CHAPTER TWO

2 Troubleshooting

IN THIS CHAPTER

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Troubleshooting Basics

When your system does not function properly (or as you expect it to operate), the first thing that you must do is identify and isolate the problem. When you have accomplished this, you can effectively begin to resolve the problem.

The first step is to isolate each system component and ensure that each component functions properly when it is run independently. You may have to dismantle your system and put it back together piece by piece to detect the problem. If you have additional units available, you may want to exchange them with existing components in your system to help identify the source of the problem.

Determine if the problem is mechanical, electrical, or software-related. Can you repeat or re-create the problem? Do not attempt to make quick rationalizations about problems. Random events may appear to be related, but they are not necessarily contributing factors to your problem. You must carefully investigate and decipher the events that occur before the subsequent system problem.

You may be experiencing more than one problem. You must isolate and solve one problem at a time. Log (document) all testing and problem isolation procedures. You may need to review and consult these notes later. This will also prevent you from duplicating your testing efforts.

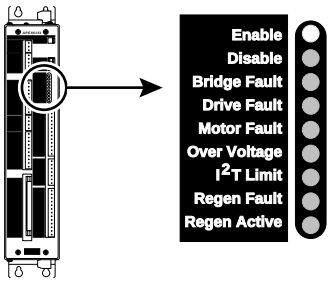
If you are having difficulty isolating a problem be sure to document all occurrences of the problem along with as much specific information, such as time of occurrence, APEX615n status, and anything else that was happening when the problem occurred.

Once you have isolated a problem, take the necessary steps to resolve it. Refer to the problem solutions contained in this chapter. If your system's problem persists, contact Technical Assistance at the numbers listed on the inside cover of this document.

Diagnostic LEDs for Hardware Problems

The APEX615n has a bank of nine light emitting diodes (LEDs) on its front panel. Use these LEDs to isolate and identify hardware problems with the APEX615n.

The LED portion of the front panel is shown below. The **Enable** LED, when illuminated, is green. All other LEDs are red when illuminated.



If a problem arises with the APEX615n, first check the LEDs for an indication of the problem's origin. The next table explains situations that can illuminate each LED, and provides the method to reset relevant fault conditions. Note that you should rectify the cause of the fault before resetting the fault condition as noted in the table below; otherwise, the fault is likely to reoccur.

LED	Description	Latched (yes/no)	How to reset the fault (see *Recovering from Faults* below for additional details)
Enable	Indicates drive is enabled	no	n/a
Disable	Indicates drive is disabled	no	Issue the DRIVE1 command
Bridge Fault *	Power stage over-temperature Power stage over-current Motor short circuit	yes yes yes	Note 1 Note 1 Note 1
Drive Fault *	Control board over-temperature Under-voltage (brownout)	yes yes	Note 1 Note 2
Motor Fault *	Resolver not connected Motor over-temperature Motor thermostat not connected	yes yes yes	Note 1 Note 1 Note 1
Over Voltage Fault *	Bus voltage exceeded 420VDC	yes	Note 1
I^2T Limit	I^2T limit. Drive is in foldback. Output is limited to continuous current setting.	no	Note 3
Regen Fault *	Excessive regeneration (external regeneration resistor may be required)	yes	Note 1
Regen Active	Regeneration circuit active (regeneration resistor is turned on, and dissipating excess power)	no	Note 4

* When these faults occur, the 615n's output current is latched off.

Note 1 Activate drive RESET input on the DRIVE AUXILIARY connector (hold the input to less than 1.0V for at least 20 milliseconds; reset begins upon release of the low voltage), issue the DRESET command, or cycle power.

Note 2 When the bus voltage drops below 85VAC 120VDC the **Drive Fault** LED will latch, indicating a under-voltage condition. The controller will then disable the drive. When the bus voltage has recovered there are 3 ways to clear the drive fault: (1) issue a reset via the drive reset input, (2) enter the DRESET command, or (3) enable the drive with the DRIVE1 command.

Note 3 This fault condition is ***not latched***. It indicates that the APEX615n is in current foldback, with its output current limited to the continuous current level. An I^2T Limit usually indicates that something is wrong with your system—a mechanical jam, the motor is undersized, the move is too aggressive for the motor, etc.

The drive may recover on its own, if the level of continuous current is low enough to permit the motor to cool. Under some conditions, the drive may not recover on its own—it may stay in current foldback. To recover, disable the drive with the DRIVEØ command. Wait for the motor to cool before you re-enable the drive (DRIVE1 command) and resume operations.

CAUTION: Do not use the **RESET** input or RESET or DRESET commands to clear the fault. If you do so, the protective circuit loses all information about motor temperature. It assumes the motor operates from a cold start, and it may not protect the motor from overheating if the motor is hot at the time the reset occurs.

The motor has less torque during an I^2T Limit. If you configure your controller to detect position errors (based on the maximum allowed position error set with the SMPER command), then an I^2T Limit will probably cause a position error fault. See the Current Foldback section of this chapter.

Note 4 This is not a fault condition. When the LED turns on, it indicates that the internal regeneration resistor is dissipating excess regenerated power. The LED will turn off when the resistor stops dissipating power. If the APEX615n experiences excessive regeneration, it will fault and the Regen Fault LED will illuminate; in this situation, you may wish to consider installing an external regeneration resistor.

Recovering from Faults

Many of the fault conditions will shut down the APEX615n's output current to the motor. Before trying to restart your system, you should first solve the problem that caused the fault. For example, if a short circuit in a motor cable caused a Drive Fault, the same fault will probably occur when you restart the drive—unless you first fix the problem.

Most of the fault conditions are *latched*. Once the problem is fixed, the APEX615n will not start up again on its own. You must first cycle power, or reset the drive/controller (see Notes 1 & 2 above).

To *cycle power*, remove AC power from the **Control L1** and **Control L2** terminals on the APEX615n, then turn the power back on. Note that there is a dual voltage supply—one for the internal drive/controller electronics, **Control L1/L2**, and one for the motor, **L1/L2** (see connection instructions in Chapter 2).

To *reset* the APEX615n, send a reset signal to the APEX615n's **RESET** input, located on the **DRIVE AUXILIARY** connector, or issue the DRESET command.

Reset the APEX615n

There are two ways to reset the APEX615n:

- The **RESET** input is a *hardware* reset—it resets the drive functions within the APEX615n. (To reset the drive, hold the reset input at a low voltage, less than 1.0V, for at least 20 milliseconds. Reset will begin upon release of the low voltage.) NOTE: An alternative is to issue the DRESET command.
- The reset command (RESET) is a *software* reset—it resets the controller functions within the APEX615n.

The two reset functions are independent, and do not directly affect each other. This means that if you use the **RESET** input or the DRESET command to reset the drive, the controller will remain up and running. Similarly, if you issue a RESET command to return the controller to power-up conditions, the drive functions will not automatically be reset (e.g., the drive will retain information about motor temperature—see Note 3 above).

Reducing Electrical Noise

For detailed information on reducing electrical noise, refer to Appendix B.

Error Messages and Debug Tools

A list of all possible error messages, and their causes, is provided in the ***6000 Series Software Reference***. For instructions on using the APEX615n's program debug tools (Trace mode, Single-Step mode, I/O activation, bad command detection, etc.) refer to *Program Debug Tools* in the *Programming Guide* section of the ***6000 Series Software Reference***.

Technical Support

If you cannot solve your system problems using this documentation, contact your local Automation Technology Center (ATC) or distributor for assistance. If you need to talk to our in-house application engineers, please contact us at the numbers listed on the inside cover of this manual. (These numbers are also provided when you issue the HELP command.)

NOTE: Compumotor maintains a BBS that contains the latest software upgrades and late-breaking product documentation, a FaxBack system, and a tech support email address.

Common Problems & Solutions

The following table presents some guidelines to help you isolate problems with your motion control system. Some common symptoms are listed along with a list of possible causes and remedies.

- Look for the symptom that most closely resembles what you are experiencing.
- Look through the list of possible causes so that you better understand what may be preventing proper operation.
- Start from the top of the list of remedies and use the suggested procedures to isolate the problem.
- Refer to other sections of the manual for more information on APEX615n set up, system connections, and feature implementation. You may also need to refer to the ***6000 Series Software Reference***.

Problem	Cause	Solution
Erratic operation	1. Electrical Noise	1. Reduce electrical noise or move the APEX615n away from noise source (refer also to Appendix A)
	2. Improper wiring	2. Check wiring for opens, shorts, and mis-wired connections
LEDs: DISABLE is red	1. Shutdown input active 2. Position error	1. Issue `DRIVE1` command 2. Issue `DRIVE1` command
LEDs: ENABLE LED is off	1. No AC power	1. Check AC power
Missing counts from feedback device	1. Improper wiring 2. Feedback device slipping 3. Feedback device too hot 4. Electrical noise 5. Feedback device frequency too high	1. Check wiring 2. Check and tighten feedback device coupling 3. Reduce encoder temperature with heatsink, thermal insulator, etc. 4a. Shield wiring (refer also to Appendix A) 4b. Use encoder with differential outputs 5. Peak encoder frequency must be below 1.2 MHz post-quadrature; peak frequency must account for velocity ripple
No Motion	1. ENABLE LED off 2. Limits engaged 3. Improper wiring 4. Load is jammed 5. No torque from motor 6. Maximum position error exceeded 7. ENABLE IN input is not grounded to GND	1. See Enable LED problems above. 2a. Move load off of limits or disable limits with `LHØ` 2b. If using soft limits, make sure `LSCW>LSCCW` 3. Check enable, fault, and limit connections. 4. Remove power and clear jam 5. See problem: *No Torque* 6. Check to see if `TAS` bit #23 is set, and issue the `DRIVE1` command 7. Ground ENABLE IN to GND and reset or cycle power

Problem	Cause	Solution
No RS-232C Communication	1. Improper RS-232C Interface or communication parameters 2. RS-232C disabled 3. In daisy chain, unit may not be set to proper address	1. See *RS-232C Troubleshooting* section 2. Enable RS-232C with the E command (all units if daisy-chained) 3. Verify proper application of the ADDR command
No Torque/Force	1. Improper wiring 2. No power to motor 3. Shutdown issued	1. Check wiring to the motor, as well as other system wiring 2. Check power at motor 3. Enable drive with DRIVE1
Power-up Program does not execute	1. ENABLE IN input is not grounded to GND 2. STARTP program is not defined	1. Ground ENABLE IN to GND and reset or cycle power 2. Check the response to the STARTP command. If no program is reported, define the STARTP program and reset
Program access denied: receive the message *ACCESS DENIED when trying to use the DEF, DEL, ERASE, INFNC, or MEMORY commands	1. Program security function has been enabled (INFNCi-Q) and the program access input has not been activated	1a. Activate the assigned program access input, perform your programming changes, then deactivate the program access input. 1b. Refer to the instructions in the INFNC command description in the ***6000 Series Software Reference***
Program execution: stops at the INFEN1 command	1. INFEN1 enables drive fault monitoring, but the drive fault level (DRFLVL) command is set incorrectly for the drive being used.	1. Issue the correct DRFLVL command for your drive (refer to the DRFLVL command)
Program execution: the first time a program is run, the move distances are incorrect. Upon downloading the program the second time, move distances are correct.	1. Scaling parameters were not issued when the program was downloaded; or scaling parameters have been changed since the program was defined	1. Issue the scaling parameters (SCALE1, SCLA, SCLD, SCLV) before saving any programs
Programmable inputs not working	1. IN-P or AUXP (input pullup) not connected 2. If external power supply is used, the grounds must be connected together 3. Improper wiring	1a. When inputs will be pulled down to 0V by an external device, connect IN-P and/or AUX-P to +5V or to another positive supply 1b. When inputs will be pulled up to 5V or higher by an external device, connect IN-P and/or AUX-P to 0V 2. Connect external power supply's ground to ISO GND 3. Check wiring for opens, shorts, and mis-wired connections
Programmable outputs not working	1. Output connected such that it must source current (pull to positive voltage) 2. OUT-P not connected to +5V or other positive voltage source 3. If external power supply is used, the grounds must be connected together 4. Improper wiring	1. Outputs are open-collector and can only sink current–change wiring. 2. Connect OUT-P to +5V supplied or other voltage in system 3. Connect external power supply's ground to ground ISO GND 4. Check wiring for opens, shorts, and mis-wired connections
Trigger, home, or end-of-travel inputs not working.	1. If external power supply is used, the grounds must be connected together. 2. Improper wiring.	1. Connect external power supply's ground to APEX615n's ground . 2.a. Check wiring for opens, shorts, and mis-wired connections. 2.b. When inputs are pulled down to 0V by an external device, connect AUX-P to +5V supplied or to an external +5-24V supply (but not to both). 2.c. When inputs are pulled to 5-24V by external device, connect AUX-P to 0V. 2.d. Make sure a 5-24V power source is connected to the V_I/O terminal.
Wrong Direction—Stable	1. Phase of encoder reversed	1. Switch CHA+ with CHA- connection from APEX615n to encoder
Wrong Direction—Unstable	1. Not tuned properly 2. Phase of encoder reversed	1. Refer to Chapter 4 for tuning instructions 2. Switch CHA+ with CHA- connection from APEX615n to encoder
Wrong Speed or Distance	1. Wrong resolution setting 2. Wrong scaling value	1. Encoder feedback: Check and set resolution on APEX615n with ERES set to 4096. 2. Check the scaling parameters (SCALE1, SCLA, SCLD, SCLV)

Troubleshooting Serial Communication Problems

General Notes

- Power up your computer or terminal *BEFORE* you power up the APEX615n.
- Make sure the serial interface is connected as instructed on page 25. Shield the cable to earth ground at one end only. Check to make sure you are using **Iso GND** as your reference, not **GND**. The maximum RS-232 cable length is 50 feet (15.25 meters).
- RS-232: Handshaking must be disabled. Most software packages allow you to do this. You can also disable handshaking by jumpering some terminals on the computer's/ terminal's serial port: connect RTS to CTS (usually pins 4 and 5) and connect DSR to DTR (usually pins 6 and 20).
- RS-485: Make sure internal DIP switches and jumpers are configured as shown on pg. 10.

Test the Interface

1. Power up the computer or terminal and launch the terminal emulator.
2. Power up the APEX615n. A power-up message (similar to the following) should be displayed, followed by a prompt (>):

```
*PARKER COMPUMOTOR 615n SERVO CONTROLLER
*RP240 CONNECTED

>
```

3. Type "TREV" and press ENTER key. (The TREV command reports software revision.) The screen should now look as follows (if not, see Problem/Remedy table below).

```
*PARKER COMPUMOTOR 6151 SERVO CONTROLLER
*RP240 CONNECTED

>TREV
*TREV92-014016-01-4.1 6151
```

Problem	Remedy (based on the possible causes)
No Response	• COM port not enabled for 6000 language communication. If RS-232 connected to COM 1: issue "PORT1" and "DRPCHKØ" commands. If RS-232 connected to COM 2: issue "PORT2" and "DRPCHKØ" commands. If RS-485 connected to COM 2: issue "PORT2" and "DRPCHKØ" commands. • RS-232: Echo may be disabled; enable with the ECHO1 command. • If using an RS-232 connection between the host computer and master APEX615n connected to multiple APEX615ns in an RS-485 multi-drop, make sure the master has these settings in the order given (place these settings in STARTP program): PORT1 (select RS-232 port, COM1, for configuration) ECHO3 (echo to both COM ports) PORT2 (select RS-485 port, COM2, for configuration) ECHO2 (echo to the other COM port, COM1) • Faulty wiring. See instructions on page 25. RS-485: verify internal DIP switch and jumper settings on page 10. Also check for shorts or opens. • Is the cable or computer/terminal bad? Here's a test: 1. Disconnect the serial cable from the APEX615n end only. 2. Connect cable's Rx and Tx lines together (echoes characters back to host). 3. Issue the TREV command. If nothing happens, the cable or computer/terminal may be faulty.
Garbled Characters	• Verify setup: 9600 baud ,8 data bits, 1 stop bit, no parity; RS-232: Full duplex; RS-485: Half duplex . • RS-485: Transmission line not properly terminated. See page 10 for internal DIP switch and jumper settings. See page 25 for connections and calculating termination resistors (if not using the internal resistors via internal DIP switches). • Faulty wiring. See instructions on page 25. RS-485: verify internal DIP switch and jumper settings on page 10. Also check for shorts or opens.
Double Characters	• Your terminal emulator is set to half-duplex; set it to full-duplex.

Faults Caused by Excessive Regeneration

The APEX615n's protection circuitry monitors regeneration activity, and can trigger one of two fault conditions if excess regeneration occurs. Exceeding the regeneration resistor's *continuous* power rating will cause a *Regen Fault*. Exceeding the resistor's *peak* power rating will cause an *Overvoltage Fault*. Either of these faults will shut down the APEX615n, to safeguard the system.

Important specifications for the regeneration circuit are:

	Nominal Operating Voltage: (based on AC input)	**Regen Resistor Turns ON:**	**Overvoltage Fault Turns ON:**
APEX6151	170VDC-340VDC	390VDC	420VDC
APEX6152	340VDC	390VDC	420VDC
APEX6154	340VDC	390VDC	420VDC

Dissipation ratings for the internal regeneration resistor are:

	Continuous Power Dissipation Rating	**Peak Power Dissipation Rating**
APEX6151	50 watts	1 KW
APEX6152	80 watts	3 KW
APEX6154	90watts	6 KW

Details regarding the Regen Fault and overvoltage fault are explained below.

Regen Fault

A regen fault indicates that the *continuous* power dissipation capabilities of the regeneration resistor have been exceeded.

When the resistor is on and dissipating power, its temperature rises. When the resistor turns off, its temperature falls. The temperature is determined by the *average* power dissipation, over time, and is affected by such things as the length of time the resistor is on, how much power it dissipates while it is on, and the length of time it is off. During a repetitive move profile, the resistor's temperature will increase during deceleration, when regeneration occurs. The temperature will decrease after regeneration stops—when the motor is accelerating, slewing, or at rest.

If the average power dissipated in the resistor is less than 40W , the resistor's temperature will stay below damaging levels. If the average power dissipated is greater than these values, the resistor temperature may rise to a level that can permanently damage the resistor. Before temperatures reach this level, however, the regen fault circuit will shut down the drive. The purpose of the regen fault is to protect the regeneration resistor from damage due to high temperatures.

CAUTION
Repeatedly cycling power or resetting the APEX615n to clear regeneration faults may damage the regeneration resistor.

You can clear the regen fault by cycling power or by resetting the drive. To cycle power, turn off AC power to the to the **Control L1/L2** terminals on the AC power connector, then turn the power back on; however, if the resistor has not had adequate time to cool, and the conditions leading to the regen fault persist, **you may damage the regen resistor by cycling power repeatedly**. Information about continuous power dissipation in the regen resistor is lost when power is cycled. To reset the drive, activate the **RESET** input on the **DRIVE AUXILIARY** connector (hold the input to less than 1.2V for at least 20 milliseconds; reset begins upon release of the low voltage), or issue the `DRESET` (Drive Reset) command.

Overvoltage Fault

An overvoltage fault indicates that the *peak* power dissipation capabilities of the regeneration resistor have been exceeded.

Regeneration causes the voltage on the DC power bus to rise. The regeneration resistor will turn on when the bus voltage reaches 390VDC. Peak power dissipation occurs at the moment the resistor turns on. The peak power value is determined by the size of the resistor, and the voltage across it:

$$APEX10\ Peak\ Power = \frac{V^2}{R} = \frac{(390VDC)^2}{150\Omega} \approx 1000W \quad (1KW)$$

As soon as the resistor turns on, regenerated power begins to be dissipated in the resistor, and, in most applications, bus voltage drops. When the voltage falls below 375VDC, the resistor turns off. If the motor is still producing regenerated power, the bus voltage will rise again, the resistor will turn on at 390VDC, and the cycle will repeat over and over until the motor no longer produces enough power to turn on the regeneration resistor.

However, some applications can regenerate more than 1 KW of peak power. Too much peak power can overwhelm the regeneration circuit—the bus voltage will continue to rise, even while the resistor is on. To protect the system from excessive voltages, an overvoltage circuit monitors the bus voltage, and triggers the overvoltage fault if the voltage exceeds 420VDC.

An overvoltage fault will shut down the drive. The red LED labeled *Over Voltage*, located on the APEX6151's front panel, will be illuminated. You can clear the fault by cycling power, or by pulling the **RESET** input low (**RESET** is located on the **DRIVE AUXILIARY** connector).

Current Foldback (I^2T Limit)

The purpose of the current foldback circuit is to protect the motor from overheating due to prolonged high currents. The eight switches of DIP Switch#2 are used to set the parameters for the current foldback circuit. These parameters are:

- **PEAK CURRENT**—the highest current that the APEX615n will produce. Peak current can be set between 6.5A and 16.0 A for the APEX6151, between 9.0A and 24.0A for the APEX6152, and between 15A and 40A for the APEX6154..
- **CONTINUOUS CURRENT**—the APEX615n reduces its current to this level when it goes into current foldback. Continuous current can be set between 1.8A and 8.0A, between 3.0A and 12.0A for the APEX6152, and between 5A and 20A for the APEX6154..
- **TIME CONSTANT**—the motor's thermal time constant, which is a physical parameter usually specified by the motor's manufacturer. The time constant can be set between 10 minutes and 40 minutes on the APEX615n.

The APEX615n uses an internal circuit to model the motor's thermal behavior, and predict motor temperature. Heat dissipated in the motor's windings is directly proportional to I^2, the square of the motor current, and the length of time the current flows.

The APEX615n monitors motor current, and uses its internal microprocessor to simulate a capacitor being charged by the motor current. The result is a number, similar to voltage on a capacitor, that represents an average, over time, of the motor's temperature.

The following equation gives an approximate time before foldback occurs, for a motor that operates from a cold start, when $I_{actual} > I_{continuous}$.

$$time_{(minutes)} = Time\ Constant\left\{-\ln\left[1-\left(\frac{I_{continuous}}{I_{actual}}\right)^2\right]\right\}$$

Three variables affect this equation:

- $I_{continuous}$ is the continuous current (set by DIP switches)
- *Time Constant* is the motor's time constant (set by DIP switches)
- I_{actual} is the current that actually flows in the motor. It can be as low as Ø amps, or as high as the peak current (which was set by DIP switches).

The shortest time until foldback occurs will be when $I_{actual} = I_{peak}$. Notice that this can be much shorter than the time constant in the equation above.

When current foldback occurs, the APEX615n clamps its output current at the $I_{continuous}$ level, and illuminates the LED labeled I^2T Limit, located on the drive's front panel. The drive does not put out a fault signal on its fault output. However, because torque will be reduced as a result of the lower motor current, excess position or following error may result.

To recover from current foldback, there are three options:

- **WAIT**—allow a period of time to pass for the motor to cool. Usually, several minutes will be required.
- **REDUCE COMMAND INPUT**—lower the commanded current to a level below continuous current. This will bleed off the voltage on the simulated capacitor, and clear the foldback condition.
- **RESET**—Pull the **RESET** input low (the **RESET** input is located on the APEX615n's **DRIVE AUXILIARY** connector). An alternative is to issue the DRESET command or cycle power on **Control L1/L2**. This will reset the drive, and clear the foldback condition. However, this method is not recommended if the motor is actually hot, because the motor temperature information in the controller will be lost. The motor should be allowed to cool before the APEX615n is reset, and operations continue. (**RESET** input and DRESET command resets drive functions; RESET command resets controller.

Offset Balance Adjustments

The offset balance potentiometer (offset pot) adjusts the offset voltage of the APEX615n's internal command signal. The offset is zeroed at the factory, with the pot set near the middle of its range of travel. Normally, you do not need to adjust it. However, if you suspect the pot's setting has been altered, the procedure below will explain how to adjust it to zero the offset balance.

NOTE

This procedure—adjusting the offset balance potentiometer—was performed at the factory. If yours is a new APEX615n, you do not need to perform this step. You can use the default factory settings.

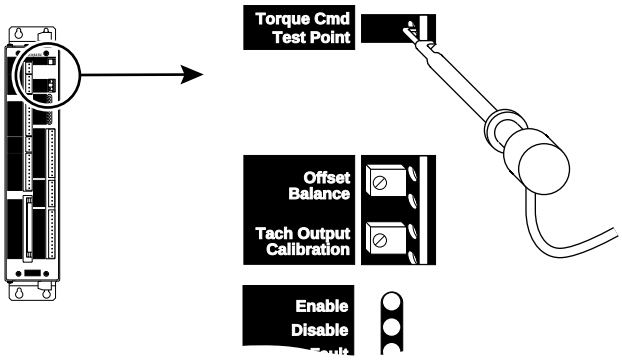
A small offset will not normally cause a problem—the APEX615n's internal controller can automatically compensate for any offset. If the offset is excessive, though, you may notice that the motor reaches a higher speed in one direction than the other. If this causes a problem in your application, follow the procedure below to zero the offset.

1. Remove the load from the motor. The motor's shaft must be free to turn.
2. Turn on AC power to the APEX615n.
3. Disable hardwired limits: `(LHØ)`
4. Disable monitoring of maximum allowable position error: `(SMPERØ)`
5. Set all servo gains to zero: `(SGPØ, SGIØ, SGVØ, SGAFØ, SGVFØ)`

CAUTION

If there is little or no load on the motor shaft, any internal offset may cause an acceleration to a high speed.

6. Set the commanded offset voltage to zero: (SOFFSØ)
7. Enable the drive with the DRIVE1 command.
8. With all gains set to zero, the APEX615n is now operating open loop. Any motion of the motor shaft is due to an internal offset. You can measure the offset by connecting a digital volt meter (DVM) to the Torque Cmd Test Point test point, as shown below. Connect the probe's negative lead to any of the GND terminals on the Drive Auxiliary connector.



The offset voltage should be very close to ØV. If it is not, zero the offset by turning the Offset Balance pot. This is a 15-turn pot, located on the front panel of the APEX615n. The null position—where the voltage approaches zero, and the motor stops turning—will be near the center of the pot's range of travel.

When you have zeroed the offset voltage, and the motor stops turning, this procedure is complete.

Tachometer Output Calibration

Use the Tachometer Output Calibration potentiometer to precisely calibrate the APEX615n Controller/Drive's tachometer output, while monitoring the actual tachometer output at the Tach Out pin on the Drive Auxiliary connector. For example, a commanded velocity of 4000 rpm should produce Tach Out signal of 4 volts. Adjust the potentiometer until the Tach Out signal is measured at 4 volts.

Aligning the Resolver

You can operate the APEX615n in *alignment mode* if you need to align your motor's resolver.

This is a rarely used feature. Resolvers on APEX Series motors are aligned at the factory, and need no further adjustments. It is usually not necessary to align resolvers on other manufacturer's motors.

However, if you need to replace the resolver on a motor, if you have a motor with unknown characteristics, or if poor speed/torque performance leads you to suspect that the resolver is out of alignment, you can follow the procedure below.

To align the resolver, perform the following steps.

1. Turn OFF AC power to the APEX615n and remove the load from the motor. The motor's shaft must be free to turn.
2. Turn DIP Switch#3, position 2, ON. Turn ON AC power to the APEX615n.
3. Set all servo gains to zero `[SGPØ, SGIØ, SGVØ, SGAFØ, & SGVFØ]`.
4. For 2-pole-pair motor: Set offset voltage to negative one half volt `[SOFFS-Ø.5]`.
   For 3-pole-pair motor: Set offset voltage to positive one half volt `[SOFFSØ.5]`.
5. Enable the APEX615n drive `[DRIVE1]`. The motor shaft should turn and lock into position. If it does not lock into position, increase `SOFFS` slightly. Use only enough current in the motor to maintain holding torque. Excess current may cause motor overheating.
6. With the motor shaft locked in the alignment position, loosen the screws on the resolver so that it can turn.
7. Slowly rotate the resolver while you observe the APEX615n's front panel LEDs. When the resolver is in the correct position, both the MOTOR FAULT and the I^2T LIMIT LEDs will be illuminated. When the resolver is close to the correct position, only one of the LEDs will be illuminated. When the rotor is not close to the correct position, no LED will be illuminated.
8. With the resolver in the correct position (both LEDs illuminated), tighten the screws on the resolver so that its case can no longer rotate.
9. Turn off AC power, and turn DIP Switch#3, position 2, OFF.

Resolver alignment is now complete. You can resume normal operations.

While the APEX615n is in alignment mode, it commutates current as follows:

- For 2–pole motors: Current out of Phase B and into Phase C
- For 3–pole motors: Two equal currents out of Phases B and C. Both currents into Phase A

Commutation Test Mode

You can operate the APEX615n in *commutation test mode* to help identify and isolate problems. When it runs in commutation test mode, the APEX615n does not use any motor feedback information for commutation. It ignores the resolver or the Hall effect sensor input, and commutates the motor in an open loop fashion at one revolution per second. The current it sends to the motor will be proportional to the internal command voltage.

You can use commutation test mode to verify that your APEX615n is commutating properly, and that the motor phases are wired correctly.

To operate in commutation test mode:

1. Turn off AC power to the APEX615n.
2. Turn DIP Switch#3, Position#3, ON.
3 Turn on AC power to the APEX615n.
4. The APEX615n should begin commutating the motor clockwise at the following speeds:
   - 1 rps (for 2-pole motors)
   - 2/3 rps (for 3-pole motors)
5. Depending upon your application, you may need to remove the load from the motor, or adjust the internal command voltage with the `SOFFS` command to get adequate motor current. You may also need to set the servo gains to zero (`SGPØ, SGIØ, SGVØ, SGAFØ & SGVFØ`)

Returning the APEX615n

Step 1

Record the serial number and the model number of the defective unit, and secure a purchase order number to cover repair costs in the event the unit is determined by the manufacturers to be out of warranty.

Step 2

Before you return the unit, have someone from your organization with a technical understanding of the APEX615n system and its application include answers to the following questions:

- What is the extent of the failure/reason for return?
- How long did it operate?
- Did any other items fail at the same time?
- What was happening when the unit failed (e.g., installing the unit, cycling power, starting other equipment, etc.)?
- How was the product configured (in detail)?
- Which, if any, cables were modified and how?
- With what equipment is the unit interfaced?
- What was the application?
- What was the system environment (temperature, enclosure, spacing, contaminants, etc.)?
- What upgrades, if any, are required (hardware, software, user guide)?

Step 3

Call for return authorization. Refer to the *Technical Assistance* phone numbers provided on the inside front cover of this document. The support personnel will also provide shipping guidelines.