FLEX-CABLE

Reducing and Eliminating Down-Time in Resistance Welding Systems

Flex-Care

Increase Cable Life and Reduce Down-Time through proper cable selection, installation and Preventive Maintenance.

PREVENTIVE MAINTENANCE HANDBOOK

FLEX-CABLE

Worldwide leaders of welding cables and specialty products for over 60 years, Flex-Cable is recognized as producers of the most advanced products globally.

Flex-Cable was founded in the USA
- where we remain today -
Proudly manufacturing American made products sold throughout the world.

Our mission at Flex-Cable is to provide our customers with accurate, on-time delivery of the highest quality parts available in the industry and to improve our company for continued success.

ANAB ACCREDITED

ISO 9001 Certified

ASR American Systems Registrar

RWMA® MEMBER

American Welding Society
THE STRENGTH OF WELDING

Table of Contents

Introduction

Continuous improvement at Flex-Cable keeps us at the TOP in welding technology. During this constant improvement process we have learned many ways to make cables last longer and reduce down time related to cable failure. This knowledge can be a vital tool in reducing total cost of operation, increasing operational efficiency and making everyone's job much easier.

Most everyone knows that proper cable selection will increase cable life. It is also becoming a well known fact that proper dress out of a robot will increase cable life. Both of these save money and reducing down time. However, it is not well known that through a properly implemented preventative maintenance program downtime, related to resistance welding cables, *can be virtually eliminated*.

This booklet contains information that can be used on any level from new builds or retro fits to everyday operation. Sections 2 & 3 cover cable selection. Section 4 covers robot dress out and Sections 5 & 6 cover Preventative Maintenance. Section 7 is a complete example of a Preventive Maintenance Program in place. All of the forms shown are available from Flex-Cable along with simple templates for use on computers.

The information used to create this document was derived from many years of testing and continuous research performed by our engineering department as well as independent testing laboratories such as Candid Logic.

More information on the Preventive Maintenance for Primary Cables, Water Cooled Cables, Air Cooled Cables and Shunts will soon be available.

For further information please contact your sales representative, call (800) 245-3539 or email us at info@flexcable.com.

Sizing a Cable

Sizing a Secondary Resistance Welding Cable is important due to the two internal enemies: heat and mechanical stress. To combat these enemies remember that *smaller is better*. This means that one should follow two simple rules of thumb:

Use the Shortest Cable that will properly do the job MECHANICALLY.
Use the Smallest Size (MCM) cable that will properly do the job ELECTRICALLY.

Using the proper length cable is important so that heat and the mechanical stress will be minimized. The longer the cable, the more resistance. This means that the transformer voltage must increase to reach the desired current and more heat will be generated which will need to be removed from the cable. Secondly, if the cable is too short, the bending points on the cable will be tighter and cable life will be reduced due to mechanical stress. **Use the Shortest Cable that will properly do the job MECHANICALLY.**

Likewise the correct MCM size will also minimize heat and mechanical stress. If a cable is sized too small, the resistance will be great and more heat will be produced causing the cable to overheat. If too large, the mechanical forces on the cable are increased and this will contribute towards the mechanical destruction of the cable. **Use the Smallest Size (MCM) cable that will properly do the job ELECTRICALLY.**

Determining cable length is relatively simple, and when dressing a robot the correct length is first estimated and then sometimes needs to be adjusted as the dress out is finalized. It can be helpful to use the length of a hose, (10'-12') to simulate the actual cable and it's routing.

Cable sizing is more complicated. Length must first be determined, and then water flow, then RMS Current. The RMS Current is derived from the maximum weld current, the weld time, and the welds per minute (Duty Cycle.) An easy to use tool for doing this computation is the Flex-Cable slide chart. NOTE: Due to the way that this chart was derived we recommend using it only on Flex-Cable products.

Section III

Cable Types

There are many different types of cables on the market today with the major differences being both internal (the makeup of the cable) and external (the type of covering or hose.) This section will first describe some of these differences and give reasons for choosing a specific type of construction; followed by some typical applications and the corresponding type of cables.

First, we will cover the different types of internal construction of kickless cables. Some cables use an *opposed polarity* construction while others use an *alternate polarity* construction. In the opposed polarity construction the ropes of wire for each polarity are grouped together, which raises the impedance by creating a large magnetic field while lowering the power available for welding (in some cases the tap switch for the transformer may need to be turned up). In an alternate polarity format, the ropes of wire for each polarity are arranged in an alternate configuration. This helps cancel out some of the magnetic field, which lowers the overall impedance (more power available for welding). Flex-Cable uses the alternate polarity construction in our kickless cables.

Another difference in kickless cables is in the number of wire ropes used during construction of the cable. Kickless cables can be constructed using either six (6) or four (4) ropes of wire. The six (6) rope construction has several advantages. Since each polarity has three (3) smaller ropes of wire instead of two (2) larger ropes, the cable lasts longer when being bent or twisted. Another important characteristic is that when a cable starts to fail, the process is slower and more easily measured. Flex-Cable has **always** used the six (6) rope construction.

The method in which the cables are separated and insulated within a kickless cable can also differ. The two main ways are by using a separator - a core with 'fins' evenly spaced around it to hold the ropes of wire - and individually encasing each wire rope within the cable. The material used to i*ndividually wrap* each rope of wire both insulates the ropes from each other and helps to keep copper strands from entering the water system. At Flex-Cable, we offer both types of construction, referring to the separator style of construction as **Standard Construction** and the individually wrapped style of construction as **Flex-Cel Construction**. The Flex-Cel style of construction has more advantages than mentioned above; it will bend and twist easier than standard construction, which is important for manual guns. Also, due to the more open structure on the inside of a cable it will last longer in tight bend and twist applications.

Just as there are many different types of interior constructions, the cable coverings or hoses have many varieties also. The most common hose material in use today is a reinforced blend of natural rubber and SBR. Rubber (natural or SBR) is a thermal set material, which means that if the temperature increases, the hose will not melt. All Flex-Cable's hoses utilize this type of construction with variations depending on specific cable application. The exterior of the hose is equally important and Flex-Cable offers a wide variety of hoses to meet many different uses.

Following are a few applications and the Flex-Cable hose type recommended for each particular use:

General Robotics Applications

After many years of continuous testing and improvement, Flex-Cable developed Color-Flex. Color-Flex is most commonly used for typical robotic applications. The Color- Flex cable has been tested by an independent laboratory and outperformed the competition as much as 2-to-1 for cable life. This, combined with the field proven track record, is why the Color-Flex cable is *the* most recommended specification in the welding industry. The outside hose has a durable rubber blend outer covering which gives good support for the cable while allowing the cable to bend and twist. The rubber blend is the same used in sandblasting hose and thus is very good at resisting abrasion. The interior construction style of the Color-Flex Cable is Standard.

Tight Bend/Twist Robotic Applications

The America's Power Cable type of construction is the solution when the application performs tight bends or many bends and twists. The Interior of the America's Power Cable is made with the Flex-Cel style of construction and uses the same style of hose as the Color-Flex, giving excellent support and abrasion resistance. This construction has been both laboratory and field tested with results proving this is a cable offering an extended life over the Color-Flex cable.

High Abrasion Applications

The Euro-Flex is by far the best cable for high abrasion applications. Euro-Flex cables have all the benefits of the America's Power Cable with the addition of a Polyurethane outer covering which provides superior resistance to abrasion. Euro-Flex cables combine all the advantages of a reinforced rubber hose with the abrasion resistance of urethane and the added durability of the interior Flex-Cel construction creating the highest performing cable ever. Testing done by an independent laboratory has shown that the Euro-Flex cable has both longer life and abrasion resistance in severe applications than any other cable available today.

Manual Gun Applications

A cable that is easy to bend and twist is needed for manual gun applications. We developed Complex hose specifically for this application. A Complex cable has excellent bend and twist ability reducing the ergonomic stress on the gun operator while maintaining the safety of a reinforced rubber tube on the inside. This, combined with Flex-Cel construction, makes the Complex the cable of choice. For these reasons, Complex has become the recommended specification by many in the welding industry for manual guns. Due to the use of softer rubber, making Complex hose more ergonomic, use of this type of cable cover should be restricted to manual operations only.

Flex-Cable offers other hose types not listed above. If you are interested in information on these hose types please contact your sales representative, call (800) 245-3538 or send an email to info@flexcable.com.

Section IV

Optimizing Robot Dress Out

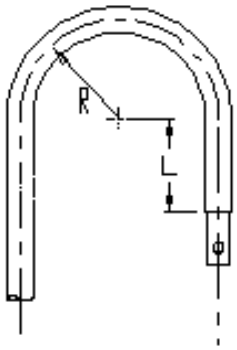
"Proper Robot Dress Out" is a phrase that can take on many meanings and have many different levels. There is no absolute right or wrong way. There is no perfect dress out. There are only those that work well and those that do not. The goal in any robot dress out is to have the cables, wires, and hoses last as long as possible. For the cables, the way to achieve this is to minimize twisting, bending and abrasion. That would be easy if the robot did not move. However, since this is not the case, here are some important notes that will help in robot dress-out and increased cable life.

Use of high quality dress out equipment and accessories is vital. Use equipment that will not bend, break, burn or melt. Robots accelerate and stop at remarkable speeds which create extremely large forces acting on the equipment. The use of dress out equipment (based on a modular system) is extremely helpful when trying out a new dress out idea. Utilizing a system, such as Flex-Cable's Robo Dress Out Package, will allow the cable or hoses to be mounted almost anywhere has definite advantages.

Run the robot through its cycle(s) many times to ensure that the dress out keeps the cable and hoses from making contacting on other surfaces, without being kinked or bent too tightly. The minimum bend radius for Flex-Cable's Kickless cable as well as the start of radius from the end of the hose is given in the chart on the next page (Figure 4-1). Through testing we have found that applications where tight bending cannot be avoided, the use of Flex-Cel cables will greatly increase the life of the cable. (See Flex-Cel in Section III.)

If contact between the cables or hoses and other items cannot be eliminated by dress out, then there are other ways of reducing the effects of abrasion. For the cable, the choice of Euro-Flex hose will minimize the effects of abrasion to the lowest point possible. The hoses can be dressed into a Robo-Harness (a polyurethane housing keeping the hoses together while providing abrasion protection.) Another option for protection is the use of EXO (a nylon material available in different coil sizes) which can be applied anywhere needed.

These are helpful suggestions as to proper robot dress out but the easiest way to achieve a good robot dress out is to call for Flex-Cable's Robo Dress Out Team. This is a Team that can provide total automation solutions saving both money and time. By setting up a continual loop of Analysis, Planning, Executing and Tracking they will tailor your needs into savings.



Cable Size	300 / 400	450 / 500	650	800
Min. Bend Radius (R)	5	5 1/2	6 1/2	8 1/2
Start of Radius From End of the Hose (L)	5 1/2	6 1/2	7 1/2	9 1/2

Length in Inches

Figure 4-1

Section V

Preventive Maintenance I (Physical)

The first step toward good cable maintenance coordinates well with proper dress out. Cable and hose life can be extended with the use of periodic inspections. The time intervals for these inspections are subject to many factors, but motion of the robot and proper dress out are two of the main factors. The inspection interval should be determined by each plant and perhaps each robot. A general guideline for this is once a week.

Things that need to be checked are:

- Abrasion, cracks or delamination of the rubber on the cable or hoses
- Bolts are tightened properly
- Water leaks
- Kinks in the hoses or wires and that the bend radius on the cable is not too small
- Controlling wires are not being pinched or kinked
- Minimal amount of breaking strands on air cooled cables or signs of over heating
- Water flow for the cables

Any problems found should be fixed or monitored on a more frequent basis.

A simple checklist is included in the appendix of this booklet that could be used for each robot or cell of robots (Document CL-1.)

Preventive Maintenance II (Electrical)

The second step - and probably the largest factor in preventing down time - is to change cables **before they fail**. To make this a cost effective method the cable has to function as long as possible and then be changed before a failure occurs.

We have developed a process in which this can be done. Through countless testing (laboratory and field) and accumulation of data we have found that the resistance of a Flex-Cable Kickless Cable will have a profile as shown in the following graph (figure 6-1). Most applications will deliver a "no weld" indicator or the cable will fail at point A, so the cable should be changed before that point. The best time to change a cable is during the *Main Rise*; however, in some cases it may be necessary to change the cable during the *Small Increase* - **if** the conditions are extremely harsh.

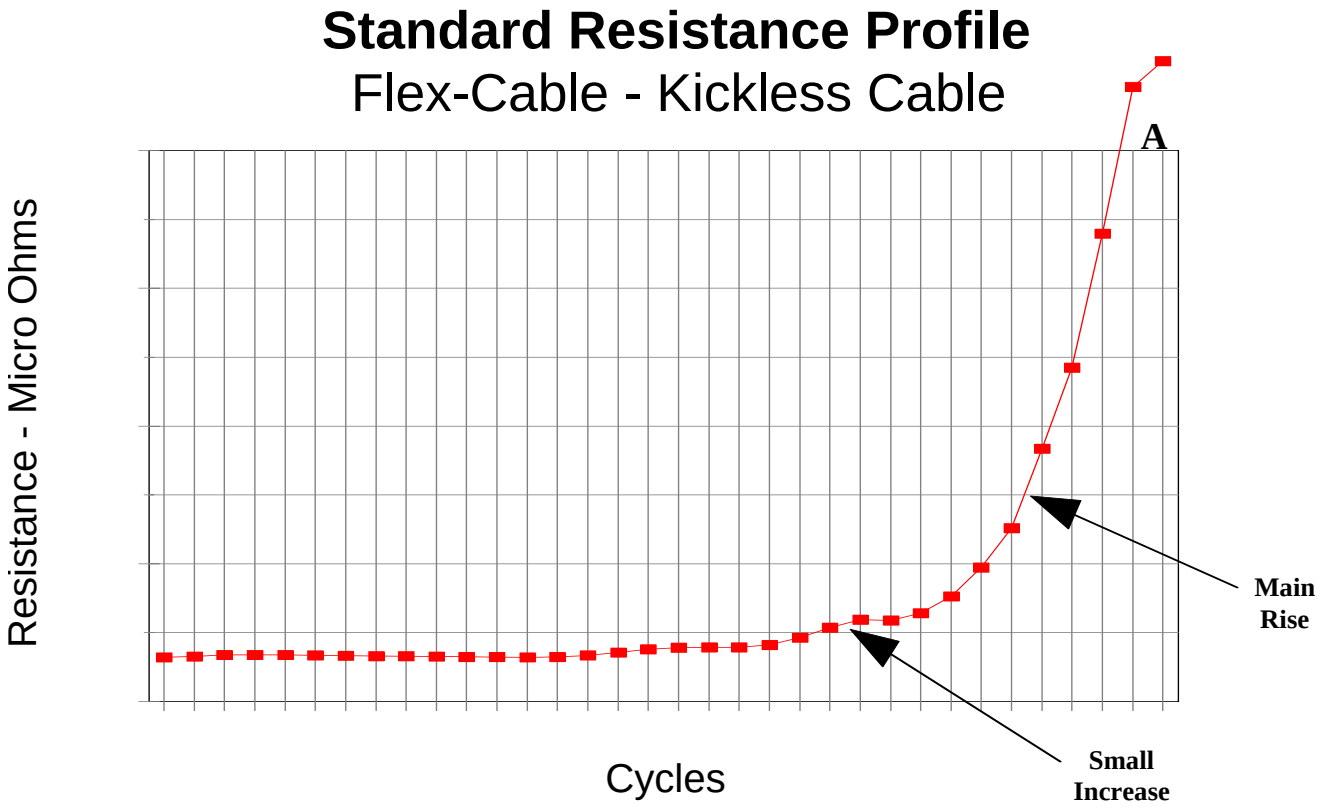


Figure 6-1

Note: This profile is typical for Flex-Cable's Kickless Cable only. The profile of other cables, not using six (6) rope construction, have a much more sudden rise to point A giving less time for detection.

The graph above (Fig. 6-1) shows a typical profile that was logged with severe robot test cycles, but would look similar when logged over a nominal time. As previously mentioned the time interval for the inspections are subject to many factors and should be determined by each plant and perhaps each robot. A general guideline for this inspection interval is once a week. We have set up a simple method in which to obtain and record the resistance each week.

The cut off limits for the cables were determined using test data obtained from our testing facility and actual data from plants. These are just a guideline and may need to be modified to suit the needs of your plant. See the charts in Appendix A (Document TC1 - TC4) for more information on the cut off limit for different sizes and length cables.

To utilize the Tracking Charts simply start with a blank copy (corresponding to the MCM size that you are using.) Draw a line at the cut off point for the cable length. Start when installing the cable and each week take a resistance measurement of the Kickless Cable and put a dot on the chart corresponding to the reading. Connect this dot to the previous marks and the profile will soon be apparent. When the cable has a resistance reading above the cut off value, it should be changed so as to prevent down time from failure.

If the recommended cut off value is too low or too high, (cable is removed too soon or it fails) a new cut off value can be determined by using the same chart. Instead of drawing the line on the Tracking Chart when starting a new chart just log the resistance with the date as before but leave the cable on until it fails. This will allow you to see what the profile looks like so that a new cut-off value can be determined.

The Flex-Cable “Lunch Box” Micro Ohm Meter, makes taking preventive maintenance resistance readings quick and easy. For more information see Appendix B or contact your sales representative, call (800) 245-3539 or email us at info@flexcable.com.

Complete Flex - Care
A working example

Example Index

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Flex - Care

Robot **32R1-1**

Physical & Electrical Check List and Data Sheet

Physical		**Check List**												
Cables														
No Abraision or Cracks on Hose		*EK*												
All Bolts Tightened		*EK*												
Cables & Hoses														
No Water Leaks		*EK*												
No kinks in the Hoses or Cable		*EK*												
Air Cooled Cable														
Over Heating														
Many Strands Broken														
General														
Control / Prox. wires OK		*EK*												
Water Flow		*2.5*												
Electrical		**Data Values**												
Kickless Cable 1	**+**	*230*												
	-	*230*												
Kickless Cable 2	**+**													
	-													
Water or Air Cooled Cable 1		*48*												
Water or Air Cooled Cable 2		*37*												
Total System Tip to Tip		*1058*												
Date		*7/23*												

FLEX-CABLE

Robot **32R1-1**

400 MCM Kickless Cable Resistance Chart

Resistance Cut Off Values Flex-Cable 400 MCM

Length	Cut-Off
4	155
5	192
6	231
7	269
8	308
9	348
10	386

FLEX-CABLE

Robot **32R1-1**

Flex - Care

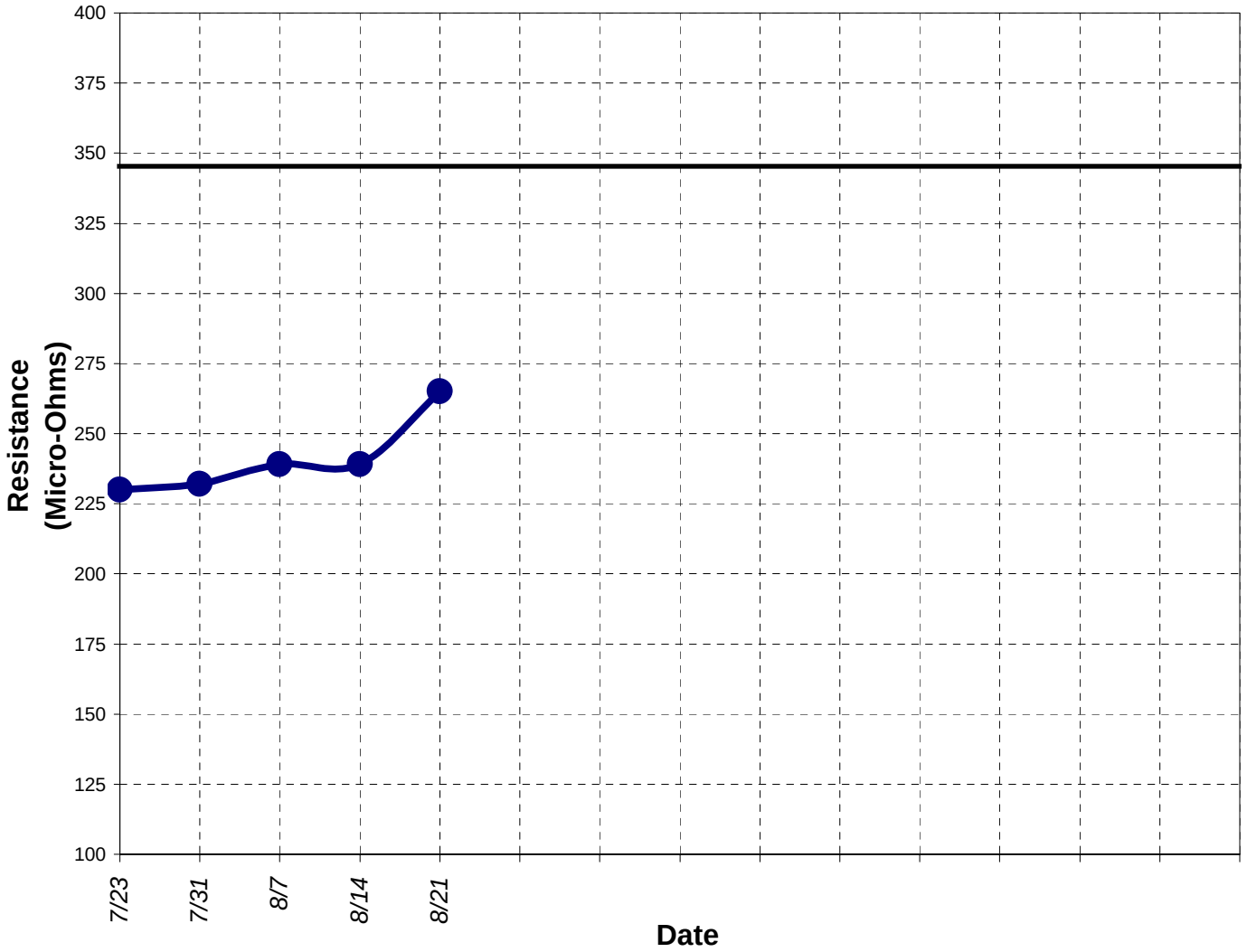
Physical & Electrical Check List and Data Sheet

Physical		**Check List**												
Cables														
No Abraision or Cracks on Hose		*EK*	*EK*	*EK*	*EK*	*EK*								
All Bolts Tightened		*EK*	*EK*	*EK*	*EK*	*EK*								
Cables & Hoses														
No Water Leaks		*EK*	*EK*	*EK*	*EK*	*EK*								
No kinks in the Hoses or Cable		*EK*	*EK*	*EK*	*EK*	*EK*								
Air Cooled Cable														
Over Heating														
Many Strands Broken														
General														
Control / Prox. wires OK		*EK*	*EK*	*EK*	*EK*	*EK*								
Water Flow		*2.5*	*2.5*	*2.5*	*2.5*	*2.5*								
Electrical		**Data Values**												
Kickless Cable 1	**+**	*230*	*230*	*240*	*245*	*260*								
	-	*230*	*232*	*239*	*239*	*265*								
Kickless Cable 2	**+**													
	-													
Water or Air Cooled Cable 1		*48*	*50*	*50*	*49*	*52*								
Water or Air Cooled Cable 2		*37*	*39*	*39*	*39*	*39*								
Total System Tip to Tip		*1058*	*1060*	*1065*	*1060*	*1080*								
Date		*7/23*	*7/31*	*8/7*	*8/14*	*8/21*								

FLEX-CABLE

Robot **32R1-1**

400 MCM Kickless Cable Resistance Chart



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Flex - Care

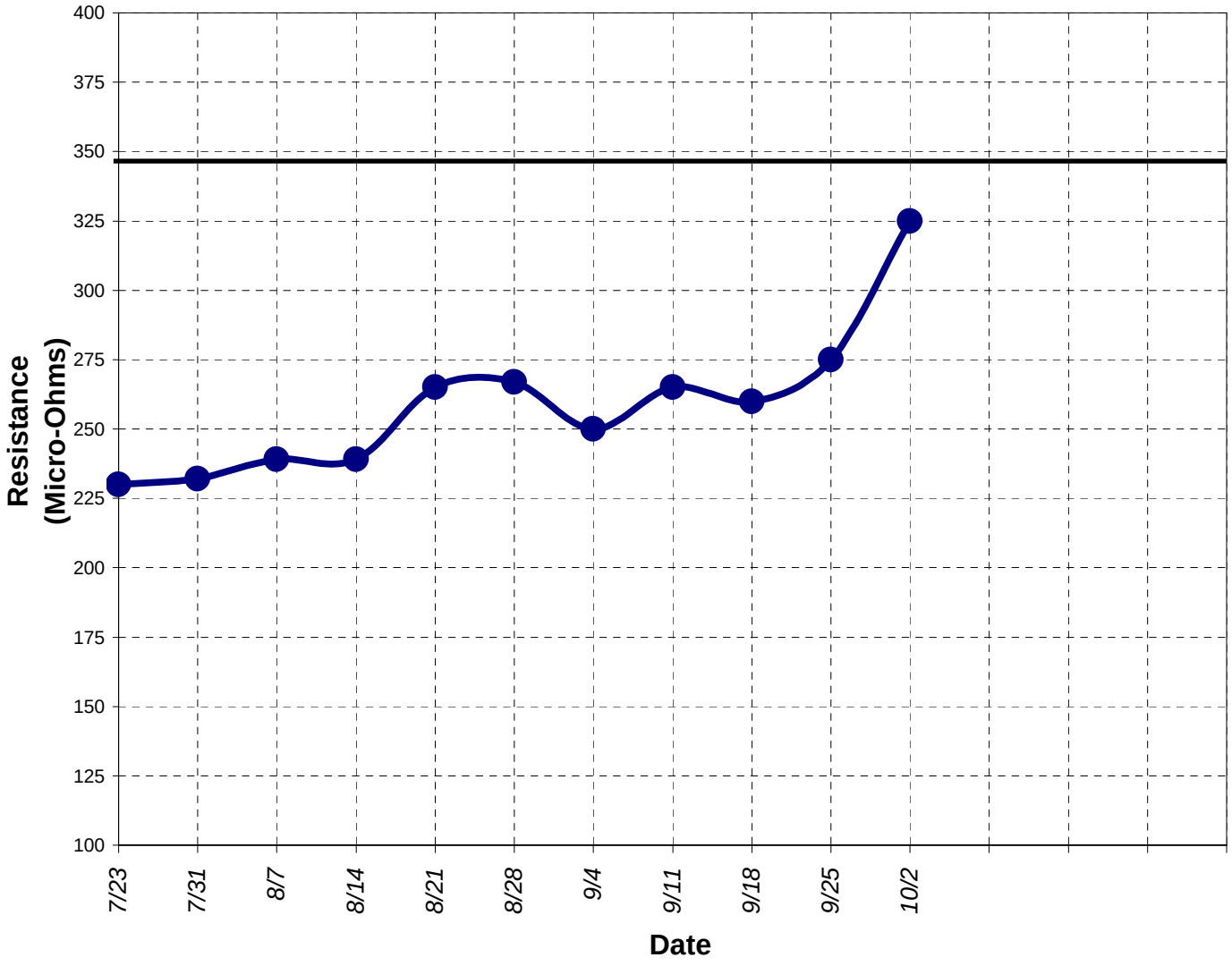
Physical & Electrical Check List and Data Sheet

Physical		**Check List**												
Cables														
No Abraision or Cracks on Hose		*EK*	*EK*	*EK*	*EK*	*EK*	*EK*	*EK*	*EK*	*EK*	*EK*	*EK*		
All Bolts Tightened		*EK*	*EK*	*EK*	*EK*	*EK*	*EK*	*EK*	*EK*	*EK*	*EK*	*EK*		
Cables & Hoses														
No Water Leaks		*EK*	*EK*	*EK*	*EK*	*EK*	*EK*	*EK*	*EK*	*EK*	*EK*	*EK*		
No kinks in the Hoses or Cable		*EK*	*EK*	*EK*	*EK*	*EK*	*EK*	*EK*	*EK*	*EK*	*EK*	*EK*		
Air Cooled Cable														
Over Heating														
Many Strands Broken														
General														
Control / Prox. wires OK		*EK*	*EK*	*EK*	*EK*	*EK*	*EK*	*EK*	*EK*	*EK*	*EK*	*EK*		
Water Flow		*2.5*	*2.5*	*2.5*	*2.5*	*2.5*	*2.5*	*2.5*	*2.5*	*2.5*	*2.5*	*2.5*		
Electrical		**Data Values**												
Kickless Cable 1	**+**	*230*	*230*	*240*	*245*	*260*	*260*	*260*	*260*	*260*	*278*	*330*		
	-	*230*	*232*	*239*	*239*	*265*	*267*	*250*	*265*	*260*	*275*	*325*		
Kickless Cable 2	**+**													
	-													
Water or Air Cooled Cable 1		*48*	*50*	*50*	*49*	*52*	*52*	*51*	*50*	*49*	*55*	*50*		
Water or Air Cooled Cable 2		*37*	*39*	*39*	*39*	*39*	*35*	*34*	*39*	*39*	*42*	*39*		
Total System Tip to Tip		*1058*	*1060*	*1065*	*1060*	*1080*	*1082*	*1082*	*1096*	*1095*	*1125*	*1175*		
Date		*7/23*	*7/31*	*8/7*	*8/14*	*8/21*	*8/28*	*9/4*	*9/11*	*9/18*	*9/25*	*10/2*		

FLEX-CABLE

Robot **32R1-1**

400 MCM Kickless Cable Resistance Chart



Resistance Cut Off Values Flex-Cable 400 MCM

Length	Cut-Off
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FLEX-CABLE

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Flex - Care

Physical & Electrical Check List and Data Sheet

Physical		**Check List**												
Cables														
No Abraision or Cracks on Hose		*EK*	*EK*	*EK*	*EK*	*EK*	*EK*	*EK*	*EK*	*EK*	*EK*	*EK*	*EK*		
All Bolts Tightened		*EK*	*EK*	*EK*	*EK*	*EK*	*EK*	*EK*	*EK*	*EK*	*EK*	*EK*	*EK*		
Cables & Hoses															
No Water Leaks		*EK*	*EK*	*EK*	*EK*	*EK*	*EK*	*EK*	*EK*	*EK*	*EK*	*EK*	*EK*		
No kinks in the Hoses or Cable		*EK*	*EK*	*EK*	*EK*	*EK*	*EK*	*EK*	*EK*	*EK*	*EK*	*EK*	*EK*		
Air Cooled Cable															
Over Heating															
Many Strands Broken															
General															
Control / Prox. wires OK		*EK*	*EK*	*EK*	*EK*	*EK*	*EK*	*EK*	*EK*	*EK*	*EK*	*EK*	*EK*		
Water Flow		*2.5*	*2.5*	*2.5*	*2.5*	*2.5*	*2.5*	*2.5*	*2.5*	*2.5*	*2.5*	*2.5*	*2.5*		
Electrical		**Data Values**											**NEW**		
Kickless Cable 1	**+**	*230*	*230*	*240*	*245*	*260*	*260*	*260*	*260*	*260*	*278*	*330*	*228*		
	-	*230*	*232*	*239*	*239*	*265*	*267*	*250*	*265*	*260*	*275*	*325*	*231*		
Kickless Cable 2	**+**														
	-														
Water or Air Cooled Cable 1		*48*	*50*	*50*	*49*	*52*	*52*	*51*	*50*	*49*	*55*	*50*	*52*		
Water or Air Cooled Cable 2		*37*	*39*	*39*	*39*	*39*	*35*	*34*	*39*	*39*	*42*	*39*	*42*		
Total System Tip to Tip		*1058*	*1060*	*1065*	*1060*	*1080*	*1082*	*1082*	*1096*	*1095*	*1125*	*1175*	*1075*		
Date		*7/23*	*7/31*	*8/7*	*8/14*	*8/21*	*8/28*	*9/4*	*9/11*	*9/18*	*9/25*	*10/2*	*10/9*		

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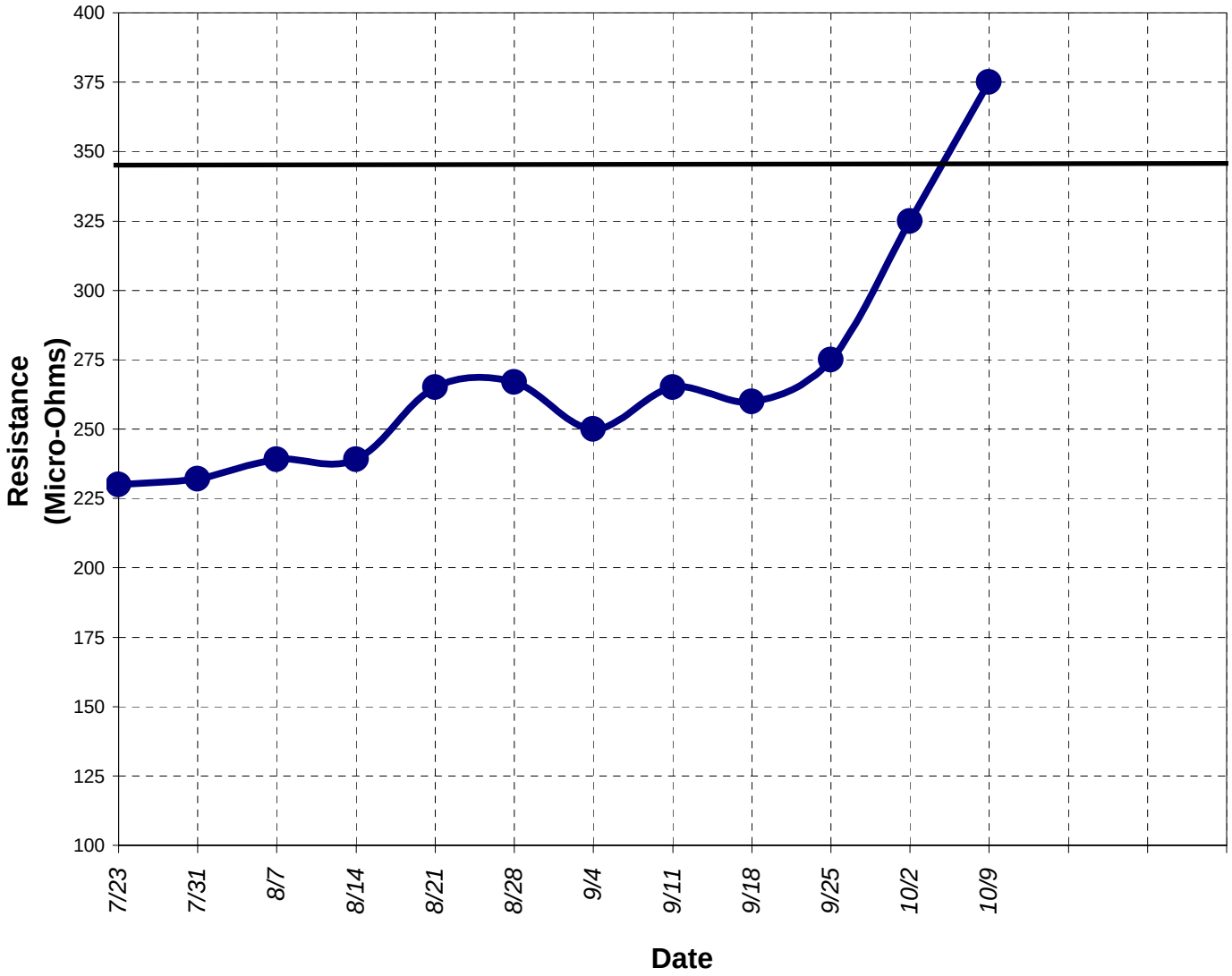
400 MCM Kickless Cable Resistance Chart



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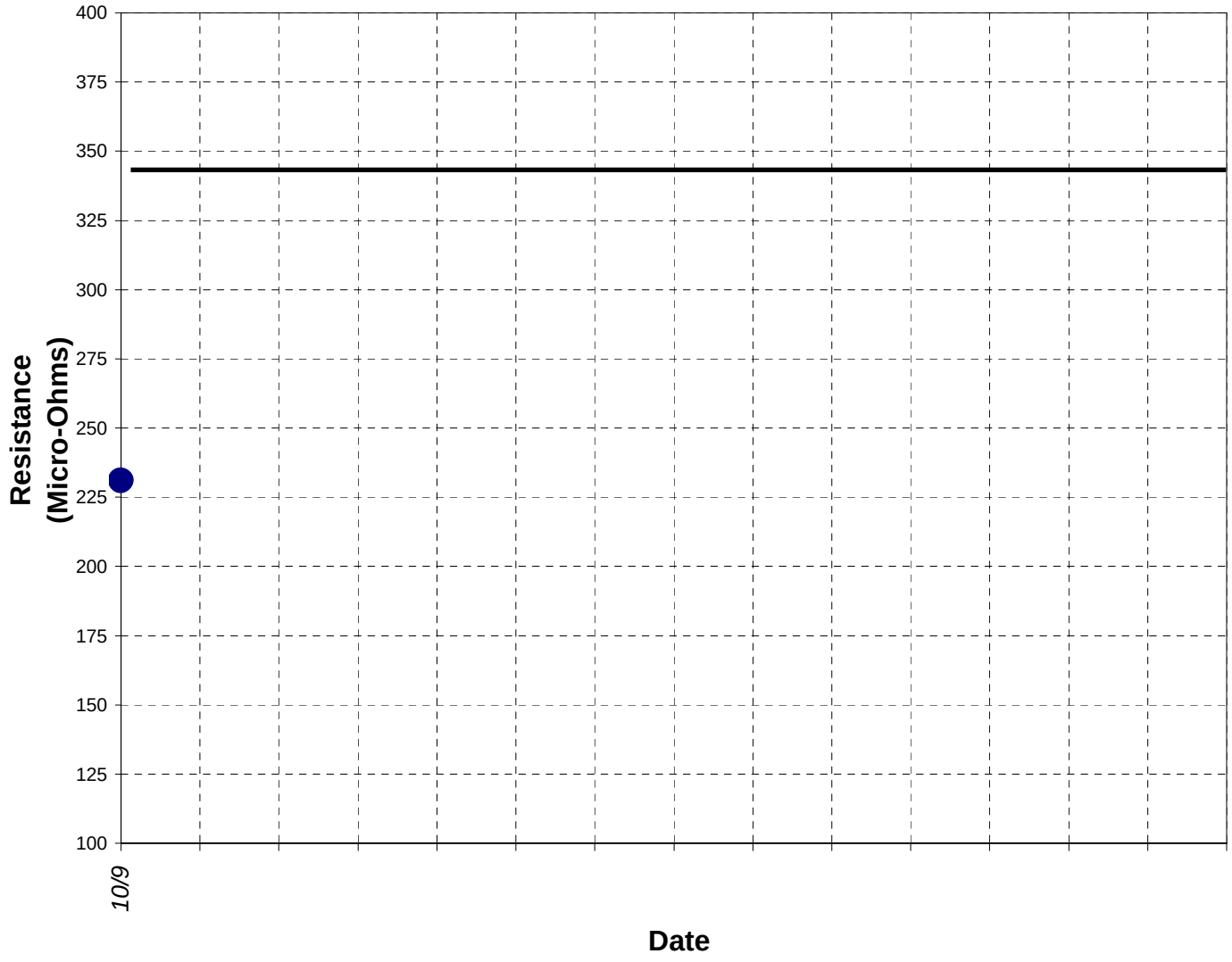

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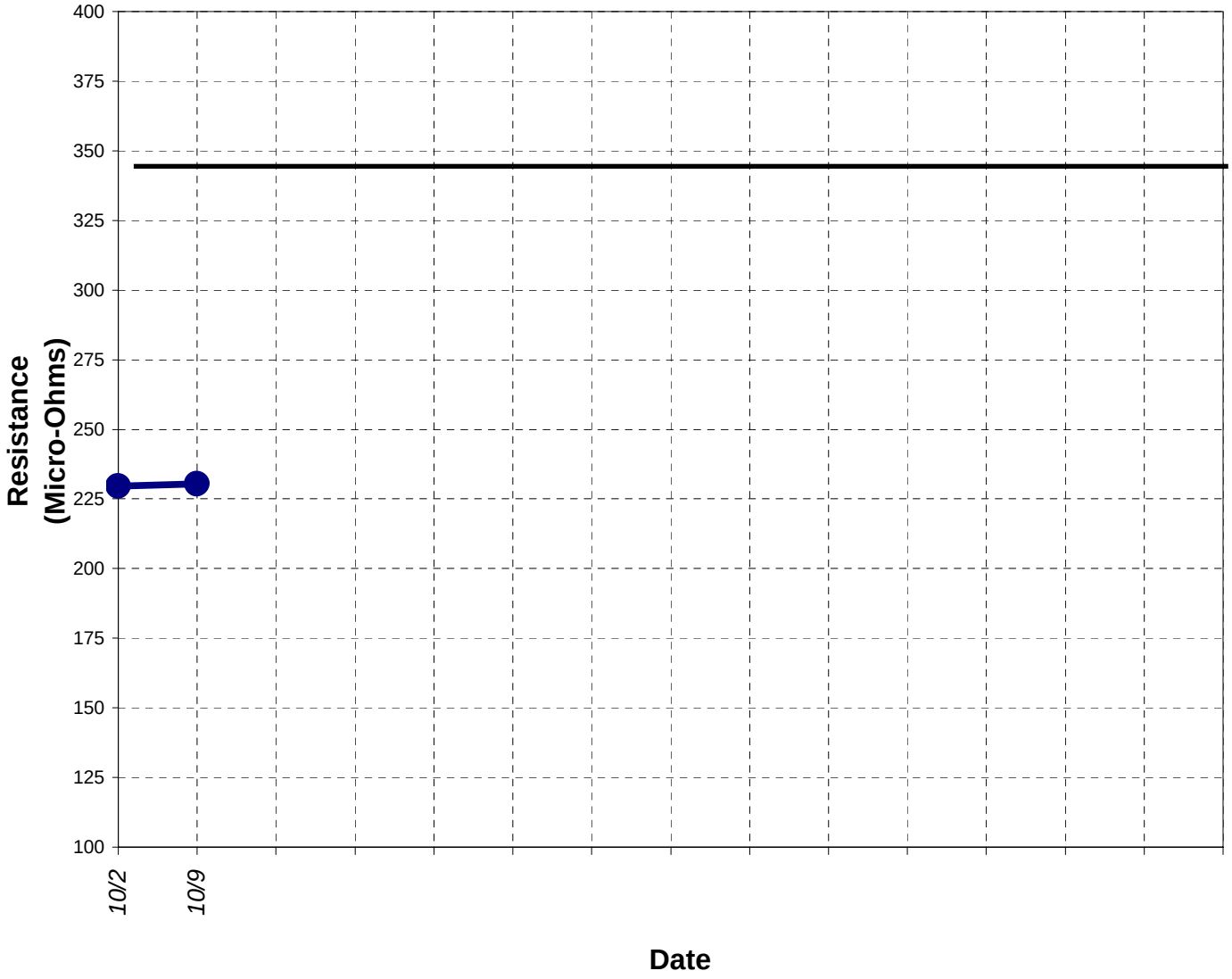
Cables														
No Abraision or Cracks on Hose		*EK*	*EK*	*EK*	*EK*	*EK*	*EK*	*EK*	*EK*	*EK*	*EK*	*EK*	*EK*	*EK*	
All Bolts Tightened		*EK*	*EK*	*EK*	*EK*	*EK*	*EK*	*EK*	*EK*	*EK*	*EK*	*EK*	*EK*	*EK*	
Cables & Hoses														
No Water Leaks		*EK*	*EK*	*EK*	*EK*	*EK*	*EK*	*EK*	*EK*	*EK*	*EK*	*EK*	*EK*	*EK*	
No kinks in the Hoses or Cable		*EK*	*EK*	*EK*	*EK*	*EK*	*EK*	*EK*	*EK*	*EK*	*EK*	*EK*	*EK*	*EK*	
Air Cooled Cable														
Over Heating														
Many Strands Broken														
General														
Control / Prox. wires OK		*EK*	*EK*	*EK*	*EK*	*EK*	*EK*	*EK*	*EK*	*EK*	*EK*	*EK*	*EK*	*EK*	
Water Flow		*2.5*	*2.5*	*2.5*	*2.5*	*2.5*	*2.5*	*2.5*	*2.5*	*2.5*	*2.5*	*2.5*	*2.5*	*2.5*	
Electrical		**Data Values**										**NEW**		
Kickless Cable 1	**+**	*230*	*230*	*240*	*245*	*260*	*260*	*260*	*260*	*260*	*278*	*330*	*228*	*230*	
	-	*230*	*232*	*239*	*239*	*265*	*267*	*250*	*265*	*260*	*275*	*325*	*231*	*231*	
Kickless Cable 2	**+**														
	-														
Water or Air Cooled Cable 1		*48*	*50*	*50*	*49*	*52*	*52*	*51*	*50*	*49*	*55*	*50*	*52*	*52*	
Water or Air Cooled Cable 2		*37*	*39*	*39*	*39*	*39*	*35*	*34*	*39*	*39*	*42*	*39*	*42*	*42*	
Total System Tip to Tip		*1058*	*1060*	*1065*	*1060*	*1080*	*1082*	*1082*	*1096*	*1095*	*1125*	*1175*	*1075*	*1075*	
Date		*7/23*	*7/31*	*8/7*	*8/14*	*8/21*	*8/28*	*9/4*	*9/11*	*9/18*	*9/25*	*10/2*	*10/9*	*10/16*	

FLEX-CABLE

Robot **32R1-1**

400 MCM Kickless Cable Resistance Chart



Resistance Cut Off Values Flex-Cable 400 MCM

Length	Cut-Off
4	155
5	192
6	231
7	269
8	308
9	348
10	386

Appendix A - Forms

Forms Index

FLEX-CABLE

Flex - Care

Robot **32R1-1**

Physical & Electrical Check List and Data Sheet

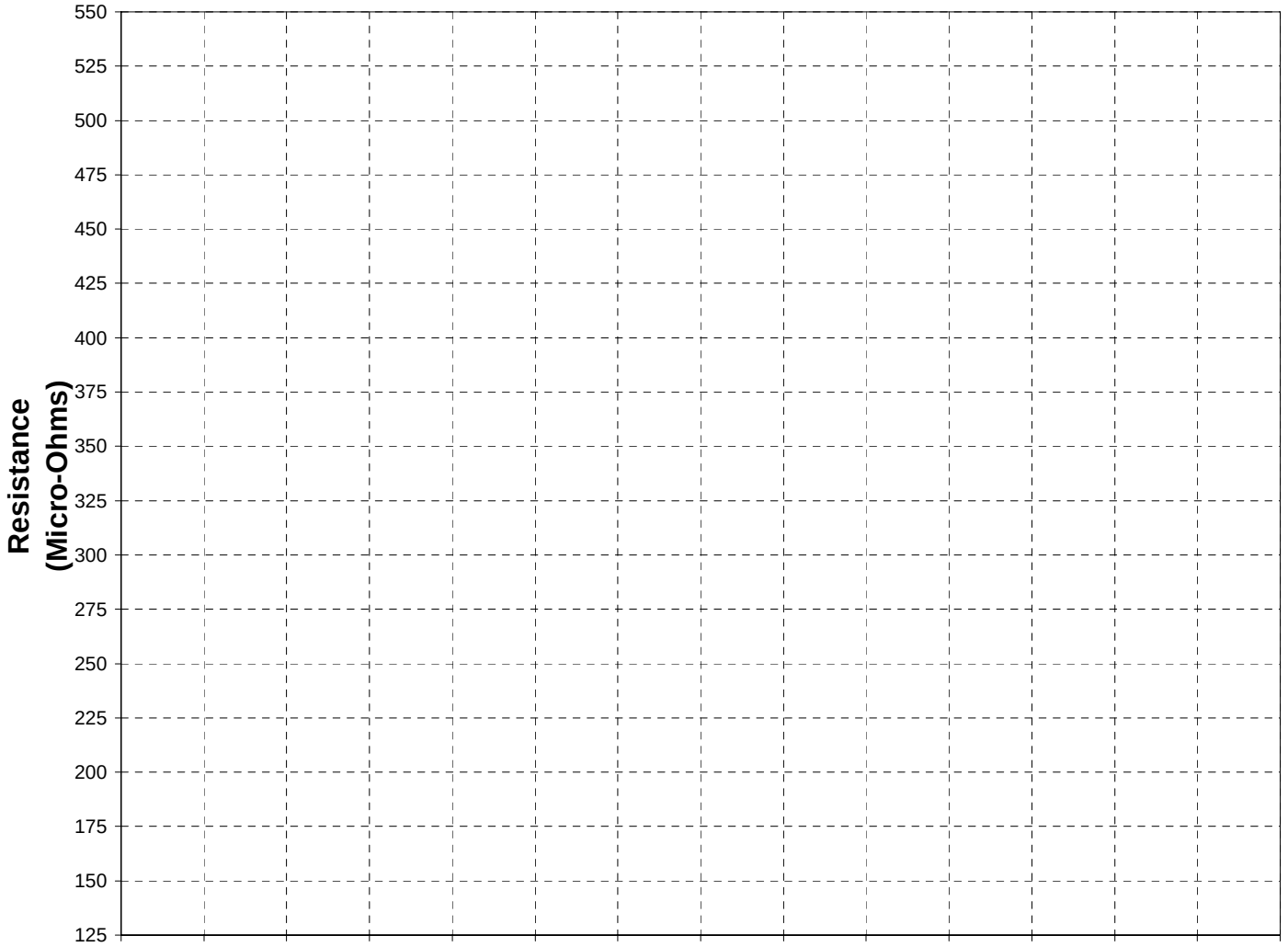
Physical		**Check List**												
Cables														
No Abrasion or Cracks on Hose														
All Bolts Tightened														
Cables & Hoses														
No Water Leaks														
No kinks in the Hoses or Cable														
Air Cooled Cable														
Over Heating														
Many Strands Broken														
General														
Control / Prox. wires OK														
Water Flow														
Electrical		**Data Values**												
Kickless Cable 1	**+**													
	-													
Kickless Cable 2	**+**													
	-													
Water or Air Cooled Cable 1														
Water or Air Cooled Cable 2														
Total System Tip to Tip														
Date														

FLEX-CABLE

Flex - Care

Robot _____

300 MCM Kickless Cable Resistance Chart



Resistance Cut Off Values
Flex-Cable
300 MCM

Length	Cut-Off
4	207
5	258
6	312
7	360
8	414
9	467
10	521

FLEX-CABLE

Flex - Care

Robot _____

400 MCM Kickless Cable Resistance Chart

Resistance Cut Off Values
Flex-Cable
400 MCM

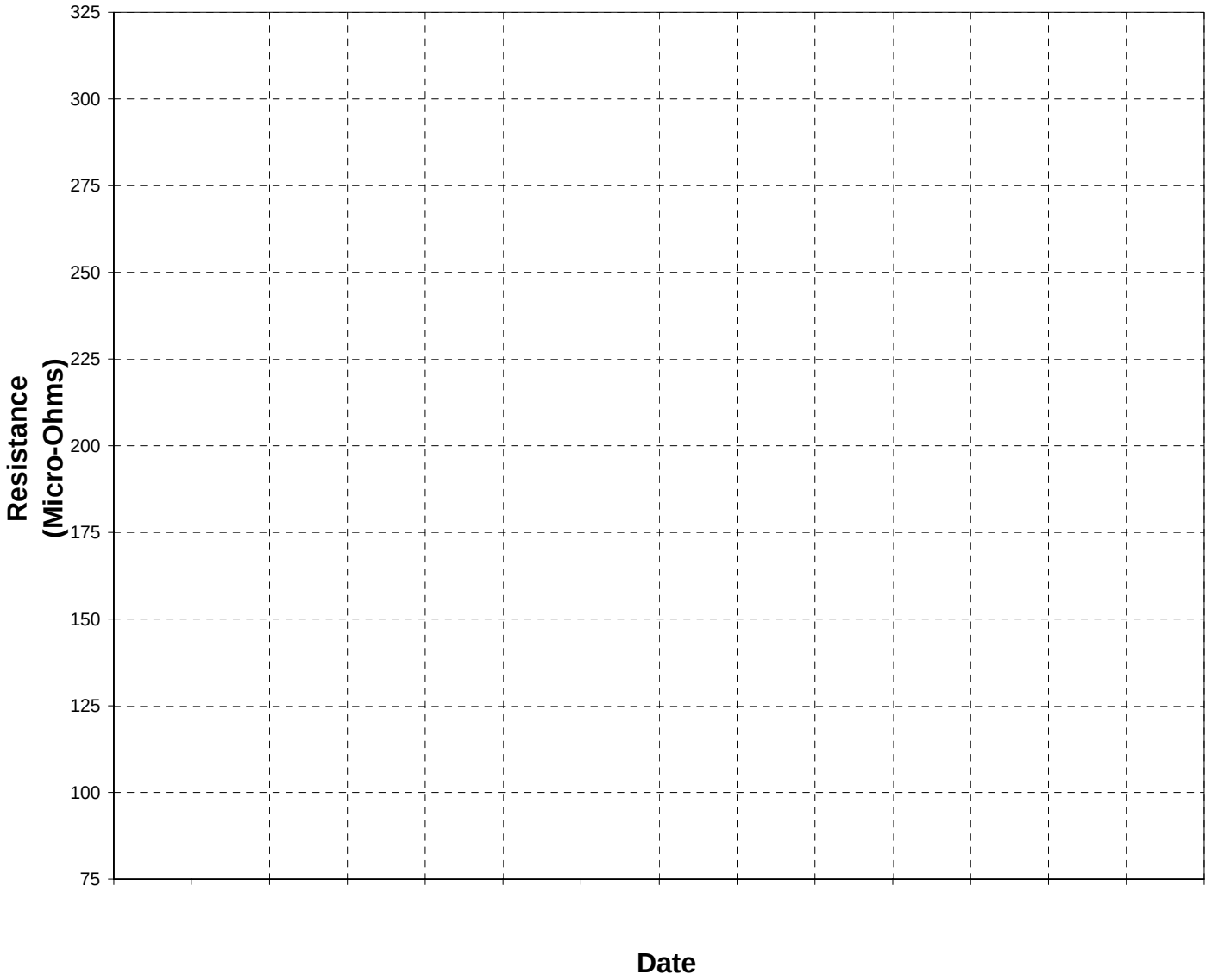
Length	Cut-Off
4	155
5	192
6	231
7	269
8	308
9	348
10	386

FLEX-CABLE

Flex - Care

Robot _____

500 MCM Kickless Cable Resistance Chart



Resistance Cut Off Values Flex-Cable 500 MCM

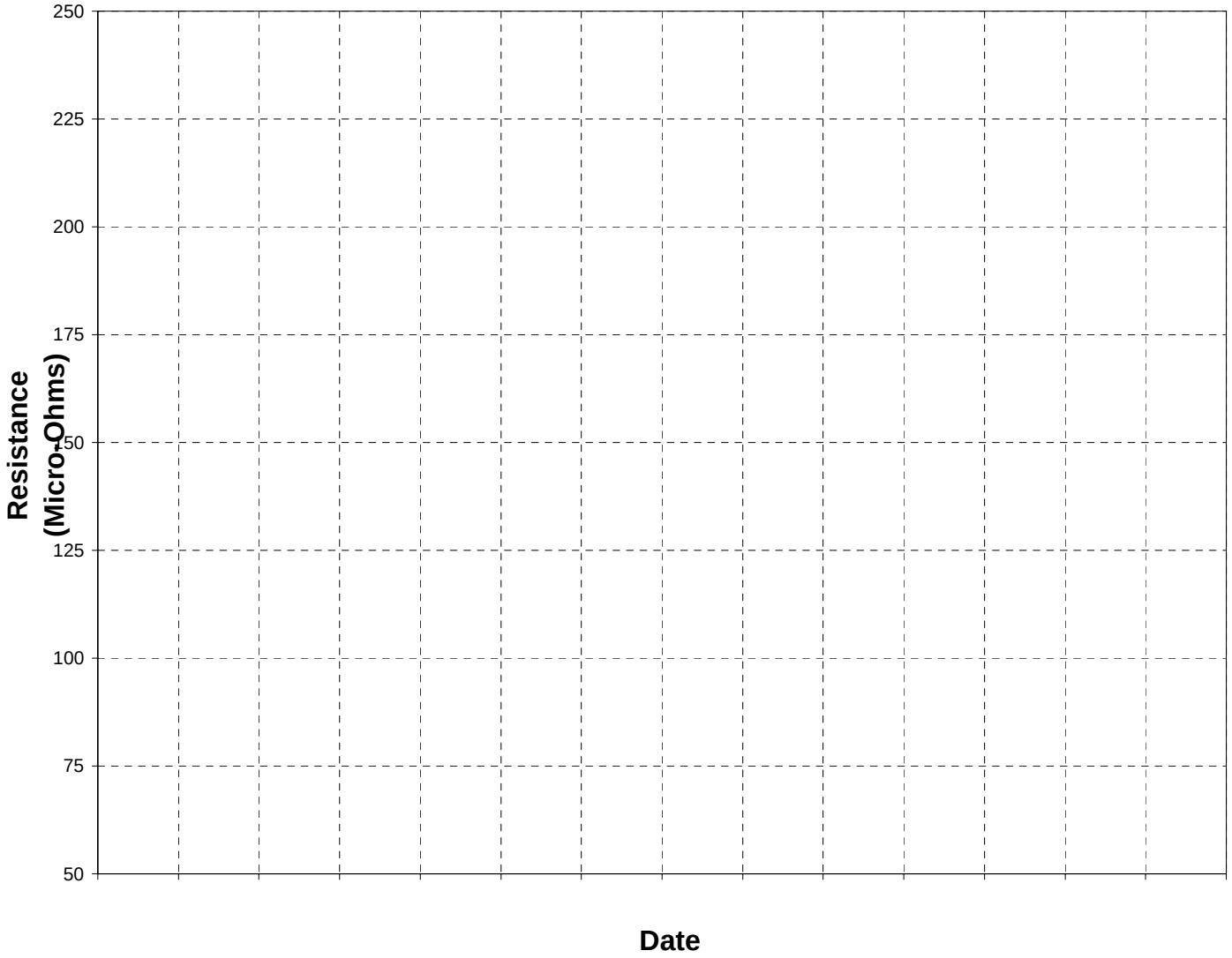
Length	Cut-Off
4	126
5	158
6	189
7	221
8	252
9	284
10	315

FLEX-CABLE

Robot _____

Flex - Care

650 MCM Kickless Cable Resistance Chart



Resistance Cut Off Values Flex-Cable 650 MCM

Length	Cut-Off
4	95
5	119
6	143
7	165
8	191
9	213
10	237

Appendix B

FLEX-CABLE

"LUNCH BOX"
MICRO & MILLI OHMMETERS

ECONOMICAL TROUBLESHOOTING TOOLS TO HELP ELIMINATE DOWN-TIME!

Micro-Ohmmeter: Used for troubleshooting secondary welding circuits. Measuring Range, 3-1999 micro ohms.
Milli -Ohmmeter: Used for troubleshooting primary circuits. Measuring Range, 0.3-199 milli ohms.

MICRO-OHMMETER: Part Number = MOCT7550
MILLI-OHMMETER: Part Number = MOCT7600

Contact FLEX-CABLE for additional information and pricing.

Sales and Administration Office
5822 N Henkel Road
Howard City, MI 49329
fax: 231-937-8091
800-245-3539
sales@flexcable.com

1.800.245.3539

www.flexcable.com

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