OPERATING MANUAL

FOR

THE AWU-4A WINCH CONTROLLER

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FIGURES

TABLES

CHAPTER 1

1. AWU-SERIES WINCH CONTROLLERS

This is a manual for the Goddard Design Company AWU-4a controller and the LEX-6 expansion module.

The Goddard Design AWU-Series is a family of electronic motion controllers for mechanized scenery. The AWU controllers allow theatrical pieces to be moved accurately and repeatedly to their playing positions. They facilitate the moving of many types of scenery that are hard to shift by hand. They also allow the smooth fluid movement which is important in today's theatre.

The AWU-Series has an accuracy of 1:2000 - or better than 1/4" in 50 feet of travel. Playing positions are stored as LIMITS in reliable, non-volatile memory. Acceleration, deceleration and speed controls are fully adjustable.

The AWU-Series is modular, making it as cost-effective to mechanize one piece of scenery as twenty. Equipment can be purchased as it is needed, building inventory.

The full AWU-Series includes auxiliary equipment such as the REM-ST unit to provide Remote "Go", "All Stop", Emergency Stop, and Start Sub-Grouping. Such equipment is discussed in this manual only to the extent that its presence in a system affects the AWU-4a. For a full discussion of the installation and operation of such equipment, please refer to the manuals specifically for those units.

As a manual for a specific piece of equipment, there are several things that this manual will not do:

1. It will not teach you the fundamental electrical and mechanical requirements for scenery mechanization and motion control. It assumes that you are already familiar with these concepts.

2. It will not provide instructions on how to install a mechanization system, except to the extent that the AWU makes certain requirements of a system.

3. It will not recommend specific components for a mechanization system. Several companies, including Goddard Design Co., offer mechanization components for

sale. Again, except to specify the type of interaction these components must provide with the AWU, no specific recommendations are made.

4. It will not offer engineering advice on any part of a mechanization system except the Goddard Design Company AWU Controllers. The problems of motion control and mechanization are too broad and too case-specific to be within the scope of an equipment manual.

What this manual will do is teach you how to use your AWU-4a controller to cue and run a system of mechanized scenery.

This manual is divided into three major sections.

Section **1** is an overview of the equipment, including front panel control drawings and a diagram of complete mechanization systems.

Section **2** is an operators' manual. It contains explanations of how to run a show, and how to set up and cue a show using an AWU. Daily safety check-lists and other information of importance to the run-of-show operator are included here.

Section **3** is an installation guide. The most technical discussions of mechanization are in this section.

Each section is a self-contained manual on its topic. To use this manual, please read - in their entirety - the sections which are appropriate. Information on some subjects is included in more than one section. If you are looking for information on a specific subject -how to use Emergency Stop, for example - look up "Emergency Stop" in the index for a complete list of all the appropriate paragraphs. The body of the manual also contains cross-references to other sections where appropriate.

1.1 A SAFETY NOTE

You will find as you read this manual that certain points on the safe operation of mechanized scenery are repeated again and again. This is no accident - and the repetition starts here.

WITHOUT PROPER CARE, MECHANIZED SCENERY CAN BE DANGEROUS. THE IMPORTANCE OF KNOWLEDGEABLE, SAFE OPERATION OF AN AWU CANNOT BE STRESSED ENOUGH.

This is a good place for one other cautionary note. There will be moments in a show - especially if you are new to mechanization - when the process will seem more complicated than just having some stage-hands push the scenery into place. This is a trade-off for a show that runs smoothly, reliably and consistently.

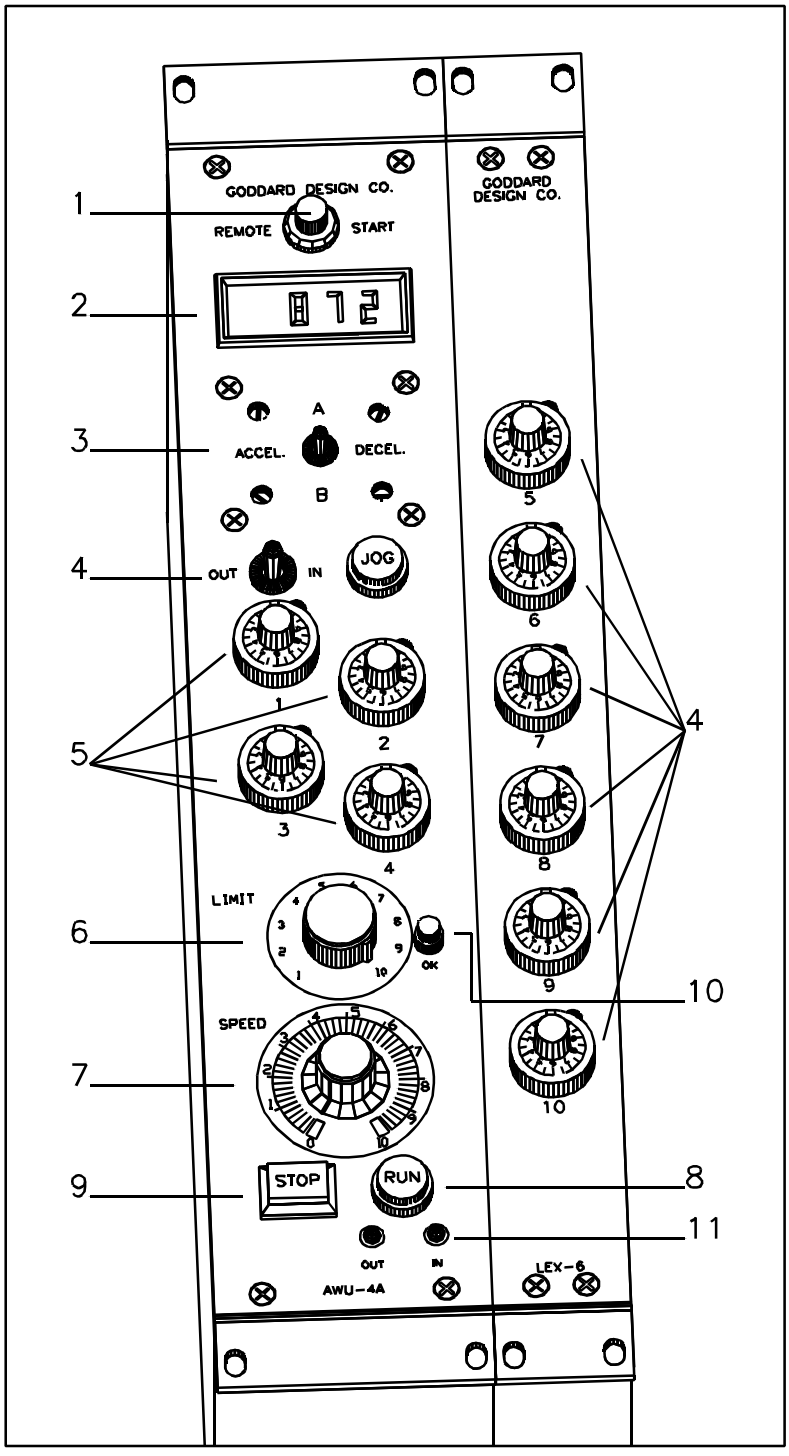


Figure 1 - The AWU4am and the LEX-6

1.2 FRONT PANEL CONTROLS

All of the controls for operating the AWU-4 and the LEX-6 are located on the front panel.

1. REMOTE START BUTTON. At the top of the AWU-4 front panel is the REMOTE START Button. When this button is depressed and showing a yellow center this AWU-4 unit will respond to a Remote Start signal from the Master Panel. This is an alternate action switch - pressing it again raises the plastic cover and hides the color tab underneath, turning the button black. In this position, the Remote Start function is disabled.

2. DIGITAL POSITION METER. The Digital Position Meter indicates the current location of the scenery.

3. ACCELERATION AND DECELERATION CONTROLS. The acceleration and deceleration controls are located near the top of the panel, below the REMOTE START Button. Two different preset acceleration and deceleration rates are possible on the AWU-4a. The rates are set using a small screwdriver to adjust the recessed potentiometers. The two potentiometers on the right side of the AWU-4 are the DECEL Pots. The two potentiometers on the left side of the AWU-4 are the ACCEL Pots. In the center of the potentiometers, the A/B Switch allows the operator to switch between pairs of preset acceleration and deceleration rates.

4. JOG ENABLE BUTTON and JOG SWITCH. The JOG controls are located in the middle of the panel between the ACCEL/DECEL Controls and the LIMIT Dials. In the JOG Mode, the piece of scenery may be moved without using a preset limit. On the right side of the panel is the orange JOG ENABLE Button. This is an alternate-action button switch. When the JOG Mode is enabled, the JOG ENABLE Button will light, and the STOP Button at the bottom of the panel will go out. Pressing the JOG ENABLE Button again disables the JOG Mode, turning off the light under the JOG ENABLE Button and lighting the STOP Button.

   Next to the JOG ENABLE Button is the JOG Switch. This is a momentary contact switch that must be held in the desired direction of travel.

5. LIMIT DIALS. In the middle of the front panel of the AWU-4a are the four LIMIT Dials. Six additional LIMIT Dials are the only controls on the LEX-6. These look like small combination locks, with a number showing in a window on the top of the dial face. In addition, on the upper right side of the LIMIT Dial is a locking mechanism.
   Some models include an optional Digital Position Meter, located at the top of the

panel. This meter displays, on a scale of 0 - 1000, the current position of the unit.

6. LIMIT SELECTOR SWITCH. Below the LIMIT Dials is the LIMIT Selector Switch. This is a ten-position switch with numbered positions. The first four positions correspond to the four LIMIT Dials on the AWU-4. The fifth thru tenth positions correspond to the six LIMIT Dials on the LEX-6. If there is no LEX-6 installed as part of the system, only LIMITS 1-4 are active.

7. SPEED DIAL. The SPEED Dial sits immediately below the Limit Selector Switch. The dial plate is numbered from 1 to 10. The dial itself travels smoothly between numbered points. The SPEED Dial is used to set the speed at which the piece of scenery will travel in both JOG Mode and RUN Mode.

8. RUN BUTTON. Two button switches sit below the SPEED Dial. On the right is the green RUN Button. This button is pressed to start a cue in motion. When the AWU-4 is in JOG Mode, this button is disabled, and scenery can only be moved using the JOG Switch.

   Do not attempt to move a piece of scenery using the RUN Button until you have read Chapters 3 (Running a Show) and 4 (Cueing).

9. STOP BUTTON. Next to the RUN Button is the red STOP Button. This button is used to stop the motion of a piece of scenery while a cue is running. Like the RUN Button, the STOP Button has no function when the AWU-4 is in JOG Mode. When the AWU is operating in REMOTE START, the STOP Button on the front panel has no function.

10. OK LIGHT AND SWITCH. The OK Light is a green LED illuminated switch located next to the Limit Selector Switch. This light should be on at all times when the unit is in operation. The function of the switch is to bypass momentarily the machine limits. A detailed description can be found in section X.x.

11. IN and OUT LIGHTS. The IN and OUT indicators are a green (IN) and yellow (OUT) LED located on the bottom of the panel. These lights are used to show the direction a piece of scenery will travel to reach the selected LIMIT.

CHAPTER 2

2. COMPONENTS OF A WINCH SYSTEM

This chapter briefly describes the various components that make up a winch system using the AWU controller. Figure 2 is a simplified block drawing of a winch system. Components in the drawing are described in the keyed list following the drawing.

This chapter defines the terms used throughout this manual in referring to components of a winch system, with a brief description of their function.

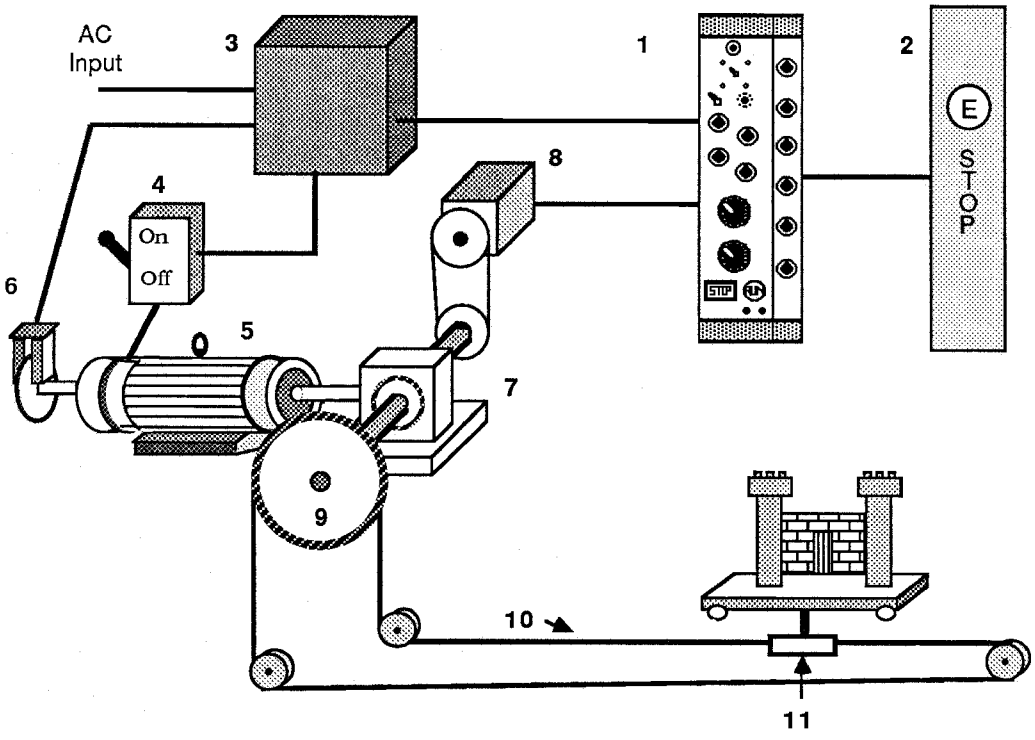


Figure 2 - A Simplified Drawing Of A Winch System.

2.1 **The AWU Controller**

The AWU stores the desired limits and during the running of a cue continuously computes the proper motor speed. The speed output of the AWU is a low voltage control signal. It and two other control signals are intended to control a variable speed motor drive. The AWU cannot directly control motors.

2.2 **The EMERGENCY STOP Switch**

The EMERGENCY STOP Switch causes the AWU to disable the motor drive so that the winch can neither be JOGGED nor RUN. The Goddard Design Co. REM-ST units include an EMERGENCY STOP Switch.

2.3 **The Motor Drive**

The Motor Drive converts the control signals to the proper power level voltage to power the selected motor type. To use all the capabilities of the AWU the scenery must be driven by a variable speed motor drive. Normally the drive will be a Four-Quadrant Regenerative DC Motor Drive. It must be chosen properly to operate the selected motor type.

If an optional mechanical brake (6) is fitted in your system, control logic to energize the brake must be included in the drive.

If a tachometer (not shown) is needed it will be connected to the drive, not to the AWU. See Section 5.7 for more information on selection of a motor drive.

2.4 **The Motor Disconnect**

A winch system must include a means of electrically disconnecting the winch motor. The motor disconnect is installed in close physical proximity to the motor so that personnel working on the motor can be sure that the winch will not be accidentally started while it is being worked on.

The selection of the device to provide the electrical motor disconnect is beyond the scope of this manual.

2.5 **The Motor**

The normal motor is a DC permanent magnet type. DC motors are the easiest type to use in variable speed service. Permanent magnet motors require fewer wires and generally give better performance than field wound types.

Different jobs may require motors with power output anywhere from 1/70 horse power to 15 or more horse power. Motors from 1 to 3 hp are the most commonly used. At this time 4 hp is the most powerful permanent magnet motor made.

More information on motors is in Section 5.7 on Selection of a Drive, but detailed

information on the selection of a motor is beyond the scope of this manual.

2.6 **The Mechanical Brake** (optional)

If the attached scenery load is at all likely to move by itself fitting a mechanical brake will be necessary. Flying pieces almost always need brakes; deck pieces require them less often.

The brake must be able to hold the torque caused by the full unbalanced weight of the scenery at the point in the system that the brake is installed.

The brake should be electrically operated and be of the fail safe type. A fail safe brake is released by electrical power; when the power is turned off, the brake sets.

Selection of a brake is beyond the scope of this manual.

2.7 **The Transmission**

The transmission provides the necessary gear ratio between the motor and main drive gear or drum. It may be a worm gear type or a chain and sprocket type or if it is located before the encoder it may be a belt type. It must be able to handle the full torque of the motor, and if a motor mounted brake is used, it must be able to handle the full torque that the brake can generate when stopping a piece travelling at full speed.

Selection of a transmission is beyond the scope of this manual.

2.8 **The Encoder**

The encoder is how the AWU knows where the scenery is. The system cannot be more accurate than the encoder or more accurate than the coupling of the encoder to the scenery. The coupling system between the encoder and scenery must have no possible slip, and have as little backlash as possible.

The AWU requires that a precision single or multi-turn potentiometer be used as the encoder. Multi-turn pots are used more often because they make the systems less sensitive to errors caused by certain types of backlash. Goddard Design Co. can provide encoder potentiometers. Goddard Design Co. will also offer encoder assemblies (limit boxes). Please contact the factory for up-to-date data.

More information on the encoder and its selection is in section 5.5.

2.9 **The Main Sprocket or Drum**

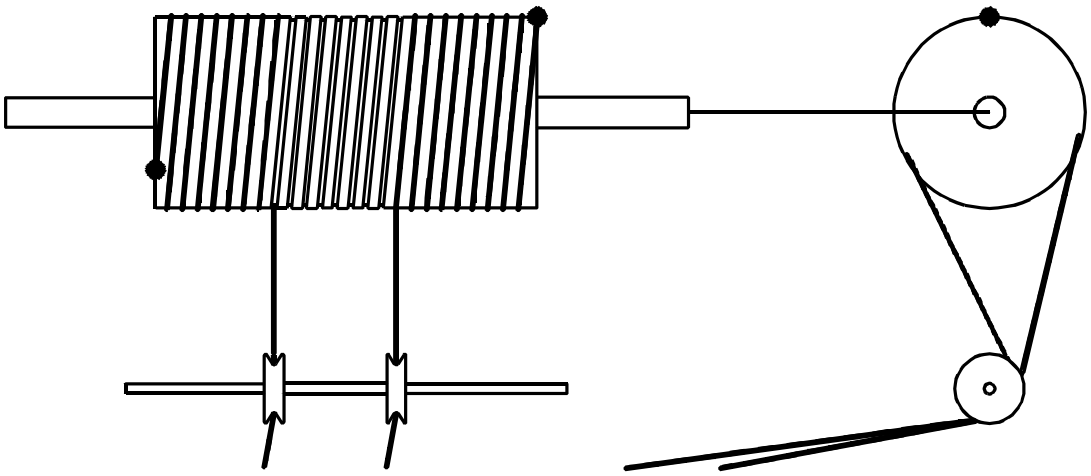


Figure 3 - Schematic Drawing Of A Cable Drum

For correctly repeated scenery positioning it is important that the encoder track the movement of the scenery exactly. If the encoder is connected to the main transmission (as is commonly the case) all drive members after that point must allow ZERO slip.

Our block drawing shows the main sprocket driving an endless loop of chain. Intellectually a main sprocket driving a loop of chain is the easiest to understand. As long as the chain cannot come off the sprocket, a chain drive will stay accurate to the play of one link on one tooth of the sprocket. Chain drives are sometimes used for traveller tracks and turntables, but they tend to be expensive. Chain also tends to have a noise problem.

Drum winches provide excellent results. But the drum type must be chosen carefully. Smooth surface drums designed to handle multiple layers of cable will cause the position to vary with different cable winds. Windlass type winches, sometimes called "mules" in theatrical use, where the cable is driven by the friction, may be fine for getting a light pipe to its dead tie point but they will not maintain position accuracy.

The cable must be dead tied to the drum. Only single layer wrap drums should be used. Except in dead lift flying systems a cable loop should be used.

Figure 3 schematically shows a drum that feeds and takes up cable at the same time. The drum is grooved (white lines) so that it winds evenly. The cable is dead tied at either end of the drum (large black dots in the front view). The drum has two

lengths of cable (black lines), one wrapped from the left end towards the middle, paying off the back of the drum, the other wrapped from the right towards the middle paying off the front of the drum. When the drum rotates it pays out and takes up equal cable lengths. The two idler pulleys shown maintain tension and guide the cable onto the drum. Generally they will be free to move left or right on their shaft.

Detailed description of drum design is beyond the scope of this manual.

2.10 **The Endless Drive Line**

The drive line is the longest moving part of a system. It must be able to transmit the maximum possible force that the system can develop while maintaining a good safety margin. It must be taut. If it is slack rough motion can result. All cable and chain stretches, so you will need a method of taking up the slack. Modern plastics may be very strong but they usually stretch more than metal. Any noise made by the drive line is the most likely noise to be heard in the house.

2.11 **The Scenery Connection Point or "Dog"**

If a winch drives only one unit or is connected to a counterweight carriage this connection will be permanent. But if more than one unit is to be connected, a quick secure connection method, which does not introduce play into the system, will be needed. Again be careful; we have seen sloppy "dog" design make an otherwise well built winch move poorly.

Poor connection of the scenery to the cable can also cause safety problems.

As with all mechanical parts, great care should be given to preventing failure, and thought should be given to what would happen if a given part should fail.

The AWU equipment is designed to be used by people and facilities who are already familiar with motor mechanized scenery and the required technical and safety problems.

If you are not already working with motor mechanized scenery, there are several shops and rigging manufacturers who can provide the needed mechanical sub-systems. Some of these suppliers can provide complete systems using our motion control products. Please consult Goddard Design Co. for a current list.

CHAPTER 3

3. RUNNING A SHOW

3.1 BASIC OPERATION

This section describes how to use the AWU-Series Controllers to run a show. It assumes that you have already installed your AWU and have already set the LIMITS for the piece of scenery being controlled. If you are not sure about the condition of the winch, scenery and controller, DON'T DO ANYTHING. Remember this is serious equipment. You could damage an expensive piece of scenery or hurt someone by playing around. Unlike lighting boards, there is no "blind" mode. So…after you are sure that the AWU is ready for use…

If you are not familiar with the front panel controls, turn back to the section in Chapter 1 describing the controls.

3.1.1 The Digital Position Meter

The Digital Position Meter will indicate the current location of the piece of scenery. If the piece is moving "IN" the number will get larger; if it is moving "OUT" the numbers will decrease. The meter reads in an arbitrary scale of 0 to 1000. This scale is the same as is used by the Limit Dials. The first AWU to have a Position Meter was #802063.

There are two ways to use the AWU to move a piece of scenery. One is by selecting a previously set LIMIT, and using the RUN Button to start the winch.

You will notice that the RUN Button has no "direction" switch associated with it, only two indicator lights labelled "IN" and "OUT" on the bottom of the panel. This is very important. When you select a LIMIT, the AWU moves the piece towards that limit from wherever the piece happens to be. You, as the operator, are responsible for knowing what will happen when you start a piece of scenery moving.

The other way to move a piece of scenery is to use the JOG Switch for manual operation. The next section describes operating the AWU in JOG. Later sections in this chapter describe operating the AWU using the preset limits.

3.2 USING JOG

The JOG mode is the simplest way to move a piece of scenery. Engage the JOG Mode by pressing the amber button near the top of the panel. The amber button will now be lighted and the STOP Button will go dark. You can then move the piece by pressing the JOG Switch to the left or right.

The JOG Switch is a momentary contact switch. When you engage the JOG Switch the green RUN Lamp will light up, and the piece of scenery will begin to move if the SPEED Dial is set to a value above zero. The AWU will accelerate at the preset rate until it reaches the speed currently selected on the SPEED Dial. The unit will only move as long as you hold the switch in the direction you have selected. When you release the switch, the unit will brake to a stop as fast as possible.

BOTH HIGH SPEED AND FAST BRAKING ARE POTENTIALLY DANGEROUS, SO WE RECOMMEND THE FOLLOWING PROCEDURE FOR USING JOG:

1. Set the SPEED Dial to "0". This will ensure that you are in control of the speed of the unit. Even when the JOG Switch is engaged, the unit will not move because its speed is zero until you change the speed setting.

2. Engage the JOG Mode by pressing the amber button.

3. Engage the JOG Switch, selecting the direction in which you want the scenery to move.

4. Watching the piece of scenery, slowly turn the SPEED Dial to start the piece moving.

5. As the piece of scenery nears its destination, slow it down by turning the SPEED Dial counter-clockwise. Then stop it by turning the SPEED Dial all the way to 0 and releasing the JOG Switch.

Don't try to move a piece of scenery too fast. There are no rewards for getting it across the stage in a hurry only to have it shake all of its set dressing out of place.

Watch the scenery to make sure it is doing what you think it should do.

If you are JOGGING a piece of scenery and the unit stops by itself, you have probably come to the end of the encoder. The AWU automatically stops scenery at the end of the encoded travel

to prevent damage to the encoder or the winch. If you are not at the end of the track - on or offstage - something is wrong. You will find a complete discussion of problems in Chapter 7 -Testing and Adjustments.

3.3 SAFETY.

Before we go further, a few words on safety.

We presume you know the safety rules for using a rigging system, or manually moving large pieces of scenery. Those rules apply just as much - even more - to using a motion control device such as the AWU. "Even more" because an AWU could be used to move a flying drop one day, a simple lightweight prop the next, and a massive wagon on the third. Mechanization brings power and power brings responsibility.

3.3.1 Daily Safety Check

Before each rehearsal or show, run a safety check to ensure that the AWU and the winch it controls are operating properly.

1. Engage the EMERGENCY STOP system. Different installations have different EMERGENCY STOP configurations. A more detailed discussion of EMERGENCY STOP systems can be found in Section 5.3. With the EMERGENCY STOP system engaged attempt to operate **EACH** AWU in the JOG Mode. The RUN Lamp will come on, but the winch will show NO sign of life. The OK LED will be out. If any other condition exists it MUST be corrected NOW.
2. If you have a Master Panel with an ALL STOP button do the following check.

    1. Check that the Master Panel is enabled.

    2. Check that the OK LED is lit on all the AWUs.

    3. Press the ALL STOP button. Check that the OK LED on all the AWUs goes out.

    4. Release the ALL STOP button, check that ALL the OK LEDs return to a lighted state.

3. Check that all pilot lamps are working daily.

    The STOP Lamp is lit whenever the AWU is in the RUN Mode.

    The JOG ENABLE Lamp is lit whenever the AWU is in the JOG Mode.

The RUN Lamp will light when the unit is moving during a JOG as well as during a normal RUN. So the RUN Lamp may be checked while you are doing the operation check, below.

4. Operation Check

1. Engage the JOG Mode. JOG the unit just off its storage limit. Check that the proper direction indicator LED comes on. Check that the numbers on the Digital Position Meter move in the appropriate direction. Stop the unit.

2. Engage the RUN Mode. Using the pre-set limits, RUN the unit back to its storage limit. Be prepared to stop the unit, using the STOP Button.

5. Machine Limit Bypass Switch (OK switch)
If your AWU has Machine Limit Bypass Switch fitted the OK LED will be part of a small momentary switch. Depressing and holding this switch will allow moving a winch off of absolute limit.
1. **It is very important that this switch not be stuck in the depressed or bypassed position.** Therefore every safety check should include a check that this switch moves freely returning to its **OUT** or non bypassed position.
2. The actual Machine Limit Switch should be tripped to determine that it does cause the winch to enter its Emergency Stop state.

3.3.2 Personnel Safety

1. NEVER LEAVE THE CONTROL STATION WITH ANY AWU WINCH CONTROLLER IN A RUNNING MODE (e.g. WITH ITS RUN LAMP ON).

2. NEVER place ANY foreign object into a winch, its track or its rigging when it is POWERED UP. Even if you think the winch has lost power because it is not making any noise, it may have jammed quietly. UNPLUG THE MOTOR OR USE THE SAFETY SWITCH TO REMOVE POWER FIRST.

HUMAN BODY PARTS are the most easily damaged foreign objects. Keep your DAMN FINGERS out of the WINCH, ETC. unless you KNOW there is no power to the WINCH motor. UNPLUG THE MOTOR OR USE THE SAFETY SWITCH TO REMOVE POWER.

3. If trying to free a mechanical problem at the winch with an operator at the controller, remember that communications are often garbled. "NO" may sound like "NOW". NEVER work on the winch, on the rigging, or the cables unless YOU are personally in control of the safety switch or the motor plug. This will slow you down if multiple tries are needed but it will save fingers.

3.3.3 EMERGENCY STOP

The EMERGENCY STOP Button is a switch which is external to the AWU-4a. Engaging the EMERGENCY STOP causes the AWU to disable to motor drive, so that the winch can neither be JOGGED nor RUN.

If the winch is RUNNING when the EMERGENCY STOP is engaged, (and the piece of scenery is moving) it will shut down and coast to a stop. (A more detailed discussion of deceleration and coasting will be found in the sections on Deceleration in Chapter 4.5)

If the winch is not moving when the EMERGENCY STOP is engaged, it cannot be started until the EMERGENCY STOP is disengaged.

3.3.4 Lamp Burnouts

The RUN lamp, the STOP lamp and the JOG ENABLE lamp are all incandescent lamps. They should be checked daily but they can burn out at any time. The AWU operates normally without these lamps, but provides no safety indication. If the RUN lamp is out you do not know if a unit is still RUNNING. If you are not sure, press the STOP Button.

In JOG Mode, the JOG Lamp is ON, and the STOP Lamp is OFF. In RUN Mode, the JOG Lamp is OFF, and the STOP Lamp is ON.

The JOG Button is more nearly flush with the front panel when in JOG Mode than in the RUN Mode.

3.4 RUNNING CUES

A "cue" in motion control is different than a "cue" in lighting control. Running a winch cue is a multi-part procedure. Let's start with a definition.

3.4.1 What is a Winch Cue?

A LIMIT is the final resting place of the piece of scenery. Once the system is set up, a limit is a fixed point. Hence they are called "Absolute Limits". One LIMIT might be a point 5 feet upstage of the proscenium. When an AWU is RUN it will move the winch in whichever direction is necessary to approach the selected LIMIT. Therefore the direction of travel is dependent on where the scenery IS and where it will END UP.

A cue is not a LIMIT. A cue is a movement of a piece of scenery defined by several

parameters. These include:

1. The starting position of the scenery.

2. The position to which the scenery is to move (LIMIT)

3. The rate at which it is to accelerate (ACCEL)

4. The speed at which the unit is to travel (SPEED)

5. The rate at which it is to slow to a stop (DECEL)

A single limit might be used in many cues. For example, a wagon might have four positions - offstage left storage, offstage right storage and two playing positions. Each playing position could be approached from either direction. The first cue might move the piece from offstage left to position 1. The second cue moves the piece to position 2. The third cue moves it off right. The fourth cue moves it from off right to position 1…and so on.

3.4.2 Running a Cue

There are seven steps in executing a cue.

1. SELECT A LIMIT. Do this by turning the LIMIT SELECTOR Dial to the number of the LIMIT to which you want to move the unit. On a standard AWU- 4, you can only select LIMITS 1-4. If you also have a LEX-6, you can select LIMITS 1-10.

2. SET A SPEED. Turn the SPEED Dial to the selected speed.

3. SELECT AN ACCEL/DECEL RATE. Select one pair of ACCEL/DECEL settings by moving the A/B switch between the pots to "A" or "B".

4. CHECK DIRECTION INDICATOR. Check the IN/OUT LED's. Make sure that the LED that is lit up corresponds to the direction in which you expect the piece to move. If it does not, double-check your LIMIT Dial to be sure you have selected the correct limit.

   IF THE WRONG DIRECTION LED IS LIT, DO NOT PROCEED TO RUN THE CUE!

5. START THE UNIT. On the "Go" for the cue, hit the RUN Button. The RUN Lamp will go on.

6. WATCH THE UNIT. The unit will accelerate to the selected speed, continue to move at speed, and then begin to decelerate as the unit approaches the LIMIT. At

the LIMIT the unit will stop.

7. WRAP UP. The RUN Light will go out. There may appear to be a moment between the time when the unit stops and the light goes out. This is perfectly normal.

For normal cues, once you have set the cue up, the RUN Button is similar to a "Go" button on a computer lighting console. While ANY winch is moving the operator MUST be alert for any problem.

3.4.3 The OK LED

The OK LED stays on during the entire cue. In fact, the OK LED is on any time the AWU is in use. IF it goes out, that means one of three things:

1. EMERGENCY STOP has been engaged.

2. The main system enable on the Master Panel is OFF, or the Remote STOP Button is being held down.

3. An invalid limit has been selected. If you do not have a LEX-6 or other expansion module only LIMITS 1 thru 4 are valid. Selection of a LIMIT 5 thru 10 will cause the OK LED to go out and prevent the AWU from starting in a RUN mode of operation. Connecting an expansion module automatically enables LIMITS 5 thru 10.

3.4.4 Changing the SPEED of a RUNNING Winch

Although it is not often necessary, the speed of a RUNNING winch can always be changed by movement of the SPEED Dial. This makes it possible to speed up or slow down the movement of a piece of scenery to adjust to changes in other stage action. Changing the speed of a RUNNING winch will not affect its ability to reach its LIMIT accurately.

Turning the SPEED Dial to a higher number will increase the speed of the winch at a rate limited by the current Acceleration Rate.

Turning the SPEED Dial to a lower number will decrease the speed of the winch at a rate limited by the maximum rate of change of which the winch is capable.

This means that slow or moderate changes of SPEED will produce corresponding changes in winch speed. Sudden increases in SPEED will produce a controlled change in winch speed,

since the rate of change is governed by the Acceleration Rate. However, sudden decreases in SPEED will produce a sudden decrease in the speed of the winch, since it is NOT governed by the Deceleration Rate.

3.4.5 Use of the STOP Button

The STOP Button terminates a RUN. Pressing this button causes the AWU to electronically brake the winch motor to a stop, and then shut down the electronic drive. The winch will stop as quickly as it can under electronic braking. This not an instantaneous stop but it may be fast enough to shake set dressing.

3.4.6 Using REMOTE START

On the top of the AWU panel is the REMOTE START enable button. The purpose of this control is to allow or restrict the ability of the AWU to respond to an external "GO" command from a master panel. This allows several AWU controllers to be started on the same signal.

This button is an alternate action push button with a colored indicator. Normally this button has a black center, but when depressed (enabled) the center changes to yellow. When the button is showing a black center, the AWU operates normally under local control.

When the button is showing a yellow center, REMOTE START operation is enabled. In addition, the operation of the RUN button is changed.

On older AWU models (serial numbers earlier than 812067) the RUN button is disabled and the AWU cannot be started locally.

On newer AWU models (serial number 812067 and later) there are two modes of operation:

1. Enabling REMOTE START disables the RUN button, exactly like earlier models. This is the standard mode and units are normally shipped set for this mode.

2. Enabling REMOTE START does not disable the RUN button, and local control of the AWU is maintained.

Instructions for setting this mode of operation can be found in Chapter 6.

To start several AWUs on one "GO" you:

1. Select the proper LIMIT, SPEED and ACCEL-DECEL setting for ALL the AWUs that are going to move. This is no different from the normal cue set up so far.

2. Depress the REMOTE START button on all the AWUs that are to start together. Check that ONLY the AWUs that are going to start together in the NEXT group have the YELLOW center showing in their REMOTE START buttons.

3. On the "GO" press the start button on the Master panel. Check immediately that only the desired AWUs' RUN lamps came on. If any other unit started, stop it NOW.

4. Let the cue run normally.

Units that do not have the REMOTE START Button engaged (or newer units with their LOC strap installed) may be RUN in the normal manner, using their RUN buttons. A possible use of REMOTE START would be to fly three drapes simultaneously.

In a system with three Fly Winches and two Track Winches, a sample cue sequence might be:

1. Set up "Track #1" to take out a prop chair using local RUN (button black),

2. Set up "Fly #1, #2, and #3" to go to high trim and start remotely (buttons yellow),

3. And set up "Track #2" to bring in a prop bed.

To execute the cues:

1. On the first "Go" you would press the RUN button on the AWU controlling "Track #1",

2. On the second "Go" you would press the RUN button on the master panel,

3. And on the third "Go" you would press the RUN button on the AWU controlling "Track #2".

The REMOTE START function must be properly set up when the controllers are installed during the load-in. See Section 6.2 for information about REMOTE START installation.

The description above is for a single Remote Start Group, but the AWU-4a will support up to eight Remote Start Groups. These groups may be thought of as "submastered" start groups. They require a master panel or other control equipment designed to use them and special setup of the AWU. This is described in Section 6.2.

3.4.7 Simple Reasons AWU will not RUN A CUE

1. If the OK LED is off, the following possibilities exist:

1. EMERGENCY STOP has been engaged.

2. The main system enable on the Master Panel is OFF.

3. An invalid LIMIT has been selected. If you do not have a LEX 6 or other expansion module only LIMITS 1 thru 4 are valid.

2. The winch is already at the LIMIT you selected. It therefore has no place to go. If this is the problem, the AWU's RUN lamp may light for a moment and then go off.

3. Both the IN and OUT LED are off. This is the same problem as above. The winch is already at the LIMIT you selected. If the winch stops exactly at the LIMIT both LEDs will go out. It is common for the winch to stop so that one LED stays on or so that one or both LEDs flicker on and off.

4. If the normally lighted STOP button is off and instead the JOG ENABLE button is lighted, the AWU is in JOG. When the controller is in JOG Mode it will not respond to the RUN Button.

5. The REMOTE START enable switch is showing a YELLOW center. You are in Remote Start Mode and the local RUN button is disabled. (If you have a newer unit, when the LOC strap is installed, the local RUN Button will not be disabled, even in Remote Start Mode.)

6. All lamps and LEDs on the AWU are out. You have most likely lost AC line power to that controller.

7. If the RUN Lamp comes on but the winch does not move, check the following possibilities:

   1. SPEED Dial is set to ZERO.

   2. If the winch makes noise, you have a mechanical obstruction, or a jam of the scenic piece, the rigging or the winch. STOP the AWU IMMEDIATELY.

   3. If the winch makes NO noise, you may have lost AC power to motor drive. STOP the AWU!

3.5 SAMPLE CUE SHEET

CUE SHEET PAGE ____

Cue	RS?	WINCH	Limit	Speed	A/D	DIR	NOTES

CHAPTER 4

4. CUEING

4.1 CUEING WITH THE AWU

The process of cueing scenery using the AWU is a combination of setting LIMITS, and setting movement parameters. Unlike computer lighting consoles, there is no "blind" mode on an AWU. If you set a piece of scenery to move too fast, or to move through the current location of another piece of scenery, you will live with the consequences of that mistake "live". So, like the rest of this manual, you will find safety rules and some background discussion mixed in with simple instructions. Some of the points are absolute mechanical safety rules, some are "standards and practices" developed in use on many shows.

4.1.1 LIMITS and Cues

A LIMIT is a final resting place of a piece of scenery. Within the mechanical accuracy of the system, a LIMIT is a fixed point - an "Absolute Limit"- on the winch's travel. LIMITS are stored on the LIMIT Dials.

A CUE is not a LIMIT. A cue is a movement of a piece of scenery defined by several parameters. These include the starting position of the scenery, the LIMIT to which the unit will travel, the rate at which it is to accelerate, the speed at which the unit is to travel, and the rate at which it is to slow to a stop.

The next three sections discuss setting LIMITS, Speed, Acceleration and Deceleration in detail. At the end of those sections is a check-list for moving a piece of scenery.

4.2 SETTING LIMITS

The AWU series controllers allow theatrical pieces to be moved accurately and repeatedly to their playing positions. Setting the LIMITS is how we teach the AWU to hit its "marks".

4.2.1 The LIMIT Scale

A LIMIT is defined on a scale of 000-1000. Those numbers do not refer to any specific unit of distance - feet and inches, for example. Instead they name positions on the travel of a winch. The distance between the position named "010" and the position "011" is a function of the gear ratio between the encoder travel and the cable travel. While this is a fixed number for any given gear ratio, different gear ratios will produce different distances between points.

The position "000" is the farthest offstage position of the encoder. This will commonly also be the farthest offstage point of travel.

The position "1000" is the farthest onstage position of the encoder. This will commonly also be the farthest onstage point of travel.

Not every gear ratio will use the full range of the encoder. Some installations may have a travel range that does not extend all the way to "1000". However, if the point three feet stage left of the center line is at "465" , it will always be at "465" for this installation, no matter which LIMIT Dial is being used.

4.2.2 The Digital Position Meter

The Position Meter provides a digital display of the current position of the unit on a scale from 000-1000. In addition to its use in monitoring the movement of a piece of scenery while it is running, it can be used for checking the accuracy of LIMIT Dials which have to be reset.

4.2.3 LIMIT Dials and Position Meter Accuracy

The reading of the Position Meter should represent the current position of the winch with a maximum error of +/-3 numbers.

The AWU will return to the same LIMIT with a resolution of better than 1 part in 1000. On a well-installed system, this resolution can be as good as 1 part in 2000. Expressed in percentages, this is an repeatability of between 0.05% and 0.025%.

The LIMIT Dials have a dial to dial linearity of +/-0.25%. This means that different dials can express the same position with an accuracy of +/-2.5 numbers on the dial, in other words, up to 5 numbers apart. In practice a difference of up to 3 numbers on the dial setting has been the norm.

The maximum difference between a LIMIT dial and the Position Meter is 5.5 numbers, but in practice, a maximum difference of 4 numbers has been more useful.

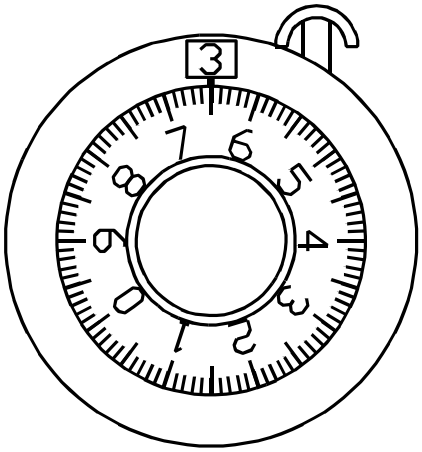
4.2.4 The Ten Turn LIMIT Dials

The LIMITS are stored on the LIMIT Dials. The AWU-4a has four. The LEX-6 expansion unit has six additional LIMIT Dials for a total of ten different LIMITS that can be stored at one time if you have both an AWU-4a and a LEX-6. LIMIT Dials may be reloaded allowing any number of limits to be used. However, reloading must be done accurately. Assuming a 50 foot travel each point on the AWU's 0 to 1000 scale, can represent up to .6"

4.2.5 Reading the Ten Turn LIMIT Dials

The standard dial looks something like a combination lock dial. In the center is a movable dial marked off with 100 marks. Every fifth mark is longer and every tenth mark has a number from 0 to 9 below it. Therefore "1" stands for 10 and "6" for 60. At the top of the fixed part of the dial is a small window which shows another digit from 0 to 9. This digit is the hundreds column - "1" stands for 100 and "6" for 600.

At the bottom of this window is a small mark. The setting on the movable dial opposite the window is the current setting of the movable dial. To INCREASE the number rotate the movable dial CLOCKWISE, to DECREASE the number rotate COUNTER CLOCKWISE.



D365

Figure 4 - Sample Dial Setting

As you turn the dial clockwise, the digit in the window will increment by one for every revolution. Similarly, counterclockwise rotation of the dial will decrement the digit in the window.

Thus, to set the dial to a reading of "365" the digit in the window must be "3" and the dial set so that the long mark between "6" and "7" lines up with the mark between the window. Figure 4 shows a dial set to 365. Figure 5 shows a dial set to 724.

Take a moment to practice until you can set the dial accurately.

Only if you are re-arranging the LIMITS on the LIMIT Dials, or reloading the LIMIT Dials during the show will you need to set a LIMIT "by the numbers'. In normal cueing you will set LIMITS by JOGGING the piece of scenery to the desired location and matching the LIMIT Dial to that position.

4.2.6 Matching the LIMIT Dials

Below the RUN Button are two LEDs; the green one is labelled "IN", the yellow one is labelled "OUT". Normally one of these LEDs is lit. This indicates the direction of travel from the winch's current position to the position defined by the selected LIMIT. In addition to their function as a direction indicator, the LEDs are used to match a LIMIT Dial to the current position of the scenery.

IF the winch is farther OFFSTAGE than the position called for by the selected LIMIT Dial, the IN LED will be lit, because the winch would have to RUN "in" to get to that LIMIT. If the winch is farther ONSTAGE than the position called for by the selected LIMIT Dial the OUT LED will be lit, because the winch would have to RUN "out" to get to that LIMIT. If the winch is at the spot called for by the LIMIT Dial BOTH LEDs WILL BE OUT.

This last point is important because it gives us an accurate way to set LIMIT Dials as follows:

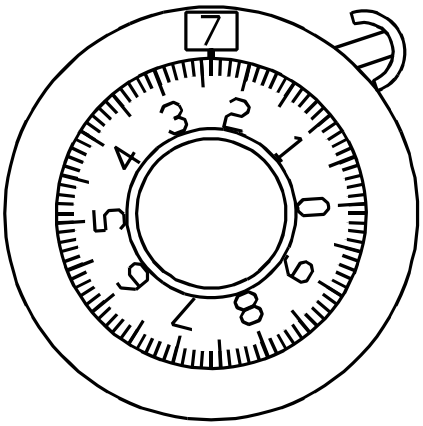


Figure 5 - Ten Turn Dial, Locked

1. Select a LIMIT Dial to be set. This is done by positioning the LIMIT SELECTOR Switch.

2. Release the lock on the LIMIT Dial. It is unlocked when the lever is moved toward the window in the dial. The dial in figure 4.1 is **unlocked**.

3. Check the Direction LEDS. If the Green LED ("IN") is on turn the dial counterclockwise. IF the Yellow LED ("OUT") is on turn the dial clockwise.

4. Watch the LEDs carefully. At some point the lit and unlit LED will reverse. Now reverse the direction you are turning and slowly back up until the lit LED goes dark. IF you are careful you can find a setting where BOTH LEDs are dark. This is the limit. You may well need to go back and forth a couple of times.

5. Relock the dial by moving the lever to the right of the window away from the window. Be careful not to knock the dial while doing this. The dial in figure 4.2 is **locked**.

6. Record the dial reading on the Limit Tracking Sheet. A sample of this form is in Section 4.8 and blank forms for duplication are in the Appendix.

4.2.7 LIMIT Conventions

Let's go over a few conventions. Some of these conventions are not required by the hardware, but have been found useful and should not be ignored without reason.

The first convention is based on a hardware requirement. If both the AWU and the winch are properly set up the following is true. An AWU with the winch at any mid travel position and a limit of 000 will always have the out (YELLOW) led LIT. An AWU with the winch at any mid travel position and a limit of 1000 will always have the IN (green) LED lit.

This must be checked during setup; running with this wrong can cause damage. This test is described in Section 7.2.2.

IN, OUT---ON,OFF---DOWN,UP---LOW,HIGH---ETC. There are many ways to describe the relative position of a theatrical piece. Some people believe that only their way is right. We

labelled the JOG control and the direction LED only once. We use "IN" and "OUT". Generally "IN" means bring IN the drop, bring ON the scenery, bring whatever to "LOW" trim etc. Generally movement in the "IN" or green LED should bring a piece from its storage position towards its playing position.

Nothing in the electronics requires, or guarantees, the direction of travel of a piece of scenery which is commanded to go "IN" or "OUT". The direction of travel is determined by many electrical and mechanical factors faced during design and installation of winch and the scenery.

Left and right have not been mentioned so far. A piece of scenery may come from the flys, from upstage, from stage left or stage right, or it can pop out of the traps. It is still coming "ON'" or "IN".

There are a few setups when consideration should be given to left and right as proper means of identifying the direction of travel. One is when you have a tracked stage with a track or tracks that run from wing to wing. Another is when even though a single piece may not run wing to wing it will play in conjunction with another piece that comes from the other side of the stage.

If you need to make all scenery, regardless of which wing it comes from, operate so that movement towards stage right equals "IN" you may need to take special steps during setup.

Directions on establishing the correct direction conventions will be found in Chapter 7 - Testing and Adjustments.

LIMIT Dial number "1" is conventionally used as the farthest "off" or "out" LIMIT. It is often the storage LIMIT. LIMIT Dial "2" is used as the next "on" stage LIMIT, etc.

In summary:

1. A LIMIT setting of "000" is all the way OUT.

2. Be consistent. "IN" should mean the same thing on all the AWU controllers. Take the time to set the system up consistently.

3. Relabel any controllers which do not follow the conventions. Relabel any controller where "IN" and "OUT" do not describe the motion of the scenery. Turntables are a good example. Relabel both the JOG Switch and the direction LEDs.

4. Generally LIMIT Dial number 1 is the farthest "out" limit and each higher numbered dial has a limit farther "in".

4.2.8 Setting a LIMIT

We assume you know how to run the AWU in JOG Mode. If you do not, read Section 3.2.

Once you are familiar with the operation of the AWU and the conventions, setting limits is simple and fast.

1. Check that the piece is clear to run, and that no personnel are in the way. Enable JOG mode.

2. JOG the piece of scenery to the first position. Stop the piece. JOG back and forth until you are on the mark correctly.

3. Select a LIMIT Dial to store this position.

4. Match the LIMIT following the instructions in Section 4.2 above.

5. JOG to next LIMIT and repeat the process until you have all the LIMITS set for that piece of scenery.

Remember that LIMITS are easily set - and reset. One of the nice things about the AWU Controllers is how easy it is. If there are several possibilities for the mark for a LIMIT, store them all - or set them all and record the settings. If the director suddenly wants to see the mark from two rehearsals ago, all you have to do is to look up that setting on the tracking sheet and load it into a LIMIT Dial.

4.2.9 Marking LIMITS Safely

As you can see marking LIMITS is technically very simple, but now we have to go over the ground rules of how to do it on a stage with real people.

1. Mark a storage position (i.e. high trim) first. When you break for dinner you want to be able to clear the stage without problem.

2. Keep good records. A tracking sheet may save time later. There is a sample tracking sheet in Section 4.8 and a blank version in the Appendix which can be reproduced.

3. This not a race! Move the piece at moderate speed. Unless you have velvet hands, you may well jerk, particularly when stopping.

4. When moving a piece of scenery in JOG keep the actor - and crew - well clear -and certainly not on the piece.

5. When the winch is moving in JOG YOU are controlling the winch, not the AWU. Give the job at hand your undivided attention. There are no special safety devices to prevent the piece of scenery you are moving from running into people or other pieces of scenery.

6. Generally at any one time only TWO people should be setting LIMITS: the person on the controller and the person on the deck calling off the marks. If you need other people to watch for possible rigging fouls or other problems be sure they are ready, but the "design committee" should comment only when the piece is not moving.

7. When a piece is moving or about to move you and the deck person must be in absolute control, therefore:

   1. If the costumer and the choreographer are having a loud argument in your ear, STOP until they are finished.

   2. Tell the leading man this is no time to run lines.

   3. The lighting designer will have plenty of time to clean up shutter cuts later. While you are moving scenery, tell him to shut up.

   Much of the above will not make you popular, but the ground rules are simple. While you are moving a piece to set LIMITS this is the ONLY important thing going on. If the other people on stage don't like it the only responsible thing to do is cease operation.

4.3 ACCELERATION, DECELERATION AND SPEED

Please read the entire section on Acceleration, Deceleration and Speed before attempting to run a piece of scenery.

The AWU has variable acceleration, deceleration and speed controls. These controls allow adjustments both for the weight of the piece of scenery being moved and for aesthetic considerations.

The Acceleration Controls are located near the top of the panel on the left side above and below the label "ACCEL". The Deceleration Controls are located near the top of the panel on the right side above and below the label "DECEL". The pair of ACCEL, DECEL controls on top are preset "A" and are so marked. The ones towards the bottom are preset "B". The A/B toggle switch between the controls selects whether the "A" or "B" set of controls is presently active. The SPEED Dial is located near the bottom of the panel below the LIMIT SELECTOR Dial. It is labelled SPEED.

4.4 ACCELERATION

Acceleration is the rate at which the winch motor reaches the selected speed. The length of time the motor will take to reach that speed - and thus the duration of the acceleration -is a function of both the speed to be reached and the selected rate of acceleration. For right now, you probably only need to remember that acceleration is a RATE not a TIME, although it can be

discussed in either terms.

4.4.1 Determining the Maximum Acceleration Rate

The maximum acceleration rate (e.g. the minimum time for a piece of scenery to accelerate from stop to its running speed) is dependent on many things. Working to keep a piece stationary is the mass of the piece, including any counterweight, the mass of the motor, transmission losses, and other friction. Working to start the piece is the cable starting torque, which is the starting torque of the motor as modified by the gearbox.

A detailed description of how much starting torque is needed for any piece is beyond the scope of this manual. But for every drive, winch and scenery combination there is a minimum time during which the scenery can be accelerated from a standstill to maximum speed. That is, there is a maximum acceleration RATE.

The ACCEL controls on the AWU can be adjusted to give a longer acceleration time than the minimum for the piece, but it cannot cause a piece to accelerate quicker than the minimum determined by electromechanical constraints. If this time is too long something in the winch, drive or scenery needs to be changed. Therefore ideally your winch should start your piece a little faster than you will ever need.

4.4.2 Acceleration Control on the AWU

Longer acceleration times (slow rates of acceleration) are often needed for pieces that start to move in full view of the audience, or for pieces carrying personnel or props. For these pieces the acceleration control will have to be adjusted to give the best theatrical results. For other sturdy pieces which start to move out of sight or under the cover of darkness the natural limits may be fine. Such pieces may often run with acceleration control set for minimum.

4.4.3 Setting the Acceleration Control

Clockwise rotation of an acceleration control decreases the RATE of acceleration. In practical terms, this will increase the time it takes to come to a given speed.

Because Acceleration is a RATE, the time to reach the top speed of any cue is dependent on the setting of both the ACCEL control and the SPEED DIAL.

4.5 DECELERATION

The electronic control of deceleration by the AWU is one of its most important functions. The presettable deceleration function brings scenery smoothly and repeatably to a stop at its mark. Long slow deceleration can be used to bring a platform to stop without spilling a glass of wine, while shorter deceleration will allow the shortest possible scene changes.

Like acceleration, deceleration is a RATE, so that the duration of time necessary for complete deceleration to a stop is a function of both the DECEL rate and the SPEED.

4.5.1 What Determines How Far a Piece Will Coast to Stop

The laws of motion say that a moving object will continue to move unless acted upon by external force. In the real world the primary force is friction.

If you simply remove power from a running piece it will coast to a stop. Working to stop the piece will be friction and if the piece is being flown "out", any unbalanced weight. Keeping it moving will be its mass, including any counterweights, and if the piece is being flown "in", any unbalanced weight. Because these factors are different for every set up no general statement can be made. Some pieces will stop naturally in a couple of inches; some will coast for a long distance.

The coasting behavior of a piece is important for two reasons. First, it determines how the AWU must respond to stop that piece in a controlled manner at the limit, and second it determines what will happen when the EMERGENCY STOP system is activated.

> Notes on Coasting During An EMERGENCY STOP
>
> Although the EMERGENCY STOP system is not the subject at hand a note is needed. The EMERGENCY STOP should shut down ALL electronic controls,immediately removing power from the motor. The piece will then coast to a stop. If the piece's coasting distance is long enough that it could lead to danger, a secondary braking method must be used. If a piece has unbalanced weight it may never stop until it runs into something. Therefore the following rules must be followed:
>
> - Unbalanced pieces that are flown or run on rake MUST have an electro-mechanical brake that can stop the piece from full speed and hold the weight.
>
> - Pieces that coast too far MUST have either an electro-mechanical brake or a secondary failsafe dynamic braking circuit.

4.5.2 How Deceleration Works

The presettable Deceleration Control sets the rate at which the scenery slows as it approaches its LIMIT. As this rate is set slower the scenery must start to slow down further from its limit. The AWU does this automatically.

The AWU constantly keeps track of the location of a running piece and compares it to the location of the limit where the piece is to stop. For any given rate of deceleration the maximum allowable speed of a piece can be calculated for any distance from the limit. The AWU constantly calculates this speed. IF the result is higher than the speed set on the SPEED Dial

the AWU deceleration circuitry does nothing, but when this maximum speed becomes less than the SPEED set on the SPEED Dial the AWU will reduce the Speed Control voltage sent to the motor drive, hence slowing the winch motor. In this manner the piece is slowed down to a stop at its limit.

For any given setting of the DECEL Control, the rate at which the winch will slow down is fixed. Also for any given setting, the maximum speed of a winch "X" feet from its LIMIT is fixed. But the distance from LIMIT at which the winch will start to slow down is dependent on the setting of the DECEL Control and the setting of the SPEED Dial. So also is the total time that the deceleration will take.

Depending on how quickly the winch naturally slows when coasting the motor drive will do one of two things. If the winch would naturally stop faster than is wanted the motor drive will continue to drive the winch and the piece, just ever more slowly. If the winch would naturally stop more slowly than is wanted, the drive will electronically brake the motor so that the winch stops as desired.

4.5.3 Trying to Stop Too Quickly

Most four quadrant drives can provide a braking force equal to their maximum driving force. It is important to note that while the drive can brake, it can only brake so hard. You can ask an AWU driving a light weight traveller to stop on a dime and it will likely do it. But if you try to stop a heavy, counterweighted wall too quickly even full reverse power won't stop it in time. The piece will overshoot its limit. This is the only way you are likely to ever get an AWU to overshoot its limits.

It works this way. If you are driving your car 60 MPH and you wait until you are 25 feet from the wall before you hit the brakes, it doesn't matter that you can see for your last half second that you should be stopping faster; there is nothing you can do about it. What is more if you have 1000 pounds of rocks in your trunk you will need more distance to stop than normal. You might be able to stop normally in 75 feet but that distance is not great enough, with the extra weight, to prevent a crash.

If you are decelerating a piece slowly you seldom will have to worry about what is its fastest possible rate. But if a piece is likely to coast and you need to stop it quickly you must check that you can do it. This will be discussed later in Section 5.7.

4.5.4 Setting the Deceleration Controls

Turning the Deceleration Controls clockwise decreases the rate of deceleration. That is, it increases the distance from the LIMIT that deceleration starts, it increases the time taken to slow down.

Fully clockwise stops the piece as slowly as possible.

Fully counter-clockwise tries to stop the piece as quickly as possible.

4.6 SPEED

SPEED is the setting for the maximum rate of travel. The actual maximum velocity reached is dependent on the maximum RPM of the motor, and the gear ratio of each mechanical system. Hence no absolute scale, such as miles per hour, is given on the AWU-4. Instead, there is a relative scale, numbered from 1 to 10.

The SPEED Dial sets the maximum velocity at which the piece will run as a fraction of the maximum velocity possible within the mechanical constraints.

If a cue's travel distance is short you may never get to full speed, even with SPEED Dial at #10 because the AWU does not have enough time to accelerate before it reaches the beginning of its deceleration curve.

4.6.1 Duration of a Cue

SPEED is only one control which affects the total duration of a cue. The run time of a cue is dependent on the setting of ACCEL, DECEL and SPEED.

For the fastest possible cue, you must set the maximum acceleration rate, the maximum SPEED setting, and the maximum deceleration rate that will not cause the piece to overshoot its LIMIT.

4.6.2 SPEED Range

For any combination of winch, motor drive and piece of scenery, there will be a range of acceptable speeds. Some speeds may be so slow that they are not "useful". Speeds which are too high may cause problems by increasing the danger of the scenery fouling, by causing the scenery to run roughly, or by causing unacceptable danger to personnel - especially actors riding on a piece of mechanized scenery. You will have to find an acceptable range for each setup.

There are some ground rules to follow:

1. If all the cues on a piece run at SPEED 3 or less, your winch is probably geared too high. This hardware situation should be changed.

2. Select a SPEED which does not cause the scenery to foul. Drops or any flown pieces will have a tendency to billow at high SPEEDS.

3. Deck pieces can also foul at high SPEEDS. The condition of the track may be a factor.

4. Work up to high SPEEDS slowly. Even though this takes up some stage time, it will

prevent unpleasant surprises and damage.

5. If the run is short the winch may never get to full SPEED because the AWU will not have enough time to accelerate before it reaches the beginning of its deceleration curve. If the piece is very close to its LIMIT the normal deceleration setting may put the AWU into the deceleration curve right from the beginning.

   If a short, quick RUN is needed, a special setting of the ACCEL and the DECEL controls may be called for. This is one use for a "B" setting of the ACCEL and DECEL controls.

4.7 ACCELERATION, DECELERATION AND SPEED SETTING CHECK LIST

1. Select either the "A" or "B" preset DECEL and ACCEL controls. This is done with the A/B toggle switch between words "ACCEL" AND "DECEL".

2. Set the Deceleration Rate:

1. Use a small screwdriver to rotate the selected DECEL control all the way counterclockwise. Note the position of the slot. The normal alignment is such that the bottom edge of the screwdriver slot in the control shaft points to about 7 o'clock. If your control points to a different position when fully CCW you will have to compensate the following settings.

2. Set a trial setting by rotating the control CW (clockwise).

   If a piece of scenery is counter weighted, or is heavy but moves easily, or if overshooting the limit could cause damage, rotate until the edge of the slot that pointed to 7 o'clock is pointing to about 4 o'clock. Fully CW on the control should only go to about 5 o'clock.

   If the piece is light weight, and not counterweighted, or has a large amount of friction, rotate the control CW to about 12 o'clock.

3. Set the Acceleration Rate

1. Use a small screwdriver to rotate the selected ACCEL control all the way counterclockwise. Note the position of the slot. The normal alignment is such that the bottom edge of the screwdriver slot in the control shaft points to about 7 o'clock. If your control points to a different position when fully CCW you will have to compensate the following settings.

   2. Set a trial setting by rotating the control CW (clockwise)

A good trial acceleration rate can be set by rotating the slot to 11 o'clock. A piece with loose set dressing, or which is likely to vibrate should be initially tested with a very low acceleration rate, with the slot set to 3 o'clock. The maximum acceleration rate is with the slot set to 7 o'clock.
Pieces which start offstage, or in darkness may start at a maximum.

The acceleration rate selected will not affect the AWU's ability to stop the piece at its LIMIT. The absolute limit on the acceleration rate is in the motor and mechanical system's ability. Your only concern should be that the piece not start so suddenly that set dressing or actors are jarred.

4. Set the SPEED Dial

By this time you should have run the piece in JOG several times and have some idea of how fast it travels for a given setting of the SPEED Dial. Set the SPEED Dial for some moderate setting that should move the piece about 1/2 to 2/3 the SPEED you guess the piece will play at. Generally do not do your first RUN with the SPEED Dial set above #5.

5. Select a LIMIT to RUN to

    1. If there is ANY fear that a piece might overshoot, select a LIMIT that is not close to an obstruction or near the end of the winch's travel. If you need to set a special LIMIT just for this purpose, do so.

    2. With a flying piece DO NOT use the LIMIT that kisses the deck for your first LIMIT unless this is a soft piece that can afford to pile up on the deck.

    3. NEVER use a test LIMIT at the grid.

6. Go over the check list below for "Running a Cue"

    1. Is the OK LED on?

    2. Is the travel to the selected LIMIT free of obstructions of any sort? This includes debris, technical equipment and people.

3. Check the direction LEDs; if the IN LED is on, is it reasonable that the piece moved in or on from its present location? if the OUT LED is on, is it reasonable to move out or off to this LIMIT?

4. If the A/B toggle switch is in "A" setting did you set appropriate settings on BOTH "A" ACCEL and DECEL controls?

5. Get ONE person to watch for problems you may not be able to see.

6. Get the stage calm.

7. You should be ready to press the RUN Button. "GO" but be ready to stop by pressing the STOP Button.

7. Wait until the piece has stopped moving, check that the lit RUN Lamp (the green button) goes out within a few seconds of the piece stopping. If it does not, hit the STOP Button. If you have to hit the STOP Button, you may have the DECEL control set too far clockwise. Decrease its setting by turning counterclockwise and try again.

8. Check the resting place of the piece. Is it on its mark?

1. Most pieces will stop at their LIMIT properly the first time with almost any setting of the DECEL Control. But they may not do what was theatrically intended. Do you need to reset the ACCEL, DECEL or SPEED Controls to get the cue right?

2. If it did not reach its LIMIT and the RUN Lamp went out promptly you should check that you have not knocked the setting of the Ten Turn LIMIT Dial. It is also possible that you mis-set the LIMIT Dial in the first place. If you cannot figure out the problem go to Section 4.9 "Troubleshooting LIMIT Problems".

3. If it overshot its LIMIT, check by how much. If you press the RUN button again, and the piece moves back to its proper LIMIT you have definitely overshot. If the RUN lamp won't come on or comes on for a brief moment you most likely have not overshot the LIMIT but have come to the wrong LIMIT for some reason.

A sure check of how badly you have overshot can be made by using the LIMIT SELECTOR Switch to select ANOTHER LIMIT Dial, and then matching this dial to the piece's location. Now compare the reading of the limit dial you used to RUN to the one you just set. If the new dial has HIGHER number the piece is farther "IN" than the LIMIT, if the new dial has a LOWER number the piece is farther "OUT".

If these tests indicate overshoot increase the deceleration distance by turning the DECEL control clockwise. Then re-RUN the piece to LIMIT.

If simply increasing the deceleration does not fix the problem go to Section 4.9.

9. Before you can check a new setting of the DECEL Control, the ACCEL, or SPEED Dial, you must move the piece off the LIMIT. This can be done in JOG, but it is often best to RUN back to another LIMIT. You then RUN back and forth

until you have a setting that works well for you. The distance moved should be similar to the amount moved during performance.

4.9 TROUBLE SHOOTING OF PROBLEMS REACHING A LIMIT

The AWU has proved to be highly reliable. The electronics are not normally subject to "drifting". Once set a limit should stay set month after month. Like any equipment it can fail, but a winch system is a reasonably complicated electro-mechanical system and the AWU is one of the last parts that will give you trouble.

Problems that prevent a winch from coming repeatably to a LIMIT can be divided into four sub-groups. The first are problems that cause the winch to undershoot, i.e. never quite reach its LIMIT. The second are problems that cause a winch to overshoot, i.e. to travel beyond the LIMIT before stopping normally. The third are problems that cause a LIMIT or all LIMITS to progressively change, usually drifting either "on" or "off". The fourth and most serious group of problems cause a winch not to stop at its LIMIT at all.

4.9.1 Causes of Undershooting a LIMIT

There are several different things that can cause a winch to undershoot. The following is one set of symptoms. A winch with the scenery attached slows to a stop normally, but the green light does not go out. Usually it will then sit there or it may slowly creep ahead. When you stop the AWU with the STOP Button you will find that the piece is just short of its LIMIT.

Probable causes include:

1. The winch may be underpowered or have the wrong gear ratio. If the motor cannot run at more than 1/2 speed you have badly overloaded it, and it may not be able to drive the load at all at slow speeds. If this is the case you must either make the piece easier to move or gear the motor down further or increase its horsepower.

2. The speed control range of the motor drive is too narrow. Many motor drives have only a 20 to 1 range. If full speed of the motor is 1800 RPM 1/20 speed = 90 RPM. Below 90 RPM the drive may allow the motor to stall and still be within spec.

   This is generally only a problem with pieces that require high torque while pulling to a stop.

The solutions include:

1. If the piece is being run with a slow deceleration, which is not needed for theatrical reasons, rest the deceleration control slightly clockwise. Flying pieces that are out of balance may require different DECEL settings for "In" and "Out" travels.

2. A temporary solution is to use the STOP Button once the piece has stopped moving.

3. There is an internal adjustment in the AWU known as the "Speed at Limit Control". It is on the AWU printed circuit board (the main board). This should allow any motor drive with a 15 to 1 control range or better to be used. Setting this control for drive with low speed control range is a simple but not always ideal solution. In some setups it may cause the piece to stop less smoothly than normal. A description of the use and setting of this control is in Section 7.3.3.

4. Use a drive with 30 to 1 or better speed control range.

5. Fit the winch with a tachometer. This often gives 50 to 1 SPEED control range.

There are problems which can be caused by electronic "noise" getting into the encoder cable. The most common symptom of electronic noise is for a RUNNING piece to suddenly stop, or to stop without decelerating, with the RUN Lamp going out normally. Generally however you should thoroughly investigate mechanical solutions before deciding the problem is electronic noise.

If a piece stops short of its LIMIT, but otherwise runs normally, read the section "Causes of LIMIT Drifting" below.

4.9.2 Causes of Overshooting a LIMIT

If you are having problems with overshooting a LIMIT re-read the sections on deceleration. Too little deceleration time is the most likely cause of this problem.

If possible, RUN the winch without the scenery. If it RUNS correctly without the weight of the scenery, but overshoots with the scenery, then resetting the DECEL control should help.

Make sure that the winch is responding to changes in the setting of the DECEL control. If it is not, the problem may well be electronic.

Check that the LIMIT is not drifting. If it is drifting see the section on LIMIT drifting below.

4.9.3 Causes of LIMIT Drifting

Nine times out of ten, LIMIT drifting is a mechanical problem. The first thing to do is to check every shaft and mechanical connection for tightness.

There are also some systematic problems that can cause drifting. A summary is given below.

1. The encoding pot must be gear or chain driven. Rollers, untoothed belts, and tire drives are not allowed.

2. A turntable may be tire driven if the encoder pot is chain driven from a hub. A tire driven platform with the motor on the platform and the pot geared or chain driven by the motor is NO GOOD. The encoder must be absolute.

3. Winch drums must have only one layer of cable on them. Pile-up drums are not allowed.

4. The cable must be dead tied, or clamped to the drum. Friction is not enough force to prevent slipping.

Drifting may not happen consistently. It may only happen when the AWU is controlling a particularly heavy piece of scenery, or when one piece knocks into another. If you suspect drifting of a mechanical nature a good test is to move the winch in JOG as fast as is safe. Then stop the winch as quickly as is safe, often by just releasing the JOG switch. Then RUN the winch to a known limit slowly. If this causes drift your problem is almost certainly mechanical.

If limits below 500 and limits above 500 shift by different amounts you might suspect electronic problems. Also a gross change of limit positions on a setup known to be working may also mean electronic problems. Most problems, however, will be mechanical!

4.9.4 Causes of Failure to Stop at a LIMIT at ALL

If a winch fails to stop at its LIMIT - or fails to stop at all without the STOP Button or EMERGENCY STOP Button being used - you have a serious problem. It may be a bad case of LIMIT drifting as described above, but proceed with extreme care.

First determine if the STOP Button works. If it does not, hit the system EMERGENCY STOP Button. Then remove power from the motor drive powering the winch with the problem.

If STOP Button works, first check that the LIMIT SELECTOR Switch is set to the proper LIMIT. If it is, check the setting of that LIMIT dial against the setting recorded on your tracking sheet. Check that the LIMIT Dial is securely mounted to the front panel. If all seems well with the LIMIT SELECTOR and the selected LIMIT Dial, adjust that LIMIT Dial so that it matches the position of the scenery now. Record this new number.

Unless the original LIMIT was near 500 be very wary of any winch that matches within 10 points of 500.

JOG the winch a small distance - a foot or so, rematch the LIMIT, and compare with new LIMIT you have just set. If you JOGGED OFF the number should have decreased. If you JOGGED ON the number should have increased. If the number changes in the opposite direction than listed above, you have a polarity problem. See section 7.3.6.

If the number does not change one of several things may have happened. The encoder pot may

have become disconnected from the winch (i.e. dropped its drive chain). If the number does not change and is very near 500 the encoder may have been unplugged. If the connection is good, the cable or the encoder itself may be damaged. A description of encoder installation is in Section 5.5.

4.10 SAMPLE TRACKING SHEET

TRACKING SHEET PAGE _____

Win #	Cue	Dial	Value	Notes	SPD	ACC	DEC	Date

CHAPTER 5

5. TECHNICAL SETUP INFORMATION

This chapter provides the information needed to install an AWU-Series controller system. It assumes a moderate working knowledge of electrics and electronics. In each section we have tried to include a description of the function under discussion in plain English in addition to the technical description.

Please read the entire chapter and Chapter 6 - The RMI Card, before attempting to install the AWU. Because of its modular nature, the AWU-4a has options built-in, using switches, alternate plugging patterns, etc. You must understand all the options before you proceed.

This chapter, and the chapter on the RMI Card contain a lot of information about the capability of the AWU-Series in addition to the technical discussions. If you are working with scenery mechanization in any capacity, especially if you are about to use an AWU-Series Controller for the first time, you should read these chapters.

If you have already unpacked your controller and plugged it in - STOP RIGHT HERE. You will notice that the JOG ENABLE Button will light up if you press it, alternating with the STOP Button. The IN or OUT Indicator Lights may light up and may change as you turn the LIMIT Selector Dial. When the JOG ENABLE Button is lit, pressing the JOG Switch will cause the RUN Button to light, and the appropriate IN/OUT Indicator Light to light. However the OK LED will not light and the AWU-4a will not actually run a piece of scenery. You may also feel the vibration of the transformer.

Nothing is wrong with your AWU-4a. The AWU-4a has been designed so that it will not run unless several connections have been made, as a basic safety feature to protect you and your equipment.

Notice, too, that each connector on the back panel is different. This is to make it as difficult as humanly possible to get the wrong plug in the wrong place.

The fuse holder on the back panel takes a 1/4 Amp SB fuse. (AWU-4a models with serial numbers 704037 and earlier use an 1/8 Amp SB fuse.)

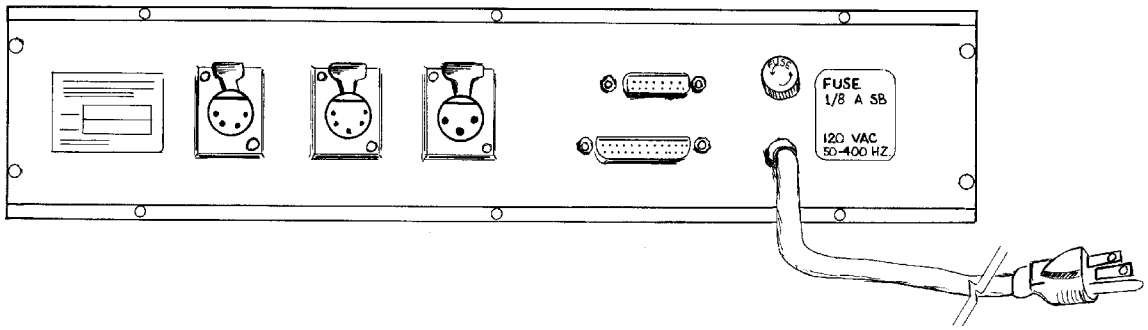


Figure 6 - AWU Back Panel Connectors

On the back panel you will find:

1. Encoder Connector: 4 pin Switchcraft connector
2. Motor Drive Connector: 5 pin Switchcraft connector
3. Machine Limits Connector: 3 pin Switchcraft connector
4. Master Buss Connector: 15 pin male D connector
5. Expansion Buss Connector: 25 pin female D connector
6. Fuse Holder: 1/4 Amp SB fuse
7. Power Cord

5.1 MASTER BUSS CONNECTIONS

AWU controllers require a connection on the Master Buss Connector for normal operation. Usually this is the cable to the REM-ST Master Panel. To use a single AWU-4a or to run without a Master Panel a "dummy plug" must be plugged in. This plug is sold as part #DP1.

If you use the Plug DP1 to enable the AWU-4a without using a Master Panel, YOU MUST PROVIDE SOME MEANS OF EMERGENCY STOP. THIS IS YOUR RESPONSIBILITY!

EMERGENCY STOP systems that can be installed without a Master Panel are described in Section 5.3.

TABLE
5.1 Pins Jumped On Master Shorting Plug DP1

7	EXT. STOP (low)
8	PS OUT
15	MASTER ENABLE/EMERGENCY STOP

5.1.1 Differences between STOP and EMERGENCY STOP

Before we go on, it is important that you understand the difference between STOP and EMERGENCY STOP.

Most stop functions including the STOP Button on the front panel and the Remote Stop line on the Master Buss bring the winch to a halt in the same way. They use the braking force of the motor drive to slow the motor until all motion has ceased.

EMERGENCY STOP is different. As its name implies, it is used to halt a moving motor in an emergency. When EMERGENCY STOP is engaged, it shuts down all electronic controls immediately removing power from the motor. The piece of scenery in motion will then coast to a stop as fast as it can (subject of course to natural forces such as friction and inertia).

For a more complete description of coasting to a stop, see Section 4.5 "Deceleration".

More specifically STOP works like this: when the control voltage on the Remote Stop line drops to zero, the Run Latch will be reset to the stop condition, turning off the RUN Light and forcing the motor drive control voltage to zero. This causes the motor drive to slow the motor to a stop using the maximum braking force of the motor drive. It does not remove power from the motor or engage the (optional) mechanical brake or dynamic braking resistor.

After a time delay the Run Loop Relay will open. The time delay is user-adjustable from about .250 to 3 seconds. When the Run Loop Relay opens one of two things happens depending on the type of motor drive used. Either the motor drive will immediately go into a standby mode, removing power from the motor, or it will wait until sensing circuits in the motor drive determine that the motor has stopped rotating and then go into the standby mode. If a mechanical brake is fitted it is normally set up so that it is engaged whenever the motor drive enters a standby or off mode.

EMERGENCY STOP, on the other hand, works like this: when voltage is removed from the EMERGENCY STOP line the Emergency Loop Relay opens. This opens both the Emergency Stop Loop and the Run Loop lines to the motor drive. (The drive must be configured so that opening the Emergency Stop Loop line removes power from the motor.) In addition, the STOP circuit described above is activated. This is done to clear the Run Latch and turn off the RUN Lamp.

5.1.2 Normal Remote Requirements

AWU controllers are normally shipped requiring both an Emergency Stop/System Enable signal and a Remote Stop/Run Mode Enable signal. They can also accept one Remote Start signal. The use of Remote Start is described in the chapter on the RMI Card.

TABLE
5.2 Master Panel Buss Connector Pin Out

1	REMOTE START #1
2	" #3
3	" #5
4	" #7
5	EXT. SPEED VOLTAGE
6	EXT. COMMON
7	EXT. STOP (low)
8	PS OUT TO EXT. DEVICE (24V or 15V)
9	REMOTE START #2
10	" #4
11	" #6
12	REMOTE START #8 OR SPEED REF OUT
13	REF. COMMON
14	EXT. COMMON
15	SYSTEM ENABLE/EMERGENCY STOP (low)

5.3.1 System Enable/Emergency Stop

For the AWU to operate it must have a +24 DC control voltage present on the System Enable/Emergency Stop line, (Pin 15 on the Master Panel Connector). The presence of the enables the system. Removing this voltage puts the system into EMERGENCY STOP. Normally this is the only external signal required for the AWU to operate in the JOG Mode. In addition, however you must have a closed circuit between Pin 2 and Pin 3 of the Machine Limit Connector. A full discussion of the Machine Limit Connector is in Section 5.2.

5.1.4 Run Enable/External Stop

For the AWU to go into the RUN Mode the AWU must also have a +24 DC control voltage on the STOP line (Pin 7 on the Master Panel Connector). Like the System Enable/Emergency Stop signal, this signal also acts as a fail-safe. For the unit to enter the RUN Mode the voltage must be present on this pin. When this voltage is removed the AWU goes into the STOP Mode.

5.1.5 Connection of REM-ST Master Panel

Full instructions for installing a REM-ST Master Panel come with the unit itself. The Master Panel connects to the AWU-4a by way of a 15-pin "D" connector cable. The female end of that

cable plugs into the Master Panel Buss Connector on the back of the AWU-4a.

You will need to provide 120 VAC at the location of the master panel for most uses.

5.2 ULTIMATE LIMIT SWITCHES AND THE MACHINE LIMIT SWITCH CONNECTOR

It is good practice for any winch that could do serious damage to scenery or personnel by running beyond its normal travel to be fitted with a mechanical switch that stops the travel in such an event. Such a switch is referred to as an Ultimate Limit Switch. There are many ways to fit such switches, depending on the particular use.

The AWU-4a is shipped with a male plug plugged into the Machine Limit Connector. Pin 2 and pin 3 of this male plug are shorted. If you are operating without an Ultimate Limit Switch, this plug must be plugged in for the AWU-4a to operate.

Beyond listing the electrical requirements and listing a few pointers, the fitting of such a switch is beyond the scope of this manual.

1. All Ultimate Limit Switches must be of the normally closed type so that they open, and stay open, when the winch or scenery overruns its travel.

   Switches that open at the point of overrun and then close again will not provide the required EMERGENCY STOP function under every condition.

2. If more than one Ultimate Limit Switch is fitted on a winch, or its scenery, all of the switches must be wired in series. Opening any Ultimate Limit Switch must open the circuit between Pin 2 and Pin 3 of the Machine Limit Switch Connector.

3. Route the cable from the AWU to the switches in a manner to protect it from damage. Use robust cable, not junk speaker wire.

   Remember that if a connector comes unplugged the AWU will "fail" in an EMERGENCY STOP mode. If the cable is cut it will likely open the circuit also causing an EMERGENCY STOP style failure. But it is possible that the ends of a cut or crushed cable can short together. If that happens the system will no longer have an Ultimate Limit Switch.

   These Ultimate Limit Switches should be tested regularly. During the installation of the system you must be sure that the moving scenery will actually trip the switch. After that, the safest way to test the switch is WITH THE WINCH OFF AND INCAPABLE OF MOVING to manually trip the switch.

4. Do not use connectors on Machine Limit Cable that could be confused for any on lines carrying AC power or for ones on high power speaker lines. Connecting 120

volts AC to this line will damage this AWU and possibly other AWUs. Connecting any outside voltage will cause undesired results.

If you use microphone connectors color code or mark them in an obvious manner.

5. Use high quality armored switches. Rig the switches in such a manner that a coasting winch won't smash the switch.

6. It is often a good idea to rig a Machine Limit Switch so that it is tripped by the scenery and not by the winch. In this way your limits can be set by the obstruction in question and not the position of the winch especially on a track used by more than one piece of scenery.

   An exception to this rule is a situation in which the winch runs out of cable before the scenery has reached the end of the track. In this situation the switch should obviously be on the winch itself.

5.3 EMERGENCY STOP SYSTEMS

An EMERGENCY STOP system is a means of quickly and unequivocally shutting down the entire winch system. It must not only stop the system (and any moving scenery) but must keep it shut down until it is specifically turned on again. The most important difference between the STOP Button and EMERGENCY STOP is that STOP (or Remote Stop) only halts specific moving winches, while EMERGENCY STOP shuts down the entire system.

5.3.1 EMERGENCY STOP Using a Master Panel

If you are using a REM-ST Master Panel, you already have the EMERGENCY STOP button built in. It is the mash button near the top of the panel, just below the System Enable keyswitch. To engage EMERGENCY STOP, firmly press the button. Once it has ben depressed it latches in the pressed condition. To release the button, it must be turned clockwise.

5.3.2 EMERGENCY STOP Using the Machine Limit Loop

For systems using only one AWU-4a the easiest way to install an Emergency Stop system is to use the Machine Limit connector. Since there must be a connection between Pin 2 and Pin 3 of this connector for the AWU-4a to operate, it is possible to install a normally closed switch between these pins. Throwing this switch would open that connection, causing the AWU-4a to cease operation.

5.3.3 EMERGENCY STOP Using the AC Line

The crudest possible method of installing an EMERGENCY STOP system is to install a switch in the AC line powering ALL the AWU controllers.

5.3.4 Basic Requirements for an EMERGENCY STOP System

Any EMERGENCY STOP System must be easy to use:

1. It must be clearly labelled. If it uses a toggle switch, label the STOP direction of throw.

2. It must be easy to reach. A switch on the wall under the control table is as good as no switch at all.

3. It must use a switch that latches off, such as a mash button or a toggle switch. It should not be a momentary contact switch which must be held.

4. It must use a good quality, robust switch. The switch cannot have a handle that breaks off when you hit it.

5. It must be easy to operate without thinking. Switches that must be turned should not be used.

5.3.5 EMERGENCY STOP Systems must be tested.

This may sound obvious, but any EMERGENCY STOP system must be tested.

When you are installing a new winch system, or setting up a new show on an already installed system, the following tests should be performed.

1. The first test is of the switch and wiring itself. With power to the motor OFF, check that the system is otherwise powered up and enabled, particularly check that the OK LED is on. Engage the EMERGENCY STOP system, check that the OK LED goes out.

2. The next test is done once you are sure that the system is working and it is known to properly respond to the JOG control.

   JOG a piece of scenery to the middle of its travel. Move the piece at a moderate speed, then while JOGGING the piece, engage the EMERGENCY STOP system. Make note of how long the system takes to shut the winch down, and how far the piece of scenery coasts before coming to a stop. If the winch does not respond to the EMERGENCY STOP system release the JOG control.

This tests that the motor drive is shut down by the EMERGENCY STOP system.

3. Next set up two LIMITS that move the piece through its mid travel position. Set a moderate SPEED. RUN the piece between the two LIMITS. When the piece is at mid travel engage EMERGENCY STOP. The winch should stop with about the same amount of coast as it did in the test above. Check that the RUN Lamp on the AWU goes out when EMERGENCY STOP button is hit. Also reset the EMERGENCY STOP system to check that the winch does not restart.

   This tests that EMERGENCY STOP clears the RUN latch in the AWU.

Once the system is installed, the EMERGENCY STOP is part of the Daily Safety Check. This procedure is listed fully in Chapter 3 - Running a Show.

For a daily test of the system, engage the EMERGENCY STOP System. While it is engaged, attempt to operate each AWU in JOG. The RUN Lamp will come on, but the winch should show no sign of life, and the OK LED should go out.

5.3.6 Practice with EMERGENCY STOP

Anyone and everyone operating a winch system must have a chance to practice using the EMERGENCY STOP system. This is an important safety procedure.

5.4 INSTALLING LIMIT EXPANSION

The AWU-4a controller provides an Expansion Buss Connector. External equipment connected to this connector can expand the number of limits from 4 to 10 and beyond. Also provided on this connector are lines that allow external control of many functions of the controller. The standard limit expansion unit offered by Goddard Design is the LEX-6.

5.4.1 Installation of the LEX-6 Limit Expansion Module

The LEX-6 adds six additional limits to any AWU-4a. Installing a LEX-6 is a simple procedure. Simply plug the 25-pin D-connector cable provided with the LEX-6 into the Expansion Connector on the back panel of the AWU-4a.

5.4.2 Installation of Other Limit Expansion Modules

Many advanced enhancements of the AWU are possible by way of the lines provided on the Expansion Buss Connector, including computer limit storage and computer system mastering.

Users are cautioned not to try to build custom expansion equipment unless they fully understand electronics, motion control and the AWU-4a.

Table 5.3 below lists the pin out of the Limit Expansion Connector. Only pins marked with an "*" are needed for the LEX-6 module. The other signals are provided for future expansion or custom interfacing.

The symbol in the second column of the table shows the signal flow direction.

= > Marks signals from the AWU to external equipment
< = Marks signals from external equipment to the AWU
= Marks signals that are bidirectional or where no direction is appropriate

If more detailed information on function of Expansion connector is needed please contact the factory.

Table
5.3 Expansion Buss Connector Pin Out

	1	<=	JOG RUN (optional)
	2	=	SECONDARY STOP
	3	=	RESERVED
	4	=>	ENCODER VOLTAGE (optional)
*	5	<=	LIMIT 5
*	6	<=	LIMIT 6
*	7	<=	LIMIT 7
*	8	<=	LIMIT 8
*	9	<=	LIMIT 9
*	10	<=	LIMIT 10
	11	=	RESERVED
	12	<=	PROFILE SELECT (optional)
	13	=>	AWU RUNNING
	14	<=	SPEED (REFERENCE)
	15	<=	EXT. START #8
	16	=>	"IN"
	17	=>	"OUT"
	18	=>	+15 VDC
	19	=>	-15 VDC
*	20	=>	POT REF+
*	21	=>	POT REF-
*	22	=	EXPANSION ENABLE A
*	23	=	EXPANSION ENABLE B
	24	=	EXT. COMMON
	25	=	COMMON

5.5 ENCODERS

The encoder is the eyes of the system. The signal produced by the encoder is the only way that an AWU controller knows at what position the cable on the winch is at any given moment. The

system can never be more accurate than the encoder and the mechanical and electrical systems coupled to the encoder.

The AWU cannot "see" the scenery, just the encoder. If the "dog" connecting a wagon to the drive cable slips but the encoder drive is tight, the AWU will drive the encoder to the right place while the scenery may undershoot, overshoot, or just stop moving. On the other hand if the encoder chain falls off but the scenery drive is ok, the AWU will try and run the winch forever trying to get the encoder to its mark.

There are two types of mechanical problems that affect encoder performance.

The first is linkage failure or slippage as described above. It is the worst type of problem, but the easiest to avoid. Build robustly and keep connections tight.

The second causes less spectacular results, but is harder to avoid. Any play in the coupling of the encoder to the scenery degrades system performance. The causes are many; floppy encoder drive chains, loosely fitted flexible couplings, poorly matched gears, slack main drive cable, poorly fitted scenery-cable connection devices (the "dog" and the "knife") are a few possible problems.

Play in encoder coupling methods leads to what is called "backlash". The amount of backlash is equal to the distance that either the scenery or the encoder to the scenery has been taken up. Creating low backlash systems required considerable attention to detail.

5.5.1 Encoder Type

AWU series is designed to use a precision potentiometer as analog position encoder. Either single turn or multi-turn potentiometers may be used, but for reasons listed below multi-turn pots are usually favored.

5.5.2 One Turn Encoders vs. Ten Turn Encoders

The decision to use a single or multi-turn encoder potentiometer depends in part on the mechanical construction of the winch system. Correct encoder choice will directly affect the accuracy of the system. The accuracy of the system is, as discussed above, largely a function of the amount of backlash in the system.

One source of backlash is in the gearing between the encoder and the cable drum. A high gear ratio here has more potential backlash than a low gear ratio. Using a ten turn pot will allow you to lower the gear ratio between the encoder drive and the winch drive line, thus lowering the potential for introducing additional backlash into the system.

The use of a ten turn pot also lowers the error factor caused by backlash. For example, using a single turn pot with a 320 degree rotation, in a system with a total of 2 degrees of backlash

produces an error factor of 0.63% - or 3.7" over 50' of travel. If a ten turn pot was used in the same system, its 3600 degrees of rotation produces an error factor of .06% - or 1/3" over the same 50' of travel.

A ten turn potentiometer thus reduces not only the potential error introduced into the system by backlash, but also reduces the significance of that error.

There are situations in which a single-turn pot is desirable. Most obvious is a system with a very low natural gear ratio, or where it would be necessary to gear up to drive a ten turn pot. These include systems with very short travel or turntables with a single rotation.

An additional advantage to single-turn pots is that many models will permit the end point of the pot's travel to be passed without damaging itself, unlike most ten-turn pots. If the end-point is passed, the AWU will no longer run accurately (it will immediately assume that the unit is at the far end of the track, and attempt to reverse the direction of travel), but should this happen during set-up the pot itself will not be destroyed.

5.5.3 Selecting an Encoder Potentiometer

Just because a pot makes a good front panel control does not make it suitable for winch use. Encoder pots are subject to considerable wear and are used in a far from clear environment, yet they must continue to give accurate, noise free performance.

Goddard Design Co. can provide encoder pots for most uses. Our standard encoder, part #LMP10A, is a 10-turn pot. Other single and multi-turn parts are available. We will also offer encoders in made up limit boxes, please check with us for current information.

5.5.4 Encoder Connector

The following specifications are recommended for the encoder connector and its cable:

1. Connector types:
   Cable: A4M toward AWU, A4F toward encoder
   Encoder Pot: A4M or D4M (panel mount)

2. Recommended cable type: Belden #8423
   Do not connect the shield of the cable to case of the connectors.

3. Encoder cable runs should be no longer than necessary. Runs of 75' to 100' have been used without problems.
   Do not run encoder cable bundled with cables carrying AC power particularly cables from the dimmers.

TABLE 5.4
Encoder Connector Pin Out
4 Pin Switchcraft[tm] Connector

PIN	CABLE COLOR	LMP10A TERMINAL	POT FUNCTION	SIGNAL NAME
1	SHIELD	none	none	SHIELD
2	WHITE	#2	WIPER	POSITION
3	BLACK	#1	CCW	+ REF
4	RED	#3	CW	- REF

CCW = Counterclockwise end of pot element
CW = Clockwise end of pot element

5.6 THE MOTOR DRIVE CONNECTOR

The output of the AWU controller is three signals used to control the motor drive. These signals are on a 5 pin Switchcraft(tm) connector on the back panel of the controller.

The signals are: (1 the Speed Control Signal (2) the Run Loop (which controls whether the drive is in RUN or STOP Mode) and (3) the Emergency Loop which is used to force the drive into disabled or standby mode. In some systems the Run Loop may serve both as run stop line and the EMERGENCY STOP line. A full description is in Section 5.7 on motor drive selection.

Depending on the drive requirements either 4 or 5 conductor cable may be used. Cable having conductors of AWG #22 or larger wire should be used. Runs should be kept short; runs of 75' are not generally a problem. Generally the cable does not need to be a shielded type. The cable chosen should be robust enough to survive the wear and tear of stage uses. Run the cable by a protected route and do not bundle with power cables.

TABLE 5.5
Motor Drive Connector Pin Out
5 Pin Switchcraft[tm] Connector

PIN	SIGNAL NAME
1	SIGNAL COMMON
2	SPEED CONTROL SIGNAL
3	LOOP SUPPLY
4	RUN LOOP
5	EMERGENCY STOP LOOP

5.7 SELECTING A MOTOR DRIVE

The AWU controller requires a motor drive to convert the low voltage control signals it provides to the high voltage, high current signal, required by the motor. In many uses you will be using a variable speed DC motor. Hence you will need a DC output motor drive.

5.7.1 Four Quadrant Regenerative DC Drives

The recommended drive type is a DC Four Quadrant Drive, which is also known as DC Regenerative Adjustable Speed Drive.

The term "regenerative" describes the ability of the motor-drive combination, when braking to convert the mechanical energy of the motor and the connected load into electrical energy which is returned to AC power line.

The term "four quadrant" refers to the ability of the drive to control not only the direction and speed of motor rotation, but also the direction of motor torque. See Figure 5.7 below.

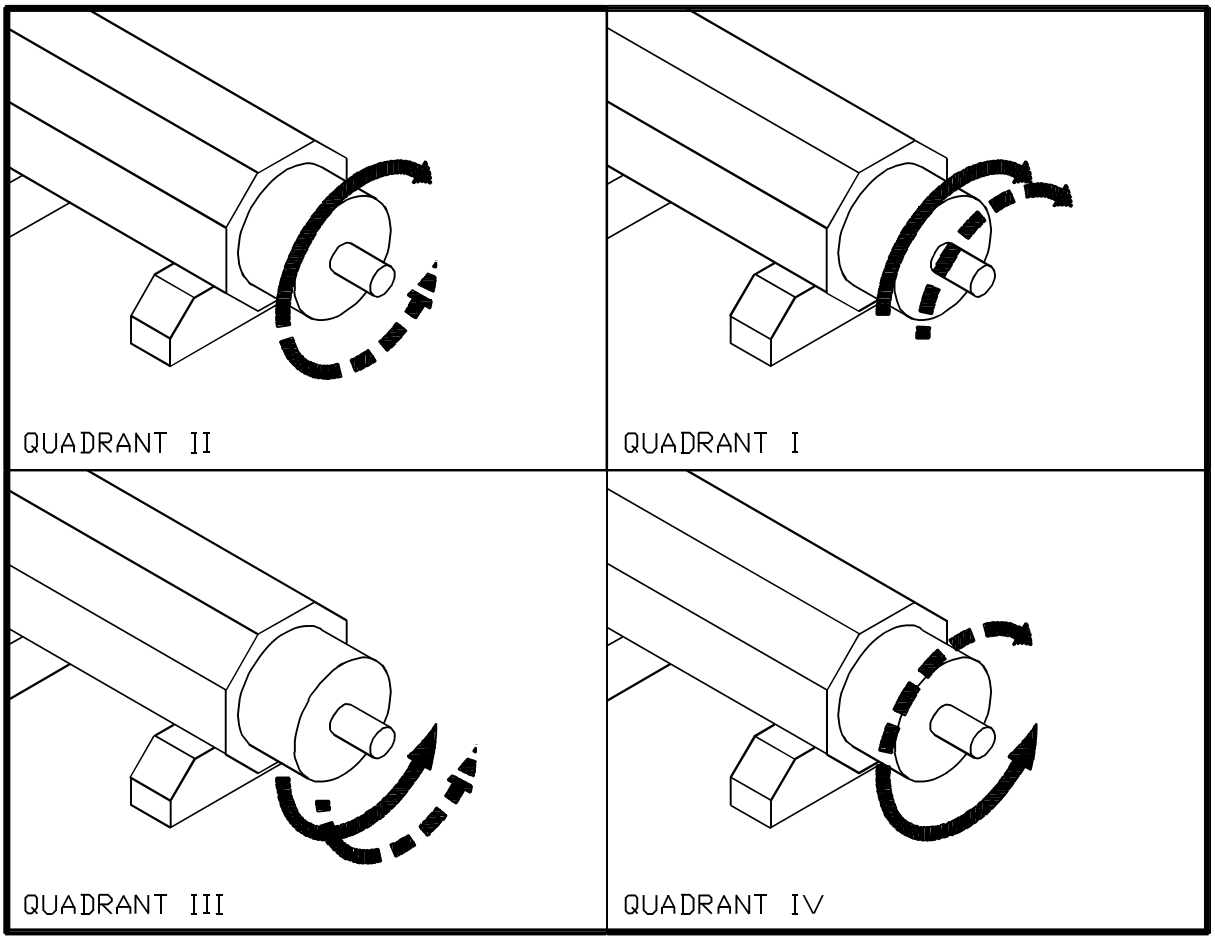


Figure 7 - Four Quadrant Operation

When the controller is operating in Quadrants I and III, both motor rotation and motor torque are in the same direction; the drive is in a non-regenerative mode of operation. In quadrants II and IV the motor torque opposes the direction of motor rotation, this provides a controlled braking force. When operating in II or IV the drive is in a regenerative mode, and some of the energy in the moving load is returned to the AC line. The unique characteristics of four quadrant drives is part of the reason the AWU can repeatably position moving scenery.

5.7.2 AC Variable Frequency Drives

Recently several AWU users have had good results using variable frequency drives with AC motors. The perceived advantages are that the AC motors are considerably less expensive than a DC motor with similar power output and they are easier to get in more powerful sizes. This allows winches to be built with reserve power. This somewhat relaxes the requirements on the drive performance. It also makes it easier to deal with the fact that the scenery is always heavier than expected and must move faster.

In general the performance requirements for an AC drive are similar to those listed for DC drives. We do not feel that we have the knowledge needed to make any specific recommendation regarding AC drives.

5.7.3 Drive Power Rating

The drive must be selected to properly match the motor used. First it must provide the proper output voltage. Smaller motors, 1/2 horsepower or less, are commonly made to run on 90 volts DC. Motors of 2 horsepower and up are commonly made to run on 180 volts DC and 1 horsepower motors are commonly made in either 90 or 180 volt types. Motors are also made in many other voltage ratings, 50, 100 and 150 volts DC being three ratings. In most cases the drive output voltage must match the motor rating.

The maximum power that the motor can deliver is dependent on both the motor and the drive. So buy a drive that is big enough for the motor you want to use. Many drives can be strapped for reduced power output. It may well be a good idea to standardize on the highest power drives you are likely to need, and restrap them if you are using smaller motors.

5.7.4 Control Voltage

The Speed Control Voltage produced by the AWU is +/-10 volts DC. The Speed Control Voltage will be -10 volts when the winch is being directed to move IN at full speed. It will be +10 volts when the winch is being directed to run OUT at full speed.

The ideal drive should accept a Speed Control Voltage of +/- 10 volts DC. Any otherwise suitable drive that accepts a bipolar analog control signal of less than + or - 10 volts DC can easily be adapted to the AWU. To use such drives you will have to provide a resistive voltage divided between the AWU control output and the Drive input.

Drives that use current inputs (4-20ma or the like) cannot be readily used, not can drives that take a digital input.

5.7.5 Drive Dead Band

When being fed a control signal of exactly zero volts the motor drive should not attempt to turn the motor in either direction. At zero the motor should not "hunt" or "creep". But since the real world is seldom exact, many drives have a range of voltages around zero volts for which the drive remains stopped or "off". This range is referred to as the drive's "dead band". The right amount of dead band is a good thing, but too much will make an AWU controlled winch stall just before reaching its limit.

A dead band of 250 millivolts is close to ideal. A dead band of up to +/-400 millivolts is sometimes desirable, and usually ok. If drives with greater dead band are to be used, please consult with Goddard Design.

5.7.6 Speed Control Range

Speed control range is defined as the ratio of the top speed of the motor to the minimum speed of the motor at which it can be repeatedly controlled by the motor drive.

If a drive has a 25:1 speed control range it may not properly drive a motor if the control voltage is 1/30 of the full speed voltage even if the motor has no load on it.

Drives are made with speed range of better than 50:1; such drives usually require a tachometer. Some low cost drives may have speed control range of only 10:1.

We generally recommend that a drive have a 20:1 or better speed control range for use with AWU controllers.

5.7.7 Speed Regulation

The speed regulation of a drive is a measurement of how much the speed of a running motor may change when the load, on that motor, is changed by a set amount. It is usually measured for a change from 10% full load to 90% full load. It is expressed as a percent. If a drive has 5% regulation that means that the driven motor may change speed by the number of RPM equal

to 5% of its full speed, not 5% of the speed at which it is running.

Drives with tachometers may be able to deliver speed regulations of 1% or better.

Since the load on a piece of scenery seldom changes during the running of a cue, highly regulated drives are not often required for theatrical reasons.

> Theatrically a drive with 10% regulation would normally be more than good enough, but to allow the AWU to properly decelerate we recommend drives with 5% regulation or better.

The effect of regulation on low speed operation can be seen by considering the following. If a motor, driven by a 5% drive,is running without a load at 1/25 of full speed, and a 90% load is applied, it may slow down by an amount equal to 1/20 its full rated speed, which is more than its present speed. It may stall and still be within specifications.

For more information on low speed drive performance with the AWU see Section 7.3.3 "Speed at Limit Adjustments".

5.7.8 Tachometers

Tachometers greatly increase the Speed Control Range, and greatly improve Speed Regulation. They are generally not needed in AWU controlled winch systems.

There are exceptions. Some drives require a tachometer. Some drives while not "requiring" a tach do not really perform properly without one.

We recommend tachometers for field wound motors and when 5 HP or larger drives are used.

Any winch that must pull a large unbalanced weight to limit can benefit from 30:1 speed range or better and 2% regulation or better. One way to get this is to use a drive with a tachometer.

5.7.9 Drive Isolation

Any drive used with an AWU must have an analog speed control input that is isolated from the AC line. This means that there is NO electrical connection (including neutral) between the speed control circuits and the AC power circuits. Some drives are isolated by nature of design. This is an important feature and will usually be identified in the drive's data sheets. (If you do not see a positive statement that a drive is isolated do not assume that it is.) Unless the manufacturer is willing to state that "the control input on our drive is electrically isolated from the AC line and no other isolation method need be used", it is not an isolated drive.

5.7.10 Using an Isolation Transformer

Unless a drive is isolated YOU must provide isolating means. The most straightforward method of doing this is to isolate the AC line by way of an isolating transformer.

* *

DISCLAIMER

The following is not a detailed discussion on the use of isolating transformers. All specification for transformer selection should be obtained from the drive manufacturer. The transformer should be wired as per the drive manufacturer's instructions. Goddard Design cannot be responsible for mis-selection or mis-use of transformer isolated drives or any damage resulting therefrom.

* *

An isolation transformer has separate primary and secondary windings. These windings are insulated from each other so that there is no DC connection between them. Beware of "autotransformers"; they are lighter and cheaper, but they DO NOT provide isolation. Also drives may sometime use so called "buck-boost transformers" - these transformers have a different function and provide NO isolation.

The usual ratio of the transformer will be 1:1, i.e. 120V in, 120V out, or 220V in, 220V out. If you are using 208-240V service do not use isolation transformers rated for only 120 volts.

The isolation transformer must be sized to handle the full load current of the drive with room to spare.

The primary of the isolation transformer should be connected to only the AC line, and the secondary should be connected only to the motor drive. No electrical connection should be made from the secondary winding to the primary. Any bonding to ground of the secondary winding should be made only as directed by the drive manufacturer.

Isolation transformers will be big, heavy and reasonably expensive. They are often a practical solution for small motors, but for motors in the 3 HP range it is often worth spending the extra money to by an isolated drive.

5.7.11 Drive Control Logic Requirements

Most drives will provide some form of control logic as well as a speed control input. For any drive to be safely used with the AWU controller, control logic performing two functions must be present. The required functions are explained below in the sections on "The Run/Stop Means" and "The Disabling Means". The two required functions can be performed by one

control mode or two separate modes. They may be inherent in the drive or they may be an add-on option. The following is a short description of the controls you are likely to find on various types of motor drives.

5.7.12 Common Drive Control Logic

There is no industry-wide standard for drive control logic. Some drives are made with no additional logic input, some can bi-directionally "talk" to a computer.

Many drives are designed to be run from remote push button control stations. Commonly the manufacturer makes provisions for a "Run" button, a "Stop" button and an "Emergency Stop" button. Often there is a "Jog" button or a switch that converts the "Run" into a "Jog" button. The terms "Run" , "Stop", "Emergency Stop" and "Jog" USUALLY have similar meaning to the same terms when used in this manual for AWU modes. BUT you must understand exactly what is meant by the manufacturer. DO NOT ASSUME THAT SIMILARLY NAMED MODES ARE THE SAME.

The "Run" mode in particular will often be different. A drive controlled by the "Run" button is often designed so that momentary closure of a normally open "Run" switch starts the drive and latches it into a run mode until the "Stop" button, usually a normally closed contact switch, is pressed.

We have a run latch in the AWU and do not wish to use the run latch in the drive. Not using the run latch decreases the number of wires from the AWU to the drive as well as making it possible to use simpler drives that do not have such a latch.

In drives that have a latched "Run" mode there is usually an unlatched "Run" mode, sometimes called "Jog". This mode will cause the drive to run as long as the Jog mode is enabled and will then return to a stop mode. The AWU controller normally uses the Jog mode as the Run/Stop Means described below.

The functions of "Stop" and "Emergency Stop" will differ from drive type to drive type. The following is an explanation of one common motor drive configuration.

IF a motor drive is running a piece with a large mass, when the "Jog" command is stopped, or the "Stop" command is issued, a four quadrant motor drive is able to electronically brake the high mass piece much faster than the piece would coast to a stop. This is one of the major reasons we use four quadrant drives. But this cannot happen unless the drive electronics stay fully active until the motor has stopped.

But after the motor is stopped, most applications, including AWU systems,want the motor drive to be in an "off" or "standby" state until the next Run or Jog command is issued. Some drives, therefore, are designed so that a Stop command first causes the motor to be regeneratively braked, then waits until it senses that the motor is no longer turning, and shuts down the drive.

Most drives that offer controlled regenerative stop control as described above also offer a method of shutting the drive down immediately to be used as an Emergency stop.

Drives that offer both types of stop control are often ideal for AWU use, because they provide both of the required stop modes described below.

5.7.13 The Run/Stop Means

When the AWU is stopped the speed control voltage sent to the motor drive is zero, so if the drive is properly set up the motors should not move. It is not desirable to leave the drive enabled for several reasons. Electronic noise induced onto the cable might cause the motor to move a small amount. More likely, the drive will turn on and off causing the motor to make a low growling noise. Most importantly, there is a very small but finite possibility that something will cause the motor drive to start moving. Unplanned scenery movement is dangerous.

> Any drive used with the AWU must have a means of placing the drive in a "stop" or off mode other than the control voltage. We will call this the Run/Stop means. Not all drives can meet the requirement of having a Run/Stop means.

5.7.14 Emergency Disable Means

Any part of a winch system can fail. Most electrical or electronic failures will cause the winch to be unable to run, but there are failures that can cause it to fail to stop. Therefore, as we have said many times, the AWU system must have an EMERGENCY STOP system, which includes the motor drive.

> Any drive used with the AWU must have an Emergency Disabling Means. This disabling means must shut down the drive output in such a manner that the probable failures of the drive will not prevent the removal of power to the motor.
>
> The disabling means should be as nearly fail safe as possible.

The easiest Emergency Disabling Means to understand is an electrically held (normally open) power relay in either the AC supply to the drive or in the DC output to the motor. When power is removed from this relay it breaks the path for power to reach the motor. Such a relay must be sized so as to safely break the power to the motor under load.

If a drive is provided with a master power relay, sometimes called a Motor Contactor, and it is possible to cause this contactor to open without waiting for the motor to come to a stop, you can most likely use this relay as the disabling means.

Some motor drives will have electronic fail-safe or disabling control input that may also be used. What is important to keep in mind is that a disabling means must stop the drive even when the problem is in the drive electronics. This function is an Emergency Stop function and the manufacturer should state that this is the intended purpose.

5.7.15 When Run/Stop and Emergency Stop Are The Same

The AWU controller is designed so that it is often possible to use a single drive function to satisfy both stop requirements. Pressing the AWU STOP Button, releasing the JOG Control or allowing a piece to RUN to a LIMIT all cause the AWU to enter the STOP Mode. When the AWU enters the STOP Mode, the SPEED control voltage is taken to zero volts. Then the Brake Delay Timer is triggered. The Brake Delay Timer has a user adjustable period of approximately .250 to 3 seconds. After the timer period is complete the AWU opens the RUN relay which opens the RUN Loop on Pin 4 of the Drive Control Connector. The timer is set so that its period is longer than the time necessary to brake the attached scenery to a stop. In most cases this provides the same function as the brake to the Stop function provided by some drives. However the AWU simply "times out" without sensing whether the motor is still turning. The timer must be set by the user. Instructions on setting the Brake Delay Timer are in Section 7.3.2.

When the AWU enters the EMERGENCY STOP Mode, it immediately opens the Emergency Loop (Pin 5); it also immediately opens the Run Loop (Pin 4). Thus, a drive that shuts down in response to the removal of signal from Pin 4 can provide both required stop means by a single control function.

5.7.16 Wiring the Drive Control Connector

The pin out for the Drive Control Connector varies with the type of motor drive used in the system and whether the Run/Stop means and Emergency Stop means are the same or separate.

Find the drive control style which matches your installation and follow the pin out listed for that style.

TABLE
5.6 Motor Drive Cable Pin Usage

I	**Contact Closure Motor Drive** **Separate Run/Stop and Emergency Stop means**	
	PIN 1	SPEED COMMON and SHIELD
	PIN 2	SPEED CONTROL VOLTAGE
	PIN 3	LOOP SUPPLY (voltage from motor drive)
	PIN 4	RUN/STOP MEANS (SIGNAL = RUN)
	PIN 5	EMERGENCY STOP MEANS (NO SIGNAL = EMERGENCY STOP)

II	**Drive Enabled by External Voltage** **Separate Run/Stop and Emergency Stop means** Note: Either the "L" or "H" shunt on the RMI card is installed for this type of drive. Section 6.4 contains a full description of the use of these shunts to select either 15VDC or 24-29VDC as the enabling voltage.	
	PIN 1	SPEED COMMON, LOOP COMMON and SHIELD
	PIN 2	SPEED CONTROL VOLTAGE
	PIN 3	15VDC or 24-29VDC from AWU - **not normally used**
	PIN 4	RUN/STOP MEANS (SIGNAL = RUN)
	PIN 5	EMER. STOP MEANS (NO SIGNAL = EMERGENCY STOP)

III	**Contact Closure Motor Drive** **Combined Run/Stop and Emergency Stop means**	
	PIN 1	SPEED COMMON and SHIELD
	PIN 2	SPEED CONTROL VOLTAGE
	PIN 3	LOOP SUPPLY (voltage from motor drive)
	PIN 4	COMBINED RUN/STOP and EMERGENCY STOP MEANS (SIGNAL = RUN; NO SIGNAL = EMERGENCY STOP)
	PIN 5	DO NOT USE!

IV	**Drive Enabled by External Voltage** **Combined Run/Stop and Emergency Stop means** Note: Either the "L" or "H" shunt on the RMI card is installed for this type of drive. Section 6.4 contains a full description of the use of these shunts to select either 15VDC or 24-29VDC as the enabling voltage.	
	PIN 1	SPEED COMMON, LOOP COMMON and SHIELD
	PIN 2	SPEED CONTROL VOLTAGE
	PIN 3	15VDC or 24-29VDC from AWU - **not normally used**
	PIN 4	COMBINED RUN/STOP and EMERGENCY STOP MEANS (SIGNAL = RUN; NO SIGNAL = EMERGENCY STOP)
	PIN 5	**DO NOT USE!**

5.7.17 Limits on External Control Voltages

For contact closure type drives, Pin 3,4 and 5 are isolated from ground and the rest of the AWU. See Section 6.4 for required RMI card strapping. Pin 3 of the Motor Drive Connector is assumed to be connected in the drive to a source of low voltage control power.

The voltage may be AC or DC, but it must be less than or equal to 50 volts. The maximum current on any of these connector pins should be limited to 1 amp or less.

5.7.18 Enabling with AWU-Generated Voltages

It is possible to strap the AWU so that output control voltages appear on Pins 4 and 5. The user has the choice of a +15VDC signal or 23-29VDC signal. The logic is the same. Voltage is present when the relays are closed.

When using AWU generated voltages, Pin 3 is always connected to the selected voltage and is generally not used. Pin 1 must be used as the common for both the control and speed signals. The total current drawn by the attached drive must be less than 200 MA.

Instructions on selecting this strapping are in Section 6.4.

5.8 CONVENTIONS

There are several conventions used with the AWU-4a. Some of these are necessary for the proper operation of the AWU and some of these are simply habitual ways of working. For example, using the highest LIMIT number as the most IN (or ON) position of the winch and the

lowest LIMIT as the farthest OUT (or OFF) position is a matter of convenience. Having the system set up so that when the motor moves the scenery in the direction indicated by the green "IN" LED, the encoder potentiometer moves the AWU to a higher LIMIT is necessary for the proper functioning of the electronics.

To put it another way, the mechanical system can be set up in any way which is convenient to your installation, but the electronic system - particularly the encoder polarity - must be set up in accordance with the conventions described below and in the various sections on wiring.

We urge you to establish a mechanical convention for your use. This will produce several advantages:

1. As you install future systems, you will have to do less re-invention of the wheel.

2. As you amass parts of mechanical systems, there will be greater interchangeability - less "custom" and more modular. This will also produce greater flexibility in the systems you are able to assemble from parts in stock.

3. It will be easier to work on your installations if everyone has agreed on a wiring convention and stuck to it. Less yelling is needed when something needs to be fixed.

5.8.1 System Conventions

TABLE
5.7 System Conventions

Direction of travel	LED color	Motor speed control voltage	Encoder output voltage	Encoder rotation (optional)
IN	GREEN	0 to -10 VDC	Increasingly NEGATIVE	CW
OUT	YELLOW	0 to +10 VDC	Increasingly POSITIVE	CCW

The basic convention of the AWU electronics is expressed in the following statement:

The AWU sends a negative control signal to the motor drive when it is RUN to a LIMIT whose dial is set to a higher number or JOGGED in the direction labelled IN on the front panel. The encoder must be mechanically installed so that as it turns in this direction its output voltage becomes increasingly negative. If the encoder is wired according to Table 5.5 and Polarity Reversal Jumpers are in the factory setting, the encoder must turn clock-wise in this situation.

Conversely, when it is RUN to a LIMIT whose dial is set to a lower number or JOGGED in the

direction labelled OUT on the front panel, the AWU sends a positive control signal to the motor drive. The encoder installation must produce a counter-clockwise rotation.

The mechanical system may be installed to produce any desired effect as long as the electronics installation conforms to this convention. A corollary to this convention is the following standard usage:

The AWU's IN direction corresponds to scenery motion "on" or "in"; and the AWU's OUT direction corresponds to scenery motion "off" or "out".

Section 5.5 includes a discussion of the encoder connector and Table 5.5 lists the encoder connector pin out and color codes.

5.8.2 Mechanical Installation

There are four mechanical or electrical connections which are made during the installation of a winch system which are critical. On the drawing below they are:

1. AWU to Motor Drive Control Cable
2. Motor Drive to Winch Motor Power Cable
3. Gearing between Winch and Encoder
4. Encoder to AWU Control Cable

The wiring polarity or gear orientation of each of these connections must be installed properly in relationship to the others for the system to function correctly.

The total sum of the relationships is more critical than any single connection. Specifically, it must produce a system in which when the motor moves the drive line in the AWU's IN direction (as indicated by the green LED, or as labelled on the JOG switch) the encoder potentiometer turns clockwise and drives the LIMITS toward their higher numbers.

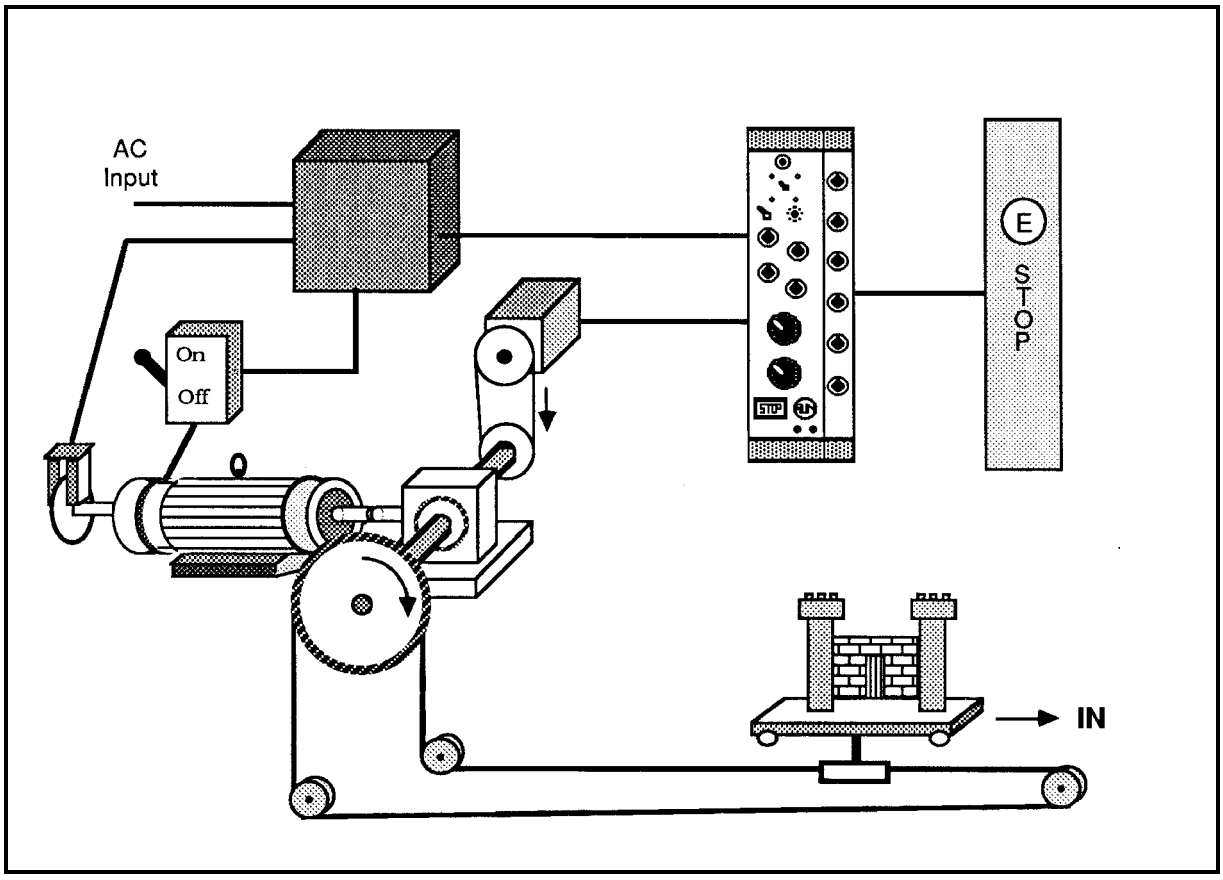


Figure 8 - Mechanical Installation

5.8.3 AWU to Motor Drive Cable

The control cable should be checked for polarity, continuity and an absence of shorts before it is installed. If Pins 1 and 2 on the Motor Drive Connector are reversed, the system may initially seem to run correctly.

If Pins 1 and 2 are reversed and the motor is wired correctly, IN and OUT will have reversed meaning. However, if Pins 1 and 2 are reversed and the motor is also wired incorrectly the error will cancel itself out. The effort to wire all cables correctly (and consistently) is worthwhile as it makes the replacement of parts and cables easier.

If the cable appears to be wired correctly, test the polarity of the control signal at the motor drive. First remove AC power from the motor drive. Set the AWU as if it were JOGGING IN, use Pin 1 as the Common, Pin 2 should be a negative voltage.

5.8.4 Motor Drive to Winch Motor Cable

Different motors are wired differently. Before you attempt to install a motor, we suggest that

you connect the motor to a motor drive and test the wiring polarities so you are sure you know how it works. Careful documentation (and storage of this information) especially if you are using several motors from the same manufacturer will save you a lot of time and aggravation. More importantly careful testing will eliminate a major source of system errors and their attendant headaches.

5.8.5 Gearing between Winch and Encoder

The direction of rotation of the encoder potentiometer for a given direction of drum rotation is dependent on many mechanical and electronic factors including the number of gears used and the direction in which the pot faces. The AWU-Series convention is that

Jogging IN = an increasingly negative voltage
and
Jogging OUT = an increasingly positive voltage

It may not always be possible to install the encoder so that this convention is followed. The AWU can work properly with the encoder rotating in either direction as long as the electronics are also reversed. It is generally easier, where possible, to follow the convention in the mechanical set up. If this is impossible, it is necessary to reverse the convention electronically. This is described in Section 7.3.6 on polarity reversal jumpers and polarity shunts.

5.8.6 Encoder to AWU Cable

If the encoder is rotating in the correct direction, but the LIMITS are changing in the wrong direction, the polarity of the Encoder-AWU cable is probably reversed. Like the AWU-Motor Drive cable, this control cable should be tested for polarity, continuity and shorts before installation.

CHAPTER 6

6. REMOTE INTERFACE PROGRAMMING AND THE RMI CARD

The AWU-4a is only one part of a complete motion control system. In order to allow the AWU to be run with a wide variety of other system components, a method of re-configuring the interface control lines has been provided.

This chapter provides the technical instructions necessary to reconfigure the control lines for your installation. Most of the reconfiguring is done by programmable straps or switches on the RMI printed circuit board (PCB) and the small PCB on the REMOTE START button on the front panel.

****

WARNING

WHEN THE AWU IS CONNECTED TO THE AC LINE EXPOSED HAZARDOUS VOLTAGE IS PRESENT INSIDE CASE

Before opening the AWU's case disconnect the AWU from AC power. Powered up testing should be performed only by qualified service personnel.

****

Only one cover of the AWU is normally removable. With the AWU sitting so that the Remote Start switch is up and the front panel is toward you, the removable cover is the large blank panel to your right.

This panel is held by five screws - two in the cover proper and three in the lip folded over the back panel. After removing the screws, lift the lip fold over the back panel and pull the cover back until its front lip is clear of the front panel. Remove. When replacing the cover check that no wiring will be caught between the front panel and the front lip of the cover.

The RMI card is the smaller of the two PCBs inside of the AWU. The straps are programmed by placing a small programming shunt over the two gold plated pins that make up each strap. The programming shunts look like a small plug which fits over two pins of the straps. Spare shunts are shipped on a spare strap located on the bottom left side of the RMI card. Using these shunts, changes can be made in the configuration of the interface control lines without additional wiring.

The AWU is shipped with a standard set of programming straps installed. With one exception, the factory settings are likely to be correct for most installations.

This exception is the Group IV straps. These straps determine the type of enable signal sent to the motor drive, and change with the type of motor drive used. They therefore often need changing from the factory setting.

Other special strappings are used to customize the AWU for uses including:

Remote Speed Mastering
Multiple Remote Start Buttons
Computer Mastering
Fixed installation without standard master panel

The following table is a summary of the functions of the programming straps and their setting at time of shipment. A "1" means shorting strap installed or DIP switch "on". A "0" means strap removed or DIP switch "off". "of" means factory installed or special use. Please consult the factory before use.

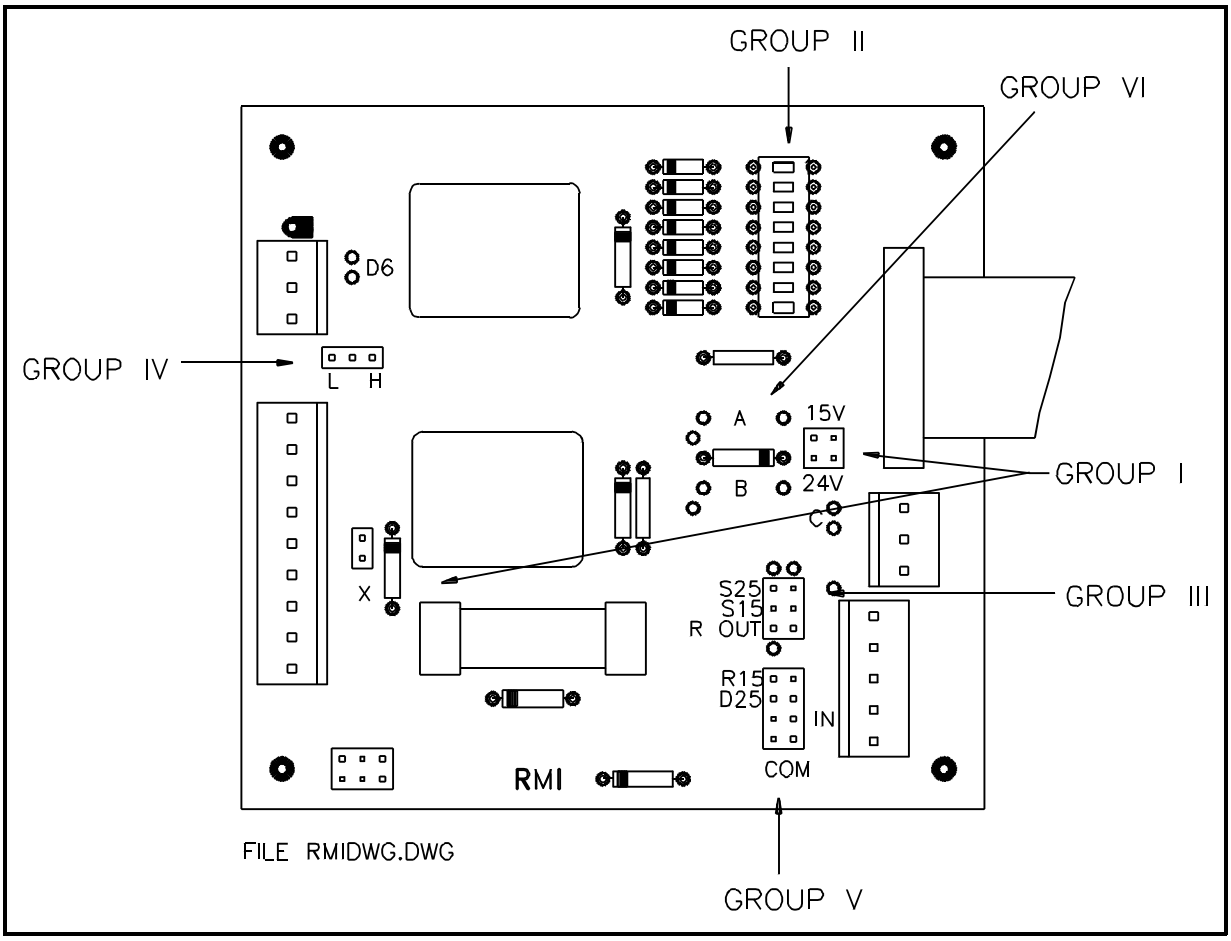


Figure 9 - Drawing Of RMI Card With GROUP Locations

TABLE
6.1 Factory Strap and Switch Settings

		GROUP I
X	1	X=External common to internal common
15V	0	15 volt external device power supply
24V	1	24 volt external device power supply
		GROUP II
DIP1	1	Start buss 1
DIP2	0	Start buss 2
DIP3	0	Start buss 3
DIP4	0	Start buss 4
DIP5	0	Start buss 5
DIP6	0	Start buss 6
DIP7	0	Start buss 7

DIP8	0	Start buss 8
		GROUP III
S25	0	Start buss 8 from D25 connector Pin 15
S15	1	Start buss 8 from D15 connector Pin 12
R OIT	0	Int. speed ref. output on D15 connector pin 12
		GROUP IV
L	0	Low=15 volt motor drive enable
H	0	High=24 volt motor drive enable
		GROUP V
R15	0	Speed ref. from ext. device via D15 Pin 5
R25	0	Speed ref. from ext. device via D25 Pin 14
IN	1	Internal speed ref.
COM	0	Ref. common connected to internal common
		GROUP IV
A	0f	Installed only by factory
B	0f	Installed only by factory
C	0f	Special use only

6.1 GROUP I - POWER SUPPLY AND COMMON

The Group I straps are located on the center of the right hand side of the RMI card, just to the left of the grey 3M ribbon cable connector. The X strap is located on the center of the left side of the card, between the 9-pin Mascon connector and the big rectangular relay.

6.1.1 X - Electrical Isolation of External Start and Stop Signals

AWU controllers are normally shipped with the X strap installed. This strap can be installed for all normal operation. The X strap determines whether the external motion control lines are totally electrically isolated or quasi-isolated from the AWU electronics.

To maintain the greatest possible system accuracy, AWU controllers treat the external motion control lines - Remote Start (1-8), Remote STOP and EMERGENCY STOP as completely separate from the AWU electronics. This helps prevent ground loops and decreases the pick up of electronic noise (EMI).

Total isolation is often not needed and it limits interfacing somewhat. With the X strap installed the AWU is in the quasi-isolated mode.

Since the signal common of most master panels will be grounded, as is the internal AWU signal common, it is possible to prevent ground loops in most instances by separating the common of

AWU units from the External Common by a diode. Installing the X strap inserts a diode with its cathode connected to the External Common and its anode connected to the Internal Common.

This allows certain convenient features. One is the ability to enable an AWU without a master panel by means of a simple jumpered D plug. Another is the ability to run some external equipment off of the AWU's power supply.

With the X strap removed, the external motion control lines EMERGENCY STOP, Remote STOP or any of the eight Remote Start busses are electrically isolated from the electronics of the AWU. There is no electrical connection between these external control circuits and speed and limit computing electronics of the AWU.

The isolation is provided by relays or optically coupled isolators. Although the relays and isolators used are all able to withstand line voltage across their isolating barrier, they are not used here for that purpose. When the X strap is removed a maximum of 50 volts AC should be maintained between the external common and the internal common.

With the X strap removed the control circuits will be isolated, but note that it is still possible to inter-connect the signal commons of multiple AWUs if the COM strap is installed in more than one AWU. See the section on the COM strap below for more details.

With the X strap removed the AWU power supply voltage is still present on Pin 8 of the 15 pin D-connector. The 24V strap may normally be left in place. If pin 8 is connected to a load that returns to a voltage other than ground and the load will cause more than a 50ma current in Pin 8, then BOTH the 15V and the 24V strap must be removed. See below for more on the 15V and 24V strap.

SUMMARY
Isolation and the X Strap

1. With the X strap removed, the AWU is not designed for use with any setup that presents more than a 50 volt AC difference between the AWU signal common and the external common.

2. With the X strap installed the common voltage differences must be less than .5 volts DC and the possible fault current limited to less than 1 amp.

3. The internal common is tied to ground in each AWU.

4. The analog speed reference sent to the motor drive is referenced to ground. There is no strapping that permits the use of line referenced motor drives. Use only isolated drives. See Section 5.7 on drive selection.

5. With the X strap removed only the following pins can be isolated

1,2,3,4,9,10,11	Start busses 1 through 7
12	Pin 12 is isolated only if it is strapped to the Start buss #8.
6,14	External common
7	External stop
15	System Enable/Emergency Stop

6. Do not attempt to use the 24V or 15V power supplies to power external equipment if the X is not installed.

The 24V strap is normally installed. It provides relay and general raw power supply which can run a number of external devices. It has a series diode so that any number of RMI cards may be bussed with the 24V strap installed.

For proper operation of any device powered from the 24V strap, the X strap must also be installed on at least one of the RMI cards which has the 24V strap installed.

The current drawn from the AWU to an external device should be limited to approximately 100 mA.

6.1.3 15V Strap

The 15V strap connects the regulated +15 volt power supply to Pin 8 of the Master Panel Buss Connector. At present no standard Goddard Design Co. equipment requires this strap to be installed. If this strap is installed the following rules must be followed:

If the 15V strap is installed the 24V strap must be removed on this RMI card, and the 15V and 24V straps must be removed on any other RMI card in other AWUs with which this RMI card's Pin 8 is bussed.

Any controllers connected by flat cable will usually have their Pin 8's bussed.

For proper operation of any device powered from the 15V strap, the X strap must also be installed on the same RMI card.

The current drawn from the AWU to an external device should be limited to approximately 75mA.

6.2 GROUP II - REMOTE START PROGRAMMING SWITCHES

The Remote Start Programming Switches are the dip switches located near the upper right corner of the RMI Card. These switches are turned on or off by using a small screwdriver or a similar tool to gently push the switch from side to side.

Each switch controls one of the start busses. Normal operation requires only that the first

switch be on. This is the normal factory setting.

In systems using multiple AWUs it is sometimes desirable to start a group of AWUs on the one "Go". Sometimes it is desirable to start several groups of AWUs in quick succession, for example, flying the downstage masking (2 winches) followed five seconds later by the upstage masking (2 winches). If there were two start sub-groups - one for the downstage masking and one for the upstage masking - this cue would be easy.

The Remote Start programming switches allow you to group AWU controllers in up to eight remote start sub groups. To assign an AWU to a sub group simply turn on the switch for that group. Example, all AWUs with Switch 5 on will start if a start signal is applied to Start Buss #5. An AWU may be assigned to any number of start sub groups. If you do not want an AWU in some start sub group make certain that switch is OFF.

To use a Remote Start sub group you must have a master panel that can generate more than one start signal. This feature may be ordered as an option on the Master Panel made by Goddard Design Co.

For any remote signal to start an AWU the Remote Start button on the front panel must be engaged. Also all other settings such as LIMIT and SPEED must be properly set in advance if the cue is to complete properly.

WARNING

REMOTE STARTING OF MULTIPLE AWUS IN NO WAY SYNCHRONIZES THE SPEED OF THE WINCHES, OR MATCHES THE LIMITS THAT THE WINCHES WILL TRAVEL TO. EACH AWU INVOLVED IN A REMOTE START MUST HAVE ITS SPEED AND LIMIT SET LOCALLY.

In addition to the programming switches, newer model AWU's with a REMOTE START Switch include an LOC strap on the card mounted on the front panel. With this strap installed, the operation of the REMOTE START switch is changed so that the local RUN button is not disabled when the Remote Start is enabled.

6.2.1 Remote Start Signal Requirements

To reliably trigger the Remote Start busses requires a filtered DC signal of between +15 and +30 volts. When not sending a start pulse all Remote Start busses should be at no more than +0.5 volts DC. The AWU triggers on the rising edge. The Remote Start signal should be pulses, because if the front panel REMOTE START button is pressed while the Remote Start signal is high (15 volts) the AWU will start.

When the programming switch for a remote start group is "on" in an AWU controller that controller presents a load of 2.7K ohm to that buss. AWUs do not load start busses that are not selected by their remote start programming switches.

6.2.2 Installing the LOC Strap

The LOC strap is located on the PCB mounted on the front panel behind the REMOTE START button. It is the only strap on the board, and is located at the top of the card. This board is included on all AWU units with Serial Number 812067 and later.

When the strap is installed, the RUN button remains enabled even when the REMOTE START button is enabled.

6.3 GROUP III STRAPS - START BUSS #8 LOCATIONS

This group controls whether start buss #8 is connected to the 15 pin or the 25 pin D connector. It also controls whether the internal +10 volt speed reference is available on the 15 pin connector.

6.3.1 S15

Strap S15 is normally installed. The #8 Start buss may come from one of two sources, or it may be disconnected. With S15 installed Start Buss #8 is connected to Pin 12 of the 15 pin Master Panel connector. With S15 installed R OUT must be removed and R25 is normally removed.

6.3.2 S25

The S25 strap connects the #8 Start buss to Pin 15 of the 25 Pin Limit Expansion connector. This strap is used for certain computer mastering systems.

6.3.3 R OUT

The R OUT strap converts Pin 12 of the 15 pin connector to a source of +10 volt reference. This reference may be needed by certain speed mastering equipment. If this strap needs to be installed this information will be in the instructions for that equipment.

Note: When the R OUT strap is installed, Pin 12 is NOT ISOLATED. Also, only one AWU in a bussed group should have its R OUT installed, and all AWUs in that bussed group must have their S15 straps REMOVED.

6.4 GROUP IV STRAPS - L,H AND THE DRIVE CONTROL LOOP

The Drive connector on the AWU is a 5 pin Switchcraft connector. Three of the pins, 3,4, and 5 are used to enable or disable the motor drive. Collectively these lines are called the "Drive Control Loop". The H and L straps control what if any voltage is applied to these lines by the AWU.

Many motor drives make provisions for Start, Stop and Emergency Stop push buttons to be fitted. Sometimes provisions for a Jog button are also made. These circuits are usually relay operated and isolated from the rest of the drive electronics. They expect to see switch closures. If both the H and the L straps on the RMI card are removed, pins 3,4 and 5 provide an isolated switch closure control loop suitable for most drives of this type.

Some drives require one or two enabling signals provided by the controller. If the L strap is installed the enabling voltage is 15 volts. If the H strap is installed the enabling voltage is the raw supply which runs from 24 to 29 volts. If other voltage levels are needed additional circuits or custom modification will be needed; consult the factory.

If either L or H straps are installed the Drive Control Loop is not isolated, and you must use the signal common, Pin 1, as the Drive Control Loop common. With either H or L installed Pin 3 will have voltage present whenever the AWU is powered. Therefore Pin 3 is generally not used with any drive that requires L or H to be installed.

The way these lines are used will depend on the type of motor drive used. The basic requirements are in Section 5.7 "Selecting a Drive".

If after reading all of these sections you have further questions please consult the factory.

6.5 GROUP V, SPEED REFERENCE SOURCE

The Group V straps determine the source of the Speed Reference signal.

6.5.1 IN

The IN strap connects the onboard speed reference for normal operation. It is the normally installed strap. If the IN strap is accidentally removed without installation of either the R15 or R25 straps and without provision of external equipment providing a speed reference, the AWU will act as if the SPEED Dial is set to zero.

6.5.2 R15

Installation of R15 strap connects the speed circuit of the AWU to pin 5 of the 15 pin connector. With R15 installed IN must be removed and COM must be installed. Normally R25 will also be removed. R15 is installed to allow speed mastering or speed presetting by master panels and other equipment that are designed to connect to the Master Panel Buss connector.

6.5.3 R25

Installation of R25 strap connects the speed circuit of the AWU to pin 14 of the 25 pin connector. With R25 installed IN must be removed and normally R15 will be removed.

R25 is used by computer mastering systems that connect to the Limit Expansion Connector.

6.5.4 COM

The COM strap connects the internal common of the AWU to pin 13 of the 15 pin connector. Pin 13 is called Reference Common and is used only by external equipment capable of speed mastering. It is never connected to External Common or any circuit connected to External Common.

When more than one AWU has the COM strap installed there is a possibility of problems from ground loops. The following guide lines will help reduce the potential problems.

1. Use COM strap only when needed.

2. Locate all units to be speed mastered close together and bolt them into a conductive rack or box. This will make certain that all the AWUs are at the same ground voltage.

3. Power all the AWUs from the same AC source.. Do not plug one into the wall outlet and another into a long extension cord.

4. Check your grounds to make certain they really are grounded.

5. Plug no other equipment into the same extension cord powering the master AWUs.

6.6 GROUP VI STRAPS

Group VI straps are primarily intended for use on custom AWU units that do not have some of the back panel connectors fitted at all. Such units are for fixed installations without a standard master panel. Group VI straps are therefore generally only for factory use.

CHAPTER 7

TESTING AND ADJUSTMENTS

This chapter on testing and adjustments has three major sections.

The first section describes the functions which must be successfully tested in any new winch installation. Following the guidelines included here will help prevent needless damage to equipment and danger to personnel.

Second, it provides descriptions of how to perform those tests. These sections can also be used as a trouble-shooting guide for a working system which develops problems. More information can be found in the previous chapters which cover the subjects in detail.

Third, it contains instructions on how to make special adjustments to customize the AWU to your installation. These sections include a description for the situations in which these adjustments might be desirable.

7.1 FIRST TEST OF A WINCH SYSTEM

The first test of a winch system determines that the AWU will automatically run in the correct direction towards a LIMIT. Once the electrical and mechanical components are installed so that the AWU can correctly interpret the signal from the encoder, the encoder itself must be aligned so that a full range of travel is possible.

This section contains a description of the tests to be performed and the reasons they are necessary. The next section provides instructions and technical data about the tests themselves. If you are installing a winch system for the first time, please read the descriptions of the tests in later sections carefully. For those experienced in mechanization this section will serve as a check-list for each new installation.

These tests do not take very long, but must be done properly.

1. Install the Mechanical System
   Before AWU testing can begin the mechanical system must be in place. The winch motor, motor drive, drive cable and the AWU must all be installed, with all connections made. Once the mechanical system is in place you are ready to begin testing.

REMOVE THE ENCODER FROM THE MECHANICAL DRIVE BEFORE YOU BEGIN TESTING

Until the encoder potentiometer is aligned to the system, you risk damaging it by running the winch with the encoder connected.

2. Test JOG Mode
   Test that when you use the AWU to move scenery the system responds by moving the scenery in the direction you expect. Use the JOG control to carefully move the system a short distance for this test.

3. Test for Smooth Operation
   Make sure that the mechanical system and motor are running smoothly. At this point you are ready to begin testing and aligning the AWU's electronic system.

4. Test for Encoder Direction
   Test that the direction of encoder rotation is consistent with the AWU's direction. Because the encoder is the "eyes" of the AWU it must be installed in a correct relationship to the AWU electronics.

   In a "standard" installation the encoder should rotate clockwise for a JOG IN or counterclockwise for a JOG OUT

5. Align the Encoder
   The encoder may be aligned either before or after the LIMIT Dials are tested.

   Once the AWU is connected to the encoder it will not allow the system to move past either end of the LIMIT scale - e.g. 000 or 1000. To ensure that a full range of travel is possible, the encoder must be aligned to the mechanical system. There are two methods of alignment, the "End Point" method and the "Center Point" method.

6. Electronic Test of the Encoder
   The LIMIT Dials may be tested either before or after the encoder is aligned.

   Test that the relationship between the two LIMIT numbers accurately reflects the relationship of those two positions on the stage. This test is a double-check on the previous tests of the system. If the system fails this test go back to the beginning of the test routine and start again.

   Do not attempt to run to a LIMIT if this test fails.

7. Test the RUN Mode
   Using the RUN mode to execute a short RUN, test that the system accurately reaches

a LIMIT. Test that the system responds accurately to the SPEED control.

8. Set ACCEL and DECEL
   Set the ACCEL and DECEL controls. Test that the system responds to changes in these controls.

7.2 TEST DESCRIPTIONS

These test descriptions are written with all movement done in the AWU's IN direction and assuming that polarity and encoder rotation are standard. If you are testing a non-standard installation or find it more convenient to move the scenery OUT, you will have to reverse the directions and results accordingly.

7.2.1 Test JOG Mode

The first tests of JOG of a new system are performed with the encoder drive mechanically disconnected from the system. Movement of the motor should cause no movement of the encoder. Until the encoder is aligned to the installation, it can easily be broken during initial tests.

JOG the AWU-4a IN for a short distance. Observe the direction in which the scenery moves.

If the scenery moves "in" - that is, in the direction the installation has been set up to correspond to IN - the system has passed the first test of JOG Mode. If your AWU has a Position Meter, it will read "500" (+/-2) and will NOT change.

If the scenery moves "out" or in the opposite direction than anticipated, first check the control cables. The proper wiring for the Motor Drive Connector is described in Section 5.6. If the motor drive cable is improperly wired fix it and try the test again.

If the motor drive cable is wired correctly the motor needs to be rewired. The motor and motor drive wiring is specified by the manufacturers of the specific equipment. Refer to their literature if you are unsure of the wiring schematic. Note that reversing the two armature wires will reverse the direction of rotation of a DC motor.

Once the system has passed the test of the JOG Mode get the winch running smoothly before proceeding to encoder testing and calibration.

7.2.2 Test for Encoder Direction

The most common type of encoder potentiometers has a fixed stop point. If your encoder is of this type attempting to rotate the pot past its stop point will damage the pot. To prevent this potential damage rotate the pot well away from the stop point before proceeding with the test

for encoder direction.

Connect the encoder's mechanical drive to the system. Slowly JOG the scenery IN a short distance, observing the direction in which the encoder potentiometer rotates.

If the encoder rotates clockwise, proceed to the section on calibrating the encoder. If the encoder rotates counterclockwise, this condition must be addressed. If the installation can be easily reversed that will solve the problem.

There are situations where the mechanical installation cannot be easily changed. For these cases the AWU includes the option of changing the polarity of the electronic system with an external polarity reversal jumper or with the internal polarity reversing shunts. These jumpers and shunts are described in detail in Section 7.3.6.

7.2.3 Align the Encoder

Aligning the encoder may be done before or after the electronic Encoder test.

There are two methods of aligning the encoder, the "center point" method and the "end point" method.

END POINT ALIGNMENT

The "end point" method calibrates the encoder by matching the furthest "out" or "off" position to the low end of the encoder or by matching the furthest "in" or "on" position to the high end of the encoder.

With the encoder drive disconnected move the scenery to the desired end point of its travel. Mechanically turn the encoder to the appropriate end of its rotation and then back off a small amount. This gives you a small margin of error and helps prevent damage to the encoder. If you are matching the OUT end of travel, turn the encoder counterclockwise. If you are matching the IN end of travel turn the encoder clockwise (for conventional setups). Lock the encoder shaft.

Once the encoder is adjusted reconnect the mechanical encoder drive and lock the encoder's mounting hardware. Check the alignment by matching a LIMIT Dial to the current location. An OUT match should produce a LIMIT of about 980; an IN match a LIMIT of about 20.

CENTER POINT ALIGNMENT

As its name implies, the "Center Point" method aligns the center point of the winch's travel with the center point of the encoder (around 500 on the LIMIT Dials). With the encoder's mechanical drive disconnected, JOG the scenery to the center point of its travel.

Centering the encoder is done electronically. There are three methods. The simplest is to connect a voltmeter to the cable leaving the potentiometer while it is still connected to the AWU. The positive lead of the meter goes to Pin 2 of the connector and the common lead to Pin 1 of the connector. Adjust the encoder until the meter reads 0 volts. When using an analog meter it is easiest to start out using the 10 volt scale and switch to the 1 volt scale for the final adjustment at zero.

If Pin 1 is not easily reached, there is a second method. It is, however, more difficult to do accurately, and best done with a digital voltmeter. Connect the common lead of the meter to Pin 4 of the connector and the positive lead to Pin 2. Adjust the encoder until the meter reads +10 volts.

The third method is possible if your AWU has a Position Meter. Rotate the encoder unit until the meter reads 500. Be sure that the meter actually changes as you rotate the meter and is not stuck at 500.

Once the encoder is adjusted, reconnect the mechanical encoder drive line and lock the encoder by tightening the mounting hardware on the shaft. Be sure the Encoder-AWU cable is connected. To check the calibration, match a LIMIT Dial to the scenery while it is at its center point. The result should be close to 500.

It is important to note here that when the AWU is disconnected from the encoder, it will LIMIT match at 500. Therefore if you get a LIMIT of exactly 500, you should be suspicious of this result and double check your work carefully. Because of this we recommend the "End Point" method be used whenever possible.

Whether you use an End Point or Center Point alignment, it is very important that the scenery never be moved after alignment with the Encoder-AWU cable disconnected. Because the AWU no longer can "see" the scenery the AWU will not run properly to its limit and will not stop at the end of the encoder's rotation. You may damage the encoder potentiometer by attempting to turn it past the end of its rotation.

7.2.4 Electronic Encoder Test

Testing the LIMIT Dials may be done before or after the encoder is aligned.

Match a LIMIT to the current location. Use the JOG Mode to move the scenery IN a short distance. Match a different LIMIT Dial to this new location. Check that the second LIMIT number is higher than the first one.

If you have a Position Meter watch the meter reading to be sure that the numbers are moving in the correct direction.

If so, the Encoder is working correctly.

If not, go back and check the encoder rotation again. If the encoder rotation is mechanically correct, check the encoder-to-AWU wire. If that connection is correct check that the internal polarity shunts are correctly installed.

If the encoder is rotating in the incorrect direction and it is not feasible to change the mechanical system, please read Section 7.3.6 on polarity reversing.

If the encoder is rotating correctly the Encoder-AWU cable is wired correctly and the shunts are installed correctly you have either missed something in your testing or something has changed since you began testing. Go back and recheck your test results.

7.2.5 Test the RUN Mode

Using the LIMITS you have set, do some test RUNS. Check that the AWU is stopping the scenery at LIMIT correctly. Test the ACCEL, DECEL and SPEED controls to be sure they respond correctly to adjustment.

7.3 SPECIAL ADJUSTMENTS

This section contains instructions on how to make customization adjustments to the AWU-4a.

7.3.1 Opening the AWU-4a Case

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WARNING

WHEN THE AWU IS CONNECTED TO THE AC LINE EXPOSED HAZARDOUS VOLTAGE IS PRESENT INSIDE CASE

Before opening the AWU's case disconnect the AWU from AC power. Powered up testing should be performed only by qualified service personnel.

****

Only one cover of the AWU is normally removable. With the AWU sitting so that the Remote Start switch is up and the front panel is toward you the removable cover is the large blank panel

to your right.

This panel is held by five screws - two in the cover proper and three in the lip folded over the back panel. After removing the screws, lift the lip fold over the back panel and then pull the cover back until its front lip is clear of the front panel. Remove.

When replacing the cover check that no wiring will be caught between the front panel and the front lip of the cover.

7.3.2 Setting the Brake Delay Timer

The Brake Delay Timer is set at the factory at approximately 2 seconds. This setting will seldom need to be changed. For winches which do not require a mechanical brake, any setting of the timer longer than that needed to stop the motor when it is running at full speed is acceptable.

The purpose of the timer is to allow the motor drive to electronically brake the motor before the drive itself shuts down even if the drive is of a type which does not wait until the motor has stopped turning before shutting down. Without the Brake Delay Timer (or with too short a timer) a winch with an optional mechanical brake may jerk the winch to a stop. With the Brake Delay Timer set for longer than necessary to electronically brake the motor, scenery is likely to drift after stopping.

The Brake Delay Timer is most likely to need adjustment in a situation where the AWU is being used with loads which require a mechanical brake, but where the motor drive cannot control the brake by sensing when the motor has stopped turning.

NOTE

We recommend that winches fitted with mechanical brakes be driven by motor drives which directly control the brake by sensing that the motor is stopped. This is often referred to as an "anti-plug" circuit or as a "back EMF sensing circuit".

We recommend that the Brake Delay Timer be relied on only for pieces that are unlikely to drift after stopping.

Pressing the AWU STOP Button, releasing the JOG Control or allowing a piece to RUN to a LIMIT all cause the AWU to enter the STOP Mode, the SPEED control voltage is taken to zero volts. Then the Brake Delay Timer is triggered. The Brake Delay Timer has a user adjustable period of approximately .250 to 3 seconds. After the timer period is complete the AWU opens the RUN relay.

Adjustment of the Brake Delay Timer Pot

On the far edge of the AWC PCB, you will see two black-finned heatsinks. To the right of the heatsinks and toward the middle of the PCB you will see three square single-turn trip pots (usually blue). The two pots closest to the heatsinks (which are nearly touching each other) are the Speed At Limit adjustments. The adjustment of these pots is described in Section 7.3.3.

The third pot which is a little closer to the front panel and is a little more to the right is the Brake Delay adjustment.

Set the timer so that the Run relay drops out just as the winch stops when braked from its highest (used) speed.

Turn the time pot clockwise to increase the time delay. Turn it counterclockwise to decrease the delay. You will need to Run the winch back and forth using trial adjustments to arrive at an optimum setting.

7.3.3 Speed at LIMIT Adjustment

The AWU controller is designed to control a winch so that the winch decelerates smoothly to a stop at any desired limit. The AWU does this by constantly checking the distance of the winch from its LIMIT and decelerating the winch as it approaches the LIMIT. The winch should be moving very slowly as it reaches LIMIT but it must be moving.

If the winch is to be moving at the moment the LIMIT is reached even an "ideal" motor drive will require an input of a small control voltage of the proper polarity.

For this reason the AWU controller is designed to output a small adjustable control voltage up to the instant the winch reaches its LIMIT. The magnitude of this control voltage determines the speed of the winch at the instant the STOP command is generated by the Limit comparator of the AWU. This non-zero control voltage at LIMIT is generated by the Speed At Limit circuitry.

Many good motor drives are far from "ideal". Real motor drives have three non "ideal" characteristics that are of interest here.

They are :

DEAD BAND (SEE Section 5.7.3)

If a winch is decelerating and the control voltage decreases to the point where it is less than the drive's dead band, the drive will act just as though a control voltage of zero was present. That is, it will stop.

SPEED REGULATION (see Section 5.7.4)

If a drive with a 5% Speed Regulation is driving a motor loaded to 90% of the full rated load, the motor may be run slow by 1/20 of full speed. If the drive is set to run the motor at only 1/25 of full speed with the 90% load it may stall and still be within spec.

SPEED CONTROL RANGE (see Section 5.7.5)

Trying to operate a motor at a slow speed outside of the drive's Speed Control Range is asking it to stall.

For a winch to come to LIMIT the minimum control voltage must be greater than or equal to the sum of three items:

1. the voltage required to cause an "ideal " drive to bring the motor to limit

2. the voltage required to keep the drive in its active speed control region, or the voltage required to overcome the decrease in speed caused by less than perfect speed regulation, whichever is greater, and

3. the motor drive's dead band voltage

On heavily loaded winches speed regulation is often the most important characteristic. On lightly loaded winches the motor drive speed control range is the most important characteristic.

Speed At Limit Adjustment Pots

The AWU-4a controller has two internal pots that adjust the Speed At Limit control voltage. One pot adjusts the voltage when the winch runs IN, the other when it runs OUT.

The approximate range of these controls is 200 to 900 millivolts of control voltages at the LIMIT point. As of this writing units are shipped with these controls factory set for a Speed At Limit voltage of approximately 500 millivolts.

If you are using a precision drive with tachometer feedback the factory setting may be too high. If you are using a drive with poor speed regulation, a low speed control range (15:1 or less), or a large dead band (+/-300 MV or more) the factory setting may be too low.

The symptom of too high a setting is that the drive decelerates normally, but stops at its proper LIMIT while still travelling faster than desired. In this case it is possible that the winch will overshoot its LIMIT by a VERY small amount. This should not be confused with a winch that stops suddenly short of its LIMIT. In this case the problem is usually electronic noise getting onto the encoder cable.

The symptoms of too low a setting of the Speed At Limit pots are that the winch decelerates normally but stops moving just short of its LIMIT; the RUN lamp stays on; and often the motor

will emit a low growling noise.

Before assuming that you need to change the Speed At Limit pots you should try adjusting the Deceleration controls as described in Section 4.5

With no power applied to the AWU remove the cover of the AWU-4a. (see Section 7.1) Place the AWU on a table with the front panel towards you and AWC PCB to your right. The AWC PCB is the larger of the two printed circuit boards.

On the far edge of the AWC PCB you will see two black-finned heatsinks. To the right of the heatsinks and toward the middle of the PCB you will see three square single-turn trim pots (usually blue). The two pots closest to the heatsinks (which are nearly touching each other) are the Speed At Limit adjustments. The third pot, which is a little closer to the front panel and is a little more to the right, is the Brake Delay adjustment. Its adjustment is described in Section 7.2.

Of the two pots the one closest to the heatsinks adjusts the Speed At Limit for runs in the OUT direction, while the one closer to the front panel adjusts the Speed At Limit for runs in the IN direction.

Adjustment of the Speed At Limit Pots

Before changing either pot note their current position so that you may come back to this setting if you choose to. Turning the pots clockwise increases the Speed At Limit. Turn the pots this way if the winch is stalling out. Turning the pots counterclockwise decreases the Speed At Limit. Turn the pots this way if you want a more complete deceleration before the winch reaches its LIMIT.

The adjustment of these pots is usually done "to taste". To see the effect of adjustments, you must RUN the winch back and forth. The IN pot (towards the front panel) only affects the AWU when it is running in the IN (green LED) direction. The OUT pot (towards the heatsinks) only affects the AWU when it is running in the OUT (yellow LED) direction.

Setting Speed At LIMIT Pots For A Specific Value

The following procedure should be used to set the Speed At Limit Pots to a specific desired voltage.

1. If the AWU is installed with a drive and winch, remove AC power from the motor drives and the AWU. Open the AWU-4a as described above. Disconnect the drive control cable from the AWU. It is the 5-pin male Switchcraft type connector.

2. If AWU is not installed with a drive and winch you will need either a male 4 pin Switchcraft connector with Pins 1 and 2 shorted together or a Test Ten Turn

Encoder Pot part #T3E. Plug either of the above into the Encoder connector.

3. You will need a male 5 pin Switchcraft connector with wires soldered to pin 1 (common) and Pin 2 (speed control voltage). These wires should be run to a 2% accurate or better DC volt meter on which a 1 volt reading can be accurately made.

4. Power up the AWU. Check that the OK light comes on. Place the AWU in the RUN mode. Set the selected deceleration pot fully counterclockwise. Set the speed dial to 10. Select a LIMIT. Match the selected limit dial to "winch". If you are using the shorting jumper the setting will be very near 500, if you are using the T3E the setting will be near the setting of the T3E.

5. Very carefully move the selected LIMIT dial so that the green IN LED JUST comes on. Move the LIMIT dial back and forth from the state with BOTH LEDs off to the state with the green LED on until you are sure you can get the green LED just on.

6. Press the RUN button and read the Speed Control Voltage. If you have set the LIMIT dial properly any motion of either the LIMIT dial or the T3E will cause the AWU to go into the STOP mode, so try not to bump anything.

7. Adjust IN Speed At Limit Pot to desired reading. CW rotation increases the voltage.

8. Now very carefully move the selected LIMIT dial so that the yellow IN LED JUST comes on. Move the LIMIT dial back and forth from the state with BOTH LEDs off to the state with the yellow LED on until you are sure you can get the LED just on.

9. Press the Run Button. Adjust IN Speed At Limit Pot to desired reading. CW rotation increases the voltage.

7.3.4 Opamp Offset Trims

Place the AWU-4a open on a table with the front panel towards you and the AWC PCB towards the right. On the right back edge of the AWC PCB are two rectangular ten turn pots.

These pots are the offset trim pots for the AWU's error amps. These pots should never need to be adjusted unless these amps are changed.

The adjustment of these pots can be done in the field but requires an accurate millivolt meter and additional circuit layout information. If you need to adjust these pots please contact the factory.

7.3.5 Power Supply and Reference Points

The following table lists some useful test points on the AWC PCB. Along the right edge of the AWC are 9 solder terminals. They run from the back corner towards the front panel. The letters in the first column are etched on the PCB at their terminal.

TABLE
7.1 POWER SUPPLY AND REFERENCE TEST POINTS

G Internal circuit common and ground. All voltage measurements are referenced to this point.

M Encoder pot signal input.

L Limit pot signal input.

\+ Plus 15 volt power supply (+/- .5 volts)

\- Minus 15 volt power supply (+/- .5 volts)

4 Encoder #1, normally Encoder plus, +10.0 +/- 0.150 volts (note Encoder Plus and Minus may be swapped by jumpers. see Section 7.3.6)

5 Encoder #2, normally Encoder minus, -10.0 +/- 0.150 volts (note Encoder Plus and Minus may be swapped by jumpers. see Section 7.3.6)

6 Limit +9.9 (Encoder plus - 0.1 +/- 0.02)

7 Limit -9.9 (Encoder minus +0.1 +/- 0.02)

7.3.6 Encoder Polarity Reversal Jumpers and Shunts

If you have installed the mechanical system in such a way that the encoder is rotating in the wrong direction and the mechanical system is not easily changed, you can reverse the polarity of the signal between the AWU and the encoder by using a polarity reversal jumper or shunt.

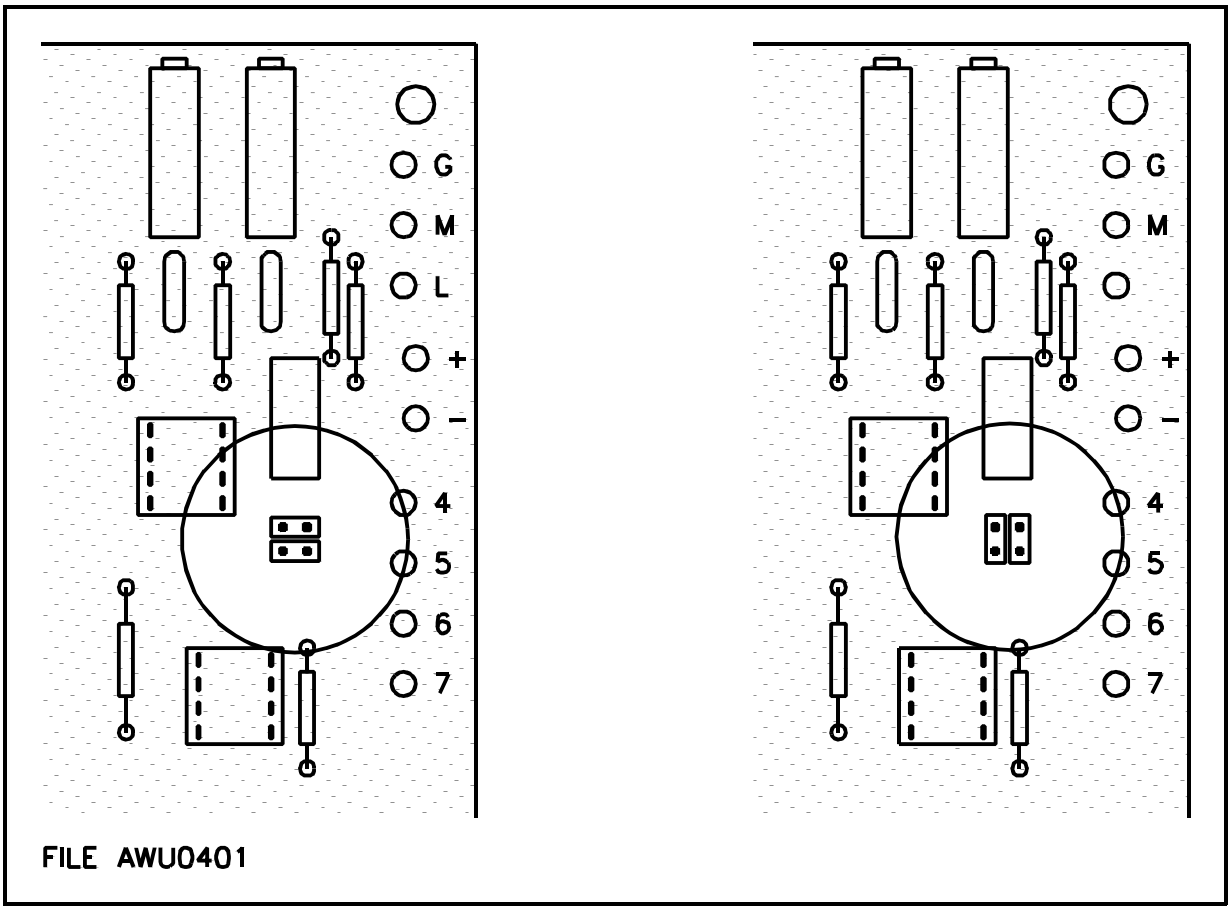

Figure 10 - Polarity Reversal Shunts

Normal Polarity Reversed Polarity

If the problem seems to be an isolated case - especially in an installation with several winches and AWU's, use a jumper. This is better than rewiring the connector because the cable is still standard and you don't end up with cables all wired differently.

A polarity reversal jumper is a four wire cable with a male Switchcraft plug on one end and a female Switchcraft plug on the other. It should be wired as shown in Table 7.2 below.

TABLE
7.2 Polarity Reversal Jumper
4 Pin Switchcraft (tm) Male-Female Cable

MALE PIN - COLOR	FEMALE PIN - COLOR
1 - SHIELD	1 - SHIELD
2 - WHITE	2 - WHITE
3 - BLACK	3 - RED
4 - RED	4 - BLACK

If you find yourself frequently needing to use polarity reversal jumpers you can make an internal change in the AWU main board which will also reverse the polarity. The drawing below shows both the normal (factory setting) position and the position for reversed polarity.

7.3.7 120/240 Volt Power Supply

Most AWU-4a units can be easily rewired to operate from 230 VAC power service. Please contact the factory for instructions.

7.4 USER SERVICEABLE PARTS

7.4.1 Fuse

On the right side of the back panel is a fuse holder for an SB type fuse. AWU-4A models with serial numbers 704037 and earlier use a 1/8 Amp SB fuse; all others use a 1/4 Amp SB fuse.

7.4.2 Indicator Lamps

The RUN, STOP and JOG buttons each use incandescent lamps. They will need periodic replacement.

The lamps are European style T5.5 slide base lamps. The RUN and JOG lamps are 24V, 50 mA types (GDC Part #01-903.2)
The STOP lamp is a 30V 40 mA type (GDC Part #01-903.3)

To replace these lamps:

1. Remove AC power from the AWU. Lamps sometimes break during replacement and you may short the contacts in the lamp holder while withdrawing the lamp.,

2. Remove the switch cap. This is done by carefully lifting the cap straight out of the

switch by catching the cap under the two small notches provided for this purpose. Two small screwdrivers will work, but this is more easily done with a switch cap removal tool. Goddard Design Co. can provide this tool (GDC Part #02-906)

3. Remove the burned out lamp with a tweezers or a rubber lamp removal tool (GDC Part #02-906).

4. Insert a new lamp of the proper type. On the STOP button the metal slide contacts are aligned vertically. On the RUN and JOG buttons the slide contacts are aligned horizontally. Slide the lamp in until it is firmly seated in the lamp socket.

5. Snap the switch cap back into place.

CHAPTER 8
AWU4 VERSIONS AND MODIFICATION

The AWU has had two major versions and several modification over the span of its production. All are generally referred to as AWU's.

8.1 **AWU4**

This is the first version was the AWU4. Fifteen AWU4 were built. They have a two digit serial number from 1 to 15. The AWU4's are visually similar later units. Operationally the major difference is the provision of a separate Jog Speed Pot and the provision of only one set of acceleration and deceleration controls. The jog function is simply a manual speed control. It is not tied into the position circuitry. It is therefore possible to Jog past the end of the limit pot.

The Limit expansion connector (female D25) lacks several of the optional lines now provided. While the master bus connector (male D15) has most of the current lines the functions now handled by the RMI card were considerable less flexible. The AWU4a was an upward compatible improvement on the plain AWU4. All existing pin outs were kept.

This manual does not cover the AWU4 in detail. If you need information on these units please consult the factory.

8.2 **AWU4a**

The first AWUs covered by this manual are AWU4a's. The first AWU4a carries serial number **607015**. They were a major improvement over the AWU4. Two preset for acceleration and deceleration were introduced. The present jog circuitry was introduced. The flexible expansion options including the RMI card were introduced. They fitted with a rotary limit selector knob. They lacked a Digital Position meter. On ordinal AWUa when the REMOTE START switch is pressed remote staring of the AWU is enabled and starting by the front panel RUN button is disabled.

Early units had a smaller power supply transformer and could provide only 40 ma of power to external devices. These units' fuse holder on the back panel takes a 1/8 Amp SB fuse.

8.2.1 **115 or 230 Volt Operation Added**

As of serial number **704035** most units may be rewired for 230 volt operation. Please consult the factory if you need to do this.

8.2.2 **Power Supply Capacity Increased**

As of serial number **704039** the fuse was increased to 1/4 Amp SB fuse. The unit may now supply 100 ma to power external devices.

8.3 **AWU4aM**

With a few exceptions units after serial number **802062** have been fitted with a Digital Position Meter.

8.3.1 **Disabling of RUN button by REMOTE START Switch becomes optional**

As of unit **812067** a programming strap on the REMOTE START PCB allows the user to determine the behavior on RUN when REMOTE START is enabled.

8.4 **AWU4aMT**

Between serial numbers 9007115 and serial 9408178 most units were of the 'MT' type. The units were with fitted with both a Digital Position Meter and a lever wheel style Limit selector switch. This switch provides a large digit showing the currently selected limit. These units also came standard with a **Machine Limit Bypass** switch fitted as a mounting for the "OK" Led.

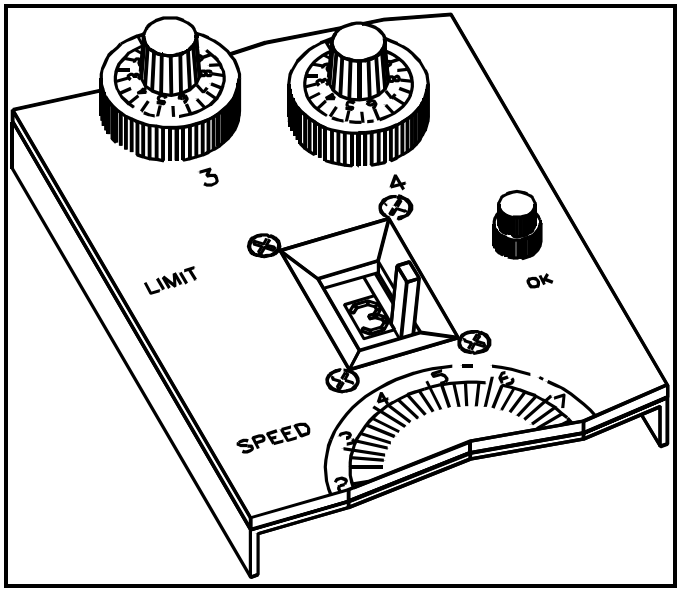

Figure 11 Type MT Limit Selector Switch

8.5 **AWU4aM**

Starting with unit 9503179 the rotary style Limit Selector Switch was reinstated because the entire lever wheel switch line was discontinued by the manufacturer. All other features remained the same.

8.6 **Serial Numbers Explained**

Serial number are made up of three parts. 1) The year made. 2) The month made. 3) The unit number. The first AWU4a carried number **607015** year (8)6, month 07, unit 015. After 1990 the year code is 2 digits. Therefore **9007115** was built in July of 1990 and is the 115 unit built.