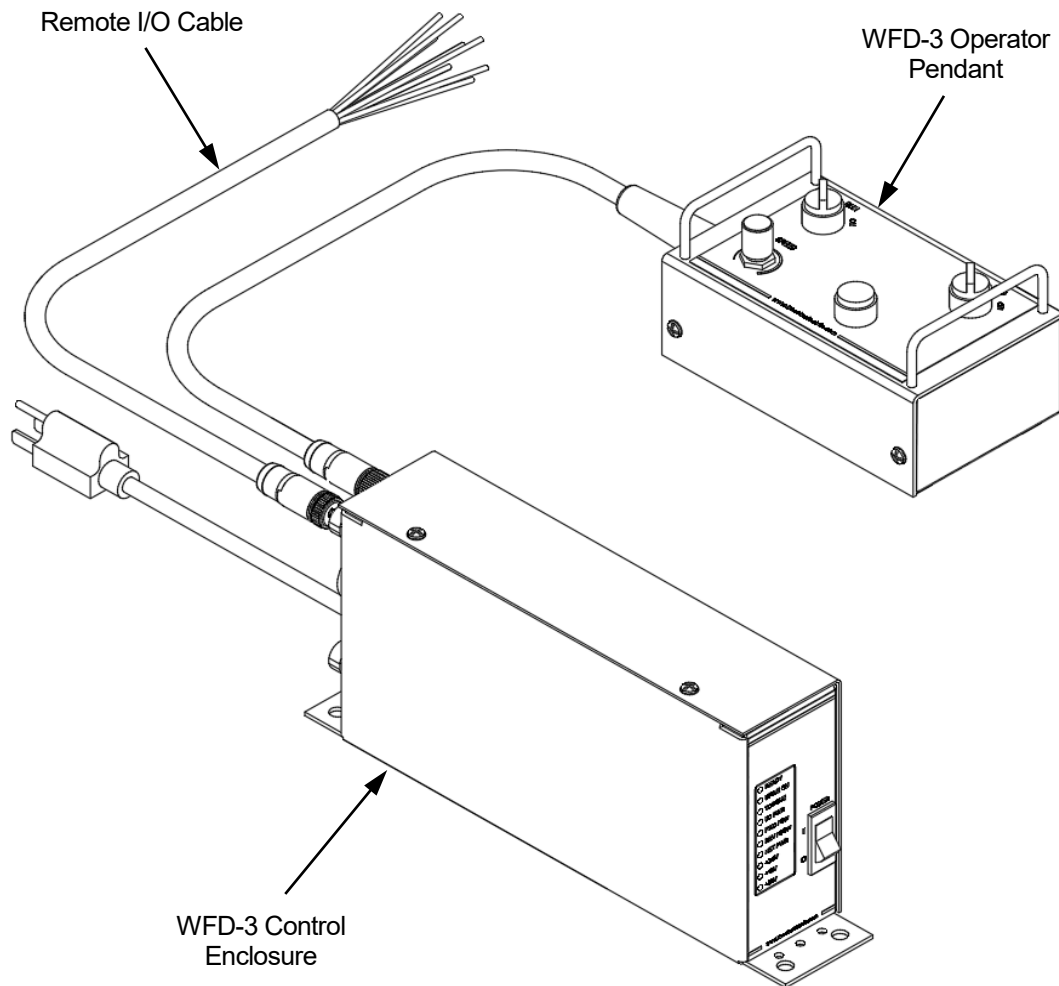


FIG 2-1: WOC-2 System Diagram

2.2 Controller and Pendant Dimensions

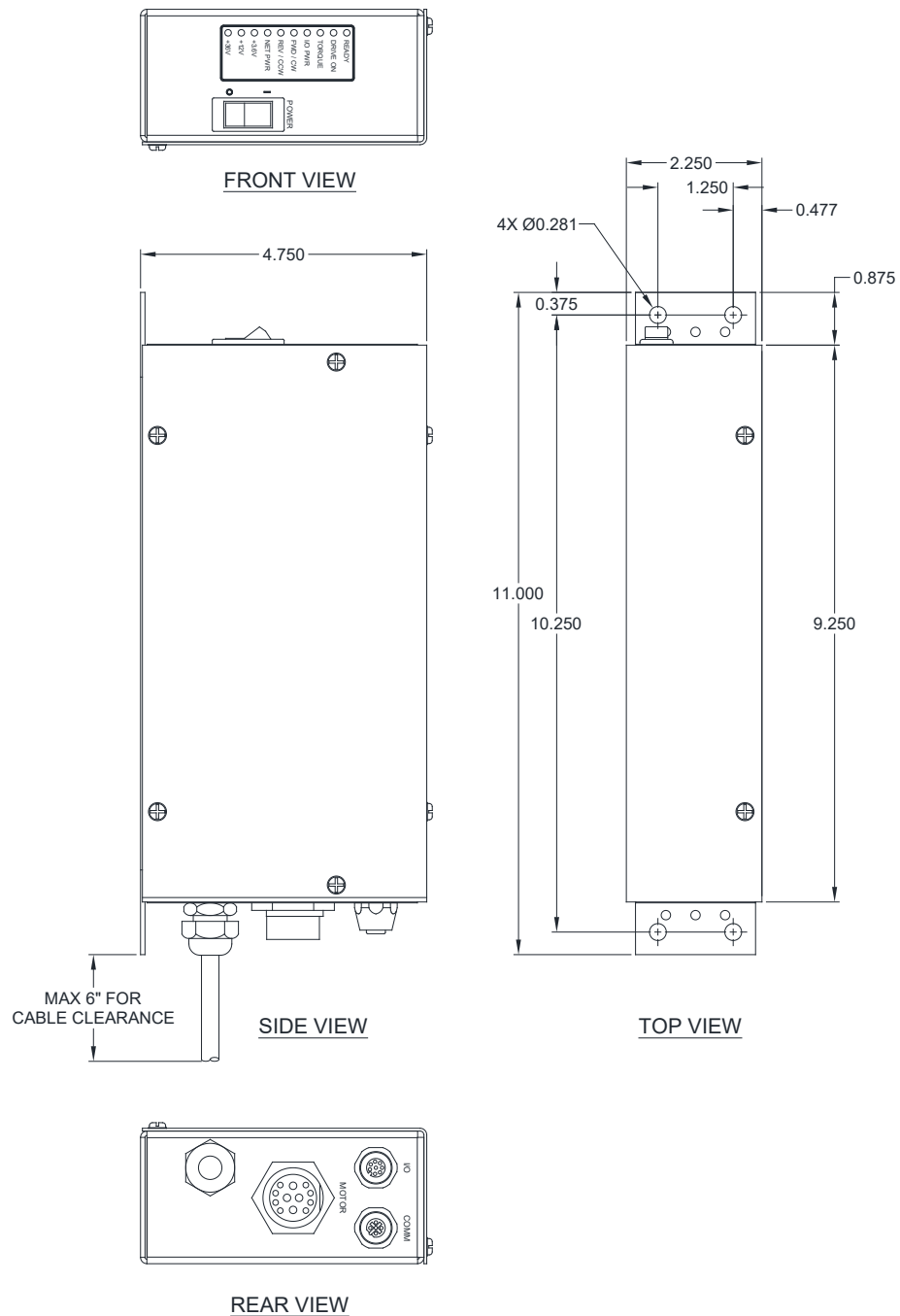


FIG 2-2: Enclosure Mounting Dimensions

Connect power cable to suitable 115 VAC power outlet. Connect motor control cable to MOTOR connector on rear of enclosure. Connect the remote I/O cable or operator pendant to I/O connector on rear of enclosure.

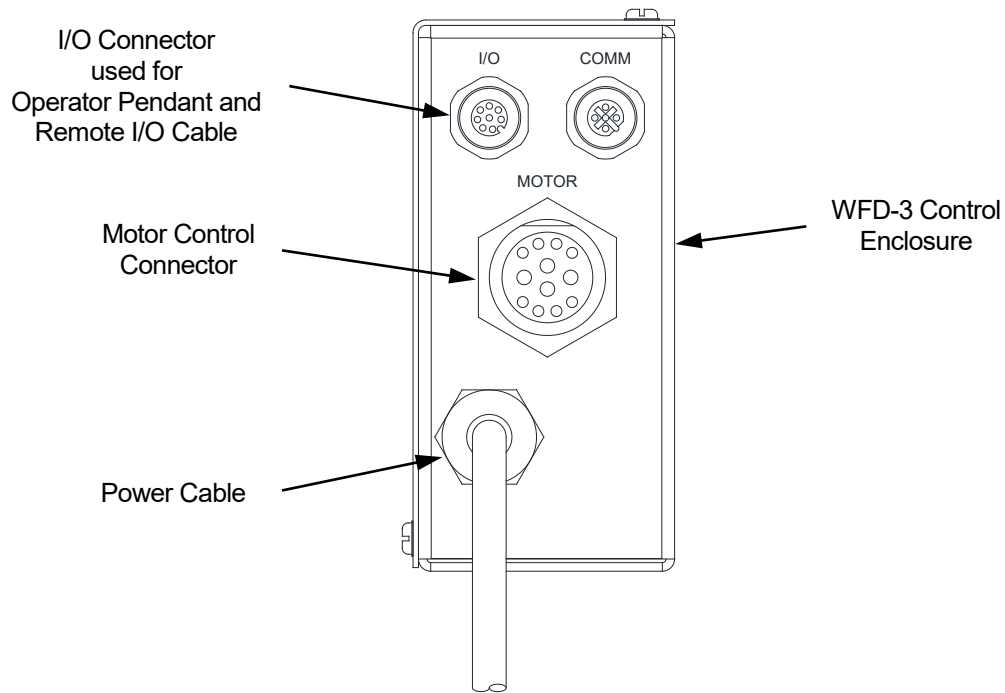


FIG 2-3: Rear Panel of WFD-3 Control Enclosure

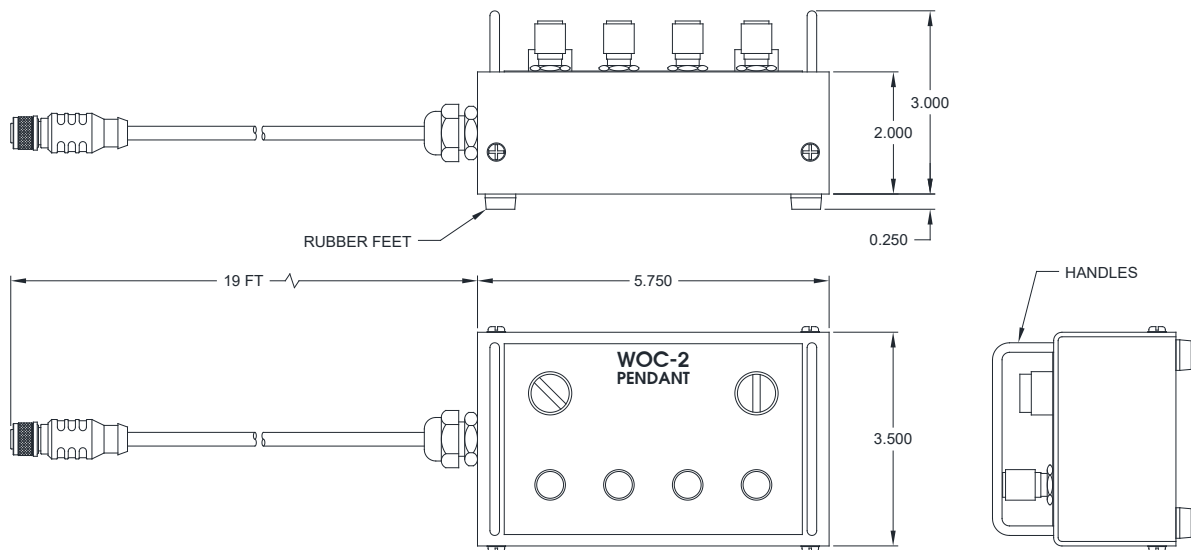


FIG 2-4: WFD-3 Operator Pendant Dimensions

2.3 DC Motor Connector Pin-Out

Several cables are available from the factory, which and can be used for connecting a DC drive motor to the WFD-3. Consult the factory for available cable assemblies. The following is the pin-out for the WFD-3 motor connector:

PIN	DESCRIPTION
A	+15 VDC for optional encoder
B	+5 VDC for optional encoder
C	Not used
D	Not used
E	Not used
F	Chassis Ground
G	Encoder Pulse input (TTL or 15 Volt Pulse)
H	Encoder Common
J	Motor Field -
K	Motor Armature -
L	Motor Field +
M	Motor Armature +

Figure 2-5: Motor Connector Pin-out

2.4 Optional Encoder Connections

The WFD-3 can use a 5-volt or 15-volt encoder. Both power outputs are provided on the connector. Connect the optional motor encoder to the correct voltage output. Use Pin A for a 15-volt encoder or Pin B for a 5-volt encoder. The WFD-3 is designed for a 100-line encoder and can be used for motor speeds up to 3000 rpm. For faster speeds, contact the factory. The following is a typical connection for a 5-volt TTL encoder:

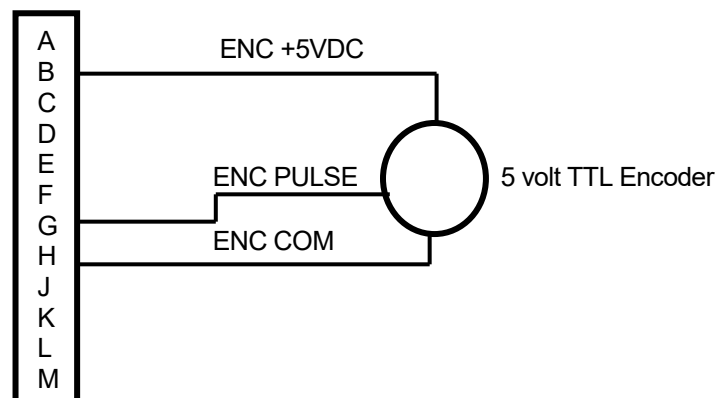


Fig 2-6 5-volt TTL encoder connection

The following is the connection diagram for a 15 VDC encoder:

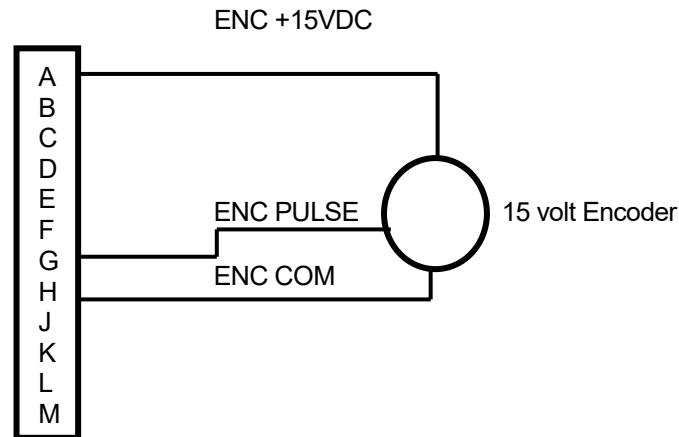


Fig 2-7 15-volt TTL encoder connection

2.5 Motor Connection

The WFD-3 can be used with a permanent magnet motors with an armature rating of 10 – 24 volt dc. The following is the connection diagram for a permanent magnet motor:

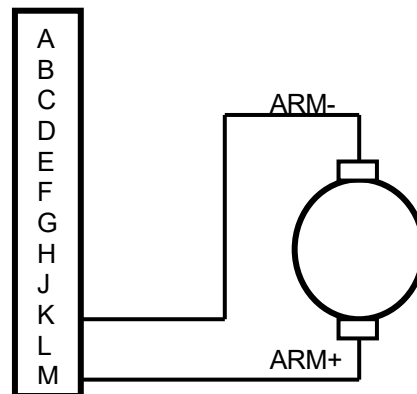


Fig 2-8 Permanent magnetic motor wiring

2.6 Remote I/O Connector Connection

The WFD-3 is controlled via the REMOTE I/O connector. The control has two (2) 24 VDC inputs for motor direction control, a 0-10 vdc input for speed control and a 24 VDC output. The following is the pin-out for the REMOTE I/O connector:

PIN	FUNCTIONAL DESCRIPTION
1	+24 vdc output @ 100ma output
2	24 vdc common
3	Speed Input signal common
4	Speed input signal (0 – 10 vdc)
5	Drive Forward command input (24 vdc @ 10 ma)
6	Drive Reverse command input (24 vdc @ 10 ma)
7	Motor Tachometer output (24 vdc)
8	Frame ground (Cable Shield connection)

Fig 2-9 Remote I/O connector pin-out

A remote I/O cable S3W5058 is available for interfacing the WFD-3 to the CWT controller or for direct interface to user supplied PLC controller. The following is an example of using the WFD-3 controller with a user supplied PLC controller:

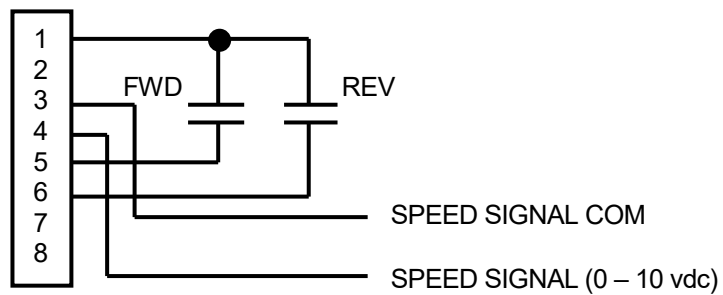


Fig 2-10 PLC interface to WFD-3

3.0 OPERATION

3.1 Theory of Operation

The WFD-3 is PWM motor speed controller. The control uses an embedded micro-controller to provide line synchronization, phased back EMF sampling and direction control logic with anti-plug motor reversing. The phased EMF sample provides precise back EMF sample for improve motor speed regulation. The Anti-plug feature prevents reversing the drive before the motor armature has stopped. This prevents excessive motor current and brush arcing in the motor.

The Micro-Controller synchronizes all input commands to the incoming line frequency and assures proper phase angle firing of the power PWM devices. The Analog speed signal is coupled to a Voltage-to-Frequency convert and is electrically isolated from the off-line control. The remote direction control inputs are optically coupled to the controller. An isolated 12-vdc-power supply is provided for all remote input control functions. The user can use this supply to operate remote input relays or switches for direction control. The supply has a solid-state circuit breaker, which protects the 12-volt I/O control from external shorts. The circuit breaker will reset when the 115-vac power is cycled off.

Optional optical tach input is provided which can be used with a 5 or 12 VDC 60-line encoder. The encoder input is also provided as an output on the remote I/O connector. This output is an isolated 24-vdc pulse representing the encoder input. When an encoder is installed on the motor shaft, the WFD-3 can be set for encoder feedback by installing a jumper on JP3. When the jumper is installed, the controller uses the tachometer to regulate motor speed. When the jumper is removed, the controller will use the motor back EMF for speed regulation.

3.2 Control Calibration

The WFD-3 controller is factory calibrated to produce 2300 rpm with an input of 10 volts. This is performed using a 100 line Tach and a permanent magnet 1/8 motor. No adjustment is required to operate different drive motors. However, there may be a need to check or recalibrate the WFD-3 for use with a different motor or motor speed range. To calibrate the WFD-3 perform the following steps:

Warning - The WFD-3 is a direct off-line controller. Do not use grounded instruments during calibration. 115 VAC is exposed on the PC Board. Only qualified personal should perform test or calibrations on the control.

- 1) Remove the cover from the WFD-3 controller. Connect a calibrated digital voltmeter to the speed reference signal on JP1-3 (-) and JP1-4 (+).
- 2) If encoder is installed on the drive motor connect a frequency counter to the encoder output JP1-7(+) and JP1-2(-). A 60-line tachometer will produce a direct readout of motor RPM. If a tach is not installed, use a hand tach to measure actual motor RPM.
- 3) Connect the WFD-3 to a suitable 115vac source. Make sure that the motor is free to rotate then power up the WFD-3 control.

- 4) Set the speed reference to 10.0 volts and adjust R4 (MAX) for 2300 (HZ or RPM) or desired motor speed. When using a Tachometer the maximum motor speed is 3000 RPM.
- 5) Disable the forward direction input. Turn the power off and reinstall the DMC cover.

4.0 MODBUS MEMORY MAP

4.1 General Description

This document provides the basic Modbus memory map and command structure for the WFD-3 RS-485 communications port. The WFD-3 supports the Modbus Protocol as specified in the Modicon Technical publications "Modbus Protocol" (intr7.html). The WFD-3 control does not support the Broadcast mode. The controller provides the slave side communications routines for the RTU mode. The user must define the Slave ID to a unique ID number from 1 – 247. Default Baud rate is 19.2 K baud - No Parity, One Stop bit. The default factory Device ID is set to 1. The device ID can be modified by the user by modifying the Device ID register. Depending on the Device ID range the following baud rate will be set. Device ID 1 – 31 the default baud rate is 19.2 K Baud, Device ID 32 – 63 the Baud rate is 115.2 K Baud, Device ID 64 – 127 the baud rate is 57.6 K Baud. Device ID 128 – 247 The Baud rate is 19.2 K Baud.

4.2 Supported Modbus Commands

The following ModBus commands are supported:

CODE	DESCRIPTION	ADDRESS RANGE
01	Read Coil Status	0-15
03	Read Holding Registers	0-19
05	Force Single Coil	0-15
06	Preset Single Register	0-19
15	Force Multiple Coils	0-15
16	Preset Multiple Registers	0-19
17	Report Slave ID	5 bytes

4.3 Memory Map for Coils (Modbus Command 01,05,15)

The following is the Coil definitions address 0-31:

COIL	ADDRESS	DESCRIPTION
1	0	INP1 – CW remote I/O input
2	1	INP2 – CCW Remote I/O Input
3	2	INP3 – Modbus CW Limit Switch Input
4	3	INP4 – Modbus CCW Limit Switch Input
5	4	Home Drive Input
6	5	Auto sequence Move to Position and Halt Input
7	6	Auto sequence Move Length and No Halt Input
8	7	Disable Remote I/O inputs
9	8	WFD-3 Ready Output (1=Ready, 0=Not Ready)
10	9	Motor Drive On (1= On)
11	10	Current Limit Output (1=Current Limit Active)
12	11	Auto Execute Complete (1= Auto Execute Complete)
13	12	Auto Routine Active (1 = Auto Execute Active)
14	13	Auto Execute Fault (1= Auto Execute Fault)
15	14	Save Default Configuration Input (1=Save)
16	15	Power Up Reset (1 = Power Up Reset has Occurred)

4.4 Coil Definitions and Operation

The WFD-3 has 16 simulated coils. These coils are used as internal bit flags to perform specific functions. The WFD-3 supports both single and group force coil commands. Refer to Section 4.3 for summary of the Coil functions.

4.5 Memory Map for Holding Register (Modbus Command 03, 06, 16)

The following is the Register definitions address 0-19:

REGISTER	ADDRESS	DESCRIPTION
1	0	Motor Speed in steps /msec. (1 - 62535)
2	1	Motor Armature Voltage (1 – 100.0)
3	2	Motor Current (0.0 – 100.0)
4	3	Max Speed Pot Setting (0 – 102.4%)
5	4	Not Used
6	5	Currents position in steps (1 – 62535)
7	6	Not Used
8	7	Move to Position in steps (1 – 62535)
9	8	Calculated Motor RPM (1 – 62535 RPM)
10	9	Auto Execute Move Motor Speed
11	10	Auto Execute Home Motor Speed
12	11	Not Used
13	12	Not Used
14	13	LOWSPD:CONFIG MSB = Min Speed: LSB = Enable Auto Drive Off low speed reference (1 = Enabled), Invert Motor Direction (2 = Invert), Enable Limit Testing in Remote mode (4=Limits Enabled) , Invert Encoder Direction (8 = Encoder Inverted) ,Disable User I/O (16 = I/O disabled), Invert Limit Switch Inputs (32 = Limits Inverted). Note: CONFIG LSB is a bit defined input only Bits 0-5 are defined
15	14	Encoder Scale in PPR used to calculate Motor RPM
16	15	Node:Iref MSB=DevID(1-247): LSB = Max Motor Amp
17	16	EMF Kd:Kp (DO NOT MODIFY) WARNING: Changing this value may result in a catastrophic failure of the controller
18	17	TACK Kd:Kp (DO NOT MODIFY) WARNING: Changing this value may result in a catastrophic failure of the controller
19	18	PWMHZ:Accel (DO NOT MODIFY) WARNING: Changing this value may result in a catastrophic failure of the controller
20	19	Max Encoder frequency (in Hz)

4.6 Holding Register and Operation

The WFD-3 has 20 Holding Register. These Holding registers are used as unsigned integers to perform specific control functions. Only 1-4, 6, 8, 10 and 10 of the Holding Registers are used. Setting the Registers 4, 6, 11-12 will not have any effect on the WFD-3 controller. However, they are reserved for future expansion. Holding Reg 13 is used a Bit defined register that enables specific modes or control configuration. Holding Registers 14 – 20 are used to configure the WFD-3 control for a specific motor consult factory before modifying these register The WFD-3 supports both single and multiple read/write function commands. Refer to Section 4.5 for summary of the Register functions. Under normal conditions, do not write to Register 14 - 20. **WARNING:**

Modifying the Holding Register[14 – 20] values may result in a catastrophic failure of the controller

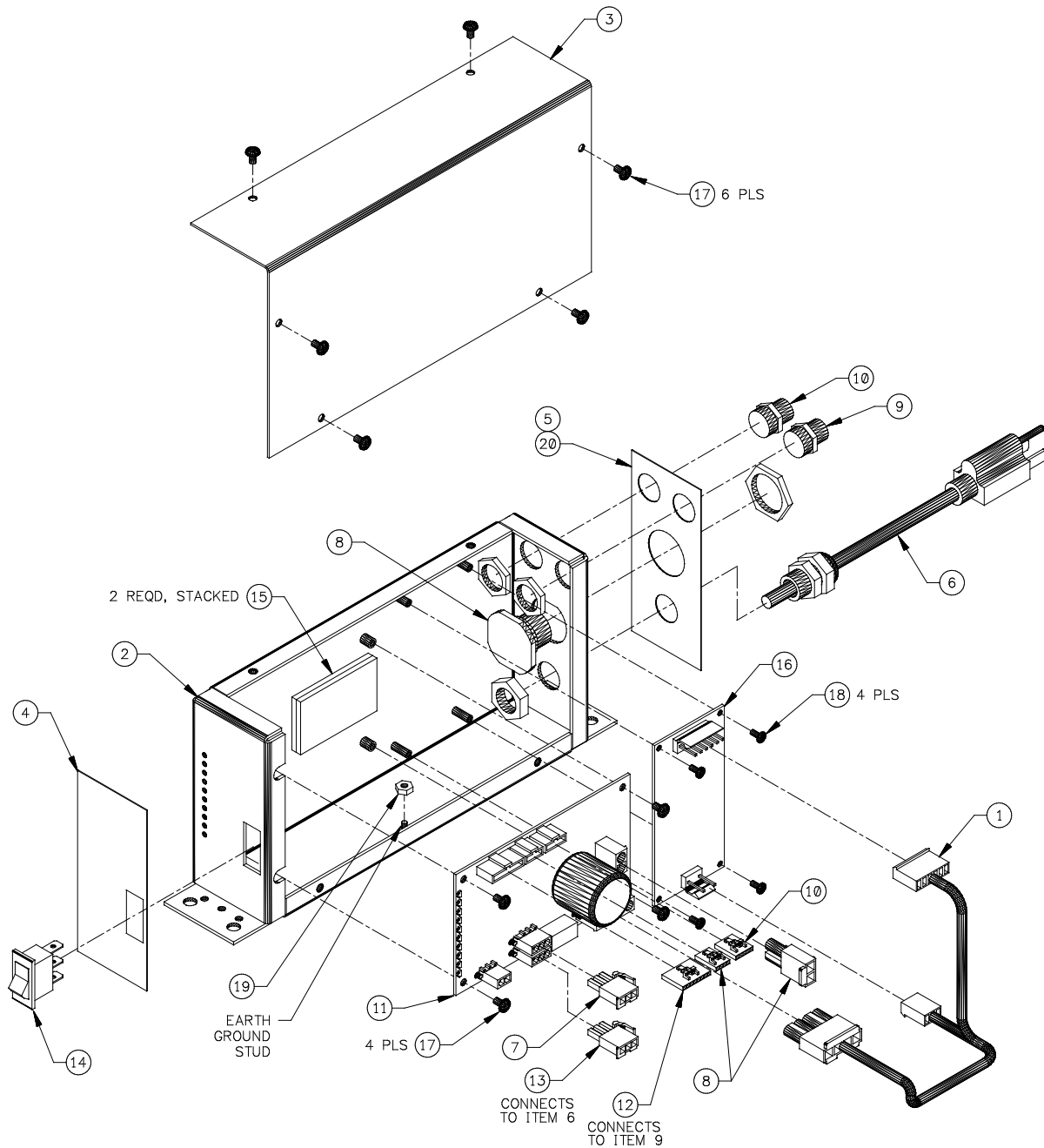
4.7 Memory Map for Slave ID (Modbus Command 17)

The following is a summary of the Report Slave ID and Status (Code 17) Response Data fields:

Byte	Contents
1	Sensor ID Number =10 Hex (Version 1, Rev0)
2	Run Indicator (0=OFF, FF=On)
3	Status Byte Bit 0 = Ram Full Bit 1 = Battery Ok Bit 2 = Self Test Ok Bit 3-7 = 0
4	Firmware Version Number – BCD Format (MSB = Major: ISB = Minor)
5	Firmware Version Number – BCD Format (MSB+LSB = Release)

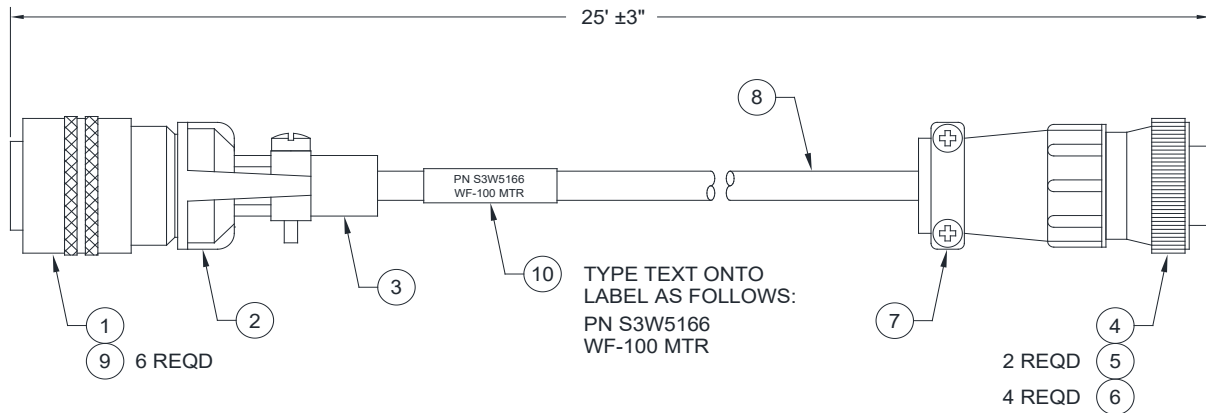
APPENDIX A SYSTEM DRAWINGS

A.1 WFD-3 Enclosure Assembly 110VAC - P/N: S3A5233



ITEM	QTY	PART NO	DESCRIPTION
1	1	S3W5216	Harness, Power Supply
2	1	S3E5165	Enclosure
3	1	S3E5166	Cover
4	1	S3E5198	Overlay, Front
5	1	S3E5111	Overlay, Rear
6	1	S3W5159	Cable, 110VAC Power
7	1	S3W5160	Harness, Power Switch
8	1	S3W5162	Harness, Motor/Encoder
9	1	S3W5163	Harness, I/O
10	1	S3W5164	Harness, Comm
11	1	S5A5076	PCB Assembly, DMC-2 36V Drive
12	1	X3P5841	Connector, Housing 8 Circuit
13	1	X3P5875	Connector, Housing 3 Circuit
14	1	X3S5078	Switch, Rocker
15	1	X3T5096	Supply, Power AC-DC 28VDC 120W
16	2	S2M5212	Pad, Thermal
17	10		Screw, #6-32 x 1/4" Pan Head w/ Internal Lock Washer
18	4		Screw, #4-40 x 1/4" Pan Head w/ Internal Lock Washer
19	1		Nut, Hex #4-40
20	1		Label, Serial Number

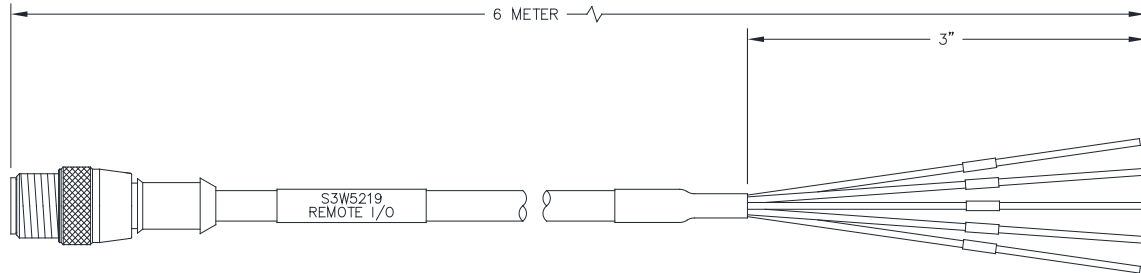
A.2 Capstan Wire Feeder Motor Cable – P/N: S3W5166



ITEM	QTY	PART NO	DESCRIPTION
1	1	X3P5586	CONN., PLUG 9 CIRCUIT - BENDIX #PT06A-14-12P
2	1	X3P5589	CLAMP, CABLE - AMPHENOL #97-3057-1008
3	1	X3P5505	BOOT, CABLE CLAMP - AMPHENOL #9779-513-8
4	1	X3P5142	CONN., PLUG 9 CIRCUIT - AMP #206708-1
5	2	X3P0302	SOCKET, 14-18 GAUGE - AMP #66601-1
6	4	X3P0303	SOCKET, 20-24 GAUGE - AMP #66105-2
7	1	X3Z5060	CLAMP, CABLE - AMP #206966-1
8	25'	X3W5020	CABLE, 2x18 AWG, 4x22 AWG - BELDEN #8446
9	6		TUBING, HEAT SHRINK Ø3/16" X 1/2" LONG
10	1		SLEEVE, WIRE

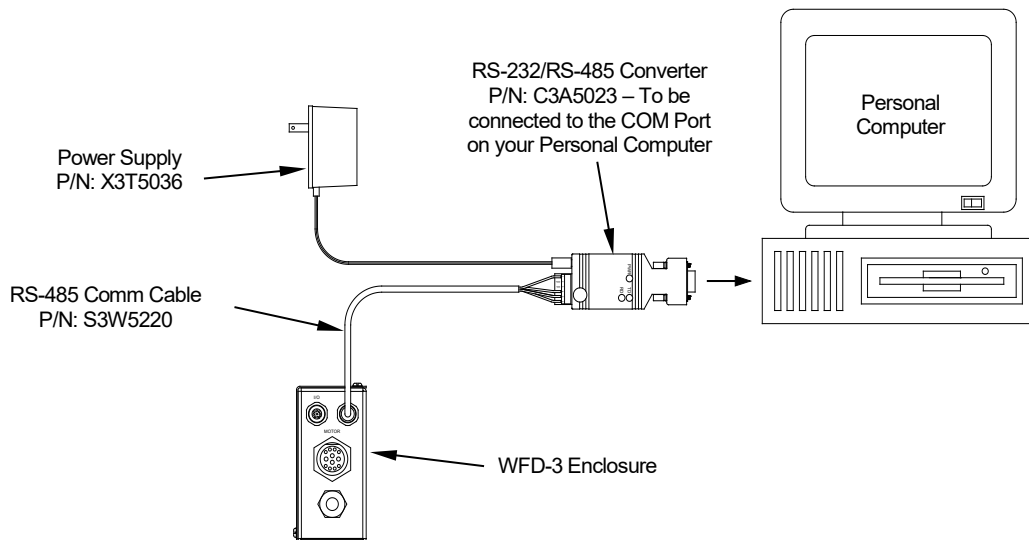
WIRE COLOR	GAUGE	FROM	TO	DESCRIPTION
WHITE	18	ITEM 1 PIN M	ITEM 4 PIN 1	ARM +
BLACK	18	ITEM 1 PIN K	ITEM 4 PIN 3	ARM -
RED	22	ITEM 1 PIN B	ITEM 4 PIN 7	ENCODER +5
BLUE	22	ITEM 1 PIN G	ITEM 4 PIN 8	ENCODER
BROWN	22	ITEM 1 PIN H	ITEM 4 PIN 9	ENCODER COM
GREEN	22	ITEM 1 PIN F	NOT CONNECTED	EARTH GROUND

A.3 Open Ended Remote I/O Cable – P/N: S3W5219

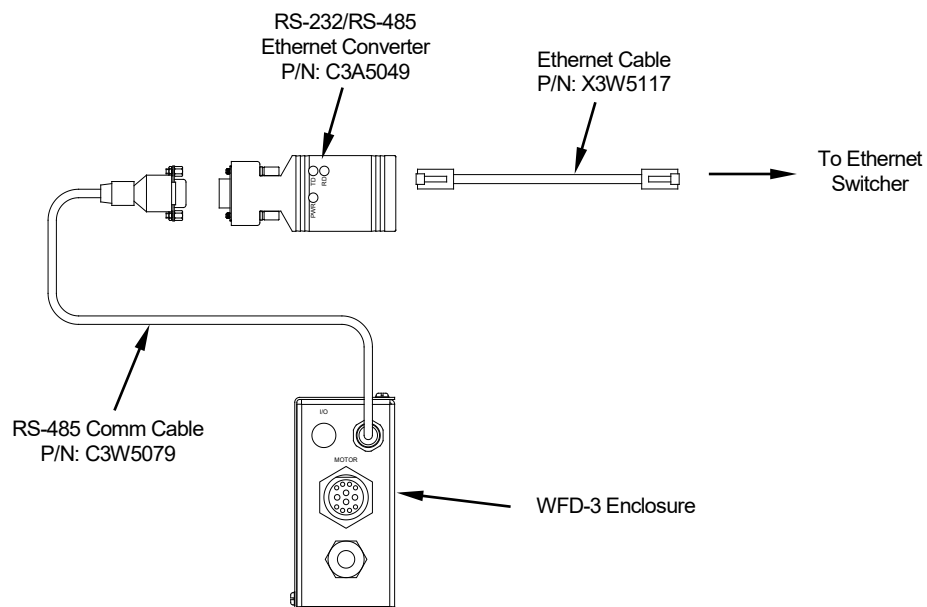


DESCRIPTION	WIRE TYPE	CONNECTOR
CW	WHITE	PIN 1
+24 I/O	BROWN	PIN 2
CCW	GREEN	PIN 3
DRVON	YELLOW	PIN 4
RDY	GRAY	PIN 5
REF+	PINK	PIN 6
I/O COM	BLUE	PIN 7
WIPER	RED	PIN 8

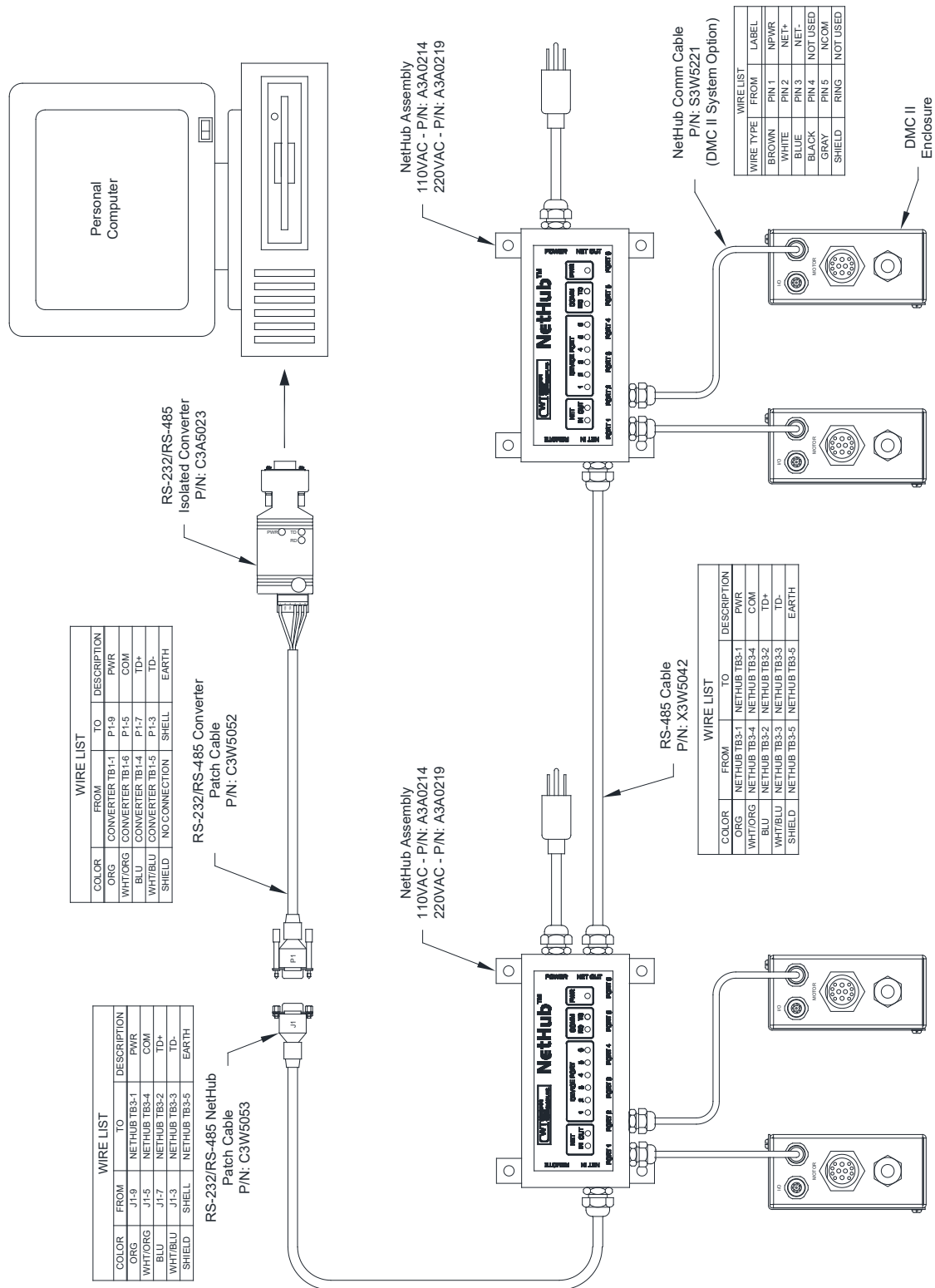
A.4 Communication Diagrams



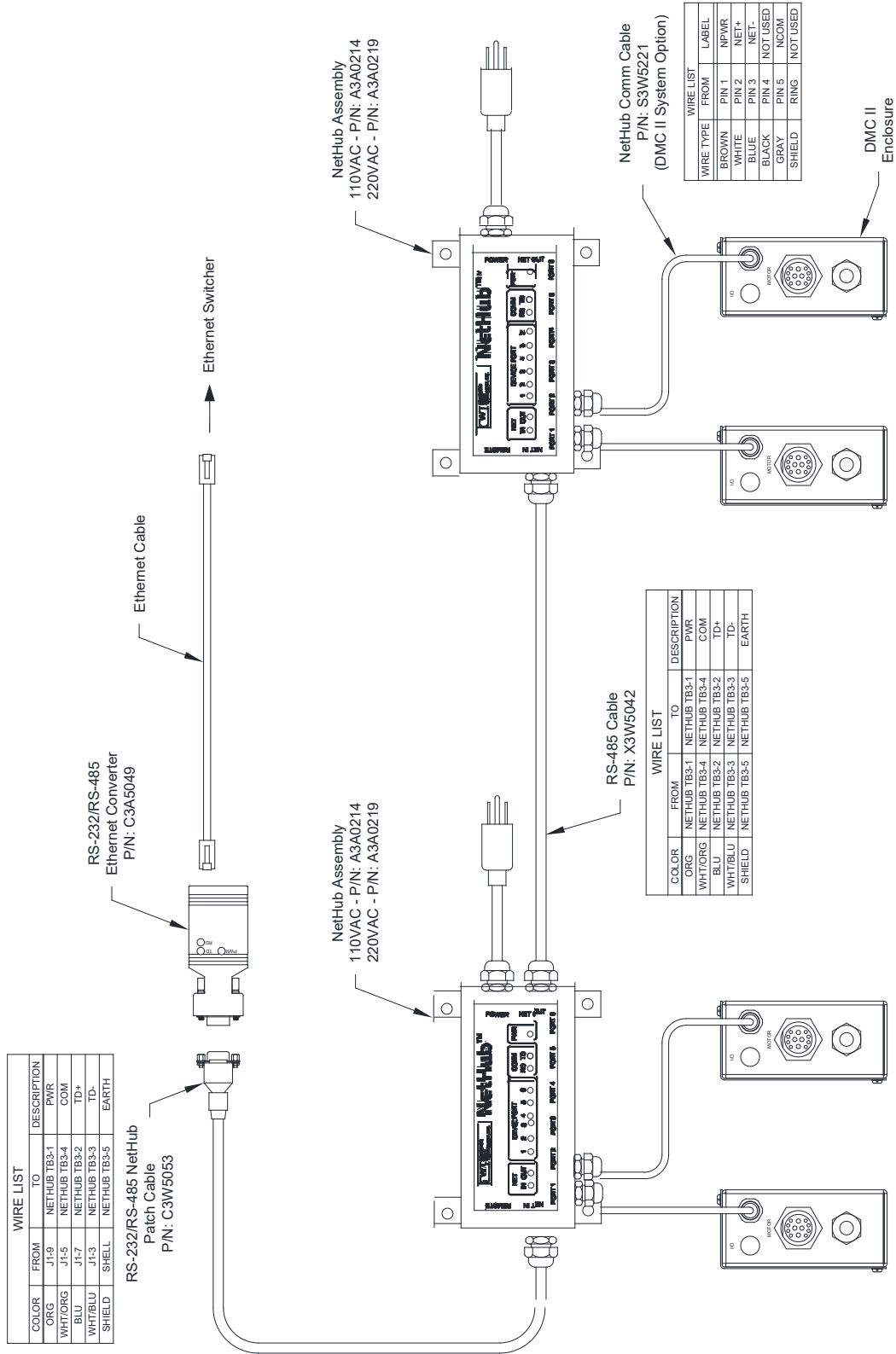
Single WFD-3 Enclosure to a RS-232/RS-485 Converter Diagram



Single WFD-3 Enclosure to an RS-485 to Ethernet Converter Diagram



Multiple WFD-3 Enclosures to a NetHub with RS-232/RS-485 Communications Diagram



Multiple WFD-3 Enclosure to a NetHub with Ethernet Communications Diagram

WARNING	<ul style="list-style-type: none"> Do not touch electrically live parts or electrode with skin or wet clothing. Insulate yourself from work and ground. 	<ul style="list-style-type: none"> Keep flammable materials away. 	<ul style="list-style-type: none"> Wear eye, ear and body protection.
Spanish AVISO DE PRECAUCION	<ul style="list-style-type: none"> No toque las partes o los electrodos bajo carga con la piel o ropa mojada. Aíslese del trabajo y de la tierra. 	<ul style="list-style-type: none"> Mantenga el material combustible fuera del área de trabajo. 	<ul style="list-style-type: none"> Protéjase los ojos, los oídos y el cuerpo.
French ATTENTION	<ul style="list-style-type: none"> Ne laissez ni la peau ni des vêtements mouillés entrer en contact avec des pièces sous tension. Isolez-vous du travail et de la terre. 	<ul style="list-style-type: none"> Gardez à l'écart de tout matériel inflammable. 	<ul style="list-style-type: none"> Protégez vos yeux, vos oreilles et votre corps.
German WARNUNG	<ul style="list-style-type: none"> Berühren Sie keine stromführenden Teile oder Elektroden mit Ihrem Körper oder feuchter Kleidung! Isolieren Sie sich von den Elektroden und dem Erdboden! 	<ul style="list-style-type: none"> Entfernen Sie brennbares Material! 	<ul style="list-style-type: none"> Tragen Sie Augen-, Ohren- und Körperschutz!
Portuguese ATENÇÃO	<ul style="list-style-type: none"> Não toque partes elétricas e electrodos com a pele ou roupa molhada. Isole-se da peça e terra. 	<ul style="list-style-type: none"> Mantenha inflamáveis bem guardados. 	<ul style="list-style-type: none"> Use proteção para a vista, ouvido e corpo.
Japanese 注意事項	<ul style="list-style-type: none"> 通電中の電気部品、又は溶材にヒフやぬれた布で触れないこと。 施工物やアースから身体が絶縁されている様にして下さい。 	<ul style="list-style-type: none"> 燃えやすいものの側での溶接作業は絶対にしてはなりません。 	<ul style="list-style-type: none"> 目、耳及び身体に保護具をして下さい。
Chinese 警告	<ul style="list-style-type: none"> 皮肤或湿衣物切勿接触带电部件及焊条。 使你自己与地面和工件绝缘。 	<ul style="list-style-type: none"> 把一切易燃物品移离工作场所。 	<ul style="list-style-type: none"> 佩戴眼、耳及身体劳动保护用具。
Korean 위험	<ul style="list-style-type: none"> 전도체나 용접봉을 젖은 형갑 또는 피부로 절대 접촉치 마십시오. 모재와 접지를 접촉치 마십시오. 	<ul style="list-style-type: none"> 인화성 물질을 접근시키지 마십시오. 	<ul style="list-style-type: none"> 눈, 귀와 몸에 보호장구를 착용하십시오.
Arabic تحذير	<ul style="list-style-type: none"> لا تلمس الاجزاء التي يسري فيها التيار الكهربائي أو الألكترود بجسد الجسم أو بالملابس المبللة بالماء. ضع عازلا على جسمك خلال العمل. 	<ul style="list-style-type: none"> ضع المواد القابلة للاشتعال في مكان بعيد. 	<ul style="list-style-type: none"> ضع أدوات وملابس واقية على عينيك وأذنيك وجسمك.

READ AND UNDERSTAND THE MANUFACTURER'S INSTRUCTION FOR THIS EQUIPMENT AND THE CONSUMABLES TO BE USED AND FOLLOW YOUR EMPLOYER'S SAFETY PRACTICES.

SE RECOMIENDA LEER Y ENTENDER LAS INSTRUCCIONES DEL FABRICANTE PARA EL USO DE ESTE EQUIPO Y LOS CONSUMIBLES QUE VA A UTILIZAR, SIGA LAS MEDIDAS DE SEGURIDAD DE SU SUPERVISOR.

LISEZ ET COMPRENEZ LES INSTRUCTIONS DU FABRICANT EN CE QUI REGARDE CET EQUIPMENT ET LES PRODUITS A ETRE EMPLOYES ET SUIVEZ LES PROCEDURES DE SECURITE DE VOTRE EMPLOYEUR.

LESEN SIE UND BEFOLGEN SIE DIE BETRIEBSANLEITUNG DER ANLAGE UND DEN ELEKTRODENEINSATZ DES HERSTELLERS. DIE UNFALLVERHÜTUNGSVORSCHRIFTEN DES ARBEITGEBERS SIND EBENFALLS ZU BEACHTEN.

			
<ul style="list-style-type: none"> ● Keep your head out of fumes. ● Use ventilation or exhaust to remove fumes from breathing zone. 	<ul style="list-style-type: none"> ● Turn power off before servicing. 	<ul style="list-style-type: none"> ● Do not operate with panel open or guards off. 	WARNING
<ul style="list-style-type: none"> ● Los humos fuera de la zona de respiración. ● Mantenga la cabeza fuera de los humos. Utilice ventilación o aspiración para gases. 	<ul style="list-style-type: none"> ● Desconectar el cable de alimentación de poder de la máquina antes de iniciar cualquier servicio. 	<ul style="list-style-type: none"> ● No operar con panel abierto o guardas quitadas. 	Spanish AVISO DE PRECAUCION
<ul style="list-style-type: none"> ● Gardez la tête à l'écart des fumées. ● Utilisez un ventilateur ou un aspirateur pour ôter les fumées des zones de travail. 	<ul style="list-style-type: none"> ● Débranchez le courant avant l'entretien. 	<ul style="list-style-type: none"> ● N'opérez pas avec les panneaux ouverts ou avec les dispositifs de protection enlevés. 	French ATTENTION
<ul style="list-style-type: none"> ● Vermeiden Sie das Einatmen von Schweißrauch! ● Sorgen Sie für gute Be- und Entlüftung des Arbeitsplatzes! 	<ul style="list-style-type: none"> ● Strom vor Wartungsarbeiten abschalten! (Netzstrom völlig öffnen; Maschine anhalten!) 	<ul style="list-style-type: none"> ● Anlage nie ohne Schutzgehäuse oder Innenschutzverkleidung in Betrieb setzen! 	German WARNUNG
<ul style="list-style-type: none"> ● Mantenha seu rosto da fumaça. ● Use ventilação e exaustão para remover fumo da zona respiratória. 	<ul style="list-style-type: none"> ● Não opere com as tampas removidas. ● Desligue a corrente antes de fazer serviço. ● Não toque as partes elétricas nuas. 	<ul style="list-style-type: none"> ● Mantenha-se afastado das partes moventes. ● Não opere com os painéis abertos ou guardas removidas. 	Portuguese ATENÇÃO
<ul style="list-style-type: none"> ● ヒュームから頭を離すようにして下さい。 ● 換気や排煙に十分留意して下さい。 	<ul style="list-style-type: none"> ● メンテナンス・サービスに取りかかる際には、まず電源スイッチを必ず切して下さい。 	<ul style="list-style-type: none"> ● パネルやカバーを取り外したまま機械操作をしないで下さい。 	Japanese 注意事項
<ul style="list-style-type: none"> ● 頭部遠離煙霧。 ● 在呼吸區使用通風或排風器除煙。 	<ul style="list-style-type: none"> ● 維修前切斷電源。 	<ul style="list-style-type: none"> ● 儀表板打開或沒有安全罩時不準作業。 	Chinese 警告
<ul style="list-style-type: none"> ● 얼굴로부터 용접가스를 멀리하십시오. ● 호흡지역으로부터 용접가스를 제거하기 위해 가스제거기나 통풍기를 사용하십시오. 	<ul style="list-style-type: none"> ● 보수전에 전원을 차단하십시오. 	<ul style="list-style-type: none"> ● 판넬이 열린 상태로 작동치 마십시오. 	Korean 위험
<ul style="list-style-type: none"> ● ابعد رأسك بعيداً عن الدخان. ● استعمل التهوية أو جهاز ضغط الدخان للخارج لكي تبعد الدخان عن المنطقة التي تتنفس فيها. 	<ul style="list-style-type: none"> ● اقطع التيار الكهربائي قبل القيام بأية صيانة. 	<ul style="list-style-type: none"> ● لا تشغيل هذا الجهاز اذا كانت الاغطية الحديدية الواقية ليست عليه. 	Arabic تحذير

LEIA E COMPREENDA AS INSTRUÇÕES DO FABRICANTE PARA ESTE EQUIPAMENTO E AS PARTES DE USO, E SIGA AS PRÁTICAS DE SEGURANÇA DO EMPREGADOR.

使う機械や溶材のメーカーの指示書をよく読み、まず理解して下さい。そして貴社の安全規定に従って下さい。

請詳細閱讀並理解製造廠提供的說明以及應該使用的銀焊材料，並請遵守貴方的有關勞動保護規定。

이 제품에 동봉된 작업지침서를 숙지하시고 귀사의 작업자 안전수칙을 준수하시기 바랍니다.

اقرأ بتمعن وافهم تعليمات المصنع المنتج لهذه المعدات والمواد قبل استعمالها واتبع تعليمات الوقاية لصاحب العمل.

CUSTOMER ASSISTANCE POLICY

The business of The Lincoln Electric Company is manufacturing and selling high quality welding equipment, consumables, and cutting equipment. Our challenge is to meet the needs of our customers and to exceed their expectations. On occasion, purchasers may ask Lincoln Electric for advice or information about their use of our products. We respond to our customers based on the best information in our possession at that time. Lincoln Electric is not in a position to warrant or guarantee such advice, and assumes no liability, with respect to such information or advice. We expressly disclaim any warranty of any kind, including any warranty of fitness for any customer's particular purpose, with respect to such information or advice. As a matter of practical consideration, we also cannot assume any responsibility for updating or correcting any such information or advice once it has been given, nor does the provision of information or advice create, expand or alter any warranty with respect to the sale of our products.

Lincoln Electric is a responsive manufacturer, but the selection and use of specific products sold by Lincoln Electric is solely within the control of, and remains the sole responsibility of the customer. Many variables beyond the control of Lincoln Electric affect the results obtained in applying these types of fabrication methods and service requirements.

Subject to Change – This information is accurate to the best of our knowledge at the time of printing. Please refer to www.lincolnelectric.com for any updated information.



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