LINCOLN ELECTRIC®
*THE WELDING EXPERTS*sm

DIGITAL COMMUNICATIONS TECHNOLOGY

Digital Communications
*Improves Productivity, Quality and Safety*

Technology has pushed us into the digital era. From video cameras to phones, "digital" is replacing "analog". Why?

Digital Communications allow for faster, more dependable, more economical equipment performance. Historically, welding system performance has been limited by the analog circuitry that controlled it. Analog signals can only be transmitted over limited distances, as the signals attenuate or "die out" over longer distances, compromising data integrity and limiting the cable distances between welding system components.

Digital Communications promote faster signal transfer, while preserving data integrity and simplifying wiring. A digital protocol also provides a scalable framework for future upgrades, which allows engineering changes to be made through software upgrades instead of module replacements. Digital Communications speed up data transfer rate and minimize delay, enhancing welder performance.
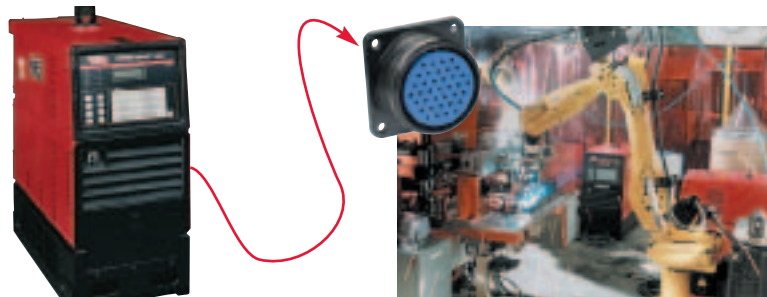
The Power Wave 450 was an analog welding system. New welding features required additional wiring and calibration between the robot and power source. Weld process controls were found on both the welding power source and at the robot controller.
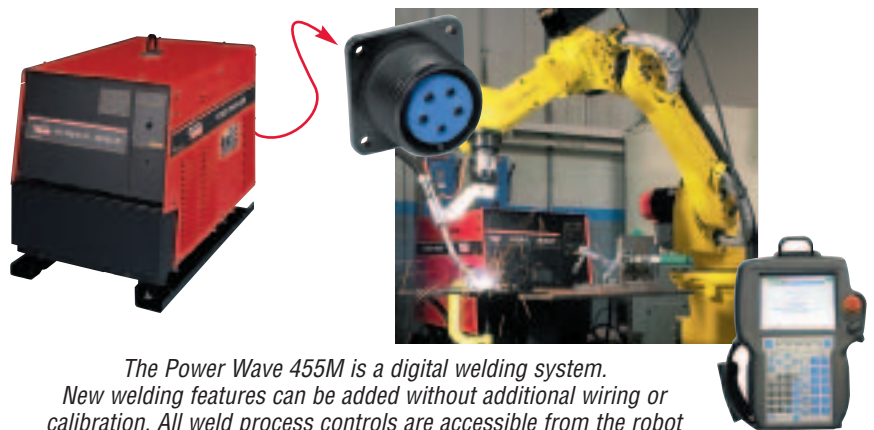
The Power Wave 455M is a digital welding system. New welding features can be added without additional wiring or calibration. All weld process controls are accessible from the robot teach pendant or hard automation control interface.

advantages

SPEED OF PERFORMANCE
Delays are reduced, allowing more data to be transferred in less time.

FLEXIBILITY/SCALABILITY
New features can be added to existing equipment through software upgrades, and new components can easily be added to an existing welding cell.

COST REDUCTION
A single cable between multiple devices is less expensive and more efficient.

SIMPLIFIED EQUIPMENT MAINTENANCE
Calibration between the power source and robot is not necessary, even after features are added to an existing system.

PROCESS CONTROLS
All weld process controls are accessible from a single user interface control panel.

PRODUCTION MONITORING
High-speed communications enable the use of software tools to track equipment usage and condition, allow configuration of limits and responses after each weld, and provide storage of thousands of weld summaries.
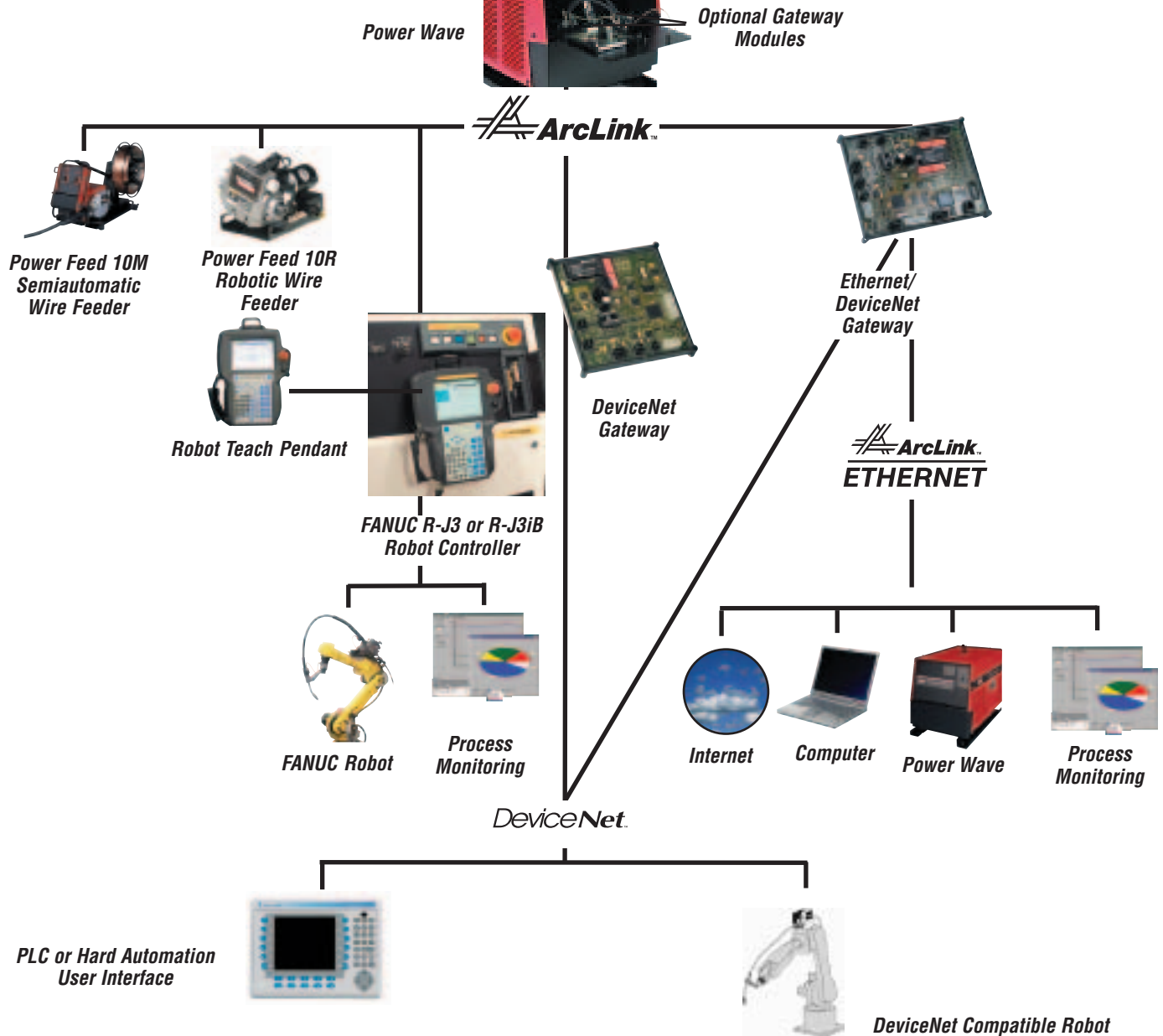
LINCOLN ELECTRIC
NEXTWELD®

Seamless Integration

The Power Wave Welding Systems are used in semiautomatic, hard automation, and in robotic applications. In addition, a number of useful Lincoln Electric developed PC tools, ranging from diagnostics to advanced production monitoring are available for use on these systems.

Lincoln Electric uses a digital communications system called ArcLink™ in all of its Power Wave Welding Systems. ArcLink was specifically designed for the arc welding environment and is the best method of communicating to cell components such as semiautomatic wire feeders or robots. ArcLink is simply the way each piece "talks" to each other in a Power Wave system. The Power Wave Welding Systems also provide "gateways" to allow other digital networks such as DeviceNet™ and Ethernet to connect to the ArcLink system.

This Nextweld Digital Communications document explains the ArcLink, DeviceNet, and Ethernet communications protocols as well as assists in defining which is the best fit for your applications.

Power Wave

Optional Gateway Modules

ArcLink™

Power Feed 10M Semiautomatic Wire Feeder

Power Feed 10R Robotic Wire Feeder

Robot Teach Pendant

FANUC R-J3 or R-J3iB Robot Controller

DeviceNet Gateway

Ethernet/ DeviceNet Gateway

ArcLink™ ETHERNET

FANUC Robot

Process Monitoring

Internet

Computer

Power Wave

Process Monitoring

DeviceNet

PLC or Hard Automation User Interface

DeviceNet Compatible Robot

Which Communications Protocol do I Need?

Use ArcLink

For These Applications

Semiautomatic Welding

The new series of Power Feed 10M and Power Feed 25M semiautomatic wire feeders support ArcLink Digital Communications.

Robotic Welding

Robots compatible with ArcLink protocol offer "Best-in-Class" performance through:

- A robot teach pendant that
    - provides access to all of the Power Wave features.
    - eliminates the need for a user panel on the power source.
    - provides detailed power source fault/alarm information.
    - enables searches of the procedures that are programmed in the power source.
- The ability to switch dynamically among 8 different welding schedules while welding.
- An arc start response time of 5 - 10 msec or less.
- Touch-sensing performance that is available with no additional hardware. Touch-sensing enables search speeds of 100 mm/sec with 0.045 (1.2 mm) steel wire.
- Full support of Lincoln diagnostic packages through R-J3iB Ethernet port.
- FANUC Through the Arc Seam Tracking (T.A.S.T.) performance, which is available with no additional hardware to provide updates of actual weld current and voltages at 250 Hz for improved seam tracking performance.

ArcLink Compatible Robot Controllers

FANUC R-J3 and R-J3iB

Use DeviceNet

For These Applications

Hard Automation Welding

Power Wave Welding Systems combined with the DeviceNet or Ethernet/DeviceNet Gateway will support any DeviceNet Programmable Logic Controllers (PLC).

Robotic Welding

For robots not compatible with ArcLink protocol, or for customers who simply prefer to integrate with DeviceNet, this protocol offers good performance and access to most power source features through the robot teach pendant. DeviceNet robots provide the ability to switch dynamically between 2 different welding schedules while welding.

DeviceNet compatible Robot Controllers

- FANUC RJ3 and R-J3iB
- ABB, Motoman, and others

DeviceNet Gateway

Use Ethernet

For These Applications

Production Monitoring and Advanced Diagnostics

These functions are available through the Ethernet port of the FANUC R-J3iB robot controller, or through the Ethernet/DeviceNet Gateway Board of DeviceNet equipment.

Ethernet/DeviceNet Gateway

What
Is ArcLink?

ArcLink is the leading digital communications protocol for the arc welding industry. It integrates all welding components for seamless, time-critical data transfer. The strength of ArcLink lies in the ability to communicate with each system component in a pre-defined welding language. In addition, ArcLink is an open communications protocol, meaning that Lincoln Electric publishes how it works and encourages other companies to adopt it.
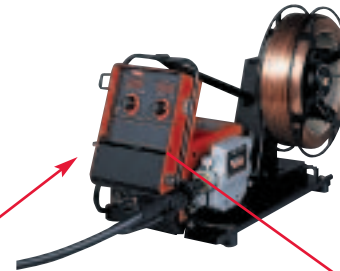
ArcLink brings modularity to welding systems and provides a single, intelligent connection between all modules. An ArcLink network can be as simple as a single stick welder or as complicated as robotic installations.

The ArcLink Protocol

ArcLink provides flexible welding options for both robotic and semiautomatic applications.

Because of ArcLink, access to limit configurations, backup & restore of settings and monitoring of arc time can now travel with you on a hand-held computer.

Semiautomatic Power Feed 10M

Power Wave 455M

Palm™ w/ Weld Manager

Robotic Power Feed 10R

The ArcLink communications protocol serves two purposes: as the native device language in Lincoln Electric welding system components, and as the interface for robotic welding applications. ArcLink also allows for networking capabilities through gateways (such as Ethernet) to allow simultaneous monitoring of multiple welding cells, which establishes a means for developing supervisory or monitoring tools.
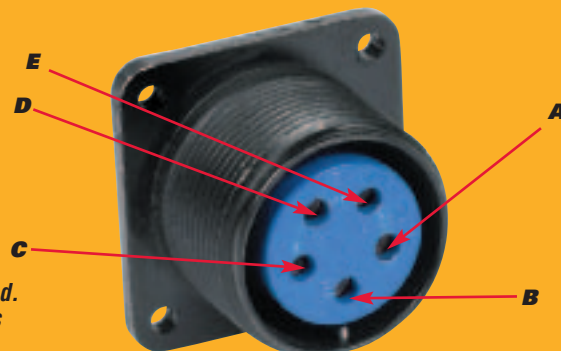
How
ArcLink Works

ArcLink uses peer-to-peer, event-driven messaging, which broadcasts on an "as-needed" basis. Peer-to-peer messaging frees space on the data highway, reducing message traffic. Because ArcLink logic is based on a Controller Area Network (CANIIB) standard, it inherits the benefits of priority-based, deterministic messaging and noise immunity. This means that critical messages are guaranteed to reach their destination with minimum delay, even in the presence of electrical noise. The ArcLink cable houses five conductors as depicted below.

Leads D and E are dedicated power leads supplying 40 VDC, enough power to run the wire feeder drive motor. This eliminates the need for a separate wire feeder power cable.

Leads A and B are dedicated to communications. They carry CANIIB messages between welding system components.

Lead C serves as the voltage sensory lead. Lincoln Electric digital welding machines supply this lead within the ArcLink cable. Certain applications may require an additional voltage sense lead.

5-pin ArcLink Connector

ArcLink™ Communications

Using ArcLink

Robotic Integration Application

ArcLink greatly improves the integration of the arc welding process into automated arc welding systems, as the advanced features of ArcLink provide process changing (between 8 weld schedules), file transfer, data acquisition, and component fault history capabilities.

Semiautomatic Application

ArcLink is used in semiautomatic applications as the method of communication internal to each welding component. ArcLink provides many of the same benefits to semiautomatic applications as it does to robotics, such as:

• data monitoring
• access to all weld process controls from a single user interface
• ability to boom-mount user interfaces

ArcLink Specifications

• 5-conductor SO-type control cable with 5-pin connectors for all interconnections
• Isolated 40 VDC power supply
• Multiple-sourced transceiver
• Data rate of 125-500 Kbaud

Features

Of ArcLink

File Transfer

• Weld files can be saved, shared, or modified.

Data Acquisition

• Weld data is collected and stored for Production Monitoring™ purposes.

Advanced Diagnostics

• ArcLink provides the capability to monitor component failures system wide.

Ease of Installation

• Uses one control cable for communications, component power, and electrode voltage sensing connections.
• Provides flexibility of physical configuration so that any component may be connected to any other component in the system.

Benefits

Of Using ArcLink

Modular System Configuration

• Allows for creation of custom welding system configurations.
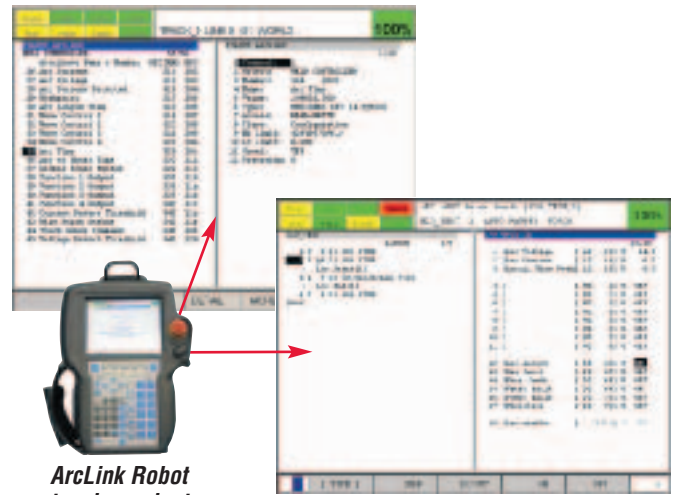
Rugged Hardware

• Establishes a high degree of tolerance for electrically noisy welding environments.

Scalable System

• Permits addition of new features and functionality without changing the existing cabling.

Power Wave F355i/FANUC RJ3iB is an example of an ArcLink Robotic Welding System

ArcLink Robot teach pendant

ArcLink Robotic systems allow weld mode searches by process and wire type through the robot teach pendant.

Performance

• Provides a repeatable and reliable method of communication for time-critical welding applications.
• Improves welding performance by increasing the amount of shared information between welding system components.

ArcLink Performance Metrics

Criteria	Performance (compared to Analog)
Arc start/end times	50-80 % reduction
Latency	More deterministic
Process switching time	80 % reduction
Part search (through the wire) speeds	100 % faster
Arc current, voltage, and wire feed speed telemetry	500 % faster, for arc seam tracking

DeviceNet™ Communications

What
is DeviceNet?

DeviceNet is a communications protocol widely used throughout the automotive, semiconductor, and packaging industries.

In its typical application, DeviceNet works in conjunction with a Programmable Logic Controller (PLC) and several system devices to provide a framework for data trafficking and monitoring.

Strong conformance testing ensures interoperability among DeviceNet products. As a result, users can mix and match products from a variety of suppliers and integrate them seamlessly.
Due to its widespread popularity and its ability to interchange equipment with several vendors, Lincoln Electric employs DeviceNet for hard cell automation and non-ArcLink compatible robotic applications. Lincoln Electric Power Wave 455M and 655R have been tested and found to comply with ODVA Protocol Conformance Test Version A-13.

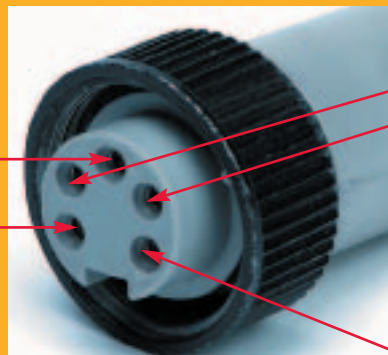## The DeviceNet Protocol

Example of a DeviceNet welding system

DeviceNet Gateway

How
DeviceNet Works

DeviceNet connectivity is established through a DeviceNet Gateway. DeviceNet carries data from the components of the welding systems (slaves) to a Programmable Logic Controller (master). DeviceNet performs deterministic messaging, so that all messages are assigned priorities, preventing interference or destruction of important data. The DeviceNet connector houses five conductors, as depicted below. Because it only carries 24 VDC, an additional cable is required to power the wire feeder drive motor. Additionally, this cable does not contain a voltage sensing lead.

Leads 2 and 4 are dedicated to communications. They carry DeviceNet messages to and from welding system components.

Lead 3 is a grounding shield

Lead 5 is a dedicated power lead supplying 24 VDC

Lead 1 is a dedicated power lead supplying 24 VDC

5-pin DeviceNet Connector

DeviceNet™ Communications

Using
DeviceNet

Robotic and Hard Automation Applications

The Lincoln Electric ArcLink protocol paired with DeviceNet gateway board and a PLC provide the ultimate answer to hard-cell automated welding. Lincoln Electric also employs DeviceNet in specific robotic welding applications. The Power Wave 455M and Power Wave 655 Robotic connect seamlessly to robot controllers and hard automation PLCs.

DeviceNet Specifications

· 24 VDC power
· 5-conductor shielded PVC control cable
· Single-sourced transceiver
· Opto-isolator optional
· Data rate of 125-500 Kbaud

Features
Of DeviceNet Gateway

Configuration Software

· Programs the master/slave relationship between the PLC and the welding system components.
· Sets the scan rate for the polled input/output.
· Allows configuration of basic system parameters.
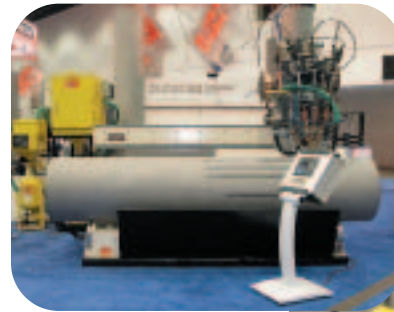
User Interface Software

· Provides the user access to all welding process controls.
· Provides ability to search the weld database.

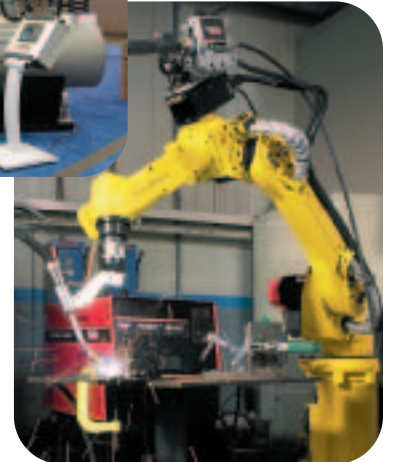### Open DeviceNet Vendors Association (ODVA) Compliance

· Lincoln Power Wave 455M and 655 Robotic have been tested and found to comply with ODVA Protocol Conformance Test Version A-13.
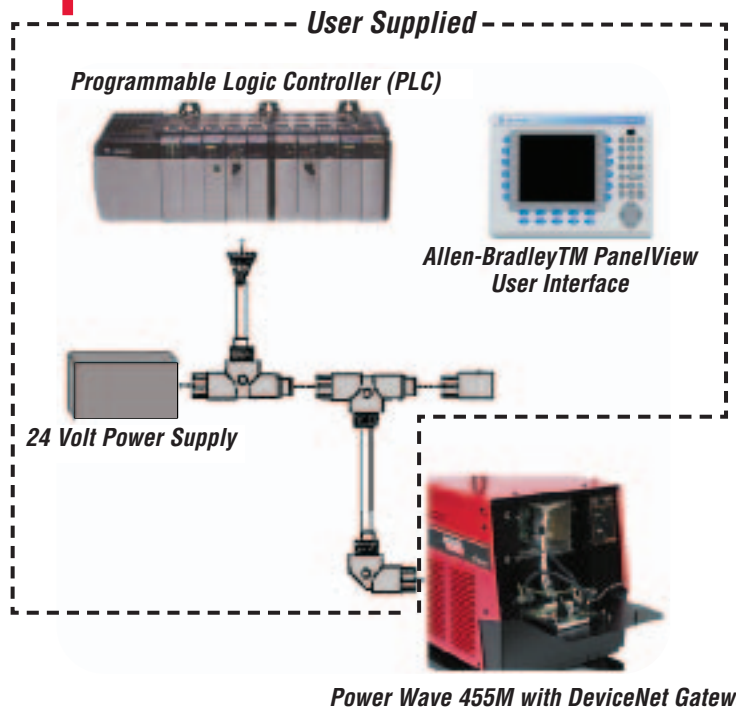

Hard Automation

Robotic

Benefits
Of Using DeviceNet

Interchangeable

· Due to the open construction of the protocol, multiple vendors' equipment can be used for replacements.

User Supplied

Programmable Logic Controller (PLC)

Allen-BradleyTM PanelView User Interface

24 Volt Power Supply

Power Wave 455M with DeviceNet Gateway

Power Wave 455M with optional DeviceNet Gateway

A Typical DeviceNet Welding System Configuration

What
Is Ethernet?

Ethernet is the networking champion for information-layer communications.

Ethernet has been a networking standard for decades, which translates to readily available equipment and an expansive knowledge base.

The data rate at which an Ethernet network operates provides the ability to pull large amounts of information into monitoring and supervisory applications. Ethernet can be networked over great distances and has the ability to distribute information to Local or Wide Area Networks (LAN or WAN)

The Ethernet Protocol

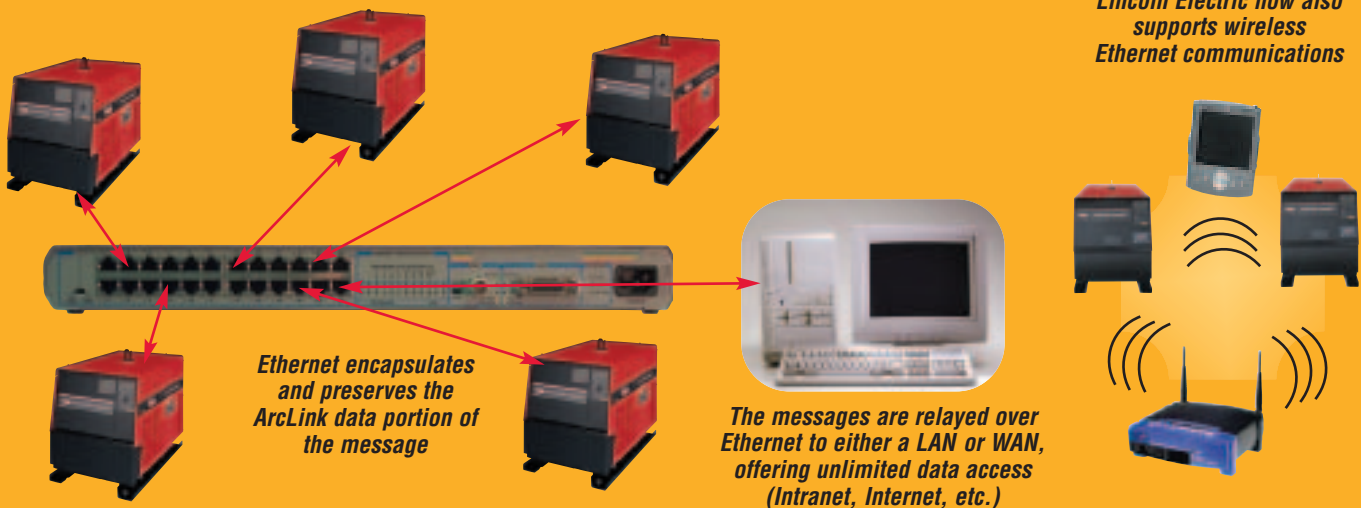*Power Wave 455M with Ethernet/DeviceNet Gateway*

Communications between ArcLink and Ethernet enable equipment tracking and production monitoring

How
Ethernet Works

Higher baud rate and non-deterministic messaging make Ethernet an excellent choice for use in applications that do not require time-critical messaging. For this purpose, Lincoln Electric employs the Ethernet interface to gather and store large amounts of information. Ethernet provides easy access to the stored data. Lincoln utilities extract the information into reports about equipment use and function.

Lincoln Electric now also supports wireless Ethernet communications

Ethernet encapsulates and preserves the ArcLink data portion of the message

The messages are relayed over Ethernet to either a LAN or WAN, offering unlimited data access (Intranet, Internet, etc.)

Using Ethernet

Ethernet Data Acquisition

Ethernet has proven itself as a robust communications protocol, able to collect large amounts of data over small time intervals, and able to broadcast that information over local or wide area networks (LAN or WAN).

Information storage on a LAN or WAN provides the ability to monitor and control all equipment from a single desktop computer.

Production Monitoring™

Each welding system component is assigned an Internet Protocol (IP) address. Groups of addresses are termed "subnets". Ethernet records data from each subnet, allowing for equipment tracking. Software tools that detail allocation of resources such as consumables used or time spent welding per machine are available.

Features

Of Production Monitoring

Management Utilities

- Keep track of equipment usage and condition.
- Allow configuration of limits and responses after each weld.
- Provide storage of thousands of weld summaries.

Advanced Configuration and Diagnostic Features

- Track equipment fault and alarm histories.

Multiple Machine Management

- Access data through a LAN or WAN to manage the software of a large number of machines simultaneously.
- Upgrade software of all machines from one location instead of individual machine upgrades.
- Tools for creating customized Ethernet interface applications.

Benefits

Of Ethernet Gateway

Fast Data Rate

- Operating at a baud rate of 10-100 MHz, Ethernet relays communications faster than low-level control protocols.
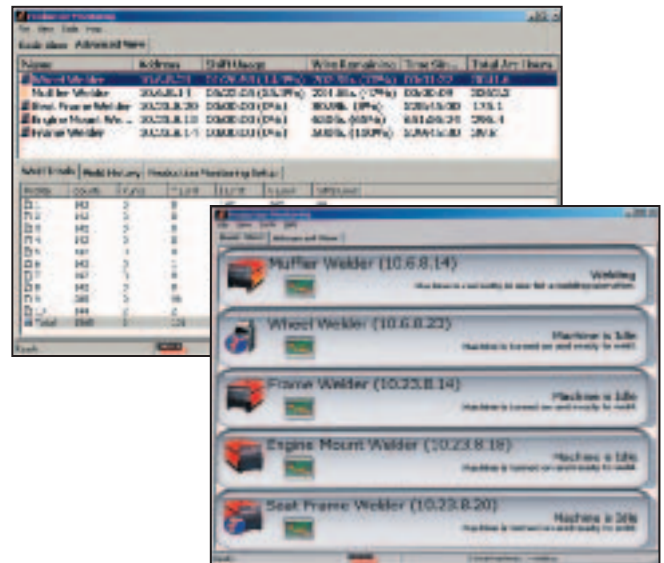
Standard Top-Layer Protocol

- Standardized physical connections are commercially available and inexpensive.

Networking

- Ethernet maintains high-speed performance over long distances, allowing for network capabilities.

View Process Details to Verify Process Selection

View Robotic, Hard Cell, and Semiautomatic Equipment Simultaneously

Event logs display fault and alarm conditions of each machine component
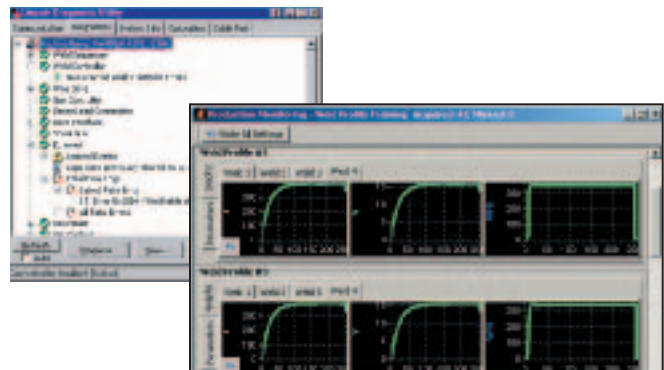
Training: Automated feature that records the values of a test weld and uses those values as a baseline for the limit on future welds.

Production Monitoring allows user to configure limits and responses after each weld

The Weld History records thousands of weld summaries

Digital Communications Products

Lincoln Welding Systems featuring Digital Communications
Power Wave Welding Systems: Simple. Innovative. Technologically Advanced.

Power Wave 455M Robotic, Power Wave 455M/STT Robotic
✔ **ArcLink** ✔ **DeviceNet** ✔ **Ethernet**

These Power Waves are designed to be part of a modular, multi-process welding system.

- The Power Wave 455M Robotic and 455M/STT Robotic are high performance, digitally controlled inverter welding power sources capable of complex, high-speed waveform control.
- Digital Communications enable the Power Wave to connect seamlessly to robot controllers and hard automation PLCs. Semi-automatic applications are also supported.
- Optional DeviceNet and Ethernet communication modules provide networking capabilities and allow process and production monitoring.
- Software-based controls can be upgraded as new features become available.

Power Wave 655 Robotic
✔ **ArcLink** ✔ **DeviceNet** ✔ **Ethernet**

The Power Wave 655R was designed for Robotic and Hard Automation applications that require extra power (650 Amps at 100 % Duty Cycle)

- Digital Communications enable the Power Wave to connect seamlessly to robot controllers and hard automation PLCs. Semi-automatic applications are also supported.
- The Ethernet/Device/Net Gateway provides networking capabilities and allows process and production monitoring.
- Software-based controls can be upgraded as new features become available.
- The Power Wave 655R has an output range of 20-880 Amps.

Power Wave 355M/Power Feed™ 10M
✔ **ArcLink** ✔ **Ethernet**

The Power Wave 355M is the smaller, lighter version of the Power Wave 455M – same machine, just leaner and lighter.

- The Power Wave 355M/Power Feed™10M welding system is factory programmed with over 60 standard welding programs to optimize the arc for a variety of materials or applications, including steel, stainless steel, aluminum, nickel alloys and others.
- ArcLink Digital Communication between components allows unprecedented waveform control and expansion capability. Simply select a program and you have the right arc characteristics for your application.
- The software is upgradeable, so your Power Wave 355M will grow with your business. If you want to reduce costs by buying a versatile machine that will do multiple jobs and last for years to come, the high efficiency Power Wave 355M delivers.

Power Feed™ 10M
Power Feed 10M is a compact wire feeder designed for use with Power Wave power sources.

Some of the features of the Power Feed 10M include:
- Push-pull system
- New MSP 4 User Interface
- 36 Segment Digital Display
- Limit Settings
- Lock Out Control
- Arc control settings for all processes
- Palm OS based hand held computer access to:
  - Limit configuration
  - Back-up
  - Diagnostics

The future of welding is here.

Lincoln Welding Systems featuring Digital Communications

Power Wave Welding Systems: Simple. Innovative. Technologically Advanced.

Power Wave® AC/DC 1000™

✔ **ArcLink** ✔ **DeviceNet** ✔ **Ethernet**

The Power Wave AC/DC 1000 is a modular welding system with a single range of control from 100 to 2500 Amps per arc at 100 % duty cycle

The Power Wave AC/DC 1000 provides:

- DC+, DC- and Variable frequency up to 200 Hertz
- Flexible Waveform Control
  - Variable Frequency
  - Variable independent amplitudes
  - Variable timing
  - The Power Wave AC/DC is 100 % software controlled

Power Feed Wire Feed Systems
Power Feed 10M

✔ **ArcLink**

This compact wire feeder is designed for field construction, pipelines, offshore, and shipyard applications. The Power Feed 10M is essential for applications where portability, ruggedness and arc performance are demanded. It is designed to work exclusively with the Power Waves.

Power Wave F355i

✔ **ArcLink** ✔ **Ethernet***

The Power Wave F355i is fully integrated with the FANUC ARC Mate™ R-J3iB controller and designed for the most demanding robotic applications.

- This compact unit delivers 350 Amps @ 60% duty cycle for MIG, Pulsed MIG or Flux-Cored welding applications.

  - The Power Wave F355i/ARC Mate R-J3iB communicates via ArcLink™, allowing all welding procedures and process controls to be managed through the ARC Mate robot teach pendant – one central control for setup, process control and diagnostics.

Power Feed 10R

✔ **ArcLink**

The Power Feed 10R is a high performance, digitally controlled, modular wire feeder designed to be a part of a modular, multi-process welding system.

It is specifically designed to mount to a robot arm or to use in hard automation applications in various types of industries. This four drive roll feeder operates on 40 VDC input power and is designed to be used with ArcLink Robotic Power Wave power sources.

Close integration of the feeder, power source, and customer's equipment create the foundation for a system with superior welding performance and reliability.

* Ethernet access is available through the Ethernet port of the R-J3iB

Lincoln Welding Systems featuring Digital Communications

Power MIG 350MP

✔ **ArcLink**

The Power MIG 350MP – a single phase, multi-process, synergic wire feeder welding package for the professional welder.

The Power MIG 350MP offers:

• Superior multi-process welding.
• Synergic design for ultimate control over the arc, by automatically aligning wire feed speed and voltage.
• Top-quality aluminum welds with push-pull wire feed capability, not usually available in competitive models.
• True MIG pulsing and Pulse-on-Pulse™ capabilities, which ensure that superior feeding is matched by high quality arc performance.

*Note: Ethernet and Production Monitoring are not an option on the Power MIG 350MP digital welding system.

WHAT IS NEXTWELD?

The challenges facing industrial fabricators today are growing in number and complexity. Rising labor, material and energy costs, intense domestic and global competition, a dwindling pool of skilled workers, more stringent and specific quality demands all contribute to a more difficult welding environment today.

LINCOLN ELECTRIC
NEXTWELD®

Through our commitment to extensive research and investments in product development, Lincoln Electric has established an industry benchmark for applying technology to improve the quality, lower the cost and enhance the performance of arc welding processes. Advancements in power electronics, digital communications and Waveform Control Technology™ are the foundation for many of the improvements.

NEXTWELD brings you a series of Process, Technology, Application and Success Story documents like this one. NEXTWELD explains how technologies, products, processes and applications are linked together to answer the important questions that all businesses face:

• *How can we work faster, smarter, more efficiently?*

• *How can we get equipment and people to perform in ways they've never had to before?*

• *How do we stay competitive?*

NEXTWELD is the future of welding but its benefits are available to you today. Ask your Lincoln Electric representative how to improve the flexibility, efficiency and quality of your welding operations to reduce your cost of fabrication.

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 customer 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 have 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 requirement.

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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