USER'S MANUAL

Model DLC300/DLC400

DIGI-LOK® Programmable Digital Control

Minarik Automation & Control

Printed in the United States of America.

Safety Warnings

- This symbol ⚠ denotes an important safety tip or warning. **Please read these instructions carefully** before performing any of the procedures contained in this manual.

- **DO NOT INSTALL, REMOVE, OR REWIRE THIS EQUIPMENT WITH POWER APPLIED.** Have a qualified electrical technician install, adjust and service this equipment. Follow the National Electrical Code and all other applicable electrical and safety codes, including the provisions of the Occupational Safety and Health Act (OSHA), when installing equipment.

- Reduce the chance of an electrical fire, shock, or explosion by proper grounding, over-current protection, thermal protection, and enclosure. Follow sound maintenance procedures.

⚠ **It is possible for a drive to run at full speed as a result of a component failure.** Minarik strongly recommends the installation of a master switch in the main power input of the drive controllng the motor to stop the drive in an emergency.

Circuit potentials are at 115 VAC or 230 VAC above earth ground. Avoid direct contact with the printed circuit board or with circuit elements to prevent the risk of serious injury or fatality. Use a non-metallic screwdriver for adjusting the calibration trimpots. Use approved personal protective equipment and insulated tools if working on this drive with power applied.

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Introduction

Minarik Models DLC300 and DLC400 Digi-Lok® Converters are used with conventional analog speed controls to produce closed-loop digital systems capable of controlling motor speed precisely and with excellent reproducibility.

The Digi-Lok® Converter (DLC) receives the feedback signal generated by a sensor that monitors a rotating element driven by the motor. The sensor assembly can be a magnetic pickup with ferromagnetic gear, or a NPN-type optical encoder or inductive proximity switch, or a Hall effect sensor with magnetic wheel.

An important distinction exists between any Digi-Lok® Converter system and a conventional servo drive. The Digi-Lok Converter reads a velocity-dependent feedback signal and corrects its output to bring the motor back to its set speed. The Digi-Lok® Converter will not compensate for any positioning errors caused by very minor speed fluctuation.

Industrial applications for Digi-Lok® Converter control systems include many within the food processing, chemical, and pharmaceutical industries, for example. Blending, mixing, grinding, pumping, and other such processes often require strict repeatability to ensure product uniformity. The digital speed-setting feature of the Digi-Lok® Converter and the closed-loop design provide that reliability and reproducibility.

DLC Compatibility

The DLC is compatible with positive reference-voltage speed controls only – controls that drive the motor when the speed adjust pot wiper is at a positive potential relative to the CCW side of the speed adjust pot.

With few exceptions, speed controls currently being manufactured meet this requirement. A few older design speed control models, including Minarik Models SL31UD4 and SL51UD4, operate with a negative reference voltage. Such controls will require use of Model DLC100 instead of the DLC300.

Feedback device selection

Acceptable feedback frequency at any set speed in an application must lie within the 10-2000 Hz range. Feedback frequency is directly proportional to the number of feedback pulses per revolution (PPR) and to the speed of the shaft (RPM) that the feedback transducer monitors.

Since the application requirements determine the shaft speed range, they also will determine the range within which the number of feedback pulses per revolution must lie:

PPRminimum = 600/(RPMminimum)

PPRmaximum = 120,000/(RPMmaximurn)

As an example, consider an application in which the feedback source is monitoring a driven shaft, and not the motor armature shaft. This shaft is to be run at speeds as low as 1 rpm. The feedback device that you select must produce at least 600 pulses per revolution.

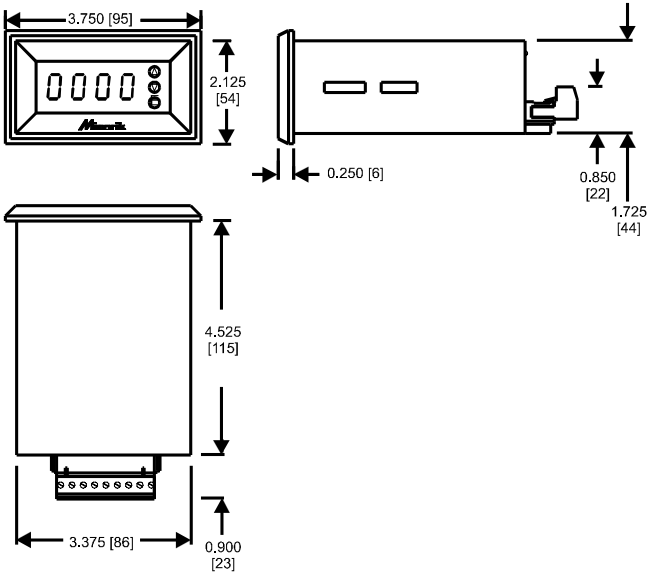
Conversely, if the application were one that required monitoring and controlling a driven shaft at speeds as high as 4000 rpm, the feedback device would be limited to one that produced 30 or fewer pulses per revolution.

The Digi-Lok® Converter system can control armature shaft speeds within a 30:1 range. Under no circumstances can the DLC be expected to control motor speed beyond the speed rating of the motor.

Specifications

Line input voltage, 50-60 Hz, single phase	
DLC300	115 VAC (+/-10%)
DLC400	230 VAC (+/-10%)
Line power	5.5 watts nominally
Acceptable feedback sources	
5V NPN-type encoder	
5V NPN-type proximity switch Hall effect sensor	
Electromagnetic pickup device	
Feedback frequency range	10-2,000 Hz
Maximum speed range	30:1 typical
Speed control reference voltage, maximum	+ 20 VDC
Ambient operating temperature	10ºC to 40ºC
Approximate weight	1 lb.

Dimensions



ALL DIMENSIONS IN INCHES [MILLIMETERS]

Figure 1. DLC300/400 Dimensions

Installation

Warning

Do not install, rewire, or remove this control with input power applied. Doing so may cause fire or serious injury. Make sure you have read and understood the Safety Warnings before attempting installation.

Mounting

Motor speed controls manufactured by other companies may require hookup procedures that differ from those given in this manual. Please contact your Minarik representative for assistance.

A schematic diagram and the manufacturer's instructions for interfacing the control with an external speed-setting signal will probably be required before the correct wiring scheme can be determined.

Install the Digi-Lok Converter in an area that is protected from exposure to dirt or moisture and from accidental contact. Provide clearance that permits access for connecting wires. Do not mount the device near other heat-producing objects, nor in an area subject to cold and moisture. Ambient temperature within the range of 10º to 40ºC must be maintained.

Wiring

Warning

Do not install, remove, or rewire this equipment with power applied. Failure to heed this warning may result in fire, explosion, or serious injury.

Circuit potentials are at 115 or 230 VAC above ground. To prevent the risk of injury or fatality, avoid direct contact with the printed circuit board or with circuit elements.

Do not disconnect any of the motor leads from the motor control unless power is removed. Opening any one motor lead may destroy the control.

Variable speed DC drives manufactured by other companies may require hookup procedures that differ from those given in this manual. Contact your local Minarik branch or distributor for assistance. A schematic diagram and the manufacturer's instruction for interfacing the drive with an external speed-setting signal may be required before the correct wiring scheme can be determined.

- Use 16–20 AWG wire for speed adjust potentiometer wiring. Use 14–16 AWG wire for AC line (L1, L2) and motor (A1 and A2) wiring.

Shielding guidelines

Warning

Under no circumstances should power and logic leads be bundled together. Induced voltage can cause unpredictable behavior in any electronic device, including motor controls.

As a general rule, Minarik recommends the shielding of all conductors.

If it is not practical to shield power conductors, Minarik recommends shielding all logic-level leads. If shielding is not practical, the user should twist all logic leads with themselves to minimize induced noise.

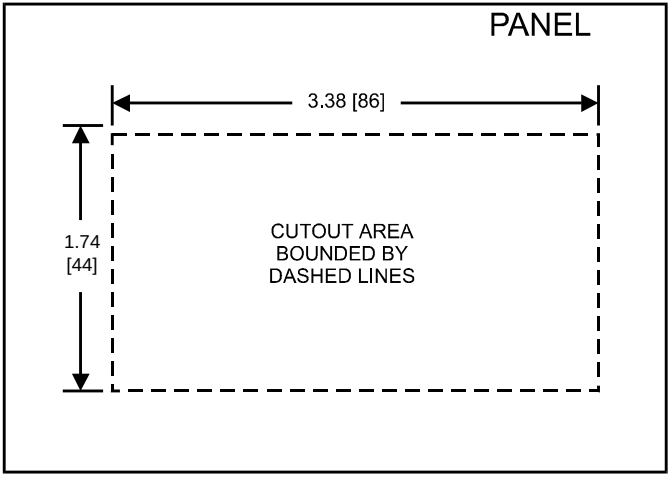
It may be necessary to earth ground the shielded cable. If noise is produced by devices other than the drive, ground the shield at the drive end. If noise is generated by a device on the drive, ground the shield at the end away from the drive. Do not ground both ends of the shield.

If the drive continues to pick up noise after grounding the shield, it may be necessary to add AC line filtering devices, or to mount the drive in a less noisy environment.

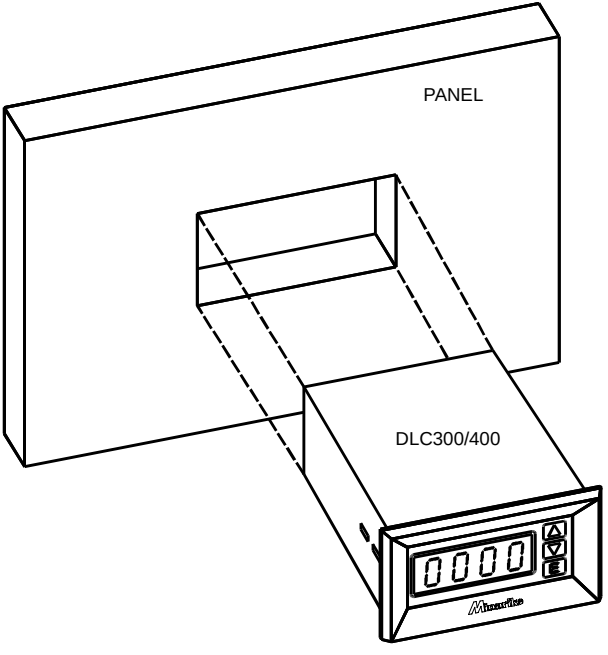
Logic wires from other input devices, such as motion controllers and PLL velocity controllers, must be separated from power lines in the same manner as the logic I/O on this drive.

Panel installation

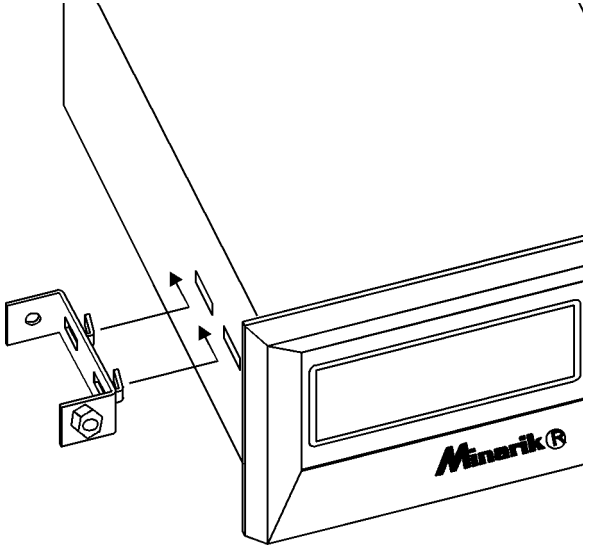
Step 1. Cut a rectangular hole in the panel 1.73 inches (44 mm) high, and 3.38 inches (86 mm) wide.



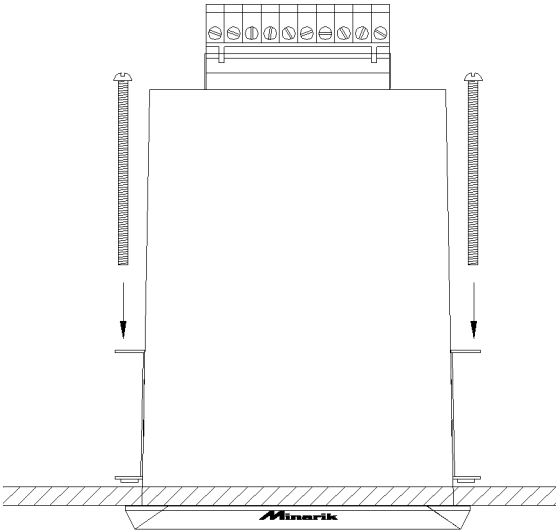
Step 2. Slide the DLC3/400 into the panel opening.



Step 3. Insert the two mounting brackets into each side of the DLC300/400 case.



Step 4. Secure the DLC300/400 to the panel using the bracket screws. Do not overtighten the screws, or damage to the enclosure may result.



DIP Switch Settings

The DLC is set at the factory to receive magnetic pickup feedback. If your application does not use a magnetic pickup, you must reset two board-mounted DIP switches located just inside the case and behind the signal input terminals. Reset these DIP switches before you connect the DLC unit to AC power.

If the near end of the DIP switch is down, that switch is ON; if up, that switch is OFF. Use a narrow non-metallic screwdriver or similar instrument to set the DIP switches. For other than magnetic pickup feedback devices, set OPTO (left DIP switch) ON and MAG (right DIP switch) OFF.

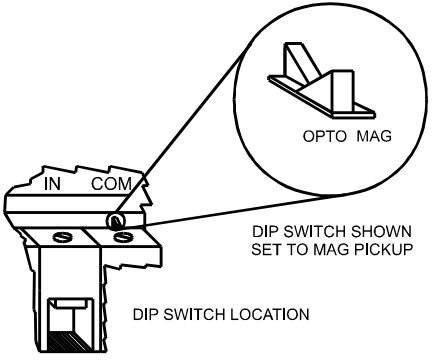


Figure 2. DIP Switch Location

Connections

Feedback signal

Terminals marked IN and COM accept the feedback signal input. Connect the signal lead to IN and the common lead to COM. The terminal marked "+ 5" is a + 5VDC power supply output available to drive an encoder feedback device.

Leads from an electromagnetic pickup device have no fixed polarity. These leads may be connected to the IN and COM terminals in either order.

To avoid signal distortion, twist the feedback leads. For those installations that require leads longer than approx. 18 inches, use shielded leads with the shield grounded only at the transducer. Good installation practice dictates that you run feedback leads, Digi-Lok® output leads, and motor leads in separate conduits.

Digi-Lok Converter output

Terminals S1, S2, and S3 are the DLC output terminals. Connect Sl to the terminal normally assigned to the CCW side of the speed pot, S2 to the speed pot wiper terminal, and S3 to the speed pot CW terminal. If the speed control already has a clamping resistor between its wiper and CCW terminals, only connect DLC terminals S2 and S3 to the control terminals. The motor speed controller must use a positive reference voltage in its speed setting circuit.

Line voltage connections

Warning

Positive disconnects in the AC supply to the speed control unit itself must be in place to ensure an emergency shutdown of the entire system. Merely disconnecting the DLC unit will not provide adequate safeguard against a runaway condition.

Connect earth ground to Terminal G. Wire AC power to Terminals L1 and L2.

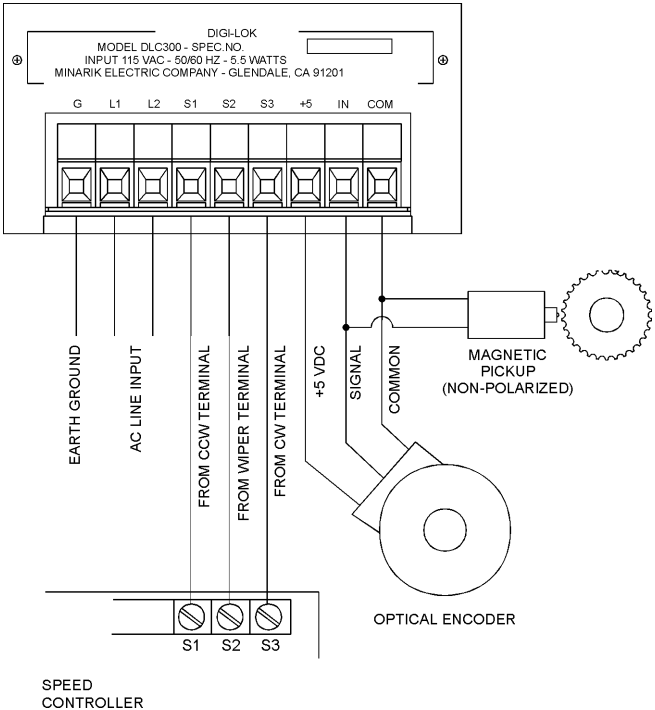


Figure 3. DLC300/400 connections

Programming Instructions

Calibrating the speed control

Warning

It is very important that the drive attached to the Digi-Lok be properly calibrated for its motor–with one exception. The IR COMP (regulation) trimpot must be set to zero (full CCW).

Calibrate the motor speed controller for use with the DLC. The objective is to optimize the response of the speed control to the DLC signal and to minimize any tendency by the speed control to independently attempt to regulate motor speed.

Set the control's Maximum Speed trimpot to its maximum setting. Set the control's Minimum Speed trimpot to its minimum setting.

Adjust the speed control to its maximum rate of acceleration (and deceleration), to obtain its most rapid response to speed setting commands. Lower the IR COMP (REGULATION) setting to its minimum setting. The motor control then will be able to respond almost transparently to the DLC commands.

Programming Mode

Programming can be done before the DLC is installed, or before it is connected to the speed controller, or after the entire system is set up. Usually, it is more convenient to program the DLC before it is connected to the speed controller, because the motor will not then be running.

Press the front panel push-button marked "E" (ENTER) at the same time that you power the DLC unit and it will be put into its Programming Mode. If the DLC is already powered up, you must interrupt power and hold in the ENTER push-button while restoring AC power.

DLC programming parameters

Four parameters must be programmed into the Digi-Lok® Converter. Three parameters can be programmed without running the motor. The *Speed Scaling Factor* correlates the digital speed set at the DLC with the desired speed at the feedback shaft. The *Display Scaling Factor* correlates the numerical value displayed by the DLC with the rpm at the feedback shaft. The *Decimal Point Location Number* fixes the position of a decimal point within the DLC display.

As the Digi-Lok® Converter senses any deviation from set speed, its output to the speed control will be changed to bring the actual motor speed back to set speed. The selected *Load Response Number* determines the rate at which the DLC output voltage is changed, for a given difference between set speed and actual speed. The higher the value of the Load Response Number, the faster the Digi-Lok® Converter will respond.

The proper DLC Load Response Number must be selected empirically. It is the value that enables the DLC system to respond as rapidly as possible without "hunting" or rapidly oscillating about its set point. Typically, there will be a range of load response numbers that gives satisfactory load response, so it is not necessary to determine its precise value. Any reprogramming from the factory setting is indicated only when and if system response needs to be improved.

Speed Scaling Factor

The DLC can be programmed to accept speed settings in units numerically different from actual shaft rpm, e.g., in feet per minute, or gallons per minute. Its feedback signal can originate from a device possessing almost any number of pulses per revolution, depending only upon the operating speed range. This flexibility is made possible through use of the Speed Scaling Factor (SSF).

The governing equation is:

SSF= [(SPEED SETTING)/(SHAFT RPM)] X [3000/PPR] [1]

Select any speed setting and the corresponding shaft rpm. The *entire* numerical speed setting entry has to be used in this equation. Delete the decimal point, if present. The number of feedback pulses per revolution is known. Substitute these values into Equation 1 and calculate SSF. Round off this value to the nearest whole number. Any value from 1 through 9999 can be accepted as the DLC Speed Scaling Factor.

The DLC is set at the factory for use with a 60 pulse-per-revolution feedback device. It is set for entering directly the speed of the monitored shaft in rpm. By Equation 1, then, the correct value for the Speed Scaling Factor under these conditions is 50.

Assume that you need to calculate the SSF for an application involving a different set of parameters: A 100-line encoder is mounted on a pinch roller shaft. Speed is to be set in feet per minute, to one decimal place. A setting of 180.0 fpm is equivalent to the roller rotating at 120 rpm. Substituting into Equation 1:

SSF = [(1800)/(120)] X [3000/100] = 450

Notice that the first term substituted into the equation is "1800", not "180.0". Always drop the decimal point, if there is one, when using the speed setting value in this equation.

If you already have enabled the Programming Mode, the DLC display will show **0050.** - the factory-set SSF value of 50. The number of decimals displayed in Programming Mode tells which parameter is being displayed. One decimal point signifies SSF programming.

If the display shows more than a single decimal point, you are viewing the wrong programming screen. Bring the display back to the one showing just one decimal point. Do this by pressing **ENTER** once, twice, or three times, to scroll to the correct screen.

Change the SSF value by pressing the **UP** push-button to increment the displayed value, or the **DOWN** push-button to decrement it. Each time the push-button is pressed, the SSF value will change by one unit. To accelerate this rate of change, hold in the push-button continuously until you get close to the desired value. Release the push-button. You will be able to make unit increments again with successive presses of the push-button.

Press **ENTER** once to move from this screen to the Load Response Number screen.

Load Response Number

The load response number appears when the display contains two decimal points. Initially, the display should read **000.8.**, the factory-set value. Thirty-one load response numbers are available: 0 through 30. Most applications will run quite successfully at the setting of 8.

If your application does not run properly, as evidenced by failure to lock into speed, you first need to check that shock loading is not occurring. The DLC system cannot compensate for the perturbations that shock loading creates.

If the speed oscillates rapidly and with wide amplitude about the set point, reduce the load response number slightly and evaluate the results. Repeat, if necessary, until the oscillation no longer is present.

If the motor accelerates too slowly, or if it oscillates slowly around its set speed, the DLC probably is responding too slowly to the detected variance in speed. Its response will be improved by your increasing the Load Response Number.

In handling highly inertial loads, it may be that no setting of the Load Response Number satisfactorily resolves the hunting problem. Should this be the case, the application may require a regenerative-type speed controller instead, with the Digi-Lok® Converter.

Change the Load Response Number by pressing the **UP** push-button to increase the displayed value, or the **DOWN** push-button to decrease it. Each time the push-button is pressed, the value will change by one unit. To accelerate this rate of change, simply hold in the push-button continuously until you approach the desired value. After releasing the push-button, you will be able to make unit increments again.

The numbers roll over at 30 and at 0. When the correct load response number is displayed, you have completed this stage. Press **ENTER** once to move from this screen to the Display Scaling Factor screen.

Display Scaling Factor

The Display Scaling Factor (DSF) is seen when the DLC programming display contains 3 decimal points. A value of 100 for the Display Scaling Factor appears in this display as **01.0.0.**

It is important to understand how the DLC display operates. In its operating mode, the DLC display shows the number of feedback pulses counted during a fixed, programmable time period-the gate time. Mathematically,

SPEED DISPLAY = FREQ X GT [2]

Where GT = gate time (sec) and FREQ = feedback frequency (Hz).

FREQ=(SHAFT RPM) x (PPR/60) [3]

Thus, the DLC gate time may be calculated from the system parameters. By combining equations [2] and [3] and solving for gate time, we arrive at the following equation:

GT= [(SPEED DISPLAY / SHAFT RPM)] x (60 / PPR), sec [4]

The display scaling factor (DSF) equals this gate time expressed as the number of 'ticks' of the DLC 50 Hz internal clock. Mathematically,

DSF = 50 x GT [5]

Combining equations [4] and [5], we arrive at the final equation:

DSF = [(SPEED DISPLAY) / (SHAFT RPM)] x (3000 / PPR) [6]

Equation [6] is identical in its form to equation [1], the speed scaling factor equation. There is, however, one important difference between the two scaling factors.

The numerical value of the speed scaling factor has no effect on the intrinsic performance of the DLC. It only scales the numerical entry to the desired motor speed. Any calculated value from 1 to 9999 is totally acceptable as the speed scaling factor.

The display scaling factor, on the other hand, defines the gate time for the DLC display (equation [5]). There are practical limitations on the range of acceptable gate times.

Gate times shorter than approximately 0.5 sec will yield blurred numbers when the pulse count (speed) varies in consecutive screen updates. To avoid an illegible display, set the gate time to at least 0.5 sec.

As gate times get longer than approximately 3 seconds, they will become less than acceptable, since the delay between consecutive updates begins to mask speed changes that may occur. Try to settle on a gate time that is less than approximately three seconds.

An acceptable DSF value must lie between 25 and 150 for the gate time to be between 0.5 and 3 seconds. A DSF outside this range can be changed to an acceptable one. You need only make the appropriate change in any one or more of the variables appearing in Equation 6.

If the calculated DSF value is too low, you can: display ten times the speed and move the decimal point one place to the left; monitor a slower rotating shaft, or select a feedback source having fewer pulses per revolution.

If your calculated DSF value is too high, you can: reduce the speed display by one or more orders of magnitude and move the decimal point. You might change to larger units of measure, e.g., feet per minute instead of inches per minute. You could also monitor a higher-speed shaft or use a feedback device having a higher number of pulses per revolution.

Change the DSF value by pressing the **UP** push-button to increase the displayed value, or the **DOWN** push-button to decrease it. Each time the pushbutton is pressed, the value will change by one unit. To accelerate this rate of change, simply hold the pushbutton continuously until you approach the desired rate. Release the pushbutton to revert to the slower incrementing rate.

Decimal point location

The decimal point location number is shown when the programming display itself contains four decimal points. There are four available settings:

Screen setting	Decimal point display
0.0.0.0	1800
0.0.0.1	180.0
0.0.0.2	18.00
0.0.0.3	1.800

Use the **UP** and **DOWN** push-buttons to change the decimal point location number. When you've done this, you can stay in the Programming Mode to correct a previous programming error or you can go to the operating mode. Press **ENTER** to stay in the Programming Mode. The SSF programming screen will be seen.

When you are ready to leave the Programming Mode, press and hold the **ENTER** button while you also press the **UP** push-button. Try to release both push-buttons at the same time.

Exit the Programming Mode

When you exit the Programming Mode, all the values you have programmed will be saved to the EEPROM. Press and hold the **ENTER** button while pressing the **UP** push-button. Release both push-buttons simultaneously. You will see the scaled speed displayed if you have properly executed this transition.

If, by chance, you release the **ENTER** push-button after the **UP** push-button, the display may show you the set speed with the left-hand digit flashing. This means that you are in the speed-setting mode. To get out of this mode, press **ENTER** until the right-hand digit flashes, then press **ENTER** one more time.

Troubleshooting

Warning

Dangerous voltages exist on the drive when it is powered. When possible, disconnect the drive while troubleshooting. High voltages can cause serious or fatal injury.

Before troubleshooting

Perform the following steps before starting any procedure in this section:

- Disconnect AC line voltage from the drive.
- Check the drive closely for damaged components.
- Check that no conductive or other foreign material has become lodged on the printed circuit board.
- Verify that every connection is correct and in good condition.
- Verify that there are no short circuits or grounded connections.
- Check that the drive's rated armature outputs are consistent with the motor ratings.

For additional assistance, contact your local Minarik® distributor, or the factory direct at:
1-800-MINARIK (646-2745) (phone) or 1-800-394-6334 (fax).

Most problems, if they do occur, will appear at initial start-up of the DLC system. The more common problems are described below.

Should your DLC fail to operate as it should after you have taken the suggestions found in this list, contact your Minarik salesperson for technical assistance.

If the motor will not run:

1. The output from the DLC to the speed control may not be wired correctly. Check the hookup carefully.

2. Check the continuity of all output leads, from the DLC to the control and from the control to the motor.

3. The speed control may be defective. Disconnect the DLC from the control. Connect the speed adjust potentiometer to the control. Check whether the motor runs properly.

4. The motor may be defective. Test the system with another motor.

If the motor will not lock into speed:

1. The load response number may be too low (if the oscillation is gradual) or too high (if the oscillation is very rapid).

2. The speed control may be incorrectly calibrated. Check that the accel, decel, and IR comp settings are at their minimums.

3. The clamping resistor on the DLC may be dragging the output if the control already has its own circuit with a clamping resistor between the wiper and CCW terminals. Remove the connection between DLC terminal S1 and the CCW terminal on the speed control.

4. Confirm that the pickup sensing tip is directly over the center of the gear teeth and is no farther than 0.010" above the teeth. Extensive shaft runout is the most common cause of this type of problem.

5. Check continuity and shielding of pickup leads. Electrical noise can cause the DLC to attempt corrections that are not justified.

6. Rapid shifts in load may be pulling the motor out of its set speed. Consider the use of a regenerative drive with the DLC.

7. The IR COMP (regulation) setting on the drive may be above zero. Set IR COMP (regulation) to zero (full CCW).

If motor runs at top speed regardless of the set speed:

1. There may be an electromechanical defect in the pickup, a break in the pickup leads, or in the leads from any sensor. Also, check the alignment of the pickup over the gear. Without accurate feedback information fed to the DLC, the system cannot be expected to operate correctly.

2. Verify that the speed control board common is coupled to DLC. terminal S1.

3. The speed control may be defective. Replace the DLC with the speed pot and check whether the motor runs properly.

4. The OPTO/MAG DIP switches may not be set correctly. Check to make sure you have correctly calculated and programmed the speed scaling factor (SSF) and display scaling factor (DSF).

If the motor is running at a fixed difference below set speed:

1. There may be a 60 Hz signal riding on the pickup leads. Check that the leads are run in their own conduit and that all connections are tightly made. For long paths, these leads must be shielded and their shielding grounded at the DLC.

2. Check to be certain that if the speed control circuit does not have a clamping resistor between its CCW and wiper terminals, you have connected all three output terminals of the DLC to their corresponding terminals on the speed control. If, on the other hand, the speed control is already clamped, verify that the connection to DLC terminal S1 is correctly left open.

Unconditional Warranty

A. Warranty

Minarik Corporation (referred to as “the Corporation”) warrants that its products will be free from defects in workmanship and material for twelve (12) months from date of manufacture thereof. Within this warranty period, the Corporation will repair or replace such products that are returned to Minarik Corporation, 901 East Thompson Avenue, Glendale, CA 91201-2011 USA.

This warranty shall not apply to any product that has been repaired by unauthorized persons. The Corporation is not responsible for removal, installation, or any other incidental expenses incurred in shipping the product to and from the repair point.

B. Disclaimer

The provisions of Paragraph A are the Corporation’s sole obligation and exclude all other warranties of merchantability for use, express or implied. The Corporation further disclaims any responsibility whatsoever to the customer or to any other person for injury to the person or damage or loss of property of value caused by any product that has been subject to misuse, negligence, or accident, or misapplied or modified by unauthorized persons or improperly installed.

C. Limitations of Liability

In the event of any claim for breach of any of the Corporation’s obligations, whether express or implied, and particularly of any other claim or breech of warranty contained in Paragraph A, or of any other warranties, express or implied, or claim of liability that might, despite Paragraph B, be decided against the Corporation by lawful authority, the Corporation shall under no circumstances be liable for any consequential damages, losses, or expense arising in connection with the use of, or inability to use, the Corporation’s product for any purpose whatsoever.

An adjustment made under warranty does not void the warranty, nor does it imply an extension of the original 12-month warranty period. Products serviced and/or parts replaced on a no-charge basis during the warranty period carry the unexpired portion of the original warranty only.

If for any reason any of the foregoing provisions shall be ineffective, the Corporation’s liability for damages arising out of its manufacture or sale of equipment, or use thereof, whether such liability is based on warranty, contract, negligence, strict liability in tort, or otherwise, shall not in any event exceed the full purchase price of such equipment.

Any action against the Corporation based upon any liability or obligation arising hereunder or under any law applicable to the sale of equipment or the use thereof, must be commenced within one year after the cause of such action arises.

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