Digital Communications

Networked Welding Equipment

A network is a pathway that allows one device to send information to, and receive information from, another device. For years, this type of system is what enabled people in offices to share files and printers located in proximity over a Local Area Network (LAN).

The Internet provides the ability to communicate over greater distances on a Wide Area Network (WAN). This ability has expanded the role of networking to include information sharing among manufacturing equipment, such as arc welders and robots.

This document reviews basic networking terminology and describes equipment which will make it easy to identify and apply. A sample installation provides basic networking instructions, and the benefits of networking equipment are illustrated by Lincoln software utilities.

**LINCOLN
ELECTRIC
NEXTWELD™**

a d v a n t a g e s

INCREASED PRODUCTIVITY

• Recording production statistics for every weld mode allows for comparison of similar machines, cells, lines, and plants, so that the most efficient combination can be identified.

• Limit and trend information can be used to improve process capabilities.

QUALITY

• Process limits ensure that parts made outside of programmed tolerances are automatically flagged, so that they can be reworked or scrapped. This reduces manual inspection labor.

• Machines can be diagnosed remotely with the diagnostic utility provided by Lincoln Electric.

AUTOMATED REPORTS AND NOTIFICATIONS

• Equipment can be programmed to send updates on machine status, faults or other production details through the e-mail notification feature.

• Purchasing or manufacturing personnel can be notified that the wire consumable has reached a usage threshold and will need to be replaced.
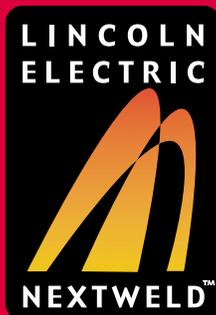
Patented. This product is protected by one or more of the following United States patents: 6,795,778; 6,809,292; 6,697,701; 6,636,776; 6,536,660; 6,486,439; 6,441,342; and other pending U.S. patents. Similar patents are maintained in other countries.

*T h e   f u t u r e   o f   w e l d i n g   i s   h e r e .* ®

What is
a Network?

A network is a set of devices that communicate with each other on one common pathway.

Networks can be local or wide, use cables or be wireless, and can be connected by either switches or hubs. Local and Wide Area Networks (LANs or WANs) usually break down into smaller units, or "subnets", by using a gateway to route messages from one subnet to another. Breaking larger networks into smaller pieces is a common method of managing network complexity and increasing performance.

The most obvious advantage to networking capability in a welding environment is that network distances are limitless. A corporation with satellite offices can consolidate and share manufacturing data by setting up subnets that all pass information on to a larger network.
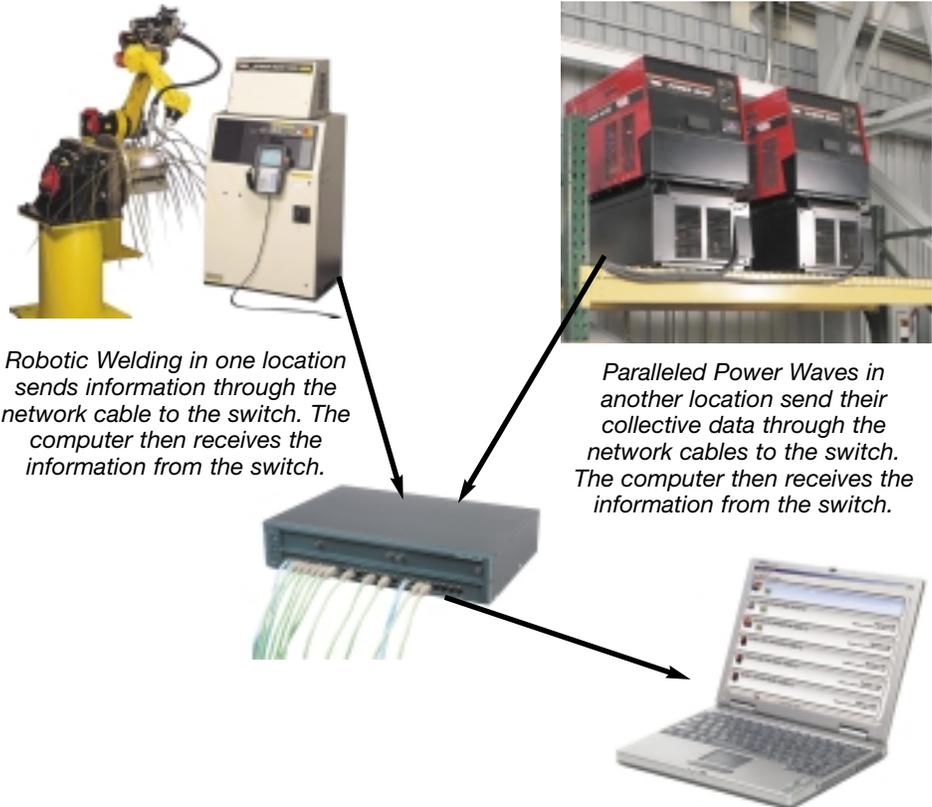
Robotic Welding in one location sends information through the network cable to the switch. The computer then receives the information from the switch.

Paralleled Power Waves in another location send their collective data through the network cables to the switch. The computer then receives the information from the switch.

Uniform communications protocols such as Ethernet and ArcLink make it possible for different types of equipment at different locations to feed into the same network.

Networking Terminology

Fundamentals

Local Area Network (LAN) — A set of devices (computers or welders) that are in the same general physical location, usually within a building or group of buildings.

Ethernet — The most widely used communications system for Local Area Networks (LAN). Each machine on the network has a card connected to the computer, and to a cable. Each card has a unique address that is attached to the messages it sends and receives.

Wide Area Network (WAN) — A set of devices that are not in the same general physical location. They may be across town or even in another part of the world, and may include two or more local area networks.

Media Access Control (MAC) address — The physical Ethernet address of a device on the network. Like a Social Security Number for equipment, every device has a unique address. Lincoln Ethernet module MAC addresses can either be read from the label on the side of the PC board or by using the Ethernet Setup utility, (provided on the CD with the module kit). Some corporate network IT administrators may require the MAC address prior to allowing the device on the network.

Bus — A type of network where all devices are connected on a branch and share the same wires, like a telephone party line.

Hub — A device that serves as a point for connecting devices to a bus.

IP Address — Internet Protocol addresses are assigned to devices sharing a local network. The IP address is what devices use to address each other. There are two types of IP addresses, static and dynamic.

Static Address — These are retained in the device's memory, regardless of where and when it is connected on the network.

Dynamic Address — These are assigned using DHCP (Dynamic Host Configuration Protocol) each time it is connected and is based on where it is connected. In dynamic addressing, a device will have a different IP address every time it connects to the network.

Gateway or Router — A device that routes information from subnet to subnet.

Subnet Mask — A subnet mask defines the range of IP addresses that fall within its "local" branch of the larger network.

ArcLink — An open communications protocol built by Lincoln Electric to bring modularity to welding systems.

Manufacturing Devices Group 1

Robot

Power Wave

PLC

RJ45 —
This Ethernet bulkhead connector is typically used for wired network connections. The Power Wave Ethernet/Devicenet Module comes with an RJ45 connector.

THE COMPONENTS OF A SIMPLE NETWORK

Ethernet

Manufacturing Devices Group 2

Switch —
A method of connecting devices to a bus, preventing message collision.

Ethernet —
The most widely used network technology in the world, Ethernet is fast and has a high bandwidth, which means that large volumes of information can be transferred in little time.

Networking Devices

Ethernet

Network Interface Card (NIC) —
Every device connects to a network through a NIC. The Power Wave connects to the Ethernet via the K2207-2 or a K2436-1 Ethernet/DeviceNet Communication Interface or through a Fanuc R-J3iB Controller.

Network Cables —
The most common cables are copper twisted pair (CAT 5 or CAT 6) and fiber optic. For best results, Lincoln recommends use of a shielded CAT 5 cable.

Router —
A device that connects your local equipment to the Internet.

Internet —
A Wide Area Network (WAN) that allows global file sharing.

Wireless Ethernet (WiFi) —
Wireless networking technologies simplify installation because they eliminate the need for network cabling. Consult manufacturers for range restrictions to ensure optimum performance.

How to Install

an Example Network

The following network example serves as a guideline for a simple installation. For the purpose of this example, we will network two power waves to a computer. The Power Waves are 25 ft. (7.62 m) apart, connected by shielded CAT5 cables to a 5 port LAN switch.

Connecting Switches and Cables

The physical layout and placement of the welding equipment is the most significant aspect in determining what length of cable and what type of switch to use. For "clusters" of machines that are all located within 50 ft. (15.24 m) of each other, pick a switch (or cascade of switches) that has enough ports for the machines AND a port for a computer and/or a connection to another network branch.

Machines separated by more than 50 ft. (15.24 m) should be connected as separate branches on the network, each with its own switch.

Example Installation:

1) **For this installation, three network cables are required.**

2) **Connect each of the Power Waves and the computer to the switch with a shielded CAT5 cable.**
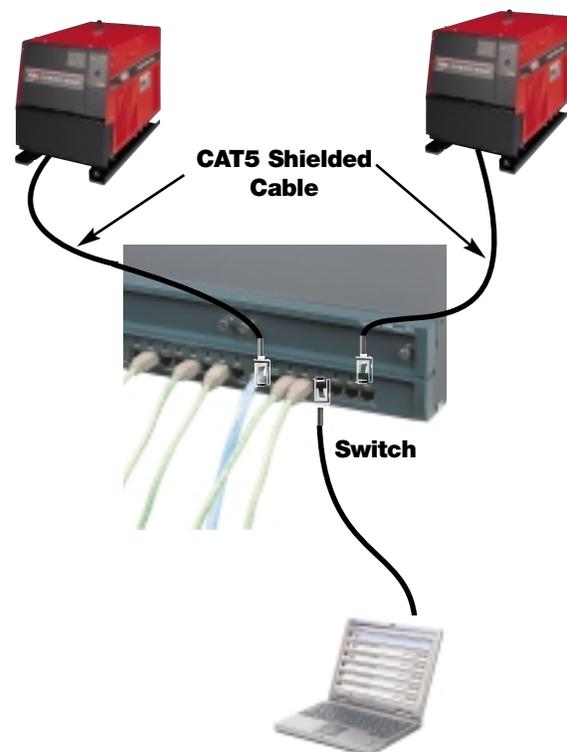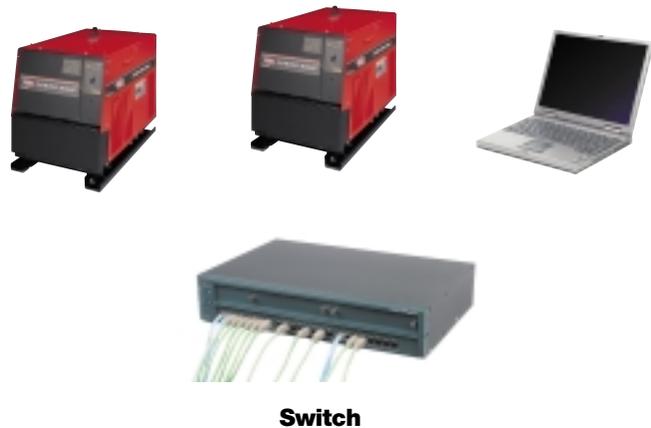
Switch

CAT5 Shielded Cable

Switch

How to Install

an Example Network (cont.)

Installing the Ethernet/DeviceNet Module (K2207-2) on a Power Wave 455M or 455M/STT

In order to get the appropriate responses out of the machine, you must first give it the necessary tools. On the computer end, this is done with a network interface card. On the Power Wave end, it is accomplished with the Ethernet/DeviceNet Module. This installation will only take about ten minutes to complete.

Example Installation:

1) Unpack the Ethernet kit from the shipping container.

2) Unscrew the set screw securing the front access panel of the Power Wave.

3) Slide the board over the fixed bolts in the front access panel.

4) Connect the 4-pin connector off of the J72 or J73 to the ArcLink networking harness.

5) Install the Ethernet bulkhead connector (RJ45) and connect the CAT5 cable between the bulkhead connector and J710.

6) Close the panel, by securing the set screw in the front panel of the Power Wave.

7) Apply the ArcLink/Ethernet decal.

*Refer to Instruction Manual 840 for specific installation details and diagrams.

For the Power Wave 355M and Power Wave 455R please refer to Instruction Manual 840 for installation and setup requirements.
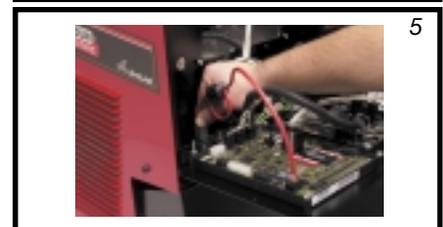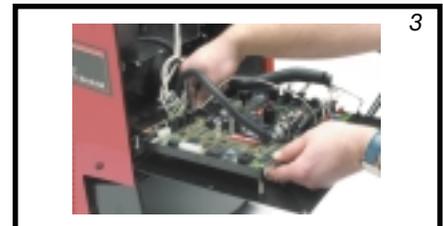
How to Install

an Example Network (cont.)

Assigning IP Addresses

Recall from the terminology section that IP means Internet Protocol. In order to establish each device on the network, it must have an assigned address that all the devices can see and read. Either static addresses (these do not change, regardless of whether or not the device is taken off the network) or DHCP addresses (these change each time the device is taken off the network, and then put back on) need to be assigned.

Using the Lincoln NetSet Utility

1) Install the CD received with the Ethernet/DeviceNet Module.

2) Follow the screen prompts to install the software on the PC.

3) Connect the computer using a serial cable (DB25 male to DB9 female), from the computer to the first Power Wave.

4) Select "Ethernet Setup" from the Start menu.

5) Check DHCP or static; If static, enter the appropriate IP, Gateway and SubNet Masks. If dynamic select "Obtain from DHCP".

6) Click on the "Sync Realtime Clock" button.

7) Click the "Apply" button.

8) Click "No" on the Verify Network prompt.

9) Repeat steps 4 – 8 for each Power Wave.

Example Installation:

1) Using the computer serial cable, connect the computer to the first Power Wave.

2) Select "Ethernet Setup" from the Start menu.

3) Check "Static Assignment".

4) Click on the "Modify" button under Static IP and enter 192.168.1.2 (for example).

5) Click on the "Modify" button under Default Gateway and enter 192.168.1.1 (for example).

6) Click on the "Modify" button under Subnet Mask and enter 255.255.0.0 (for example).

7) Click on the "Sync Realtime Clock" button.

8) Click on the "Apply" button.

9) Click "no" on the Verify Network prompt.

10) Repeat steps 2 – 9 for the second Power Wave, and assign IP address 192.168.1.3 (for example).

NOTE: All IP addresses on a LAN must be unique.
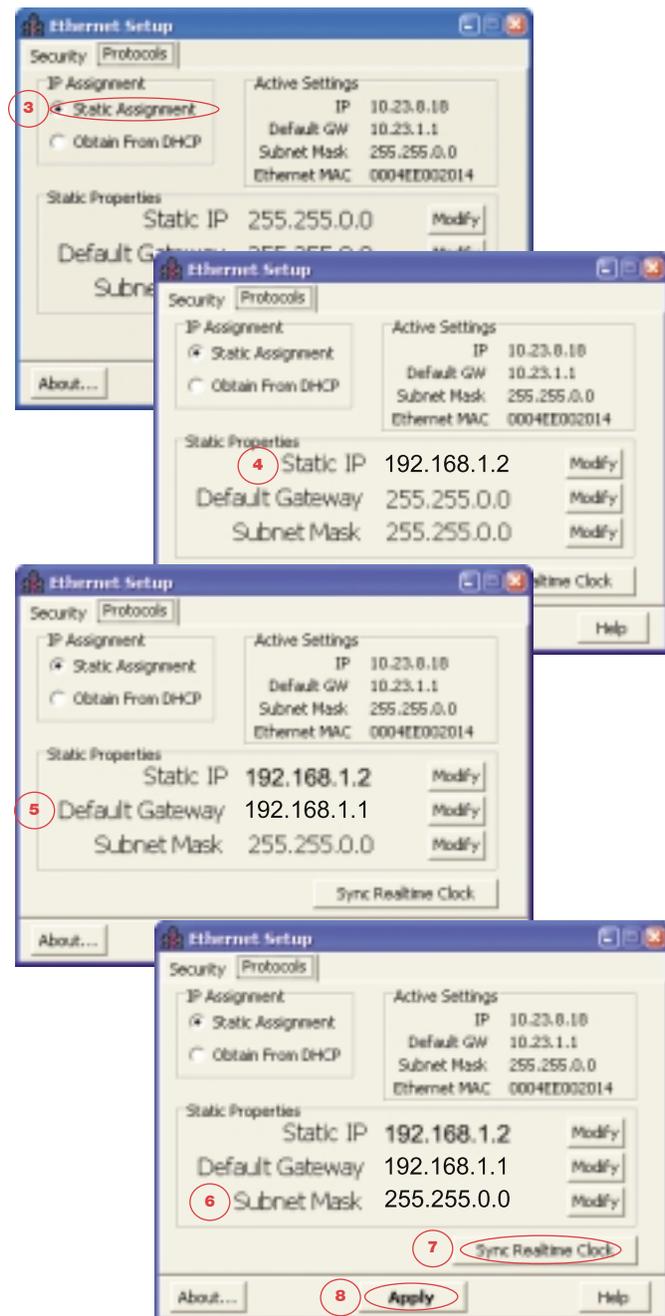
How to Install

an Example Network (cont.)

Computer Setup

The computer needs to have either a static or dynamic IP assignment. This step is highly dependent on the Windows Operating System that you are running (Windows NT 2000 or XP) and the design of the network you are connected to.

It may be necessary to obtain Administrative rights to your computer before changing it's network settings.

Often, corporate laptop PCs will have a mobile or LAN/Office boot option. Select LAN. Most corporate laptop PCs will have dynamic IP addresses.

1) Select Network Connections from the Windows settings and either reconfigure an existing LAN connection (as opposed to a dial up) or add a new LAN connection.

2) Select the Internet Protocol (TCP/IP) properties.

3) Select "Obtain an IP address automatically" (i.e. dynamic or DHCP) or "Use the following IP address" (i.e. static). If static, enter the appropriate IP, gateway and subnet masks.

Example Installation:

1) Double-click on the Network Connections icon in the Control Panel of the computer.
2) Select the TCP/IP properties.
3) Check "Use the following IP address".
4) Enter 192.168.1.4 (for example) for the IP address.
5) Enter 255.255.0.0 (for example) for the SubNet Mask.
6) Enter 192.168.1.1 (for example) for the Gateway.

NOTE: All IP addresses on a LAN must be unique.
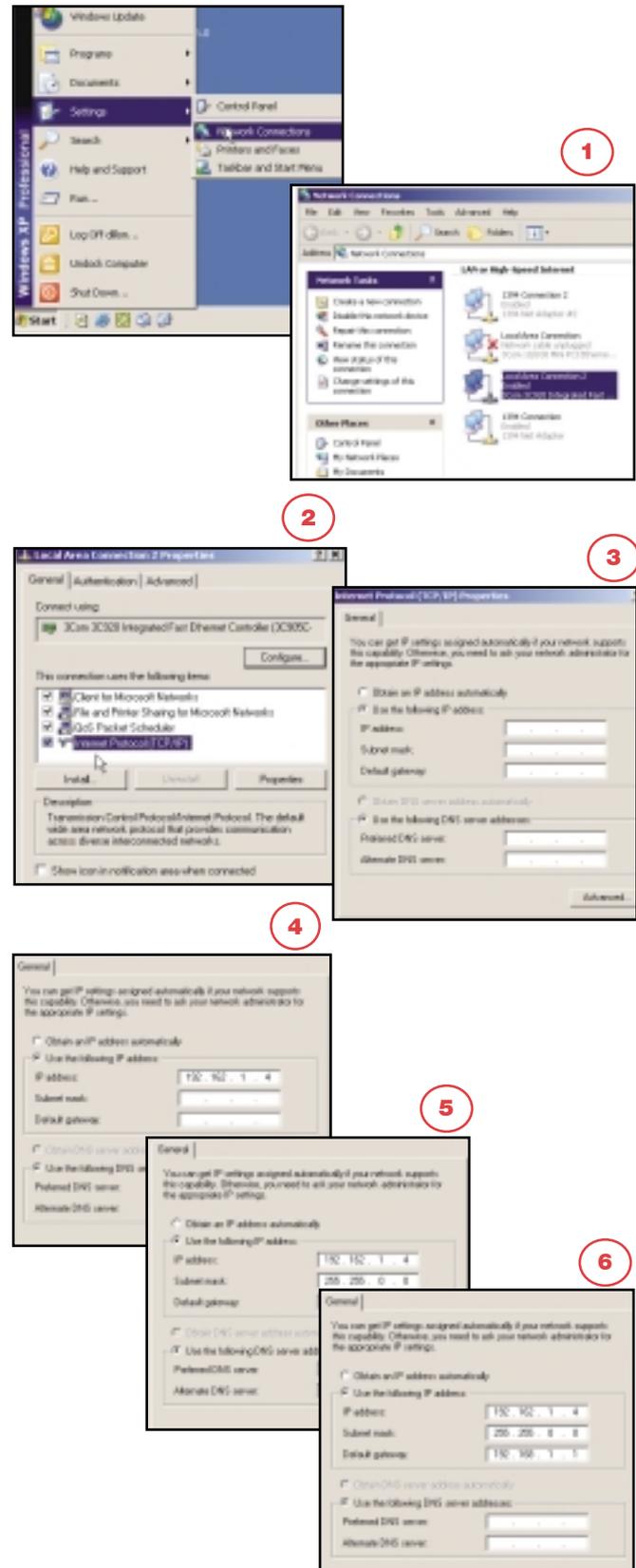
Using the Network

for Production Monitoring

Now that the Ethernet/DeviceNet Module has been installed and the IP addresses configured, the Power Waves can be managed over the network using the Production Monitoring utility.

This tool allows the user to build and store weld profiles for repeatable welds. Setting limits can be easily achieved by using the Production Monitoring tool. A user can manually set the limits or use the tool to "train" the limits based on a number of sample welds. Limits may be set for wire feed speed, voltage, current, and time. Additionally, wire usage, machine run-time, and weld histories can be tracked, and reports of each generated. Finally, gathered weld data can be stored in files that can be shared over the network, and/or e-mailed to a user-defined distribution list.

Production Monitoring: Basic View

All of the welding equipment accessible over the local network can be added to the Production Monitoring window. In the first screen shown in the top right, all four Power Waves have the Production Monitoring capability installed.

Installed Production Monitoring is indicated by this icon.

In this example the first listed Power Wave is actually welding.

Welding status is indicated by this icon.

The listed equipment in the first screen shows machines functioning normally (Muffler Welder, SP Welder, PW455M LAB and PW455R-Grid LAB). If the equipment were faulted the line would be highlighted in red, and a a fault message would be displayed.

Equipment faults are indicated by this icon.

To launch the diagnostic utility that can aid in solving the problem, right-click the faulted line and select "Diagnose". This is shown in the second image to the right, *Equipment Fault Notification and Diagnostic Utility.*
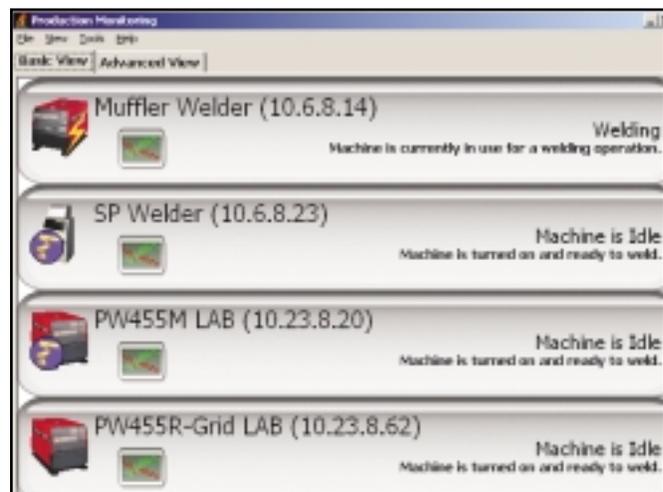
Production Monitoring Basic View — Lists Networked Equipment, shows equipment status, and indicates whether the production monitoring function is enabled
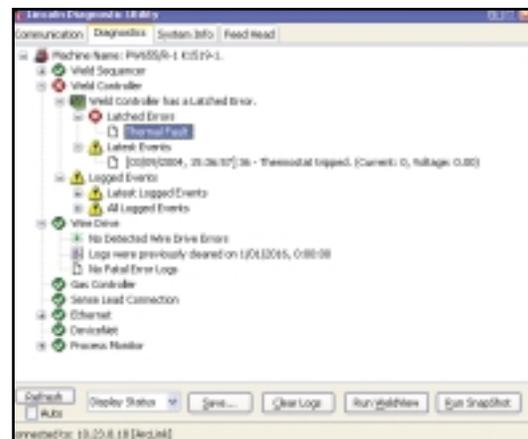
Equipment Fault Notification and Diagnostic Utility

Using the Network
for Production Monitoring (cont.)

Production Monitoring: Advanced View

Most of the Production Monitoring tasks can be found in the Advanced View Tab. The lower pane consists of several tabs that house different Production Monitoring capabilities. From the Advanced View:

- *Set and view weld profile limits*

  A weld profile is a set of repeatable weld parameters. To weld a muffler, for example, a robot may employ six welds, each with different joints, inclusion angles, durations, etc. Those six welds will be repeated to make 100 mufflers, and each is referred to as a weld profile. A tolerance can be created for each profile, by setting maximum and minimum limits for weld duration, current, voltage, start and end delay, and wire feed speed.

- *View weld profile history*

  Each weld profile retains a log of runs and faults. When the weld deviates from the acceptable range of profile settings, it is logged as a fault. For the purposes of quality and efficiency, faults can be programmed to initiate actions, such as shutting down the power supply.

- *View remaining consumable*

  When a wire spool is loaded, its weight, diameter, and material can be entered. As welds are performed, the amount of wire deposited is calculated and subtracted from the original weight. The percentage of consumable wire remaining is displayed next to the arc time.

- *View machine usage*

  The hours of weld time can be monitored in order to perform necessary maintenance tasks at regular intervals.

- *Configure E-mail notification*

  E-mail distribution lists can be set, and e-mails can be set to send automatically as a result of specific faults, low consumable inventory, or other user-defined events.

- *Configure shift timers*

  Set the shift timer for the shift-end time, and all event logs, usage information, and fault messages from that shift are automatically saved.

Production Monitoring Wizard

To assist users with the more complex features of the tasks listed above, Lincoln Electric also provides a wizard. The wizard is accessible from the context (right-click) menu and provides instruction for beginning, novice, and advanced weld profiling.

*Production Monitoring Advanced View —
Production Monitoring tools are accessed here*

*The Production Monitoring Wizard guides the user through
setting up limits and e-mail configuration*

## Using the Network

for Production Monitoring (cont.)

Production Monitoring Setup: Training the Weld

Weld limits can be "trained" based on a sample weld run. Any number of welds can be completed to "train" the limits. The Production Monitoring utility records the values of a test weld, and uses those values as a baseline for the limits for that profile. The user can then modify the maximum and minimum tolerance levels to what is acceptable for the application.

Weld "Training" Example

1) Launch the Training window of the Production Monitoring utility by selecting the Production Monitoring Setup tab, and then right-clicking the General Settings heading.

2) Run model welds for each type of weld (weld profile) that is to be monitored.

3) Click on the "Parameters" tab to review the automatically generated settings.

4) Click on "Apply All Settings" if the recorded parameters are an acceptable baseline to build the weld profiles.

5) For each weld profile, apply minimum and maximum tolerance levels (according to application requirements) to the following procedure settings:

> Start and End Delay
> Duration
> Current
> Voltage
> Wire Feed Speed

Run a test weld of the first weld profile

Run a test weld of the second weld profile
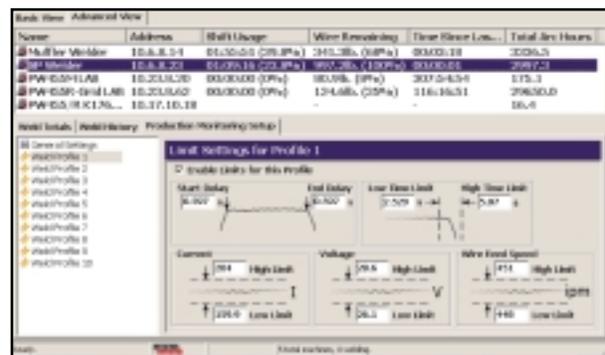
Set the minimum and maximum limits for Time, Current, Voltage, and Wire Feed Speed

Using the Network
for Production Monitoring (cont.)

Weld History

Each weld profile will store a number of runs, and will record the output values of each run. Welds that wander outside of the specified limits will be tagged as a faulted weld, and will appear in the history with the following icon.

⚠️

Weld history may be programmed for e-mail notification or report generation.

Weld Totals

The weld totals tab keeps a running count on the number of welds performed in each weld profile.

E-mail Configuration

The e-mail feature allows the user to:

• Send daily welding report, including attachments containing production history

• Send faulted weld notices

• Send consumable wire replacement notices

• Complete a software/hardware change.

A configurable address book is included for storage of e-mail recipients and the notifications each respective address is to receive. The address book holds up to 13 e-mail addresses, and each address can be assigned unique report options.

To configure the address book, right click on one of the machines listed in the Basic View and select either the Configuration Wizard or e-mail item.

Certain setup information is required for items such as the Mail Server IP address. Consult IT administrators for this information.

Production Monitoring: Other Features

Software Upgrades

A true strength of the Power Wave welder is that its capabilities expand as your needs grow. For customers that develop custom weld procedures, this strength is seen in the ease with which procedures can be loaded onto existing welding cells. New welding procedures are uploaded to all networked machines simultaneously. One upgrade takes care of all equipment.

Production Monitoring Advanced View —
Weld History

E-mail Notification Feature — Setting distribution list and
selecting equipment for report generation

Networked Welding Equipment

Lincoln Welding Systems featuring Digital Communications

Power Wave Welding Systems

The Power Wave 355M, 455M, 455M/STT, 455R, 455M Robotic, 455M/STT Robotic and 655R are all equipped with digital communications capabilities. Upon installation of the Ethernet Gateway module, these welding systems are ready to be networked.

Does your welding system talk? Networking allows your Power Wave to send you an e-mail when it experiences an out-of-limit weld, or when the consumable wire is running low.

While maintaining Lincoln's level of weld quality and machine reliability, these network-ready systems are here to assist with quality control, increased efficiency, and ultimately, making your job a little easier.

Power Wave 455M/STT

Power Wave AC/DC 1000

Power Wave 655R

Power Wave 355M with Power Feed 10M

Table 1: Communications Compatibility

	K2207-2 Ethernet/DeviceNet Communication Interface	K2436-1 Ethernet/DeviceNet Communication Interface	M18456-50 Automation Weld Profile Selection Kit
Power Wave 355M		X	
Power Wave 455M Power Wave 455M/STT Power Wave 455M Robotic Power Wave 455M/STT Robotic	X		X (Non-robotic requires K2205-1)
Power Wave 455R		X	X
Power Wave 655 Robotic	Included		X
Power Wave AC/DC 1000	Included		

Note: Firmware upgrades may be required in the field.

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 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 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.

WHAT IS NEXTWELD?

The challenges facing industrial fabricators today are increasingly difficult. Rising labor, material, and energy costs, intense domestic and global competition, a dwindling pool of skilled workers, more stringent and specific quality demands.

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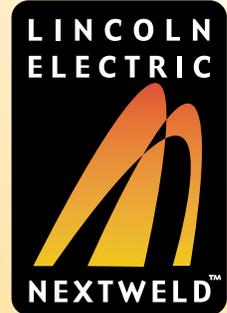
NEXTWELD brings you a series of Process, Technology, Application and Success Story documents like this one. NEXTWELD explains how technologies, products, processes and applications are linked together to answer the important questions that all businesses face:

• *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.

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