LIVINGSTON

& COMPANY, INC.

THE WELD MONITORING SPECIALISTS

THE POD™

User's Manual

Revision C.003

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Product Road Map

The Livingston User's Manual includes the following sections:

- **Overview of Resistance Welding**: Explains the fundamentals of resistance welding and factors that affect the quality of resistance welds

- **Introduction to Resistance Weld Monitoring**: Explains the fundamentals of resistance weld monitoring and reasons for weld monitoring

- **Tolerancing & Monitoring**: Describes Livingston's concept of resistance weld monitoring and terminology used regarding Livingston equipment

- **Getting Familiar With POD™ Server**: A brief physical overview of navigating with the software

- **WMS Quick Start**: A basic how-to guide to weld monitoring with Livingston equipment

- **WMS Reference Guide**: A complete software reference to the Livingston Weld Monitoring Software (WMS) program

- **Installing the Sensors**: Describes the various types of sensors available for use with Livingston weld monitors and installation guidelines

- **Calibrating the Sensors**: Explains how to calibrate sensors using the WMS program

- **FAQ**: Includes answers to frequently asked questions

- **Troubleshooting Guide**: A beginner's guide to basic troubleshooting for Livingston systems

- **Appendices**: Includes information reprinted from the RWMA, various subject matter pertaining to both Livingston equipment and software and additional DeviceNet troubleshooting information

- **Application Notes**: Includes general 'how-to' procedures and notes relating to software and/or hardware issues

- **Contact Information**: How to reach Livingston

Table of Contents

Overview of Resistance Welding

Introduction

In simplest terms, welding is a process by which two or more pieces of metal are joined by applying heat and pressure. Back in the good old days, blacksmiths and other crafty people would heat metals in a furnace and then weld them by hammering the red-hot metals together. By hammering the metals as they cooled, the weld would be made stronger. This heating-and-hammering method is known as forge welding. While forge welding worked quite well for most of the welding done back then, today's welding requirements are a bit more advanced. After all, it would be pretty difficult to heat all the metal needed to build an automobile in a big factory furnace and expect workers to hammer together each specific part used in the manufacturing process. We'd all still be riding horses to work!

Fortunately, there are always a handful of brilliant people throughout history who are kind enough to invent newer, faster, and better ways of doing things. One of these people was a professor by the name of Elihu Thompson. Sometime in the year 1885, Professor Thompson invented a process called electric resistance welding. He discovered that to weld metals together, one could fire an electric current through the metals while they were tightly clamped together. When the current passed through the metals, it would create such a high heat that the metals would melt and run together and a weld would be made. Many times, the welded metal would be even stronger than the original metals used in the welding process.

Today's resistance welders work almost exactly the same way they did when Thompson invented the process. The current is generated by a transformer, and is fired through electrodes, which hold the metal pieces in place. These electrodes also apply force to the metal pieces, usually before, during, and after the firing of the electric current. This method is called *resistance* welding because it is the resistance between the contact surfaces of the metals being welded that generates the heat to fuse them together.

Resistance is the opposition that a substance offers to the flow of electric current. The less resistance a metal has, the less heat is generated when current passes through it. Conversely, the higher the resistance of a metal, the more heat is generated when that same current passes through it. This behavior can be paraphrased as follows: the heat is where the resistance is, and the resistance is where the heat will be. Obtaining the best results in resistance welding requires a thorough understanding of the materials being welded, careful control of the heat and pressure at the weld point, and consideration of numerous other factors. This chapter will deal with the basics of resistance welding, the variables involved, and why they're so important to the welding process.

Variables in the Welding Process

The many variables involved in welding can be broadly categorized into two basic sections: process variables and material variables.

Process variables include:

- Weld current
- Squeeze time
- Weld time
- Hold time
- Electrode force
- Design of the electrode
- Workpiece material

Material variables include:

- Coating thickness and type
- Part fit-up
- Surface condition & cleanliness of materials

The Weld Cycle

A typical resistance weld is broken down into several distinct periods, as shown in figure 1-1 below:
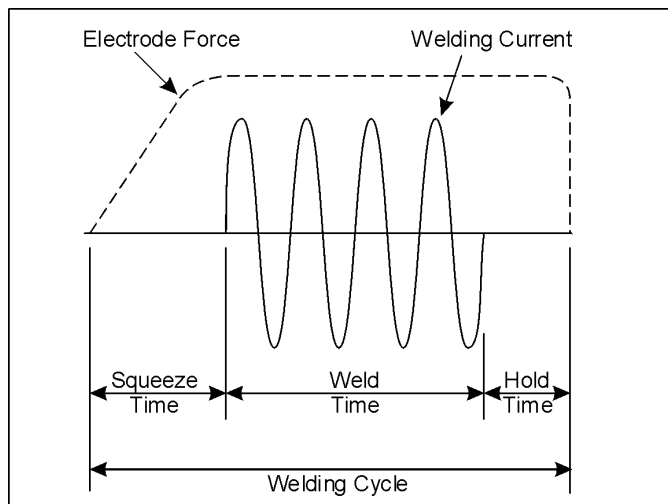
Figure **1-1** A typical weld cycle

The **Squeeze Time** is when the weld heads (electrodes) come together and build up to a specified amount of force before the current is fired.

The **Weld Time** is when the current is actually passing through the workpieces. This is when the metals are being heated enough to melt and fuse together to form what is called a weld nugget.

During the **Hold Time**, electrode force is still applied, even after the weld current has ceased. During this period, the weld nugget cools and the metals are forged under the force of the electrodes. The continuing electrode force helps keep the weld intact until it solidifies, cools, and the weld nugget reaches its maximum strength.

Critical Factors in Welding

Understanding the resistance weld process requires an understanding of the main factors involved and how they work together. This section will review current, voltage, resistance, and power, as well as the various functions of the electrodes and how they affect surface contact and current density.

Current

Current, usually measured in Kilo-Amperes (KA — one Kilo-Amp is equal to 1,000 Amps), is one of the most important factors. A resistance weld cannot be made unless there is sufficient weld current. According to the RWMA, the typical amount of current needed to weld low-carbon steel, for example, is about 10,000 Amps (10 KA) at about 5 Volts. To put this in perspective, a normal household or office outlet provides a maximum of 15-20 Amps (0.015-0.020 KA) at 120 Volts, while a power circuit in a factory may only be capable of providing 200 Amps (0.200 KA) at 500 Volts to a welder. The factory's 200 Amps is then converted to the 10,000 Amps needed to weld by means of a welding transformer.

A transformer consists of two coils of wire, called the primary and the secondary, wound around an iron core. Power is transferred from primary to secondary via the magnetic properties of the iron. The factor by which the current and voltage is stepped up or down is equal to the ratio between the number of turns of wire in the coils forming the primary and secondary windings of the transformer. Consider the steel that needs 10,000 Amps (10 KA) of current to be welded in a factory that can only provide 200 Amps (0.200 KA). If the welding transformer had 100 turns on the primary and 2 turns on the secondary, the 'turns ratio' would be 100 to 2, or more simply, 50 to 1. The 200 Amp current in the primary would then be converted (stepped up) to 10,000 Amps (200 Amps x 50 turns = 10,000 Amps) in the secondary, which would yield enough amperage to make a weld.

Voltage

If current is the amount of electricity flowing, then Voltage (measured in Volts) is the pressure or force that's causing the flow. A good analogy is water flowing through a pipe. A larger voltage will result in greater water pressure, which will cause more water (current) to flow through the pipe. Using the transformer example above, after the 200 Amps at 500 Volts on the primary passes through the transformer coils, the secondary amperage increases to 10,000 Amps, but the voltage actually drops to 10 Volts. This decrease in voltage occurs because the amount of power coming out of a transformer isn't actually *increased*, but more accurately *exchanged*.

Power

Power is Voltage multiplied by Current, and is measured in Watts, or KVA (KVA stands for Kilo-Volt-Amperes. Watts and KVA will be used interchangeably in this text). This means that the amount of current flowing times the pressure that's causing it to flow equals the amount of power generated. A basic law to bear in mind is that the power going into a transformer will always equal the power coming out of it. Returning to the transformer example, 200 Amps coming in at 500 Volts (200 x 500 = 100,000 KVA) on the primary with a 50 to 1 turns ratio in the transformer will be converted into 10,000 Amps at 10 Volts (10,000 x 10 = 100,000 KVA) going out. As the math illustrates, the results are the same. The initial and final amperage and voltage may be different, but because the ratio is the same, the total amount of power is also the same.

Resistance

As mentioned earlier, resistance is defined as the opposition that a substance offers to the flow of electric current. Resistance is calculated by dividing the Voltage by the Current, and is measured in Ohms. (When written, Ohms are represented by the Greek letter Omega: Ω). Since resistance to the current is what generates the heat in the workpiece, it is critically important that the area with the greatest resistance be at the interface between the two parts being joined. This interface is also known as the faying surfaces. Remember that the heat is where the resistance is, and the resistance is where the heat will be. If the area with the most resistance is, for example, where the lower bus bar connects to the transformer of the welder and *not* at the faying surfaces of the workpieces, then that's where the heat will go. Likewise, if the greatest resistance is at the contact area between the electrode tip and the workpiece, the heat generated there will cause the tip to weld directly to the workpiece.

Electrodes

Typically made of copper alloys, electrodes actually have three separate functions: to conduct current to the workpieces being welded, to transmit the proper pressure or force to those workpieces to produce and forge a good weld, and to help dissipate heat from the area being welded. To ensure that all three of these functions are executed properly, it is important to regularly maintain the electrodes, keeping them clean and in good condition. A reprint of an RWMA chart describing various types of electrode materials and their different uses may be found in Chapter 11, <u>APPENDICES</u>, of this manual.

Conducting Current

The first of these functions is purely electrical— fire weld current through the workpiece. Taking into account the relationship among current, voltage and resistance, it becomes important to pay attention to the type of electrodes used. For example, it wouldn't be wise to select electrodes made entirely from a high resistance material, since they would get so hot they'd melt before the current even had a chance to flow to the workpiece. It is also important to make sure that the electrodes are the right size for the application; proper electrode sizing is largely dependent on the amount of force being used on the workpieces.

Transmitting Force

The second function of the electrodes is mechanical. The amount of force needed to make a good weld varies, depending on the type of metal being welded and other factors, but a general figure would be about 600-800 lbs. Because electrodes are typically on the small side— roughly from about the size of

an acorn to the size of a plum, it is also important to choose electrodes that are able to withstand the force needed to make a good weld.

A key point to understand is that force and resistance have an inverse relationship: more force will result in less resistance, and vice-versa. The equation has to do with surface contact, which refers to the specific area on the workpieces touched by the electrodes. Surface contact will be covered further in the next section, but the following example will begin to illustrate this relationship: if you examine your fingertip under a magnifying glass, what first appears to be a smooth surface is actually a mass of rough-looking ridges and bumps. The same is true of electrodes and workpieces. The tips of the electrodes and the surfaces of the workpieces may look to be smooth and in good condition, but in reality their surfaces are quite rough, especially if the electrodes are old and worn or if the workpieces are dirty. By applying pressure to these rough surfaces, any microscopic inconsistencies (e.g., dirt or grease on the workpiece and/or pits and cracks in the electrodes) are compressed and the surface actually evens out. This results in improved (increased) surface contact between the electrode tips and the workpiece, and between the workpieces themselves. When the surface contact is increased, current can flow more readily from the tips through the workpieces, which means that the resistance has been lowered.

Force also is what helps to keep the weld intact as it's being formed. As the current generates heat, the workpiece metal begins to melt. A good analogy to this process is a child eating a popsicle on a hot summer day. When the popsicle melts, it doesn't remain on the stick— it drips everywhere. When metal melts it wants to do the same thing, however because it's molten metal and not a runny popsicle, it doesn't simply drip. It *explodes* out of the workpiece. This is why proper weld force is so important: it literally forces the molten metal to stay put, so it can then cool to form a weld nugget. Without sufficient force, the metal will do what it wants to do, which is what causes expulsion. Expulsion is nothing more than little pieces of molten metal exploding out of the weld because they're not being properly held in. The problem with expulsion is that all the metal flying *out* of the weld is metal that's not going *in* to the weld; a weld cannot be made stronger by removing metal from it. Determining the proper amount of force is entirely application dependent. The RMWA can be contacted for additional recommendations and guidelines.

Cooling the Workpiece

Electrodes get considerably hot with 10-20 KA or more repeatedly flowing under hundreds of pounds of force. Although most welders have an internal water cooling system that allows water to circulate through the tips of the electrodes while welds are being made, a common problem is a lost, damaged or improperly sized cooling water tube. Without anything to cool off the tips, heat can quickly build up to the point where the electrodes will eventually weld to the workpieces. To correct this problem, the water tube should be placed so that the incoming cold water strikes the hottest part of the tip first, as shown in figure 1-2.
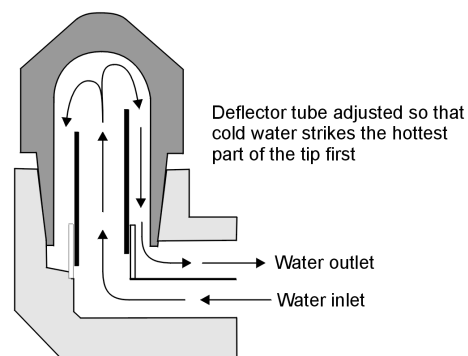

Deflector tube adjusted so that cold water strikes the hottest part of the tip first

Water outlet

Water inlet

Figure **1-2** Example of an electrode cooling channel.

Surface Contact

The ultimate goal of the weld process is for the weld current to generate sufficient heat between the workpieces being welded so that the metal will melt, fuse together and form a weld nugget. For this to happen, the surface contact must be maximized. The following experiment may sound silly, but proves an important point: take a piece of Scotch tape and stick it to a clean piece of paper. Assuming that the tape was clean beforehand, it probably sticks very well. Now sprinkle some salt on the piece of paper. Stick another piece of tape to the paper with the salt on it. Depending on how much salt is there, the tape probably sticks somewhat to not at all. Lastly, stick a third piece of tape to some carpeting, then pull it off. Now try to stick that same tape to the paper. The third piece probably doesn't stick at all.

Compare the electrodes to the tape and the workpiece to the paper. The clean tape sticks best to the clean paper, just like well-maintained, clean electrodes have the best contact with a clean workpiece. The tape sticks so-so to the paper with the salt on it, just like electrodes will have a so-so contact with the workpiece if it's dirty, greasy, etc. Lastly, the tape that has been stuck to the carpet and then re-stuck to the paper probably doesn't stick well at all, just like worn or pitted electrodes don't have very good contact with the workpiece. By maximizing the surface contact, current density is increased. Both of these factors play key roles in ensuring that enough heat is generated to reach that ultimate goal of forming a weld nugget.

Current Density

Current density describes how much current is being delivered to a specific area. In other words, it describes the concentration of the current in a small area of the workpiece— namely, the area where the weld is. To calculate current density, the amperage (how much current) is divided by the surface area (area of contact between the electrode and the workpiece). As a rule, the smaller the surface area, the denser the current. When the current is denser, the surface area gets hotter and the metal melts faster. Consequently, a current density that is too high for the application may cause expulsion. In contrast, a larger surface area delivers a less dense current. If the current density is too low for the application, there may be cold welds or perhaps no welds at all.

The size, shape and overall condition of the electrodes affect the surface area in contact. Small pieces missing from the tips of the electrodes (pitting) will result in an increased current density due to the decreased surface area. The same amount of current fired through a smaller surface area may cause little hot spots that expel molten metal (expulsion), and/or may result in undersized weld nuggets. Conversely, if the electrode tips mushroom and get bigger, the current density is lower. For example, suppose that there are 6-mm round tips on a welder. The area of each tip is about 28 mm^2. (The area of a circle is πr^2: $3^2 * 3.14 \approx 28$). Suppose the tips deliver 10 KA to a workpiece. Current density equals the amperage divided by the surface area, so the current density will be 0.36 KA, or 36 Amps for every millimeter squared of surface (10 KA/28 mm^2 = 0.36 KA/mm^2). What happens if the tips mushroom to measure 7-mm (about 0.040 inches greater in diameter)? Although one millimeter doesn't seem like a significant increase, consider what happens to the current density: The 7-mm tips now have a surface area of about 38 mm^2 ($3.5^2 * 3.14 \approx 38$). Dividing the amperage by the surface area results in 0.26 KA or 26 Amps for every millimeter squared of surface. The difference between 36 Amps per mm^2 and 26 Amps per mm^2 is a rather significant 28% reduction in current density! (36 Amps – 26 Amps = 10 Amps difference; 10 Amps is 27.78% of 36 Amps).

By allowing the electrodes to mushroom only one millimeter bigger, over a quarter of the current density has been lost, even though the same amount of current is passing through the tips. Imagine the

size of the loss if they've mushroomed 2, 3, even 4 millimeters! A constant current control or a weld stepper may be used to regulate the amount of current used, but a controller or stepper does not track the change in surface area. So, even though the *current* is regulated, the *current density* is overlooked. Unfortunately, inadequate current density usually produces inadequate welds. Following proper preventive maintenance schedules can help ensure sufficient current density by ensuring that the electrodes remain in good condition.

As proven in the example above, it is crucial to have the proper current density at the area where the weld is to be made. Depending on the materials being welded, however, 'proper' current density is actually a range, rather than one specific amount. Welding engineers call this range the *weld lobe*. Each parameter involved in making the weld (current, voltage, resistance, etc.) has its own range, or lobe. Quality welds are made when the weld process stays within the lobe. The next chapter will discuss weld lobes and *tolerancing*, which is a way to ensure that the weld process does not fall outside of the lobe.

Ohm's Law and Joule's Laws

The following laws are widely thought to be what make or break resistance welding. While it is true that these laws are very important to resistance welding, there are a few details that should be clarified.

Ohm's Law states that **V** (Voltage) = **I** (Current) **x R** (Resistance).

What does this mean in real-world terms? Returning to the pipe example, the more water pressure there is in a pipe (more voltage), the more water can flow through that pipe (more current). If the size of the pipe decreases (more resistance), then the water flow will decrease (less current) but the pressure drop along the pipe will increase (more voltage).

Joule's Law states that **H** (Heat) = **I** (Current) **x V** (Voltage) **x T** (Time the current is allowed to flow).

Or, written differently,

H (Heat) = $\mathbf{I^2}$ (Current squared) **x R** (Resistance) **x T** (Time the current is allowed to flow).

Note: V (Voltage) = **I** (Current) x **R** (Resistance), so the two equations are the same, just stated differently. The second version of this law is probably more common in the field.

Joule's Law is an equation that gives the amount of heat (energy) delivered to *something*. It would seem sensible to assume that it's the amount of heat delivered to the weld. However, it is important to consider all the factors in the equation: Current, Voltage, and Time. Joule's Law assumes that each of these factors remains constant in the secondary of the welding transformer. A weld controller or weld timer may indeed provide a constant amount of current at the electrodes, but recall Ohm's Law: Voltage equals Current times Resistance, or written differently, Current equals Voltage divided by Resistance. Factors like pitting or mushrooming of the electrodes, dirty workpieces, changes in force, etc. all have an effect on the surface area (the area of contact) between the electrode and the workpiece. Since changes in the surface area affect the contact resistance (resistance of the surface area), it is reasonable to say that the resistance at the workpiece is not constant, but rather a factor that can change depending on a number of other conditions. If Resistance is not constant, then according to Ohm's

Law, Current is not constant either. This means that the I-squared version Joule's Law will not reveal the amount of heat generated at the workpiece unless the resistance at the tips is known.

Simply put, to determine how much heat is being generated at the workpiece using Joule's Law, current, voltage or resistance must be measured at the workpiece. Although a weld controller may be programmed to deliver 20 KA at 10 Volts, if there is significant resistance in the secondary weld loop, the heat will go there and not to the workpiece. Likewise, if the electrodes are worn or the workpiece is dirty, resistance and current density will be affected. In such a situation, a controller might indicate 10 Volts at the secondary, however there might actually be only 5 Volts at the weld tips. Such a disparity could easily cause bad welds.

Identifying and Correcting Weld Problems

A simple rule to remember is that quality usually equals consistency: welds that are always made within the specified weld lobe will consistently be of high quality. The question is, how can you determine if welds are being made consistently within the lobe? If a weld control is programmed to deliver a certain amount of current at a certain amount of force, how can you ensure that the right amount of current and force was delivered at the tips? The amount of current coming out of the transformer may be correct, but is the current density at the workpiece where it should be? How do you know if the weld is good? The most common method of answering these questions is through destructive testing. It's hard to dispute the quality of a weld after it has been pulled apart and inspected. However, destructive testing produces a lot of scrap metal, and while it will reveal whether the weld is good or bad, it cannot explain the specific details of why or how a weld turned out the way it did.

Resistance weld monitoring provides a way to see what is happening while each weld is being made. Critical parameters, such as resistance and current density, can be observed and measured *at the workpiece* during the weld process. The next chapter will discuss how this process works.
The following is an abbreviated guide of commonly encountered welding problems and their possible causes, adapted from documents published by the Resistance Welder Manufacturers' Association and reprinted with permission.

	Excess Indentation	Electrode Mushrooming	Undersized Weld Nugget	Offset Weld Nugget	Misshapen Weld Nugget	Explusion at Surface	Expulsion at Interface	Cracked or Poor Weld Nugget	Discolored Weld Nugget	No Weld
Weld Force Too High	X	X	X							X
Weld Current Too High	X	X				X	X		X	
Weld Time Too Long	X	X				X	X		X	
Weld Force Too Low	*					X	X	X	X	
Weld Current Too Low			X							X
Weld Time Too Short			X							X
Electrode Face Too Small	X	X				X	X		X	
Electrode Face Too Large			X							X
Insufficient Electrode Cooling		X								
Electrode Allow Too Soft		X								
Electrodes Not Flat & Parallel				X	X	X				
Electrodes Misaligned				X	X					
Poor Fit Up	X		X	X	X	X	X		X	
Poor Heat Balance			X	X						
Weld Spacing Too Close			X							X
Weld Too Close To Edge of Part			X				X		X	
Dirty Material						X	X	X	X	X
Metallurgy of Material								X		X
Squeeze Time Too Short						X	X			
Poor Follow-Up						X	X	X	X	
No Speed Regulator On Cylinder	X									
Poor Pressure Regulation	X									
Hold Time Too Short								X		
Transformer Tap Set To Off										X
No Weld Switch(es) In No Weld										X
Pressure Switch Open										X
Temperature Limit Switch Open										X
Electrodes Do Not Contact Work										X
Insulated Electrodes/Holders										X
Shunt Path In Secondary			X							X
Excess Ferrous Material In Throat			X							X
Emergency Stop Switch Open										X

* If Weld Force is too low, excess heating of the material surface may cause excess indentation.

Figure **1-3** Chart of weld defects and possible causes

Recommendations for Producing Quality Welds

To produce high quality welds consistently, follow these tips:

1. Be sure that the electrodes you are using are suitable for the job.

2. Use standard electrodes whenever possible.

3. Select an electrode tip diameter suited to the thickness of the stock being welded.

4. Make use of flow indicators for viewing and assuring proper cooling water flow through the electrodes (typically, 1.5 gallons per minute).

5. Ensure that the internal water cooling tube of the holder projects into the tip water hole to within ¼ inch of the bottom of the tip hole.

6. Adjust the internal water-cooling tube of the holder to the appropriate height when switching to a different length tip.

7. Ensure that the top of the adjustable water-cooling tube in the holders is the proper height when changing to a different tip length.

8. Coat the tip with a thin film of cup grease before placing it in the holder to simplify removal.

9. Use ejector type holders for easy tip removal that won't damage the tip walls.

10. Clean the tip taper and holder taper on a regular basis, removing any foreign materials.

11. Perform dressing of electrodes on a regular basis to maintain the correct contour.

12. Use a rubber mallet to align holder and tips, rather than a metallic tool.

Avoid these potential sources of weld problems:

1. Never weld using unidentified electrodes or electrode materials.

2. Avoid using special-purpose or offset tips if the job can be handled with a standard straight tip.

3. Do not use a small tip for welding heavy gauge materials or a large tip on small piece.

4. Do not overlook turning on the cooling water to the appropriate force when beginning to weld.

5. Never use a water hose that does not firmly fit the water connection nipples.

6. Avoid leaky, clogged or broken water connections.

7. Do not use holders that have leaking or deformed tapers.

8. Do not use electrode holders without an adjustable internal water cooling tube.

9. Avoid leaving the electrodes unused in tapered holder seats for long periods.

10. Do not use pipe wrenches or similar tools when removing electrodes.

11. Never dress an electrode using a coarse file.

These recommendations can help improve the quality and consistency of your welds. For more information, you can contact the RWMA (Resistance Welding Manufacturing Alliance) or AWS (American Welding Society) directly:

550 NW LeJeune Road
Miami, FL 33126
Tel: (800) 443-9353
Intl.: (305) 443-9353
URL: www.aws.org

Introduction to Resistance Weld Monitoring

Introduction

As discussed in the last chapter, what you see is not always what you get. Although a constant current control may indicate that there is sufficient weld current to create a quality weld, unless the measurement is taken at the electrodes, the actual amount of heat generated is only speculation. In view of the fact that the generation of sufficient weld heat is a function of current density, it could logically be argued that the primary cause of bad welds is inadequate current density. Many factors affect current density: poorly maintained, worn or improperly sized electrodes, dirty materials, lack of sufficient force at the tips and lack of sufficient weld current at the tips are just a few examples. This being the case, how can a production person or weld engineer catch these (or other) potential problems before they lead to bad welds? *How do you make sure that what you see is what you get?* The answer lies in the subject of this chapter: resistance weld monitoring.

Why Monitor?

When Professor Elihu Thompson developed the concept of resistance welding, the idea of weld monitoring most likely didn't exist. At that time, the only means available of differentiating a good weld from a bad weld was through destructive testing. Even today, destructive testing is regularly used to provide a reliable answer— 'good weld' or 'bad weld'— depending on how the weld reacts during its destruction. For all its reliability, however, destructive testing doesn't tell the whole story. While it can easily be determined whether a weld is good or bad, uncovering the precise factors that made it that way is not as straightforward. Was there an excess or deficiency of one or many factors during the weld? At what point or points in the welding process did the excess or deficiency occur? Resistance weld monitoring can provide immediate answers to these questions.

With the advent of advanced computer technology, today's methods of observing and testing individual weld integrity have advanced significantly, keeping in step with ever-evolving safety and quality standards. By monitoring the welding process, compliance with international quality standards– such as ISO and/or QS 9000+, or MVSS– is simplified. Weld quality can be instantly verified with electronic documentation of individual weld characteristics; hard copy of weld data can even be printed for comprehensive record keeping or for inspection. It's hard to dispute the integrity of a product when the most critical stages in the manufacturing process have been systematically observed, recorded and analyzed.

It's important to realize that weld monitoring is **not** a substitute for destructive testing. Rather, monitoring and destructive testing go hand in hand. While destructive testing can unconditionally guarantee whether an individual weld is good or bad, monitoring can show *why* that particular weld was good or bad. Together, they can answer what is perhaps the most important question of all: is the welding process consistently within the defined weld lobe?

Weld Lobes and the Weld Process

Each of the factors involved in the creation of a weld (Current, Voltage, Resistance, etc.) has a specific range in which good welds can be made. This range is commonly known as the *weld lobe*. Bad welds are made when the weld process falls outside of the lobe, so the simple answer to making consistently good welds is to keep the process inside the lobe. It is not so simple, however, to ensure that this happens for each weld made. This is where resistance weld monitoring is most valuable. The following example uses a weld nut and the relative movement of the electrodes during the weld to examine what goes on during the weld process. Livingston terminology (*in italics*) is used to describe various measurements.

The nut itself has a number of little metal feet or projections on the bottom of it. These projections sit on top of the workpiece to which they'll be welded. A measurement of the nut sitting on top of the workpiece with the electrodes clamped on it before the weld is made is called the *Initial Thickness*. When the proper electrode force is applied and weld current is fired, the projections melt into the workpiece and create a weld. When the projections melt, the molten metal expands for a moment, pushing the electrodes apart (this movement is called *Expansion*) before sinking down into the workpiece (this movement is called *Setdown*). The expansion-setdown process is very much like a pot of water boiling over before it's removed from the heat: as the metal is heated, it expands and then quickly contracts as it cools to form the weld. A subsequent measurement of the nut/workpiece after the weld is made is called the *Final Thickness*. All these different measurements of electrode movement are measures of what's commonly called Electrode Displacement, or simply Displacement.

Measuring displacement provides a good indication of whether or not the resulting weld was formed properly. If the nut sinks too far into the workpiece, it may be a sign of excessive heat which could render the weld no good. It could also indicate that too much force was applied, the weld time was too long, or a number of other things. Conversely, if the nut doesn't sink far enough, it may mean that not enough heat was generated for the materials to weld properly, the force was insufficient, etc. Problems with displacement can be problematic in many applications, such as welding hydraulic fittings. If the setdown is too much/too little, chances are that the welded fitting will leak. When taken into account that displacement is only one of many factors that, when measured, provide valuable information about the formation of the weld and its overall quality, it becomes clear that weld monitoring is indeed a valuable tool. Weld monitoring provides the user with an easy way to access a wealth of information about the welding process— information that can actually help improve the process itself, as well as alert the user to any number of potential problems.

Styles of Monitoring

There are many different types of monitoring systems on the market nowadays. These systems can be broadly categorized into three different styles, which for educational purposes are nicknamed as follows: *Before & After* monitoring, *Mass* monitoring, and *Dynamic* monitoring.

Before & After Monitoring

As the name suggests, Before & After monitoring (hereafter referred to as BA monitoring) focuses on only two phases of the weld process: before the weld is made, and after the weld is made. This type of monitoring is typically used to measure displacement only. As mentioned above, measuring

displacement can indicate whether the resulting weld was formed properly. BA monitoring measures the displacement before the weld is made (Initial Thickness), and then again after the weld is made (Final Thickness). However, if it is determined that the displacement is consistently below where it should be (e.g., the nut is not sinking far down enough into the workpiece to make a good weld), BA monitoring cannot identify exactly where in the process the problem is occurring. Similarly, the BA monitor may indicate a normal setdown, yet the nut may be sinking down much too quickly due to expulsion. While BA monitoring provides an account of the beginning and end of the weld process, the key middle-portion of the process is unwisely overlooked.

Mass Monitoring

Mass monitoring provides a more in-depth examination of the weld process, but does it by averaging all the measured parameters during the course of the weld. Using the weld nut from the displacement example in the previous section, we'll examine force during the weld process. The nut and workpiece are clamped together under pressure between the electrodes, and the weld current is fired, generating heat and creating a weld. A Mass monitor will measure parameters during the weld process and will provide an average for each after the weld is made. In this particular example, the monitor might indicate that the average force during the weld was 800 lbs. Suppose, however, that subsequent destructive testing of the part showed that the weld was bad. Why would this be the case if the monitor indicated that the average force was appropriate?

The trouble with this type of monitoring system lies in the averaging of the parameters before a result is presented. Recall that a typical weld cycle can be broken up into three separate sections: the pre-weld, weld, and post-weld segments. If the force during each of these sections was 1700, 300, and 400 lbs., respectively, the average would be 800 lbs. The end result appears acceptable, but the averaging only serves to disguise substantial irregularities in the force during the weld process. Mass monitoring is also relatively insensitive to changes in the weld schedule and weld current. Aspects such as upslope and downslope are recorded, but are delivered as averages rather than by the cycle (or halfcycle). Although the average current for a 10-cycle weld could be the same as for a 20-cycle weld, there would probably be a great deal of expulsion in the 20-cycle weld. A Mass monitor would not be able to detect anything amiss in this situation, because the average would likely be an acceptable figure. While Mass monitoring is a more thorough method of observation than BA monitoring, it's still not the most effective method of monitoring the resistance weld process.

Dynamic Monitoring

Dynamic monitoring is currently the most comprehensive method of observing and recording the weld process. A Dynamic resistance weld monitor measures weld parameters in real-time, while the weld process is happening. More detailed than a before/after picture, and more accurate than an average of each parameter, a Dynamic monitor provides a complete view of the weld process as the weld is being made, measured in either halfcycles or cycles (based on a 50 or 60 Hz sine wave). Because the weld process is observed so closely, events such as Expansion and Setdown can be pinpointed down to the halfcycle. If weld irregularities are suspected, recorded weld data can be analyzed to determine where in the process they're occurring and what factors are contributing to the problem. Potential problems can also be detected before they occur: parameters such as resistance or force can be trended to ultimately predict electrode wear and improve preventive maintenance schedules.

Effects of Different Factors

Each of the four main parameters— Current, Voltage, Force, and Displacement— affect the properties of a weld.

Current, measured in KA, is typically set and expressed as a percentage of heat on weld controls used by a number of manufacturers, although some of the more modern equipment allows a current setting in KA instead of a percentage. Throughout the industry, the majority of welds are performed using single-phase AC current, but there are other sources of welding current used as well. These include:

- Single and Three-phase rectified DC

- Mid-frequency DC (600-1,200 Hz)

- High-frequency DC (2,000-25,000 Hz)

- Capacitive Discharge DC

Whatever type of current is used, control of current density during welding is the most important factor involved in making a quality weld. Without proper current density, too much heat can be generated, leading to expulsion and/or part deformation. Conversely, there may be too little heat generated, causing cold welds and/or incomplete weld nugget formation. Some people uphold the 'bake it longer' theory, which prescribes lower weld heat for a longer time. While this reduces expulsion, the longer weld time makes it much less efficient. Others think that in order to have good welds, expulsion is necessary as an indicator that a weld is being made. However, tiny pieces of molten metal exploding out of a weld cause the weld itself to be weaker than it would be without expulsion.

Voltage, measured in Volts, is also a key indicator during the weld process. As discussed earlier, voltage is a relative measure in that the location of the measurement is important. The voltage in the secondary of a welder can vary during operation due to a variety of factors, including:

- variances in the part fit-up;

- loose connections;

- line load variations within the plant;

- differences in power factor throughout the day.

Voltage variations at the tips due to worn or pitted electrodes, dirty materials, or insufficient surface contact with the workpiece can also affect resistance and current density. As a partial solution, many of today's controllers are equipped with an Automatic Voltage Compensation (AVC). If a voltage drop in the factory line is detected, the control will adjust in an attempt to provide the same amount of energy to the weld. Despite the adjustment, what comes out of the transformer is not necessarily what comes out of the electrodes. The same conditions apply to constant current controls. Even though the amount of current coming out of the transformer secondary is regulated, the amount at the tips may be variable.

Force, measured in pounds per square inch (psi), pounds (lbs.), or kilograms (kg), indicates the amount of pressure being applied to the electrodes before, during and after the weld process. Electrode force is typically provided by air, hydraulic, or spring pressure. Changes in force can result in a significant increase or decrease in resistance as the weld is taking place. This is particularly true of welders using

air over oil cylinders. If the electrode force drops too low, resistance can increase between the electrodes and the workpiece, resulting in expulsion. If the electrode force becomes too great, the resistance is lowered, resulting in poorly formed nuggets or even brittle welds, particularly with coated metals. Excessive force also reduces electrode life, causing tips to mushroom more quickly.

Electrode displacement, measured in inches or millimeters, indicates the relative movement of the electrodes during the welding process. The displacement measurement corresponds with the nugget formation at the weld site: as the materials being welded become molten, the metal expands, pushing up against the electrodes. Force is maintained as the electrodes push back, applying pressure to the weld. Follow-up force is critical in containing nugget expansion and in eliminating weld expulsion.

How Monitors Work

Typically, a weld monitor receives input from the welder through a variety of sensors that can be configured for specific applications. These sensors measure the characteristics of the weld process and transmit this data to the weld monitor. Toroids are used for measuring current, and pressure sensors or load cells are used for measuring force. Relative movement of the electrodes during welding is measured using displacement sensors, while voltage leads measure voltage at the weld head. Data is collected from all or a combination of these sensors and displayed by the halfcycle, cycle or average for the entire weld, depending on the type of monitor used. The more weld parameters monitored, the harder it is to unknowingly make a bad weld. Using a Dynamic monitor, factors that may adversely affect the quality of a weld can be easily tracked and identified, and the exact moment when a problem occurs can be isolated, down to the halfcycle.

A weld monitor will not control the weld process, nor will it inform the user what the process parameters are supposed to be. It will confirm if welds are made within the limits set by the user, and a monitor can be used to simplify methods of refining process parameters. It's important to understand that *the user* first needs to define the weld lobe and proper weld schedule. Once a weld lobe and schedule are established (according to internal standards, or through trial-and-error), monitoring can begin.

More Benefits

Below are additional benefits of weld monitoring:

- Optimize weld schedules for individual parts and conditions.

- Ensure a 100% inspection level— *every single part* being produced can be monitored in seconds and the resulting weld data compared to known good values.

- Detect weld setup problems and maintenance issues before they cause bad welds.

- Provide traceability of welded components— the recorded hard copy or electronically stored weld history helps ensure regulatory compliance in specialized industries.

- Minimize production downtime— if a welder isn't working properly, the problem can quickly be tracked down and repaired faster. Less downtime means more money!

Both quality improvements and efficiency can be gained through weld-process monitoring. For example, by demonstrating and tracking the consistent high quality of primary welds, the need for additional "safety" or "delta" welds can be reduced or even eliminated. The ability to quantify what constitutes a known good weld makes it possible to achieve consistent results, even in high-volume situations. Productivity gains can also be achieved by replicating and tracking those conditions that have been shown to result in ideal welds. In a high-volume, automated factory line environment, the resulting gain in productivity can be substantial.

Tolerancing and Monitoring

Introduction

This chapter will introduce Livingston's concept of dynamic resistance weld monitoring. The definitions of *tolerances* and *segments* as they pertain to a POD™ system will be discussed, as well as how these features allow the user to immediately identify and correct faulty parameters or conditions that can produce poor quality welds. Different parameters that can be monitored using Livingston equipment will be identified, in addition to some of the ways that monitoring can be used to simplify and refine the weld process.

Livingston Pod Monitors

The POD™ is a compact device designed to work like a "limit switch" for welding. Each POD™ is interfaced with a shared POD™ Server via DeviceNet. As many as 60 weld heads can be simultaneously monitored on a single network. If a weld is not within master tolerance limits, the POD™ sends a *reject* signal to the POD™ Server and/or a PLC, which is then displayed on the monitor as a 'rejected' weld. If the weld is within defined tolerances, the POD™ sends an *accept* signal, which is displayed as an 'accepted' weld.

The POD™ performs real-time monitoring on a halfcycle-by-halfcycle basis for AC and DC (single-phase), and on a millisecond basis for MFDC welds. A 'halfcycle' is exactly what the name implies: one half of a weld cycle, based on a 50 or 60 Hz sine wave.

Signatures and Masters

Once a Livingston weld monitor and sensors have been installed and the WMS (Weld Monitoring Software) program is running, the monitor continually collects data from the sensors. When a weld is made, information about that weld is captured, analyzed, displayed and stored by the monitor. This information is called a *weld signature*. Simply put, a weld signature is the distinct characteristics of any particular weld. From either one or a collection of high-quality weld signatures, a *master signature* is made. Throughout this text, a *master signature* and its related tolerances (see below) will be referred to simply as a *master*. A 'high-quality' weld signature is the signature of any production weld made that was proven to be high quality through destructive testing. A *master* is a set of values representing those conditions that make for a high-quality weld.

A master is created in the WMS program by making a high-quality production weld and using its corresponding signature. The master is what defines the acceptable range for individual weld parameters through *tolerances*, which are initially drawn from a set of default values installed when the master is made. Once a master is created, tolerances can be individually modified by the user and depending on the application, can be loosely or strictly defined. Once tolerances are defined for a master, every subsequent weld made will be compared with the stored *master tolerance limits*. If the weld does not fall within the *master tolerance limits* of that master, the monitor will record a *reject* signal and display it as a rejected weld. Using a PLC, this signal can also be set to trigger a variety of rejected-weld responses, such as lights, buzzers, and reset-reliant restrictions (the electrodes will

remain clamped until the ladder logic has been reset). Parts with rejected welds can then be immediately identified and isolated from parts with accepted welds.

Note: The P1 Pod is a basic featured weld monitor. The master tolerance limits are set directly in the tolerancing screen. The Master contains these tolerance limits but does not contain a master weld signature.

Selecting a Master

A Livingston weld monitor can store a number of *masters (contains master tolerance limits)* that are selectable using the *binary select* inputs. Selecting different masters is desirable for weld heads that make more than one weld perhaps with a different weld schedule or different part stack up. Please refer to the General Setup Menu section in this manual for more information on *binary select* modes. Pod system *Binary Select* inputs are typically via DeviceNet (from a PLC) or discrete inputs (from a DeviceNet I/O block).

Tolerances

Understanding tolerances requires an understanding of the weld lobe. Restated simply, a weld lobe is the range for any welding parameter in which a high-quality weld can be made. A weld lobe is typically defined by destructively testing welds and then examining the corresponding weld data to determine quality limits.

An example of collected weld data is shown in figure 3-1. In this graph, the diamond shapes represent welds made. The horizontal axis is the weld Current (measured in KA) and the vertical axis is Force (measured in lbs.). Although this particular graph only shows force and current, *all* weld parameters can be toleranced using a Livingston monitor. The locations of the diamonds show exactly how much force was used at a particular current for the displayed weld set. For example, the circled diamond in figure 3-1 indicates a weld made with approximately 9.5 KA of weld current at 895 lbs. of force.
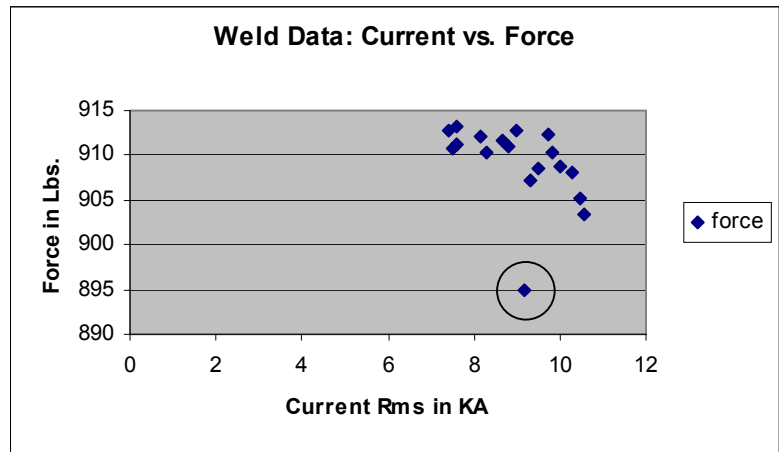
Figure **3-1** Weld data showing Force and Current
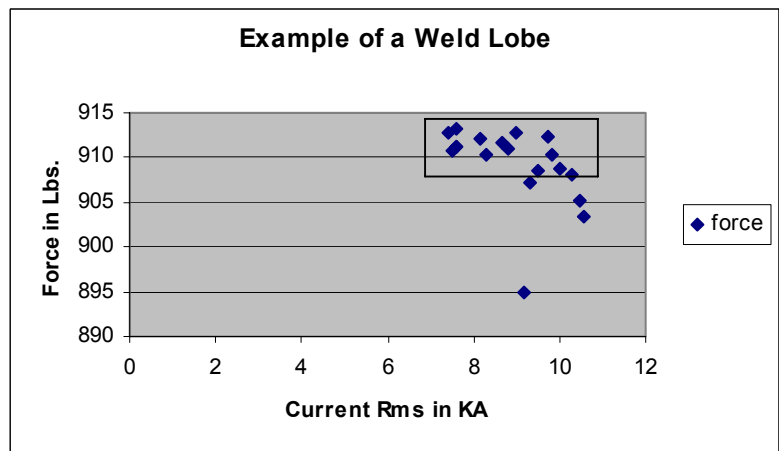
Figure **3-2** Example of a Weld Lobe for Force

To determine the lobe for this particular data set, each part associated with these welds would be destructively tested. Suppose that testing revealed that the welds made within a range of about 908 to 914 lbs. of force, with a range of about 7 – 11 KA of current were all good. If a box is drawn to isolate these ranges, as shown in figure 3-2, the area within that box is the weld lobe. The box itself represents the tolerance limits, or the limits of the range in which good (high-quality) welds can be made. A

master is what provides the monitor with a weld signature that is within the weld lobe. Tolerances are what define the boundaries of that box. Once a master is created and toleranced, Livingston monitors will reject any welds that have fallen outside of the box (out of tolerance), while any welds inside the box (within tolerance) will be accepted.

Every factor involved in making a weld has its own weld lobe and set of unique tolerances. There are up to multiple parameters that can be measured and toleranced* using a Livingston monitor. The WMS program makes it easy to define, track and record tolerances for each parameter critical to the weld process. For maximum flexibility, acceptable tolerances can be specified by absolute or relative* values when comparing weld data in real-time against a master.

*Please refer to the P1 and P3 specifications in the Appendices of this manual for a complete listing of supported parameters and tolerancing methods.

Measured Parameters

Livingston monitors capture measurements from up to four sensors attached to a welder. From these four measurements, the monitors then calculate and record the following parameters:

- Current Rms
- Part Expansion
- Current Peak
- Electrode Setdown
- Voltage Rms
- Conduction Angle
- Voltage Peak
- Energy
- Force
- Resistance (dynamic)
- Initial Part Thickness
- Number of Halfcycles (or ms for MFDC)
- Final Part Thickness

For a complete definition of each of these measured parameters, please refer to section 6, the WMS Reference Guide.

Segments – P3 Pod

Since there are many different weld processes, users may be more interested in observing and analyzing certain time periods during a weld. To accommodate these differences and needs, Livingston devised the concept of *segments*. A *segment* is simply a collection of halfcycles (or milliseconds) before, during and after the firing of weld current. By default, there are three segments created when a master is made: the Pre-Weld (Squeeze), Weld, and Post-Weld (Hold) segments. Different tolerances can be set for each segment, segment lengths can be increased or decreased and new segments can easily be created. Using segments, each weld can be divided into as many parts as necessary to focus on the data that is critical to the weld process. Consider the following example:

Coated steel is being welded with the following weld schedule: 8 cycles of Squeeze, 10 cycles of Weld and 12 cycles of Hold. The objective is to monitor the current density during the Weld time, to ensure sufficient concentration for high-quality welds. According to the factory weld lobe, the current at the electrodes during the weld must be 12 KA, with an allowable difference of only +/-0.5 Amp. After

examining preliminary weld data, it is discovered that the current during the first few halfcycles of the Weld period is much less than 12 KA. The reason for the decrease is that the coating must first be burned off before the weld current actually reaches the steel at the faying surfaces and makes the weld. How can tolerances be properly set to accommodate the weld lobe specification of 12 KA +/- 0.5 Amp without automatically rejecting welds during the time it takes for the coating to burn off?

To resolve this issue, the exact time (in halfcycles) needed for the weld current to burn through the coating could be determined by examining collected weld data. Using this information, a segment could then be added that would effectively divide the Weld segment into two. The first Weld segment would start when the weld current fires, and would end when the coating had been burned off. The weld current tolerances in this particular segment could be widened to accommodate the change in current density when burning through the coating. The second Weld segment would begin at that point when the weld current had reached the metal to be welded, and would end when the weld current ceases. In this segment, the weld current tolerances could be tightened to ensure the necessary amount of current (in the example, 12 KA, +/- 0.5 amps) to make a good weld.

Segments provide a useful means for organizing the weld data and comparing changes over time. The ability to specify different tolerances within several different segments allows the user to precisely isolate weld factors that may be critically important to weld integrity and include these factors when accepting or rejecting welds.

Segments – P1 Pod

A *segment* is simply a collection of halfcycles (or milliseconds for MFDC) before, during and after the firing of weld current. A P1 Pod records data in three segments: the Pre-Weld (Squeeze), Weld, and Post-Weld (Hold) segments. Tolerances are set for the weld summary parameters (calculated from the three segments).

Data Collection

Data can be collected for each halfcycle (millisecond for MFDC), segment and/or weld.   Please refer to the General Setup Menu in section 6, WMS Reference Guide.

Weld data is continuously recorded whenever the weld monitor is operating, however only a pre-specified amount of data is stored. The monitor is 'triggered' at the instant that weld current is fired; this moment is referred to as the *trigger*. The quantity of data stored is based on the trigger. The user can choose a number of halfcycles prior to the trigger (the Pre-weld segment) and a number of halfcycles after the current has ceased (the Post-weld segment), depending on the importance of this data to weld analysis.

For example, a weld schedule may have 8 cycles (16 halfcycles) of Squeeze, 12 cycles (24 halfcycles) of Weld and 8 cycles (16 halfcycles) of Hold. In this particular process, the force during the last six halfcycles of the Squeeze period and the first eight halfcycles of the Hold are especially important. Accordingly, the segment length can be set to include only those specific halfcycles. All additional data before and after the indicated number of halfcycles would consequently be discarded by the monitor.

Getting Familiar With The
Pod™ Server

This chapter will review the various menus and options of the Weld Monitoring Software (WMS) program as it pertains to a Pod System. The WMS software runs on a properly equipped* PC (desktop computer, laptop, industrial PC). This computer is referred to as the Pod™ Server. It is connected to a DeviceNet network along with Pod™ monitors. The Pod Server is used to update pod firmware, configure pod parameters, set weld tolerances, and record and display weld data.

*Please refer to the Pod Server specification in Chapter 11, <u>APPENDICES</u>, of this manual for computer requirements.

WMS Navigation and Editing

There are two modes in the WMS program: navigating mode and editing mode. Navigating mode simply refers to moving from one portion of the screen to another or from screen to screen. Editing mode refers to selecting an item for change and/or actually changing the value of it.

There are four directional arrows on the virtual keypad. In the middle of the arrow is a SELECT button, and an ENTER button on the bottom right. On the top are three other buttons: ESCAPE, MENU and HELP. The PRINT button is on the bottom left.

The virtual keypad is intended for use with a computer touch screen where the buttons are pressed by touching the screen. Clicking on a button with a mouse also presses the button.

If you are using an keyboard, these options may be quickly accessed with the 'hot keys', represented by the underlined letters (ALT + <u>letter</u>). You can also use the keyboard arrows instead of the arrows on the virtual keypad.
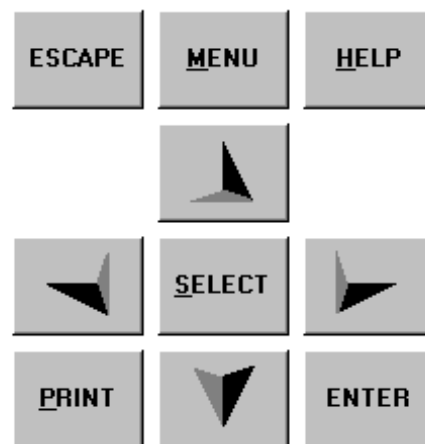
Figure **4-1** The virtual keypad

Navigation

Generally, anytime you move within a screen or from screen to screen, the location of the cursor is shown by a highlighted or enhanced border.

ESCAPE This button reverses your path through the program. For example, if you selected the Data option from the Main Menu, you can use the ESCAPE button to return to the Main Menu. ESCAPE always takes you back one level at a time towards the Main Menu of the program or cancels your previous action. If you press ESCAPE enough times from anywhere in the program, you will always end up at the opening program screen.

MENU This button accesses the Main Menu from many, but not all, points in the program. Use it to return to the Main Menu options.

Arrow Use the arrow buttons to move up, down, left or right on the touch-screen. The arrows will also allow you to change options once an item has been selected.

Editing

SELECT The SELECT button is used to select an item. This either performs the action associated with that item, or puts you into Editing mode. A selected item is usually highlighted, shown with a highlighted border or indicated with a flashing cursor. Once an item has been chosen (shown by a highlighted or enhanced border) in the touch-screen, press the SELECT button to highlight (shown by a different fill color) that item for use or change. For example, if the item is a menu option, the program opens to the next appropriate display. If the item is parameter, you can cycle through a list of additional choices using the Arrow Buttons. If the choices show a number, you can increase or decrease it by using the arrow buttons, or if you have a keyboard you can simply type in the desired number. The SELECT button takes you to the next level or the next set of choices. You can also double click the item with a mouse or press Enter on an external keyboard.

ENTER When you have changed a value or completed some type of operation in the program, use the ENTER button to confirm the change and store the new value. For example, if you change the value of a tolerance using the Arrow Buttons, use the ENTER button to confirm the change and save the new tolerance setting. You can do this using the ENTER button on the touch-pad or by pressing the Enter button on a keyboard. Pressing the ENTER button will return you to navigation mode.

Note: Once you have selected and highlighted a value to be changed, you must use the ENTER button to exit the highlighted item, even if the value has not changed.

Other Buttons

HELP This button accesses the built-in help features of the WMS program. Although new help features are continually being incorporated into the program, you may find that in some windows the HELP button does not activate. If you are having difficulties with a particular feature, please consult this manual or your Livingston representative for further information.

PRINT This button will print the contents of the WMS window to the default Windows printer. Printing can take place from most of the screens that appear in the display window. NOTE: The printer will *only* print what is visible in the display window to the left of the virtual keypad

Proper Shutdown Procedure

The WMS program uses databases to keep track of configuration settings and weld data. Properly shutting down or exiting the software is important since improper shutdown may result in a corrupt database. Many times a corrupt database can be repaired but other times data may not be recovered.

Proper Manual Monitor Shutdown Procedure:

1. Use either the ESCAPE key or MENU key to return to the **Main Menu**;

2. Select **Shutdown;**

3. You will be taken to a shutdown menu with four different options:
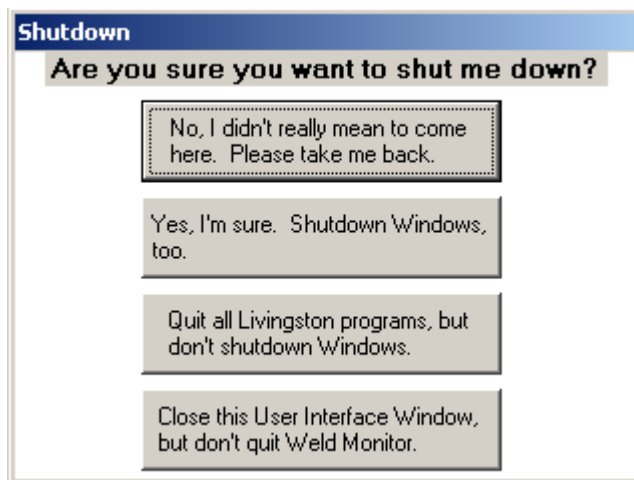
4. Select the appropriate shutdown option.

Figure **4-2** Shutdown screen

"Yes, I'm sure. Shutdown Windows too." Once this option is selected, the WMS software will exit and then shutdown Windows.

"Quit all Livingston programs, but don't shutdown Windows" This option will cause all of the Livingston programs to exit and close all open databases.

"Close this User Interface Window but don't quit Weld Monitor." The WMS software on a Pod Server consists of two pieces of software that are running at the same time; the User Interface (livcoset.exe) and another "behind-the-scenes" application (GUIPodServer.exe) that handles the recording of weld data received from Pods. This shutdown option will close the User Interface but will leave GUIPodServer running so that weld data may still be collected from the Pods and also allow interlock to a PLC via the Pod Server.

If the Pod system has a dedicated Pod™ Server, the installation of a UPS (uninterruptible power supply) is recommended to avoid a "hard" shutdown of the computer due to sudden loss of power. This kind of shutdown may result in corrupt databases and in some cases damage to Windows system files leaving the computer inoperable.

WMS Quick Start Guide – P3 POD

This chapter is a quick how-to guide to begin using a Livingston Pod weld monitor. The provided example describes the necessary steps to collect and view data, create a master and set tolerances.

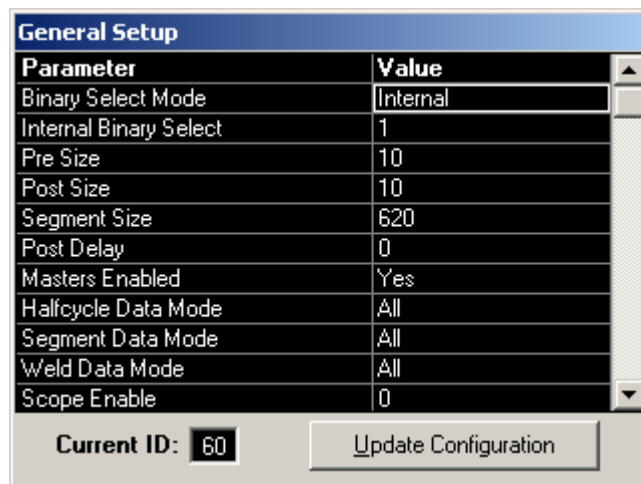**Note:** Since this is only an example, it assumes the following:

- All hardware has been properly installed, all sensors have been properly calibrated, and the Pod™ system is powered, the Pod is online and ready to monitor;

- You are familiar with the navigation and editing functions within the WMS program (see Chapter 4, Getting Familiar With The Pod™ Server).

- *For MFDC: Please note that this quick start guide refers to halfcycles. If your weld process is MFDC, please set the **weld type** to **MFDC** in the General Setup (see below). MFDC is monitored in milliseconds. All of the references to halfcycles in this section will correspond to milliseconds for MFDC.*

Due to the variety of welding processes and schedules throughout the welding industry, the following example steps may not be applicable to every welding process. For a complete description of all functions in the WMS program, refer to Chapter 6, WMS Reference Guide.

General Setup

The first step is to confirm that the general configuration settings are appropriate for this procedure.

1. With the equipment set up for monitoring and the WMS program running, go to the **Main Menu**. Select **Setup**, then **General Setup**.

2. **Current ID** should be set to select the Pod that you are using. In the example the Pod ID is 60.

3. For the purposes of this example, set the General Setup parameters to the following values (parameters not mentioned here can be left at their default settings). Refer to the General Setup Menu in Section 6, WMS Reference Guide, for parameter specifics.

Figure **5-1** General Setup screen

Pre Size = 10	**Halfcycle Data Mode = All**
Post Size = 10	**Segment Data Mode = All**
Post Delay = 0	**Weld Data Mode = All**
Masters Enabled = Yes	**Segment Tolerance Fault = Disabled**
Weld Tolerance Fault = Disabled	

   Note: To simplify the quick start example, segment and weld fault have been disabled.

4. Once these changes have been made, click on the Update Configuration button to update settings to the weld monitor.

5. ESCAPE to the main program screen.

Gathering Data

1. Make one weld and then look at the main screen of the monitor. It should appear similar to the figure below (Please refer to Main Program Screen in Section 6, <u>WMS Reference Guide,</u> for main screen specifics):

Figure **5-2** Main screen
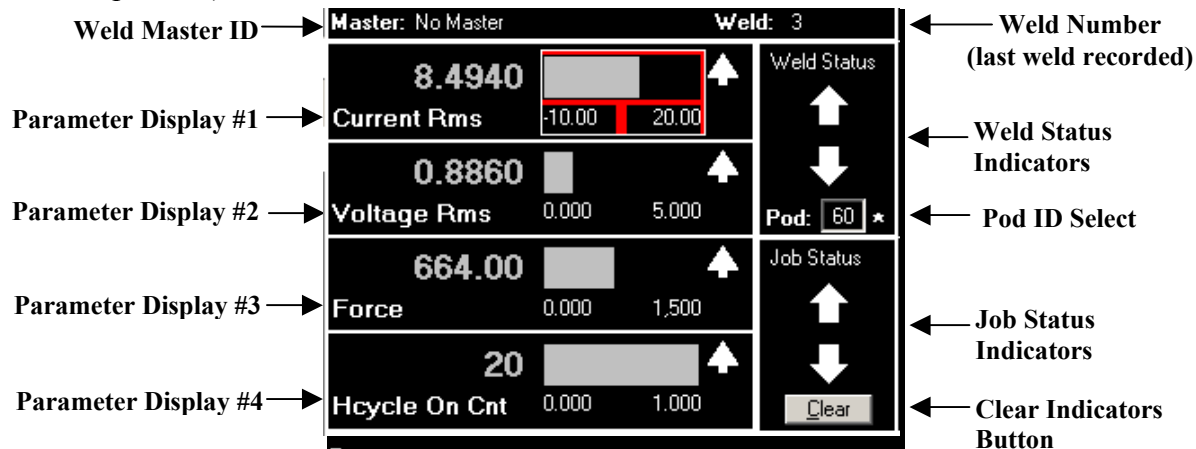
- **Weld Master ID**

   Indicates which master the displayed weld data was compared to. If masters are not enabled, or if there aren't any updated masters, it will say **No Master**. If there is an active master, the name of the master will be displayed.

- **Weld Number**

   The weld number indicates which weld corresponds to the displayed data. In figure 5-2, the weld number is **3**. This means that for **Weld 3**, the **Current Rms** was **8.494 KA**, the **Voltage Rms** was **0.886 Volts**, the **Force** was **664 lbs.** and the **Hcycle On Cnt** was **20 Halfcycles**. Each time a weld is recorded by the monitor, the weld count will increase.

- **Parameter Displays**

   Four parameters may be viewed on the main screen at one time. In this example, **Current RMS**, **Voltage RMS**, **Force** and **Hcycle On Cnt** are shown. Your screen may look different if other parameters have been selected. There are multiple parameters recorded by the monitor: **Current Rms**, **Current Peak**, **Voltage Rms**, **Voltage Peak**, **Force**, Conduction Angle (**Cond. Angle**), **Setdown**, **Expansion**, **Initial Thickness**, **Final Thickness**, **Resistance**, **Energy**, and Halfcycle On Count (**Hcycle On Cnt**). These parameters are explained in detail in Chapter 6, <u>WMS Reference Guide</u>.

   In each parameter display window is the weld summary value for that parameter. To the right of each value is a bar graph. To adjust the high and low settings see Graph Setup in Section 6, <u>WMS Reference Guide</u>. You can select the bar graph to view a trend of the last 30 welds taken, as shown in figures 5-3 and 5-4. Use ESCAPE to return to the main screen.
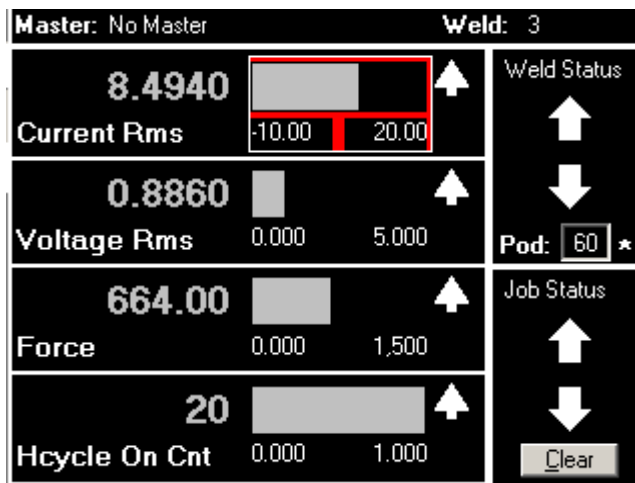
Figure **5-3** Select the bar graph to the right of a parameter (shown here with an outline around it) by mouse-clicking on the graph.
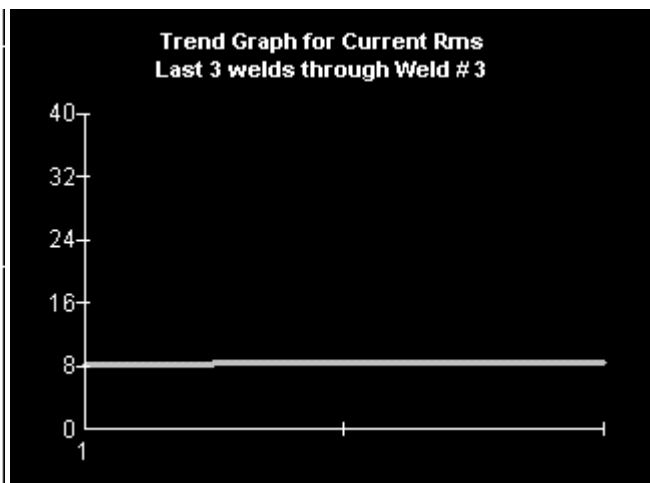
Figure **5-4** The Trend Graph for the selected parameter will display information for up to 30 welds.

- **POD / ID Select**

  Pod ID indicates which Pod (DeviceNet node address) is currently selected. All information on this screen corresponds to that Pod. **POD / ID** may be changed to select different Pods. An asterisk (*) after the **POD / ID** number indicates that that POD™ is Online and communicating with the POD™ Server.

- **Weld Status Indicators**

  Indicates the status of the displayed weld. If a check mark is displayed then the weld was accepted. If a flashing up or down arrow is displayed then the weld was rejected.

- **Job Status Indicators**

  Indicate whether any weld made in a series of welds has been rejected. If all of the welds have accepted, a check mark is displayed. If any one of them has rejected, either one or both of the arrows will flash, the same as in the **Weld Status** box. By selecting the **Weld Summary** option in the **Data Menu**, you can find out which weld(s) were rejected. See Chapter 6, WMS Reference Guide for more details.

  Smaller arrows are displayed to the right of the bar graphs for each parameter display. While the big arrows in the both the **Weld Status** and **Job Status** boxes tell you if any of the multiple parameters are over or under limit, these smaller arrows will show up next to the failed parameter. If the arrow points up, the parameter was over the tolerance limit; down signifies it was under the tolerance limit. Remember, if no master has been updated or masters are not enabled, all weld parameters will fail by default and the arrows will flash.

- **Clear Indicator Button**

  This button at the bottom of the Job Status box will clear all flashing arrows from the screen and display check marks.

2. Make a few welds using weld settings and parts customary for the application. After each weld is made, notice the weld number increase by one.

- Use the MENU key to go to the **Main Menu**. Select **Data**, then **Halfcycle Summary**. The screen should look similar to figure 5-5.

At the top of the screen is the name of the master to which the weld number at the bottom of the screen was compared. If there was no master in use when the weld was made, it will say **No Master**. Below the master name are two parameter boxes. The parameter on the left is represented by the axis on the left; the parameter on the right is represented by the axis on the right. You can select either box and scroll through the list to change which two parameters are displayed. The parameter in the left box will be displayed as a non-bold line. The parameter in the right box will show up as a bold bright solid line. If you have trouble differentiating between the two, select the same parameter in both boxes. The horizontal axis is measured in halfcycles.

Figure **5-5** Halfcycle Summary (graph)

If the graph extends vertically off the screen, you can change the graph display range by doing the following:

1. ESCAPE to the **Main Menu**. Select **Setup**, then **Graph Setup.**

2. Select the value in the **Graph Low** or **Graph High** boxes that correspond with the parameter displayed in the **Halfcycle Summary** screen and scroll through or type in the desired high / low value. When you return to the **Halfcycle Summary** screen, the changes will take effect immediately.

Parameter	Unit	Graph Low	Graph High
CondAngle	Deg	0	180
CurrentPeak	KA	-50	50
CurrentRms	KA	-10	20
cycleon	HC	0	1
Energy	KVA	0	50
Expansion	IN	-0.05	0.05
FinalThickness	IN	-0.05	0.05
Force	LBS	0	1500
InitialThickness	IN	-0.05	0.05
PowerFactor	PF	0	1
Resistance	uOH	0	500
SetDown	IN	-0.05	0.05
VoltagePeak	V	-60	60
VoltageRms	V	0	5

Figure **5-6** By changing the Low/High values for a displayed parameter in the Graph Setup…

Figure **5-7** …you can alter the graph display on the monitor.

At the bottom of the **Halfcycle Summary** screen are two buttons: **Zoom** and **Table**. In between them is a box labeled "**Weld**:" that is followed by the number of the weld being displayed.

- Selecting the **Table** button will display a table of the collected weld data for the weld by the halfcycle as shown in figure 5-8. Definitions of these parameters can be found in Chapter 6, <u>WMS Reference Guide</u>.
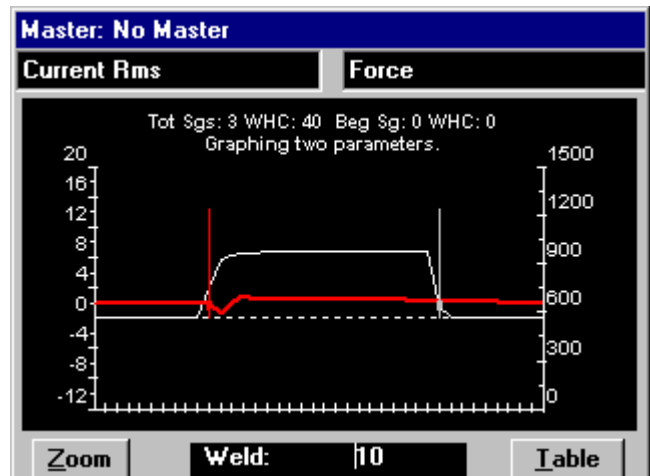
- The information shown in this table is for <u>one</u> weld, the weld number displayed on the bottom of the screen. To see data for past welds, select the **Weld** number by mouse-clicking on the screen and using the arrow keys to scroll through or enter the desired weld number.

- To return to graph format, select **Graph.**

Master: No Master

Segment	Rtype	Hcycle	Accept Status	CurrentRms	Curre
0	0	0	680277	0.005871468	0.014
0	0	1	680277	0.006876951	0.023
0	0	2	680277	0.006061618	0.028
0	0	3	680277	0.006351841	0.017
0	0	4	680277	0.006040236	0.017
0	0	5	680277	0.005851092	0.01
0	0	6	680277	0.005604363	0.01
0	0	7	680277	0.006549323	0.02
0	0	8	680277	0.006258716	0.021
0	0	9	680277	0.006443619	0.020
1	0	0	5924245	3.93578	8.16

Weld: 10 — Graph

Figure **5-8** Halfcycle Summary (table)

Highlight any cell in the **Accept Status** column and click on the SELECT key. A window will appear giving a summary of failed parameters as shown in figure 5-9. By highlighting a specific parameter value and clicking on the SELECT key, a window will display the high and low tolerance limits for that parameter based on the master tolerances. Refer to Chapter 6, <u>WMS Reference Guide</u> for additional details.

Master: No Master

Segment	Rtype	Hcycle	Accept Status	CurrentRms	Curre
0	0	0			
0	0	1			
0	0	2			
0	0	3			
0	0	4			
0	0	5			
0	0	6			
0	0	7			
0	0	8			
0	0	9			
1	0	0			

Out of tolerance:
Current Rms: Over limit
Current Peak: Over limit
Voltage Rms: Over limit
Voltage Peak: Over limit
Force: Over limit
Setdown: Under limit
Expansion: Over limit
InitialThickness: Under limit
FinalThickness: Under limit

Weld: 10 — Graph

Figure **5-9** Pop-up window of failed parameters in the Halfcycle Summary

Master: 3/20/01 11:35:05 AM M01

Segment	Rtype	Hcycle	Accept Status	CurrentRms	Curre
0	0	0			
0	0	1			
0	0	2			
0	0	3			
0	0	4			
0	0	5			
0	0	6			
0	0	7			
0	0	8			
0	0	9			
1	0	0			

Tolerance limits for Current Rms:

Halfcycle:
Low: -9.992909
High: 10.007091

Segment Average:
Low: -10.0
High: 10.0

Weld: 873 — Graph

Figure **5-10** Tolerance Limits are displayed by using the SELECT key on a parameter value once a master has been made and toleranced

- ESCAPE to the **Data Menu** and then select **Weld Summary**.

- The screen will look similar to figure 5-11 below. Unlike the **Halfcycle Summary** screen, the **Weld Summary** screen displays recorded weld summary information for each weld made. The most recent weld recorded will always be at the top of the list; you can scroll down to see information for each weld. Definitions of additional parameter headings in this screen can be found in Chapter 6, <u>WMS Reference Guide</u>.

For the **Weld Summary** screen, use the SELECT key the same way as in the **Halfcycle Summary** screen to get a breakdown of failed parameters and weld tolerance limits.

Weld	Halfcycles	Hcycles on	Accept Status	Binselec
10	40	20	73065941	0
9	40	20	73065941	0
8	40	20	73065941	0
7	40	20	73065941	0
6	40	20	73065941	0
5	40	20	73065941	0
4	40	20	73065941	0
3	40	20	73065941	0
2	40	20	73065941	0
1	40	20	73065941	0

Figure **5-11** Weld Summary

Creating a Master

Now that you have observed recorded weld data, we will make a master, which will provide known good values to compare subsequent welds against.

Note: An appropriate weld schedule should be established before creating a master. General Setup Parameters and tolerance defaults should be set appropriately before creating a new master.

To start data capture for a new master:

1. Use ESCAPE to exit the **Weld Summary** screen, then click on the MENU key to display the **Main Menu** options;

2. Select **Mastering**;

3. Select **New** from the options. The message displayed reads "Initializing master memory," then "Creating new master: Ready to accept welds..." The **New** button changes to **Done**.

4. Make **one** weld, using weld settings and new parts customary for the application..

5. Click on the **Done** button to end the data capture. The screen will say "**Updating master weld set**." The date/time stamp of the new master is displayed at the top left of the screen.

6. Your screen should now look similar to figure 5-13. Click on the **Update** button to save the newly created master into the monitor's memory.

    Note: Anytime you create a new master, change the name of a master or change tolerances for a master you MUST hit the Update button for the new master / tolerance changes to take effect.

    The 'MO1' after the date/time stamp of a master refers to the Master Select (binary select) number. For more information about Bin Selects, please refer to Chapter 6, <u>WMS Reference Guide</u>.

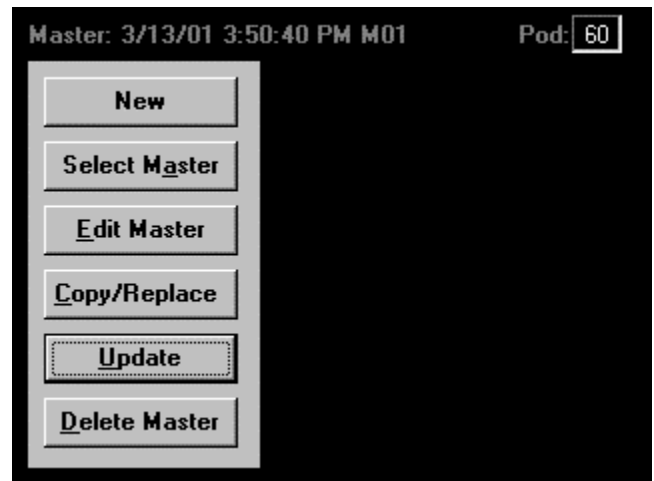Figure **5-12** Mastering screen, ready to accept welds.

Figure **5-13** Mastering screen with new master date/time stamp displayed at the top left. Click on **Update** to update master for use by the monitor.

Accepting / Rejecting Welds

Once a master has been created and updated, the monitor has a basis on which to compare subsequent welds. If all parameters fall within the master tolerance limits, the weld is *accepted* by the monitor. If any of the parameters fall outside of the master tolerance limits, the weld is *rejected* by the monitor. This section will demonstrate an *accepted* weld and a *rejected* weld.

Making an accepted weld

1. ESCAPE to the main program screen.

2. Make another weld. Notice that the newly created master is displayed in the top left, indicating that the weld was compared against this master, as shown in figure 5-14. Ideally this weld should have accepted and a check mark should be displayed in the **Weld Status** box. If there are flashing arrows in the **Weld Status** box, then weld rejected for some reason. Either the weld was rejected because the master tolerances are set too tightly, or either the master weld or the last weld made was not characteristic of a typical weld for this process.

Figure **5-14** Main program screen with new master date/time stamp displayed

3. Go to the **Weld Summary** screen and look at the **Accept Status** for the weld you just made (the most recent weld will be at the top). An Accept Status of 0 indicates that the weld was accepted. If the weld was rejected, highlight the Accept Status number and click on the SELECT key to see what parameters failed.

4. Go to the **Halfcycle Summary** Screen to graphically compare the half cycle data with the master tolerance limits. Change the parameter in the top left box to **Current Rms** and the parameter in the top right box to **Hcycle Limits**. Your screen should now look similar to figure 5-15.

   The thin vertical arrows pointing down separate the three default segments (Pre-weld, Weld and Post-weld) of the weld process. The upper and lower horizontal lines represent the default tolerances assigned to the master. The middle line represents the weld signature for the weld number at the bottom of the screen. As you can see, the parameter Current Rms was within the tolerance defaults of this master. For the weld to be *accepted*, all parameters must be within the master tolerance limits.

   Selecting different parameters in the upper left box will allow you to compare all parameters with the master tolerance limits.
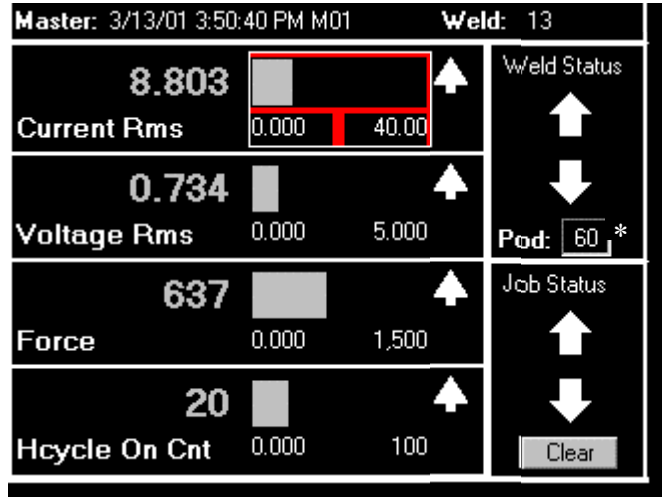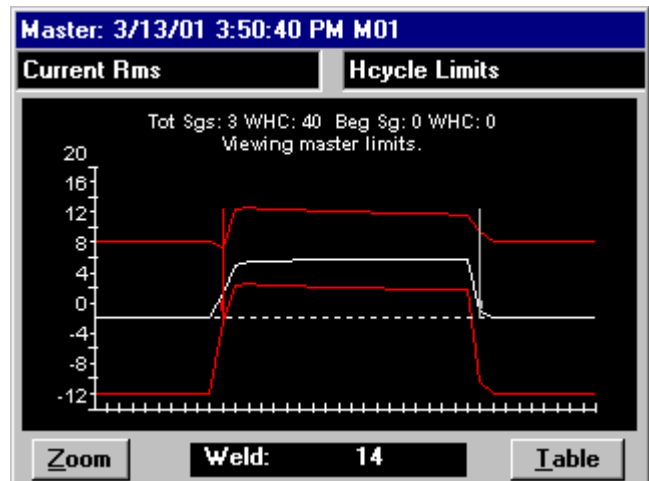
Figure **5-15** Halfcycle Summary, Current Rms shown with Halfcycle Limits

5. If for some reason your weld rejected, try making more welds to see if any accept. If the welds continue to reject, review the failed parameters and skip ahead to the tolerancing section of the WMS quick start guide. Adjust master tolerances until welds are accepted and continue with the following steps to make a rejected weld.

Making a rejected weld

Now we will deliberately reject weld and see what the resulting halfcycle data looks like. We'll use an increased halfcycle count as an example.

1. ESCAPE to the main program screen.

2. Increase the weld cycle count by 2 on your weld controller.

3. Make a weld using the new weld schedule and observe the monitor screen. You should see a blinking arrow in the **Weld Status** box, as shown in figure 5-16. If one of your displayed parameters is **Hcycle On Cnt**, you'll also see a small blinking arrow next to the bar graph.
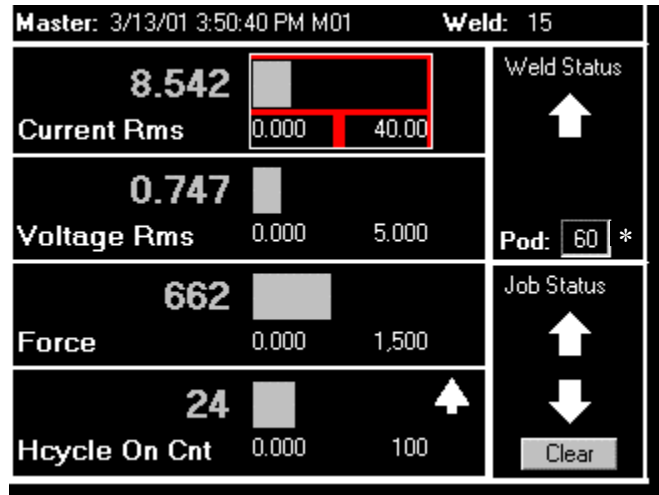
Figure **5-16** Main program screen showing REJECTED weld

4. Go to the **Halfcycle Summary** screen. It should look something like figure 5-17.

Notice that although the line representing **Current Rms** has remained within the tolerance boundaries, it has extended past the Weld segment boundary. Because of the 4 added halfcycles in the weld schedule, this weld did not match the master (the master was made without the extra 2 cycles) and as a result was not passed (REJECTED).

5. Remove the two additional cycles from your weld schedule before proceeding.
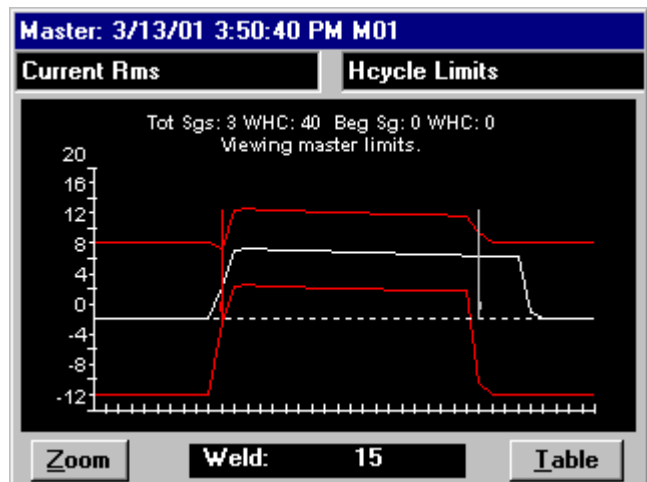
Figure **5-17** Halfcycle Summary of REJECTED weld

Tolerancing

In the WMS program, welds are *accepted* or *rejected* based on specific tolerances assigned for individual parameters within an active master. Tolerances can be defined as relative or absolute values. Refer to the Tolerancing in section 6, <u>WMS Reference Guide,</u> for a definition of relative and absolute tolerances.

As weld data is recorded and compared to the master tolerance limits, the monitor flags values that are out of tolerance. In this section, we'll change the tolerances for the master that was just made and then accept / reject welds based on those master tolerance limits.

1. From the **Main Menu**, select <u>**Tolerancing**</u>. If nothing comes up, click on the **Select Master** button and highlight the master we just made. Click on SELECT. Your screen should look similar to figure 5-18.

2. Mouse-click anywhere within the Weld segment (middle of the screen) so that the pointer (thinnest vertical arrow) is in Segment 1 (Weld segment). Under HALFCYCLE TOLERANCES, the screen should say **Segment: 1**.
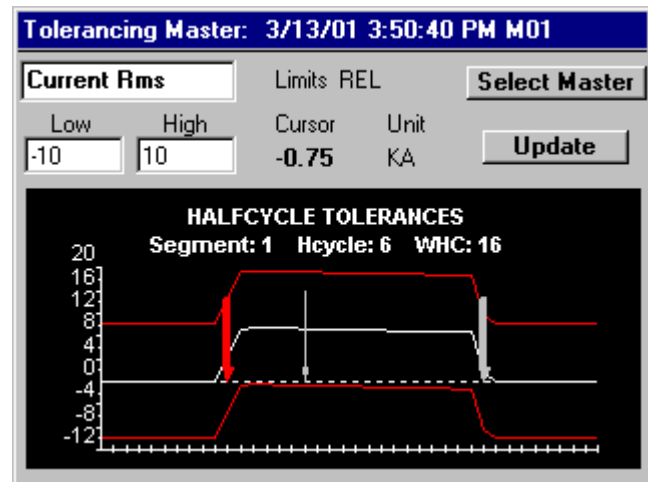
Figure **5-18** Tolerancing screen

3. Select the parameter **Current Rms**.

4. Select the **Low** number and change it to –1. Select the **High** number and change it to 1.

5. Click on the **Update** button. After a few moments, the screen should now look similar to figure 5-19. Notice that the tolerance bands have adjusted accordingly.
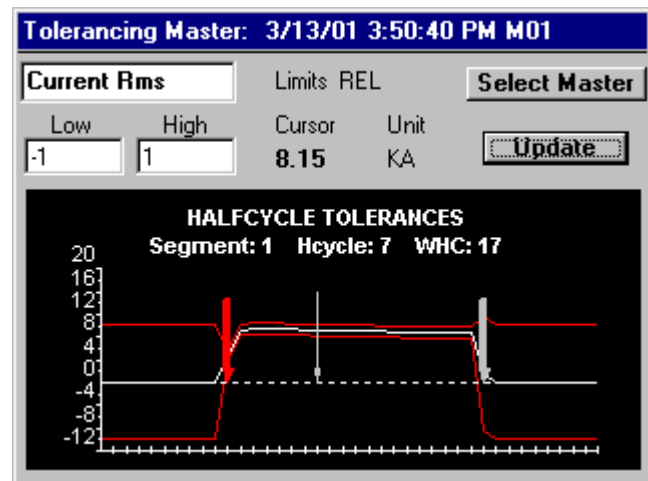
Figure **5-19** Master with Low/High tolerances changed

6. ESCAPE to the main screen and make a weld. If the weld passes, go to the **Halfcycle Summary** screen. Your **Halfcycle Summary** screen should look similar to figure 5-20. Notice that the **Current Rms** line is within the set tolerances. Now we'll lower the heat for the next weld so you can see what happens.

7. Decrease the heat on your weld schedule by 20. (If your schedule is set for 45% heat, lower it to 25% heat). ESCAPE to the main screen and make a weld.

8. The **Weld Status** box should display flashing arrows, indicating a REJECTED weld, as shown in figure 5-21. Go to the **Halfcycle Summary** screen. It should look similar to figure 5-22. Notice that the **Current Rms** line is below the lower tolerance boundary, causing a REJECTED weld.

Figure **5-20** Halfcycle Summary for ACCEPTED weld

Figure **5-21** Main program screen displaying a REJECTED weld (**Current Rms**, etc. too low)

Figure **5-22** Halfcycle Summary for REJECTED weld

WMS Quick Start Guide – P1 POD

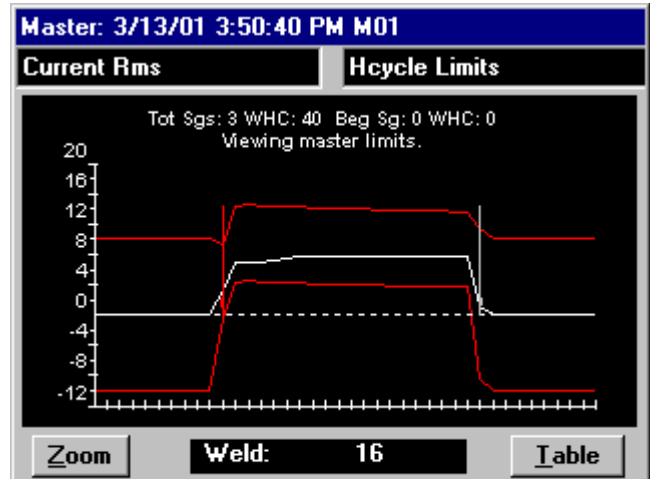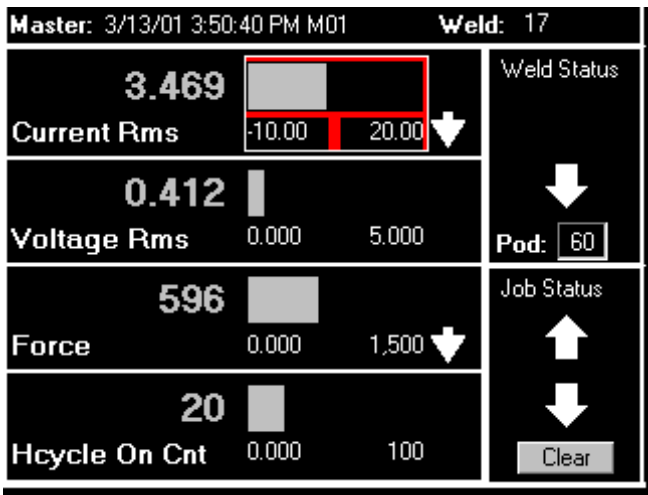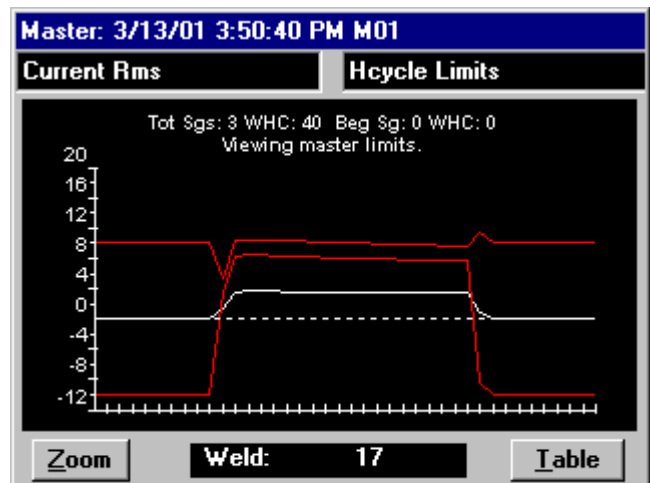This chapter is a quick how-to guide to begin using a Livingston P1 Pod weld monitor. The provided example describes the necessary steps to collect and view data and create weld tolerances. The P1 Pod is a basic feature weld monitor that will accept/reject welds based on absolute weld tolerances for Current RMS, Voltage RMS, Force, Initial Thickness, Set Down, and cycle count. All other parameters are recorded but ignored when determining the weld status.

Note: Since this is only an example, it assumes the following:
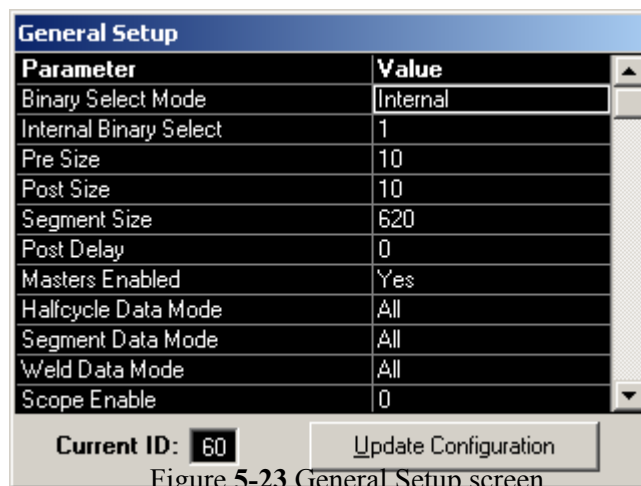
- All hardware has been properly installed, all sensors have been properly calibrated, and the Pod™ system is powered, the Pod is online and ready to monitor;

- You are familiar with the navigation and editing functions within the WMS program (see Chapter 4, Getting Familiar With The Pod™ Server).

- *For MFDC: Please note that this quick start guide refers to halfcycles. If your weld process is MFDC, please set the **weld type** to **MFDC** in the General Setup (see below). MFDC is monitored in milliseconds. All of the references to halfcycles in this section will correspond to milliseconds for MFDC.*

Due to the variety of welding processes and schedules throughout the welding industry, the following example steps may not be applicable to every welding process. For a complete description of all functions in the WMS program, refer to Chapter 6, WMS Reference Guide.

General Setup

The first step is to confirm that the general configuration settings are appropriate for this procedure.

1. With the equipment set up for monitoring and the WMS program running, go to the **Main Menu**. Select **Setup**, then **General Setup**.

2. **Current ID** should be set to select the Pod that you are using. In the example the Pod ID is 60.

3. For the purposes of this example, set the General Setup parameters to the following values (parameters not mentioned here can be left at their default settings). Refer to the General Setup Menu in Section 6, WMS Reference Guide, for parameter specifics.

Figure **5-23** General Setup screen

|	
Pre Size = 10	**Halfcycle Data Mode = All**
Post Size = 10	**Segment Data Mode = All**
Post Delay = 0	**Weld Data Mode = All**
Masters Enabled = Yes	

4. Once these changes have been made, click on the Update Configuration button to update settings to the weld monitor.

5. ESCAPE to the main program screen.

Gathering Data

Make one weld and then look at the main screen of the monitor. It should appear similar to the figure below (Please refer to Main Program Screen in Section 6, <u>WMS Reference Guide,</u> for main screen specifics):

Figure **5-24** Main screen
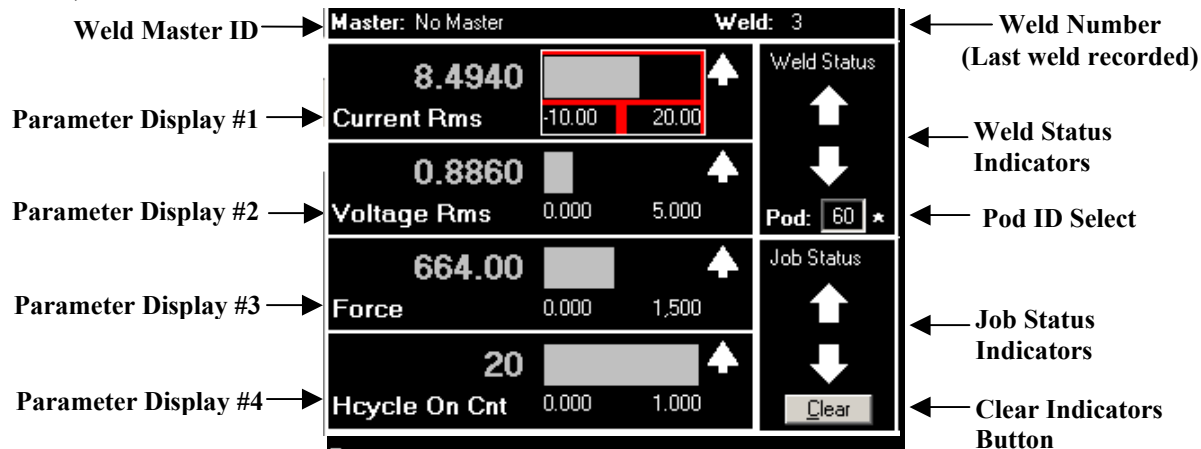
- **Weld Master ID**

  Indicates which master the displayed weld data was compared to. If masters are not enabled, or if there aren't any updated masters, it will say **No Master**. If there is an active master, the name of the master will be displayed.

- **Weld Number**

  The weld number indicates which weld corresponds to the displayed data. In figure 5-24, the weld number is **3**. This means that for **Weld 3**, the **Current Rms** was **8.494 KA**, the **Voltage Rms** was **0.886 Volts**, the **Force** was **664 lbs.** and the **Hcycle On Cnt** was **20 Halfcycles**. Each time a weld is recorded by the monitor, the weld count will increase.

- **Parameter Displays**

  Four parameters may be viewed on the main screen at one time. In this example, **Current RMS**, **Voltage RMS**, **Force** and **Hcycle On Cnt** are shown. Your screen may look different if other parameters have been selected. There are multiple parameters recorded by the monitor: **Current Rms**, **Current Peak**, **Voltage Rms**, **Voltage Peak**, **Force**, Conduction Angle (**Cond. Angle**), **Setdown**, **Expansion**, **Initial Thickness**, **Final Thickness**, **Resistance**, **Energy**, and Halfcycle On Count (**Hcycle On Cnt**). These parameters are explained in detail in Chapter 6, <u>WMS Reference Guide</u>.

  In each parameter display window is the weld summary value for that parameter. To the right of each value is a bar graph. To adjust the high and low settings see Graph Setup in Section 6, <u>WMS Reference Guide</u>. You can select the bar graph to view a trend of the last 30 welds taken, as shown in figures 5-25 and 5-26. Use ESCAPE to return to the main screen.
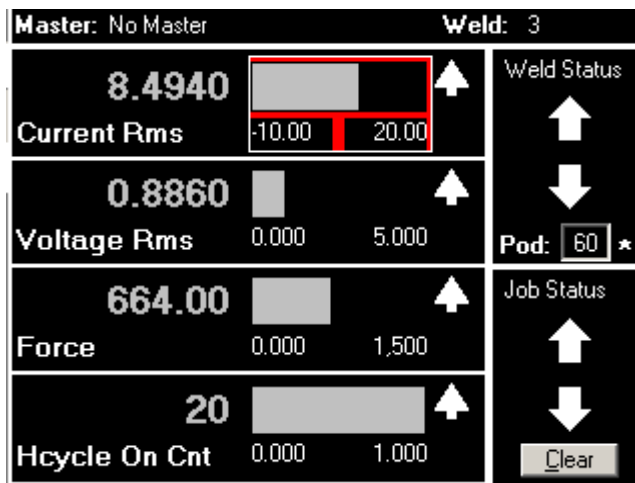
Figure **5-25** Select the bar graph to the right of a parameter (shown here with an outline around it) by mouse-clicking on the graph.

Figure **5-26** The Trend Graph for the selected parameter will display information for up to 30 welds.

- **POD / ID Select**

  Pod ID indicates which Pod (DeviceNet node address) is currently selected. All information on this screen corresponds to that Pod. **POD / ID** may be changed to select different Pods. An asterisk (*) after the **POD / ID** number indicates that the POD™ is Online and communicating with the POD™ Server.

- **Weld Status Indicators**

  Indicates the status of the displayed weld. If a check mark is displayed then the weld was accepted. If a flashing up or down arrow is displayed then the weld was rejected.

- **Job Status Indicators**

  Indicate whether any weld made in a series of welds has been rejected. If all of the welds have accepted, a check mark is displayed. If any one of them has rejected, either one or both of the arrows will flash, the same as in the **Weld Status** box. By selecting the **Weld Summary** option in the **Data Menu**, you can find out which weld(s) were rejected. See Chapter 6, WMS Reference Guide for more details.

  Smaller arrows are displayed to the right of the bar graphs for each parameter display. While the big arrows in both the **Weld Status** and **Job Status** boxes tell you if any of the parameters are over or under limit, these smaller arrows will show up next to the failed parameter. If the arrow points up, the parameter was over the tolerance limit; down signifies it was under the tolerance limit. Remember, if no master tolerance limits have been updated or masters are not enabled, all weld parameters will fail by default and the arrows will flash.

- **Clear Indicator Button**

  This button at the bottom of the Job Status box will clear all flashing arrows from the screen and display check marks.

2. Make a few welds using weld settings and parts customary for the application. After each weld is made, notice the weld number increase by one.

    •   Use the MENU key to go to the **Main Menu**. Select **Data**, then **Halfcycle Summary**. The screen should look similar to figure 5-27.

At the top of the screen is the name of the master to which the weld number at the bottom of the screen was compared. If there was no master in use when the weld was made, it will say **No Master**. Below the master name are two parameter boxes. The parameter on the left is represented by the axis on the left; the parameter on the right is represented by the axis on the right. You can select either box and scroll through the list to change which two parameters are displayed. The parameter in the left box will be displayed as a white line. The parameter in the right box will show up as a red line. The horizontal axis is measured in halfcycles.
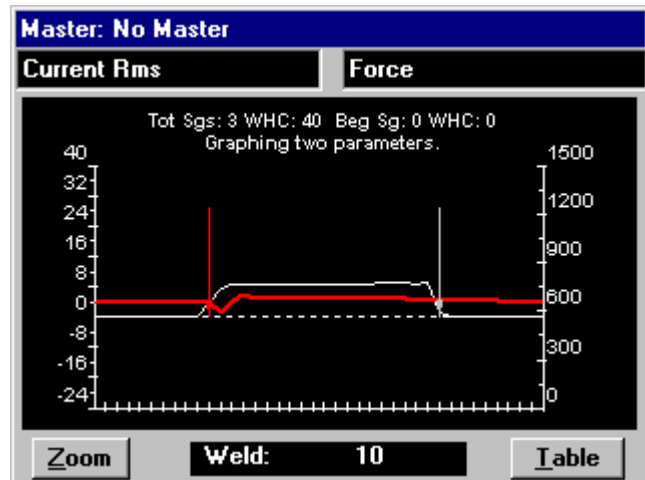
Figure **5-27** Halfcycle Summary (graph)

If the graph extends vertically off the screen, you can change the graph display range by doing the following:

1. ESCAPE to the **Main Menu**. Select **Setup**, then **Graph Setup.**

2. Select the value in the **Graph Low** or **Graph High** boxes that correspond with the parameter displayed in the **Halfcycle Summary** screen and scroll through or type in the desired high / low value. When you return to the **Halfcycle Summary** screen, the changes will take effect immediately.

Figure **5-28** By changing the Low/High values for a displayed parameter in the Graph Setup…

Figure **5-29** you can alter the graph display on the monitor.

At the bottom of the **Halfcycle Summary** screen are two buttons: **Zoom** and **Table**. In between them is a box labeled "**Weld**:" that is followed by the number of the weld being displayed.

- Selecting the **Table** button will display a table of the collected weld data for the weld by the halfcycle as shown in figure 5-30. Definitions of these parameters can be found in Section 6, WMS Reference Guide.

- The data shown in this table is for <u>one</u> weld, the weld number displayed on the bottom of the screen. The data includes Halfcycle, Segment and Weld summary records. For more information about these records, refer to Halfcycle Summary Screen in Section 6, WMS Reference Guide. To see data for past welds, select the **Weld** number and use the arrow keys to scroll through or enter the desired weld number.

Master: No Master

Segment	Rtype	Hcycle	Accept Status	CurrentRms	Curre
0	0	0	680277	0.005871468	0.014
0	0	1	680277	0.006876951	0.023
0	0	2	680277	0.006061618	0.028
0	0	3	680277	0.006351841	0.017
0	0	4	680277	0.006040236	0.017
0	0	5	680277	0.005851092	0.01
0	0	6	680277	0.005604363	0.01
0	0	7	680277	0.006549323	0.02
0	0	8	680277	0.006258716	0.021
0	0	9	680277	0.006443619	0.020
1	0	0	5924245	3.93578	8.16

Weld: 10   **Graph**

Figure **5-30** Halfcycle Summary (table)

- To return to graph format, select **Graph.**

- ESCAPE to the **Data Menu** and then select **Weld Summary**.

- The screen will look similar to figure 5-31 below. Unlike the **Halfcycle Summary** screen, the **Weld Summary** screen displays recorded weld summary information for each weld made. The most recent weld recorded will always be at the top of the list; you can scroll down to see information for each weld. Definitions of additional parameter headings in this screen can be found in Chapter 6, WMS Reference Guide.

Weld	Halfcycles	Hcycles on	Accept Status	Binselec
10	40	20	73065941	0
9	40	20	73065941	0
8	40	20	73065941	0
7	40	20	73065941	0
6	40	20	73065941	0
5	40	20	73065941	0
4	40	20	73065941	0
3	40	20	73065941	0
2	40	20	73065941	0
1	40	20	73065941	0

Figure **5-31** Weld Summary

- Highlight any cell in the **Accept Status** column and click on the SELECT key. A window will appear giving a summary of failed parameters as shown in figure 5-32. By highlighting a specific parameter value and clicking on the SELECT key, a window will display the high and low tolerance limits for that parameter based on the master weld tolerances, see figures 5-33 and 5-34. Refer to Chapter 6, <u>WMS Reference Guide</u> for additional details.

Figure **5-32** Pop-up window of failed parameters in the Halfcycle Summary

Figure **5-33** Tolerance Limits are not displayed for a parameter until master tolerances have been created and updated

Figure **5-34** Tolerance Limits are displayed by using the SELECT key on a parameter value once master tolerances have been created and updated

Creating Master Tolerance Limits

Now that you have observed recorded weld data, we will create master tolerance limits, which will provide known good values to compare subsequent welds against.

Note: An appropriate weld schedule should be established before setting master tolerance limits. General Setup Parameters and tolerance defaults should be set appropriately before creating new master tolerance limits.

To create new master tolerance limits for a P1 Pod:

1. Use ESCAPE to exit the **Weld Summary** screen, then click on the MENU key to display the **Main Menu** options;

2. Select **Tolerancing**.

3. Click the **New** button from the options (see Figure 5-35). The message displayed reads, "Creating new P1 tolerances." This creates a new set of master tolerance limits for the Bin (binary select) and Pod displayed on the screen. In the example the Bin is 1 and the Pod is 60. For more information about Bin Selects, please refer to Chapter 6, WMS Reference Guide.

Figure **5-35** P1 Tolerancing screen.

4. Set the tolerance limits for each of the parameters by selecting the cell and entering the desired value or using the arrow keys to adjust the numbers. For a P1 pod all tolerances are *absolute*. In the example the tolerances were set as in Figure 5-36.

5. Your screen should now look similar to figure 5-36. Notice the message "P1 Tolerances have NOT been updated." Click the **Update** button for the new master tolerance limits to take effect.

Note: Anytime you create a new set of master tolerance limits or make changes to the tolerances you MUST click the **Update** button for the new master / tolerance changes to take effect.

Figure **5-36** P1 Tolerance limits.

When creating master tolerance limits for a P1 Pod, the master name is always "P", followed by the Pod number, followed by "M", following by the Bin number. In the example the master has the name of "P60 M01". This name will be displayed along with weld data for any welds that are compared to these master tolerance limits.

Accepting / Rejecting Welds

Once a master has been created and updated, the monitor has a basis on which to compare subsequent welds. If all parameters fall within the master tolerance limits, the weld is *accepted* by the monitor. If any of the parameters fall outside of the master tolerance limits, the weld is *rejected* by the monitor. This section will demonstrate an *accepted* weld and a *rejected* weld.

Making an accepted weld

1. ESCAPE to the main program screen.

2. Make another weld. Notice that master created in the last section is displayed in the top left, indicating that the weld was compared against this master's tolerance limits, as shown in figure 5-37. Ideally this weld should have accepted and a check mark should be displayed in the **Weld Status** box.

   If there are flashing arrows in the **Weld Status** box, then weld rejected for some reason. Either the weld was rejected because the master tolerances are set too tightly, or either the master weld or the last weld made was not characteristic of a typical weld for this process. Try making more welds to see if any accept. If the welds continue to reject, review the failed parameters and adjust your tolerances accordingly until welds are accepted and then continue with the following steps
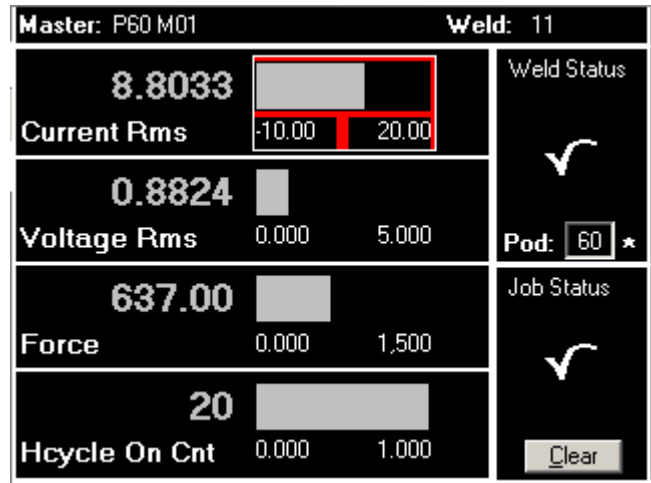
Figure **5-37** Main program screen with new master date/time stamp displayed

3. Go to the **Weld Summary** screen (Figure 5-38) and look at the **Accept Status** for the weld you just made (the most recent weld will be at the top). An Accept Status of 0 indicates that the weld was accepted. If the weld was rejected, highlight the Accept Status number and click on the SELECT key to see what parameters failed.

4. Highlight the CurrentRms cell and click **SELECT** to view the tolerances limits for this parameter (Figure 5-39). Notice that CurrentRms is within the tolerances. For the weld to be *accepted*, all parameters must be within the master tolerance limits. Selecting different parameters will allow you to compare all parameters with the master tolerance limits.

Figure **5-38** Weld Summary – All parameters within tolerance.

Hcycles on	Accept Status	Binselect	CurrentRms	CurrentF
20	0	0	8.803299	12.4774
20	73065941			
20	73065941			
20	73065941			
20	73065941			
20	73065941			
20	73065941			
20	73065941			
20	73065941			
20	73065941			
20	73065941			

Tolerance limits for
Current Rms:

Weld:
  Low: 8.0
  High: 9.0

Figure **5-39** Tolerance Limits are displayed by using the SELECT key on a parameter value once master tolerances have been created and updated

Making a rejected weld

Now we will deliberately reject weld and see what the resulting halfcycle data looks like. We'll use an increased halfcycle count as an example.

1. ESCAPE to the main program screen.

2. Increase the weld cycle count by 2 on your weld controller.

3. Make a weld using the new weld schedule and observe the monitor screen. You should see a blinking arrow in the **Weld Status** box, as shown in figure 5-40. If one of your displayed parameters is **Hcycle On Cnt**, you'll also see a small blinking arrow next to the bar graph.

4. Go to the **Weld Summary** screen and look at the accept status. It should look something like figure 5-41. Notice the reason for the reject was that the halfcycle count (Hcycle On Cnt) was too high (over the master tolerance limit).

5. Remove the two additional cycles from your weld schedule before proceeding.
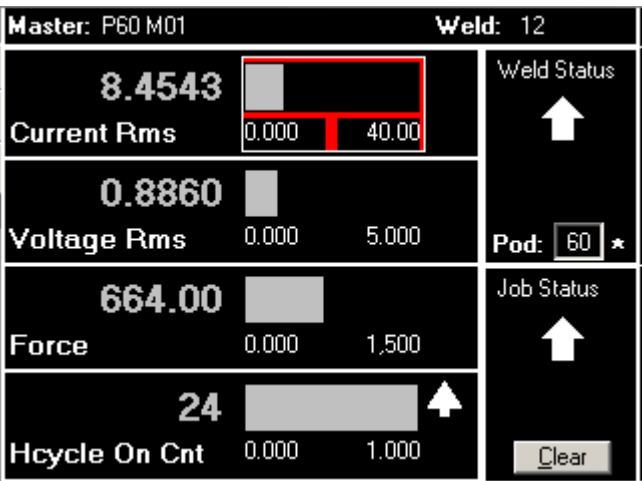
Figure **5-40** Rejected weld

Figure **5-41** Weld Summary of rejected weld

Summary

Remember, this guide is intended as an example only— the creation of master tolerance limits for individual weld processes will vary. Please refer to Chapter 6, <u>WMS Reference Guide</u> for a complete description of all functions in the WMS program, or use Chapter 10, <u>Troubleshooting Guide</u> for more information about mastering.

WMS Reference Guide

This chapter reviews every screen in the WMS program. There is an organizational chart (WMS Road Map) for the all screens in Chapter 11, <u>Appendices</u>.

Main Program Screen

The main program screen of the POD™ Server is shown in figure 6-1 below. It displays information from the most recently recorded weld.
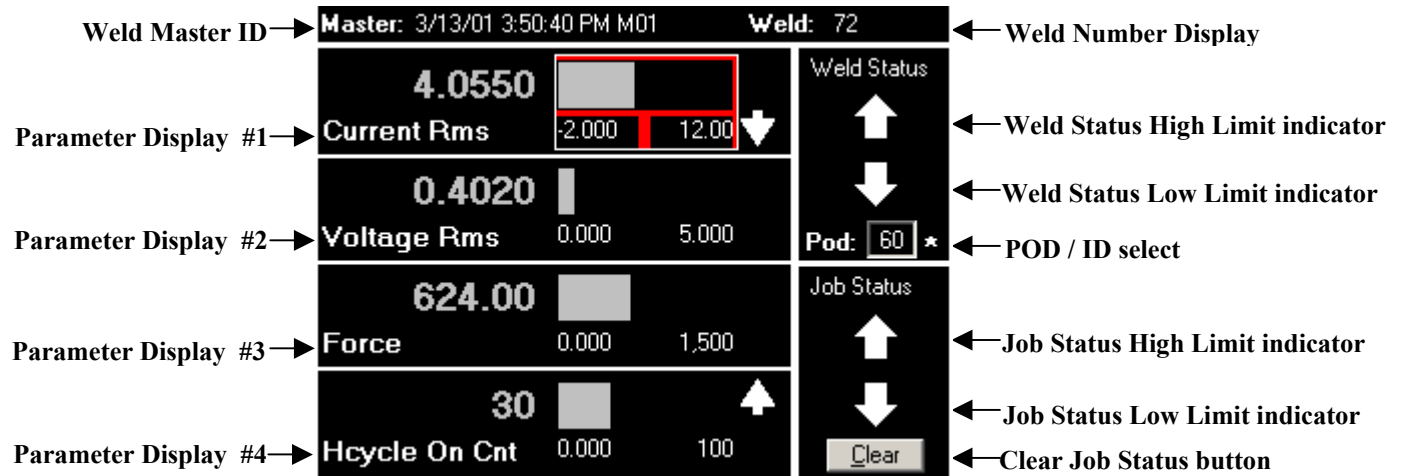
Figure **6-1** Main program screen

- **Pod / ID Select**

  This field displays/selects the DeviceNet ID of the selected POD™. An asterisk appears next to the ID if the POD™ is Online. The Pod/ID number range is set in the Pods / Server Setup screen (described later in this chapter). Weld data on the main screen corresponds to the displayed ID. Unless noted otherwise, when navigating to other screens all data, settings, commands and updates are specific to this Pod/ID.

- **Weld Master ID**

  If the Pod/ID has been set up to compare welds to a master (contains master tolerance limits), the **Master ID** is displayed. If masters are not enabled, or there is no master for this weld, the display will read **No Master**. If the weld data for this weld was used to generate a master, then the display will read **Master Weld**.

  P3 Pod: In the figure 6-1, the Master ID is **3/13/01 3:50:40 PM M01,** where **3/13/01 3:50:40 PM** is the data/time when the master was created followed by **M01** which indicates which Binary Select is associated with the master (Binary Select 01 for this master).   P1 Pod: The Master ID is "P",   followed by the Pod/ID, followed by "M", followed by the binary select value (example: **P60 M01**). There are a total of 31 binary selects available for use with a P1 or P3 POD™.

- **Weld Number Display**

  This field displays the weld number corresponding to the weld data on the Main Screen. This is the number of monitored welds since the weld data was last deleted from the database.

- **Weld Status High/Low Limit Indicators**

  One or both of the indicators will be displayed if the most recent weld was rejected. The top arrow will flash if a parameter exceeded high limits; the bottom arrow will flash if a parameter exceeded low limits. Both indicators will flash when both high and low limits were exceeded. Both indicators will also flash if there is no master made or if masters are not enabled in the **General Setup**.

- **Job Status High/Low Limit Indicators**

  One or both of the indicators will be displayed if for any of the welds were rejected since the Job Status was last cleared. Both indicators will also flash if no master has been created and updated, or if masters are not enabled in the **General Setup Menu**.

- **Weld/Job Status Good Indicator**

  If all of the weld parameters are within the master tolerance limits, a "Check Mark" is displayed in place of the high/low limit indicators.

- **Clear Job Status Button**

  When the **Clear** button is clicked, both Job Status and Weld Status are cleared, and a "Check Mark" is displayed.

- **Parameter Displays**

  All of the different weld summary parameters are available from the main screen. Each parameter display can show data for one of these parameters. A parameter display section of the main screen is shown in figure 6-2 below:
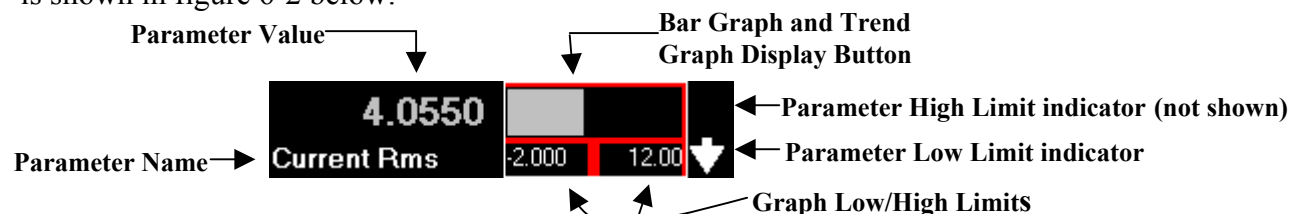
Figure **6-2** Parameter display

- **Parameter Name**

  Each parameter display can show data for one of these parameters:

Current RMS	Current Peak	Voltage RMS	Voltage Peak	Force
Conduction Angle	Setdown	Part Expansion	Initial Thickness	Energy
Final Thickness	Resistance	Power Factor	Halfcycle On Count (Msec On Count)	

Note: Power Factor is not yet implemented and will display zero.

To select a different parameter in a parameter display, touch the parameter name on the touch-screen, or navigate to the parameter name with the arrow keys so that the parameter name is outlined and click on the SELECT button to highlight it, as shown in figure 6-3. Once the parameter box is highlighted, the up/down arrows will scroll through the parameter list.

Figure **6-3** Click on the parameter display and use the SELECT button to highlight it

- **Parameter Value**

  The most recent weld summary data for the selected parameter is displayed. The units displayed may be changed in the **Tolerance Defaults** screen. In figure 6-3, the weld summary data for **Current Rms** is displayed in **KA**.

- **Graph Low/High Limit**

  Each parameter has its own graph limit settings. These can be specified in the **Graph Setup** option of the **Setup Menu**. In figure 6-3, the **Graph Low** limit is **–2** and the **Graph High** limit is **12**.

- **Parameter High/Low Limit Indicators**

  These are displayed if the current weld's parameters are not within the master tolerance limits. The top arrow will flash if a value exceeded its high limit; the bottom arrow will flash if a value is below its low limit. If the value for that parameter is within tolerances, no indicator is displayed.

  Note: If a parameter was out of tolerance but is not shown in one of the parameter displays, the **Weld Status** high/low indicators will flash. In this situation, you can scroll through the parameters or use the **Weld Summary** to determine why a weld has failed.

- **Bar Graph and Trend Graph Display button**

  This field shows the parameter value as a bar graph between the high and low graph limits.

  Note: If the data value falls outside the graph limits, the bar will not be visible. Graph limits may be changed using the **Graph Setup** option of the **Setup** menu.

The bar graph also serves as a button to display a trend graph for the selected parameter. Touch (on touch screen), mouse click on the bar graph, or navigate to the bar graph and click SELECT. A trend graph of the last 30 welds is displayed. The weld number is displayed on the x-axis (horizontal) and the data parameter value is displayed on the y-axis (vertical). To return to the Main Screen, use the ESCAPE button.

Figure **6-4** Touch (touch screen) or mouse click on the parameter bar graph to display a Trend Graph for that parameter
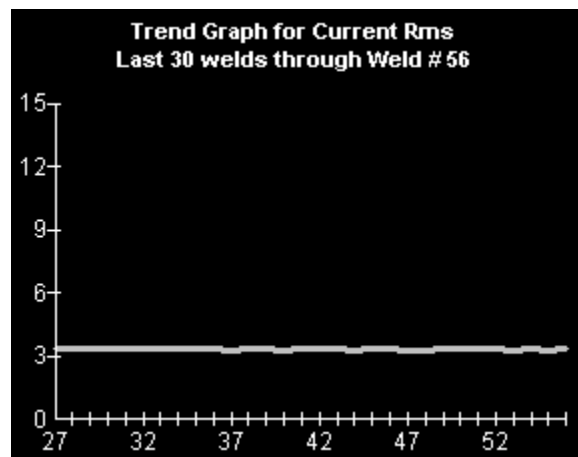
Figure **6-5** Example of a Trend Graph for Current Rms.

Main Menu Options

Selecting the MENU button on the touch-pad displays the **Main Menu**, as shown in figure 6-6. You can return to the Main Menu from sub-menus by using the MENU or ESCAPE buttons.

Note: From the keyboard, you may quickly access menu options by holding down the **ALT** key and pressing the underlined letter. For example, to go to the **Data Menu** from the **Main Menu**, hold down **ALT**, and press **D**.
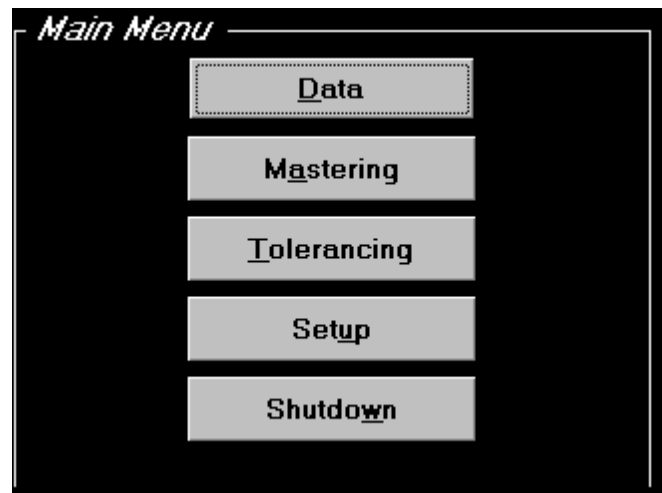
Figure **6-6** Main Menu

- **Data**

  This option displays the **Data Menu** which allows you to review weld data, access the system log, and perform database backup / restore options.

- **Mastering**

  This option displays the **Mastering** screen, which allows you to create and edit weld masters.

  NOTE: This button is disabled for a P1 Pod™.

- **Tolerancing**

  This option displays the **Tolerancing Master** screen, which allows you to adjust the high and low tolerance limits of each parameter in a selected master.

- **Setup**

  This option displays the **Setup Menu**, which provides setup options to help you configure the system and to calibrate sensors.

- **Shutdown**

  This option displays a list of shutdown choices.

Data Menu Options

- **Halfcycle Summary or Millisec Summary (for MFDC)**

This option displays **Halfcycle**, **Segment** and **Weld Summary** data in a graphical or tabular format.

- **Weld Summary**

This option displays **Weld Summary** data in a tabular format.

Figure **6-7** Data Menu screen

- **System Log**

This option displays **System Log** information for different system events. This information is used by Livingston technicians for system diagnostics.

- **Database**

Displays sub-menus and commands which backup, restore or delete information from the weld databases.

- **Scope Data**

Displays raw and filtered data from the external sensors. The **Scope Data** feature is used for diagnostic purposes only, and must be enabled in the **Setup Menu** to operate. It should not be enabled during normal production. Please contact Livingston for more details.

Halfcycle Summary Screen (Millisec Summary Screen *for MFDC*)

The WMS software displays weld data on a halfcycle, segment and weld basis. If the system is set up to record halfcycle information, data records are stored in a database for each halfcycle of the weld. Each stored weld data record contains data values for all parameters, as well as other system information.

Weld Master ID →

Left y-axis parameter →
pickbox

← **Right y-axis parameter**
pickbox

Zoom button →

← **Table / Graph button**

Weld number select / display
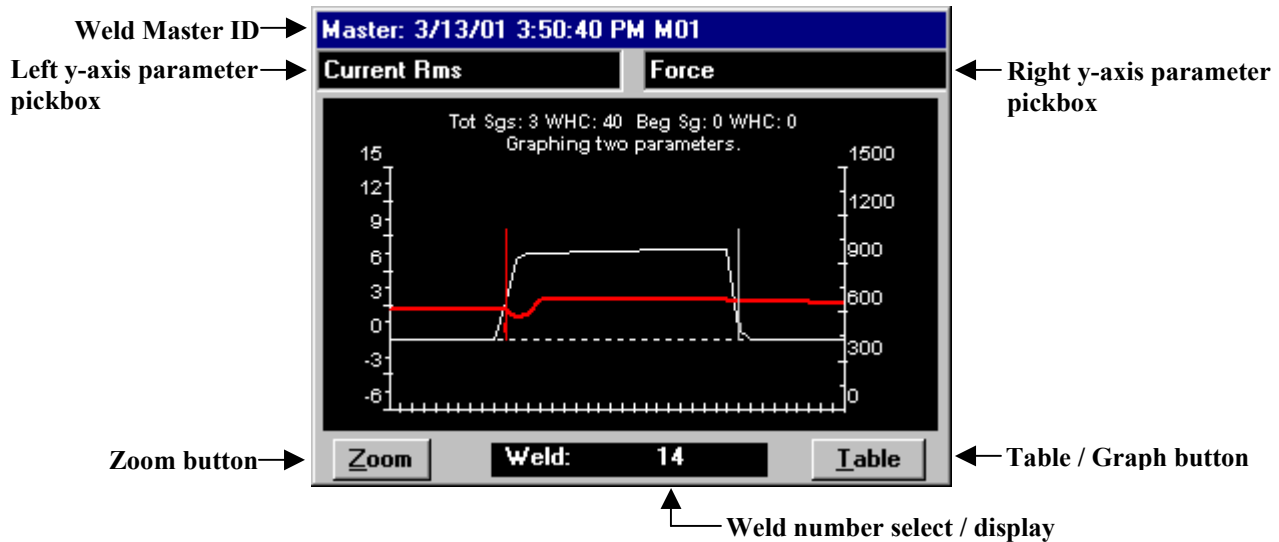
Figure **6-8** Halfcycle Summary (graph)

The **Halfcycle Summary** graph can display two parameters at a time, as shown in figures 6-8 and 6-9. Halfcycle data points are shown, with the points connected to form a trace. The summary graph displays data traces for any two parameters. The halfcycle count of the weld (including the pre-weld and post-weld segments) is shown on the x-axis (horizontal).

Weld Halfcycle Count

Total Segments

Beginning Segment
(Zoom only)

← **Weld Halfcycle Count**
(Zoom only)

Graph description

Figure **6-9** Halfcycle Summary (graph)

- **Left/Right axis Parameter Select**

  The left parameter select box corresponds to the left y-axis (vertical), and the white trace on the graph. The right parameter select box corresponds to the y-axis on the right, and the red trace on the graph.

  The parameter pick box on the right can also be set to **Hcycle Limits** (figure 6-10) or **Segment limits**. If a master has qualified the weld**, Hcycle Limits** or **Segment Limits** will show the upper and lower tolerance limits on each halfcycle for the parameter in the left pickbox.

Figure **6-10** Current Rms shown with Halfcycle tolerances

- **Zoom Button**

  Expands the graph in the horizontal direction. When the graph is selected in zoom view, it can be scrolled left or right using the arrow buttons. The **Beginning Segment** (**Beg Sg**) defines which segment the cursor (arrow) is in. The second **Weld Halfcycle Count** (**WHC**) shows which halfcycle the cursor is on (see figure 6-9). If you are working in zoom view and a new weld is made, the screen will not automatically update.

- **Weld Number Select / Display**

  Use the arrow buttons to select a weld. If the graph is selected, the most recent weld is displayed, and the graph screen updates automatically.

Segment	Rtype	Hcycle	Accept Status	CurrentRms	Curre
0	0	0	0	0.006804208	0.02
0	0	1	0	0.00754098	0.02
0	0	2	0	0.006767543	0.020
0	0	3	0	0.007085088	0.023
0	0	4	0	0.006443619	0.02
0	0	5	0	0.00728455	0.021
0	0	6	0	0.006792496	0.031
0	0	7	0	0.007193817	0.021
0	0	8	0	0.006984646	0.021
0	0	9	0	0.007813212	0.030
1	0	0	0	3.416732	7.44

Weld: 14

Figure **6-12** Halfcycle Summary (table)

- **Table/Graph Button**

  Switches the display to either graph or table format. Each row of the table shows a data record from the selected weld, as shown in figure 6-12. Segment and weld summary records are also shown in this table. Use the scroll bars or the arrow buttons to move through the table display.

The **Halfcycle (or Millisec) Summary Table** contains the following parameters:

- **Segment**

  A weld is divided into segments. The segment field indicates which segment the data record is from. By default, **0** = **Pre-weld**; **1** = **Weld**; **2** = **Post-weld**. The segment field of a weld summary record shows the number of segments in the weld.

- **Rtype**

  (Record type) indicates what type of data is in the row (data record).

  0 = **Halfcycle Summary** (Millisecond Summary for MFDC)
  1 = **Segment Summary** (average for the segment)
  2 = **Weld Summary** (average for the weld)

- **Hcycle (Halfcycle) or Millisec (Millisecond for MFDC)**

  In a halfcycle data record (Rtype 0), this field contains the halfcycle number of the data record. In a segment record (Rtype 1), this field contains the number of halfcycles in the segment. In a weld record (Rtype 2), this field contains the number of halfcycles in the weld. This is similar for MFDC except data is in milliseconds.

  Note: Many weld timers control the length of a weld on a cycle basis. If this is the case, the number of halfcycles of weld current should be twice the count of the weld timer.

- **Accept Status**

  The **Accept Status** field will be zero if the weld was within all specified tolerances in the master. If the Accept Status field is not zero, then at least one parameter of the weld was outside of the master tolerance limits.

  Use the arrow keys to scroll through the rows (data records) and columns (data parameters). To determine the parameters that were out of tolerance in a given row (data record), highlight the Accept Status, and click the SELECT button. A pop-up window will display the failed parameters, as shown in figure 6-13. Refer to the topic Identifying and Interpreting Accept Status Codes (Chapter 11) in the Appendices of this manual for more information about the Accept Status codes.

Figure **6-13** Pop-up window displaying all parameters that were out of tolerance

  If the SELECT button is clicked while an individual data record is highlighted, the pop-up window will display the Halfcycle (or millisecond for MFDC), Segment and Weld High and Low Tolerance limits for that parameter, as shown in figure 6-14.

  If a master was NOT used to qualify this weld then no limits will be displayed.

  The tolerance limits displayed are taking from the master. In figure 6-14 the Master weld data (for this halfcycle) for CurrentRms is 0.006786 and the tolerances are set to +/-10 (relative tolerancing) in the master. The high tolerance limit is 0.006786 + 10 = 10.006786. The Low tolerance limit is 0.006786 - 10 = -9.993214.

Figure **6-14** Pop-up window displaying tolerance limits for selected parameter

  Use ESCAPE or Arrow Keys to close the pop-up window. Refer to the topic Identifying and Interpreting Accept Status Codes (Chapter 11) in the Appendices of this manual for more information about the Accept Status codes.

NOTE: In the following parameter descriptions that refer to "halfcycle" are applicable to "millisecond" for MFDC welds.

- **CurrentRms**

  The RMS (Root-Mean-Square) current in a halfcycle, or average RMS current for a segment or weld.

- **CurrentPeak**

  The peak (positive or negative) current in a halfcycle, or the peak current in a segment or weld.

- **VoltageRms**

  The RMS voltage in a halfcycle, or average RMS voltage for a segment or weld.

- **VoltagePeak**

  The peak (positive or negative) voltage in a halfcycle, or the peak voltage in a segment or weld.

- **Force**

  The average force at the electrode tips during the halfcycle, segment or weld (average of Pre, Weld and Post segment half cycles).

- **Set Down**

  Set Down is the decrease in thickness as a part is welded (relative to initial thickness).

  Halfcycle: Set Down is the lowest thickness during the halfcycle minus the Initial Thickness value at the beginning of the weld (halfcycle 0 from segment 1).

  Segment: Set Down for a segment is lowest Set Down reported for a halfcycle within the segment.

  Weld: Set Down is the difference between the initial thickness at the beginning of the weld segment (halfcycle 0 from segment 1) and the Final Thickness at the end of the Post segment.

- **Expansion**

  Expansion is the increase in thickness as a part is welded (relative to initial thickness).

  Halfcycle: Expansion is the highest thickness during the halfcycle minus from the Initial Thickness value at the beginning of the weld (halfcycle 0 from segment 1).

  Segment: Expansion for a segment is the highest Expansion value for a halfcycle within the segment.

  Weld: Expansion is the highest Expansion value from all of the segments (excludes Pre segment).

- **Initial Thickness**

  The thickness of the workpiece at the start of a halfcycle, segment or weld (Initial Thickness from the first halfcycle in segment 1, the first weld segment).

- **Final Thickness**

  The thickness of the workpiece at the end of a halfcycle, segment or weld (final thickness from the POST segment).

- **CondAngle (Conduction angle)**

  For AC weld type - A measure in degrees of how long the weld timer SCR's were turned on, allowing current flow during a halfcycle.

For DC 1P (single phase) - A measure in degrees of how long the weld timer SCR's were turned on plus the length of time for the tailing current, during a halfcycle. Due to the DC component of this type of weld, the reported conduction is typically higher than the actual SCR firing angle.

For MFDC weld type – The reported conduction angle is either 180 (when the inverter is passing current) or 0 degrees (no current) for millisecond data.

For the Segment of Weld, conduction angle is the average of the half cycles or milliseconds with "on" current. Refer to Avg. Null Halfcycles / Avg. Null Milliseconds setting.

- **Resistance (dynamic)**

  The calculated dynamic resistance of the workpiece during the halfcycle, equal to Voltage RMS divided by Current RMS. The average dynamic resistance for a segment or weld.

- **Energy**

  The calculated energy during the halfcycle, equal to Current RMS multiplied by Voltage RMS. The average energy for a segment or weld.

- **Power Factor**

  Power Factor is not yet implemented and will display zero

- **Cyc Len**

  Cyc Len shows the number of samples per halfcycle in the A-D conversion. For Rtype 0, this number is typically between 102 and 107 (half cycle @60Hz sampled at 12.5kHz). This field is used by Livingston technicians as a diagnostic tool and should generally be ignored.

- **Date/Time**

  The date and time when the halfcycle (or millisecond), segment or weld data was recorded.

- **MasterID**

  Name of the master used to qualify the weld.

- **Bin Select (Binary Master Select)**

  For each POD / ID there are up to 31 masters which are selected using the binary select inputs. The Bin Select reported in the weld data indicates the binary select setting or master number used for this weld. Example: A Bin Select of 3 indicates that master associated with binary select 3 was used. Typically the binary select number corresponds with the weld schedule number or the sequential order of welds made by the welder during a part cycle.

Weld Summary Screen

The **Weld Summary** displays a table of stored weld summary data records (Rtype 2), with the most current record at the top.

Use the arrow keys to scroll through the rows (data records) and columns (data parameters).

To determine the parameters that were out of tolerance in a given row (weld data record), pick that row and click the SELECT key. A pop-up window will display the offending parameters, as shown in figure 6-16. Use ESCAPE to close the pop-up window.

To view the weld tolerance limits for a specific parameter, navigate to the data for that parameter and click the SELECT key. A pop-up window will display the weld tolerance limits. Use ESCAPE to close the pop-up window.

In addition to many of the Halfcycle Summary parameters described in the previous section, the **Weld Summary** parameters also include the following:

- **Weld**
  The weld number, with the most recent at the top.

- **Hcycles On** or **Millisec On** (MFDC)
  Number of halfcycles or milliseconds in the weld that actually had current flow.

Weld	Halfcycles	Hcycles on	Accept Status	Binselec
15	50	30	0	1
14	50	30	1147139541	1
13	50	30	1074089984	1
12	50	30	1147139541	1
11	50	30	1074791424	1
10	50	30	1147139541	1
9	50	30	1073743104	1
8	50	30	1073743104	1
7	50	30	1147139541	1
6	60	40	1075139840	1
5	60	40	1075139841	1
4	60	40	1147139541	1
3	60	40	1079313665	1
2	60	40	1079334165	1

Figure **6-15** Weld Summary

Weld	Halfcycles	Hcycles on	Accept Status	Binselec
15	50	30	0	1
14	50		Out of tolerance:	
13	50		Current Rms: Over limit	
12	50		Current Peak: Over limit	
11	50		Voltage Rms: Over limit	
10	50		Voltage Peak: Over limit	
9	50		Voltage Peak: Under limit	
8	50		Force: Over limit	
7	50		Cond. Angle: Over limit	
6	60		Setdown: Over limit	
5	60		Setdown: Under limit	
4	60		Expansion: Over limit	
3	60		Expansion: Under limit	
2	60		InitialThickness: Over limit	

Figure **6-16** Pop-up window displaying all parameters that were out of tolerance

Note: The **Rtype** field is omitted because all weld summary records have the same record type (2). Weld summary data records are also shown in the Halfcycle Summary table.

System Log Screen

- ## System Log

  This screen displays a table of recorded system information. It is an event log with date/time stamps intended for diagnostic purposes.

  Note: When a Pod Server is interfaced to a DeviceNet device with explicit messaging capability (PLC with DeviceNet Scanner), it is possible to send ASCII text messages from the device to the system log to track manufacturing process events, fault codes, etc.

  It is recommend that the system log be deleted periodically as it does add to the size of the livco.mdb database. It is also recommend that a 'Compact Database' be performed following the deletion of system log entries.

Figure **6-17** System Log

Database Management

The WMS software running on the Pod Server uses Microsoft Access database files for storing Pod configurations, calibrations, master tolerance limits, and more. This section describes all of the database operations available in the Database Management Utilities screen. Recommendations for maintaining your Pod Server databases can be found in the Recommended Database Management section in Chapter 11, APPENDICES.

Before performing any database functions, all remote user interfaces and applications accessing the database should be closed. Database functions should be performed from the Pod Server only. Some options will allow you to cancel the action being performed. If the action is cancelled, you will need to shutdown and restart the Pod Server software.

Note: Weld data cannot be recorded and welds cannot be monitored during any database operations. Typically weld accept/reject status will be unavailable depending on system configuration. This will affect accept/reject signals used to interface with PLCs (or other controllers) via the Pod Server.
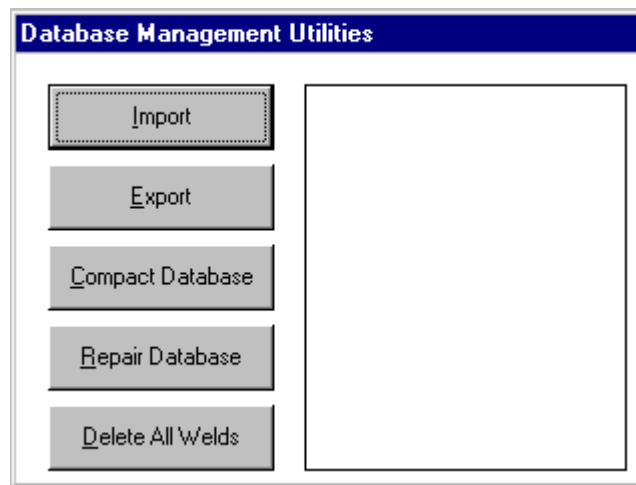
Figure **6-18** Database Management options

- **Import**

   This option displays the import menu, which allows data and setup information to be retrieved from backup databases.

- **Export**

   This option displays the export menu, which allows data and setup information to be stored to backup databases.

- **Compact Database**

  System data records are constantly added to and deleted from the database during normal operation. When certain data records are deleted from the database (e.g., when deleting P1 tolerance limits, or when **Delete System Log** or **Delete Master** is performed), space for these records is not automatically reclaimed. The **Compact Database** option removes all unused records from the database files. If you copy databases to an archive over the network, the **Compact Database** command will reduce the archive space required. This compact option is basically the same compact tool that is provided with Microsoft Access.

Figure **6-19** Compact Database

WARNING: **Welds cannot be monitored while the Compact Database option is in use**. **Any remote user interface windows must also be closed.** A large database may take over ½ an hour to compact. If the **Cancel** button is used, the Pod Server software must be shut down and restarted. <u>DO NOT</u> shutdown the Pod Server during this operation.
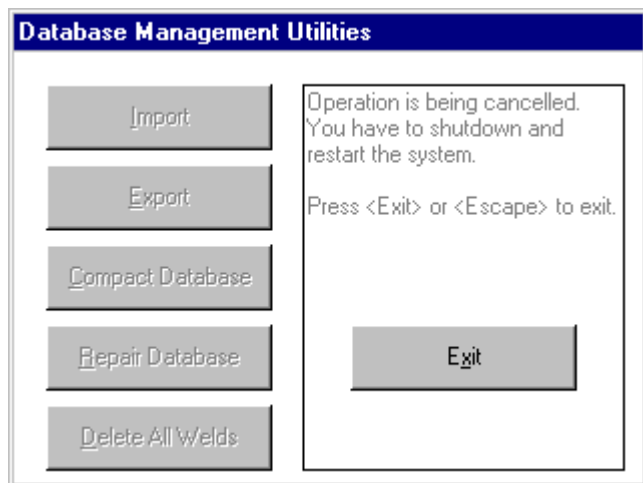
Figure **6-20** If a database operation is cancelled, the monitor must be shut down and restarted

- **Repair Database**

  If a database file is open by the Pod Server software (or an external application such as Microsoft Access) and an improper shutdown occurs, the database may become damaged. This repair option is basically the same repair tool that is provided with Microsoft Access. This option should only be executed if recommended by a Livingston service technician. It is recommended that a **Compact Database** be performed after the database is repaired.

WARNING: <u>**Welds cannot be monitored while the Repair Database option is in use**</u>. <u>**Any remote user interface windows must also be closed.**</u> The program will not let you leave this screen or monitor welds until the repair operation is complete. <u>DO NOT</u> shutdown the Pod Server during this operation.

Figure **6-21** Repair Database

- **Delete All Welds**

  This option will delete all weld data records but will not compact the database. Master data will not be deleted. It is recommended that the System Log be deleted at this time. Refer to System Log section in this Chapter.

WARNING: <u>**Welds cannot be monitored while the Delete All Welds option is in use**</u>. <u>**Any remote user interface windows must also be closed.**</u> If the **Cancel** button is used, the Pod Server software must be shut down and restarted. <u>DO NOT</u> shutdown the Pod Server during this operation.
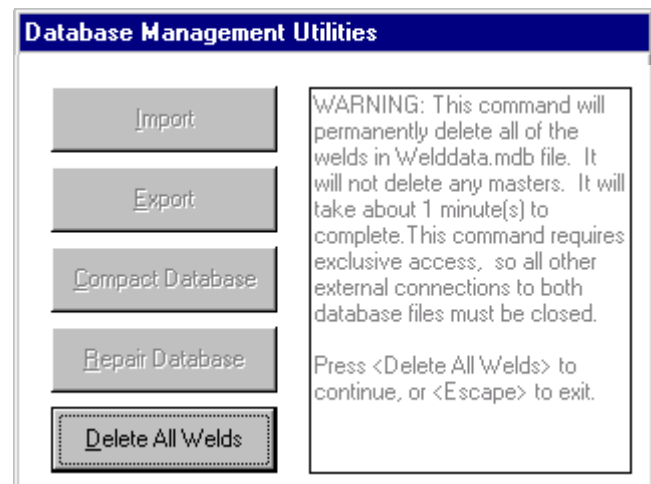
Figure **6-22** Delete All Welds screen

Note: The weld data database holds data for all of the Pods attached to the Pod System. Weld data should be deleted periodically to avoid filling the weld database to capacity (refer to Chapter 9, <u>FAQ</u>).

Database Import Screen

- **Import All**

This option deletes the current databases, and reverts to archive databases that have been saved by a previous **Export All** command. The current and archive database file names are:

Current Database	Archive Database
Livco.mdb	Livcopy.mdb
Welddata.mdb	Weldcopy.mdb

Note: You can only perform an **Import All** if an **Export All** command has been previously performed.

WARNING: <u>**Welds cannot be monitored while the Import All option is in use**</u>. <u>**Any remote user interface windows must also be closed.**</u> It may take more than ten minutes to complete an **Import All** command. If the **Cancel** button is used, the Pod Server software must be shut down and restarted. <u>DO NOT</u> shutdown the Pod Server during this operation.

Figure **6-23** Import All

- **Import Masters**

This option imports masters previously stored in an archive database by an **Export Masters** command. The masters archive database file name is **masters.mdb**. This command will not overwrite any existing masters. If an **Import Masters** command is executed and one of the current masters has the same name as one of the masters in the archive, the import of that master will be skipped. To delete a master, use the **Delete Master** command in the **Mastering** screen.

WARNING: <u>**Welds cannot be monitored while the Import Masters option is in use**</u>. <u>**Any remote user interface windows must also be closed**</u>. If the **Cancel** button is used, the Pod Server software must be shut down and restarted. <u>DO NOT</u> shutdown the Pod Server during this operation.

Figure **6-24** Import Masters

Figure **6-25** Import Masters From Floppy

- **Import Masters From Floppy**

This option is the same as the **Import Masters** command above, except that the archive database has been compressed and stored to a floppy disk previously by an **Export Masters To Floppy** command.

WARNING: <u>**Welds cannot be monitored while the Import Masters From Floppy option is in use. Any remote user interface windows must also be closed**</u>. If the **Cancel** button is used, the Pod Server software must be shut down and restarted. <u>DO NOT</u> shutdown the Pod Server during this operation.
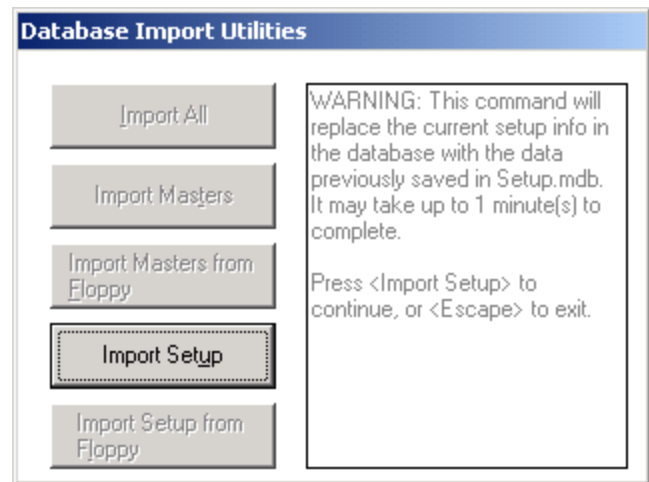
Figure **6-26** Import Setup

- **Import Setup**

This option imports general setup and sensor calibration data previously stored in an archive database by an **Export Setup** command. The setup archive database file name is **setup.mdb**. This command will overwrite the existing setup and calibration data.

WARNING: <u>**Welds cannot be monitored while the Import Setup option is in use. Any remote user interface windows must also be closed**</u>. If the **Cancel** button is used, the Pod Server software must be shut down and restarted. <u>DO NOT</u> shutdown the Pod Server during this operation.
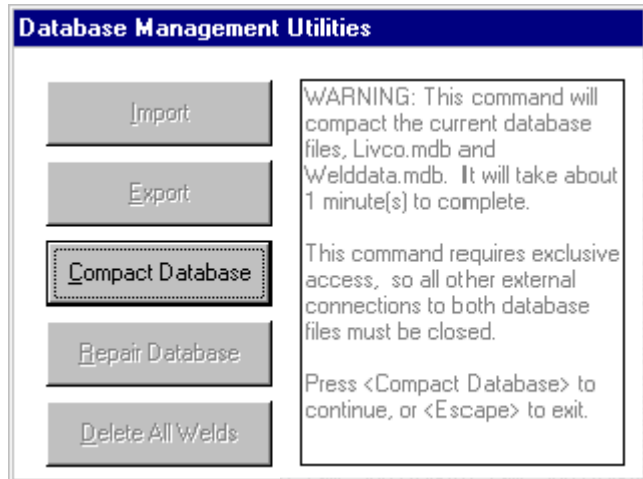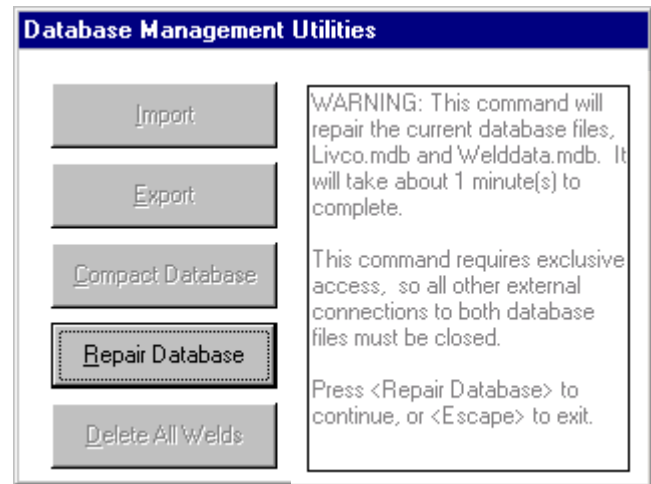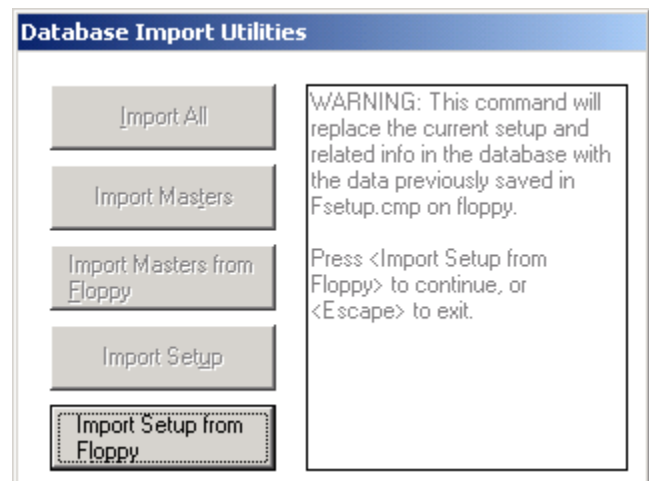

Figure **6-27** Import Setup From Floppy

- **Import Setup From Floppy**

This option is the same as the Import Setup command above, except that the archive database has been compressed and stored to a floppy disk previously by an **Export Setup To Floppy** command. Only one setup archive can be stored on a floppy disk.

WARNING: <u>**Welds cannot be monitored while the Import Setup From Floppy option is in use. Any remote user interface windows must also be closed**</u>. If the **Cancel** button is used, the Pod Server software must be shut down and restarted. <u>DO NOT</u> shutdown the Pod Server during this operation.

Database Export Screen

- **Export All**

This option saves the current databases to archive databases, backing up all system and weld data. An **Export All** command should be executed periodically as system settings are changed and masters are developed. The current and archive database file names are:

Current Database   Archive Database
 Livco.mdb   Livcopy.mdb
Welddata.mdb   Weldcopy.mdb

WARNING: **Welds cannot be monitored while the Export All option is in use. Any remote user interface windows must also be closed.** It may take more than ½ an hour to complete an **Export All** command. If the **Cancel** button is used, the Pod Server software must be shut down and restarted. DO NOT shutdown the Pod Server during this operation.

- **Export Masters**

This option saves the current masters to an archive database, backing up all current masters. An **Export Masters** command should be executed periodically as masters are developed. The masters archive database file name is **masters.mdb**. This command will overwrite any masters written by a previous **Export Masters** command.

WARNING: **Welds cannot be monitored while the Export Masters option is in use. Any remote user interface windows must also be closed**. If the **Cancel** button is used, the Pod Server software must be shut down and restarted. DO NOT shutdown the Pod Server during this operation.

Figure **6-28** Export All
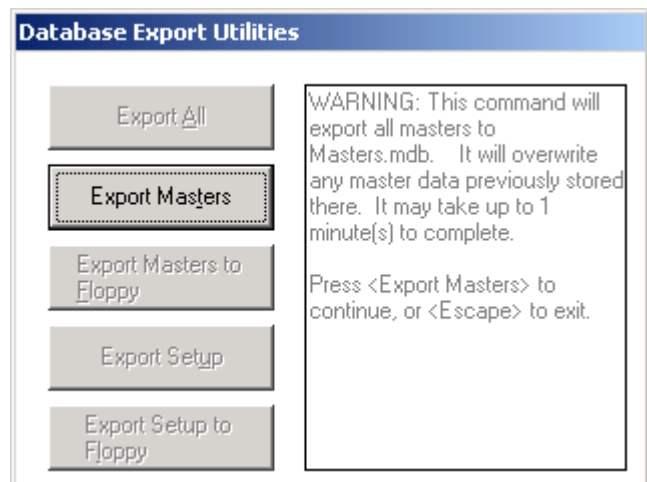
Figure **6-29** Export Masters
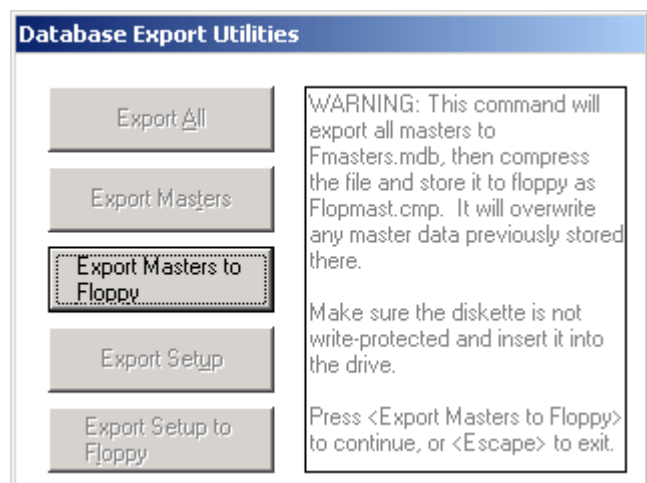
Figure **6-30** Export Masters to Floppy

- **Export Masters To Floppy**

This option is the same as the **Export Masters** command above, except that the archive database is compressed and stored to a floppy disk. This command will overwrite any masters written by a previous **Export Masters To Floppy** command. Only one masters archive can be stored on a floppy disk.

Note: A floppy disk can typically hold 1.4MB. If the data you are trying to export exceeds that size, it should be transferred via a networked computer. Call Livingston Service for additional information.

Figure **6-31** Export Setup

WARNING: **Welds cannot be monitored while the Export Masters to Floppy option is in use. Any remote user interface windows must also be closed**. If the **Cancel** button is used, the Pod Server software must be shut down and restarted. <u>DO NOT</u> shutdown the Pod Server during this operation.

- **Export Setup**

This option saves the current general setup and sensor calibration information to an archive database. The setup archive database file name is **setup.mdb**. This command will overwrite the existing setup and calibration data.

Figure **6-32** Export Setup to Floppy

WARNING: **Welds cannot be monitored while the Export Masters to Floppy option is in use. Any remote user interface windows must also be closed**. If the **Cancel** button is used, the Pod Server software must be shut down and restarted. <u>DO NOT</u> shutdown the Pod Server during this operation.
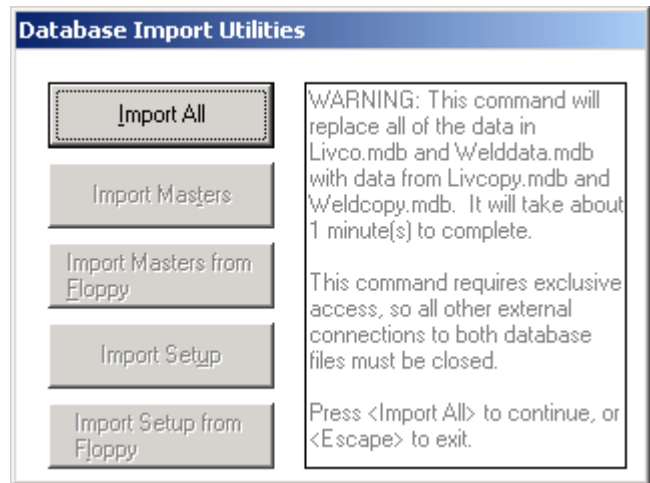
- **Export Setup To Floppy**
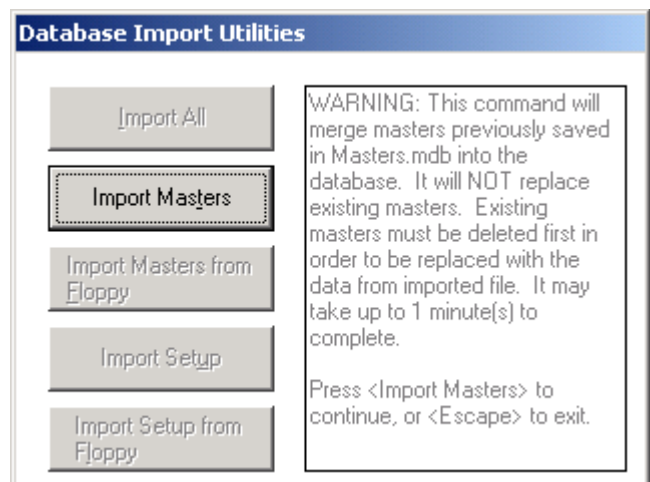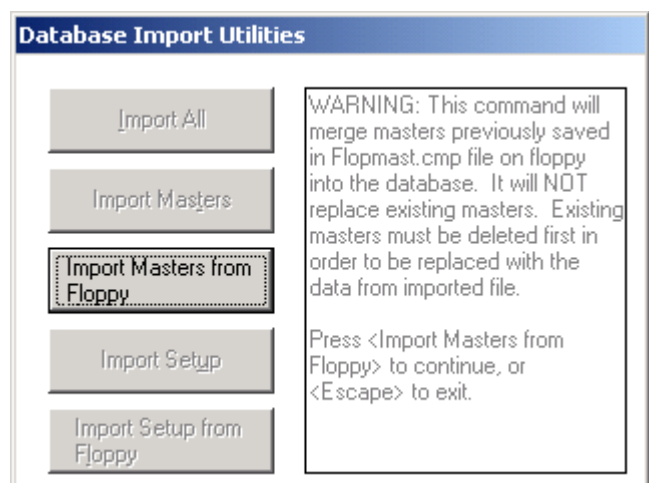
This option is the same as the **Export Setup** command above, except that the archive database is compressed and stored to a floppy disk. This command will over-write any setup information written by a previous **Export Setup To Floppy** command. Only one setup archive can be stored on a floppy disk.

WARNING: **Welds cannot be monitored while the Import Setup From Floppy option is in use. Any remote user interface windows must also be closed**. If the **Cancel** button is used, the Pod Server software must be shut down and restarted. <u>DO NOT</u> shutdown the Pod Server during this operation.

Scope Data Screen

NOTE: *The scope data feature is intended for use as a diagnostic tool by Livingston. Please contact Livingston if you need the ability to record scope data.*

- **Scope Data**

This screen displays the raw and filtered data from the external sensors, for the last scope data waveform recorded within the weld history depth. The scope feature must be enabled in the **General Setup** in order to record Scope data. For more information, refer to the **Scope Enable** and related settings in the **General Setup**.

Figure 6-33 shows the raw A-D toroid signal (pre-integration). The left y-axis represents the A-D counts. The graph heading shows which weld the waveform is for, as well as how many samples there were in the waveform. The current sampling rate of 12.5kHz used by Livingston monitors in **Scope Mode** is about 104 samples per halfcycle.

When the screen is zoomed, as shown in figure 6-34, the graph heading will read **500 Samples at Sample # x**, where **x** is the first sample number of a 500 sample series. The graph can be scrolled across in increments of 100 samples using the Left/Right Arrows.

NOTE: The integration algorithm for the current waveform is not the same as the algorithm used to calculate current for the main program screen. For this reason, baseline drift may be observed in DC waveforms.
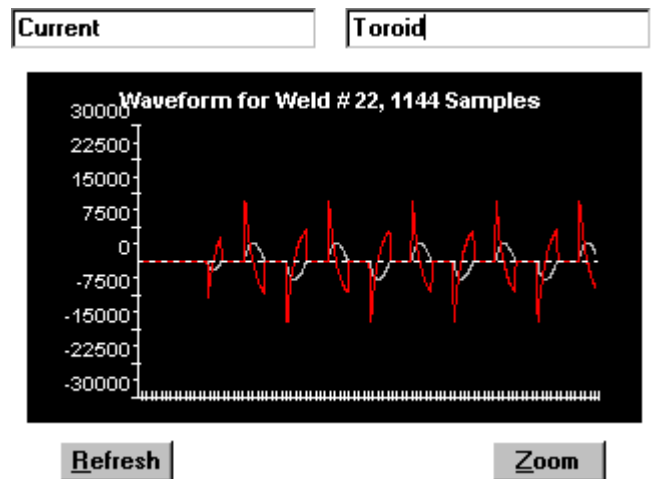
Figure **6-33** Scope Enable with waveform displayed
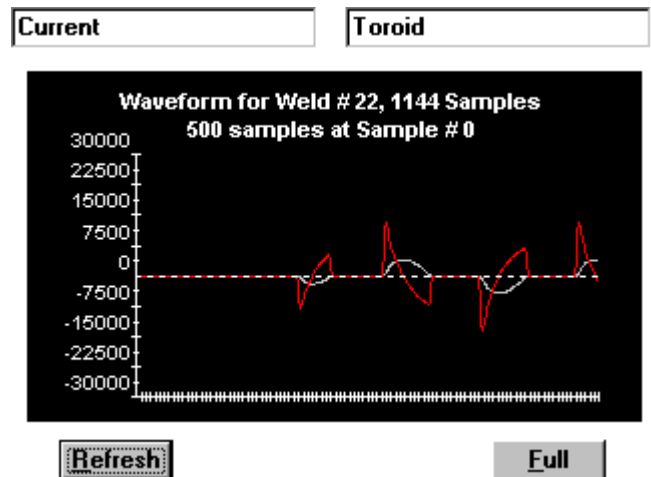
Figure **6-34** Scope Enable in zoom view

Mastering Screen (P3 Pod)

In order to be sure that production welds are good, it must be verified that the parameters of each weld match the parameters of a known good weld. A *master* is made from a weld or welds which are proven to be good through destructive testing. The master is the average of all parameters for these welds. The general procedure for creating a master is as follows:

Note: Individual applications may have different procedures for creating masters. If this is the case, you should create masters according to the procedure specific to your application.

Figure **6-35** Mastering screen

1. Click the **New** button. Using the same weld schedule and bin select, make several of the same type of weld, marking the weld number on each workpiece.

2. Click the **Done** button. Destructively test all of the welds made during mastering.

3. Using the **Edit Master** option, delete any welds from the master that failed destructive testing.

4. **Update** the master. New welds will now be compared to the known good welds in the master.

Note: Using different bin selects, multiple masters can be made at the same time. For more information, refer to Chapter 9, FAQ.

The **Mastering** options are described below. Some option buttons will be disabled (text shown fuzzy) during the mastering process, or if no masters exist for the selected POD / ID.

- **New/Done**

This option button starts and ends the mastering process. Once the **New** button is clicked, the screen reads **Initializing master memory…** The button text then changes to **Done** and the screen reads **Creating new master: Ready to accept welds…** Once you have finished adding welds to the master, click the **Done** button to end the mastering process.

When the **Done** button is clicked, the software calculates a master from the average of the welds that were included in the master. The Master ID (name) defaults to be the current date and time. When the master is complete, by default it will be broken up into three segments:

Figure **6-36** Creating a master

> **Segment 0 – Pre Weld** (before current starts)
> **Segment 1 – Weld** (portion of weld with current)
> **Segment 2 – Post Weld** (after current stops)

Each segment will have the tolerances specified in the **Tolerance Defaults** Screen. (The weld can be divided up into more segments in the **Tolerancing Screen**). The binary select value when the master was made is indicated at the end of the master name by "Mxx", where xx is the binary select number. A master will be created for each unique binary select received during mastering.

Note: Livingston weld monitors are initially set with very forgiving default tolerances. Tolerances usually need to be tightened by the customer for most applications. Refer to the <u>Tolerancing</u> section in Chapter 6 for more information.

- **Select Master**

  This option displays a list of stored masters, and allows one to be picked for editing or update.

- **Edit Master**

  The edit master option selects the **Edit Master** screen. This can be used to add/remove welds from a master set, change the binary select, or rename a master.

- **Copy/Replace**

  This button has two functions. The first is to copy a selected master (COPY): if the **Copy/Replace** button is clicked and then the **Done** button is clicked without any new welds being made, the selected master will be copied and named with the current date and time. The second is to create a new master with the same tolerances as the selected master but with new master data (REPLACE): if the **Copy/Replace** button is clicked and new welds are recorded before the **Done** button is clicked, the original welds that were used to create the selected master are deleted from the copy, and the new weld data is used instead. The segment structure and tolerance settings of the original master are preserved. To replace a master, the source master must first be Updated and the new welds recorded must contain the same number of half cycles (milliseconds for MFDC).
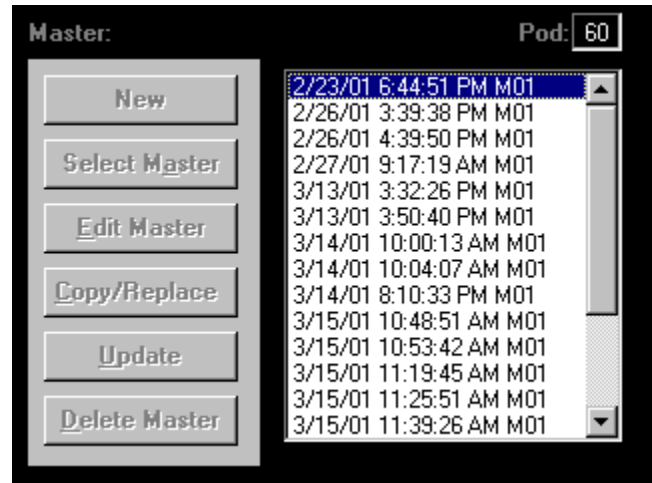
Figure **6-37** Select Master

Figure **6-38** Copy/Replace

Note: Masters cannot be copied/replaced between binary selects however the binary select associated with the master can be edited using the edit master feature .

Note: Copy/Replace should be used only if the replacing weld (new weld) contains the same number of halfcycles (or milliseconds) as the existing master being copied. Otherwise, a new master should be created.

- **Update**

When a master is created, edited or selected, it must be updated in order for the Pod weld monitor to begin qualifying welds with the new/edited master. A master must also be updated before using the replace function.

- **Delete Master**

This button deletes the selected master.

- **Pod / ID**

The current Pod/ID is selected/displayed. You can select, create, edit and update masters that are associated with the displayed Pod/ID.

Edit Master Screen (P3 Pod)

The Edit Master screen is shown below in figure 6-39. The graph line represents the data for the displayed parameter and weld number. The shaded area represents the average of all the welds included in the master set. If there was more than one weld used to create the master, the screen will display the first weld in the set.
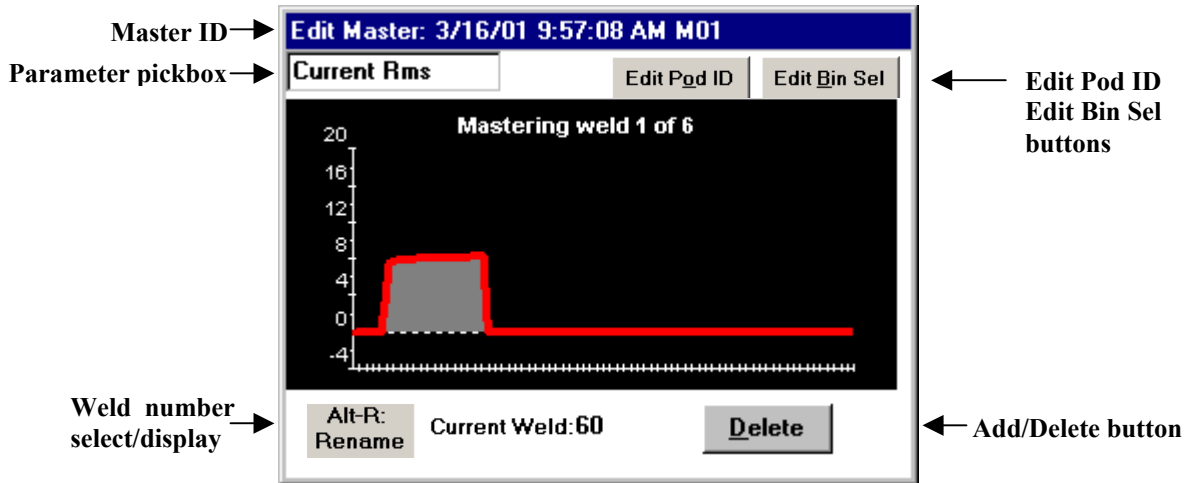
Figure **6-39** Edit Master

- **Parameter Pickbox**

  The parameter select box corresponds to the y-axis (vertical). This allows you to view data for any of the parameters while editing a master.

- **Weld Number Select / Display**

  The weld number select allows you to select any of the welds that were used to create the current master.

- **Add/Delete Button**

  Use this button to add/delete welds to/from the master set. If a weld is accidentally deleted from the master set, it can be re-added using the **Add** button. New welds cannot be added to an existing master set. Refer to Chapter 10, FAQ for further information.

- **Edit Pod ID / Edit Bin Sel buttons**

  Use these buttons to edit the Pod ID and binary select associated with this master.

  Note: The master name (by default, a date/time stamp) can be changed by using the **Alt-R** key combination on the keyboard. Use the ENTER key to save the new name and ESCAPE to return to the **Edit Master** screen.
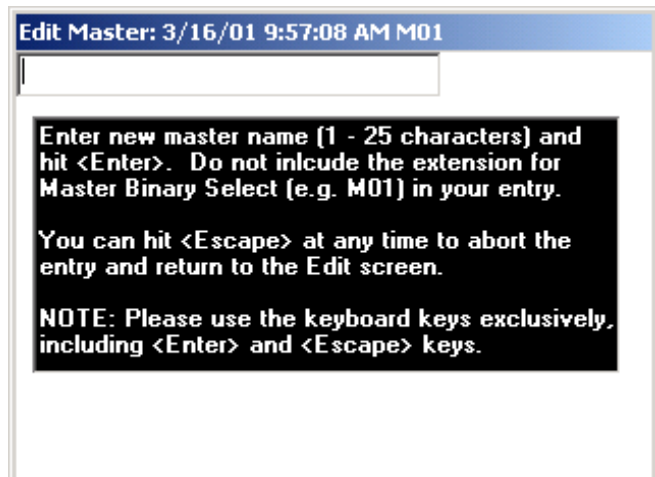
Figure **6-40** Rename Master screen

Tolerancing Screen P3 Pod (For P1 Pod, refer to Tolerancing Screen P1 Pod)

When new welds are compared to the master, they are given a certain amount of "forgiveness" relative to the values in the master. This is because even good welds aren't exactly alike. The amount of forgiveness is referred to as "tolerance" and is implemented by high and low limits relative to the master. Default tolerances (set in the **Tolerance Defaults** screen) are installed when a master is made and are set to be very forgiving. The default tolerances can be changed; new default tolerances will only be applied to masters made after the adjustment. <u>It is up to the weld process engineer to document the weld process and adjust tolerance limits to the proper values.</u>

The WMS supports **Halfcycle (or Millisecond for MFDC), Segment and Weld Tolerancing**.

Halfcycle Tolerancing compares the data from each halfcycle in a segment to *halfcycle limits* specified for that segment. All of the halfcycles in a segment are compared to the same halfcycle limits for that segment. If you move the cursor to any halfcycle in a segment and set the halfcycle tolerance, this sets the limits for all of the halfcycles in that segment. If you want to impose different limits on halfcycles in the same weld, you can divide the weld up into more segments, and tolerance the halfcycles in each segment differently.

Millisecond Tolerancing (MFDC) – similar to Halfcycle tolerancing but in milliseconds.

Segment Tolerancing calculates an average value for all of the halfcycles (or milliseconds) in each segment, and then compares that value to separate *segment limits* specified for that segment.

Weld Tolerancing compares weld summary data with the *weld limits*.

To switch between the **Halfcycle (or millisecond) Tolerancing, Segment Tolerancing** and **Weld Tolerancing** screens, touch (touch screen) or mouse-click anywhere on the graph to highlight it and click the SELECT button. The display will shift between HALFCYCLE TOLERANCES, SEGMENT TOLERANCES and WELD TOLERANCES. To change the graph scale for these screens, use the radio buttons to select **Hcycle** (for halfcycle tolerancing), **Segment** (for segment tolerancing) or **Weld** (for weld tolerancing), in the **Graph Setup** screen.
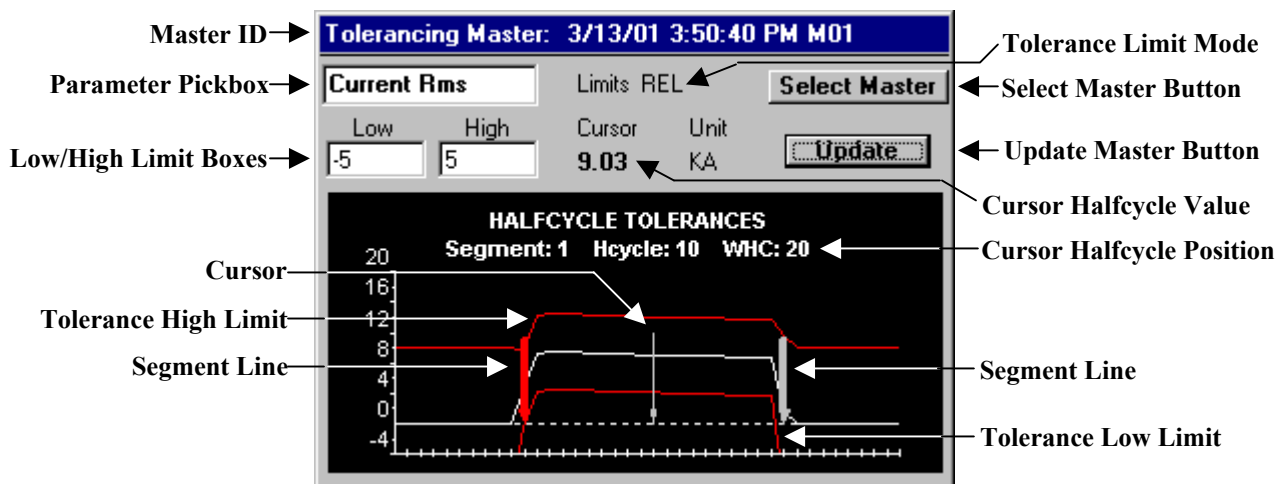
Figure **6-41** Tolerancing Master (halfcycles)

Note: You will not be able to use tolerancing until a master has been created and selected. Once master tolerances have been edited, the **Update** button must be used in order for the Pod weld monitor to begin using these new tolerances.

- **Master ID**

  When a master is selected, the Master ID is displayed at the top of the screen. The tolerancing screen adjusts the limits for this master.

- **Select Master Button**

  This option displays a list of stored masters and allows one to be picked for tolerance editing.

- **Parameter Pickbox**

  Each parameter can be selected for tolerancing. The values for the selected parameter are shown on the y-axis (vertical). The graph scale for each parameter can be adjusted via the **Graph Setup** option of the **Setup** menu.

- **Cursor / Cursor Halfcycle Position (millisecond position for MFDC)**

  The cursor is the thin arrow on the tolerancing screen which is slightly taller than the others. The cursor may be moved by the Arrow Keys, or by touching the graph. The units and value of the selected data parameter at the cursor are displayed as the **Cursor Halfcycle Value**. The **Cursor Halfcycle Position** is displayed just above the graph. The segment, halfcycle count within the segment and halfcycle count of the weld are displayed.

- **Update**

  After the tolerance limits of a master are edited, the master **must** be updated in order for the Pod weld monitor to begin comparing welds with the new tolerances limits. After the master has been updated, the current limits are displayed graphically along with the master. The limit traces are displayed as the red traces on the display.

- **Low/High Limit Boxes**

  The high and low limits for the selected parameter are displayed/edited in these boxes. The displayed limits correspond to the segment where the cursor is. The **Tolerance Limit Mode** is displayed next to the parameter pickbox, and cannot be changed in this menu. **Tolerance Limit Mode** is set in the **Tolerance Defaults** screen.

  There are two **Tolerance Limit Modes**:

  REL – Relative Limits. All tolerance limits are set relative to the master signature data. For example, for a given master, the high tolerance limit for Current Rms in Segment 1 is set to 5. If the Cursor Halfcycle Value for hcycle 10 is 9.03 KA and the Cursor Halfcycle Value for hcycle 11 is 8.53 KA, the high tolerance limit for hcycle 10 will be 14.03 KA and for hcycle 11 it will be 13.53 KA. If a weld is made using that master and the Current Rms for hcycle 10 in Segment 1 is 10 KA, the weld will be *rejected* and the parameter Current Rms will be flagged as out of tolerance.

  ABS – Absolute Limits. The master data values are ignored, and tolerances are absolute. Only the master segment structure is used. For example, for a given master, the high tolerance limit for Current Rms is set to 5. If the cursor halfcycle value for hcycle 10 is 9.03 KA and the cursor halfcycle value for hcycle 11 is 8.53 KA, the high tolerance limit for both halfcycles will be 5 KA.

- **Segment Line**

  When a master is originally created, a weld is divided into three segments. More segments can be added if desired in the **Tolerancing Master** screen. Segment lines are placed at the beginning of each segment, with the exception of segment 0. The initial size of these segments can be set in the **General Setup** screen.

  Segment 0: (Pre-weld): The pre-weld is the segment before current flows through the part. Current and Voltage data are zero, but tolerances can be placed on force and thickness before current flow begins.

  Segment 1: (Weld segment): Tolerances are placed on all parameters during weld current flow. The first segment line marks the beginning of current flow and cannot be deleted or moved.

  Segment 2: (Post weld): The post weld is the segment after current flow stops. Tolerances can be placed on force and thickness after current flow.

- **Add Segment Line**

  Move the cursor to a section of the weld other than the pre-weld segment, and use the Down Arrow Key to add a segment line. The new segment line will divide the existing segment into two at the location of the cursor. The new segments will have the same tolerance limits, which can then be adjusted separately. Use the **Update** button to record any segment line or tolerancing changes.

  In figure 6-42, a segment line was added in the middle of segment 1. Segment 1 was divided in two to become segment 1 and segment 2. There are now four segments total:

  Segment 0: Pre-Weld
  Segment 1: Beginning of weld
  Segment 2: Remainder of weld
  Segment 3: Post-Weld

  In figure 6-43, the tolerance limits for Current Rms in segment 2 were changed from +/- 5 KA to +/-3 KA relative to the master. The limits for segment 1 are still +/- 5 KA. Refer to Chapter 9, FAQ for further information about tolerancing.
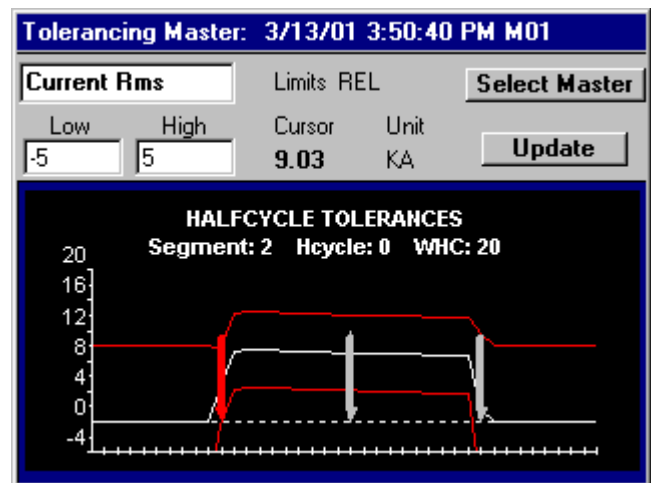
Figure **6-42** A new segment line was added to this master. Tolerance limits are the same for the each segment.
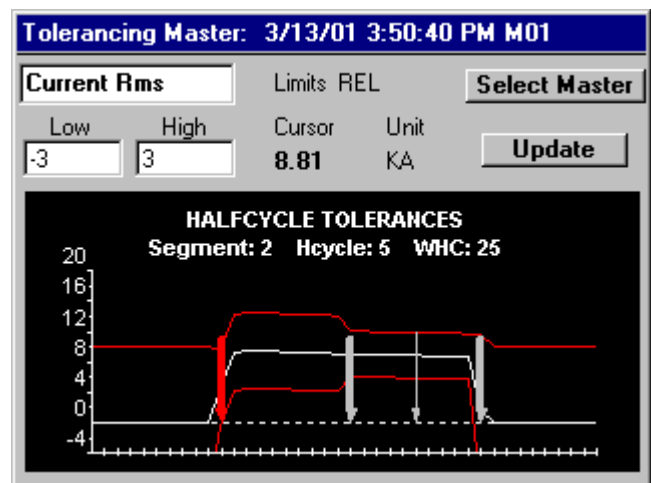
Figure **6-43** New tolerance limits were assigned to the segment that was added and the master was updated.

- **Delete Segment Line**

  Move the cursor to a segment line other than the first segment line, and use the Up Arrow button to delete the line. Once the segment has been deleted, the tolerance limits will be those to the left of the cursor. Use the **Update** button to record any segment line or tolerancing changes.
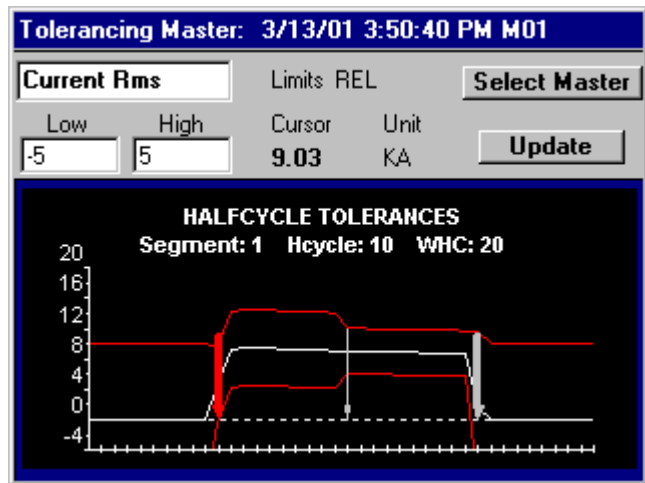
Figure **6-44** The segment line has been removed and the **Update** button has not been clicked. The different tolerance limits for the removed segment are still shown.
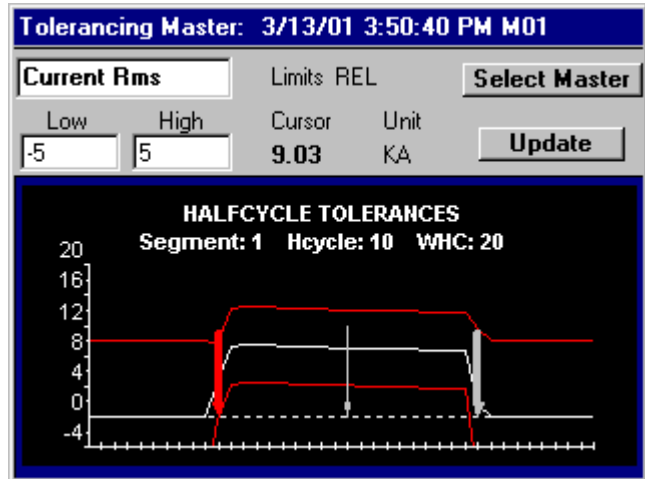
Figure **6-45** The master has been updated. The tolerance limits return to those of the segment to the left of the cursor.

Segment Tolerancing allows each segment summary (the average of all halfcycles in a segment) to be toleranced, as shown in figure 6-46.
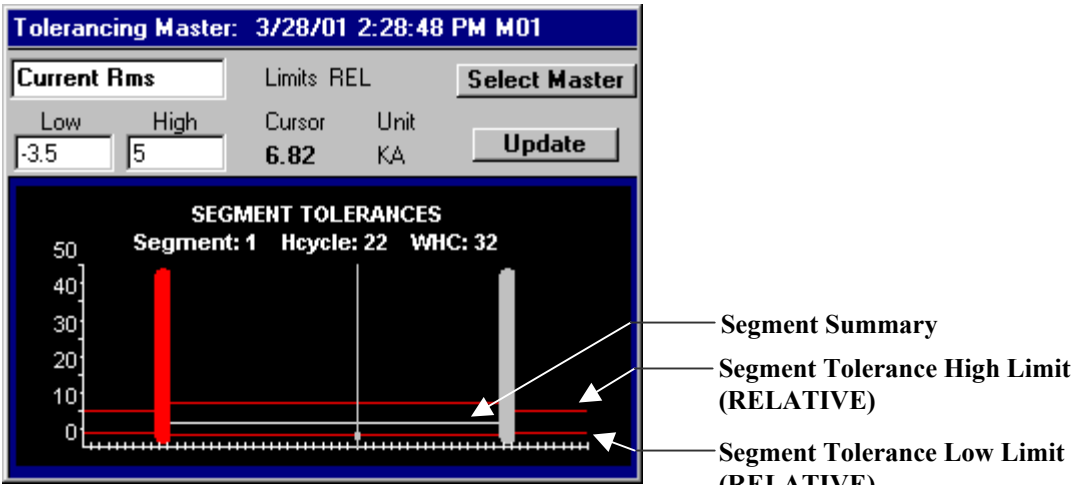
Figure **6-46** Segment Tolerancing

Weld Tolerancing allows tolerancing of the weld summary, as shown in figure 6-47.
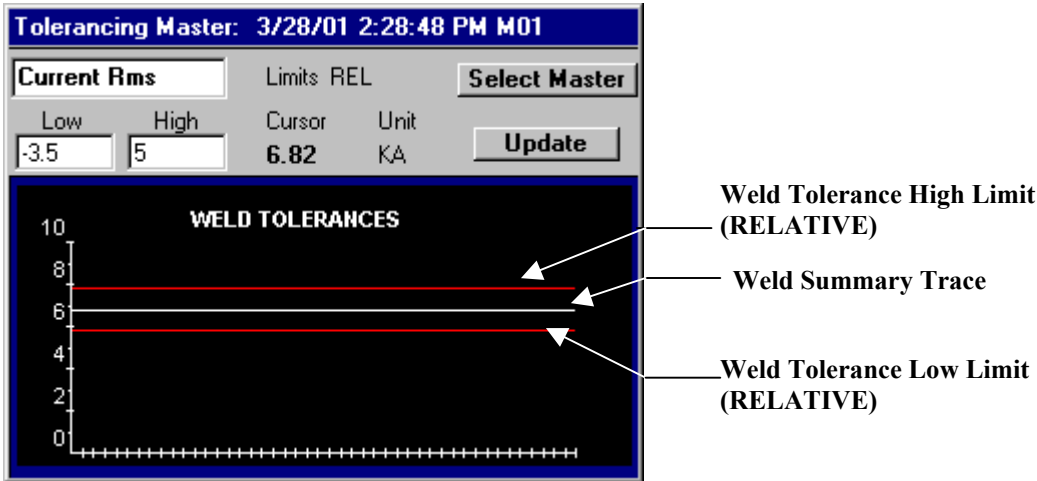
Figure **6-47** Weld Tolerancing

Tolerancing Screen P1 pod (For P3 Pod, refer to Tolerancing Screen P3 Pod)

This screen is used to create *master tolerance limits* for a P1 Pod. P1 tolerance limits are "absolute" for the weld summary data (half cycle / millisecond and segment tolerancing are not available). P1 tolerancing supports the following parameters: *CurrentRms, cycleon*, *Force, InitialThickness, Setdown and VoltageRms*. All other weld parameters are disabled however data may still be collected for all parameters.

Since P1 tolerance limits are *absolute*, the recording of Master welds is NOT required however these master tolerances limits are still stored and used like non-P1 masters. The master ID for a P1 master is "P" followed by the Pod id and "M" followed by the binary select for the master. For example the P1 master ID for Pod 50 with binary select 1 is "P50 M01".

Figure **6-48** P1 Weld Tolerancing

- **Status box**

  This box provides information about the P1 tolerances for the displayed Pod and Bin.

- **Pod box**

  P1 tolerance limits in this screen belong to this Pod/ID number.

- **Bin box**

  P1 tolerance limits in this screen belong to this Bin (binary select) number, or master number.

- **Pre, Post and Weld Seg**

  The *Pre, Post* and *Weld Seg* values indicate the segment structure for all of the welds monitored while using these P1 master tolerances for this Bin (binary select).

  The Pre and Post are initially set to the Pre Size and Post Size in the General Setup (Chapter 6) but can be changed at any time. Pre and Post are typically set to slightly less than the weld schedule's squeeze" and "hold" times respectively.

  When the P1 master tolerances are updated, the weld segment size for this binary select will be set to the highest of *Weld Seg* and the *cycleon HIGH limit*. This is to ensure that the WELD segment will always be long enough to accommodate the maximum length weld.

  Typically the *Weld Seg* setting is not set higher than the *cycleon HIGH limit* unless the weld being monitored is a pulse weld. For pulse welds, *Weld Seg* should be set equal to the total number of ON (heat) and OFF (cool) half cycles (ms for MFDC) in the weld process, not including the "squeeze" and "hold" times. This will ensure that the weld segment is long to accommodate the entire weld.

  In the example in Figure 6-48, all of the welds for this binary select will have a segment structure of 10 PRE, 32 WELD, and 10 POST.

  NOTE: If the Pre, Post or WeldSeg settings are changed, then the P1 master tolerances must be updated for the new settings to take effect.

- **New button**

  Use this button to create P1 master tolerance limits for this Pod and Bin. Tolerances will initially come from the weld *Tolerance Defaults*, if the *measure* is set to *ABS* (absolute).   If the *measure* is set to *REL* (relative) then the high/low tolerances will default to 0. The "cycleon" parameter high/low tolerances will always default to 1.

- **Delete button**

  Use this button to delete existing P1 master tolerance limits for this Pod and Bin.

- **Update button**

  Use this button to Update the P1 master tolerances limits and setting to the Pod. P1 tolerance limits must be updated to the before welds will be qualified using these tolerances and settings.

- **P1 Tolerances (master tolerance limits)**

  High and Low *absolute* limits may be set for each of the parameters in this window. For example setting CurrentRms Low to 12KA and CurrentRms High 14.2KA requires that for a weld to be accepted, the CurrentRms for the weld (averaged) must be at least 12KA and not exceed 14.2KA.

NOTE: Units of measure are set using the *Tolerances Defaults* screen when a system is installed and are not typically adjusted after a system is set up. The P1 tolerance units displayed were taken from the *Tolerance Defaults* when the P1 tolerances were created. ***If Tolerance Default units are changed, the P1 tolerances units will no longer agree with the units that the system is using. Therefore if Tolerance Default units are changed then ALL P1 tolerances should be deleted and created again!***

Setup Menu

Figure **6-49** Setup Menu

- **General Setup**

This option displays the **General Setup** screen, which controls setup parameters for a POD / ID.

- **Setup Utilities**

This option displays the **Utilities Menu**, which provides diagnostic and calibration utilities.

- **Tolerance Defaults**

This option displays the **Tolerance Defaults** screen, which controls the default tolerances used when a master is created.

- **Graph Setup**

This option displays the **Graph Setup** screen, which controls the graph display units for data parameters.

- **Pods / Server**

This option displays the **Pod / Pod Server Setup** screen, which provides the status of any/all PODs on the network. MAC IDs, baud rates, and POD Server settings can be changed in this screen. New firmware can also be downloaded to a Pod.

General Setup

The **General Setup** is used to change the general configuration of a specific POD™ ID. The **Current ID** at the bottom of the screen is the POD™ or ID to which the configuration settings apply. Separate configuration settings for each POD™ / ID are maintained in the database. After the settings in this menu are adjusted for a particular weld process application, they should be archived using an **Export Setup** command. For more information, refer to, Database Export options in Chapter 6.

NOTE: Pod Servers and 2400 use the same User Interface software and by default contain the same General Setup parameters in the livco.mdb database. Not all of these parameters are used by BOTH the Pod Server and 2400 systems. Please refer to General Setup Parameter descriptions (below) in order to determine which parameters apply to your system.

IMPORTANT NOTE: References to half cycles are made in this section for use with AC and DC_1P weld types. In general, all descriptions referring to *half cycles* are applicable to *milliseconds* for the MFDC weld type.

- **Current ID**

  Current ID (Pod ID) refers to the DeviceNet™ node address of a POD whose general configuration settings are shown and edited in this menu.

- **Update Configuration button**

  This button is used to Update the settings to the Pod™ monitor. The settings will not take effect until updated!

Parameter	Value
Binary Select Mode	Internal
Internal Binary Select	1
Pre Size	10
Post Size	8
Segment Size	620
Post Delay	2
Masters Enabled	Yes
Halfcycle Data Mode	None
Segment Data Mode	None
Weld Data Mode	All
Scope Enable	0
Trigger Mode	Repeat
Trigger Hcycle	0
Trigger Segment	1
Trigger Pre	1
Trigger Post	10
Max Bad Hcycles	0
AD Threshold	750
AD Hysteresis	250
Line Frequency	60 Hz
Relay Mode	ACC/REJ
Relay Out 0	N/O
Relay Out 1	N/O
Displacement Polarity	Positive
Avg. Null Cycles	No
Weld Type	AC
Weld History Depth	100
Segment Tolerance Mode	Average
Cumulative Halfcycles	Off
Current RMS Fault	Enabled
Current Peak Fault	Enabled
Voltage RMS Fault	Enabled
Voltage Peak Fault	Enabled
Force Fault	Enabled
Cond. Angle Fault	Enabled
Setdown Fault	Enabled
Expansion Fault	Enabled
Initial Thickness Fault	Enabled
Final Thickness Fault	Enabled
Resistance Fault	Enabled
Energy Fault	Enabled
Power Factor Fault	Enabled
Hcycle On Cnt Fault	Enabled
Segment Tolerance Fault	Disabled
Half Cycle Tolerance Fault	Disabled
Weld Tolerance Fault	Enabled
Slave MACID	0
Tip Dress Mode	Disabled

Current ID: 50   Update Configuration

Figure **6-50** General Setup Menu

GENERAL SETUP - *Parameter Descriptions*

- ### Binary Select Mode (Default Setting: Internal)

Binary Select inputs are to select different masters for a single weld head. For each POD™ / ID there are up to 31 masters which can be on line, and immediately available for use. This is useful when a single weld head has several weld schedules. Typically the binary select number corresponds with the weld schedule number or the sequential order of welds made the welder during a part cycle.

Internal:

> The binary select is set to the Internal Binary Select setting in the General Setup Menu (see below).

External:

> The Binary Select is determined by an external source (typically a PLC) via a DeviceNet™ *Polled* connection with the POD™ Server. A Binary Select of 0 is invalid.

Explicit:

> The Binary Select is determined by an external source (typically a PLC) via a DeviceNet™ *Explicit message* sent to the Pod™ Server. The Pod™ Server will then communicate the Binary Select to the Pod™ using an Explicit message. If a Pod™ Server is not connected to the DeviceNet™ network then the Binary Select can be set by sending an *Explicit message* directly to the Pod™. A Binary Select of 0 is invalid; it must be set to a value from 1 to 31.

Slave I/O:

> This setting is for use with a configuration where the Pod is a DeviceNet™ *master* (not to be confused with a weld master) to a DeviceNet™ *slave* device such as a discrete I/O block. The Binary Select is set using inputs from the slave device as opposed to receiving the Binary Select from the Pod™ Server. For more information, refer to Livingston document number 0600-SPC-763 (Discrete I/O using DeviceNet I/O block) in Chapter 11.

- ### Internal Binary Select (Default Setting: 1)

The Internal Binary Select value is only used if the **Binary Select Mode** is set to **Internal**. The Internal Binary Select should be set to a number from 1 to 31. In internal mode, all masters created will be associated with this Binary Select.

- **Pre Size (Default Setting: 10) (see figure 6-50)**

  This setting determines the amount of time in halfcycles (milliseconds for MFDC) that data is recorded before the weld current begins. It is recommended that the Pre be set to less than the 'Squeeze' time used for the weld schedule.

- **Post Size (Default Setting: 10) (see figure 6-50)**

  This setting determines the amount of time in halfcycles (milliseconds for MFDC) that data is recorded after the weld current ends. It is recommended that the Post be set to slightly less than the 'Hold' time used for the weld schedule, yet long enough for the weld to have solidified.

- **Segment Size (Default Setting: 620) (see figure 6-50)**

  The **Segment Size** setting determines the maximum number of halfcycles (milliseconds for MFDC) that data is recorded after weld current begins until the weld current ends. This setting should be set to a number higher than the expected halfcycles (or milliseconds) in the weld. Note that Weld Segment data is truncated to the actual number of halfcycles (or milliseconds) in the weld. The Segment Size is the maximum number of halfcycles (or milliseconds) that will be recorded in the weld segment when making a master. If a master is being used and masters are enabled, then the master's segment size will override this setting.
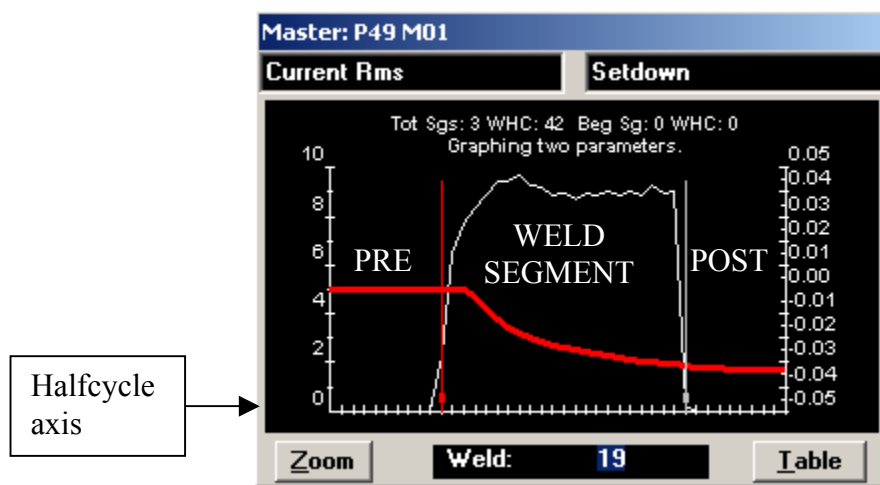
Figure **6-50** Segment Size sets the maximum weld segment size

- **Post Delay (Default Setting: 0)**

  Once weld current has ended, the Pod™ weld monitor waits for a period of time to see if weld current begins again. This amount of 'wait' time is specified in halfcycles (milliseconds for MFDC) using the Post Delay setting. If weld current does not begin again after the Post Delay, the weld monitor considers the weld finished. If weld current resumes within the Post Delay time period, the weld monitor continues data collection. This is particularly useful for pulse welding applications.

  For example, if the weld process included a pulsed weld (5 cycles on, 2 cycles off, 5 cycles on) the Post Delay would need to be increased to at least 4 halfcycles in order to bridge the 2 cycle gap between the pulses. If the Post Delay were set to 0, then the weld monitor would incorrectly consider this process as two separate welds.

  Note: The Post Delay should be set to the same value used during mastering.

- **Masters Enabled** (Default Setting: Yes)

    Yes: Each weld is compared to a master, if one exists. Depending on tolerance settings, each weld is *accepted* or *rejected* based on this comparison.

    No: Masters are disabled, and the Pod™ monitors without comparing welds to masters.

    Note: When masters are disabled, all tolerances limits are ignored, all welds are rejected, and the 'window bit' indicates an "out of window" condition.

- **Halfcycle Data Mode** or **Millisecond Data Mode** (Default Setting: None)

    All: All halfcycle data records (record type 0) will be recorded and stored in the database. If a halfcycle is stored in the database, then the associated weld record must be stored also. If **Halfcycle Data Mode** is set to **All**, **Weld Data Mode** is also automatically set to **All**.

    Failed: If a weld is rejected, halfcycle data is recorded only for those halfcycles that were out of tolerances (failed). If **Halfcycle Data Mode** is set to **Failed**, **Weld Data Mode** cannot be set to **None**.

    P3 Pod Note: When viewing the halfcycle data graph, halfcycles that did NOT fail are filled in with data points from the master and displayed along with the "failed" halfcycles.

    P1 Pod Note: P1 Pods do not reject parameters based on halfcycle tolerance limits. The only recording of 'Failed' halfcycle records will occur if masters are disabled, or if no master tolerance limits have been defined. In these cases ALL halfcycle records will be recorded.

    None: No halfcycle data records will be recorded.

    For most high-volume applications, storing all of the halfcycle data records is not practical during normal production. A 20-cycle weld will produce 60 halfcycle data records, including 10 halfcycles of pre-weld data, and 10 halfcycles of post-weld data. For this reason, the default settings have **Halfcycle Data Mode** in **None**. Additionally, a DeviceNet network allows a limited amount of data to be transferred at a time. Due to these network limitations, it is recommended that **Halfcycle Data Mode** settings **All** or **Failed** should be used ONLY for diagnostic purposes and with one POD™ at a time. It is also recommended that **Halfcycle Data Mode** be set to **None** in order to avoid loss of data when using multiple POD™s.

- **Segment Data Mode** (Default Setting: None)

    All: All segment summary data records will be recorded and stored in the database. If a segment summary is stored in the database, then the associated weld record must be stored also. If **Segment Data Mode** is set to **All**, then **Weld Data Mode** is also automatically set to **All**.

    Failed: If a weld is rejected, segment summary data is recorded only for those segments that contained failed halfcycles. If **Segment Data Mode** is set to **Failed**, **Weld Data Mode** cannot be set to **None**.

P1 Pod Note: P1 Pods do not reject parameters based on segment tolerance limits. The only recording of 'Failed' segment data records will occur if masters are disabled, or if no master tolerance limits have been defined. In these cases ALL segment records will be recorded.

None: No segment summary data records will be recorded.

- **Weld Data Mode (Default Setting: All)**

    All: All weld summary data records will be recorded and stored in the database.

    Failed: Weld summary data is recorded for failed welds only.

    None: No weld summary data records will be recorded but Accept/Reject signals are still asserted.

- **Scope Enable, Trigger Mode, Trigger Hcycle, Trigger Segment, Trigger Pre,** and **Trigger Post** are all used in conjunction with scope mode to gather high-resolution sensor data.

    NOTE: The scope data feature is intended for use as a diagnostic tool by Livingston. Please contact Livingston if you need the ability to record scope data.

    Once scope data has been recorded and stored in the welddata.mdb database, it may be viewed using the Scope Data screen, discussed in this chapter.

    Scope Enable (Default Setting: 0) - 0: Scope Mode is disabled, **1:** Scope Mode is enabled. Scope Enable should be disabled for normal Pod usage.

    Due to the large amount of data recorded in Scope Mode, the POD™ system may be busy for a considerably long period of time after a weld has been completed. Increasing the **Trigger Pre** and **Trigger Post** settings will increase the time needed for this processing.

    Trigger Hcycle – contact Livingston for specific settings to use with your Pod software.

    Trigger Segment – contact Livingston for specific settings to use with your Pod software.

    Trigger Pre determines the amount of time that data is gathered before the 'trigger point' in Scope Mode.

    Trigger Post determines the amount of time that data is gathered after the 'trigger point' in Scope Mode.

- **Max Bad Hcycles** or **Max Bad Milliseconds** (Default Setting: 0)

  Max Bad Hcycles is the number of rejected halfcycles that the weld monitor ignores when determining whether the weld is rejected or accepted based on a halfcycle fault. NOTE: When reviewing halfcycle data, halfcycles that are masked (would have rejected) will have an accept status that indicates out of tolerance parameters but will NOT indicate a "halfcycle tolerance fault". Halfcycles that are not masked and that did reject will have an accept status code that indicates the out of tolerance parameters and also indicates a "halfcycle tolerance fault".

  Note: A P1 Pod does not reject welds due to halfcycle tolerance faults; therefore this setting does not apply to a P1 Pod.

- **AD Threshold (adjustment may be required)**

  Default setting: 1500.

  The weld monitor determines that a weld is occurring by using a toroid to monitor the flow of weld current in the secondary (weld loop) of the transformer. AD Threshold is adjusted (increased) in order to avoid false triggering due to electrical noise due to electrostatic and magnetic fields. This noise may be caused by nearby contactors, other secondary shunts in multi-head applications, servo drives, etc.

  The AD Threshold setting determines the minimum amount of Current that must flow before the weld monitor begins (triggers) capturing weld data and also the minimum Current required to consider the halfcycle as being an "On" halfcycle (contains weld current). The halfcycle count for a weld is simply the sum of all of the "On" half cycles that occurred during the weld. *NOTE: For weld type MFDC, the count is in milliseconds.*

  The default setting is intended to work over a wide range of current with Livingston standard toroids, however depending on Toroid sensor sensitivity the setting may need to be adjusted. If the AD Threshold is set too high, the monitor may record inaccurate halfcycle counts since the actual weld current for a halfcycle may be too low to trigger at this setting. If the sum is too low, false triggering may occur.

- **AD Hysteresis (2400 only, not for use with Pods)**

- **Line Frequency (Default Setting: 60 Hz)**

  Line Frequency should be set to the frequency of the AC line power feeding power to the primary of the welder's transformer. It can be set to either 50 or 60 Hz.

- **Relay Mode (Default Setting: ACC/REJ)**

  This setting is used to set different output modes for a Pod™ system where the Pod communicates with a DeviceNet slave, typically an I/O block. More information can be found in Livingston Document 0600-SPC-763 (Discrete I/O using DeviceNet I/O Block) in Chapter 11.

  ACC/REJ: Selects pulsed outputs for Accept/Reject signals. Pulse is 125ms in duration.

  BUSY/STAT: Selects latched outputs for Accept/Reject signals. Accept/Reject signals update at the end of each weld.

  BYPODAL: Pod Server legacy support only. BYPODAL not supported for new installations.

  STACK LIGHT: Similar to BUSY/STAT except that the REJECT output toggles on/off to create a flashing reject light when used with a stack light.

  AR_WINDOW: Similar to ACC/REJ mode but also enables a window bit.

  BS_WINDOW: Similar to BUSY/STAT mode but also enables a window bit.

- **Relay Out 0 (2400 only)**

- **Relay Out 1 (2400 only)**

- **Displacement Polarity (Default Setting: Positive)**

  Positive: Displacement data is recorded and displayed indicating "positive" displacement changes for positive voltage changes at the displacement sensor.

  Negative: Displacement data is recorded and displayed indicating "negative" displacement changes for positive voltage changes at the displacement sensor. Setting the **Displacement Polarity** to **Negative** will invert the halfcycle graph displayed in the halfcycle summary screen.

  Displacement polarity should be set so that opening the electrodes will cause an increase in displacement (when viewed using the Input Monitor screen, see Chapter 6) and closing the electrodes will cause a decrease in displacement. This will ensure that Expansion and Set Down are calculated properly.

- **Avg. Null Cycles** or **Avg. Null Milliseconds** **(Default Setting: No)**

  The weld monitor calculates average values for parameters within the weld segment. Within a given segment there may be halfcycles (or millseconds) in which there was no measured current, referred to as "null cycles".

  No: The weld monitor calculates average values for the Segment and Weld Summaries using data only from halfcycles (or milliseconds) in which there was measurable current within the weld segment.

  Yes: The weld monitor calculates average values using data from all of the halfcycles (or milliseconds) in the weld segment, including null cycles.

Note: The **Avg. Null** setting only affects values calculated from Current and Voltage. Force- and Displacement-related calculations are not affected by this setting.

- **Weld Type** **(Default Setting: AC)**

  This parameter should be set to the type of weld being monitored. *Note: This may require different weld monitor software versions.*

  AC: The weld monitor is set to monitor single-phase AC welds, in halfcycles.

  MFDC: The weld monitor is set to monitor MFDC welds, in milliseconds.

  DC 1P: The weld monitor is set to monitor single-phase rectified (DC) welds, in halfcycles.

- **Weld History Depth** **(Default Setting: 100)**

  The Weld History Depth determines the number of welds displayed in the **Weld Summary** screen.

- **Segment Tolerance Mode** **(2400 setting only)**

- **Cumulative Halfcycles** **(2400 setting only)**

- **CurrentRMS Fault to HcycleOnCnt Fault (MillisecondOnCnt)**

  Enabled: The weld monitor will reject any welds where this parameter is out of tolerance.

  Disabled: The weld monitor will NOT reject any welds where this parameter is out of tolerance.

  Note: P1 Pod will only reject the weld based on the following parameters when enabled: CurrentRMS, VoltageRMS, Force, Initial Thickness, Final Thickness, and On Cnt.

  Note: If weld is made and no master tolerance limits are set, then the weld will rejected on all parameters, regardless of this setting.

- **Segment Tolerance Fault**

  Enabled: The weld monitor will reject welds based on segment tolerances for those parameters that are Enabled.

  Disabled: The weld monitor will NOT reject any welds based on Segment tolerances.

    Note: P1 Pod will not reject on segment tolerances.

- **Half Cycle Tolerance Fault** or **Millisecond Tolerance Fault**

  Enabled: The weld monitor will reject welds based on Half Cycle (or millisecond) tolerances for those parameters that are Enabled.

  Disabled: The weld monitor will NOT reject any welds based on Half Cycle (or millisecond) tolerances.

    Note: P1 Pod will not reject on halfcycle (or millisecond) tolerances.

- **Weld Tolerance Fault**

  Enabled: The weld monitor will reject welds based on weld tolerances for those parameters that are Enabled.

  Disabled: The weld monitor will NOT reject any welds based on weld tolerances.

- **Slave MACID**

  This setting is used for a Pod configuration where the Pod communicates with a DeviceNet slave, typically a DeviceNet I/O block.

  0:   Pod will maintain its current Slave MACID setting in memory.

  1 to 63: The Slave MACID value specifies the MAC ID or Node address of the Pod's slave.

  64: This disables the Pod's slave mode. At this setting the Pod will not search the network for a slave.

- **Tip Dress Mode**

  Enabled: This enables Tip Dressing mode for specially equipped Pods.

  Disabled: This disables Tip Dressing mode for specially equipped Pods.

Setup Utilities

- **Input Monitor**

This option displays the input monitor screen, which shows the data values from external sensors and inputs. A **Zero Displacement** utility is also provided.

- **Toroid Settings**

This utility is used adjust the toroid calibration. The calibration is set at the factory for use with a toroid that has a CF of 0.400 (calibration factor of 400). When installing a toroid, the CF setting labeled on the toroid should be entered as a whole number in this screen (Example CF of 0.354 should be entered as 354).

Figure **6-51** Setup Utilities

- **Calibrate Voltage**

This utility is used to calibrate the voltage sensor input channel. The voltage calibration values are set at the factory, and therefore do not require calibration.

- **Calibrate Force**

This utility is used to calibrate the force sensor input channel. The Force channel must be calibrated when a new force or pressure sensor is installed.

- **Calibrate Displacement**

This utility is used to calibrate the displacement sensor input channel. This channel should be calibrated when a new displacement sensor is installed.

Note: Once sensor calibration has been changed for a Pod sensor the calibrated readings on the input monitor will correctly display the new calibrated value however the master tolerance limits used by the Pod will not be correct until all masters (master tolerance limits) have been updated. Any one of the following methods will update the master tolerance limits for a Pod:

➢ Reboot the Pod by removing and reapplying power to the Pod or to the DeviceNet network (reboots all pods). The Pod Server will then send the entire configuration to the rebooted Pod(s).

➢ Shutdown and restart the Pod Server software. When the Pod Server software starts it will send the entire configuration to each Pod on the network.

➢ Update the P3 master or P1 master tolerance limits that is in use for each binary select.

Input Monitor

The Input Monitor display allows you to see the raw data readings from the sensor input channels (A/D values) as well as the calibrated readings for Voltage, Force, and Displacement are also shown (Value). Calculated Current values are not displayed. The values in this screen change as the monitor continuously updates each channel.

If the sensor has not been properly calibrated, the incoming calibrated readings shown in the **Value** column will not be correct.

Use the Input Monitor after calibrating a sensor to check the validity of your calibration adjustment.

Figure **6-52** Input Monitor

A/D values of (+32767) and (-32768) indicate saturation or overflow on that channel. If all of the A/D values appear frozen, you may have a problem with your monitor. Refer to Chapter 10, Troubleshooting Guide for more information.

- **External Master Select**
  This value indicates the binary select (Master Select number) that Pod is receiving from Internal, External, Explicit or Slave I/O inputs.

- **Current Master Select**
  This value indicates the master that is in use, whether from an external or internal selection. If the **Binary Select (Master select)** value does not correspond to an existing master, then the **Current Master Select** will be **0** (No Master).

- **Zero Displacement**
  This button is used to re-establish the range in which the displacement readings are being taken. Refer to Chapter 11, Displacement Channel Overview for additional information.

- **"Window" Bit Indicators**
  ✓ , ▼ and ▲ are "window" bit indicators for Force and Displacement which indicate whether the parameter is within, lower or higher than the weld tolerance limits for that parameter. For more "window" bit information, please refer to General Setup (Masters Enabled, and Relay Mode) in Chapter 6, and Chapter 11, Appendices, documents 0600-SPC-763 (Discrete I/O with DeviceNet Block) and 0454-APP-292 (DeviceNet Polled I/O).

Toroid Settings Utility

The screen is used to calibrate the current reported by the weld monitor. This calibration will affect the data reported for Current RMS, Current Peak, Energy, and Resistance. ***Note: Both Pod™s and Toroids are calibrated at the factory. The only setting that requires adjustment is the Toroid Calibration Factor.***

Figure **6-53** Toroid Calibration

- **Last Weld's Current RMS**

    This is the weld summary Current RMS recorded for the last weld.

- **Desired Current RMS / Percent**

    Desired Current RMS or Percent maybe adjusted to match the reported current to a desired current (from a weld timer, weld controller or other weld meter, etc.). Once the desired settings have been entered, the calibration must be updated to the weld monitor by using the Update Configuration button. To return to the factory calibration, simply enter 100% for a percentage.

- **Update Configuration**

    Sends the calibration to the weld monitor. This button must be used for any new settings to take effect.

- **Toroid Calibration Factor**

    Each Livingston toroid has proprietary conditioning circuitry in an inline cylindrical housing. The Toroid Serial Number and Calibration Factor are printed on the cylindrical housing. When a new toroid is installed, the **Toroid Calibration Factor** should be entered in this field, as a whole number without decimals (For example, a CF of 0.354 should be entered as 354). Once the calibration factor has been entered, the calibration must be updated by clicking on the Update Cal Factor button. Refer to Chapter 8, Calibrating the Sensors for additional information.

- **Update Cal. Factor**

    Sends the calibration to the weld monitor. This button must be used for any new settings to take effect.
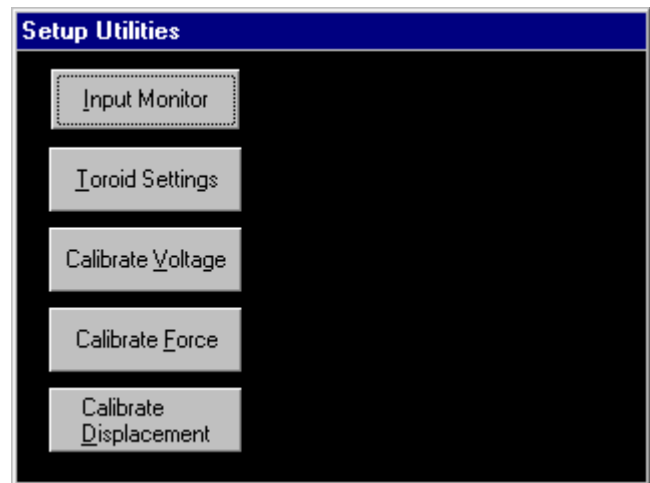
Note: Once sensor calibration has been changed for a Pod sensor the calibrated readings on the input monitor will correctly display the new calibrated value however the master tolerance limits used by the Pod will not be correct until all masters (master tolerance limits) have been updated. When exiting the Utilities screen you will be prompted with an option to perform this update. Any one of the following methods will also update the master tolerance limits for a Pod:

- ➢ Reboot the Pod by removing and reapplying power to the Pod or to the DeviceNet network (reboots all pods). The Pod Server will then send the entire configuration to the rebooted Pod(s), updating the master tolerance limits.

- ➢ Shutdown and restart the Pod Server software. When the Pod Server software starts it will send the entire configuration to each Pod on the network, updating the master tolerance limits.

- ➢ Update the P3 master or P1 master tolerance limits that is in use for each binary select.

Voltage Calibration Utility

Voltage is calibrated at the factory and does not
need to be re-calibrated. If, however, there is an
extenuating circumstance requiring re-calibration of
the voltage, use the following procedure. You will
need a battery and a multimeter to calibrate voltage.
Refer to Chapter 8, Calibrating the Sensors for
additional information.
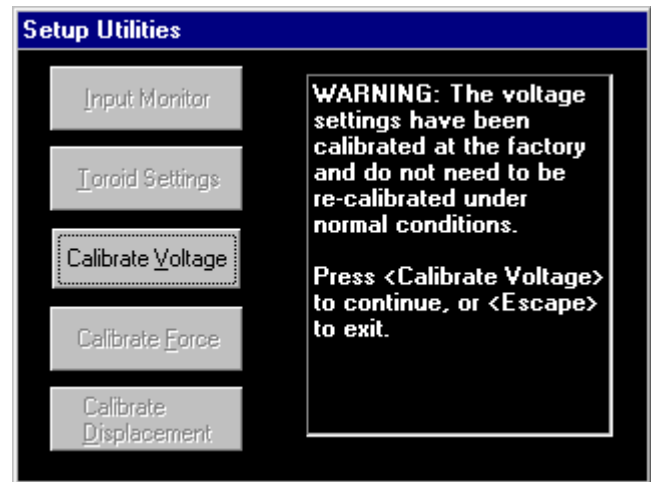
Figure **6-55** Voltage calibration warning
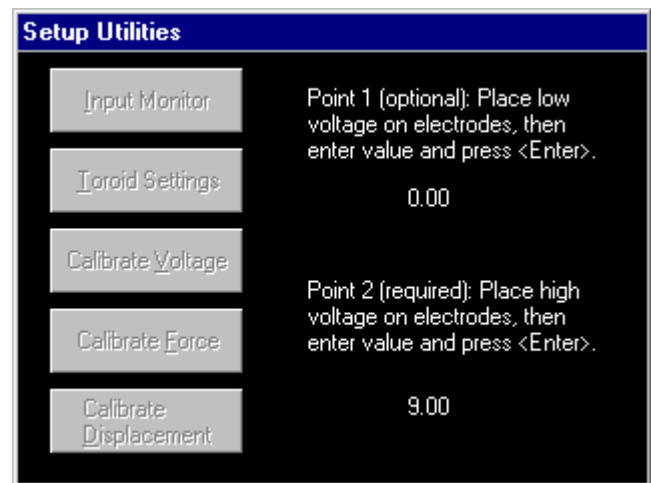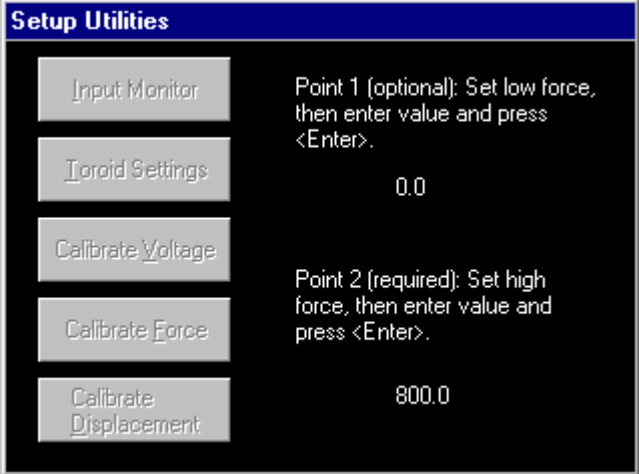
Figure **6-56** Voltage calibration fields

*Note: Once sensor calibration has been changed for a Pod sensor the calibrated readings on the input
monitor will correctly display the new calibrated value however the master tolerance limits used by the
Pod will not be correct until all masters (master tolerance limits) have been updated. When exiting the
Utilities screen you will be prompted with an option to perform this update. Any one of the following
methods will also update the master tolerance limits for a Pod:*

➢ Reboot the Pod by removing and reapplying power to the Pod or to the DeviceNet network
(reboots all pods). The Pod Server will then send the entire configuration to the rebooted
Pod(s), updating the master tolerance limits.

➢ Shutdown and restart the Pod Server software. When the Pod Server software starts it will
send the entire configuration to each Pod on the network, updating the master tolerance limits.

➢ Update the P3 master or P1 master tolerance limits that is in use for each binary select.

Force Calibration Utility

Force sensor calibration is required when a new sensor is installed. An external hand-held force gauge will be required to determine the exact amount of force that is being applied during this calibration. Refer to Chapter 8, Calibrating the Sensors for additional information.

Figure **6-57** Force calibration fields

Note: Once sensor calibration has been changed for a Pod sensor the calibrated readings on the input monitor will correctly display the new calibrated value however the master tolerance limits used by the Pod will not be correct until all masters (master tolerance limits) have been updated. When exiting the Utilities screen you will be prompted with an option to perform this update. Any one of the following methods will also update the master tolerance limits for a Pod:

➢ Reboot the Pod by removing and reapplying power to the Pod or to the DeviceNet network (reboots all pods). The Pod Server will then send the entire configuration to the rebooted Pod(s), updating the master tolerance limits.

➢ Shutdown and restart the Pod Server software. When the Pod Server software starts it will send the entire configuration to each Pod on the network, updating the master tolerance limits.

➢ Update the P3 master or P1 master tolerance limits that is in use for each binary select.

Displacement Calibration Utility

Displacement sensor calibration is required when a new sensor is installed. The displacement channel calibration procedure is basically the same as the procedure for the voltage and force channels. A piece of metal with known thickness less than 0.100" (or less than 4.5% of the displacement sensor stroke) will be required as a reference. For more information on the Displacement Input Channel, refer to Chapter 11, <u>Displacement Channel Overview</u>.

Figure **6-58** Displacement calibration fields

Note: Once sensor calibration has been changed for a Pod sensor the calibrated readings on the input monitor will correctly display the new calibrated value however the master tolerance limits used by the Pod will not be correct until all masters (master tolerance limits) have been updated. When exiting the Utilities screen you will be prompted with an option to perform this update. Any one of the following methods will also update the master tolerance limits for a Pod:

➢ Reboot the Pod by removing and reapplying power to the Pod or to the DeviceNet network (reboots all pods). The Pod Server will then send the entire configuration to the rebooted Pod(s), updating the master tolerance limits.

➢ Shutdown and restart the Pod Server software. When the Pod Server software starts it will send the entire configuration to each Pod on the network, updating the master tolerance limits.

➢ Update the P3 master or P1 master tolerance limits that is in use for each binary select.

Tolerance Defaults Setup

These tolerance defaults settings are 'global' and used for all Pod IDs.

P3 Pod: When a Pod master is first created, the default measurement mode, units and High/Low limits for both Halfcycle (or millisecond) and Segment displays are specified by this table. These settings have no impact on any master that has already been made. Use the radio buttons at the top of the screen to select the display to be toleranced.

P1 Pod: When P1 tolerances limits are created, the units from this table are used. Since the P1 only supports absolute tolerancing, the ABS/REL measure, and Low/High limits are not used when creating P1 tolerances.

Tolerance Defaults ⦿ Hcycle ◯ Segment ◯ Weld				
Parameter	**Measure**	**Unit**	**Low**	**High**
CondAngle	REL	Deg	-20	20
CurrentPeak	REL	KA	-100	100
CurrentRms	REL	KA	-1	1
cycleon	REL	HC	0	0
Energy	REL	KVA	-2	2
Expansion	REL	IN	-0.02	0.02
FinalThickness	REL	IN	-0.02	0.02
Force	REL	LBS	-100	100
InitialThickness	ABS	IN	-0.02	0.02
PowerFactor	REL	PF	-1	1
Resistance	REL	uOH	-50	50
SetDown	REL	IN	-0.02	0.02
VoltagePeak	REL	V	-60	60
VoltageRms	REL	V	-1	1

Figure **6-59** Tolerance Defaults Screen

Note: The input monitor screen units for displacement are taken from the Initial Thickness units setting in the Tolerance Defaults table.

- **Measure (Tolerancing Mode)**

  This field can be set to **REL** or **ABS** measure for each parameter.

  REL – Relative Limits. All tolerance limits are relative to the master.

  ABS – Absolute Limits. The master values are ignored, and all limits are absolute.

  Note: P1 Pod only supports absolute tolerancing. This setting is ignored when creating P1 tolerancing limits.

- **Unit**

  Some parameters can be measured in different units (i.e. inches or millimeters). Change the value in the Unit field to select the measurement/display units for a data parameter.

  Note: Units should be chosen prior to setting up a system. Units can be changed after a system has been calibrated and the reported data will be recalculated to match the new unit. However, Masters will retain the unit of measure that was set when the master was created. For a P3 Pod, once the units have been changed all masters should be deleted and new masters created. For a P1 Pod, once the units have been changed all master tolerance limits should be deleted and new master tolerance limits created.

  Note: The units in this table are used by ALL ids. This means that all Pods for a Pod system will use the same units specified in this table.

- **Low**

  Set the default Low Limit value for each data parameter.

- **High**

  Set the default High Limit value for each data parameter.

Graph Setup

This option allows you to customize the graph scale settings for each parameter. These settings affect the high and low display limits for the Main Screen bar graphs, Trend Graph display and the graphs in the Summary and Tolerancing screens. Radio buttons also allow separate settings for Halfcycle (millisecond for MFDC), Segment and Weld displays.

Note: These graph settings are 'global' and used for all Pod IDs.
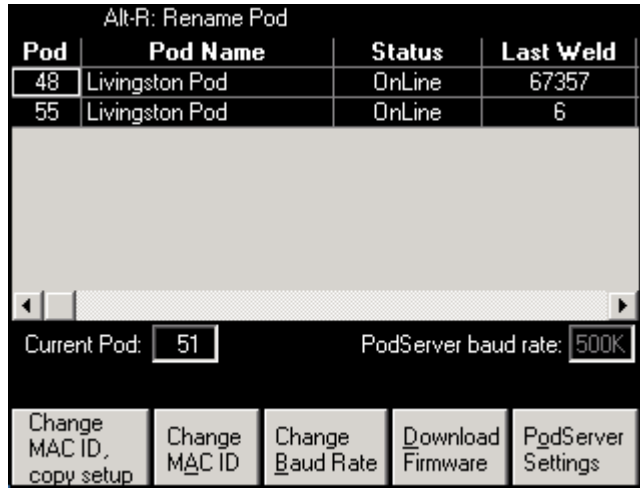
Graph Setup ⦿ Hcycle ⦾ Segment ⦾ Weld			
Parameter	Unit	Graph Low	Graph High
CurrentPeak	KA	8	15
CurrentRms	KA	0	10
cycleon	HC	0	40
Energy	KVA	0	50
Expansion	IN	-0.1	0.05
FinalThickness	IN	-0.1	0.05
Force	LBS	-33	36
InitialThickness	IN	-0.1	0.319
PowerFactor	PF	-0.09	1
Resistance	uOH	0	100
SetDown	IN	-0.1	0.05
VoltagePeak	V	-60	60
VoltageRms	V	0	1

Figure **6-60** Graph Setup

Pods / Server Setup

The Pods/Server Setup screen is shown in figure 6-61. This screen displays information about all POD™s in use: MAC ID, name, status, last weld recorded, firmware revision, serial number, and product type. Options on the bottom of the screen allow various settings to be changed, including MAC ID, Baud Rate and POD™ Server settings. New firmware can also be downloaded to the POD™s from this screen.

Note: POD™s and POD™ Servers are configured at the factory and usually don't require modification unless they are installed on an existing DeviceNet network with other devices.

Figure **6-61** Pods/Server screen

For a listing of the various **Status** codes and their meanings, please refer to Chapter 11, <u>Status Decoder for Pods/Server Screen</u> in the <u>Appendices</u>.

- **Change MAC ID / Change MAC ID, copy setup**

  The **Change MAC ID** option is used to re-assign the DeviceNet ID of the POD™ displayed in the **Current Pod** field. The **copy setup** option also copies the existing calibration and general setup to the new ID. *Note: Masters/Tolerances are NOT copied to the new ID.*

- **Change Baud Rate**

  This option is used to change the Baud Rate of the POD™ displayed in the **Current Pod** field. Choose the desired DeviceNet Baud Rate from the pop-up box, and click the ENTER button to confirm the entry. This command will not work unless the POD™ is Online. Pod must be rebooted for change to take effect. NOTE: Pod Server and Pod baud rates must match in order for Pod Server to bring the pod online. After changing a Pod's baud rate, the Pod Server's baud rate will need to be changed in order to communicate with the Pod. **Caution:** Changing baud rates can crash the DeviceNet Network. Please refer to Chapter 11, <u>Troubleshooting a DeviceNet Network</u> in the <u>Appendices</u> for additional information.

- **Download Firmware**

  This option is used to download new firmware to the POD™ displayed in the Current Pod Box. The POD™ Server first checks the floppy drive for a valid POD™ firmware file. If one exists, the firmware will be downloaded from the floppy disk. Otherwise, the POD™ Server will download firmware from the Livingston system folder. This command will not work unless the POD™ is online, and should only be done under the direction of Livingston Customer Service.

- **PodServer Settings**

  This option is used to change the DeviceNet ID and Baud Rate of the POD™ Server. Choose the desired DeviceNet Baud Rate from the pop-up box, and/or enter the new DeviceNet MAC ID, and click the ENTER button to confirm the entry. This option also allows changing the DeviceNet interface driver name, used by the Pod Server software to identify the hardware that is communicating with DeviceNet™. Refer to Figure 6-62.

PodServer Settings

Figure **6-62** PodServer settings

- **PodServer MAC ID:** This setting determines the PodServer's MAC ID (node address) on the DeviceNet™ network. This should be a unique address that is set lower than the Pod MAC IDs, and other generic I/O devices such as I/O blocks, bar code scanners, etc.

- **PodServer baud rate:** This setting determines the PodServer's baud rate, which should match all other devices on the network. *Caution: Changing the baud rate can crash the DeviceNet™ Network. Please refer to Chapter 11, Troubleshooting a DeviceNet Network in the Appendices for additional information.*

- **Min and Max:** These settings determine the DeviceNet™ scan range used by the PodServer. The PodServer (Master device) will enslave any devices with a MAC ID within this scan range. The PodServer only supports Pods as slaves. All other devices will be enslaved but will not be able communicate with other devices on the network. For this reason, all non-Pod devices must have a MAC ID (node address) that is outside of the PodServer scan range.

- **DNET Driver:** This setting determines the DeviceNet™ device driver used by the Pod Server to communicate with the DeviceNet™ network. The WMS Pod Server software supports single-channel SST 5136-DNP and DN3 DeviceNet™ hardware manufactured by SST (Division of Woodhead Industries). There are different model cards (PCI, ISA, PC104, PCMCIA) which when installed will have different card driver names. For the PodServer to function correctly, the DNET Driver name must be entered exactly as it appears in the SST and Windows settings. The name is case sensitive and cannot have any preceding or proceeding "spaces". *Note: Once this setting has been changed, the WMS Pod Server software must be shutdown and restarted for the new driver name to take effect.*
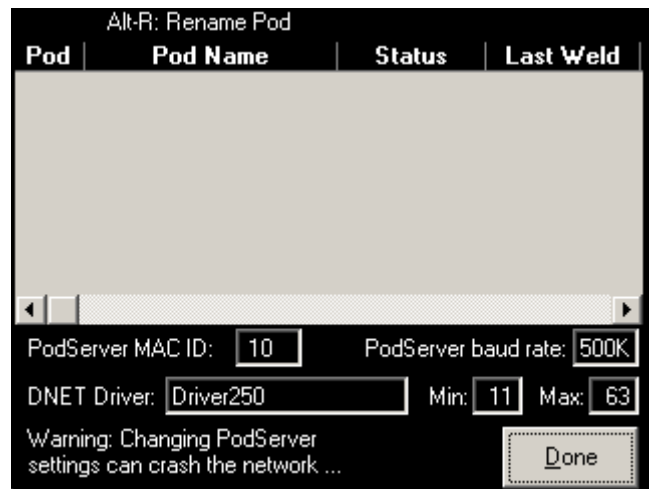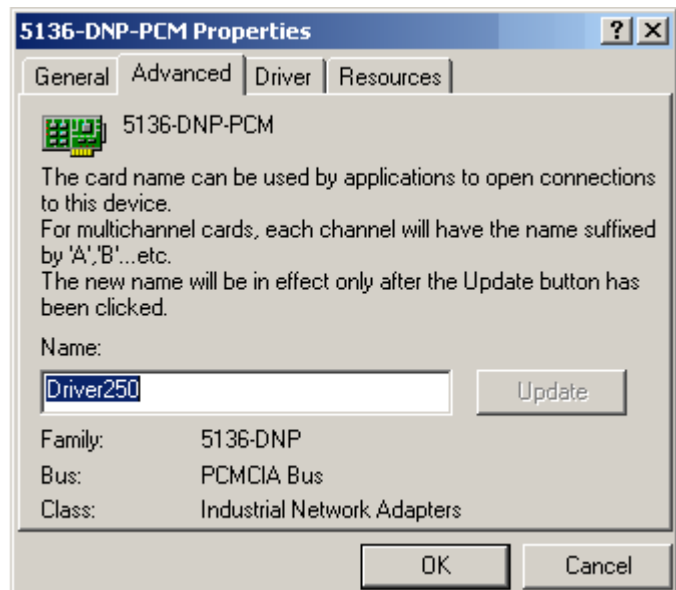
Figure **6-63** SST DeviceNet Card - Driver Name

There several ways to determine the SST DeviceNet™ card driver "name" used by Windows. The easiest way is use the Windows Device Manager: **Right-click on "My Computer" and select properties -> Hardware -> Device Manager -> Industrial Network Adapters -> Select appropriate card -> double-Click or Right-click Properties -> Advanced tab.**

In the example, Figure 6-63, **Driver250** is the name of the card installed as it appears in Device Manager.

Shutdown Menu

The Shutdown Menu gives you 4 different exit options. Figure 6-64 shows the typical options.

Figure **6-64** Shutdown menu

- **No, I didn't really mean to come here, please take me back**

Use this button or ESCAPE to leave the Shutdown Menu.

- **Yes, I'm sure. Shutdown Windows too.**

This option closes all programs and shuts down Windows.

- **Quit All Livingston programs, but don't shutdown Windows.**

This option closes the Livingston programs but doesn't shutdown Windows.

- **Close this User Interface Window, but don't quit Weld Monitor.**

This option closes the WMS graphical user interface (livcoset.exe), but does not stop the WMS Pod Server service (GUIPodServer.exe). The WMS Pod Server software will continue to interface with DeviceNet™ and collect weld data for the Pod™s.

If a database operation has failed, the shutdown menu will appear slightly different, as shown in figure 6-65. Likewise, if a database function has been cancelled, the shutdown menu will feature only one option, as shown in figure 6-66.
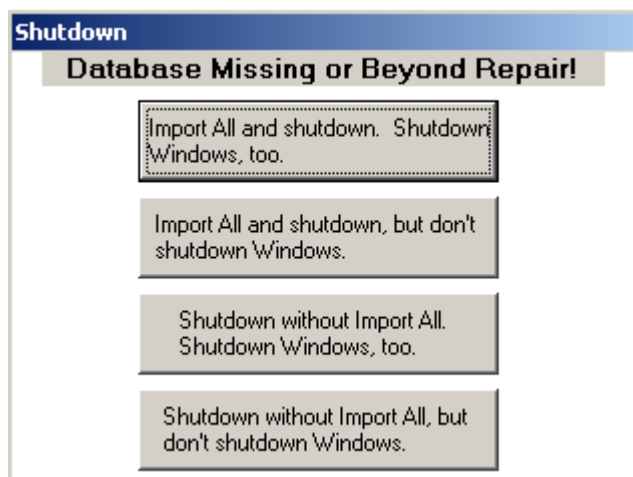
Figure **6-65** Alternate shutdown options
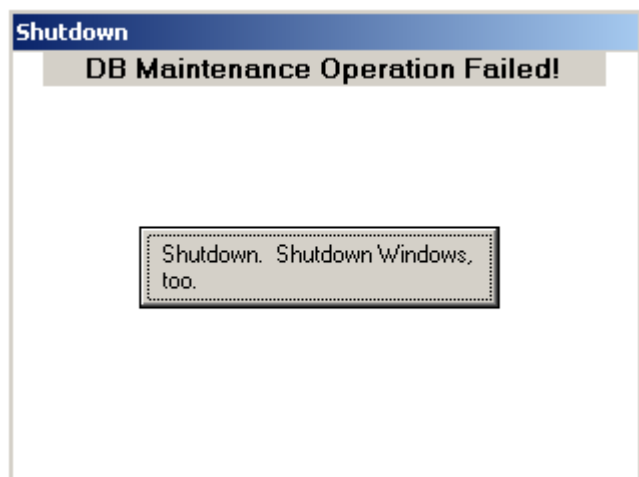
Figure **6-66** Shutdown monitor

Installing the Sensors

The Monitor-Sensor cable included with each POD™ routes input from four possible external signal sources (Current, Voltage, Force, and Displacement sensors) to the weld monitor. Each sensor must be attached to the appropriate cable lead as indicated by the color-coding. It is not necessary to have a sensor attached to every lead, however a Livingston current toroid must always be used.

Note: Any sensor lead not in use should have its connector protected to prevent contamination of internal pins.

Figure **7-1** Color-coding on the Monitor-Sensor cable

Red: Current sensor

Green: Voltage sensor
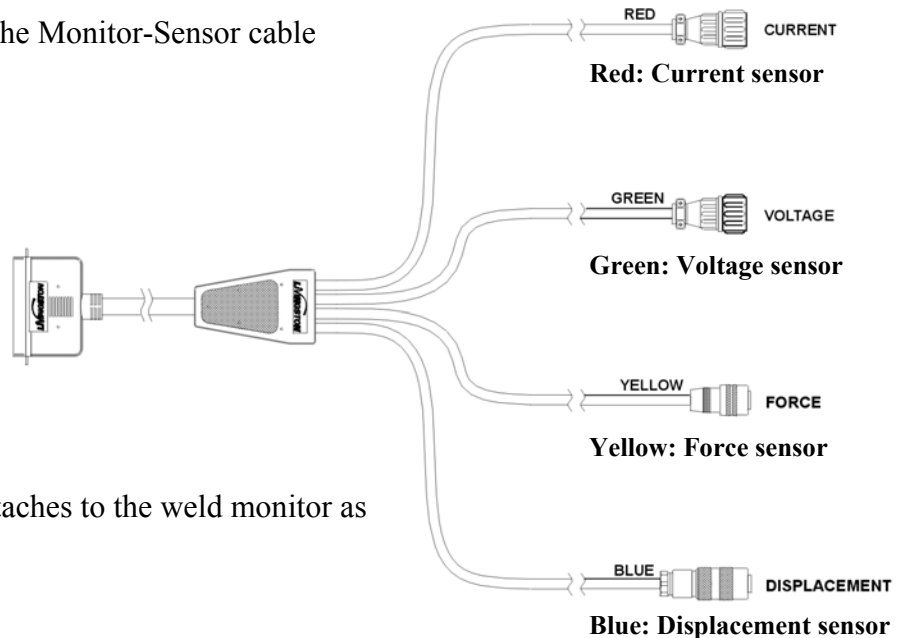
The Monitor-Sensor cable attaches to the weld monitor as shown below:

Yellow: Force sensor

Blue: Displacement sensor
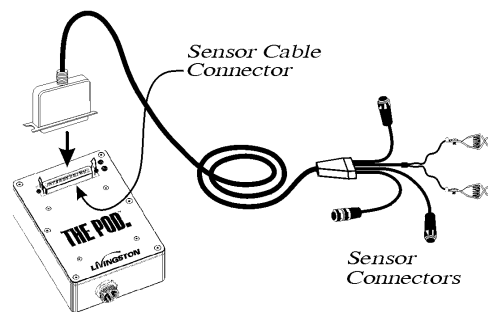
Figure **7-2** Attaching the Monitor-Sensor cable to a POD™

Types of Sensors

Current:

A Livingston-supplied toroid must be used with a Livingston weld monitor. <u>No substitutions can be made</u>.

Voltage:

Livingston uses voltage leads to read incoming voltage signals and to calibrate the weld monitor. These leads are typically included with the Livingston shipment.

Force:

A variety of force sensors is available for use with Livingston weld monitors:

- **Load Cells:** Possibly the best for measuring small changes in force, a load cell measures directly from the electrode tooling and is therefore not susceptible to changes in force readings related to seal leakage, sticky cylinders or valves, etc. Load cells are generally designed into the tooling of the weld head by the machine manufacturer. Due to the time and cost of tooling modification, this type of sensor may be less desirable when installing in a retrofit application.

- **Weld-Thru Load Cell:** This sensor works very similar to the above load cell, but installs directly into the weld loop so that weld current can flow right through the sensor. This particular load cell comes with a male and female RWMA taper and is perhaps the easiest to retrofit, although there are a few issues to consider: Approximately 1.75" of adjustment at the electrodes is required for sufficient clearance of the sensor body and cable to incorporate it into the weld loop.

- **Pressure Sensors**: These sensors are typically small transducers that connect to the supply line of a hydraulic or pneumatic cylinder. They work by sensing the pressure driving the piston attached to the rod that applies force to the work piece. Typically, these sensors show less detail and are less sensitive than a mechanically connected load cell, but still provide valuable data about the consistency of weld force.

  Hydraulic: Excellent results can be achieved by installing a hydraulic sensor into the hydraulic cavity of an air over oil type cylinder (**not** into the intensifier line). The intensification of a small amount of oil gives a very high resolution that can show minute changes in force. This arrangement provides force measurement nearly as good as a load cell, however it is susceptible to problems caused by leaky seals, cylinders, or air in the hydraulics.

  Pneumatic: Typically installed in the airline feeding an air cylinder, the problem with this type of sensor is that it measures line pressure rather than tip force.

The type of sensor that is best depends entirely on the application. The best performing solution is a pancake load cell built into the weld tooling, while the next best solution— a hydraulic pressure sensor— requires having an air over oil cylinder. A pneumatic sensor can be used with an air cylinder, but the force reading will be less accurate due to the compressibility of air. Ultimately, any of these sensors will work well; the choice is up to the user.

Displacement:

- **Double Rod End:** This type of sensor is an industrial linear potentiometer, utilizing rod ends to connect it to weld head tooling. The rod end's spherical bearings take up any minor misalignment in tooling or brackets, making installation a little more forgiving than a spring return type. This type of displacement sensor is a very robust unit and is highly recommended by Livingston for most applications.

- **Spring Return**: This type of sensor is also an industrial linear potentiometer and is typically used in situations when the space surrounding the weld force cylinder is limited. When the potentiometer (pot) is retracted by the weld head tooling, an internal spring allows the pot to extend with the tooling without actually being connected to it. Special care must be taken to keep the rod perpendicular to the tooling or side loading may occur.

- **Rotary**: Some applications (using a rotating pin or pivot) may require the use of a rotary potentiometer. This type of sensor is a small can with a rotating shaft. The shaft can be coupled to the pivot transmitting the rotary motion from the pivot to the pot. A rotary sensor is a good choice when tooling design makes it difficult to mount a linear potentiometer.

Installing the Current Toroid

Before installing the toroid, make a note of the three-digit calibration factor that appears on a Livingston sticker on the toroid (for example, .388); this value will be used later to enter the toroid calibration factor.

1. **Shut down the welder to be monitored;**

2. **Install the current toroid:**

- Unhook the clasp on the toroid ring and place it around a stationary secondary welding cable or bus. If there is no stationary cable or bus, place it around the secondary with the least movement. Be sure that the clasp is at least ¾ inch away from the framework of the machine or any ferrous metal.

- Reconnect the clasp on the toroid and route the cable away from current-carrying tooling. Best results are achieved with the toroid centered on the cable or bus: This may be accomplished by using a piece of plastic, or a similar non-conductive material.

- Secure the toroid in its location using cable ties. The toroid should not be able to move around after being secured. The clasp should also be secured so that it cannot accidentally come undone. Keep the toroid as round as possible; avoid doubling it over or securing it in such a way so that it resembles a figure '8', as this will result in inaccurate readings and Less reliable data.
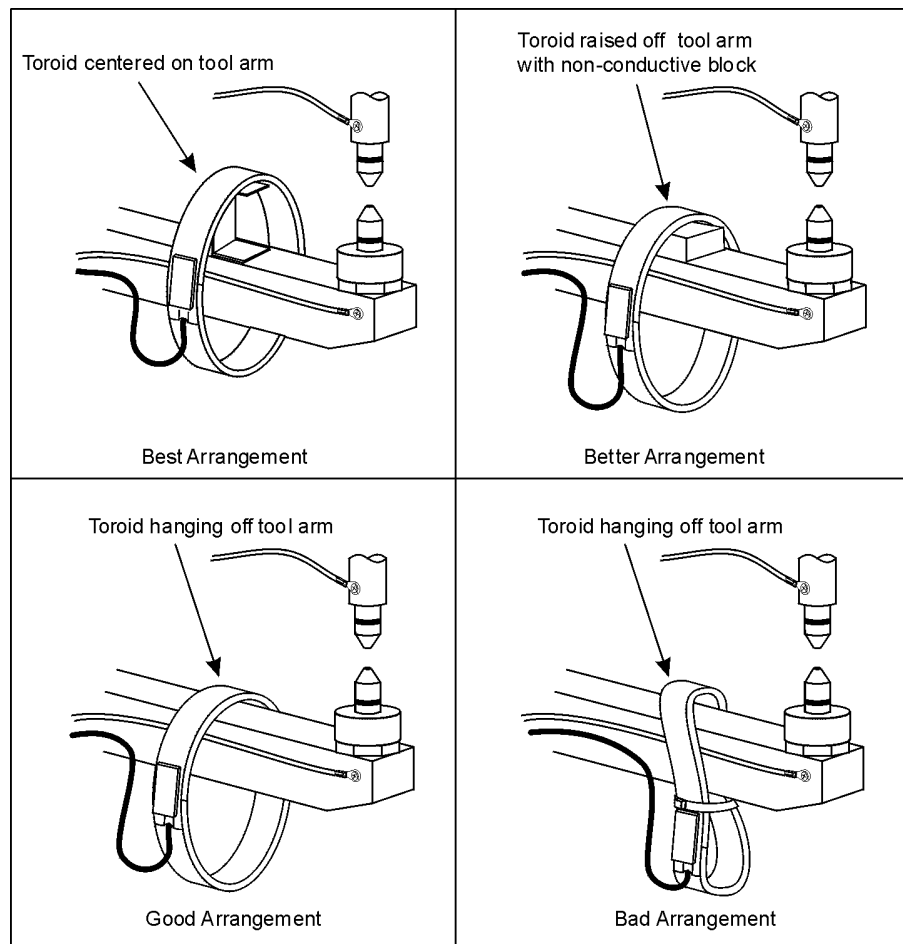
Figure **7-3** Different ways to mount a toroid

Installing the Voltage Leads

Voltage leads should be as short as possible; do not be afraid to cut them. They should be connected as close as possible to the electrodes, ideally on a permanent fixture so that the leads will not have to be re-attached during electrode maintenance. Typically a small hole (10-32 is recommended) is drilled and tapped near the electrode tip and a ring terminal installed on the voltage lead.

Affixing the voltage leads is a process that requires working both from front to back, as well as back to front. It is a balance between keeping the cable connector as close to the leads as possible while leaving sufficient excess to accommodate head motion. Keeping the leads short and twisting the wire whenever possible will greatly reduce unwanted noise and help ensure the integrity of the sensor readings. You may also choose to protect the leads with a flame resistant spiral wrap, or a miniature flexible conduit to protect wires from damage. If you are installing on a Servo Gun or have reason to believe you may have noise from a Servo motor, you should install a Voltage Lead Noise Suppression Filter.

Secure the ring terminals as close as possible to the electrodes
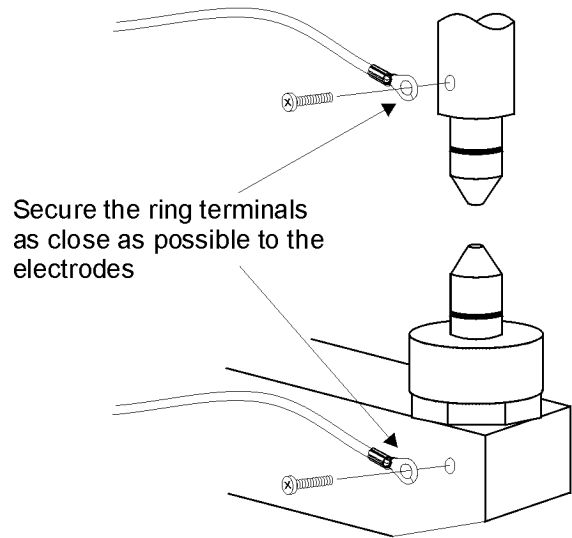
Figure **7-4** Mounting the Voltage leads

- Make sure that the contact surfaces on the ring terminals and the electrodes are free of dirt, grease or corrosion.

- The cable connector should be out of the way of moving parts or current carrying pieces. The leads should be attached as close to the tips of the electrodes as possible, without interfering with the weld process. Ideally, you will want to select a location on a permanent piece of tooling to prevent re-mounting the leads.

- Once you have selected a location, drill and tap a hole for a 10-32 screw, taking care not to tap into an area where the electrode's cooling channels are located.

- The Noise Suppression Filter should be attached close to the connector, and should be wrapped 13 times with the leads. Do not twist the leads while wrapping them around the filter. The filter itself should then be secured using cable ties.

- Run the voltage lead wire from the connector up to the point of connection near the electrode tips. Open and close the tips to see exactly how much excess lead wire is needed to accommodate the motion.

- Secure the voltage wires back along the bus using cable ties or some type of hold-down clamps.

- Attach # 10 ring terminals to the ends of the voltage leads.

Installing the Force Sensor

The mounting of the force transducer is completely dependent on the configuration of the equipment and the type of sensor in use. In the case of a load cell, an equipment integrator may have already installed the transducer or special tooling may be needed to accommodate it. An inline pressure transducer can be integrated with the air/oil/hydraulic cylinder via the inlet port or pressure port on a modified air over oil cylinder.

General mounting guidelines:

- Be sure to avoid mounting the sensor on or too close to an electrical bus;

- Take precautions to isolate the load cell from the welding ground;

- Do not mount the sensor within the loop formed by the weld head secondary bus;

- The sensor should be tightly secured at its mounting point and should be isolated as best as possible from sources of magnetic fields.

- The yellow force cable connector couples with the force sensor.

The Livingston Monitor-Sensor cable may be modified to work with qualified third-party sensors. Please contact your Livingston representative for further information.

Installing the Displacement Sensor

Livingston recommends the use of a double rod end displacement sensor. The size of this sensor will depend on the stroke of weld cylinder: the sensor's stroke must always be greater than the full stroke of the cylinder to prevent over-travel of the sensor.

It is important to leave at least ¼" of travel on either end of the sensor stroke as the resistive element inside the sensor has a small dead band on each end. Try to position the sensor so readings are being taken in the middle range of the full stroke, because scaling resistors are tuned to work best with readings being taken in the area that is centered between 25% of travel on each end. The sensor itself should be mounted on a non-flexible aluminum (or other non-magnetic) bracket. It is essential that the mounting be extremely stiff, since any mounting bracket that can be deflected a few thousandths of an inch can result in erratic and inaccurate displacement readings.

The displacement sensor window is approximately 9% of the range of the stroke of the displacement sensor. For example, a 4-inch sensor has a .354-inch range (+/- 0.177 inches from the zero point). For additional info on displacement window and sensor sizing, please contact your Livingston representative. The displacement sensor can be zeroed electronically at any point on its stroke. For more information on zeroing the displacement sensor, please refer to Chapter 8, Calibrating the Sensors.

General mounting guidelines:

- Affix the mounting bracket to the welder. If possible, avoid locating the mounting on an electrical bus, especially the transformer secondary bus;

- Mount the sensor to the bracket; use a service removable thread locking compound on rod end bolts and all other bracket fasteners to keep parts from loosening.

- Locate the blue displacement cable and plug it into the sensor.

The Livingston Monitor-Sensor cable may be modified to work with qualified third-party sensors. Please contact your Livingston representative for further information.

Testing Sensor Installation

This quick test will verify if all sensors have been properly installed by confirming that the weld monitor is receiving incoming sensor readings. To test the sensor installation, the POD™s and POD™ Server must be installed and the WMS program running. Be sure the POD™ you are testing sensor readings on has an **online** status.

Note: Incoming sensor readings will not be accurate if the sensors have not been calibrated.
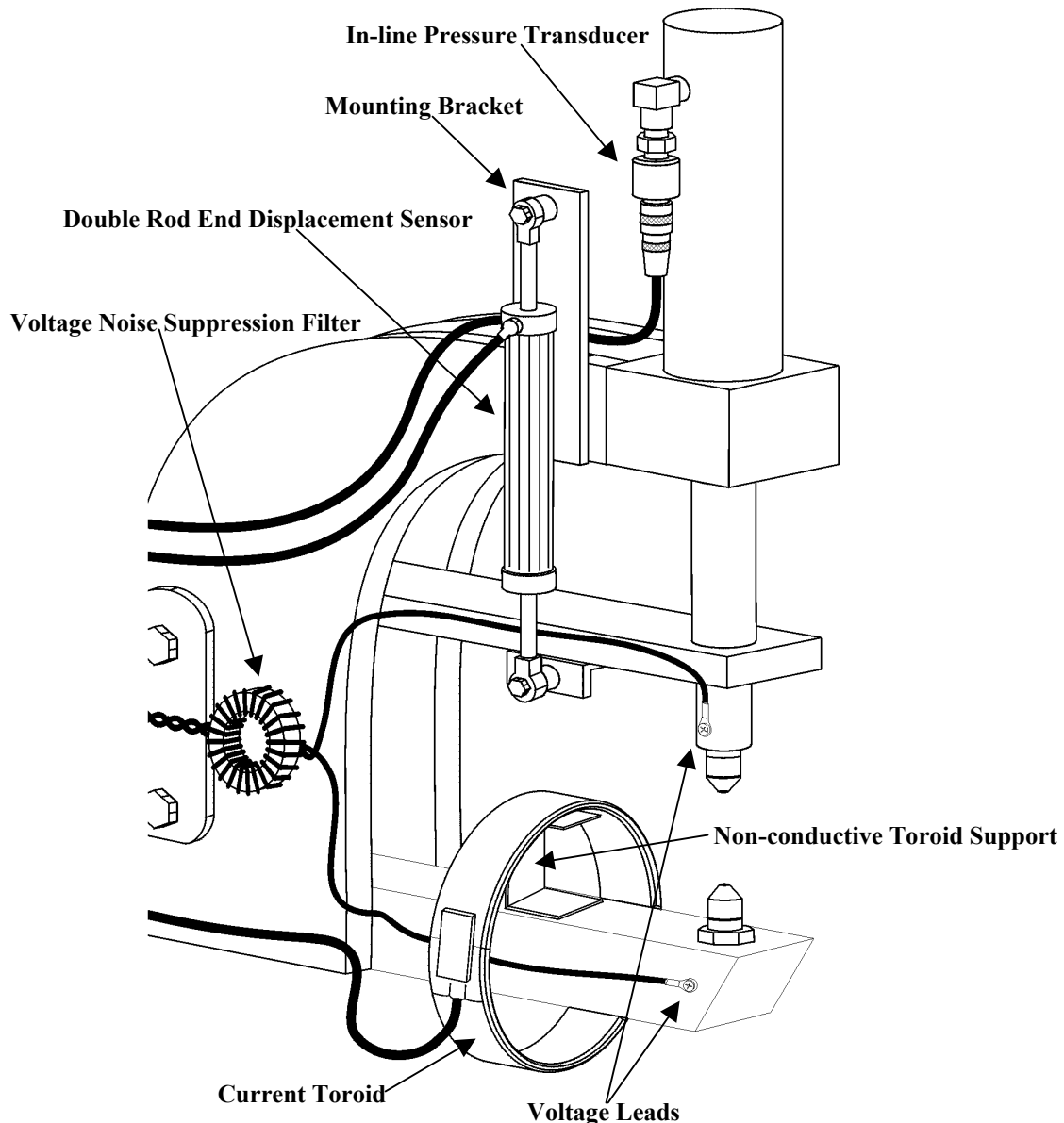
Figure **7-5** Example of a welder with all four sensors attached

To perform a quick test of the sensor installation:

1. With the sensors connected and the POD™ Server turned on, set up the welder as usual to perform a weld. The monitoring of weld events is triggered by current detection and is preset, so no further setup is required to begin recording values during welding.

2. Make a few welds.

3. Note the values that appear on the monitor's main program screen. If the parameters **CurrentRms** and **VoltageRms** are not already displayed on the weld monitor's screen, click any parameter box on the screen itself, click the SELECT key on the Virtual Key-pad and then use the Arrow Keys to scroll through the various parameters until **CurrentRms** is displayed. Press ENTER to show incoming readings for that parameter. Do the same with another parameter box and select **VoltageRms**. The graphic display indicates the levels of the sensor readings for these factors and these values are recorded for the weld.

Note: Readings will be uncalibrated, as the sensors have not been calibrated yet. Calibration is covered in Chapter 8, Calibrating the Sensors

4. Click the MENU button on the Key-pad.

5. Select the **Data** option from the **Main Menu.**

6. Select **Weld Summary**. The program displays the data collected for the welds, organized by weld number, as shown in figure 7-7. For each weld made, the Halfcycle count should be twice the amount of cycles in the weld. For example, a schedule with 5 cycles of Squeeze, 10 cycles of Weld and 8 cycles of Hold would have 46 total halfcycles (5 + 10 + 8 = 23, 23 times 2 = 46). Use the Arrow Keys to scroll through the various headings to view readings for Current, Voltage, Force and Setdown/Expansion (Displacement).

Weld	Halfcycles	Hcycles on	Accept Status	Binselec
17	40	24	68158464	1
16	40	20	1025	1
15	40	20	1281	1
14	40	20	0	1
13	40	20	0	1
12	40	24	68158464	1
11	40	20	0	1
10	40	24	68158464	1
9	40	20	0	1
8	40	20	67108867	1
7	40	20	67109379	0
6	40	20	67109379	0
5	40	20	67109379	0
4	40	20	67109379	0

Figure **7-6** Weld Summary screen

If any of these operations don't work as described, recheck the setup instructions in this chapter or consult Chapter 6, <u>WMS Reference Guide</u>.

Calibrating the Sensors

All sensors must be properly calibrated to obtain maximum accuracy from the weld monitor. The WMS program includes calibration screens that simplify this process by guiding the user through the necessary steps. Both raw A/D and calibrated sensor readings can be viewed using the **Input Monitor**, a screen that displays incoming values for all input channels.

Important Notes

❖ Units of measure should be set prior to calibrating the sensors. These units are set in the tolerance defaults screen.

❖ Calibrating and Zeroing the displacement sensor are not the same thing. As a rule, calibration is done only once while zeroing is done during periodic maintenance (whenever tooling, tips or shunts are changed), and whenever work-piece material thickness changes (e.g., a new lot or batch of parts).

❖ Once sensor calibration has been changed for a Pod sensor, the calibrated readings on the input monitor will correctly display the new calibrated value however the master tolerance limits used by the Pod will not be correct until all masters (master tolerance limits) have been updated.

Following the calibration of a sensor an option will appear on the screen: <ENTER> to update the masters (master tolerance limits), or <ESC> to ignore.

Any one of the following methods will also update the master tolerance limits for a Pod:

➢ Reboot the Pod by removing and reapplying power to the Pod or to the DeviceNet network (reboots all pods). The Pod Server will then send the entire configuration to the rebooted Pod(s), updating the master tolerance limits.

➢ Shutdown and restart the Pod Server software. When the Pod Server software starts it will send the entire configuration to each Pod on the network, updating the master tolerance limits.

➢ Update the P3 master or P1 master tolerance limits that is in use for each binary select.

Frequency of Calibration

Each set of sensors connected to the POD™ inputs needs to be calibrated just once. A re-calibration is necessary only if:
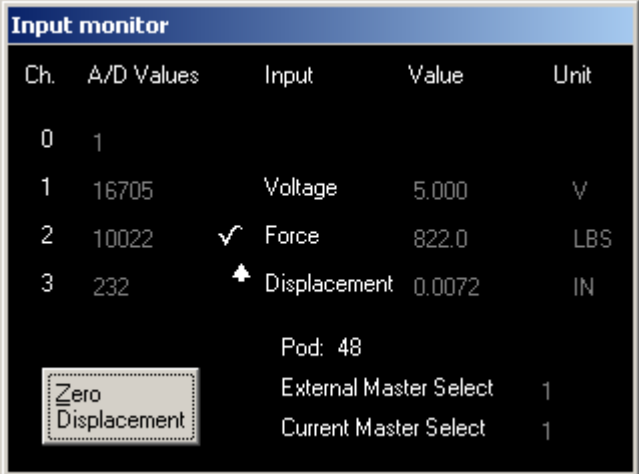
- A new sensor is substituted for an existing sensor;

- An existing sensor is removed and remounted;

- You are doing a re-calibration periodically every 6 months, largely done for force transducers;

- You are re-calibrating to troubleshoot a sensor or sensor cable problem.

The Input Monitor

Sensor calibration is managed through the **Utilities Menu**, under the **Setup Utilities** option of the **Setup Menu**. The **Input Monitor** display shows the real-time readings on all sensor input channels. Use this display after calibrating a sensor to check the validity of the calibration adjustment.

To view the Input Monitor:

1. Select **Setup** from the **Main Menu**.

2. Choose **Setup Utilities**.

3. Select **Input Monitor**. For each input channel 0-3, raw incoming A/D values are displayed, as well as incoming calibrated values and unit measurements (see note). <u>If the sensor has not been properly calibrated, the incoming calibrated readings shown in the **Value** column will not be correct.</u>

Note: Calculated weld Current values are not displayed on the Input Monitor.

Figure **8-1** Input Monitor screen

The values in this screen change as the monitor continuously updates each channel. If the monitor-sensor cable is attached to the unit and the A/D values appear frozen, there may be a problem with the monitor. Refer to Chapter 10, <u>Troubleshooting Guide</u> for more information.

- **External Master Select**

  This value indicates the binary select (Master select number) that the POD is receiving from Internal, External, Explicit or Slave I/O inputs.

- **Current Master Select**

  This value indicates the master that is in use, whether from an external or internal selection. If the binary select (master select) value does not correspond to an existing master, then the **Current Master Select** will be 0 (No Master).

  For more information about binary selects, please refer to the General Setup section of Chapter 6 of the users manual, <u>WMS Reference Guide</u>.

- **Zero Displacement**

  This button is used to re-establish the range in which the displacement readings are being taken. For more information about this feature, please refer to Chapter 11, Appendices, <u>Displacement Channel Overview.</u>

- **"Window" Bit Indicators**

  ✓ , ⬇ and ⬆ are "window" bit indicators for Force and Displacement which indicate whether the parameter is within, lower or higher than the weld tolerance limits for that parameter. For more "window" bit information, please refer to General Setup (Masters Enabled, and Relay Mode) in Chapter 6, and Chapter 11, Appendices, documents 0600-SPC-763 (Discrete I/O with DeviceNet Block) and 0454-APP-292 (DeviceNet Polled I/O).

Installing/Swapping Toroids

Each toroid has its own properties. The Toroid Calibration Factor, established when the toroid was manufactured, is clearly labeled on a sticker located on a cylindrical housing on the cable. This value is entered directly into the monitoring program**.** <u>The toroid does not need to be re-calibrated</u>. When a toroid is installed or replaced, a new calibration factor must be entered in the **Toroid Settings** screen.

To enter the toroid calibration factor:

1. From the **Utilities Menu**, select **Toroid Settings**.

2. Enter the number shown on the calibration factor sticker located on the cylindrical housing on the cable. Be sure to input the value as a whole number, without a decimal. For example, a calibration value of 0.319 would be input as 319 Hit Enter to confirm.

3. Click the **Update Cal Factor** to put new calibration factor into the monitor's memory.

Figure **8-2** Screen with Default Cal. Factor

4. Use ESCAPE to end the toroid calibration. Return to screen; note the change in last weld's current RMS reading in Figure 8-3 after Cal. Factor update.

Figure **8-3** New Toroid Cal. Entered and Updated

Note: You must update all masters for each POD every time you change and update the calibration factor. When exiting the Utilities screen you will be prompted with an option to perform this update. You can also reboot the POD, which automatically updates all masters.

Percentage Adjustment

The current reading from a Livingston toroid may not match the local factory weld current standard. There are three reasons for this:

1. The way a toroid is mounted on the welding bus can affect the accuracy of the reading;

2. There is no recognized 'standard' for high current calibration, so calibrations tend to vary among manufacturers.

3. Not all manufacturers use the same math to calculate the current measurement.

To compensate for these differences, Livingston offers a feature called **Percentage Adjustment**. The percent adjustment option takes whatever value was received from the channel and adjusts it by whatever percentage you specify. The adjustment applies both to **Current Peak** and to **Current Rms**. This means that if the current reading from a Livingston monitor absolutely needs to match the current reading from another current measuring device, the Livingston monitor can be easily adjusted so that the readings are the same.

To obtain the correct Percentage Adjustment:

1. Make a weld then return to the toroid settings screen. The last weld's Current RMS value is displayed.

2. Take the reading from your weld control or Plant standard current meter and enter the value into the Desired Current RMS field. Press Enter on your keyboard or click the Enter button on the virtual Keypad. You will see the Percent adjusted display, see Figure 8-4.

3. Click the **Update Configuration** Button. This will save the percentage change. Now escape out to the main screen, make another weld and return to the Toroid Settings screen. The two current RMS fields will now match, as shown in figure 8-5.

4. If you would like to return to 100% simply edit the Percent field back to 100 and press enter and then click the Update Configuration button.

Note: You must update all masters for each POD every time you calibrate. When exiting the Utilities screen you will be prompted with an option to perform this update. You can also reboot the POD, which automatically updates all masters.

Figure **8-4** Percent change After Entering

Figure **8-5**

Calibrating Displacement

Livingston strongly recommends fabricating two different gauge blocks that fit into the welding electrodes for displacement calibration. Typically, these blocks are made of hardened steel. The first block should be equal to the stack-up thickness of the parts to be welded. The second block should have a known thickness that is not more than 4.5% of the overall stroke of the sensor. For example, a gauge block for a sensor with a 4-inch stroke should be of a thickness generally around half and no greater than 0.180 inches.
 These blocks can be chained to the machine for easy access.

To calibrate the displacement:

1. From the **Utilities Menu**, choose the **Calibrate Displacement** option.

2. Place a gauge block equaling the stack-up thickness of the parts to be welded between the weld head electrodes. Close the weld head electrodes on the gauge block.

3. Enter '0' for the Point 1 value and press ENTER. (This does exactly the same thing as the **Zero Displacement** Button. Refer to the section below for more details).
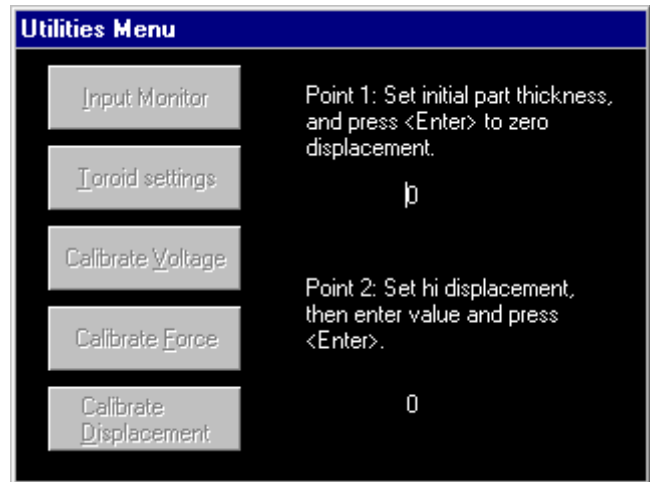
Figure **8-6** Calibrate Displacement screen

4. Open the weld head electrodes and add a second gauge block of known thickness on top of the first block. Close the weld electrodes onto the blocks and enter the known thickness of the gauge block as the Point 2 value and press ENTER.

5. Select ESCAPE to exit the window. Return to the **Input Monitor** screen and check the readings both with and without the second gauge block in place. The values displayed should correspond to those that were entered when calibrating the displacement sensor.

Note: If it is not possible to position two known thicknesses, calibration may be done with the tips together. Zero with the electrodes closed together, then use a shim or washer of a known thickness placed between the electrodes for calibration. Once you have verified the values with the **Input Monitor** re-zero with the full part stack-up clamped up.

Zeroing the Displacement

The **Zero Displacement** button on the Input Monitor screen centers the range of the displacement readings so that incoming values will be within the appropriate measurement range. The monitoring program compensates for the incoming voltage readings to establish a mid-range setting at the appropriate sensitivity. Refer to Chapter 6, <u>WMS Reference Guide</u> for more details.

Note: You must update all masters for each POD every time you calibrate. When exiting the Utilities screen you will be prompted with an option to perform this update. You can also reboot the POD, which automatically updates all masters.

Calibrating Force

An external handheld force gauge is required to determine the exact amount of force that is being applied during this calibration. If an external force gauge is not available, refer to the note below. Should you have any problems with your force calibration due to an unusual force sensor and/or equipment setup, please contact Livingston technical support.

To calibrate the force:

1. From the **Utilities Menu**, choose the **Calibrate Force** option.

2. Depending on the type of welder, you will need to either:

   (a) Set the squeeze force with just enough pressure to hold the part in place. Using an external force meter to read the force, enter Point 1 from the value displayed. This value is listed as optional, but is highly recommended to reduce error. Press ENTER to input the value. Or;

Figure **8-7** Calibrate Force screen

   (b) With the electrodes unclamped, enter '0' for Point 1. This value is listed as optional, but is highly recommended to reduce error. Press ENTER to input the value.

3. Clamp the electrodes and apply full weld force. Record the Point 2 value as shown on the external force meter. Press ENTER to input the value.

4. Use the ESCAPE button to exit the screen, then go to the **Input Monitor** display to check the values.

Note: If an external hand-held force gauge is not available, relative force measurement input values may be calculated as follows:

Air/Oil Cylinder:

Multiply the ratio of the cylinder by the airline pressure (psig). Input this number as the Point 2 value.

For example, a 22:1 cylinder with an 80 psi line pressure:

> 22*80 = 1760 lbs. (force at the tips)
>
> Enter '1760' in the Point 2 value field.

Air Cylinder:

Multiply the surface area of the bore of the cylinder by the airline pressure. Input this number as the Point 2 value.

For example, an 8" bore cylinder with a 70 psi line pressure:

Surface area of the bore = πr^2

Radius of an 8" bore = 4"

$4^2 = 16$

$16*3.14 = 50.24$

$50.24*70$ psi = 3516.8 psi electrode force

Enter '3516.8' in the Point 2 value field.

Note: Many tandem or multiple piston cylinder manufacturers supply force @ inlet pressure specification charts.

Note: You must update all masters for each POD every time you calibrate. When exiting the Utilities screen you will be prompted with an option to perform this update. You can also reboot the POD, which automatically updates all masters

Calibrating Voltage

Voltage is calibrated at the factory and does not need to be re-calibrated. If there is an extenuating circumstance requiring re-calibration of the voltage, use the following procedure. You will need a set of Livingston voltage leads, a battery and a multimeter to calibrate voltage. A Livingston Voltage Calibrator may also be used.

Note: Do not insert paper clips or wire into the connectors. The connector pins may be damaged, resulting in intermittent readings on the voltage channel.

To calibrate the voltage using a set of voltage leads, a battery and multimeter:

1. Disconnect the green Voltage sensor cable from the voltage leads installed on your welder.

2. Connect the calibration leads to the green cable connector.

3. From the **Utilities Menu**, select **Calibrate Voltage**.

4. Short the voltage leads together and set the value to 0. This reading is listed as optional, but is highly recommended. Click ENTER to confirm the entry.

5. Connect a 1.5V or 9V battery to the leads. The red lead is positive; the black lead is negative. Make sure the DC voltage polarity is observed during calibration. Take the voltage reading of a battery using a multimeter while it is still connected. With the leads still connected to the battery, set the entry for Point 2 to the known value. This value must be entered to proceed. Press ENTER to input the value.
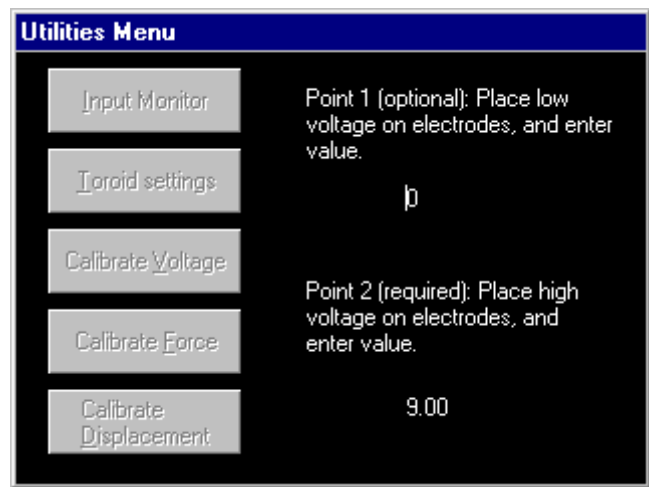
Figure **8-8** Calibrate Voltage screen.

Note: The Maximum input for voltage channel is 9.5V, channel will saturate at 10V.

6. Use the ESCAPE button to exit.

7. Go back to the **Input Monitor** screen and compare the incoming values on the voltage channel with the leads shorted together as well as with the battery connected.

To calibrate the voltage using a Livingston Voltage Calibrator:

Follow the instructions that came with the Voltage Calibrator.

Note: You must update all masters for each POD every time you calibrate. When exiting the Utilities screen you will be prompted with an option to perform this update. You can also reboot the POD which automatically updates all masters

Frequently Asked Questions

I have a bad POD and need to replace it. What do I need to do to install a spare POD?

Refer to the procedure in Chapter 12, <u>Application Notes</u>.

When I change my electrodes, why do I have to zero displacement? Do I have to re-calibrate?

Any time minor changes to the tooling are made, electrodes ware or mushroom beyond tolerance limits or when work piece material thickness changes (e.g., a new lot or batch of parts) the displacement should be zeroed. The reason for this is that all measurements having to do with displacement are calculated based on where the 'zero point' is set. Masters are also made and toleranced based on the zero point. When electrodes are changed, the size of the tips may be significantly different, especially if the old tips are mushroomed and worn. This difference may be enough to cause a weld to exceed its tolerances and consequently be 'Rejected'. This difference may also lead to inaccurate displacement measurement. By zeroing the displacement sensor, the 'zero point' is adjusted to accommodate the new tip size or work piece material variation. Zeroing the displacement should be incorporated into the daily maintenance schedule for the welder.

Calibration, on the other hand, typically only needs to be done once, unless the sensor itself is replaced.

Why does the gauge block for zeroing displacement have to be the same size as my part stack-up? Why do I even need to make a gauge block— can't I just zero with the electrodes closed together?

The answer to both of these questions has to do with: a) the resolution quality of the displacement sensor versus the cost of that sensor; b) the stackup height of the parts being welded; and c) consistency.

A high-cost displacement sensor can measure to four places (0.0001) using the full stroke length. A low-cost displacement sensor can accomplish the same resolution, however it can only be attained using about 9% of the stroke length. That 9% 'window' can be anywhere along the stroke of the sensor, but the measurement must be within half of that window (because zeroing occurs in the middle of the window).

For example, using a 100mm sensor, 9% of the stroke is 9mm, or approx. 0.354 inches. The half window is then 4.5mm, or 0.180". If you were welding a nut with a thickness of 5.08mm (0.200"), that was stacked on a 1mm (0.03937") thick plate, the total thickness to be measured would be 6.08mm, or 0.240". Since the stack-up height (0.240") is greater than the half window (0.180"), if you zeroed the monitor with the electrodes closed together without the part. Then when the part stack-up is added the sensor travel would be outside the measurement window.

Fabricate a zeroing gauge block that represents the stack-up height of the parts being welded. Use the block to zero the sensor, this way the 'window' can be moved to the appropriate location for the weld.

 If you're doing flat plate welds (e.g., sheet metals), the chances are pretty good that the stack-up will already be within the "half window". However, for any type of projection or nut welding, the stack-up is likely to fall out of range. It is possible to use actual parts for zeroing on instead of a gauge block,

however nuts vary, plates vary and the tip force used to hold the part in place may cause deformation of the metal. With a gauge block, the sensor is zeroed in the same place every time, regardless of part variances.

Livingston strongly recommends fabricating a calibration block as well— typically sized 3-4% of the stroke length. Such a block provides a known thickness for sensor calibration. By using both a zeroing gauge block and calibration gauge block, you can be assured of a consistent zero and a proper calibration. Hardening of gauge blocks is recommended so blocks remain the same thickness through repeated calibrations.

Why do I have to delete weld data?

Refer to the Recommended Database Management section of Chapter 11, Appendices.

I was working with a Master in the tolerancing screen, and I selected another Master to work with. When the new Master came up, the tolerancing bands disappeared.

 A Master must be updated for use to display tolerance bands. Select the Master and click UPDATE to load the Master for use.

If I did an Export All, but I only want to retrieve setup information, can I just do an Import Setup?

No. An **Import Setup** will only work if an **Export Setup** has been performed; likewise with an **Import All** and **Export All**.

If I use the Copy/Replace feature, will the Master I'm copying/replacing be deleted?

No. Whether you are copying or replacing, the selected Master is always copied first.

When would I use the Copy/Replace feature? (P3 System)

This feature is useful in a situation where the tolerances for a particular Master have been carefully refined and adjusted, but a slight adjustment needs to be made to the weld schedule. For example, it may be determined that more current or less force is needed, or perhaps the material thickness has changed slightly. In such a case, a new Master will be needed, but you may wish to keep the tolerances and segment structure of the old Master. Using the **Copy/Replace** feature, a copy of the original toleranced Master is made and then a new weld is recorded using the adjusted weld schedule or work pieces. The new weld is then used to replace the original weld in the copied Master while keeping the tolerances and segment structure of the copied Master.

 Note: Copy/Replace will work only for a new weld with the same number of halfcycles in the weld segment.

Can I Copy/Replace between bin selects with my P3 System?

No. When a Master is Copied/Replaced, it will always be in the same bin select as the existing Master.

Note: You can Copy/Replace a Master then use the Edit Master Screen to change the Bin Select

Can I make more than one Master at a time with my P3 System?

Yes, if multiple binary selects are used. For example, if the **New** button is pressed in the **Mastering** screen, then three different welds on three different bin selects are made with the welder in auto mode, as the welds are made the binary selects are sent by the PLC. When the **Done** button is pressed, there will be three new Masters made, one for each bin select in the weld sequence. If you only wanted to make 1 Master on a specific bin select just delete the other two Masters.

Why does the weld monitor display a single weld as several welds?

If you're using a pulsed weld then the *post delay* may not be set high enough to account for the time between pulses. In this case the weld monitor will consider each pulse as an individual weld. Refer to General Setup in Chapter 6, <u>WMS reference Guide</u>.

Another possibility is that the weld schedule has changed since a master (P3) or master tolerance limits (P1) were created (i.e The 'on' time of the weld has increased). The solution in this case is to return the weld schedule to it's previous weld length, create a new master (P3), or adjust the *cycleon* High limit (P1) so that the monitor will accommodate the length of the weld.

For additional possibilities, refer to Chapter 10, <u>Trouble-Shooting Guide</u>.

INDEX

TROUBLESHOOTING GUIDE _____

Troubleshooting Guide

Before You Begin

A little common sense will go a long way in troubleshooting a Livingston system. Check for obvious problems first, such as loose sensors or cables and/or physically damaged components. Pay attention to the system settings, especially calibrations and zeroing. A sensor that is not properly calibrated can cause all kinds of problems, including inaccurate master data and tolerances. Examining weld data can also provide a good indication of something not functioning properly. For example, a **Setdown** of 0.000" for a projection nut weld does not make much sense. However, if the displacement sensor was not properly zeroed and the data being measured is outside of the displacement window, the **Setdown** parameter will be zero.

The following chart is not intended to be a comprehensive problem-solver for every possible situation; rather, it is designed to provide the user with a starting point from which to diagnose possible causes of system problems. If you are unsure about or are having serious problems with a Livingston system, contact Livingston Service for assistance.

Notes:

- It is OK if a force sensor does not read zero when the electrodes are open. The tooling itself has weight and the amount supported by cabling, shunts, etc. is not repeatable.

- When troubleshooting displacement, be sure to check the rigidity of the displacement bracket. While observing the displacement channel on the **Input Monitor**, with the gun closed @ force attempt to move one end of the displacement sensor. If the readings jump, the bracket or rod ends may be loose. To avoid inaccurate readings it is important that the displacement sensor-mounting brackets have no mechanical slop, are rigid and do not move.

- If the displacement reading saturates in the **Input Monitor** (+/- 32767**,** channel input range has been exceeded) while attempting to calibrate with a gauge block, the gauge block is too thick. Refer to Chapter 9, FAQ for more information about using a gauge blocks to zero and calibrate the displacement.

Understanding A/D Readings

This chapter utilizes the Input Monitor screen for troubleshooting the various sensors.

There are two different values reported for each sensor; calibrated values (not reported for current) and A/D values.

The A/D values represent the analog sensor signals that have been converted to digital readings.

The calibrated values displayed are the incoming readings after the sensor has been calibrated. The A/D values can help determine the electrical integrity of the sensor and/or sensor cable. Always take note of the A/D readings if a sensor does not calibrate properly. If a sensor and/or

cable are shorted or open, an inaccurate calibration will result. Check for "frozen" or "pegged" A/D readings.

Plug in a known good sensor and cable check the A/D values and compare them with the suspect sensor and cable.

As an example a properly sized force sensor with no load on it will have an A/D reading of approximately 0 to 40. When full force is applied the reading should be from 50% to 75% of full scale. 50% of 32767 = 16383 A/D counts.

These numbers will vary based on sensor millivolt per volt output and load range verses actual load. The point is that if A/D readings with sensor loaded are similar to the sensor with no load this generally indicates a failure of the sensor or sensor cable.

Remember when checking a displacement sensor you must be within the measurement window to get meaningful A/D readings. If you are not within (e.g. gun is retracted) the reading will be "pegged"(+/- 32767, channel input range has been exceeded). Refer to Chapter, 8 Calibrating the sensors, Chapter 9, FAQ and the Displacement Channel Over view Section of Chapter 11 for additional Information on displacement.

1. SOME OR ALL WELDS ARE REJECTED, NOT CATCHING FAULTY WELDS, WELD COUNT NOT INCREASING

PROBLEM	POSSIBLE CAUSE OR SYMPTOM	POSSIBLE FIX
EVERY WELD IS REJECTED: The weld summary screen indicates that almost every parameter is rejecting.	No Master (P3) or Master tolerance limits (P1) have been created. It is possible that they were made, but not updated.	Check to see if "No Master" is displayed on the Main Program screen. If so, create a new Master or new Master tolerance limits. (Refer to Chapter 5, <u>WMS Quick Start Guide</u> or Supplementary Procedure, if applicable).
	Masters are not enabled.	Go to the **General Setup** menu and set **Masters Enabled** to **Yes**.
	Weld schedule has changed.	Change weld schedule back to what it was when the Master (P3) or Master tolerance limits (P1) were created or create a new Master or new set of Master Tolerance Limits for the new schedule.
	Tolerances are set improperly.	Adjust the tolerances.
	Calibration has been changed.	Check calibration and recalibrate sensor if necessary (Refer to Chapter 8, <u>Calibrating the Sensors</u>). **Note:** If an **Export Setup** was performed the last time this sensor was properly calibrated, an **Import Setup** may be performed to reload the saved calibration settings. Refer to Chapter 6, <u>WMS Reference Guide</u>.
	Incorrect Bin Select.	Depending on system configuration, the Bin Select may be Internally or Externally selected. Refer to <u>Trouble With Bin Select or Accept/Reject</u>. Section 7 of this Chapter.
	No welds are being detected.	Refer to <u>Trouble With Weld Count.</u>
	Sensor failure.	Inspect sensor for physical damage. Inspect electrical connections for poor connections or corrosion. Replace sensor if any damage is found.
		Replace the sensor and Re-calibrate. (Refer to Chapter 8, <u>Calibrating the Sensors</u> for more information about this screen).

PROBLEM	POSSIBLE CAUSE OR SYMPTOM	POSSIBLE FIX
EVERY WELD IS REJECTED: The weld summary screen indicates that almost every parameter is rejecting. **CONT'D**	Sensor cable failure.	Inspect sensor cable for physical damage. A cable that is deformed, severed, partially severed, shredded, abraded and/or has bare wires showing may be suspect. Disconnect sensor cable from POD and replace. Try to reposition new cable to avoid recurring damage. Spiral wrap or guards will also help to protect cable.
		Inspect electrical connections for damage, poor connections and/or corrosion. Replace connectors and/or cable.
EVERY WELD IS REJECTED: The Weld Summary screen indicates that the HalfCycle (Hcycle) Count is incorrect.	Weld Schedule changed.	Change weld schedule back to what it was when the Master (P3) or Master tolerance limits (P1) were created or create a new Master or new set of Master Tolerance Limits for the new schedule.
EVERY WELD IS REJECTED: The Weld Summary screen indicates that any or all Displacement parameters (Initial Thickness, Final Thickness, Setdown, Expansion) are out of tolerance.	Electrodes were changed/dressed and the displacement was not zeroed. Electrodes worn or mushroomed.	Zero the displacement. (Refer to Chapter 8, <u>Calibrating the Sensors</u> or Supplementary Procedure, if applicable).
	Calibration has changed.	Check calibration and recalibrate sensor if necessary (Refer to Chapter 8, <u>Calibrating the Sensors</u>). **Note:** If an **Export Setup** was performed the last time this sensor was properly calibrated, an **Import Setup** may be performed to reload the saved calibration settings. Refer to Chapter 6, <u>WMS Reference Guide</u>.
	Tolerances are set improperly.	Adjust the tolerances.

PROBLEM	POSSIBLE CAUSE OR SYMPTOM	POSSIBLE FIX
EVERY WELD IS REJECTED: The Weld Summary screen indicates that any or all Displacement parameters (Initial Thickness, Final Thickness, Setdown, Expansion) are out of tolerance. **CONT'D**	Sensor is reading outside of usable range (window).	Zero the displacement. (Refer to Chapter 8, <u>Calibrating the Sensors</u> or Supplementary Procedure, if applicable). If monitoring more than 1 specific weld with a POD (e.g., weld gun shuttles or moves to multiple locations when welding), verify that the initial and final stack-ups are within the displacement window for each weld being made. (Refer to the <u>FAQ</u> for more information about the displacement window).
	Mechanical problems: loose displacement brackets or loose tooling.	Check the tooling and brackets for looseness or mechanical slop. Check for loose electrodes. Repair as necessary.
	Welds are being made with missing parts.	Check welded parts for missing parts, nuts, etc. Check nut feeder.
	Mechanical binding.	Check for mechanical binding.
	Process timing has changed. Weld head is extending too late or retracting too soon.	Check for mechanical binding. Check for PLC program changes.
	Sensor failure.	Refer to Section 3, <u>Trouble With Displacement Sensor, Readings or Channel</u>.
	Sensor cable failure.	Inspect sensor cable for physical damage. A cable that is deformed, severed, partially severed, shredded, abraded and/or has bare wires showing may be suspect. Disconnect sensor cable from POD and replace. Try to reposition cable new to avoid recurring damage. Spiral wrap or guards will also help to protect cable. Refer to Section 6, <u>Possible Sensor Cable Failure</u>.
		Inspect electrical connections for damage, poor connections and/or corrosion. Replace connectors and/or cable.

PROBLEM	POSSIBLE CAUSE OR SYMPTOM	POSSIBLE FIX
EVERY WELD IS REJECTED: The Weld Summary screen indicates that any or all Displacement parameters (Initial Thickness, Final Thickness, Setdown, Expansion) are out of tolerance**.** **CONT'D**	Sensor cable failure. **CONT'D**	Use the **Input Monitor** to observe the displacement channel readings. Mechanically disconnect one end of the sensor and extend/retract until you are reading within the window of the displacement channel. Try flexing different areas of the sensor cable looking for any area that causes the readings on the Input Monitor to "jump". Replace the cable if flexing any part of it causes intermittent readings.
		Using the cable pinout documentation for your system, check the continuity of all connections relating to this sensor. Repair or replace cable as necessary.

PROBLEM	POSSIBLE CAUSE OR SYMPTOM	POSSIBLE FIX
EVERY WELD IS REJECTED: The Weld Summary screen indicates that Force Parameters are out of tolerance.	Calibration has changed.	Check calibration and recalibrate sensor if necessary (Refer to Chapter 8, Calibrating the Sensors). **Note**: If an **Export Setup** was performed the last time this sensor was properly calibrated, an **Import Setup** may be performed to reload the saved calibration settings. Refer to Chapter 6, WMS Reference Guide.
	Tolerances are set improperly.	Adjust the tolerances.
	Welds are being made with missing parts and the weld gun is not closing completely.	Check welded parts for missing parts, nuts, etc. Check nut feeder.
	Weld gun or solenoid valve failure.	Check the force at the electrodes. Verify that solenoid valves or servo is working correctly.
	Force sensor failure.	Refer to Section 2, Trouble With Force Sensor, Readings or Channel.

PROBLEM	POSSIBLE CAUSE OR SYMPTOM	POSSIBLE FIX
EVERY WELD IS REJECTED: The Weld Summary screen indicates that Force Parameters are out of tolerance. **CONT'D**	Sensor cable failure.	Inspect sensor cable for physical damage. A cable that is deformed, severed, partially severed, shredded, abraded and/or has bare wires showing may be suspect. Disconnect sensor cable from POD and replace. Try to reposition new cable to avoid recurring damage. Spiral wrap or guards will also help to protect cable. Refer to Section 6, <u>Possible Sensor Cable Failure</u>.
		Inspect electrical connections for damage, poor connections and/or corrosion. Replace connectors and/or cable.
		Use the **Input Monitor** screen to observe the force channel readings. Try flexing different areas of the sensor cable looking for any area that causes the readings on the Input Monitor to "jump". Replace the cable if flexing any part of it causes intermittent readings.
		Disconnect the sensor cable from the POD & sensor and then using Livingston sensor cable documentation, check continuity of all connections within the cable. Repair or replace cable as necessary.

PROBLEM	POSSIBLE CAUSE OR SYMPTOM	POSSIBLE FIX
EVERY WELD IS REJECTED: The Weld Summary screen indicates that Current, Voltage, Energy, Resistance or Conduction Angle Parameters are out of tolerance.	Calibration has changed.	Inspect and re-enter toroid calibration factor if necessary (Refer to Chapter 8, <u>Calibrating the Sensors</u>).
	Tolerances are set improperly.	Adjust the tolerances.
	Voltage lead failure or poor connections.	Inspect the voltage leads for severed or abraded wires, or poor connections and repair as necessary.
	Weld process has changed due to shunt, tooling change or tooling failure.	Check welded parts for missing parts, nuts, etc. Check nut feeder. Inspect the shunts and tooling.

PROBLEM	POSSIBLE CAUSE OR SYMPTOM	POSSIBLE FIX
EVERY WELD IS REJECTED: The Weld Summary screen indicates that Current, Voltage, Energy, Resistance or Conduction Angle Parameters are out of tolerance. **CONT'D**	Sensor cable failure.	Inspect sensor cable for physical damage. A cable that is deformed, severed, partially severed, shredded, abraded and/or has bare wires showing may be suspect. Disconnect sensor cable from POD and replace. Try to reposition new cable to avoid recurring damage. Spiral wrap or guards will also help to protect cable. Refer to Section 6, <u>Possible Sensor Cable Failure</u>.
		Inspect electrical connections for damage, poor connections and/or corrosion. Replace connectors and/or cable.
		Using the cable pinout documentation for your system, check the continuity of all connections relating to this sensor. Repair or replace cable as necessary.
		Disconnect the sensor cable from the POD & sensor and then using Livingston sensor cable documentation, check continuity of all connections within the cable. Repair or replace cable as necessary.
	Toroid failure.	Inspect the toroid for physical damage or abrasion. Inspect for loose buckle. Replace and/or relocate toroid if necessary.

PROBLEM	POSSIBLE CAUSE OR SYMPTOM	POSSIBLE FIX
SOME WELDS ARE REJECTED: The weld summary screen indicates that some welds are Rejected. Almost every parameter is out of tolerance except for Half Cycle count	External Bin Select is working intermittently.	Refer to Section 7, <u>Trouble With Bin Select or Accept /Reject.</u>
	Internal Bin Select is working intermittently.	Refer to Section 7, <u>Trouble With Bin Select or Accept /Reject.</u>
	Weld Timer is malfunctioning or the logic controlling the Weld Timer is incorrect.	Check weld timer operation (firing boards and SCRs). Call your resident logic programmer and have the logic inspected.

PROBLEM	POSSIBLE CAUSE OR SYMPTOM	POSSIBLE FIX
SOME WELDS ARE REJECTED: The weld summary screen indicates that some welds are rejecting due to incorrect Half Cycle Count.	Weld Timer is malfunctioning or the logic controlling the Weld Timer is incorrect.	Check Weld Timer operation (Firings boards and SCRs). Call your resident logic programmer and have him/her inspect the logic.
	Toroid failure or loose buckle.	Inspect the Toroid for physical damage or abrasion. Replace and/or relocate Toroid if necessary. Inspect for loose buckle.
	AD Threshold settings require adjustment.	Refer to the <u>General Setup</u> Section in Chapter 6, <u>WMS Reference Guide</u> for rule of thumb settings and overview on these settings. Try increasing the settings. Call Livingston Service for support.
	The transformer secondary is not properly grounded.	Check the transformer for grounding issues. The transformer secondary should be grounded either directly or through a grounding inductor. A 1megaOhm resistor in parallel to a .01microFarad/600V capacitor may also be used.

PROBLEM	POSSIBLE CAUSE OR SYMPTOM	POSSIBLE FIX
WELDS THAT SHOULD BE REJECTED ARE NOT BEING REJECTED: The weld summary screen indicates that welds have an ACCEPT status of "0" for parts that should be REJECTED.	Tolerances are improperly adjusted.	Analyze the weld data and process to determine which parameters need tighter tolerances to REJECT defective welds.
	Displacement sensor was not zeroed before a new Master was created. Displacement readings are inaccurate or static.	Check the zero reference of displacement sensor and zero if necessary. Create a new Master or set of Master Tolerance Limits and examine the weld data for inconsistencies.
	A sensor is not calibrated correctly before a new Master was created.	Using the **Input Monitor**, check the calibration of the sensors and recalibrate if necessary. Create a new Master or set of Master tolerance limits and examine the weld data for inconsistencies.
	A sensor is malfunctioning and a new Master was created. Sensor readings are inaccurate or static.	Using the **Input Monitor**, check the calibration of the sensors and recalibrate if necessary. Create a new Master or set of Master tolerance limits and examine the weld data for inconsistencies.
	You are looking at the wrong data or the wrong POD ID.	Verify that the POD data really belongs to the welds in question.

PROBLEM	POSSIBLE CAUSE OR SYMPTOM	POSSIBLE FIX
WELD COUNT DOES NOT INCREASE	Sensor cable disconnected.	Check to see if the sensor cable is properly connected to the POD.
	Toroid disconnected or damaged.	Inspect the toroid for poor connections and/or physical damage or abrasion. Reconnect, replace and/or relocate toroid if necessary.
	Pod is Offline.	From the **Main Menu**, select **Setup > Pods/Server**. All PODs on the network should appear on the screen. If a POD does not appear on the screen, check all DeviceNet connections thoroughly. If a POD appears on the screen with a status code other than **Online**, refer to, <u>Status Decoder in Pods/Server Screen</u> in Chapter 11, <u>Appendices.</u>
	Incorrect POD ID number.	Check to see if the POD/ID Select Box is set to the appropriate head to be monitored.
	A-D Threshold setting is too high/incorrect.	In the **General Setup Menu**, decrease setting until a weld is detected.
	Hardware/Software failure	Call Livingston Service.
	DeviceNet trouble.	Refer to <u>Troubleshooting a DeviceNet Network</u> in Chapter 11, <u>Appendices</u>.

2. TROUBLE WITH FORCE SENSOR, READINGS OR CHANNEL

PROBLEM	POSSIBLE CAUSE OR SYMPTOM	POSSIBLE FIX
CALIBRATED FORCE SIGNAL IS READINGS HIGHER OR LOWER THAN NORMAL	Calibration has changed or is incorrect.	Inspect and recalibrate sensor if necessary (Refer to Chapter 8, Calibrating the Sensors). **Note:** If an **Export Setup** was performed the last time this sensor was properly calibrated, an **Import Setup** may be performed to reload the saved calibration settings. Refer to Chapter 6, WMS Reference Guide.
CALIBRATED FORCE SIGNAL IS INDICATING A "FROZEN" (static) READING	The force sensor is not connected properly.	Inspect electrical connections for poor connections or corrosion.
	The force sensor, sensor cable, or POD is malfunctioning.	Use the **Input Monitor** to observe the force channel readings. With the sensor disconnected an A/D value of +/-32767 may indicate a failed sensor cable or POD hardware. Refer to Section 8 of this chapter, Trouble With Hardware.
		Use the **Input Monitor** to observe the force channel readings. Apply and remove pressure. If the A/D value does not change, this may indicate a failed sensor, sensor cable (see below) or POD hardware. Refer to Section 8 of this chapter, Trouble With Hardware.
		Use the **Input Monitor** to observe the force channel readings and compare the readings to those of another similar weld head adjusted to the same pressure. Apply and remove pressure. If the A/D values are not similar to those displayed on a different POD that is functioning properly, this may indicate a failed sensor, sensor cable or POD hardware.
		Use the **Input Monitor** to observe the force channel readings. Apply and remove pressure. If the A/D values are not close to expected values, this may indicate a failed sensor, sensor cable (see below) or POD hardware. If sensor and cable are ok refer to Section 8 of this chapter, Trouble With Hardware.

PROBLEM	POSSIBLE CAUSE OR SYMPTOM	POSSIBLE FIX
WHEN A WELD IS MADE, THERE IS LITTLE OR NO FORCE REPORTED.	The air pressure was adjusted or system pressure has changed.	Check air pressure setting. Check the force at the electrodes.
	Process timing has changed. Weld head is extending later or retracting sooner than it was when Master or tolerance limits were set. Intensification timing has changed.	Check for mechanical binding. Check for PLC program changes.
	Mechanical binding.	Check for mechanical binding of the weld head.

| ”FROZEN” A/D READING: The **Input Monitor** indicates a constant (static) A/D reading for the force sensor. This value never changes; the other sensor channels do not change or update either. | POD system: DeviceNet communications failure. | If other channel readings are not changing, the data may not be updating. Go to the **Pods/Server** screen and confirm that the POD is Online. Check the DeviceNet network for communication issues. If no network faults are found, reboot the POD by disconnecting the unit from the DeviceNet network and then reconnecting it. This will remove and re-apply power to the POD. If problem persists contact Livingston Service. |

| “PEGGED” A/D READING: The **Input Monitor** indicates a force channel A/D reading of +/-32767. This value never changes; the other sensor channels appear to be working and the A/D values for these channels are changing/updating. | Sensor failure. | A reading of +/-32767 indicates that the input channel is reading its maximum value and is saturated. There may be problem with the sensor, sensor cable, or POD. Disconnect the sensor from the sensor cable. If the A/D reading changes to a value within +/- 100 from 0, the sensor may be malfunctioning. Repair or replace the sensor. If the A/D reading remains at maximum value then the sensor may be OK and the sensor cable may be malfunctioning. Refer to Section 6, <u>Possible Sensor Cable Failure</u>. |
| | Sensor cable failure. | Disconnect the sensor from the cable, if still pegged. Disconnect cable from the POD. If the A/D reading changes to a value within +/- 100 from 0, the sensor cable should be repaired or replaced. If the A/D reading remains at maximum value, refer to Section 8, <u>Trouble With Hardware</u>. |

PROBLEM	POSSIBLE CAUSE OR SYMPTOM	POSSIBLE FIX
INACCURATE A/D READINGS: The **Input Monitor** indicates the force sensor A/D readings are changing but the readings may not be correct.	Sensor failure.	A damaged force sensor may result in an offset or inaccurate readings. Use the **Input Monitor** to observe the force channel readings, then refer to the force sensor manufacturer specifications and determine what the mV output of the sensor should be at a given force. +/-32767 A/D readings are equivalent to +/- 20mV. Apply and remove force and see if the A/D input readings compare to what the sensor readings should be. If the values seem to be incorrect, there may a problem with the sensor, sensor cable, or POD. Try using a known good spare sensor cable and/or POD. If the readings still appear to be incorrect, replace the sensor.
	Sensor cable failure.	Try using a spare sensor cable. Apply and remove force and see if the A/D input readings compare to what the sensor readings should be. If the values are still incorrect, there may be a problem with the sensor or the POD.
	POD failure.	Try using a spare POD (refer to the procedure in Chapter 12, Application notes for instruction on how to replace a POD). Apply and remove force and see if the A/D input readings compare to what the sensor readings should be. If the values are still incorrect then there may be a problem with the sensor or the sensor cable. Refer to Section 6, Possible Sensor Cable Failure.

3. TROUBLE WITH DISPLACEMENT SENSOR, READINGS OR CHANNEL

PROBLEM	POSSIBLE CAUSE OR SYMPTOM	POSSIBLE FIX
CALIBRATED DISPLACEMENT SIGNAL IS READING HIGHER OR LOWER THAN NORMAL	The sensor was not zeroed.	Zero the displacement sensor.

PROBLEM	POSSIBLE CAUSE OR SYMPTOM	POSSIBLE FIX
CALIBRATED DISPLACEMENT SIGNAL IS INDICATING A "FROZEN" (static) READING	Calibration has changed.	Inspect and recalibrate sensor if necessary (Refer to Chapter 8, <u>Calibrating the Sensors</u>). **Note:** If an **Export Setup** was performed the last time this sensor was properly calibrated, an **Import Setup** may be performed to reload the saved calibration settings. Refer to Chapter 6, <u>WMS Reference Guide</u>.
	Sensor failure.	Inspect sensor for physical damage. Inspect electrical connections for poor connections or corrosion. Try recalibrating sensor if the sensor will not calibrate or A/D readings don't look right. Test the sensor Independent of the Livingston system.
		Test the sensor independent of the Livingston System by using an Oscilloscope. Different model sensors may require different methods of testing. Call Livingston & Co. for details regarding the testing of your sensor.
	Sensor Cable or POD failure.	Inspect sensor cable for physical damage. A cable that is deformed, severed, partially severed, shredded, abraded and/or has bare wires showing may be suspect. Disconnect sensor cable from POD and replace with a spare sensor cable. Try to reposition the new cable to avoid recurring damage. Spiral wrap or guards will also help to protect cable. Refer to Section 6, <u>Possible Sensor Cable Failure</u>.

PROBLEM	POSSIBLE CAUSE OR SYMPTOM	POSSIBLE FIX
CALIBRATED DISPLACEMENT SIGNAL IS INDICATING A FROZEN (static) READING CONT'D	Sensor Cable or POD failure. CONT'D	Inspect electrical connections for damage, poor connections and/or corrosion. Replace connectors and/or cable.
		Use the **Input Monitor** screen to observe the displacement channel readings. Mechanically disconnect one end of the sensor and slowly extend/retract until you are reading within the 'window' of the displacement channel. (Refer to Chapter 9, FAQ for additional information about the displacement window). Try flexing different areas of the sensor cable looking for any area that causes the readings on the **Input Monitor** to "jump". Replace the cable if flexing any part of it causes intermittent readings.
		If the displacement window cannot be found then the sensor OR the sensor cable may be failing. To check the sensor cable, refer to Section 6, Possible Sensor Cable Failure or refer to Trouble With Hardware. If the cable and POD appear to be OK, replace the sensor.

PROBLEM	POSSIBLE CAUSE OR SYMPTOM	POSSIBLE FIX
FROZEN A/D READING (ALL): The **Input Monitor** indicates a constant (static) A/D reading for the displacement sensor. This value never changes; the other sensor channels do not change or update either.	POD system: DeviceNet communications failure.	If other channel readings are not changing, the data may not be updating. Go to the **Pods/Server** screen and confirm that the POD is Online. Check the DeviceNet network for communication issues. If no network faults are found, reboot the POD by disconnecting the unit from the DeviceNet network and then reconnecting it. This will remove and re-apply power to the POD. If problem persists contact Livingston Service.

PROBLEM	POSSIBLE CAUSE OR SYMPTOM	POSSIBLE FIX
PEGGED A/D READING: The **Input Monitor** indicates a displacement channel A/D reading of +/- 32767. This value never changes; the other sensor channels appear to be working and the A/D values for these channels are changing/updating.	The sensor was not zeroed (displacement only).	Zero the displacement sensor. If the sensor will not zero, the sensor, sensor cable or POD may be malfunctioning.
	Sensor failure.	A reading of +/-32767 indicates that the input channel is saturated and reading its maximum value. There may be a problem with the sensor, sensor cable, or POD. Disconnect the sensor from the sensor cable. If the A/D reading changes to a value of less than 100, the sensor may be malfunctioning. Repair or replace the sensor. If the A/D reading remains at maximum value then the sensor may be OK and the sensor cable or POD may be malfunctioning. Refer to Section 6, Possible Sensor Cable Failure.
	Sensor cable failure.	Disconnect the sensor from the cable, if still pegged. Disconnect cable from the POD. If the A/D reading changes to a value within +/- 100 from 0, the sensor cable should be repaired or replaced. If the A/D reading remains at maximum value, refer to Section 8, Trouble With Hardware.
FROZEN A/D READING (DISPLACEMENT ONLY): The **Input Monitor** indicates a constant (static) A/D reading for the displacement sensor. This value never changes; the other sensor channels appear to be working and the A/D values for these channels are changing/updating.	Sensor failure.	A static reading may indicate a problem with the sensor, sensor cable, or POD. Disconnect the sensor from the sensor cable. If the A/D reading changes to a value of less than 100, the sensor may be malfunctioning. Repair or replace the sensor. If the A/D reading remains at the same value or does not change to a value of less than 100, the sensor may be OK and the sensor cable or POD may be malfunctioning. Refer to Section 6, Possible Sensor Cable Failure.
	Sensor cable failure.	Disconnect the sensor from the cable, if value remains the same. Disconnect cable from the POD. If the A/D reading changes to a value within +/- 100 from 0, the sensor cable should be repaired or replaced. If the A/D reading remains at maximum value, refer to Section 8, Trouble With Hardware.

PROBLEM	POSSIBLE CAUSE OR SYMPTOM	POSSIBLE FIX
INACCURATE A/D READINGS: The **Input Monitor** indicates the displacement sensor A/D readings are changing but the readings may not be correct.	Sensor failure.	A reading of +/-32767 indicates that the input channel is saturated and reading its maximum value. There may be a problem with the sensor, sensor cable, or POD. Disconnect the sensor from the sensor cable. If the A/D reading changes to a value of less than 100, the sensor may be malfunctioning. Repair or replace the sensor. If the A/D reading remains at maximum value then the sensor may be OK and the sensor cable or POD may be malfunctioning. Refer to Section 6, <u>Possible Sensor Cable Failure</u>.
	Sensor cable failure.	Disconnect the sensor from the cable, if reading remains the same. Disconnect cable from the POD. If the A/D reading changes to a value within +/- 100 from 0, the sensor cable should be repaired or replaced. If the A/D reading remains at maximum value, refer to Section 8, <u>Trouble With Hardware</u>.
	POD failure.	Try using a spare POD (refer to the procedure in Chapter 12, <u>Application notes</u> for instruction on how to replace a POD). Use the **Input Monitor** screen to observe the displacement channel readings. Mechanically disconnect one end of the sensor and slowly extend/retract until you are reading within the window of the displacement channel. (See <u>Displacement Sensor Overview</u>) See if the A/D input readings compare to what the sensor readings should be. If the values are still incorrect then there may be a problem with the sensor or the sensor cable. Refer to Section 6, <u>Possible Sensor Cable Failure</u>.

4. TROUBLE WITH TOROID

PROBLEM	POSSIBLE CAUSE OR SYMPTOM	POSSIBLE FIX
INTERMITTENT LOW HALFCYCLE COUNT (HCYCLES ON)	Weld control failure.	Check the weld controller.
	Toroid settings not properly adjusted.	In the **General Setup** menu, check the **A/D Threshold** settings. Set the **A/D Threshold** to **1500**. Call Livingston Service if this does not solve the problem.
	Toroid failure.	Check to be sure the buckle fastened on the toroid. Check the placement of the toroid. Inspect the toroid for physical damage. Also inspect connector pins for contaminants or corrosion. A toroid that is deformed, severed, partially severed, shredded, abraded and/or has bare wires showing may be suspect. If any damage is found, replace the toroid.
	Sensor cable failure.	Inspect sensor cable for physical damage. A cable that is deformed, severed, partially severed, shredded, abraded and/or has bare wires showing may be suspect. Disconnect sensor cable from POD and replace. Try to reposition cable so that any flexing is over a greater length of the cable and not in one small area. Spiral wrap or guards will also help to protect cable. Refer to Section 6, <u>Possible Sensor Cable Failure</u>.

WELDS ARE RECORDED WHEN THE WELDER IS NOT WELDING	Toroid settings not properly adjusted.	In the **General Setup** menu, check the **A/D Threshold** settings. Adjust these settings as necessary until the problem is resolved. Refer to <u>General Setup</u> Section in Chapter 6, WMS Reference guide
	Toroid needs relocating.	Reposition toroid to avoid other sources of current or noise.

WELDS ARE RECORDED, BUT THE CURRENT IS NOT READING CORRECTLY	Calibration factor not entered correctly.	Re-enter cal factor located on cylindrical housing. Remember to enter the cal. factor without the decimal point. Example 0.356 = 356.

5. TROUBLE WITH VOLTAGE LEADS, READINGS OR CHANNEL

PROBLEM	SYMPTOM OR POSSIBLE CAUSE	POSSIBLE FIX
CALIBRATED VOLTAGE SIGNAL IS READING HIGHER OR LOWER THAN NORMAL *OR* **CALIBRATED VOLTAGE SIGNAL IS INDICATING A FROZEN (static) READING**	Voltage leads are broken.	Inspect for damage, use an ohmmeter to check for high resistance, flex and manipulate leads to see if readings change, indicating an intermittent connection. Replace leads if necessary. Refer to Chapter 7, Installing the Sensors.
	Calibration has changed.	Verify calibration by disconnecting leads from electrodes and connecting to a 1.5V flashlight battery, also connect a DMM, the reading on the multimeter should match the calibrated reading on the **Input Monitor** screen. Recalibrate voltage if necessary (Refer to Chapter 8, Calibrating the Sensors).
	Voltage leads are not connected properly.	Inspect electrical connections for poor connections or corrosion.
	Sensor Cable or POD failure.	Inspect sensor cable for physical damage. A cable that is deformed, severed, partially severed, shredded, abraded and/or has bare wires showing may be suspect. With the flashlight battery connected flex and manipulate leads to see if the calibrated readings "jump" or change. If so disconnect sensor cable from POD and replace with a spare sensor cable. Try to reposition the new cable to avoid recurring damage. Spiral wrap or guards will also help to protect cable.
FROZEN A/D READING (VOLTAGE ONLY): The **Input Monitor** indicates a constant (static) A/D reading for voltage. This value never changes; the other sensor channels appear to be working and the A/D values for these channels are changing/updating.	POD has a problem with the voltage channel.	A static reading may indicate a problem with the POD voltage channel. Refer to Section 8, Trouble With Hardware.

PROBLEM	POSSIBLE CAUSE OR SYMPTOM	POSSIBLE FIX
PEGGED A/D READING: The **Input Monitor** momentarily indicates a voltage channel A/D reading of +/- 32767 during a weld.	Voltage applied to leads is above 9.9 volts.	A reading of +/-32767 indicates that the input channel is saturated and reading its maximum value. It is possible that the voltage leads were connected too close to the transformer. Typical readings are between 10V to 15V at the transformer and depending on the size of the secondary loop will be approximately 3 to 0.5 volts out at the electrodes. This variation is due to the voltage drop along the secondary loop. If it is not possible to connect any closer to the electrodes, inline resistors can be used to attenuate the incoming voltage.
	POD has a problem with the voltage channel.	If the A/D reading remains at maximum value when not welding (zero volts on the secondary), refer to Section 8, Trouble With Hardware.
FROZEN A/D READING (ALL): The **Input Monitor** indicates a constant (static) A/D reading for voltage. This value never changes; the other sensor channels do not change or update either.	POD system: DeviceNet communications failure.	If other channel readings are not changing, the data may not be updating. Check the DeviceNet network for communication issues. If no network faults are found, reboot the POD by disconnecting the unit from the DeviceNet network and then reconnecting it. This will remove and re-apply power to the POD. If problem persists contact Livingston Service.
WELDS ARE RECORDED WHEN THE WELDER IS NOT WELDING .	The transformer secondary is not properly grounded	Check the transformer for grounding issues. The transformer secondary should be grounded either directly or through a grounding inductor. A 1megaOhm resistor in parallel with a .01microFarad/600V capacitor may also be used.

6. POSSIBLE SENSOR CABLE FAILURE

PROBLEM	POSSIBLE CAUSE OR SYMPTOM	POSSIBLE FIX
POSSIBLE SENSOR CABLE FAILURE	Unknown; everything else replaced.	Inspect sensor cable for physical damage. A cable that is deformed, severed, partially severed, shredded, abraded and/or has bare wires showing may be suspect. Disconnect sensor cable from POD and replace. Try to reposition new cable to avoid recurring damage. Spiral wrap or guards will also help to protect cable.
		Inspect electrical connections for damage, poor connections and/or corrosion. Replace connectors and/or cable.
		Using the cable pinout documentation for your system, check the continuity of all connections relating to the sensors. Repair or replace cable as necessary.
	The **Input Monitor** indicates +/- 32767 A/D reading for one of the sensor readings (FORCE, CURRENT, VOLTAGE); The input channel is saturated and reading its maximum value.	Use the **Input Monitor** to observe the incoming sensor readings. If the A/D readings for the FORCE, CURRENT, or VOLTAGE channels are +/- 32767, there may be problem with the sensor, sensor cable, or POD hardware. Disconnect the sensor from the channel in question. If the A/D reading changes, the sensor may be malfunctioning (refer to Sections 2, 3, 4, 5 for Troubleshooting Sensors). If the A/D reading remains at maximum value, the sensor may be OK. Disconnect the sensor cable from the POD. If the A/D reading changes to a value of less than 100, the sensor cable should be repaired or replaced. If the AD reading remains at maximum value then refer to Section 8, Trouble With Hardware.
	One of the sensors (FORCE, CURRENT, VOLTAGE) seems to give usual readings and the calibration hasn't been changed.	
	Constant failure on the DISPLACEMENT channel.	
	Intermittent Rejected welds due to one of the sensor channels.	Use the **Input Monitor** to observe the channel readings. Exercise the sensor in question. Try flexing different areas of the sensor cable looking for any area that causes the readings on the Input Monitor to "jump". Replace the cable if flexing any part of it causes intermittent readings.

7. TROUBLE WITH BIN SELECTS OR ACCEPT/REJECT

PROBLEM	POSSIBLE CAUSE OR SYMPTOM	POSSIBLE FIX
THE BIN SELECT IS ALWAYS "0": The weld summary screen indicates that weld data is being recorded with the Binary Select of **0**. Main screen indicates that the weld was recorded with **No Master**.	No Master has been created for the requested Binary Select. The value will default to **0**.	If a Master does not already exist for this Bin Select, create a new Master for this Binary Select value. (Refer to Chapter 5, WMS Quick Start Guide or Supplementary Procedure, if applicable).
	No master has been downloaded to the POD.	In the **Mastering** screen select the Master and click **Update** to load the master for use.
	Masters are not enabled. The Binary Select Value will default to **0**.	Go to the **General Setup** menu and set **Masters Enabled** to **Yes**.
	External Binary Select is not working.	Go to the **General Setup** menu and set **Binary Select Mode** to **External**. Refer to the General Setup Section, Binary Select Mode in Chapter 6, WMS Quick Start Guide for information on External select modes.
	Pod Malfunction.	Reboot the POD by disconnecting the unit from the DeviceNet network and then reconnecting it. This will remove and re-apply power to the POD. If the problem persists, contact Livingston Service.

PROBLEM	POSSIBLE CAUSE OR SYMPTOM	POSSIBLE FIX
THE BIN SELECT IS INCORRECT AND IS NOT "0": The weld summary screen indicates that weld data is being recorded with the wrong Binary Select.	Internal Binary Select is not set correctly.	Go to the **General Setup** menu and set **Binary Select Mode** to **Internal**. Set **Internal Binary Select** to the desired value.
	External Binary Select is not working.	Go to the **General Setup** menu and set **Binary Select Mode** to **External**. Refer to the General Setup Section, Binary Select Mode in Chapter 6, WMS Quick Start Guide for information on External select modes.
	Pod Malfunction.	Reboot the POD by disconnecting the unit from the DeviceNet network and then reconnecting it. This will remove and re-apply power to the POD. If the problem persists, contact Livingston Service.

PROBLEM	POSSIBLE CAUSE OR SYMPTOM	POSSIBLE FIX
THE EXTERNAL BIN SELECT IS NOT WORKING CORRECTLY: The weld summary screen indicates that weld data is being recorded with the wrong Binary Select.	**Binary Select Mode** is not set to **External**.	Go to the **General Setup** menu and set **Binary Select Mode** to **External**.
	Device controlling the Binary Select signals is not working correctly.	Typically the Binary Select is controlled by a PLC and/or switches on a panel. Check all connections and programming logic.
	DeviceNet Scanner Card in the PLC is malfunctioning.	Inspect the scanner card for error codes and reboot if necessary. The manufacturer's documentation that comes with the scanner card typically has a list of error codes or status indicator definitions.
	The timing of the bin select logic is not working properly.	Check the programming logic.
	Pod Malfunction.	Reboot the POD by disconnecting the unit from the DeviceNet network and then reconnecting it. This will remove and re-apply power to the POD. If the problem persists, contact Livingston Service.
POD SYSTEM - ACCEPT/REJECT SIGNALS NOT WORKING PROPERLY	DeviceNet problems.	Check all DeviceNet connections. Check for errors on the PLC scanner card (reboot if necessary). Check DeviceNet power supply for correct voltage (refer to the DeviceNet - Troubleshooting section in Chapter 11, Appendices).
	PLC programming is flawed.	The ladder logic may be using data from the wrong POD. Call your resident PLC programmer.

8. TROUBLE WITH HARDWARE

PROBLEM	SYMPTOM OR POSSIBLE CAUSE	POSSIBLE FIX
THE TOP POD LED IS OUT	The POD was just rebooted or is in the middle of a weld.	Wait a few minutes for the POD to finish rebooting or recording the weld.
	There is no power to the POD.	Check the DeviceNet power.

PROBLEM	SYMPTOM OR POSSIBLE CAUSE	POSSIBLE FIX
THE BOTTOM POD LED IS OUT	There is no power to the POD.	Check all DeviceNet connections, including the power supply. Ensure that the POD is receiving 24VDC network power.
	The POD is malfunctioning.	Call Livingston Service. Replace POD.

PROBLEM	SYMPTOM OR POSSIBLE CAUSE	POSSIBLE FIX
TOP LED WON'T STOP BLINKING	POD is triggering due to external noise.	**A/D Threshold** may be set to low. Check setting Adjust as necessary.

PROBLEM	SYMPTOM OR POSSIBLE CAUSE	POSSIBLE FIX
BOTTOM LED WON'T STOP BLINKING	The POD (Slave Device) has no master on the DeviceNet network. *Note: This is normal is there is no POD server attached to the network.*	Check to be sure the POD Server is turned on and Plugged into the network. If the problem doesn't correct itself (Server uploads data to the POD, the POD comes online) after a few minutes, call Livingston Service.

PROBLEM	SYMPTOM OR POSSIBLE CAUSE	POSSIBLE FIX
BOTTOM LED IS RED	POD Fault.	Refer to the section <u>Troubleshooting a DeviceNet Network</u> in the <u>Appendices</u> or call Livingston Service.

PROBLEM	SYMPTOM OR POSSIBLE CAUSE	POSSIBLE FIX
ONE OR MORE PODS IS OFFLINE: In the **Pods/Server** screen, one or more PODs are either absent from the screen or displays a **Timed Out** status.	POD malfunction.	Check LEDs on POD. If the bottom light remains blinking green (doesn't go solid), there may be a problem with the DeviceNet connection. If the bottom light is solid green, there may be a problem with the POD Server. Try rebooting the POD. If this does not work try rebooting the POD Server.

PROBLEM	POSSIBLE CAUSE OR SYMPTOM	POSSIBLE FIX
THE A/D READING ON THE INPUT MONITOR REMAINS AT MAXIMUM VALUE: Both the sensor in question and the sensor cable have been examined, repaired and/or replaced but the A/D reading for the FORCE, CURRENT or VOLTAGE channel remains at +/- 32767.	POD Server failure.	Try rebooting the weld monitor. If the any or all A/D channels are pegged (saturated), there is a problem with the weld monitor. Call Livingston Service.
THE A/D READING ON THE INPUT MONITOR IS FROZEN: Both the sensor in question and the sensor cable have been examined, repaired and/or replaced but the A/D reading for the FORCE, CURRENT or VOLTAGE channel is frozen (static).	POD Server failure.	Reboot the POD in question. If this does not work, try rebooting the Server. If any or all A/D channels remain frozen, there is a problem with the POD Server software. Call Livingston Service.

PROBLEM	POSSIBLE CAUSE OR SYMPTOM	POSSIBLE FIX
THE DISPLACEMENT WINDOW CANNOT BE FOUND: The displacement sensor has been mechanically disconnected and extended/retracted, but the readings on the **Input Monitor** do not make sense.	Sensor failure.	Try re-zeroing the displacement sensor. See the appropriate sensor troubleshooting section. Repair or replace sensor. Call Livingston Service if the problem persists.

DEVICENET TROUBLE	Network problems	See the Troubleshooting a DeviceNet Network Section in Chapter 11

A POD APPEARS TO BE TAKING WELDS NORMALLY BUT DOES NOT APPEAR ON THE PODS/SERVER SCREEN	POD does not appear on **Pods/Server** screen.	Check to be sure that the POD Server is connected to the DeviceNet network. Reboot the POD if the server is connected. If this does not solve the problem, call Livingston Service.

WMS Road Map

Main Screen — Trend Graph

Main Menu

Data
- Halfcycle Summary
  - Zoom/Full
  - Graph/Table
- Weld Summary
- System Log
  - Delete System Log Entries
- Database Management
  - Import Utilities
    - Import All
    - Import Masters
    - Import Masters From Floppy
    - Import Setup
    - Import Setup From Floppy
  - Export Utilities
    - Export All
    - Export Masters
    - Export Masters From Floppy
    - Export Setup
    - Export Setup From Floppy
  - Compact Database
  - Repair Database
  - Delete All Welds
- Scope Data (2400 only)
  - Refresh
  - Zoom/Full

Mastering (P3 Pod or 2400)
- New
- Select master
- Edit Master
- Copy / Replace Master
- Update Master
- Delete Master

Tolerancing

P3 Pod or 2400
- Select Master
- Update Master

P1 Pod or N1 Pod
- New
- Delete
- Update

Setup
- General Setup Menu
- Setup Utilities
  - Input Monitor
    - Zero Displacement
  - Toroid Settings
  - Calibrate Voltage
  - Calibrate Force
  - Calibrate Displacement
- Tolerance Defaults
- Graph Setup
- Pods/Server
  - Change MAC ID & Copy setup
  - Chang MAC ID
  - Change Baud Rate
  - Download Firmware
  - PodServer Settings
    - PodServer MAC ID
    - PodServer Baud Rate
    - DNET Driver
    - Scan Range Min:
    - Scan Range Max:

Shutdown
- No, I didn't really mean to come here, please take me back.
- Yes, I'm sure. Shutdown Windows too.
- Quit All Livingston programs, but don't shutdown Windows.
- Close this User Interface Window but don't quit Weld Monitor

0436-INS-763 Rev. D

Recommended Database Management

This section discusses recommendations for maintaining Pod Server databases to get the best system performance, calculate database size, and backup the Pod system configuration to prepare for a quick and easy recovery if the configuration needs to be restored.

Database file overview

The Pod Server uses two database files when the system is online with the Pods and collecting data. **Livco.mdb** contains the entire Pod System configuration. **Welddata.mdb** contains all of the stored weld data. Understanding what and how information is stored in these database files should make it easier to determine the best database management for a particular system. For specifics on using each database operation, refer to Database Management in Chapter 6, <u>WMS Reference Guide</u>.

The following diagram is intended to provide a basic understanding of what information is within each database file and what information is exchanged during the different database operations.
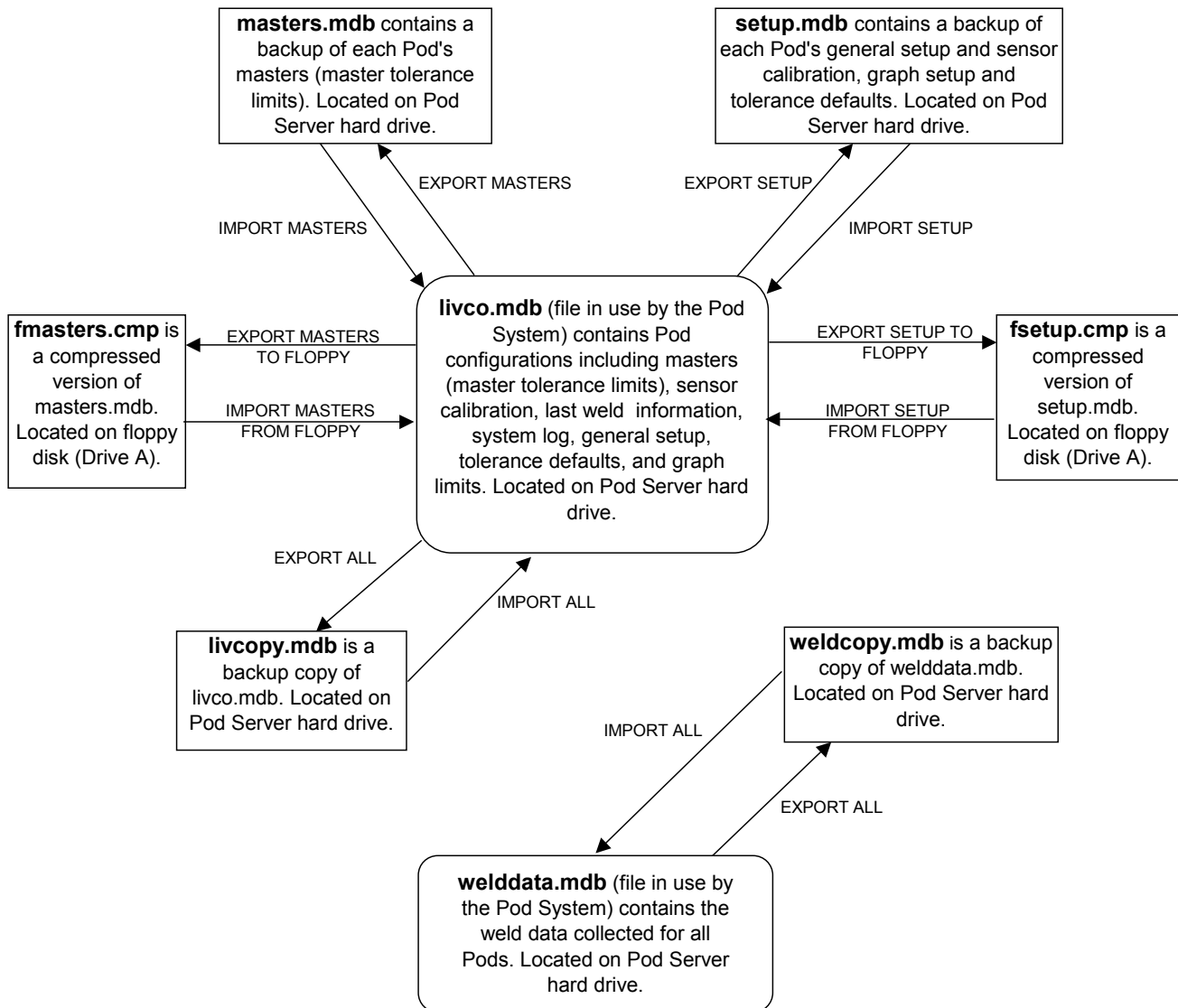
Probably the most difficult concept for users to understand is that each Import/Export operation, imports/exports data to/from a different file or files. For example, the "**Export All**" writes to livcopy.mdb and welddata.mdb but does NOT write any information to masters.mdb or setup.mdb. The "**Export Masters**" only writes information to the masters.mdb but does NOT write any master-related information to livcopy.mdb.   The "**Export Setup**" only writes information into the setup.mdb file and so on.   Similarly for the Import utilities, the "**Import All**" and "**Import Masters**" both import master- related information (Import All also imports additional information) but since the information is imported from different files, it is possible that the master-related information is different.

Note: In order to keep all of the various database files in "synch", all Export operations should be performed any time it is necessary to perform any one of the Export operations. This will ensure that that master-related information is the same in both livcopy.mdb and masters.mdb. It will also ensure that the calibration and setup information is the same in both livcopy.mdb and setup.mdb. Keeping the files in "synch" will also avoid confusion when using the import utilities. For example, if the livcopy.mdb and setup.mdb files are in "synch" then using the "**Import All**" or the "**Import Masters**" will provide the same master-related results.

System Performance

As the livco.mdb and welddata.mdb databases get larger, it takes longer for the Pod Server software to sort through all of the data records to find the data it's looking for, and in some cases it takes longer to add new data records (Example: when creating masters). The most noticeable effect is that the Pod Server will be slower when displaying weld data. This change in performance is unperceivable if database maintenance is performed regularly.

Note: Once the welddata.mdb database reaches capacity (just under 1 gigabyte), the Pod Server will no longer be able to collect data for any of the Pods. The main screen will still display incoming welds however the Halfcycle/Millisec and Weld summary screen data will no longer be up to date. All accept and reject signals will still function normally.

Recommended maintenance

Refer to Database Management section in Chapter 6, the WMS reference Guide, for more information about the database operations referenced in this document.

Each Pod System is different in the number Pods collecting data and how often each Pod records data for a weld. For example, it is likely that a 30-Pod system recording welds made by transfer line robots will gather significantly more weld data than a 1-Pod system recording welds from a manually fed pedestal welder. For a typical Pod system, performing database maintenance once a week is a "suggested" and conservative starting point.

The following steps should be performed in order, to "clean out" and minimize the size of the databases. If weld data is being archived, it should be archived prior to performing these steps:

1) "**Delete All Welds**" - It is recommended that weld data be deleted so that the welddata.mdb database is kept to less than 600Mbytes in size. This will make it easier for those who wish to make a copy of the data prior to deleting weld data. A file size of 600Mbytes is still manageable when copying data across the company network, querying the data, and archiving the database files to a CD-R.

2) "**Delete System Log**" – The System Log records system events such as starting up, shutting down, errors on the network, general diagnostic events, certain pod configuration events, database upgrades, etc. Although this log does not fill up quickly, it is recommended that the log entries be deleted any time weld data is deleted.

3) "**Compact Database**" – When information is deleted from a database, database records are only 'marked' for deletion but still take up space in the database. For example, deleting the system log does not make the livco.mdb file any smaller. Even if the system log were deleted every day, livco.mdb would continue to grow. To recover this space and reduce the size of the database file, the Compact Database operation should be performed periodically.

Determining the file size of the stored weld data

The following can be used as an aide to determine how quickly the welddata.mdb database will fill up with weld data. This database can hold up to 1 gigabyte (minus some overhead) of weld data. Each weld data record is approximately 280 bytes in size. This means that 125,000 weld records would be approximately 35Mbytes in size.

For a review of the different data modes, please refer to the General Setup section of Chapter 6, <u>WMS Reference Guide</u>. Depending on the weld data mode settings it is possible to collect data for each half cycle (millisecond for MFDC), segment or weld. It is even possible to shut off data collection altogether.

The number of records collected for a single weld is dependent on the data modes. The most data is collected when all three modes are set to 'ALL'. *It is recommended that only one Pod at a time collect data with all three modes set to 'ALL' since passing this data to the Pod Server for storage consumes most of the DeviceNet™ network bandwidth.* Typically only weld summary data is collected unless there is a special need to record the more detailed halfcycle or millisecond data (Example: when trouble-shooting a weld process).

Records per weld (1 Pod, 1 binary select) = halfcycles (milliseconds for MFDC) + segments + weld summary

Records per process cycle = Records per weld (weld 1)   +   Records per weld (weld 2)   +   etc.

Database size per process cycle (bytes) =   (Records per process cycle) X 280 bytes each

Database size per day (1 pod) =   Database size per process cycle (1 pod) X   process cycles per day

Total Size per day in bytes (all pods) = Database size per day (Pod #1) + Database size per day (Pod #2) + etc.

The following example calculates the size based on the worst-case setting only to demonstrate how to account for all of the different record types. When calculating the number of records recorded per weld, do not forget to include the number of halfcycles (or milliseconds for MFDC) in all of the segments, including the PRE and POST.

Example: A single Pod monitors 2 AC welds during one process cycle. Both welds have a PRE and POST of 10 and welds of length 16 halfcycles and 20 halfcycles respectively. There are 5000 process cycles per day. Assume 3 segments (PRE, WELD, POST), collecting all of the halfcycle, segment and weld summary data.

Records per weld #1   = (36 halfcycles(total from all segments) + 3 segments + 1 weld summary) = 40

Records per weld #2   = (40 halfcycles + 3 segments + 1 weld summary) = 44

Database size per process   = 84 records   X   280 bytes   =   23520 bytes

Database size per day = 23520 bytes X   5000 process cycles per day   = 117,600,000 bytes

Total Size per day = 117,600,000 bytes   = > **117.6 Mbytes**

Note: When only weld summary data records are collected, this calculation gives **2.8 Mbytes** per day. This is a more typical value for data collection in a production environment.

Backup of Pod System Settings

One feature with a Pod Server is that the entire Pod System configuration can be quickly restored provided the proper steps have been taken ahead of time.

The export database utilities provide a great way to back up all of the Pod System settings. Refer to the diagram at the beginning of this document or to the Database Management section in Chapter 6, <u>WMS Reference Guide</u>, for a description of these functions. It is recommended that system settings be periodically exported and stored in a safe place.

Note: It is recommended that all Export operations be performed any time it is necessary to perform any one of the Export operations. This will ensure that all of the exported information located in the database files is in "synch".

Following the steps below will provide the best means of recovery:

1) "**Delete all welds**", "**Delete System Log**" and then "**Compact Database**" as described in the Recommended Database Maintenance section of this document. This will "clean out" and minimize the size of the databases.

2) "**Export Setup**" - This makes a backup of each Pod's calibration and general setup, as well as the tolerance defaults and graph setup, and stores the information in the setup.mdb file.

3) "**Export Masters**" - This makes a backup of each Pod's masters (P3) or master tolerance limits (P1) and stores the information in the masters.mdb file.

4) "**Export All**" – This makes a backup all of the system information to the livcopy.mdb and weldcopy.mdb files.

The exported files exist on the Pod Server hard drive in the Pod system software folder ('\\livcosetup' is the default folder). If possible these files should be copied and stored on a separate computer. If an Ethernet connection with the Pod Server is not possible, then the following additional steps are also recommended to store the setup and masters on removable media.

Place a blank formatted 3 ½" floppy disk in the Pod Server floppy drive (A:). If your server does not have floppy drive, you may use another removable media that has been 'mapped' to drive A.

5) "**Export Setup to Floppy**" - This makes a backup of each Pod's calibration and general setup, as well as the tolerance defaults and graph setup, and stores the information in the setup.cmp file (compressed version of setup.mdb).

6) "**Export Masters to Floppy**" - This makes a backup of each Pod's masters (P3) or master tolerance limits (P1) and stores the information in the masters.cmp file (compressed version of masters.mdb).

The exported files on the floppy disk are compressed database files that contain necessary information required to recover the Pod System settings. The floppy should be stored in a safe place until needed.

It is also recommended that a copy of livco.mdb and welddata.mdb (Pod Server system folder – '\\livcosetup' is default) be stored on a computer other than the Pod Server in case something happens that physically damages the Pod Server.

What If?

What if someone made changes to some settings and then forgot the known-good settings, or changed sensor calibration and then realized that they had made a mistake and wanted to put these things back to the way they were prior to the mishap?

> ➤ Use either the "**Import All**" or the "**Import Setup**" utility to recover the known good settings.

OR

> ➤ If a floppy was created with the "**Export Setup from Floppy**" then insert the floppy and use the "**Import Setup from Floppy**" option.

What if someone accidentally deleted a master or master tolerance limits?

> ➤ Use either the "**Import All**" or the "**Import Masters**" utility to recover the known good masters.

OR

> ➤ If a floppy was created with the "**Export Masters from Floppy**" then insert the floppy and use the "**Import Masters from Floppy**" option.

What if at some point a sudden lost of power to the Pod Server causes a "hard" shutdown of the computer, resulting in corrupt databases.

> ➤ Use the "**Import All**" option for a full recovery

What if something happened that physically damaged the Pod Server to the point that it needed to be replaced?

1) Find your spare Pod Server, turn it on but don't launch the Pod Server software.
2) Find your backup copy of livco.mdb and welddata.mdb that you luckily stored on another computer.
3) Copy the backup files (livco.mdb and welddata.mdb), into the Pod Server system folder ('\\livcosetup' is the default folder) located on the spare Pod Server.
4) Attach the spare Pod Server to the DeviceNet network and launch the Pod Server software.
5) Resume production.

Importing / Exporting Tables

This procedure describes how to import and/or export default calibration tables to a floppy disk. *If your Pod Server is not equipped with a floppy drive, you may use other removable media that has been 'mapped' to drive A.* It is recommended that you make copy of the default calibration settings in your Livingston monitor before performing sensor calibration. It is also recommended that you make a copy of the calibration settings after you have calibrated the sensors in use on the welder you will be monitoring. You will need two blank, formatted floppy disks to complete this procedure.

To copy (export) the default toroid calibration tables:

1. From the **Main Menu** screen, select **Data**;

2. Select **Database**;

3. Select **Export**;

4. Select **Export Setup to Floppy**. Insert the floppy disk into the drive on the front of your Livingston monitor. Follow the instructions to the right of the screen;

5. Use the ESCAPE button to exit this window.
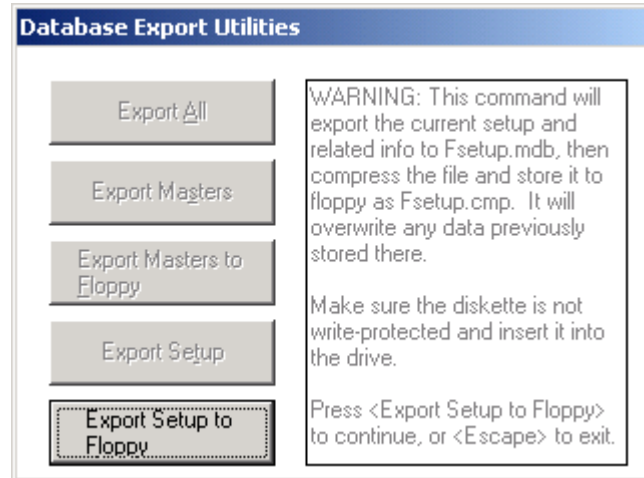
Figure **11-1** Export Setup To Floppy

Label this disk "**LDCT**" (Livco Default Calibration Tables) and keep it with the rest of your Livingston files. To make a copy of the adjusted calibrations, perform the same steps after all your sensors have been calibrated. Use a new disk to capture this information. Label this disk "**ACT**" (Adjusted Calibration Tables) and note the current date and welder being monitored on the label.

Should you ever need to return your Livingston monitor for repair, it will be returned to you with the factory default calibration table. You will need the **ACT** disk to reload your adjusted calibrations. In this situation, follow the import procedure below.

To import the default calibration tables:

1. From the **Main Menu** screen, select **Data**;

2. Select **Database**;

3. Select **Import**;

4. Select **Import Setup From Floppy**. Insert either the "LDCT" or "ACT" floppy disk containing the exported files. Follow the directions to the right of the screen;

5. Use ESCAPE to exit this window.
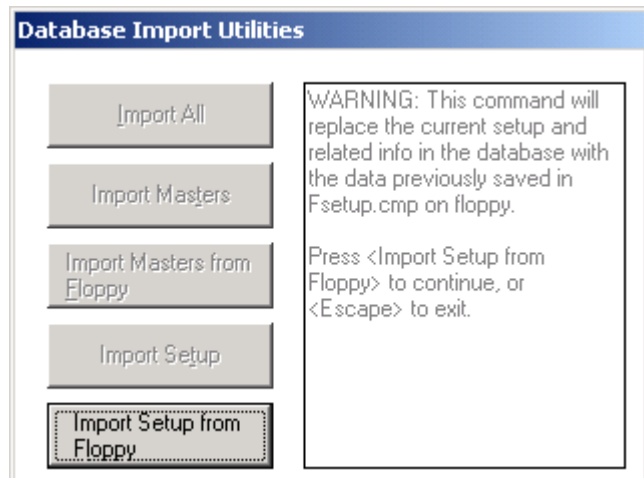
Figure **11-2** Import Setup From Floppy

You will want to keep the LDCT disk in a safe place, should you ever need it for future use. Should your calibration settings change, you should update the ACT disk.

Calibration settings, weld data and masters can also be imported/exported to an archive in the monitor itself. Refer to chapter 6, WMS Reference Guide for additional information.

Displacement Channel Overview

The displacement channel is used to measure the thickness of a part before, during, and after the weld process. This channel is designed to work with a potentiometer type sensor, which is a variable resistor with three terminals; one on each end of the resistor and one "wiper" which contacts the resistor to indicate a variable position.   The potentiometer is used as a voltage divider to indicate position of the electrodes. For proper installation, please refer to Chapter 7, **Installing the Sensors**.

The Pod provides a 10-volt excitation voltage for the sensor. The signal returned from the potentiometer is 0 to 10 volts depending on the position of the potentiometer shaft. For example, a 4" stroke linear potentiometer will return 0 volts when the shaft is fully extended, 10 volts when fully retracted and 5 volts at a position of 2" (mid-stroke). Depending on wiring and sensor mounting, opening and closing the electrodes may cause a positive or a negative voltage change. The Pod will accommodate either polarity by setting the Displacement Polarity accordingly in the **General Setup** (Refer to **WMS Reference Guide** in Chapter 6).

In order to get an accurate high-resolution measurement over a relatively small window of travel of the sensor, the displacement channel is designed to read an input voltage of +/- 0.45 volts, which corresponds to 9% (+/- 4.5%) of the sensor's full stroke. When viewed using the **Input Monitor** screen (see chapter 6, WMS Reference Guide), the A/D reading will saturate at +32767 (0.45 volts), and –32768 (-0.45 volts). Since the displacement sensor returns a signal from 0 to 10 volts, the displacement channel will be saturated over all but 9% of the stroke. *Note: This saturation is normal and will not damage the displacement channel.*

The **Zero Displacement** feature is used to center the displacement readings within the 9% window. Typically, displacement is zeroed using a "zeroing" gauge block to represent the initial part stack-up (projection welds), or zeroed with electrodes closed (spot welding). Refer to the **Input Monitor** screen in chapter 6, **WMS Reference Guide** to use the **Zero Displacement** feature. Refer to Chapter 9 - **Frequently Asked Questions** and Chapter 8- **Calibrating the Sensors** for how to calibrate the displacement sensor.

Example: A linear potentiometer with a 4" stroke will have a usable displacement window of 0.360" (9% of 4"). If the potentiometer is extended to a stroke of 1", and the displacement is "zeroed" at this point, then the 9 % window would be +/- 4.5% (+/- 0.180") of the stroke, relative to 1". In other words, the Pod would measure usable readings when the actual stroke is between 0.820"and 1.180". The calibrated readings reported by the monitor within this window would be –0.180" to + 0.180".   In the example, the maximum allowed displacement change is +/-0.180" during the weld.

Note: If in the example the part stack-up physically changed by greater than 0.180" then the reading reported by the monitor would be in error since the displacement was saturated at some point during the weld. The solution would be to use a longer stroke sensor or mechanically change the ratio of electrode movement to sensor stroke to enlarge the measured window.

Sensor Calibration Utilities Overview

Sensors such as toroids, slide-potentiometers, and force gauges are used by Livingston weld monitors to get information about the weld process as welds are taking place. The relationship between the output of a particular sensor and a standard unit of measure (such as inches) is defined during the calibration process. Many factors can influence the relationship between the output of a sensor and a defined unit of measure, such as variations between sensors and different application techniques.

A good sensor will provide an output with a linear relationship to what the sensor is intended to measure. During the calibration process, two known reference points are provided. From these points, the Livingston weld monitor records the linear relationship between the installed sensor and standard units of measure.

- The toroid (current sensor) channel is calibrated at the factory, however the calibration factor (labeled as CF on the toroid) must be entered using the Toroid Settings screen, described in Chapter 6.

- The voltage channel has no sensor (readings are picked up via lead wires attached close to the electrode tips), and therefore does not require calibration after leaving the factory.

- The remaining two channels— force and displacement— must be calibrated only when a new sensor or slide-potentiometer is installed.

- Under normal operating conditions, the only continuing procedure that is required is to zero the displacement sensor when changing or dressing electrodes or when using workpieces of significantly different thickness. This can be done via the **Zero Displacement** button in the **Input Monitor** display.

Force sensor note: If it is not possible to obtain two distinct readings at different levels, the monitoring program can work from a single value. For example, suppose you open the welder tips, but cannot completely remove the force from a transducer because of the weight of connected mechanics. Suppose you also can't easily determine how much force is on the sensor, because it's not practical to get a calibrated force gauge into the mechanics. In this case, the weld monitor can perform a single-point calibration by assuming that a zero output from the force transducer corresponds to a force of zero PSI. When the weld tips are closed and a known force is provided as the second (high) reference point, the linear relationship is established.

Note: It is strongly recommended that whenever possible you use two calibration values to ensure more accurate calibration and more precise monitoring operations. For more information about calibrating sensors, please refer to chapter 8, Calibrating the Sensors.

Identifying and Interpreting Accept Status Codes

The main operating display for the weld monitor provides a quick view of the ongoing status of the welding operation. The **Accept Status** codes, displayed at several points in the program, indicate the nature of any rejected welds, including the parameters that were out of tolerance according to the limits defined by the current signature. For each **Accept Status** code, the weld monitor can display a text description indicating the parameters that were not within master tolerance limits. You can track and interpret this information from the stored database values that are logged during weld monitoring. Advanced users can convert the Accept Status decimal numeric value into a binary value that signifies the parameters that failed and whether the failure was higher or lower than the tolerance threshold.

To convert an Accept Status code:

1. Enter the value of the code into a calculator that can handle decimal-to-binary conversion (such as the Windows calculator application). For example, figure 11-3 shows a decimal value of 260 for the status code:

2. Change the display view from decimal to binary. The equivalent binary value appears (100000100), as shown in figure 11-4:

3. Counting from the right (starting at 0), bit positions 2 and 9 indicate failures. Consult the table on the following page to identify the failed parameter.
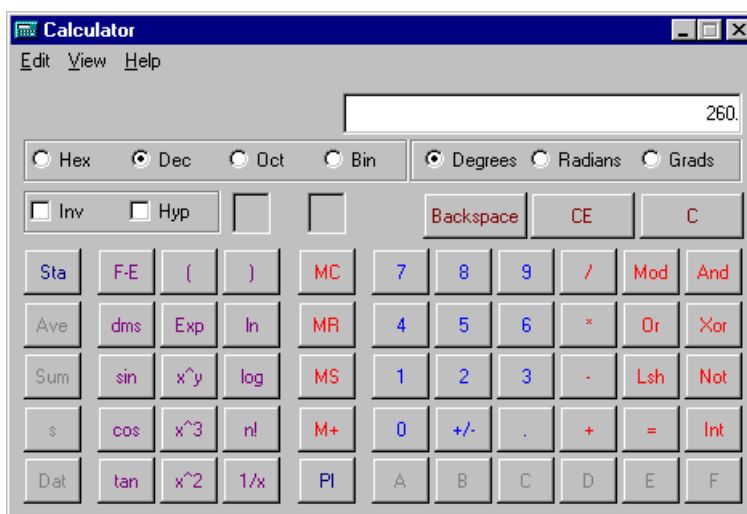
Figure **11-3**

The following table maps bit positions to failures. A binary "1" will appear in each position where there is an associated failure. From the previous example, bit positions 2 and 9 indicate CURRENTPEAK_HI and FORCE_HI failures. In other words, peak current and force were outside of their master tolerance limits.
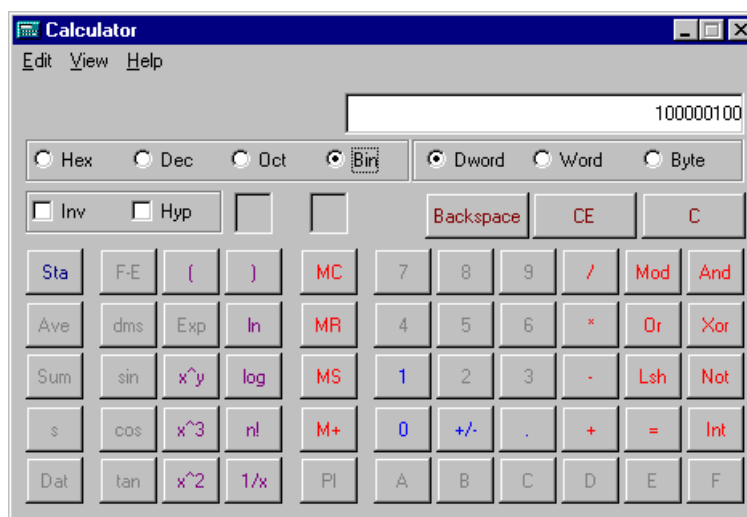
Figure **11-4**

Table 11-5: Accept Status Code Values

Bit	Decimal	Binary Values				Fault
0	1	00000000	00000000	00000000	0000000**1**	CURRENTRMS_HI
1	2	00000000	00000000	00000000	000000**1**0	CURRENTRMS_LOW
2	4	00000000	00000000	00000000	00000**1**00	CURRENTPEAK_HI
3	8	00000000	00000000	00000000	0000**1**000	CURRENTPEAK_LOW
4	16	00000000	00000000	00000000	000**1**0000	VOLTAGERMS_HI
5	32	00000000	00000000	00000000	00**1**00000	VOLTAGERMS_LOW
6	64	00000000	00000000	00000000	0**1**000000	VOLTAGEPEAK_HI
7	128	00000000	00000000	00000000	**1**0000000	VOLTAGEPEAK_LOW
8	256	00000000	00000000	0000000**1**	00000000	FORCE_HI
9	512	00000000	00000000	000000**1**0	00000000	FORCE_LOW
10	1024	00000000	00000000	00000**1**00	00000000	CONDANGLE_HI
11	2048	00000000	00000000	0000**1**000	00000000	CONDANGLE_LOW
12	4096	00000000	00000000	000**1**0000	00000000	SETDOWN_HI
13	8192	00000000	00000000	00**1**00000	00000000	SETDOWN_LOW
14	16384	00000000	00000000	0**1**000000	00000000	EXPANSION_HI
15	32768	00000000	00000000	**1**0000000	00000000	EXPANSION_LOW
16	65536	00000000	0000000**1**	00000000	00000000	INITTHICK_HI
17	131072	00000000	000000**1**0	00000000	00000000	INITTHICK_LOW
18	262144	00000000	00000**1**00	00000000	00000000	FINALTHICK_HI
19	524288	00000000	0000**1**000	00000000	00000000	FINALTHICK_LOW
20	1048576	00000000	000**1**0000	00000000	00000000	RESISTANCE_HI
21	2097152	00000000	00**1**00000	00000000	00000000	RESISTANCE_LOW
22	4194304	00000000	0**1**000000	00000000	00000000	ENERGY_HI
23	8388608	00000000	**1**0000000	00000000	00000000	ENERGY_LOW
24	16777216	0000000**1**	00000000	00000000	00000000	POWER_FACTOR HI
25	33554432	000000**1**0	00000000	00000000	00000000	POWER_FACTOR LOW
26	67108864	00000**1**00	00000000	00000000	00000000	HCYCLE_CNT_LOW
27	134217728	0000**1**000	00000000	00000000	00000000	HCYCLE_CNT_HI
28	268435456	000**1**0000	00000000	00000000	00000000	WELD_TOLERANCE_ERROR
29	536870912	00**1**00000	00000000	00000000	00000000	HCYCLE_TOLERANCE_ERROR
30	1073741824	0**1**000000	00000000	00000000	00000000	SEGMENT_TOLERANCE_ERROR
31	-2147483648	**1**0000000	00000000	00000000	00000000	MISSING RECORDS

Note: MFDC is monitored in milliseconds. When monitoring MFDC welds, the references to HCYCLE in table 11-5 would instead be MILLISECONDS.

Status Decoder for Pods/Server Screen

Status Code	Definition	Action to take (if any)
Online	The POD is ready to record weld data.	None.
Timed Out	The POD was communicating on the DeviceNet network but is no longer communicating with the Pod Server.	This status may indicate a problem with the POD or the network. Refer to chapter 10, Troubleshooting Guide for further information.
Active	The POD at that MAC ID has answered the POD Server query, but is not yet initialized and Online.	None.
Reconfiguring	The POD is completing communications setup with the POD Server.	None.
No Device	There is no POD at that MAC ID.	None.
Unknown	The POD Server is querying the device at that MAC ID; it does not know if it is a POD or not.	None.
Alien	A non-POD device is at that MAC ID.	None.
Data Error	There was an error in the transmission of data between the POD and the POD Server.	This code should clear itself.
Retry	A connection between the POD and POD Server has been broken and is trying to be re-established.	None.
Deleted	The MAC ID has been deleted or changed and removed from the POD Server scan list.	This code should clear itself.
Reboot Pod	Once Pod firmware has been updated, this status indicates that the Pod must be rebooted.	Disconnect and then reconnect the Pod from the DeviceNet network. This reboots the Pod by removing and reapplying power.
DS_OBSOLETE_FIRMWARE	The Pod firmware is not compatible with the Pod Server software version.	Install compatible Pod Server software or download compatible firmware to the Pod.
DNS_BAD_CODE	The Pod Server recognizes the Pod on the network however the Pod's Product Code does not agree with the Product Code stored in Pod Server memory.	Shutdown and restart the Pod Server software.
ALLOC ERROR	There was a failure in the DeviceNet communications between the POD and the POD Server.	If this code does not clear itself, reboot the POD.
Idle	The POD Server is not querying this MAC ID to see if the device is a POD.	If this code remains displayed, contact Livingston Service.
New ID	The POD has been assigned a new MAC ID.	None.
DN/ERROR	There has been an unspecified DeviceNet error.	This code should clear itself.

Example DeviceNet Layouts

Please see the following pages for examples of POD™ systems.

LEGEND

MALE FIELD CONNECTOR	
FEMALE FIELD CONNECTOR	
MALE FIELD CONNECTOR	
MALE TERMINATOR	
FEMALE TERMINATOR	
MALE MOLDED CONNECTOR	
FEMALE MOLDED CONNECTOR	
POWER TEE	TEE

Cable run is approx. 75 FT

Cable between PLC enclosure and welder was replaced with THICK DeviceNet cable Dec. 00.

POD SERVER

CONTROL ENCLOSURE WITH PLC

DEVICENET SHIELD CONNECTED TO GND

PLC 5/30

1771-SDN

NODE 5

THE POD
NODE 51 CABLE #1

THE POD
NODE 52 CABLE #2

THE POD
NODE 53 CABLE #3

THE POD
NODE 54 CABLE #4

J5 J6 J3 J4 J1 J2 P1 J0

120VAC
Fused @4A

SOLA
SDN 4-24-100
+ + - -
N L G

RD & WH
BK & GN

LIVINGSTON & COMPANY, INC.

TITLE
Example of a 4-POD system

MATL

FINISH

STK NO.

DRAWN EJB   DATE 10-25-00

CHKD   DATE

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES/mm
DIMENSIONAL TOLERANCES

INCHES
.XX   .01   .X   mm   .2
.XXX   .005   .XX   .02
FRACT 1/64

SIZE DWG NO.   REV
A   2

SHEET 1 OF 1

LEGEND

MALE FIELD CONNECTOR	
FEMALE FIELD CONNECTOR	
MALE MOLDED CONNECTOR	
FEMALE MOLDED CONNECTOR	
MALE TERMINATOR	
FEMALE TERMINATOR	
POWER TEE	
TEE	

NODE 41 CABLE #1 — THE POD
NODE 42 CABLE #2 — THE POD
NODE 43 CABLE #3 — THE POD
NODE 44 CABLE #4 — THE POD

NODE 45 CABLE #5 — THE POD
NODE 46 CABLE #6 — THE POD
NODE 47 CABLE #7 — THE POD
NODE 48 CABLE #8 — THE POD

NODE 49 CABLE #9 — THE POD

ENCLOSURE WITH PLC

Allen Bradley SLC 5/03 or higher

1747-SDN

NODE 5
DEVICENET SHIELD CONNECTED TO GND

NODE 0
POD SERVER

MLG SDN
SDN 10-24-00

LIVINGSTON & COMPANY, INC.

MATL		STK NO.
FINISH		

TITLE
Example 9-Pod system

DRAWN EJB	DATE 08-15-00
CHKD	DATE

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES/mm
DIMENSIONAL TOLERANCES

INCHES		mm
.XX .01		.X .2
.XXX .005		.XX .02
FRACT 1/64		

SIZE A	DWG NO.	REV 2
SHEET 1 OF 1		

DeviceNet Connector Wiring

SEALED CONNECTORS & FIELD CONNECTORS

VIEW FACING PIN SIDE OF CONNECTOR

DeviceNet Male
MINI
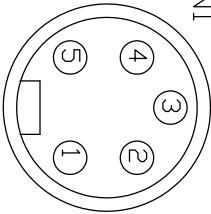
DeviceNet Female
MINI
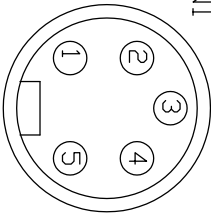
VIEW FACING WIRING SIDE OF CONNECTOR

DeviceNet Male
MINI
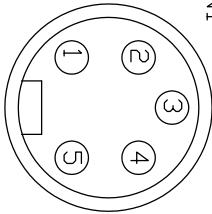
DeviceNet Female
MINI
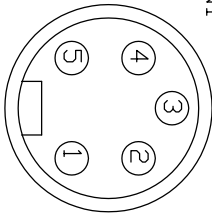
PIN / DESCRIPTION

1: BARE   (Shield)
2: RED   (+24VDC)
3: BLACK   (0V COM)
4: WHITE   (CAN_HI)
5: BLUE   (CAN_LO)

OPEN TERMINATIONS

DeviceNet Male
Contacts
OPEN
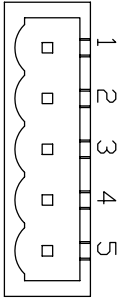
DeviceNet Female
Contacts
OPEN
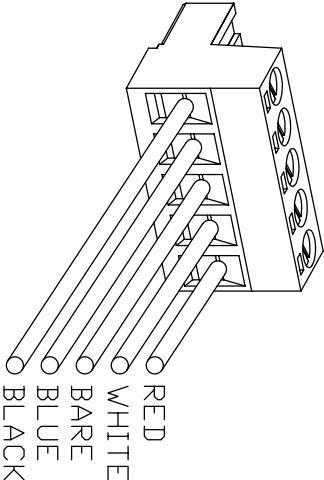
PIN / DESCRIPTION

1: BLACK   (0V COM)
2: BLUE   (CAN_LO)
3: BARE   (Shield)
4: WHITE   (CAN_HI)
5: RED   (+24VDC)

RED
WHITE
BARE
BLUE
BLACK

LIVINGSTON & COMPANY, INC.

TITLE	DeviceNet Connector Wiring
MATL	
FINISH	
STK NO.	

DRAWN EJB   DATE 03-06-07
CHKD   DATE

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES/mm
DIMENSIONAL TOLERANCES

INCHES		mm	
.XX	.01	.X	2
.XXX	.005	.XX	.02
FRACT	1/64		

SIZE A   DWG NO. 0391-WIR-450   REV B
SHEET 1 OF 1

DeviceNet Power Supply — 24VDC (++ − −), 115VAC (N L G)
RED / WHITE / BLACK / GREEN

DNET−POWERTC
CABLE CUT TO LENGTH

DNET−POWERT

DNET−SPTC2C
CABLE CUT TO LENGTH

DNET−SPTC2 or **DNET−SPTC1**

PIN	COLOR	POWERT	SPTC1	SPTC2
1	RD	+24VDC	+24VDC	+24VDC
2	GN	No Connection	0VDC	0VDC
3	WH	No Connection	+24VDC	+24VDC
4	BK	0VDC	0VDC	0VDC

LIVINGSTON & COMPANY, INC.

MATL	
FINISH	
STK NO.	

DRAWN EJB DATE 11-07-00
CHKD DATE

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES/mm
DIMENSIONAL TOLERANCES
INCHES
.XX .01   .X ² mm
.XXX .005   .XX .02
FRACT 1/64

TITLE
DeviceNet Power Wiring for Livingston
#DNET−POWERT and #DNET−SPTC2

SIZE A DWG NO. 0493-WIR-ENG REV B
SHEET 1 OF 1

Troubleshooting A DeviceNet Network

Last Modified:	09/13/2000
Document ID:	8842

The information in this document applies to the following products:

1787 (DNet) 1747 (SLC500) 1771 (I/O And H/W) 1747SDN 1771SDN 1787MGR

Document details:

**DeviceNet will not function correctly if design rules are not followed.
Even a Network previously thought to be functioning correctly may begin to exhibit abnormal or anomalous operation due to incorrect system design.
The following are tips to help locate and correct these abnormalities.**

For specific DeviceNet System Installation Information, please refer to publication DN-6.7.2 entitled "DeviceNet Planning and Installation Manual".

Manuals can be ordered via the Internet at **http://www.theautomationbookstore.com/**

[ ] Termination Resistors:

A termination resistor equal to 121 Ohms 1% , 1/4W must be attached at each end of the Trunk cable. The resistors must be connected across the Blue & White wires of the DeviceNet cable.

Resistor connection can be verified by disconnecting DeviceNet power and measuring the resistance across the Can_H & Can_L lines (Blue & White Wire). This can be measured with an Ohm meter. The reading should be *approximately 60 Ohms.*

Very Important: The DeviceNet network will not operate correctly without terminating resistors. Termination resistors can be ordered from your local Allen-Bradley Distributor using the *part number 1485A-C2.*

[ ] Network Grounding:

The DeviceNet cable must by grounded at only one location. This should be done closest to the center of the network. Connect the network Shield and Drain wire to an earth ground using #8 AWG wire up to a maximum 3m (10Ft) in length. Also connect the V- conductor (Black Wire) of the network trunk cable and the DC ground of the power supply to this ground connection.

[ ] Power Supply Discussion:

DeviceNet requires 24VDC. Use a power supply rated 24VDC (+/- 1%). Make sure the power supply has its own current limit protection. Provide fuse protection for each segment of the cable system. DeviceNet requires a power supply to have a rise time of less then 250mS to within 5% of its rated output voltage. The power supply must be sized correctly to provide each device with its required power.

1. The thin wire trunk line can only handle 3 amps and the thick wire trunk line can physically handle 8 amps. However, in North America the current is limited to 4 amps. Multiple power supplies can be installed on a DeviceNet network, but no section of cable should have more current flowing than the appropriate rating. An important note is that when putting multiple power supplies on a network, break the Red V+ wire between the power supplies. This effectively isolates the power supplies from each other.

2. Common mode voltage can sometimes be an issue on DeviceNet networks which have trunk lines that are extra long and/or have devices on them, drawing large currents at longer distances. If the voltage on the Black V- wire ever gets more than 4.65 volts different from one point of the network to another, then communication problems could occur. On an existing network, if the voltage between the Red V+ wire and the Black V- wire ever gets below 15 volts, then common mode voltage could be adversely affecting network communications. Adding an additional power supply or moving an existing power supply closer to the heavier current loads will normally cure common mode voltage problems.

Important: The power supply should be used to power the DeviceNet network only. When multiple power supplies are required, verify that the V+ connection is broken between the supplies. Please refer to the " DeviceNet Planning and Installation Manual " for more specific installation procedures.

[ ] Verify Network Voltages

It needs to be understood that DeviceNet is actually a three wire Differential Voltage network. Communication is accomplished by switching the CAN-H (White wire) and CAN-L (Blue wire) signals relative to the V- line (Black Wire). The CAN-H swings

between 2.5 VDC (Recessive State) and 4.0 VDC (Dominant State) while the CAN-L swings between 1.5 VDC (Dominant State) and 2.5 VDC (Recessive State). Without a network master connected to the DeviceNet, the CAN-H and CAN-L lines should read between 2.5 VDC and 3.0 VDC relative to V- and the voltages should be identical (Recessive State). Measure these voltages right at the SDN scanner. Use a voltmeter in DC mode.

With a network master connected **and polling the network,** the CAN-H to V- voltage will be around +3.2 VDC. The CAN-L to V- voltage will be around 2.4 VDC. The reason these values appear a little different than the ranges shown on the scope trace, is that the signals are switching, which slightly affects the DC value being read by the VOM.

If Can-H to V- and Can_L to V- are too low (less than 2.5 VDC and 2.0 VDC respectively), the issue is probably a bad transceiver or bad wiring. To find a bad transceiver remove one node at a time measuring Can-H and Can-L to V- each time a device is removed.

To check a transceiver (rough test) with everything removed from a device use an ohm meter to measure resistance between V+ and Can-H V+ and Can-L V- and Can-H V- and Can-L. These impedances should all be greater than 1 M ohm.

Examine the System Design of the Installation

1. Walk the network if possible to determine the actual layout. (Make a sketch of the network).
2. Check number of nodes.
3. Check cumulative drop length.
4. Check individual drop lengths.
5. Check branched drop length.
6. Check total trunk length, including long drop near the ends.
7. Check the termination location and measure the terminators.
8. Check the power supply cable length and gauge.
9. Check for one, and only one, earth ground of the V- and shield.
10. Break the combination shield/V- connection to frame ground and verify >1.0 M ohm to frame ground.
11. Check for one and only one V- to shield connection.
12. Break the shield/V- connection at the power supply and verify >1.0 M ohm shield to V- with 24VDC off.
13. Check for shorts of CAN- and/or CAN+ to shield or V- verify with an ohm meter.

14. Check the length and gauge of the earth ground connection.

15. Check total power load and its distribution points.

Check the Power

1. Check trunk and drop current limits.

2. Check type (size and length) of cable bringing power into the trunk.

3. Measure the 24V supply at the middle and ends of the network.

4. Consider spot checking the power for noise with an oscilloscope.

The 24 VDC Network Power for DeviceNet MUSTt be for the DeviceNet network only.

Check the Wiring

1. Check lead dress in junction boxes.

2. Check that connectors are screwed together tightly.

3. Check that glands are screwed tightly.

4. Check for foreign material (electrical tape, RTV, etc.) in glands.

5. Check that nodes are not touching extremely hot or cold surfaces.

6. Check that cables are kept a few inches away from power wiring.

7. Check that cables are not draped on electric motors, relays, contactors or solenoids.

8. Check that cables are not constrained so as to place excessive tension on connectors.

9. Wiggle connectors to provoke intermittent failures.

Check the Scanner Configuration

1. Verify the scanlist

2. Baud Rate

3. Node Address

4. Series/Revision of the 1747/1771-SDN scanner

Refer to these documents for Factory Defaulting the scanner:

Knowledgebase Document 10137 (□) - 1747-SDN
Knowledgebase Document 10742 (□) - 1771-SDN

Check the Nodes

1. Drop 24V supply, re-power and reset the scanner to initialize the network.
2. Examine the scanner display codes to identify problem nodes.
   (Reference the SDN manual for a description of these codes).

At problem nodes:

Blinking GREEN means the node is not being allocated by the scanner:

1. Check that the node is in the scan list.
2. Check that the scanner is not bus off.
3. Check if connection is timing out.

Blinking RED means no communication:

4. Check for missing power on all nodes.
5. Check if all other nodes are disconnected.
6. Check node baud rate (Bad baud rate does not always cause buss off).
7. Check scanner, if it is bus off (code 91) communications connection with the node has then timed out.
8. Recycle 24V supply and then reset scanner.

If scanner goes bus off again, the problem is some combination of:

1. Defective node
2. Node baud rate
3. Bad topology
4. Bad connections
5. Bad scanner
6. Bad power
7. Bad grounding
8. Bad electrical noise

A Solid RED light at power-up means two nodes have the same address.
A Solid RED after allocation means bus off, check baud rate.

If the problems persist:

1. Replace T-Tap.

2. Check topology.

3. Check power for noise with oscilloscope or power disturbance analyze.

Finally, if the problem remains after all else has been tried, replace the node.
(Be sure to set the node address and baud rate on the replacement node, if applicable).

Points to Remember

- Pressing the reset button on the scanner does not reset the network.

- Cycling the rack power does not reset the network.

- When using a DeviceLink, a bus off (solid RED) condition can only be cleared by cycling the 24V power.

- Cycling power on the network will cause the scanner to go bus off.

- DeviceNet 9000 bus off (solid RED) condition can be cleared by cycling the 24V power or by pressing the program button for several seconds.

- Extreme care must be given to the task of setting initial addresses and baud rates because one incorrect node address or incorrect baud rate will cause other nodes to appear to be bad (solid RED).

- If the scanner is bus off (code 91), nodes will not reallocate (flashing GREEN or RED) even if they are functioning correctly.

- DeviceNet manager and a 1770-KFD can be used to identify the functioning nodes on the network.

- If a node goes bus off (solid RED for DeviceLink), and is replaced and still goes bus off, the problem is not the node but rather the setting of the address or baud rate OR a network wide problem related to topology, grounding, electrical noise or an intermittent node.

MORE TROUBLESHOOTING TIPS

- Try to distinguish, as soon as possible, a device problem from a media problem.

- Try to reduce the system to the smallest size which still exhibits the problem.

- This can be done by removing nodes, drops, taps, or lengths of trunk.

    Use substitution where possible to rule things out, but be careful!

Real Case:

Product A works with Product B and not with Product C.
We conclude that the problem is with Product C -- WRONG!!
The problem was with Product A. Product C was operating correctly, but just happened to be susceptible to the fault in Product A.

Always remember: do not assume too much!
If you suspect a media problem, inspection is always a good first step.
Verify lengths, topology, and proper termination (*VERY IMPORTANT*).

Most of all........... check all connections!!

Opens or shorts may be the biggest problem. On an idle bus (without traffic) voltages can indicate problems. CAN_L and CAN_H should be about 2.5 to 3.0 volts relative to V-. If there is traffic, CAN_L will be a little lower, CAN_H a little higher.

Use an ohm meter to check resistance between CAN_H and CAN_L when idle. This should be about 60 ohms (two 120 ohm terminators in parallel). This value may be as low as 50 ohms if there are many nodes attached. Make sure all wires are well attached to the right places. The V+ level, relative to V-, should always be between 11 to 25 volts.

One common problem people run across is incorrect setting of baud rates and node addresses. Always verify the nodes address and baud rate before installing it on a network. Try not to change a nodes baud rate while on the network. Do all baud changes on a point to point only connection.

Ground Loops

Before trying this make sure the shield is grounded in only one place.

Use the oscilloscope to determine if there are ground loops in your system. You should NOT see 60 Hz or Harmonics in your signal. Assuming you use DC coupling on the oscilloscope, you should see....

2.8 VDC offset on both Can_High & Can_Low NO Sinusoidal signal (i.e 60 Hz components).

DeviceNet Cable

BLACK Common ----------- COM
BLUE-- Signal Low --------- CAN_L
Uninsulated Shield ---------- SHIELD
WHITE Signal High ------ -- CAN_H
RED Power Supply ---------- VDC+
GREEN Chassis Ground --- EARTH GROUND

DeviceNet Connector

Examine the connector with the keyway pointing down. Number the pins starting at the pin rightmost to the keyway (1) and continue counter clockwise until you reach pin (5).

PIN 1 SHIELD GREEN (or Bare wire)
PIN 2 VDC+ RED
PIN 3 COM BLACK
PIN 4 CAN_HIGH WHITE
PIN 5 CAN_LOW BLUE

Micro QD Cable Mini QD Cable

10-Pin Linear Plug with Jack Screws – 1787-PLUG10R
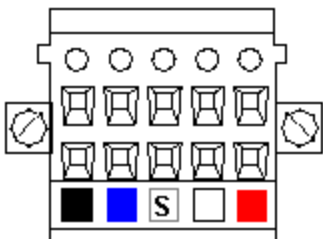
recommended for making a daisy-chain segment with thick or thin cable

Black * Blue * Shield * White * Red

DeviceNet Scanner Status / Error Codes

The bicolor (GREEN/RED) module status indicator displays device status. It indicates whether the device has power and is functioning properly.

Indicator is	Then	Take this action
Off	There is no power applied to the device.	Apply power.
Green	The device is operating in normal condition.	Do nothing.
Flashing Green	The device needs configuring.	Configure the device.

Flashing Red	There is an invalid configuration.		Verify dip switch settings.
			Check configuration setup.
Red	The device has an unrecoverable fault.		Replace the module.

The network status indicator is a bicolor (GREEN/RED) LED. The following table provides troubleshooting information about communication links.

Indicator is	Then	Which Indicates	Take this action
Off	The device has no power or the channel is disabled for communication due to bus off condition, loss of network power or has been intentionally disabled.	The channel is disabled for DeviceNet communication.	Power-up the scanner, provide network power to channel and make sure channel is enabled in both the scanner configuration table and module command word.
Flashing Green	The two-digit numeric display for the channel indicates an error code that provides more information about the condition of the channel.	The channel is enabled but no communication is occurring.	Configure scan list table for channel to add devices.
Solid Green	There's normal operation.	All slave devices in the scan list table are communicating normally with the scanner.	Do nothing.
Solid Red	The communications channel has failed. The two digit numeric display for the channel displays an error code that provides more information about the condition of the channel.	The scanner may be defective.	Reset module. If failures continue replace module.
Flashing Red	The two-digit numeric display for the channel displays an error code that provides more information about the condition of the channel.	At least one of the slave devices in the scanner's scan list table has failed to communicate with the scanner. The network has faulted.	Examine the failed device and check the scan list table for accuracy.

Your 1747/1771-SDN Scanner Module has a node address/status indicator that uses numeric displays to indicate diagnostic information about your module. The display flashes at approximately 1 second intervals, depending on network traffic. The following table summarizes the meanings of the numeric codes.

Numeric Code	Description	Take this action
Network Address Displays 0 - 63	Normal operation. The numeric display matches the scanner's node address on the DeviceNet network.	Do nothing.
70	Scanner failed Duplicate Node Address check.	Change the scanner channel address to another available one. The node address you selected is already in use on that channel.
71	Illegal data in scan list table (node number alternately flashes).	Reconfigure scan list table and remove any illegal data.
72	Slave device stopped communicating (node number alternately flashes).	Inspect the field devices and verify connections.
73	Device's identity information does not match electronic key in scan list table entry (node number alternately flashes).	Verify that the correct device is at this node number. Make sure that the device at the flashing node address matches the desired electronic key (vendor product code product type).
74	Data overrun on port detected.	Modify your configuration and check for invalid data. Check network communication traffic.
75	No network traffic at all has been detected.	Verify connections.
76	No direct network traffic for scanner detected.	None. The scanner hears other network communication.
77	Data size expected by the device does not match scan list entry (node number alternately flashes).	Reconfigure your module for the correct transmit and receive data sizes.
78	Slave device in scan list table does not exist (node number alternately flashes).	Add the device to the network, or delete the scan list entry for that device.
79	Scanners duplicate node check was not acknowledged or module failed to transmit a message.	Make sure that your module is connected to a valid network. Check for disconnected cables. Verify baud rate.

80	Scanner is in IDLE mode.	Enable RUN bit in SDN module command register. Put PLC/SLC in RUN mode.
81	Scanner is in FAULT mode.	Check ladder program for fault bits being set in SDN.
82	Error detected in sequence of fragmented I/O messages from device (node number alternately flashes).	Check scan list table entry for slave device to make sure that input and output data lengths are correct. Check slave device configuration.
83	Slave device is returning error responses when scanner attempts to communicate with it (node number alternately flashes).	Check accuracy of scan list table entry. Check slave device configuration. Slave device may be in another master's scan list. Reboot slave device.
84	Scanner is initializing the DeviceNet channel.	None. This code clears itself once scanner attempts to initialize all slave devices on the channel.
85	Data size larger than 255 bytes (node number alternately flashes).	Configure the device for a smaller data size.
86	Device is producing zero length data (idle state) while channel is in Run Mode.	Check device configuration and slave node status.
88	This is not an error. At power-up and reset, the module displays all 14 segments of the node address and status display LEDs.	None.
89	This is an ADR error. The Device does not support the Auto-Device Recovery or is not configured properly.	Check configuration or disable the ADR function for this device.
90	User has disabled communication port.	Reconfigure your module. Check Module Command Register.
91	Bus-off condition detected on comm port. Scanner is detecting communication errors.	Check DeviceNet connections and physical media integrity. Check system for failed slave devices or other possible sources of network interference.
92	No network power detected on comm port.	Provide network power. Make sure that scanner drop cable is providing network power to scanner comm port.

95	Application FLASH update in progress.	None. Do not disconnect the module while application FLASH is in progress. You will lose any existing data in the scanner's memory.
97	Scanner halted by user command.	Check ladder program for cause of fault bits.
98	Unrecoverable firmware failure.	Service or replace your module.
99	Unrecoverable hardware failure.	Service or replace your module.
E2	RAM Test Failure.	Return/Replace module.
E4	Lost Power During FLASH Upgrade.	Return/Replace module.
E5	No Boot or Main Code.	Return/Replace module.
E9	The 1747-SDN scanner has been flushed from the command register.	Cycle Power on SDN to recover.

POD™ Specifications – General

External Controls and Connectors

The POD™ features a sensor input connector on its front panel for receiving weld data via the Monitor-Sensor cable. There is also a DeviceNet™ connector on the bottom for powering the Pod and communicating with the DeviceNet™ network.

Power Requirements – DeviceNet™

The POD™ is powered from the DeviceNet™ network connection. The Pod requires 19 – 24 VDC @0.5A (Peak current is 1.8A at startup).

LED Indicators

The LEDs on the POD™s conform to ODVA specifications.

Upper LED: This bi-color (red/green) LED provides POD™ status. It indicates whether the POD™ has power and is operating properly. The following table defines the states:

LED is:	For this state:	To indicate:
Off	Not powered; P1,P3 During a weld it means undetermined weld status)	There is no power applied to the device, or the POD™ is recording a weld.
Green	Powered and Online; P1, P3 – Accepted weld N1 – Within the Force and Displacement window	The POD™ is powered and communicating with the POD™ Server; P1,P3 - the last weld seen was 'Accepted'; N1 – Within window.
Red	Fault; P1, P3 – Rejected weld N1 – Outside of the Force and Displacement window	The POD™ has an unrecoverable fault or has detected an error that has rendered it incapable of communicating on the network (may need replacing); P1,P3 - the last weld seen was 'Rejected'; N1 – outside of window.

Figure **11-6**

Lower LED: Also referred to as the **Combined Module/Network Status LED**. This bi-color (red/green) LED indicates the status of the communication link. The following table defines the states

LED is:	For this state:	To indicate:
Off	Not Powered	The POD™ is not powered.
Flashing Green	During startup	The POD™ has been powered but is not yet communicating with the POD™ Server.
Green	Powered and Online	The POD™ is powered and communicating with the POD™ Server.
Red	Time-out	The POD™ has an unrecoverable fault or has detected an error that has rendered it incapable of communicating on the network (may need replacing).

Figure **11-7** Combined Module/Network Status LED Table

Dimensions

REAR VIEW OF POD WITH MOUNTING BRACKETS

1.00

BRACKET HOLES WITH
COUNTERBORE 0.14",
CLEARANCE FOR #10-24
PAN HEAD SCREW

UNITS ARE IN INCHES

POD CASE IS 2.18" DEEP

5.27 6.73

CLEARANCE FOR
1/4" MACHINE SCREW

HOLES IN POD:
#10-24 THREAD 3/8" DEEP

MOUNTING BRACKETS ARE
0.25" THICK

4.065
4.75
6.25
7
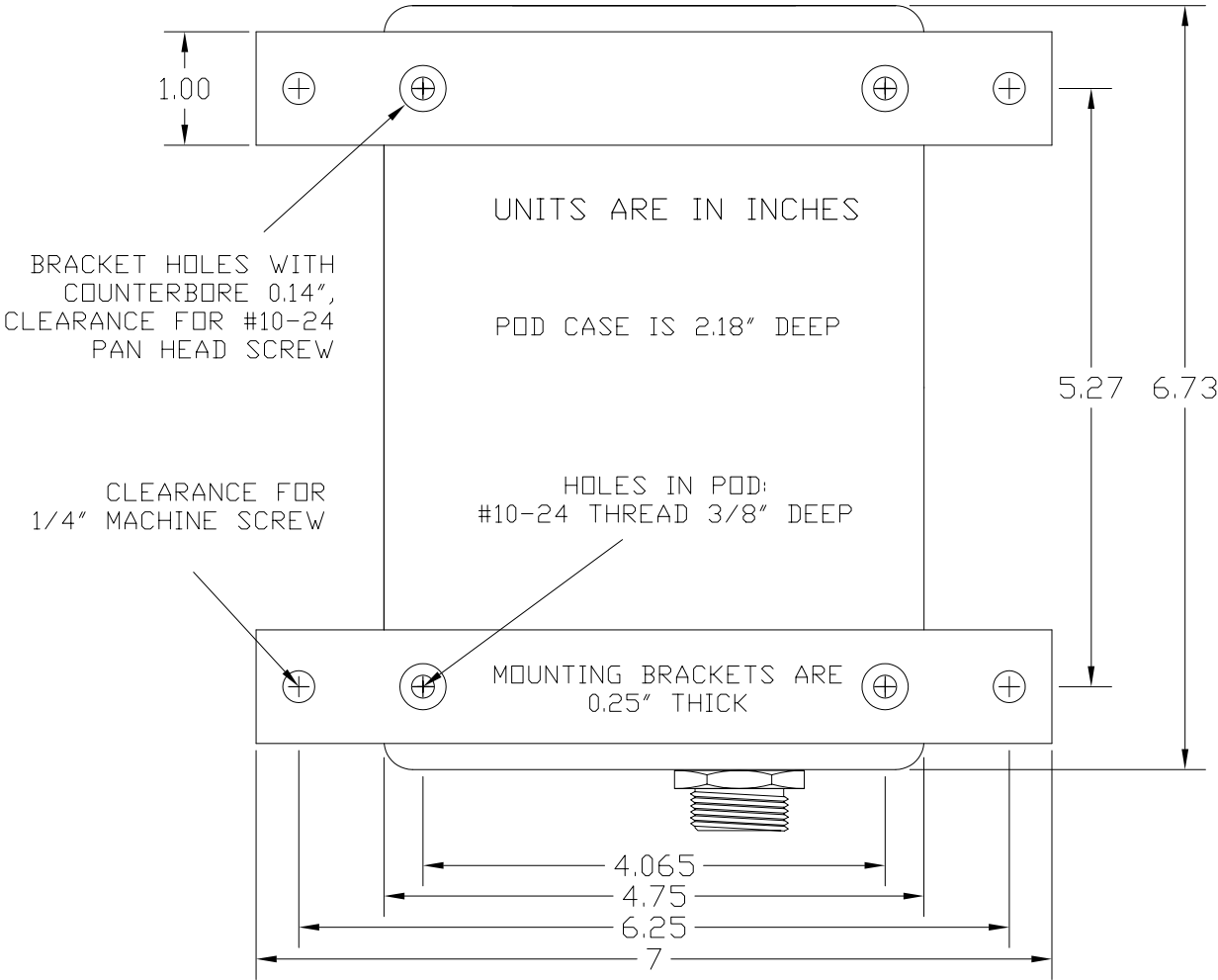
POD™ SERVER

A Pod™ Server is a computer (Industrial PC, Laptop, Desktop) with an installed SST 5136-DNP or DN3 DeviceNet interface that is running Livingston Pod™ Server software

A Pod Server™ is used to configure Pod parameters and tolerances, record weld data, display weld data, and calibrate sensors.

Pod™ Server Computer Requirements

Processor: Pentium Class PII or better; 300MHz minimum
Memory (Windows NT 4.0): 64MB RAM minimum
Memory (Windows 2000 Pro or XP): 128MB RAM minimum
Hard Drive: Local drive, SCSI or IDE UDMA 66 or faster.
O/S (operating system): Windows NT 4.0 (SP 5 or newer), Windows 2000 Pro (SP3 or newer), Windows XP Pro

SST™ 5136-DNP or DN3 Single Channel DeviceNet Card: PCI, ISA, PC104, PCMCIA

Installation: From CD-ROM DRIVE or over network from computer with CD-ROM DRIVE.

NOTE: Due to the nature of real-time data collection, Livingston does NOT guarantee the performance of Pod Server software if other applications are running on the computer.

Advantages

- Simple and quick installation using DeviceNet™ network (only 5 wires).
- Interlocks with existing PLC via DeviceNet™ (PLC must have a DeviceNet™ Scanner module installed).
- Pod™ Server weld database is accessible via Ethernet allowing advanced statistical analysis and up-to-the-minute report generation.
- System logging: * Allows PLC to send ASCII text messages to Pod™ Server where they are time-stamped and stored in the System log (viewable from Pod™ Server screen).
- Part and process "traceability": * Allows PLC to send and store time-stamped data (integer and floating point values) to the weld data database. Data could be used to track cycle-time, machine down time, parts per shift, how often specific faults occur, overall machine and process performance, etc.

  *NOTE: Requires PLC with DeviceNet™ explicit messaging capability.

DeviceNet™ I/O – Inputs and Outputs

Polled I/O 64 bytes IN, 64 bytes OUT (refer to Livingston Doc# 0454-APP-292 for more about Polled I/O).

Inputs (per pod) – 1 byte – Binary Select (up to 31)
Outputs (per pod) – 1 byte – Accept, Reject, Busy, Window, Weld Count (least significant 4 bits of pod's weld count)

DeviceNet™ Explicit Messaging

Refer to the following Livingston Documents for more about Pod Server Explicit Messaging:

0454-APP-295 – Sending data from PLC to weld database
0454-APP-296 – Send ASCII text from PLC to System Log

N1 - POD™ MONITOR

The N1 Pod™ is intended for pre-weld process monitoring of displacement and force.

The N1 is ideal for checking part stack up and weld force prior to welding. This is useful for eliminating scrap welds that lead to costly rework due to missing parts, cold welds or expulsion. A DeviceNet output bit is used to indicate when both displacement and force are within acceptable limits. This output can be used with a stack light for visual indication or used with a PLC for pre-weld and post-weld conditions.

Monitored Parameters

- *Force-* LBS, PSI, KPA, KG, or N: Differential Input +/-20mv for use with tension and compression load cells, diaphragm type pressure transducers. Typical resolution: 0.01% of full scale.

- *Displacement* – IN or MM**:** For use with resistive voltage divider type potentiometers. Typical resolution: 0.00002" or 0.0005mm with 100mm sensor.

Tolerance Limits

- *"Absolute"* tolerance limits for a force and displacement window.
- Up to 31 different sets of "Absolute" limits for use with multiple weld schedules that have different weld forces or initial part stack-ups.

DeviceNet™ Inputs

- 5 Binary Select inputs for selecting up to 31 different sets of "Absolute" limits
- Zero Displacement – to reset the displacement sensor zero reference
- Reset – to clear latched outputs

DeviceNet™ Outputs

- Window bit – Real-time window status for Force and Displacement
- Hi/Lo bits – Real-time status for Force Hi, Force Lo, Displacement Hi, and Displacement Lo.
- Accept/Reject bits – Provide either pulsed or latched signals for changes in window status.
- Busy bit – Used to indicate when Pod is busy during configuration or setting displacement zero reference.

Features

- Cost effective
- Easy to understand, configure and operate.
- Compact, modular units can mount directly at the weld head
- Simple and quick installation using DeviceNet™ network for easy integration with factory automation
- Up to 60 Pod™s on one network
- Does not require a dedicated Pod™ Server
- Easy firmware upgrade without disassembly or removal from system
- Interlocks with PLC (or welder) using optional DeviceNet™ scanner card or DeviceNet™ I/O blocks
- PLC can read calibrated sensor readings (Displacement and Force) via explicit messaging*
- Built-in 10VDC excitation voltage for load cells, pressure sensors and displacement sensors.
- Pentium-Class CPU with on-board Digital Signal Processor

NOTE: Requires PLC with DeviceNet™ explicit messaging capability

Livingston Product Feature Comparison Chart

	N1	P1	P3	2400
Weld Summary Parameter tolerancing	[*1]YES	YES	YES	NO
Current RMS		X	X	
Current Peak			X	
Voltage RMS		X	X	
Votlage Peak			X	
Force	X	X	X	
Initial Thickness	X	X	X	
Final Thickness			X	
Setdown		X	X	
Expansion			X	
Conduction Angle			X	
Resistance (Dynamic)			X	
Energy			X	
Half Cycle Count[*2]		X	X	
Segment and [*2]Half Cycle Parameter Tolerancing	NO	NO	YES	YES
Current RMS			X	X
Current Peak			X	X
Voltage RMS			X	X
Votlage Peak			X	X
Force			X	X
Initial Thickness			X	X
Final Thickness			X	X
Setdown			X	X
Expansion			X	X
Conduction Angle			X	X
Resistance (Dynamic)			X	X
Energy			X	X
Tolerancing	YES	YES	YES	YES
Absolute	X	X	X	X
Relative			X	X
Multiple Segments			X	X
Masters/Mastering			X	X
Adjustable Post Delay		X	X	X
Binary Selects	31	31	31	15
Weld Type				
AC	X	X	X	X
MFDC[*2]	X	X	X	
DC 1P (single phase)	X	X	X	

*1 - N1 parameter tolerancing is for Force and Initial thickness "window" bit control only.
*2 – MFDC monitored in milliseconds.

P1 - POD™ WELD MONITOR

The P1 Pod™ Monitor is Livingston's cost effective, basic feature set weld monitor used primarily to detect catastrophic weld process events.

Monitored and Calculated Parameters

- *Current (secondary)-* RMS average for weld (1-100KA). Standard toroid measures (4 - 45KA), Higher currents supported with special-order toroids
- *Voltage-* RMS average for the weld (+/-7V)
- *Force-* Average for the weld in LBS, PSI, KPA, KG, or N (Differential Input +/-20mv)
- *Displacement –* IN or MM *- Initial thickness, Setdown* (Projection welds); Typical resolution: 0.00002" or 0.0005mm with 100mm sensor
- *Half Cycle Count* (AC, DC single-phase), *Millisecond Count* (MFDC)

Tolerancing

- *"Absolute"* tolerancing of monitored and calculated parameters *per Weld*
- Up to 31 different sets of "Absolute" tolerances for use with multiple weld schedules
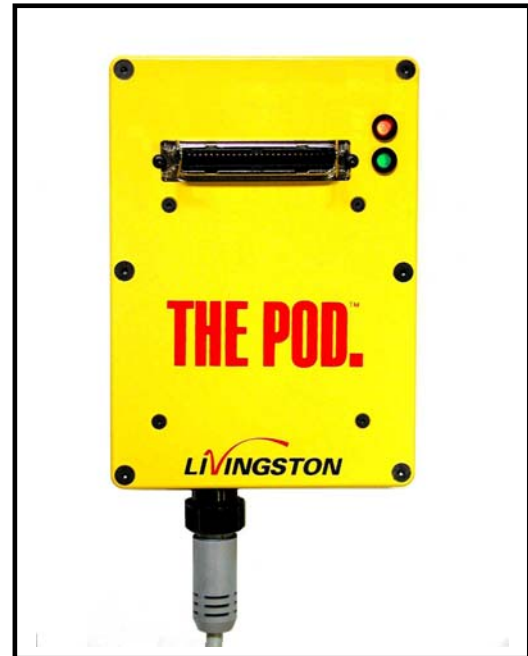
Features

- Pre-weld "Window" bit for Force and Displacement.
- Cost effective.
- Easy to understand, configure and operate.
- Supports AC and MFDC welding (spot, projection, and pulse welds)
- Compact, modular units mount directly at the weld head
- Simple and quick installation using DeviceNet™ network (only 5 wires)
- DeviceNet™ for easy integration with factory automation
- Up to 60 Pod™s on one network
- Does not require a dedicated Pod™ Server
- Easy firmware upgrade without disassembly or removal from system
- Interlocks with PLC (or welder) using optional DeviceNet™ scanner card or DeviceNet™ I/O blocks
- PLC can read calibrated sensor readings (Displacement and Force) via explicit messaging*
- Built-in 10VDC excitation voltage for load cells, pressure sensors and displacement sensors.
- Pentium-Class CPU with on-board Digital Signal Processor
- 4 simultaneous sampling 16-bit Analog-to-Digital converters at up to 100kHz sample rate.

NOTE: Requires PLC with DeviceNet™ explicit messaging capability

Features when used with dedicated Pod™ Server (PC running WMS software)

- Low MTTR (Mean Time To Repair) since Pod™ Server initializes replacement Pod™ at power up using backed up Pod™ configuration (tolerances, settings, Calibration, etc.)
- Real-time ERP (Enterprise Resource Planning) integration.
- Real-time access to weld data and setup parameters. Data is accessible via Ethernet for statistical analysis and up-to-the-minute report generation. Databases compatible with Microsoft Office®, SQL Server and any ODBC compliant database.
- Remote user interface and control of Pod™ Server. Remote data backup capable.
- System logging: Explicit messaging* allows PLC to send and store time-stamped ASCII text messages to System Log for logging machine or process events. System Log is viewable on Pod™ Server screen.
- Real-time part and process "traceability": Explicit messaging* allows PLC to send and store process related time-stamped data (integer and floating point values) in the weld database.

NOTE: Requires PLC with DeviceNet™ explicit messaging capability

Livingston Product Feature Comparison Chart

	N1	P1	P3	2400
Weld Summary Parameter tolerancing	[*1]YES	YES	YES	NO
Current RMS		X	X	
Current Peak			X	
Voltage RMS		X	X	
Votlage Peak			X	
Force	X	X	X	
Initial Thickness	X	X	X	
Final Thickness			X	
Setdown		X	X	
Expansion			X	
Conduction Angle			X	
Resistance (Dynamic)			X	
Energy			X	
Half Cycle Count[*2]		X	X	
Segment and [*2]Half Cycle Parameter Tolerancing	NO	NO	YES	YES
Current RMS			X	X
Current Peak			X	X
Voltage RMS			X	X
Votlage Peak			X	X
Force			X	X
Initial Thickness			X	X
Final Thickness			X	X
Setdown			X	X
Expansion			X	X
Conduction Angle			X	X
Resistance (Dynamic)			X	X
Energy			X	X
Tolerancing	YES	YES	YES	YES
Absolute	X	X	X	X
Relative			X	X
Multiple Segments			X	X
Masters/Mastering			X	X
Adjustable Post Delay		X	X	X
Binary Selects	31	31	31	15
Weld Type				
AC	X	X	X	X
MFDC[*2]	X	X	X	
DC 1P (single phase)	X	X	X	

*1 - N1 parameter tolerancing is for Force and Initial thickness "window" bit control only.
*2 – MFDC monitored in milliseconds.

P3 - POD™ WELD MONITOR

The P3 Pod™ Monitor is Livingston's full feature set POD™ weld monitor.

Monitored and Calculated Parameters

- *Current (secondary)* – RMS and Peak (1-100KA). Standard toroid measures (4 - 45KA), Higher currents supported with special-order toroids
- *Voltage* – RMS (+/-7V) and Peak (+/- 9.9V)
- *Force* – LBS, PSI, KPA, KG, or N (Differential Input +/-20mv)
- *Displacement* – IN or MM - *Initial thickness, Final thickness, Setdown* (Projection welds), *Expansion* (Spot welds); Typical resolution: 0.00002" or 0.0005mm with 100mm sensor
- *Conduction Angle-* Resolution 1.8 degrees
- *Resistance* – OHMs, mOHMs, or uOHMs
- *Energy -* KVA
- *Half Cycle Count (AC, DC single-phase), Millisecond Count (MFDC)*

Tolerancing

- Up to 31 different *"Master"* signatures allows tolerancing of multiple weld schedules
- Multiple user-defined adjustable weld segments for advanced tolerancing
- Advanced *"Relative"* and/or *"Absolute"* tolerancing of monitored and calculated parameters *per Half cycle, per Segment and per Weld*
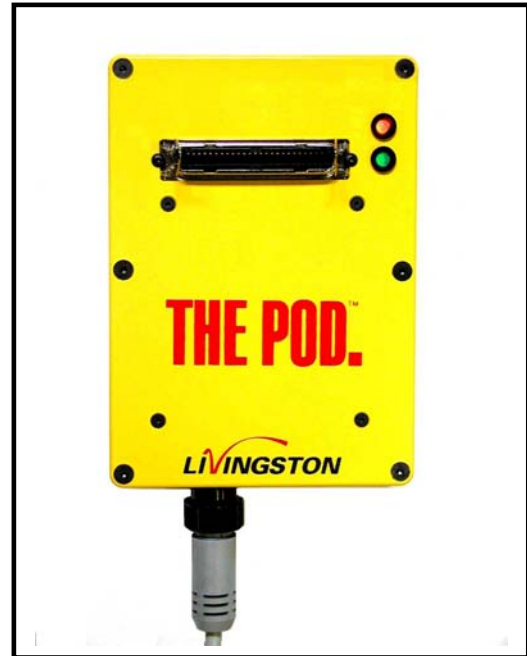
Features

- Pre-weld "Window" bit for Force and Displacement.
- Supports AC and MFDC welding (spot, projection, and pulse welds)
- Compact, modular units mount directly at the weld head
- Simple and quick installation using DeviceNet™ network (only 5 wires)
- DeviceNet™ for easy integration with factory automation
- Up to 60 Pod™s on one network
- Does not require a dedicated Pod™ Server
- Easy firmware upgrade without disassembly or removal from system
- Interlocks with PLC (or welder) using optional DeviceNet™ scanner card or DeviceNet™ I/O blocks
- PLC can read calibrated sensor readings (Displacement and Force) via explicit messaging*
- Built-in 10VDC excitation voltage for load cells, pressure sensors and displacement sensors.
- Pentium-Class CPU with on-board Digital Signal Processor
- 4 simultaneous sampling 16-bit Analog-to-Digital converters at up to 100kHz sample rate.

NOTE: Requires PLC with DeviceNet™ explicit messaging capability

Features when used with a dedicated Pod™ Server (PC running WMS software)

- Low MTTR (Mean Time To Repair) since Pod™ Server initializes replacement Pod™ at power up using backed up Pod™ configuration (tolerances, settings, Calibration, Masters, etc.)
- Real-time ERP (Enterprise Resource Planning) integration.
- Real-time access to weld data and setup parameters. Data is accessible via Ethernet for statistical analysis and up-to-the-minute report generation. Databases compatible with Microsoft Office®, SQL Server and any ODBC compliant database.
- Remote user interface and control of Pod™ Server via Ethernet. Automated remote data backup capable.
- System logging: Explicit messaging* allows PLC to send and store time-stamped ASCII text messages to System Log for logging machine or process events. System Log is viewable on Pod™ Server screen.
- Real-time part and process "traceability": Explicit messaging* allows PLC to send and store process related time-stamped data (integer and floating point values) in the weld database.

NOTE: Requires PLC with DeviceNet™ explicit messaging capability

Livingston Product Feature Comparison Chart

	N1	P1	P3	2400
Weld Summary Parameter tolerancing	[1]YES	YES	YES	NO
Current RMS		X	X	
Current Peak			X	
Voltage RMS		X	X	
Votlage Peak			X	
Force	X	X	X	
Initial Thickness	X	X	X	
Final Thickness			X	
Setdown		X	X	
Expansion			X	
Conduction Angle			X	
Resistance (Dynamic)			X	
Energy			X	
Half Cycle Count[2]		X	X	
Segment and [2]Half Cycle Parameter Tolerancing	NO	NO	YES	YES
Current RMS			X	X
Current Peak			X	X
Voltage RMS			X	X
Votlage Peak			X	X
Force			X	X
Initial Thickness			X	X
Final Thickness			X	X
Setdown			X	X
Expansion			X	X
Conduction Angle			X	X
Resistance (Dynamic)			X	X
Energy			X	X
Tolerancing	YES	YES	YES	YES
Absolute	X	X	X	X
Relative			X	X
Multiple Segments			X	X
Masters/Mastering			X	X
Adjustable Post Delay		X	X	X
Binary Selects	31	31	31	15
Weld Type				
AC	X	X	X	X
MFDC[2]	X	X	X	
DC 1P (single phase)	X	X	X	

*1 - N1 parameter tolerancing is for Force and Initial thickness "window" bit control only.
*2 – MFDC monitored in milliseconds.

Discrete I/O using DeviceNet™ I/O Block

Interlocking Method
- Discrete I/O (Hard-wired) with DeviceNet™ I/O block (24VDC or 120VAC). Call Livingston for supported I/O blocks.
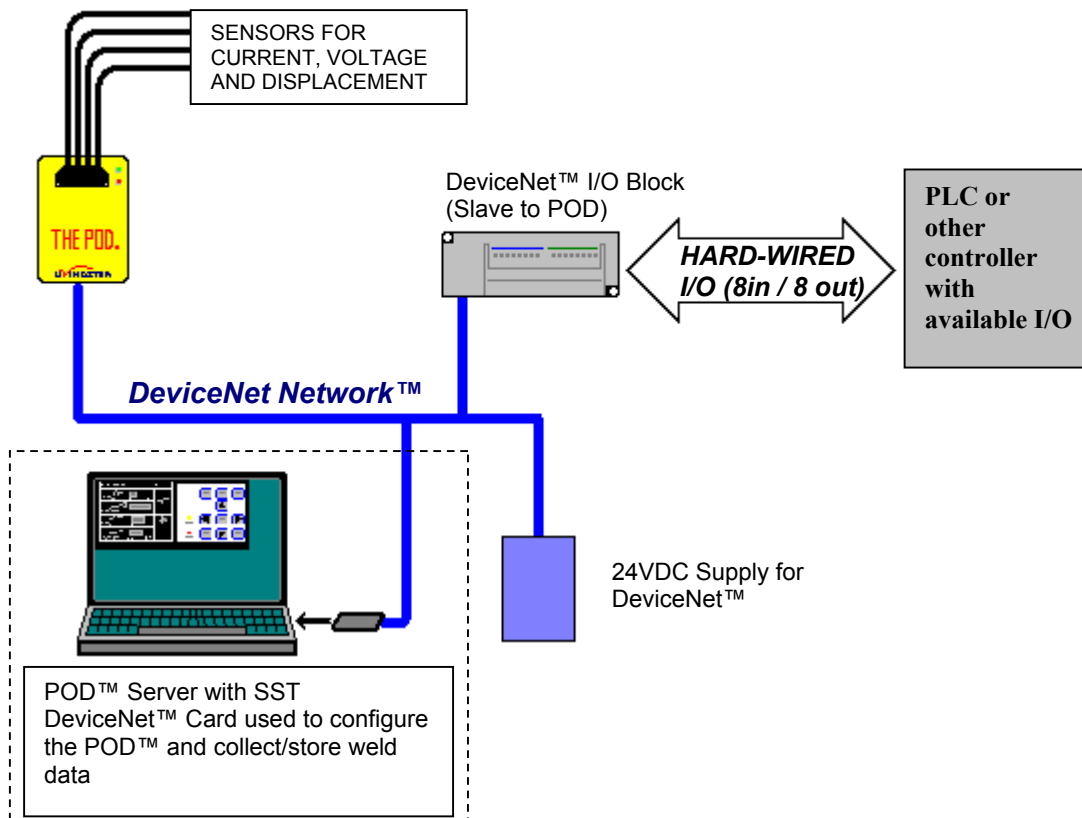
Advantages
- Cost effective for 1 to 5 weld heads using DeviceNet™ I/O blocks to interface with PLC (or other logic controller) using discrete I/O wiring
- Visual weld Accept/Reject status using stack lights with DeviceNet I/O blocks
- Does not require a DeviceNet™ scanner module in order to interface with a PLC

Configuration software
Pod™ parameters and tolerances are configured using Pod™ Server software (*compatible only with Windows NT 4.0, Windows 2000 Pro, Windows XP*). This software could be running on a Livingston Pod™ Server OR a laptop or industrial computer that has been outfitted with a DeviceNet™ card (single-channel SST 5136 or DN3). *NOTE: The Pod™ Server is used to configure the Pod™ and collect/store weld data.*

System Description

SENSORS FOR CURRENT, VOLTAGE AND DISPLACEMENT

THE POD.

DeviceNet™ I/O Block (Slave to POD)

HARD-WIRED I/O (8in / 8 out)

PLC or other controller with available I/O

DeviceNet Network™

24VDC Supply for DeviceNet™

POD™ Server with SST DeviceNet™ Card used to configure the POD™ and collect/store weld data

The Pod™ monitor and associated sensors are installed at the weld head.

A small DeviceNet™ network is installed to allow communication between the Pod™, I/O block, and Pod™ Server (used to configure the Pod). A 24VDC supply is required to provide power to the DeviceNet™ network, which powers the Pod™ and I/O block. The Pod™ is configured so that it is a DeviceNet™ *Master* to the *Slave* I/O block. Once configured, the I/O block's discrete I/O is automatically passed to/from the Pod™ via DeviceNet™. As the Pod™ processes weld data; the weld status is propagated to the I/O blocks outputs. *Note: No other DeviceNet™ device (i.e. scanner module in a PLC) is required for this system to operate.*

The discrete I/O (I/O block) can be hard-wired to a programmable logic controller (or other controller), stack light, switches, buttons, relays, etc. Examples:
➢ A switch can be wired to the inputs for selecting different weld Masters (binary select inputs)
➢ A button can be wired to the RESET input for resetting a rejected weld status.
➢ The outputs can be wired to a stack light for visual indication of weld status (GREEN – Accept, RED- Reject).
➢ The outputs can be wired to a logic controller for interlocking with system sequencing (Rejected part is clamped in the fixture requiring a FAULT RESET).
➢ The outputs can be wired to robot controller inputs for decision making (A robot places rejected parts into a reject bin, etc.)
➢ The outputs can be wired to solid state relays for switching solenoid valves

I/O Block – P1 and P3 Pod - Discrete Inputs and Outputs

**P1 P3 POD STAND ALONE - DEVICENET I/O BLOCK USAGE**					
INPUTS	**NAME**	**GENERAL DESCRIPTION**	**ACC/REJ MODE**	**BUSY/STAT MODE**	**STACK LIGHT MODE**
0	BINARY SELECT 1	Used to select different weld Masters (up to 31). A binary select value of 0 is invalid.	SAME FOR ALL MODES - Binary Select inputs must be applied and stable prior to the initiation of weld current (assume a small propagation delay). (See chart for selecting masters)		
1	BINARY SELECT 2				
2	BINARY SELECT 4				
3	BINARY SELECT 8				
4	BINARY SELECT 16				
5	UNUSED				
6	ZERO DISPLACEMENT	Used to reset the "zero" reference for the displacement sensor (if used).	Zeroing occurs following an OFF to ON transition OR an ON to OFF transition IF the Pod is NOT already in the process of zeroing in which case the transition is IGNORED. This input is intended to work with a pulsed signal, which should be shorter in duration than the zeroing process (1 to 2 seconds). Recommended pulse time is from 100ms to 500ms. A PLC could also be programmed to turn ON the ZERO DISPLACEMENT bit until the BUSY output turns ON (indicating that the POD is in the process of zeroing) and then turn OFF the ZERO DISPLACEMENT bit.		
7	RESET NW/STAT	Clears the ACCEPT, REJECT (all REJECT outputs) and NEW WELD outputs.	A reset occurs following an OFF to ON transition.		
OUTPUTS	**NAME**	**GENERAL DESCRIPTION**	**ACC/REJ MODE**	**BUSY/STAT MODE**	**STACK LIGHT MODE**
0	ACCEPT	Indicates that the last weld was ACCEPTED	Pulse (OFF-ON-OFF)- 125ms following an ACCEPTED weld	Level (ON)- following an ACCEPTED weld. (OFF) during weld or following a REJECTED weld.	Level (ON)- following an ACCEPTED weld. (OFF) during weld or following a REJECTED weld.
1	REJECT	Indicates that the last weld was REJECTED	Pulse (OFF-ON-OFF)- 125ms following a REJECTED weld	Level (ON) following a REJECTED weld. (OFF) during a weld or following an ACCEPTED weld.	Blinks (ON/OFF) following a REJECTED weld. (OFF) during a weld or following an ACCEPTED weld.
2	BUSY	Indicates that Pod is BUSY and unable to monitor welds. Indicates that displacement "zeroing" is in progress	Level (ON) energized when POD is busy, including zeroing. (OFF) when pod is no longer BUSY.		
3	NEW WELD	Indicates that at least one NEW WELD has occurred since it was cleared by the RESET NW/STAT input	Level (ON)- following any weld (ACCEPTED or REJECTED).		
4	CURRENT/HC REJECT	Indicates REJECT occurred due to any one of these toleranced parameters: Current (RMS or Peak), Half Cycle count, Conduction Angle	Level (ON) - following a REJECTED weld due to Current (RMS or Peak), Half Cycle Count or Conduction Angle.		
5	VOLTAGE REJECT	Indicates REJECT occurred due to any one of these toleranced parameters: Voltage (RMS or Peak), Resistance, Energy	Level (ON) - following a REJECTED weld due to Voltage (RMS or Peak), Resistance or Energy.		
6	FORCE REJECT	Indicates REJECT occurred due to any one of these toleranced parameters: Force	Level (ON) - following a REJECTED weld due to Force.		
7	DISPLACEMENT REJECT	Indicates REJECT occurred due to any one of these toleranced parameters: Initial Thickness, Final Thickness, Setdown, Expansion	Level (ON) - following a REJECTED weld due to Initial Thickness, Final thickness, Setdown, or Expansion.		

P1 P3 POD STAND ALONE - DEVICENET I/O BLOCK USAGE

INPUTS	NAME	GENERAL DESCRIPTION	AR_WINDOW MODE	BS_WINDOW MODE
0	BINARY SELECT 1	Used to select different weld Masters (up to 31). A binary select value of 0 is invalid.	SAME FOR ALL MODES - Binary Select inputs must be applied and stable prior to the initiation of weld current (assume a small propagation delay). (See chart for selecting masters)	
1	BINARY SELECT 2			
2	BINARY SELECT 4			
3	BINARY SELECT 8			
4	BINARY SELECT 16			
5	UNUSED			
6	ZERO DISPLACEMENT	Used to reset the "zero" reference for the displacement sensor (if used).	Zeroing occurs following an OFF to ON transition OR an ON to OFF transition IF the Pod is NOT already in the process of zeroing in which case the transition is IGNORED. This input is intended to work with a pulsed signal, which should be shorter in duration than the zeroing process (1 to 2 seconds). Recommended pulse time is from 100ms to 500ms. A PLC could also be programmed to turn ON the ZERO DISPLACEMENT bit until the BUSY output turns ON (indicating that the POD is in the process of zeroing) and then turn OFF the ZERO DISPLACEMENT bit.	
7	RESET STAT	Clears the ACCEPT and REJECT (all REJECT) outputs.	A reset occurs following an OFF to ON transition.	

OUTPUTS	NAME	GENERAL DESCRIPTION	AR_WINDOW MODE	BS_WINDOW MODE
0	ACCEPT	Indicates that the last weld was ACCEPTED	Pulse (OFF-ON-OFF)- 125ms following an ACCEPTED weld	Level (ON)- following an ACCEPTED weld. (OFF) during weld or following a REJECTED weld.
1	REJECT	Indicates that the last weld was REJECTED	Pulse (OFF-ON-OFF)- 125ms following a REJECTED weld	Level (ON) following a REJECTED weld. (OFF) during a weld or following an ACCEPTED weld.
2	BUSY	Indicates that Pod is BUSY and unable to monitor welds. Indicates that displacement "zeroing" is in progress	Level (ON) energized when POD is busy, including zeroing. (OFF) when pod is no longer BUSY.	
3	WINDOW	Indicates that both Force and Displacement readings are within defined "Weld Summary" tolerances for Force and Initial Thickness.	(ON)- Force and Initial thickness are within the window, (OFF) - Either Force or Initial Thickness is NOT within the window.	
4	CURRENT/HC REJECT	Indicates REJECT occurred due to any one of these toleranced parameters: Current (RMS or Peak), Half Cycle count, Conduction Angle	Level (ON) - following a REJECTED weld due to Current (RMS or Peak), Half Cycle Count or Conduction Angle.	
5	VOLTAGE REJECT	Indicates REJECT occurred due to any one of these toleranced parameters: Voltage (RMS or Peak), Resistance, Energy	Level (ON) - following a REJECTED weld due to Voltage (RMS or Peak), Resistance or Energy.	
6	FORCE REJECT	Indicates REJECT occurred due to any one of these toleranced parameters: Force	Level (ON) - following a REJECTED weld due to Force. Note: Not an indicator for "window" bit status.	
7	DISPLACEMENT REJECT	Indicates REJECT occurred due to any one of these toleranced parameters: Initial Thickness, Final Thickness, Setdown, Expansion	Level (ON) - following a REJECTED weld due to Initial Thickness, Final thickness, Setdown, or Expansion. Note: Not an indicator for "window" bit status.	

I/O Block – N1 Pod - Discrete Inputs and Outputs

**N1 POD STAND ALONE - DEVICENET I/O BLOCK USAGE**
INPUTS	**NAME**	**GENERAL DESCRIPTION**	**ACC/REJ, AR_WINDOW MODE**	**BUSY/STAT, BS_WINDOW MODE**	**STACK LIGHT MODE**
0	BINARY SELECT 1	Used to select different tolerance limits (up to 31) for Force and Displacement (Initial Thickness). A binary select value of 0 is invalid.	SAME FOR ALL MODES (see chart for selecting masters)		
1	BINARY SELECT 2				
2	BINARY SELECT 4				
3	BINARY SELECT 8				
4	BINARY SELECT 16				
5	UNUSED				
6	ZERO DISPLACEMENT	Used to reset the "zero" reference for the displacement sensor (if used).	Zeroing occurs following an OFF to ON transition OR an ON to OFF transition IF the Pod is NOT already in the process of zeroing in which case the transition is IGNORED. This input is intended to work with a pulsed signal, which should be shorter in duration than the zeroing process (1 to 2 seconds). Recommended pulse time is from 100ms to 500ms. A PLC could also be programmed to turn ON the ZERO DISPLACEMENT bit until the BUSY output turns ON (indicating that the POD is in the process of zeroing) and then turn OFF the ZERO DISPLACEMENT bit.		
7	RESET STAT	Clears the ACCEPT and REJECT outputs.	A reset occurs following an OFF to ON transition.		
OUTPUTS	**NAME**	**GENERAL DESCRIPTION**	**ACC/REJ, AR_WINDOW MODES**	**BUSY/STAT, BS_WINDOW MODES**	**STACK LIGHT MODE**
0	ACCEPT*	Indicates that both Force and Displacement have entered the WINDOW (see WINDOW bit below).	Pulse (OFF-ON-OFF)- 125ms pulse following the transition into the WINDOW (WINDOW bit OFF to ON).	Latched level (ON)- following the transition into the WINDOW. Unlatched (OFF) using the RESET input.	(ON) - when WINDOW bit is ON. (OFF) - when WINDOW bit is OFF
1	REJECT*	Indicates that either Force or Displacement has left the WINDOW (see WINDOW bit below).	Pulse (OFF-ON-OFF)- 125ms following the transition out of the WINDOW (WINDOW bit ON to OFF).	Latched level (ON) following the transition out of the WINDOW. Unlatched (OFF) using the RESET input.	(ON) - when WINDOW bit is OFF. (OFF) - when WINDOW bit is ON
2	BUSY	Indicates that Pod is BUSY and unable to monitor welds. Indicates that displacement "zeroing" is in progress	Level (ON) energized when POD is busy, including zeroing. (OFF) when pod is no longer BUSY.		
3	WINDOW*	Indicates that both Force and Displacement readings are within defined "Weld Summary" tolerances for Force and Initial Thickness.	(ON)- Force and Initial thickness are within the window, (OFF) – If either Force or Initial Thickness is NOT within the window.		
4	FORCE HI	Indicates that the Force reading is higher than the upper tolerance limit for Force.	(ON) - Force is hi, (OFF) - Force is NOT hi.		
5	FORCE LO	Indicates that the Force reading is lower than the lower tolerance limit for Force.	(ON) - Force is lo, (OFF) - Force is NOT lo.		
6	DISPLACEMENT HI	Indicates that the displacement reading is higher than the upper tolerance limit for Initial Thickness.	(ON) - Initial Thickness is hi, (OFF) - Initial Thickness is NOT hi.		
7	DISPLACEMENT LO	Indicates that the displacement reading is lower than the lower tolerance limit for Initial Thickness.	(ON) - Initial Thickness is lo, (OFF) - Initial Thickness is NOT lo.		

Note: When a binary select is selected that has no defined tolerances, the WINDOW bit is turned OFF and all HI/LO bits are turned ON and the ACCEPT and REJECT bits do not update(except ofr STACKLIGHT mode). When a binary select is selected with defined tolerances, the ACCEPT and REJECT bits will update as the WINDOW status changes. Changing from any binary select to a binary select with defined tolerances will also update the ACCEPT and REJECT outputs.

Chart for Selecting Masters

	Binary Select 16 (Bit 4)	Binary Select 8 (Bit 3)	Binary Select 4 (Bit 2)	Binary Select 2 (Bit 1)	Binary Select 1 (Bit 0)	Master selected
1 - input is ON 0 - input is OFF	0	0	0	0	0	NONE
	0	0	0	0	1	1
	0	0	0	1	0	2
	0	0	0	1	1	3
	0	0	1	0	0	4
	0	0	1	0	1	5
	0	0	1	1	0	6
	0	0	1	1	1	7
	0	1	0	0	0	8
	0	1	0	0	1	9
	0	1	0	1	0	10
	0	1	0	1	1	11
	0	1	1	0	0	12
	0	1	1	0	1	13
	0	1	1	1	0	14
	0	1	1	1	1	15
	1	0	0	0	0	16
	1	0	0	0	1	17
	1	0	0	1	0	18
	1	0	0	1	1	19
	1	0	1	0	0	20
	1	0	1	0	1	21
	1	0	1	1	0	22
	1	0	1	1	1	23
	1	1	0	0	0	24
	1	1	0	0	1	25
	1	1	0	1	0	26
	1	1	0	1	1	27
	1	1	1	0	0	28
	1	1	1	0	1	29
	1	1	1	1	0	30
	1	1	1	1	1	31

Common Uses of RWMA Material

Electrode Material	Properties	Material To Be Welded
Class 1 High Conductivity Soft	High current and heat conduction	Electrodes for welding aluminum alloys, magnesium alloys, coated materials, brass and bronzes. Can be used for both spot and seam welding.
Class 2 Medium Conductivity Medium Hard	Improved strength and good electrical and thermal properties	They are used for the spot and seam welding of cold and hot rolled steel, stainless steel and low conductivity brass and bronze. They are also used as flash welding dies and as electrodes for the welding of galvanized steel and other coated materials.
Class 3 Low Conductivity Very Hard	High heat and pressure resistance	Electrodes for the spot and seam welding of high resistance materials such as stainless steel, nichrome and monel metal. As a casting, they are used for flash, butt and projection welding electrodes and fixtures. They can also be used for seam welder bearings and other current carrying structural parts.
Class 20 Medium Conductivity Medium Hard	Good electrical and thermal properties with heat and temperature resistance	Welding of metallic coated metal such as galvanized steel, terne plate, mild steel, low alloy steel, etc.
Class 10-14 Low Conductivity High Hardness	High heat, high pressure and mechanical wear resistance	They are used for welding highly conductive materials like copper or silvers, projection welding, cross-wire welding, electro-forming, electroforging and upsetting. Also used for low conductors like stainless where high pressures are needed.

Figure **11-8** Common Uses of RWMA Material (reprinted with permission)

Warranty & Repair Policy

Livingston & Company, Inc. shall herein be referred to as the "Company" and any customer Purchasing goods or services from the Company shall herein be referred to as Purchaser. In the case that the Purchaser and the Warrantee are not the same entity, for purposes of the following warranty provisions, they shall be referred to collectively as the "Customer".

LIMITED WARRANTY

Any Company manufactured product which, under normal operating conditions, proves defective in material or in workmanship within one (1) year from the date of shipment by the Company, will be repaired or replaced at the discretion of the Company free of charge, as per the conditions set forth in Obtaining Service Under Warranty, provided that the "Customer" a) provides written notice to the Company of such defect within fourteen (14) days of Customer's discovery of such defect, and b) establishes that the product has been properly installed, maintained, and operated within the rated limits of normal usage.

> Repaired or replaced parts: the warranty is effective ninety (90) days from date of shipment by the Company, or the remainder of the original warranty, whichever is longer.

THIS WARRANTY SET FORTH HEREIN IS THE CUSTOMER'S SOLE AND EXCLUSIVE REMEDY, AND WILL STATISFY ALL OBLIGATIONS OF THE COMPANY, WHETHER BASED ON CONTRACT, STRICT LIABILITY, TORT (INCLUDING NEGLIGENCE), OR OTHERWISE. IN NO EVENT SHALL THE COMPANY BE LIABLE FOR ANY CONSEQUENTIAL, INDIRECT, SPECIAL, INCIDENTAL, EXEMPLARY OR PUNITIVE DAMAGES, INCLUDING BUT NOT LIMITED TO, ANY LOSS OF PROFITS, HARM TO BUSINESS, HARM TO REPUTATION, OR PROCUREMENT OF SUBSTITUTE GOODS OR SERVICES; LOSS OF USE OR DATA, OR BUSINESS INTERRUPTION, HOWEVER CAUSED AND ON ANY THEORY OF LIABILITY, WHETHER IN CONTRACT, STRICT LIABILTY, OR TORT (INCLUDING NEGLIGENCE) OR OTHERWISE, ARISING IN ANY WAY OUT OF THE USE OF, FAILURE OF OR DEFECT IN, MISUSE OF, OR IN CONNECTION WITH, ANY COMPANY PRODUCT, EVEN IF THE COMPANY HAS BEEN OR IS ADVISED OF THE POSSIBILITY OF SUCH DAMAGE. THIS EXPRESS WARRANTY IS MADE IN LIEU OF ANY AND ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.   ANY UNAUTHORIZED DISASSEMBLY OR ATTEMPT TO REPAIR VOIDS ANY WARRANTY.

OBTAINING SERVICE UNDER WARRANTY

Advance authorization is required prior to all returns to the Company. Before returning any product, the Customer must first contact the Customer Service Department at (802) 763-2934. A Company technician will ask for a description of the problem and try to solve it over the phone, if possible. If this is not possible, the technician will require the following information for the defective product; 1) part number; 2) serial number; 3) ship to and bill to addresses. The technician will then issue a return material authorization (RMA) number. The damaged product must be packaged in its original shipping carton, or equivalent, to ensure adequate protection. Damage sustained in transit is not covered under warranty and is the responsibility of the Customer. (It is recommended that the Customer obtain insurance to cover damage that might occur during shipping). Shipment to the Company shall be at the Customer's expense. Repaired or Replacement products shipped ground to the Customer shall be at the Company's expense. Expedited shipment of Repaired or Replacement products at the Customer's request shall be at the Customer's expense. Products should be shipped to the Customer Service Department c/o the Company, 415 Waterman Road, South Royalton, VT 05068.

The Customer must return the damaged product to the Company within 10 business days from the date of the RMA. Non-verified problems or defects may be subject to an $80.00 evaluation charge.

The Company will contact the Customer within 2 business days of receipt of the damaged product with a time estimate for repair.

All warranty repairs are performed at the Company's manufacturing facility. This warranty does not apply to on-site service or repair.

OBTAINING NON-WARRANTY SERVICE

Advance authorization is required prior to all returns to the Company. Before returning any product, the Customer must first contact the Customer Service Department at (802) 763-2934. A Company technician will ask for a description of the problem and try to solve it over the phone, if possible. If this is not possible, the technician will require the following information for the defective product; 1) part number; 2) serial number; 3) ship to and bill to addresses. The technician will then issue a return material authorization (RMA) number. The damaged product must be packaged in its original shipping carton, or equivalent, to ensure adequate protection. Damage sustained in transit is not covered under warranty and is the responsibility of the Customer. (It is recommended that the Customer obtain insurance to cover damage that might occur during shipping.) Shipment to the Company shall be at the Customer's expense. Repaired products shipped ground to the Customer shall be at the Customer's expense. Expedited shipment at the Customer's request shall be at the Customer's expense. Products should be shipped to the Customer Service Department c/o the Company, 415 Waterman Road, South Royalton, VT 05068.

The Company will evaluate the Product and will contact the Customer with a repair cost estimate and will require a Purchase Order for the repair from the Customer before proceeding. An initial evaluation charge of $80.00 will be assessed.

Repaired parts: the warranty is effective ninety (90) days from date of shipment by the Company.

SPECIAL CIRCUMSTANCES

The Company may ship pre-paid or COD to some Customers depending on credit status and/or location. Customers will be notified in advance of any such action.

UNCLAIMED PRODUCTS

Any unclaimed products will become the property of the Company after a period of 90 days.

LIVINGSTON & COMPANY, INC.

APPLICATION NOTE

Category: Procedure
Applies to: 2400 or POD Server
Subject: Copy weld data & create a MS Excel chart

HOW TO COPY WELD DATA FROM A 2400 OR POD SERVER & CREATE EXCEL CHARTS WITH THE COPIED WELD DATA

Objective: This procedure will first explain how to copy stored weld data from your 2400 or POD Server and then show how to use that copied data to create simple MS Excel charts and graphs. *Please note that all of the screen shots in the procedure are using MS Excel 97 with Windows NT. If you are using another system/version, the procedure may be different.*

TO COPY THE LIVCO DATABASE (USING WINDOWS 95/98/NT):

1. Make sure that the computer you are using has a network connection to the Livingston monitor (for further information, please refer to the procedure on <u>How to Establish a Network Connection</u>).

2. On your computer's desktop (or on another drive to which the collected weld data will be transferred) right-click and create a new folder named **'2400_xxxx MMDDYY'** where 'xxxx' is the four-digit serial number found on the back of the Livingston unit and MMDDYY is the current date. In the example at right, the serial number is 0172 and the date is 11-20-00. <u>Leave this window open while you proceed with the following steps.</u>
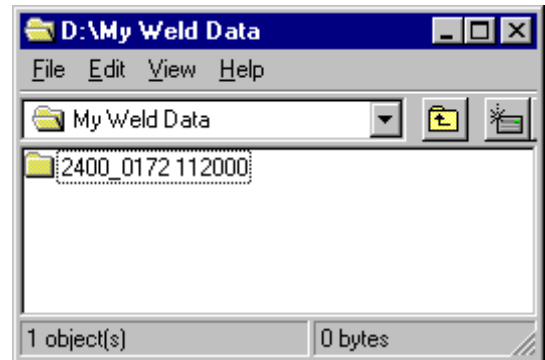
3. Go to **Start** ⇨ **<u>Find</u>** ⇨ **<u>Computer</u>**. In the 'Find: Computer' window, type in the 9-character name of the 2400/POD Server in the format '2400_xxxx' where 'xxxx' is the four-digit serial number found on the back of the Livingston unit.

    Note: If you have changed the name of your Livingston unit, type in the name that you have changed it to.
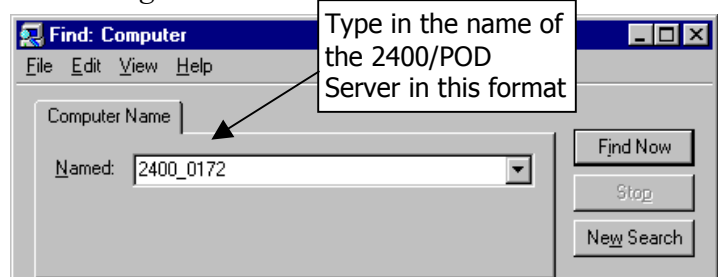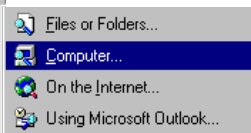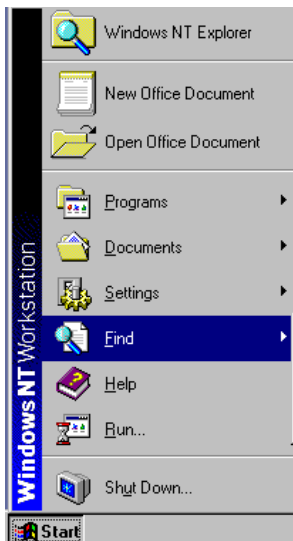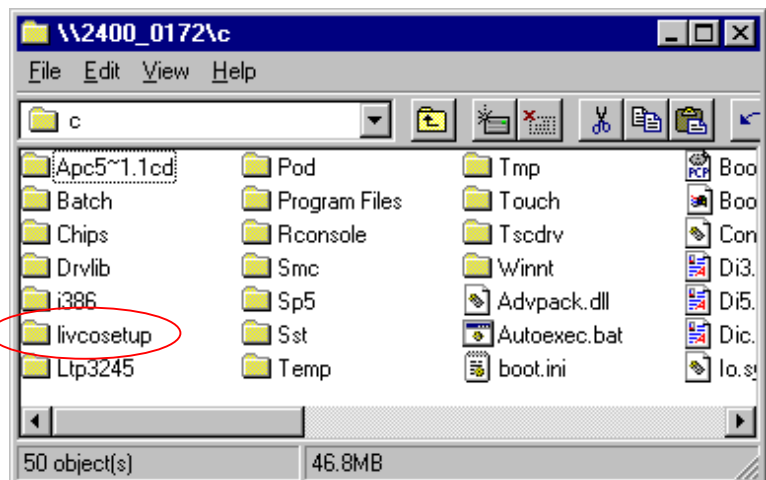
4. Once the unit is found, double-click on it to open it (this may take a minute or two). If you are using Windows NT, you may be prompted for a password. Type in **Administrator** in the 'Connect As:' box and **2400** in the 'Password:' box.
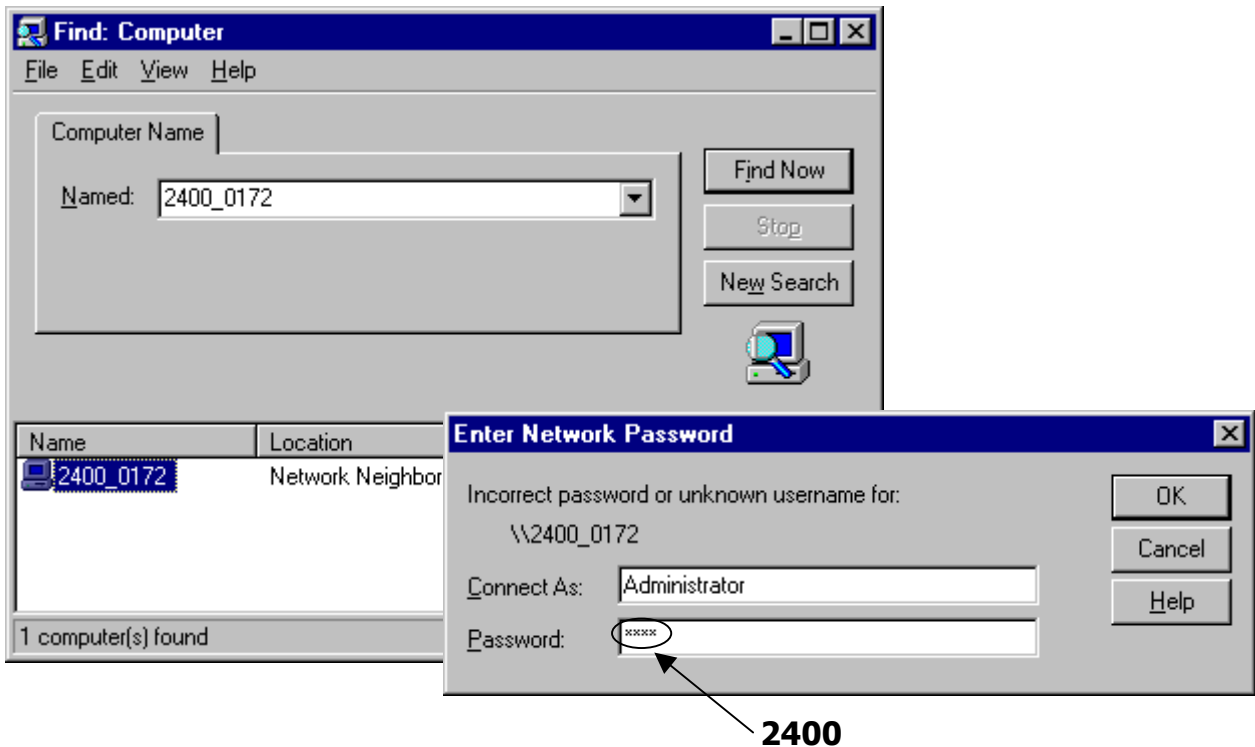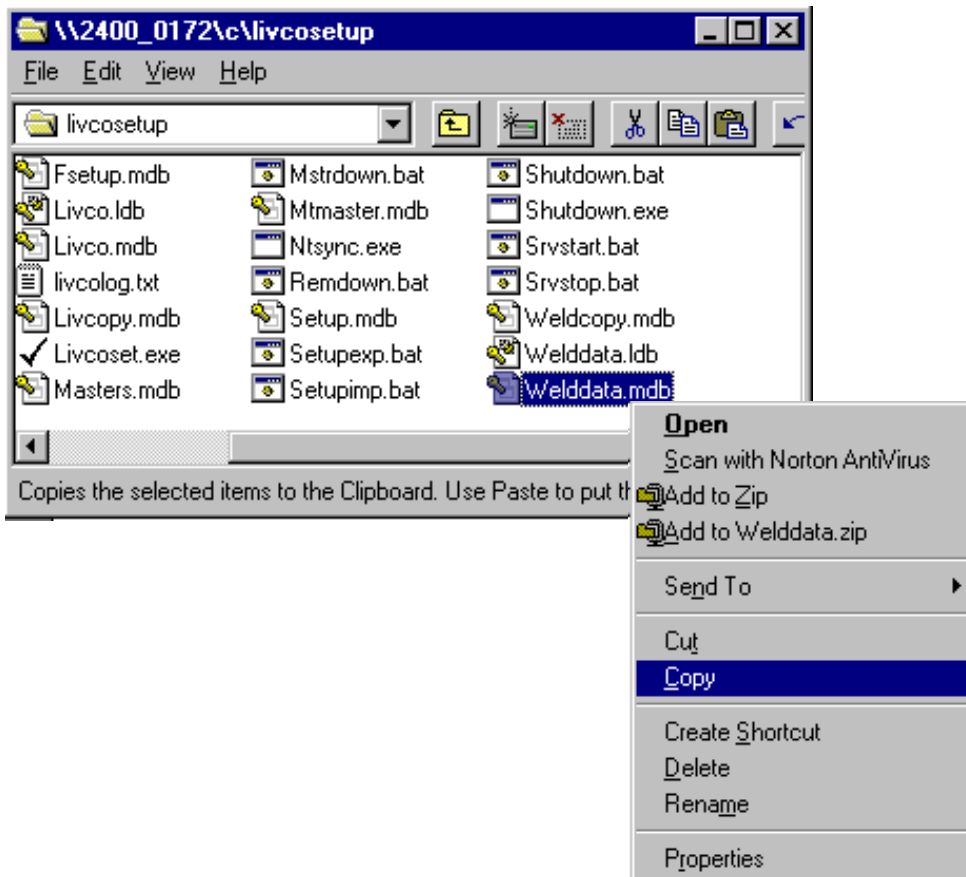

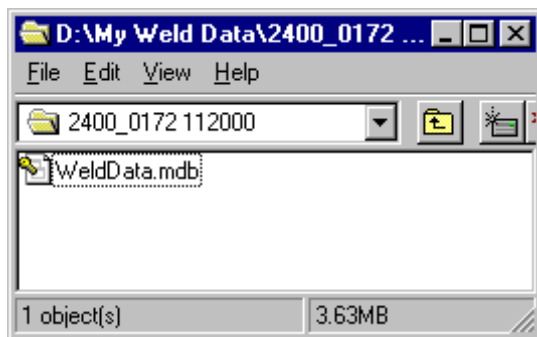5. If the unit is a 2400, open the **c** folder. If the unit is a POD Server, open the **d** folder.
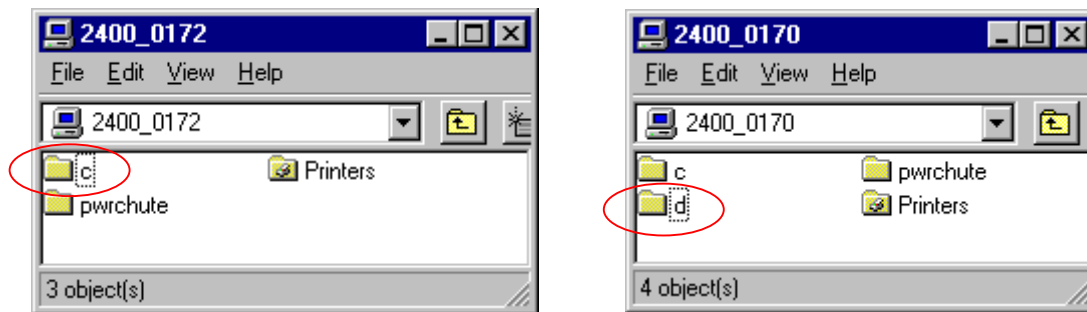
6. Open the file named **livcosetup**.

7. Right click on the file named **WeldData.mdb** ('WeldData' may or may not be capitalized) and select <u>C</u>opy.

8. Go back to the open window containing the new folder that you created named '2400_xxxx MMDDYY'. Open the folder and paste **WeldData.mdb**.

9. Return to the livcosetup window and close it. You now have a copy of the Livingston database on your computer.

TO CREATE A SIMPLE MS EXCEL CHART OR GRAPH FROM THE LIVINGSTON DATABASE:

1. Open a new spreadsheet in MS Excel.

2. Go to **Data** ⇨ **Get External Data** ⇨ **Create New Query**.
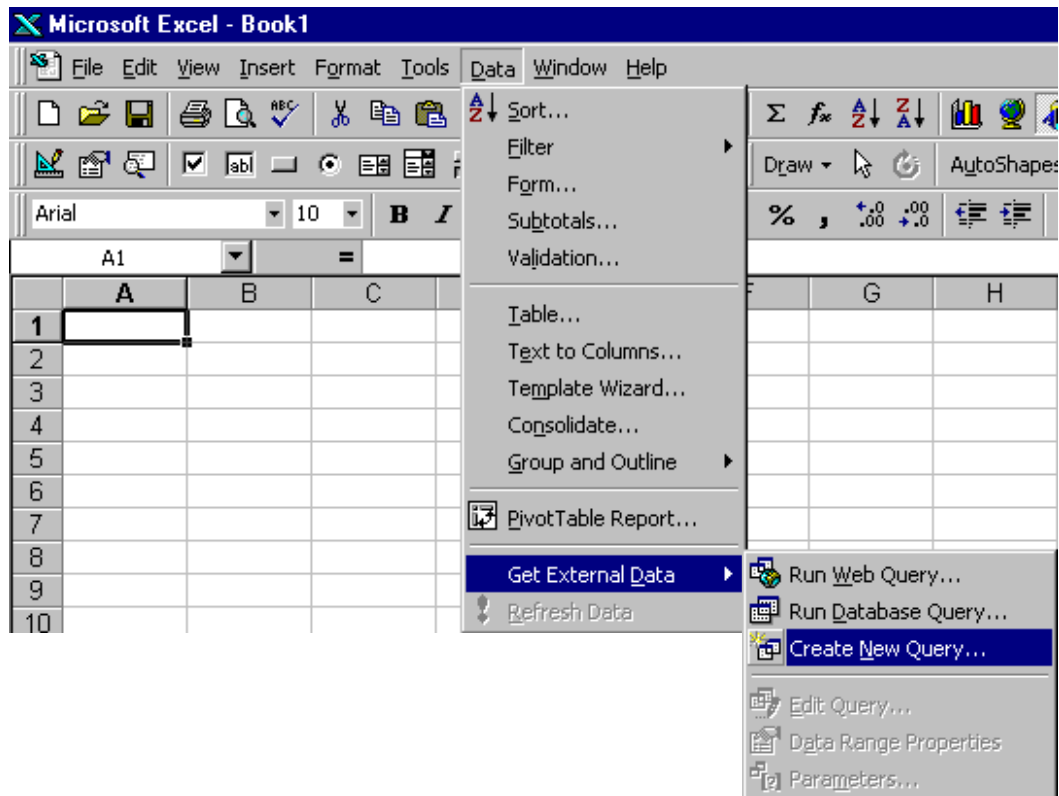
3. The 'Choose Data Source' window will appear. Under the Databases tab, <New Data Source> will be highlighted. Click **OK**.
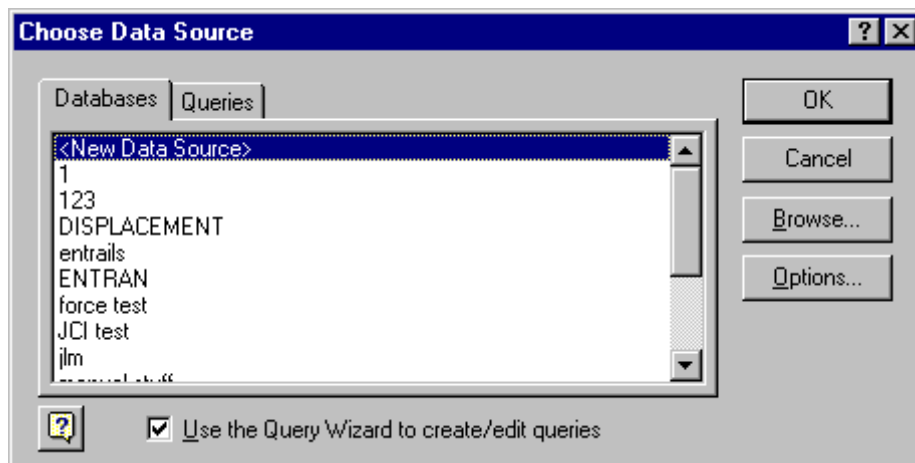
4. The 'Create New Data Source' window will appear. The first item will ask for a name. Type in whatever name you wish to call your query.

5. The second item will ask for a driver. Select **Microsoft Access Driver (*.mdb)** from the pull-down list.


6. Click **Connect**.

7. The 'ODBC Microsoft Access Setup' window will appear. Under Database, click **Select...**
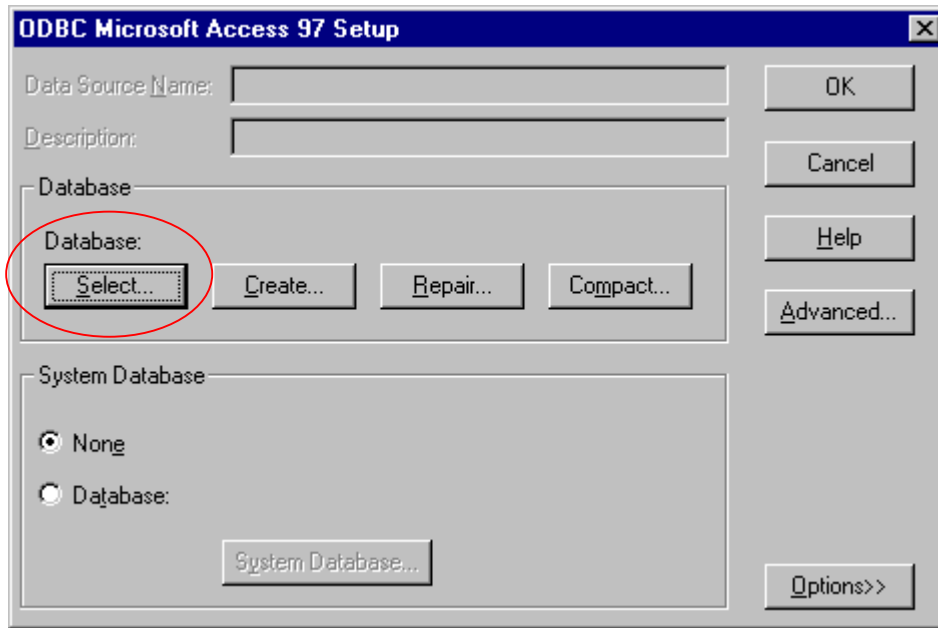
8. The 'Select Database' window will appear. On the bottom right is a window labeled Drives. Select from the pull-down list the drive on which you created the folder named '2400_xxxx MMDDYY'. (See example below).

9. In the window labeled 'Directories:', find the 2400_xxxx MMDDYY folder and double-click it to open it. The file **WeldData.mdb** should appear in the left-side window labeled Database Name. (See example below).

10. Click once on **WeldData.mdb** to highlight it and then click **OK**.
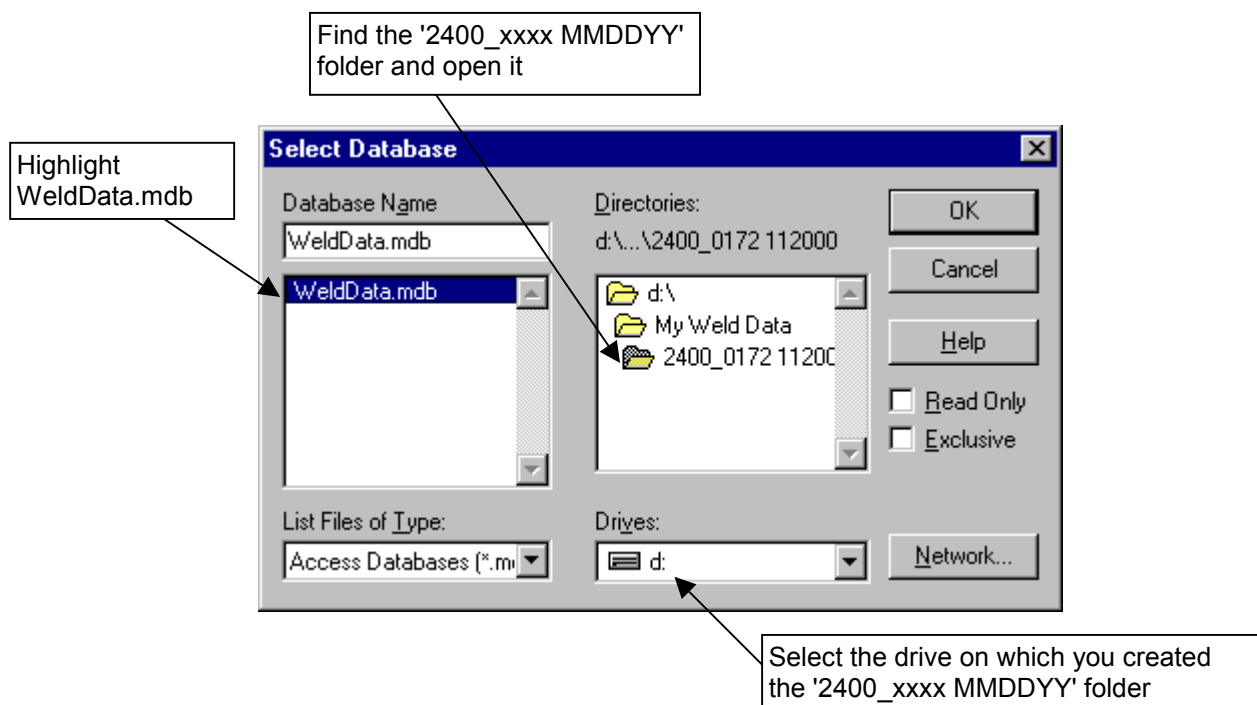
11. You will be returned to the 'ODBC Microsoft Access Setup' window. Under Database, the file path of WeldData.mdb will be displayed. Click **OK**.
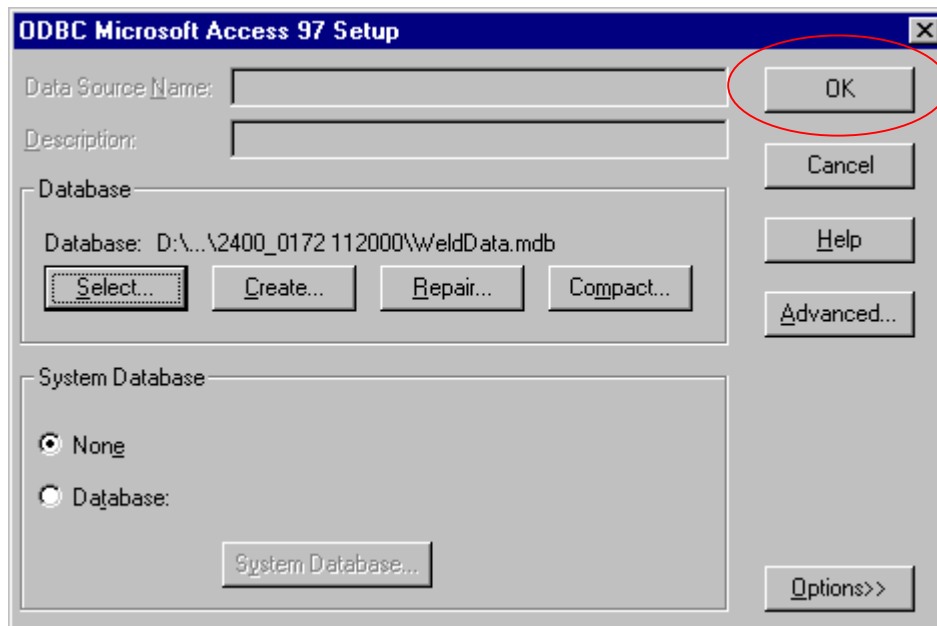

12. You will now be returned to the 'Create New Data Source' window. Leave item 4 blank and click **OK**.
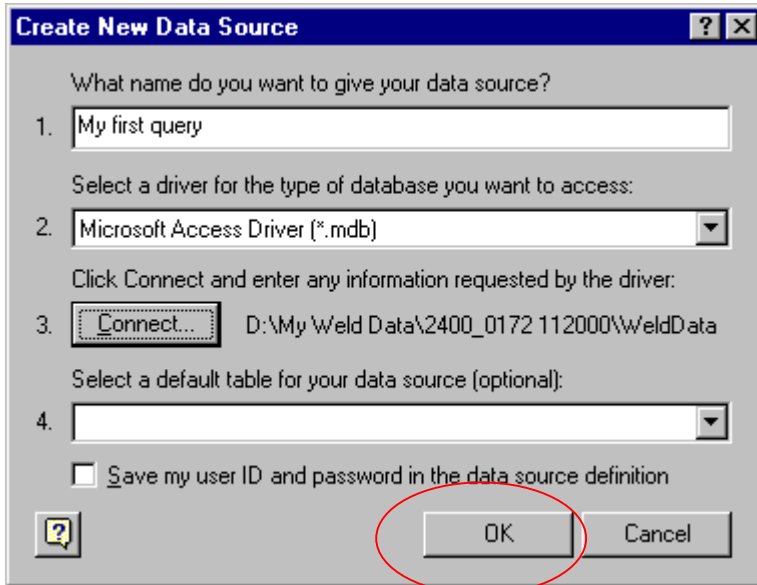
13. The 'Choose Data Source' window will reappear, with the new data source you named highlighted. Click **OK**.

14. The 'Query Wizard – Choose Columns' window will appear. Under the 'Available tables and columns:' should be **posteddata**, with a small checkbox next to it. Click the '>' button between the two windows. This will transfer the contents of posteddata into the 'Columns in your query:' window. Click **Next >.**
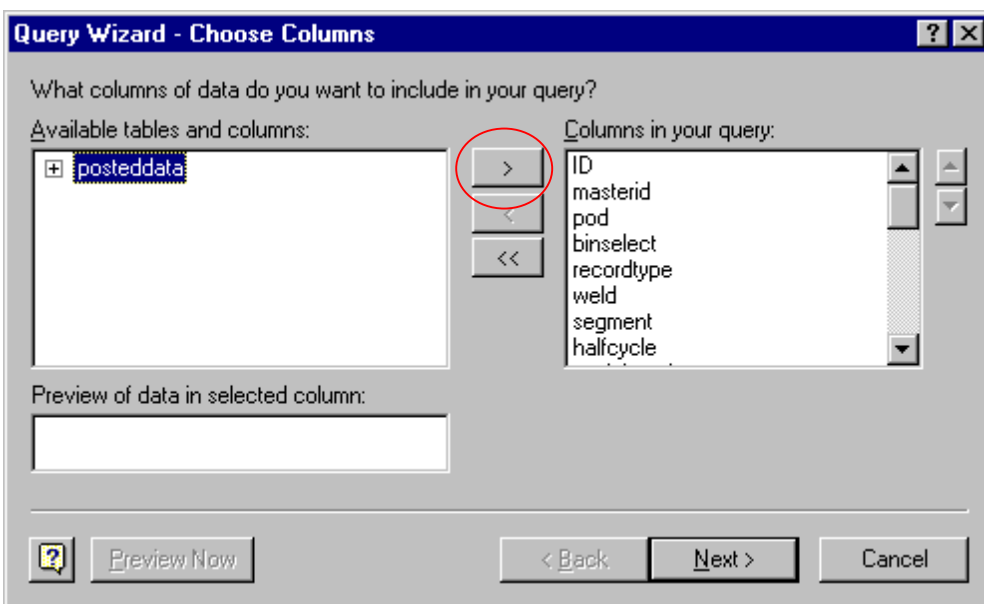
15. The 'Query Wizard – Filter Data' window will appear. This window allows you to filter or sort the weld data in a number of different ways.

    Note: In this procedure, we'll use the pod*,* recordtype *and* weld *fields as examples. Once you are familiar with this process, you can filter the data however you like.*

    Click once on **pod** to highlight it in the 'Column to filter:' window. It will appear above the 'Only include rows where:' windows. If you are using a 2400, use the first pull-down list to select **equals**. In the second window, type **60**. If you are using a POD Server with a number of PODs, type the POD ID number whose data you wish to look at into the second window.
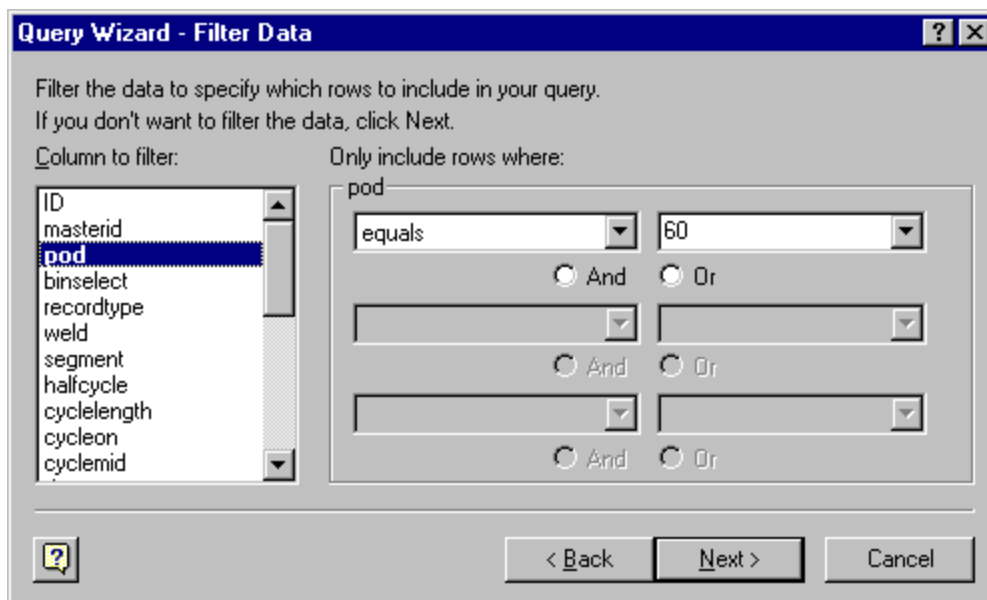
16. Go back to the 'Column to filter:' window and click once on **recordtype** to highlight it. (Once you have clicked another field, the 'pod' field will appear in bold). It will appear in the first of the 'Only include rows where:' windows. Use the first pull-down list to select **equals**. In the second window, type **2**.

    Note: Recordtype '2' is a weld summary. '0' is a Halfcycle summary; '1' is a Segment summary. See Chapter 6 in the User's Manual for further information.

17. Go back to the 'Column to filter:' window and click once on **weld** to highlight it. It will appear under the 'Only include rows where:' windows. Use the first pull-down list to select is **greater than or equal to**. In the second window, type **0**.

    Note: DO NOT use the pull-down list in the second window. The reason for this is that you will have to wait for the entire database to be searched. For example, if you have 8000 welds, you will have to wait for the system to find all 8000 weld records and display them in the pull-down box. It is much faster and easier to simply type in a number in this window for this particular field.

> Don't press this pull-down arrow when filtering the weld field! Type in a number instead.

Query Wizard - Filter Data

Filter the data to specify which rows to include in your query.
If you don't want to filter the data, click Next.

Column to filter:
- ID
- masterid
- **pod**
- binselect
- **recordtype**
- weld
- segment
- halfcycle
- cyclelength
- cycleon
- cyclemid

Only include rows where:
weld
is greater than or equal to | 0

○ And ○ Or

○ And ○ Or

○ And ○ Or

< Back   Next >   Cancel

18. Click **Next >**.

19. The 'Query Wizard – Sort Order' window will appear. This allows you to sort the returned information by whichever parameter you want. We'll use **ID** as an example. Select **ID** from the pull-down list, and **Descending** (most recent welds will appear first).
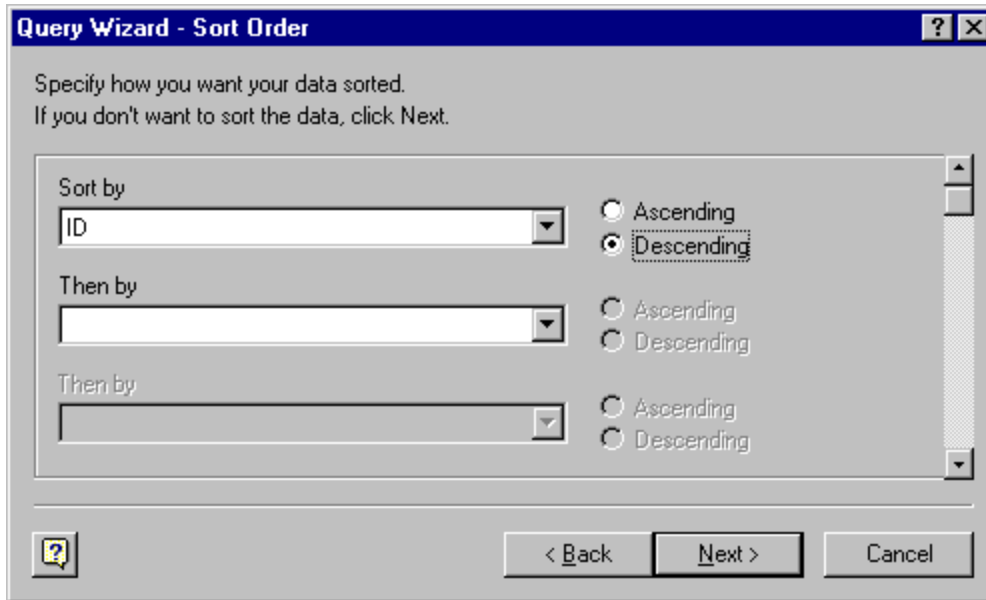
20. Click **Next >**.

21. The 'Query Wizard – Finish' window will appear. The button next to 'Return Data to Microsoft Excel' should be selected. Click **Finish**.
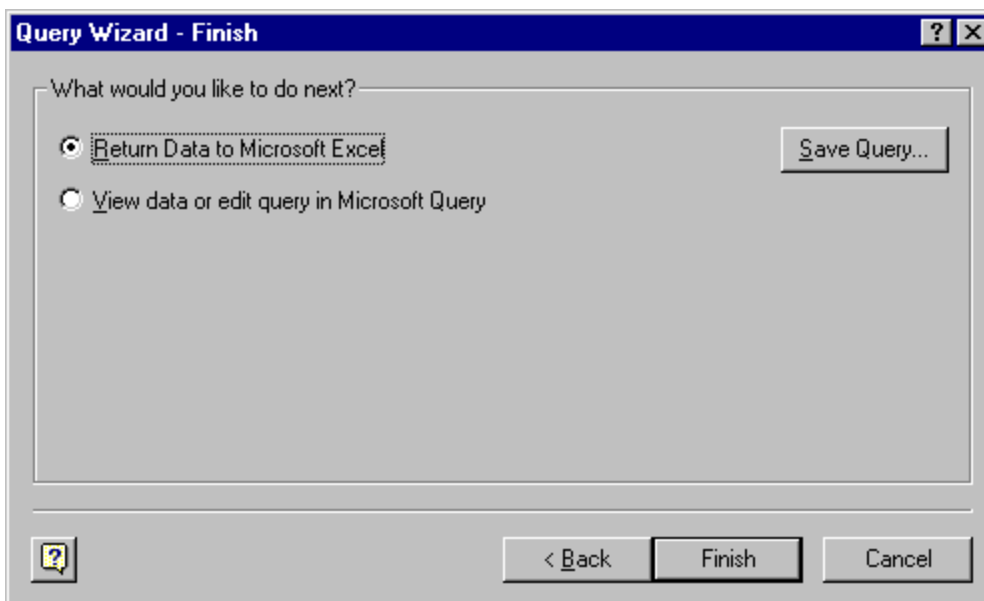
22. The 'Returning Data To Microsoft Excel' window will appear, asking where you want to put the data. Click **OK**.

   Note: This will paste the data into the uppermost left-hand corner of the spreadsheet.
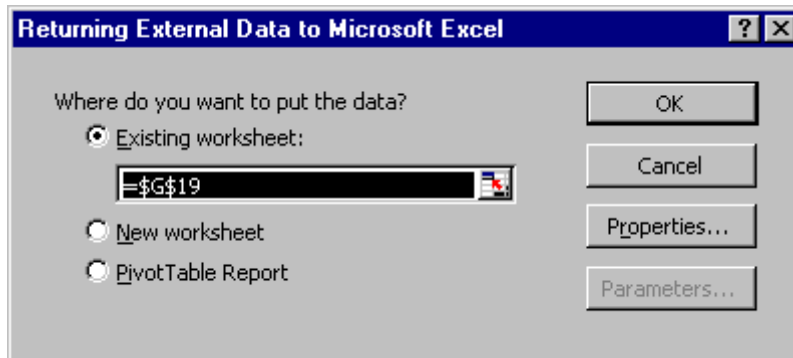
23. You should now have a spreadsheet containing weld data for the 2400 (or whichever POD ID you selected) of recordtype 2, sorted by ID. You should save this file with a name in case you want to return to it at a later date. Use **Save As…** to store this file wherever you want.

Save this workbook on your computer
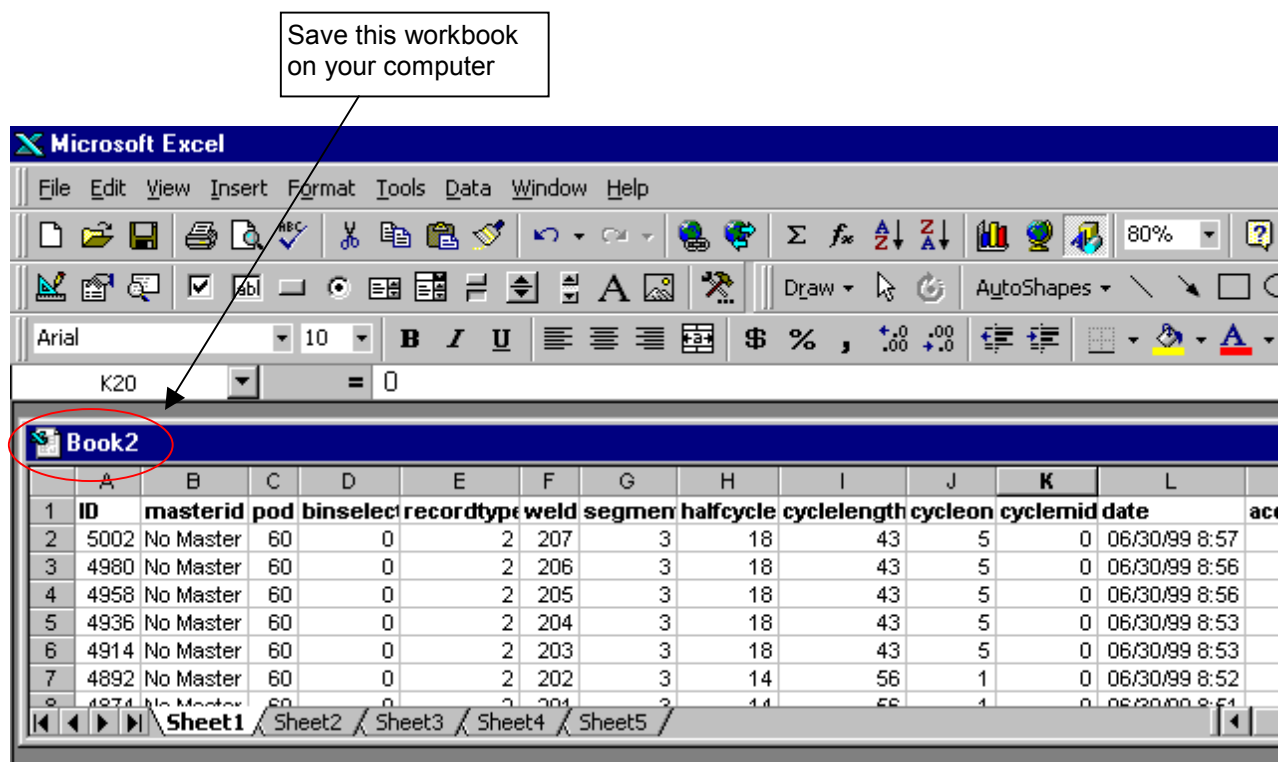
24. To keep the headers on top, click once on the **2** at the beginning of row two to highlight the entire row. On the top toolbar, under **Window**, select **Freeze Panes**. You will now be able to scroll down through the weld data while preserving the top headers.
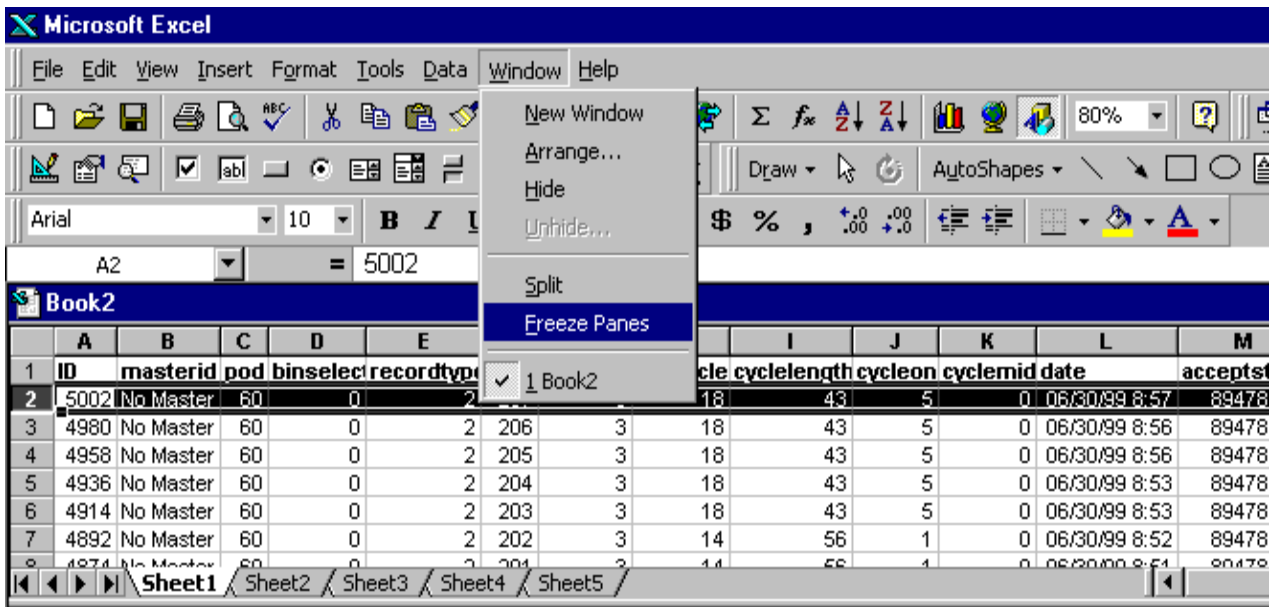
25. Let's say (for example) that you wanted to look at Current Rms plotted against Force. On your spreadsheet, click once on the column letter (in this example, it should be **N**) containing **currentrms** to highlight the entire column. While holding down the **Control** key on your keyboard, click once on the column letter (in this example, it should be **R**) containing **force** to highlight that entire column as well.
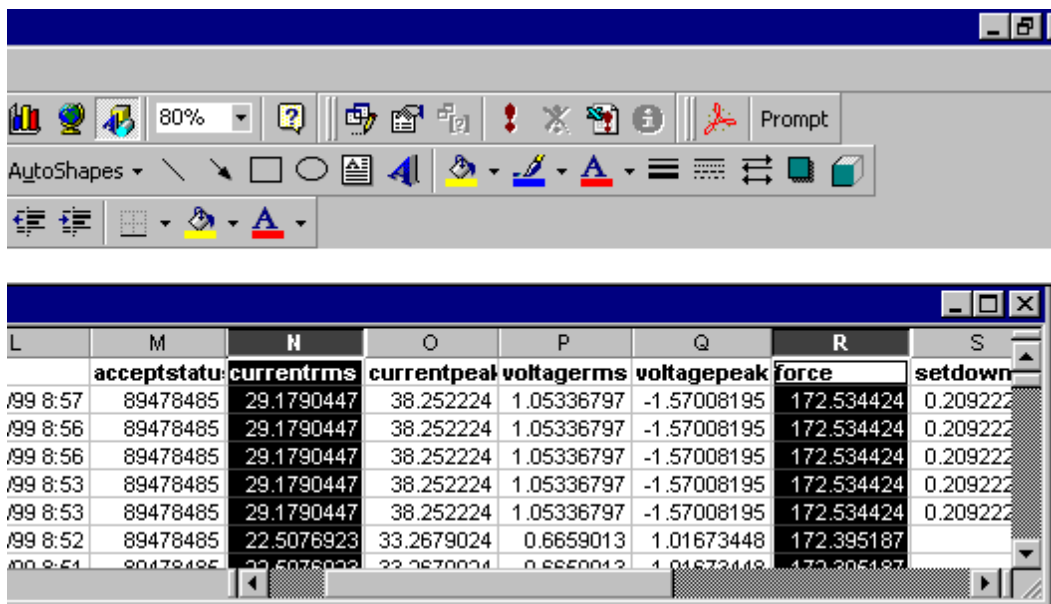
26. Go to the top toolbar under **Insert** and select **Chart** (or you can click on the chart icon in the standard toolbar).

Note: This screen shot has been cropped to show the selected columns.
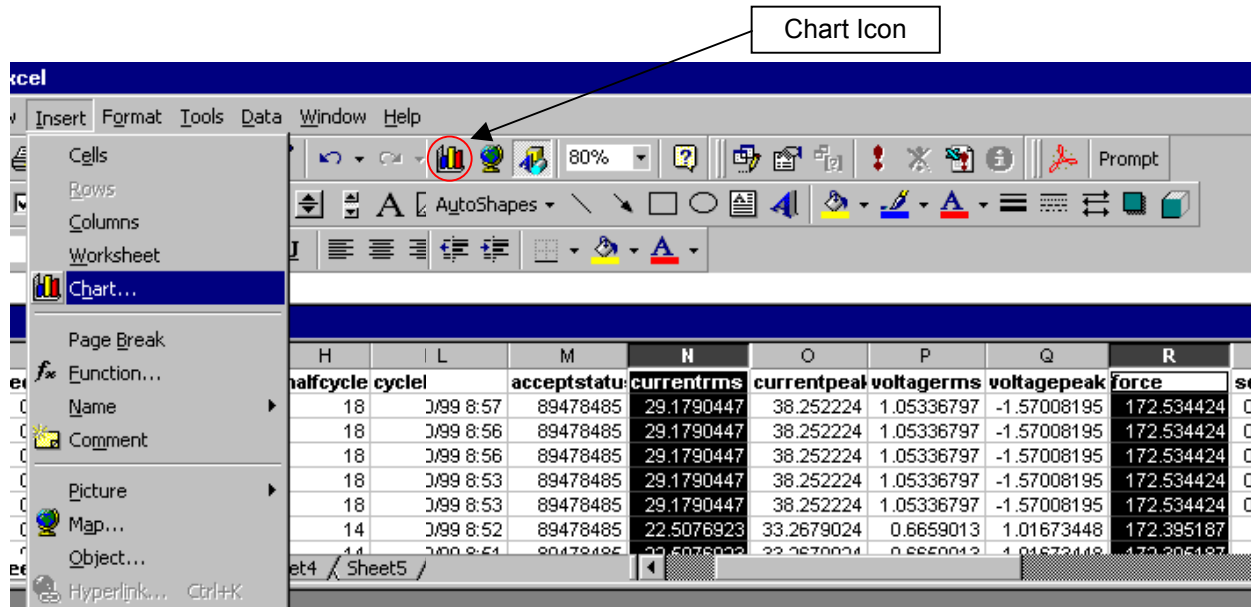
27. The 'Chart Wizard – Step 1 of 4 – Chart Type' window will appear. Under the 'Standard Types' tab, click once on **XY (Scatter)** in the 'Chart type:' window. Under 'Chart sub-type:', leave the default selection highlighted (it should be the top-most selection). Click **Finish**.
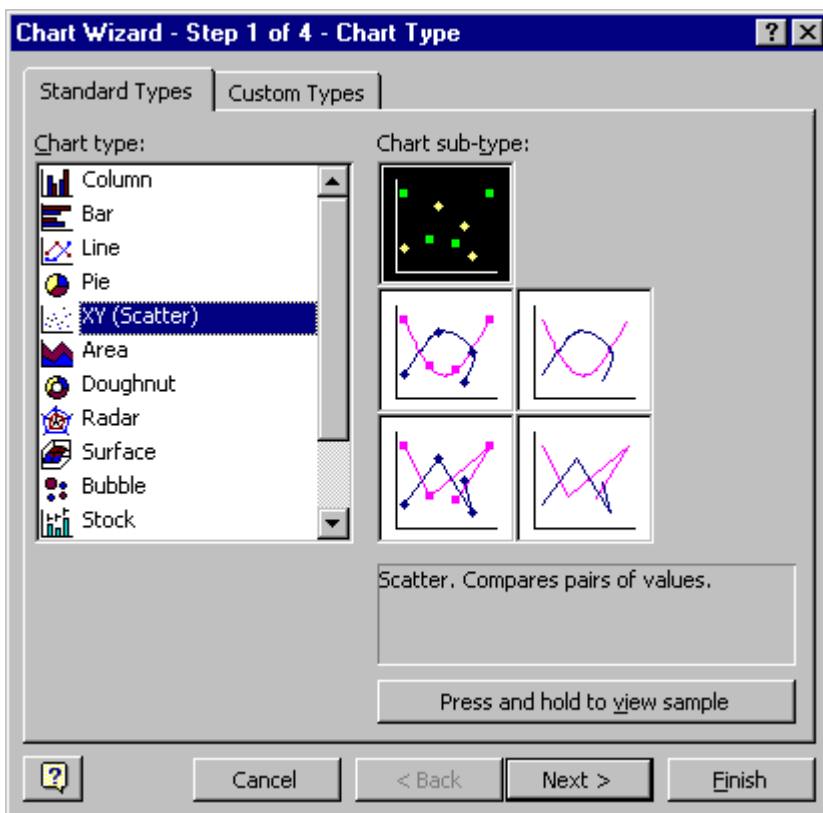
28. You will now have a chart that appears over the spreadsheet. For easier viewing, right-click on the white border of the chart and select Cut. Go to Sheet2 of the workbook and paste the chart anywhere in the sheet.

29. You can now format the chart as you like. The x-axis represents Current Rms in KA, while the y-axis represents Force in lbs. To change the title of the chart, double-click on the title box and type in the desired title. To format the legend, double-click on it and modify it as desired. The axes can also be modified by double-clicking on them. The Microsoft Help feature also contains a great deal of information about working with Charts.

END

APPLICATION NOTE

Category: DeviceNet™
Applies to: DeviceNet™, Pod™, and Pod™ Server
Subject: DeviceNet™ Polled I/O overview
Software: Guipodserver.exe (starting with v8.002)

DESCRIPTION

This document describes the DeviceNet *Polled I/O* connection between a Livingston Pod Server and a DeviceNet scanner (typically installed in a PLC). When using the *polled I/O* connection, the Pod Server is the DeviceNet *slave* and the DeviceNet scanner is the *master*. The Pod Server cannot be a *master* to any DeviceNet device other than a Pod.

POLLED I/O INTERSCAN DELAY

When configuring the *polled I/O* size and the data refresh rate (Interscan delay), please refer to these recommended settings:

BAUD RATE	BYTES Tx	BYTES Rx	SCAN	INTERSCAN DELAY
125kbd	64	64	Every Scan	80ms
250kbd	64	64	Every Scan	40ms
500kbd	64	64	Every Scan	20ms

At these settings, the *polled I/O connection* between the Pod Server and DeviceNet scanner (PLC) consumes approximately 21% of the DeviceNet network bandwidth.

DeviceNet scanner module configuration is typically done using a software programming tool such as RSNetworx for DeviceNet or SST™ DeviceNet Node Commissioning tool. Please contact Livingston for Pod and Pod Server EDS files for use with DeviceNet configuration tools.

POLLED OUTPUT FROM POD SERVER (Input to DeviceNet Scanner)

The DeviceNet scanner receives 32 words (64 bytes) from the Pod Server. Each byte represents the "status" of a single Pod. The lower byte is the status for the even-numbered Pod and the upper byte is the status for the odd-numbered Pod.

Starting with the first word for Pod 0 (lower byte) & Pod 1(upper byte), all of the bytes are consecutive Pods 0 to 63. The last word is for Pod 62 (lower byte) and Pod 63 (upper byte).

The following PLC data file shows an example of the data received by a DeviceNet scanner and the data stored starting at PLC address N163:0 :

Start of Pod Server Data Input to PLC, status Pods 0 & 1	End of Pod Server Data, status for Pods 62 & 63	Status for Pods 26 & 27

Data File N163 (hex) -- DNET_IN -- DeviceNet I/O Input

Offset	0	1	2	3	4	5	6	7	8	9
N163:0	404	404	404	404	404	404	404	20	0	0
N163:10	20	404	404	404	404	404	404	404	404	404
N163:20	404	404	404	404	404	404	404	404	404	404
N163:30	404	404	0	0	0	0	0	0	0	0

N163:13

Symbol: POD_26_27

Desc:

N163

Radix: Hex/BCD

Columns: 10

Properties   Usage   Help
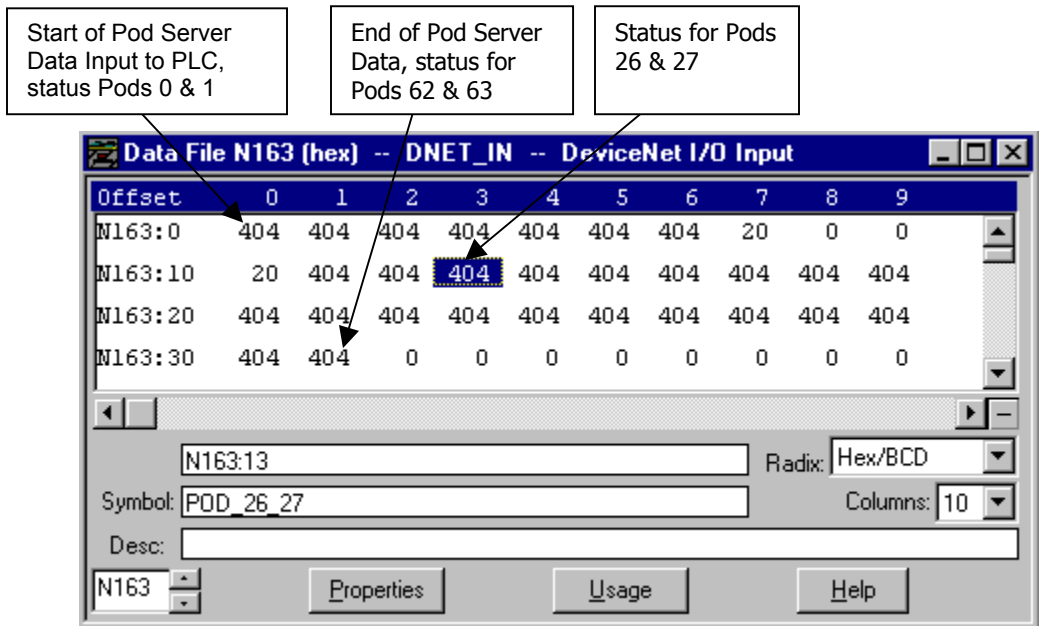
POLLED OUTPUT FROM POD SERVER (P1 AND P3 PODS)

Refer to the following table for the bits in each status byte:

POD	BIT	DESCRIPTION
Lower byte: Even number POD	0	ACCEPT
	1	REJECT
	2	BUSY (not ready to monitor welds)
	3	WINDOW
	4	WELD COUNT (Bit 0)
	5	WELD COUNT (Bit 1)
	6	WELD COUNT (Bit 2)
	7	WELD COUNT (Bit 3)
Upper byte: Odd number POD	8	ACCEPT
	9	REJECT
	10	BUSY (not ready to monitor welds)
	11	WINDOW
	12	WELD COUNT (Bit 0)
	13	WELD COUNT (Bit 1)
	14	WELD COUNT (Bit 2)
	15	WELD COUNT (Bit 3)

ACCEPT / REJECT: Accept and Reject bits will be set immediately after the Pod weld monitor has determined the status of a weld. These bits hold state between welds. Both bits are 0 or OFF during the weld since the status is unkown (weld is neither rejected or accepted until weld is completed). It is not recommended that a "new weld" be detected using this "OFF pulse" since this pulse may be absorbed between polled updates. Instead, the weld count (4 bits) should be used to determine a "new weld" event.

The Pod determines weld status following the POST segment time. POST is the period of time that the weld is monitored after weld current has ended. This POST monitoring is intended to provide more accurate displacement (setdown and final thickness) readings since a weld is usually still molten during the first part of the *cool* period.   Force and displacement are sometimes toleranced during this POST period to ensure that the electrodes are holding the welded area together until the weld has sufficiently cooled. Increasing the POST and POST DELAY settings will increase the time it takes to determine the weld status. Refer to Livingston's User manual for more information on POST and POST DELAY settings.

NOTE: There is a delay from the time when the Pod determines weld status until a PLC (with scanner) actually sees the updated Accept/Reject. This latency is mostly due to DeviceNet baud rate, Polled I/O Interscan delay, Pod Server computer specifications, etc. Configuring DeviceNet at the highest possible baud rate and using the shortest recommended Interscan delay will help minimize the delay.

BUSY: This bit will be 1 or ON when the Pod monitor is busy and unable to monitor welds. Typically a Pod will be busy during configuration, firmware update and displacement sensor zeroing.

WINDOW: This bit indicates whether or not both of the Force and Displacement readings are currently within the "weld summary" tolerance limits for Force and Initial Thickness. If both readings are within the tolerance limits then the bit is 1 or ON. If either reading is outside of the tolerance limits then the bit is 0 or OFF. Different tolerance sets (masters) may be selected using the binary select

inputs. *Note: This bit is OFF when a binary select is selected that has no defined tolerances. This includes out of range binary select values of 0 and greater than 31.*

WELD COUNT: The weld count sent from the Pod Server is the least significant 4 bits from the Pod's real-time weld count (32-bit). This weld count increments with each *new weld* that the Pod detects. A Pod only detects a new weld when weld current is detected by the toroid coil. If there is NO weld current then the Pod will NOT detect a weld. A PLC can be programmed to monitor this weld count in order to determine when the Pod has detected a *new weld* and also determine whether or not current was actually passed by the weld timer.

The following PLC data file shows an example of the data received by a DeviceNet scanner and the data stored starting at PLC address N163:0 :

POLLED OUTPUT FROM POD SERVER (N1 PODS)

Refer to the following table for the bits in each status byte:

POD	BIT	DESCRIPTION
Lower byte: Even number POD	0	Not used - diagnostic
	1	Not used - diagnostic
	2	BUSY (not ready to monitor welds)
	3	WINDOW
	4	FORCE HI
	5	FORCE LO
	6	DISPLACEMENT HI
	7	DISPLACEMENT LO
Upper byte: Odd number POD	8	Not used - diagnostic
	9	Not used - diagnostic
	10	BUSY (not ready to monitor welds)
	11	WINDOW
	12	FORCE HI
	13	FORCE LO
	14	DISPLACEMENT HI
	15	DISPLACEMENT LO

BUSY: This bit will be 1 or ON when the Pod monitor is busy and unable to monitor welds. Typically a Pod will be busy during configuration, firmware update and displacement sensor zeroing.

WINDOW: This bit indicates whether or not both of the Force and Displacement readings are currently within the "weld summary" tolerance limits for Force and Initial Thickness. If both readings are within the tolerance limits then the bit is 1 or ON indicating an "in the window" status. If either reading is outside of the tolerance limits then the bit is 0 or OFF indicating an "out of window" status.. Different tolerance sets (masters) may be selected using the binary select inputs.

FORCE HI: This bit Indicates that the Force reading is higher than the upper tolerance limit for Force.

FORCE LO: This bit Indicates that the Force reading is lower than the lower tolerance limit for Force.

DISPLACEMENT HI: This bit indicates that the displacement reading is higher than the upper tolerance limit for Initial Thickness.

DISPLACEMENT LO: This bit indicates that the displacement reading is lower than the lower tolerance limit for Initial Thickness.

Note: The WINDOW bit is turned OFF and all HI/LO bits are turned ON when a binary select is selected that has no defined master tolerances. This includes out of range binary select values of 0 and greater than 31.

The following PLC data file shows an example of the data received by a DeviceNet scanner and the data stored starting at PLC address N163:0 :

POLLED INPUT TO POD SERVER (Output from the DeviceNet Scanner)

The DeviceNet scanner sends 32 words (64 bytes) to the Pod Server. Each byte represents the *binary select* and *zero displacement* (command) for a single Pod. The lower byte is for the even-numbered Pod and the upper byte is for the odd-numbered Pod.

Starting with the first word for Pod 0 (lower byte) & Pod 1 (upper byte), all of the bytes are consecutive Pods 0 to 63. The last word is for Pod 62 (lower byte) and Pod 63 (upper byte).

The following PLC data file shows an example of the data received by a DeviceNet scanner and the data stored starting at PLC address N162:0 :

Start of Polled data to Pod™ Server, for Pods 0 & 1

End of Polled data, for Pods 62 & 63

Polled data for Pods 26 & 27

Binary select and Zero Displacement for Pod 27

Binary select and Zero Displacement for Pod 26
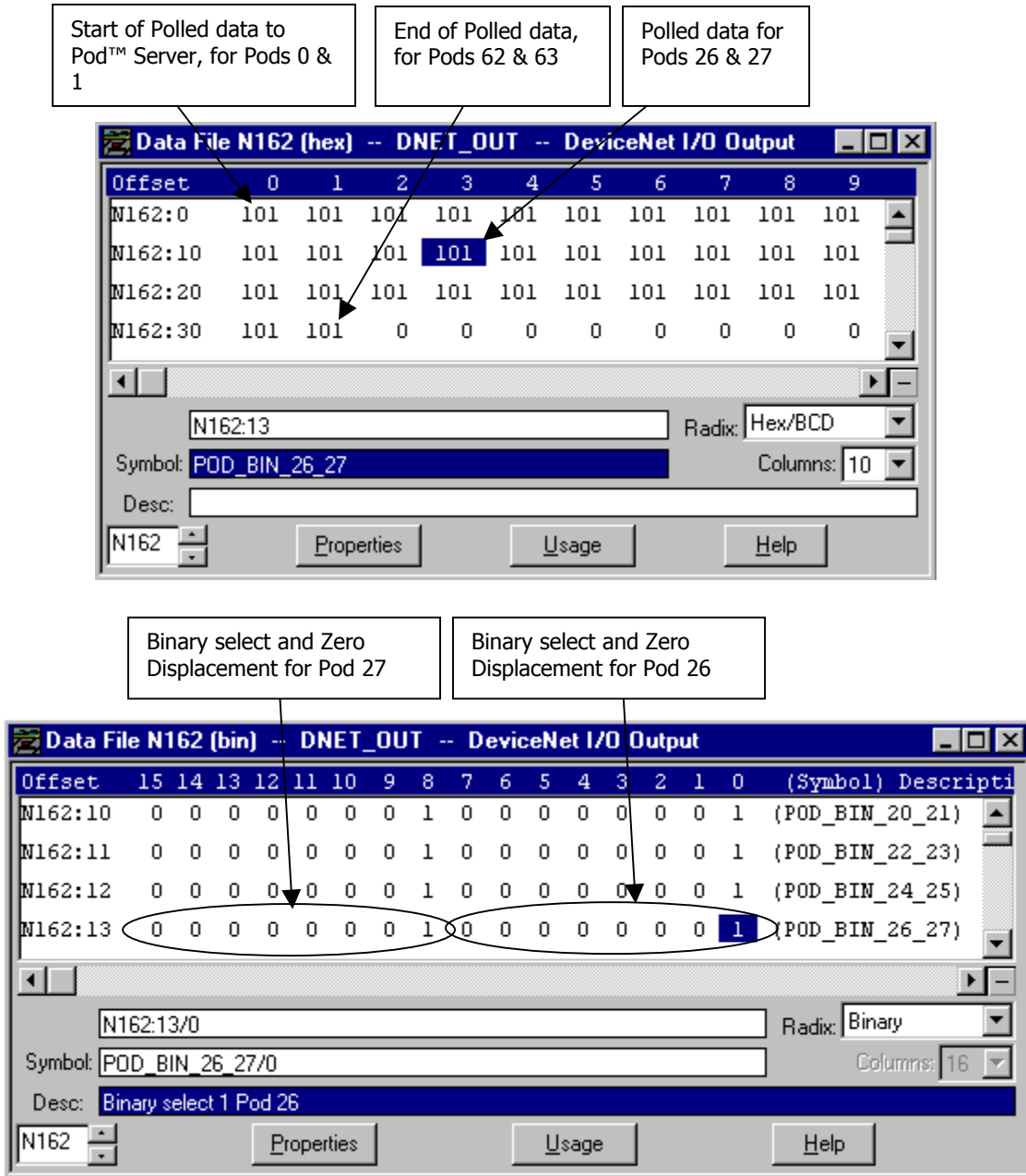
POLLED INPUT TO POD SERVER (P1 AND P3 PODS)

Refer to the following table for the bits in each byte:

POD	BIT	DESCRIPTION
Lower byte: Even number POD	0	Binary Select (Bit 0)
	1	Binary Select (Bit 1)
	2	Binary Select (Bit 2)
	3	Binary Select (Bit 3)
	4	Binary Select (Bit 4)
	5	Reserved for future use
	6	Zero Displacement
	7	Reserved for future use
Upper byte: Odd number POD	8	Binary Select (Bit 0)
	9	Binary Select (Bit 1)
	10	Binary Select (Bit 2)
	11	Binary Select (Bit 3)
	12	Binary Select (Bit 4)
	13	Reserved for future use
	14	Zero Displacement
	15	Reserved for future use

BINARY SELECT: The binary select value must be between 1 and 31, all other values are invalid and will be ingnored. The binary select value is used to select different weld *masters* within the Pod and must be set prior to initiating weld current.

Depending on system configuration (PLC scan time, polled Interscan delay, DeviceNet baud rate, etc.) the delay between setting the *binary select* at the PLC and the Pod receiving the binary select is typically from 30 ms to 100ms. Weld timer *squeeze time* is usually enough time to absorb this latency.

NOTE: Changing a *binary select* value will **NOT** cause the Pod to trigger ! The Pod will ONLY trigger when there is detection of weld current (toroid coil).

The *binary select* can be set ahead of time, in anticipation of a weld. This is recommended since it will avoid the most common timing problems.

The Pod latches the *binary select* and increments the weld count when weld current is detected. A PLC can be programmed to monitor the real-time weld count (least significant 4 bits) for a Pod (sent to the DeviceNet scanner by the Pod Server) in order to detect a *new weld*. The *binary select* for the next weld can be set as soon as this *new weld* is detected.

ZERO DISPLACEMENT: Bit used to reset the "zero" reference for the Pod's displacement sensor. Zeroing occurs following an OFF to ON bit transition if the Pod is not already in the process of zeroing displacement. This input can be used with a "pulse" signal (recommended minimum pulse of 100ms) where the normal bit state is OFF.   Another option is to turn ON the ZERO DISPLACEMENT input bit until the BUSY output bit turns ON (indicating that the POD is in the process of zeroing) and then turn OFF the ZERO DISPLACEMENT input bit.

NOTE: It is important that the position being monitored by the displacement sensor does not change during the zeroing process (takes 2 to 10 seconds). The Pod's BUSY bit (polled output from Pod Server) will turn ON during the zeroing process and turn OFF once zeroing has completed.

Please refer to the Livingston User's Manual for *THE POD™* for additional information about displacement sensor usage.

POLLED INPUT TO POD SERVER (N1 PODS)

Refer to the following table for the bits in each byte:

POD	BIT	DESCRIPTION
Lower byte: Even number POD	0	Binary Select (Bit 0)
	1	Binary Select (Bit 1)
	2	Binary Select (Bit 2)
	3	Binary Select (Bit 3)
	4	Binary Select (Bit 4)
	5	Reserved for future use
	6	Zero Displacement
	7	Reserved for future use
Upper byte: Odd number POD	8	Binary Select (Bit 0)
	9	Binary Select (Bit 1)
	10	Binary Select (Bit 2)
	11	Binary Select (Bit 3)
	12	Binary Select (Bit 4)
	13	Reserved for future use
	14	Zero Displacement
	15	Reserved for future use

BINARY SELECT: The *binary select* value is set between 1 and 31 to select different tolerance limits for the Force and Displacement "window". All other binary select values are invalid and will result in an "out of window" status.

Depending on system configuration (PLC scan time, polled Interscan delay, DeviceNet baud rate, etc.) the delay between setting the binary select at the PLC and the Pod receiving the binary select is typically from 30 ms to 100ms. Similarly, the "window" bit status received by the PLC is delayed.

ZERO DISPLACEMENT: Bit used to reset the "zero" reference for the Pod's displacement sensor. Zeroing occurs following an OFF to ON bit transition if the Pod is not already in the process of zeroing displacement. This input can be used with a "pulse" signal (recommended minimum pulse of 100ms) where the normal bit state is OFF. Another option is to turn ON the ZERO DISPLACEMENT input bit until the BUSY output bit turns ON (indicating that the POD is in the process of zeroing) and then turn OFF the ZERO DISPLACEMENT input bit.

NOTE: It is important that the position being monitored by the displacement sensor does not change during the zeroing process (takes 2 to 10 seconds). The Pod's BUSY bit (polled output from Pod Server) will turn ON during the zeroing process and turn OFF once zeroing has completed.

Please refer to the Livingston User's Manual for *THE POD™* for additional information about displacement sensor usage.

BINARY SELECT CHART FOR SELECTING MASTERS

	Binary Select 16 (Bit 4)	Binary Select 8 (Bit 3)	Binary Select 4 (Bit 2)	Binary Select 2 (Bit 1)	Binary Select 1 (Bit 0)	Master selected
1 - input is ON	0	0	0	0	0	NONE
	0	0	0	0	1	1
0 - input is OFF	0	0	0	1	0	2
	0	0	0	1	1	3
	0	0	1	0	0	4
	0	0	1	0	1	5
	0	0	1	1	0	6
	0	0	1	1	1	7
	0	1	0	0	0	8
	0	1	0	0	1	9
	0	1	0	1	0	10
	0	1	0	1	1	11
	0	1	1	0	0	12
	0	1	1	0	1	13
	0	1	1	1	0	14
	0	1	1	1	1	15
	1	0	0	0	0	16
	1	0	0	0	1	17
	1	0	0	1	0	18
	1	0	0	1	1	19
	1	0	1	0	0	20
	1	0	1	0	1	21
	1	0	1	1	0	22
	1	0	1	1	1	23
	1	1	0	0	0	24
	1	1	0	0	1	25
	1	1	0	1	0	26
	1	1	0	1	1	27
	1	1	1	0	0	28
	1	1	1	0	1	29
	1	1	1	1	0	30
	1	1	1	1	1	31

APPLICATION NOTE

Category: POD systems
Applies to: User Interface version- 8,3,0,0 and Weld Monitor Version- 8,1,0,0
Subject: Replacing a POD

Replacing a POD If the replacement POD already has the same MACID (Node Address, POD ID) as the POD being replaced:

1.   Unplug the DeviceNet and sensor cables from the old POD.

2.   Remove the old POD from its mounting plate, bracket or similar by removing the 4 screws that come through the back of the plate.

Note: The replacement POD may not have the same mounting hardware. PODs with serial numbers that the last 4 digits are above 0400 have 10-24 threads and use a 10-24X.625 cap screw. All PODs below 0400 have M4 metric threads and use an M4X10mm screw. Matching screws are provided with replacement PODs.

3.   Mount the replacement POD and plug in the DeviceNet and sensor cables, wait for POD to come online.

Replacing a POD If the new POD has a different MACID (Node Address, POD ID) than the POD being replaced:

1.   Unplug the DeviceNet and Sensor cables from the old POD.

2.   Remove the old POD from its mounting plate, bracket or similar by removing the 4 screws that come through the   back of the plate.

Note: The replacement POD may not have the same mounting hardware. PODs with serial numbers that the last 4 digits are above 0400 have 10-24 threads and use a 10-24X.625 cap screw. All PODs below 0400 have M4 metric threads and use an M4X10mm screw. Matching screws are provided with replacement PODs.

3.   Mount the replacement POD and Plug in the sensor cable, but do not plug in DeviceNet cable.

4.   Unplug ALL PODs from the DeviceNet network. This will avoid any possible duplicate IDs on the network.

5.   Plug in the DeviceNet cable for the replacement POD.

6.   Wait for POD to come online. Use the "PODs/Server" screen to check POD status.

7.   Once POD is online, change the MACID to match the POD being replaced.

8.   Once the POD is online with the new MACID, shutdown the POD Server using the Shutdown menu.

9.   Re-attach all PODs to the DeviceNet network, restart the POD Server and Wait for all PODs to come online.

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UPDATES – THE POD™ USER'S MANUAL

Revision C: The Pod™ User's Manual Revision C is intended for use with Version 8 Pod System software starting with the following versions:

User Interface:	livcoset.exe 8.001 (8,1,0,0)
Pod Server:	guipodserver.exe 8.001 (8,1,0,0)
Pod Firmware:	8.001

Revision C.001: Changes to the Pod™ User's Manual starting with the following software versions:

User Interface:	livcoset.exe 8.005 (8,5,0,0)
Pod Server:	guipodserver.exe 8.002 (8,2,0,0)

Pod Server Polled I/O – A new feature has been incorporated into the Pod Server feature which allows Pod displacement sensor "zeroing" via the Pod Server using DeviceNet™ polled I/O. Document 0454-APP-292 has been revised to Rev C (affected manual pages 12-22, 12-23).

P1 Tolerancing – The P1 Tolerancing screen has new features to accommodate changing of PRE, POST and WELD segment sizes for each tolerance set. Document 0432-INS-763 has been revised to Rev D (screen snapshots changed - manual page 5-18). Document 0433-INS-763 has been revised to Rev D (document updated to incorporate new features – manual pages 6-30, 6-31).

Revision C.002: Notable changes to the Pod™ User's Manual starting with the following software versions:

User Interface:	livcoset.exe 8.010 (8,10,0,0)
Pod Server:	guipodserver.exe 8.004 (8,4,0,0)

MFDC milliseconds – Added references in the manual for MFDC weld type and that data is recorded in milliseconds.

DC_1P weld type – DC 1P (single phase) weld type has been added.

DeviceNet SST DN3 – SST single channel DeviceNet card now supported for use with Pod Server.

Window Bit – Input monitor screen has indicators for use with the Window bit (pages 6-43 to 6-47, 8-2). Must have 'masters enabled' and correct "Relay Mode' to use the Window Bit. (pages 6-36, 6-39). For more about Window bit (pages 12-15, 11-41)

P1 Tolerance Defaults – P1 Pod now uses Tolerance Defaults when creating "new" tolerances. (page 6-31).

Pods/Server Screen – Added a button to change a Pod's DeviceNet MAC ID and also copy the setup and calibration to the new ID (page 6-50).

Pod General – Added dimensional information for Pod and mounting brackets (page 11-33).

Revision C.003: Notable changes to the Pod™ User's Manual starting with the following software versions:

User Interface:	livcoset.exe 8.011 (8,11,0,0)
Pod Server:	guipodserver.exe 8.004 (8,4,0,0)

<u>Warranty & Repair Policy</u> – Added.

<u>Contact Information</u> – Updated all address/phone information to reflect Livingston's new Vermont location.