Nucleus Fault Specification

Revision 1.0

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Overview

The Nucleus system has the ability to detect faults and report these fault events to a console using the protocol detailed in the Nucleus Control Protocol.

The purpose of this document is to:

- detail how all the faults are detected
- indicate the fault message or code that is displayed on the console when the fault occurs
- list the possible causes of the faults to provide a troubleshooting reference
- detail if and how the nucleus system can recovery from the fault

This document is split up into different fault categories. They are:

- Overview
- Core
- Communication
- Treadmill
- Adjustable Stride Elliptical
- Lower board: IBK2T
- Lower board: IDCD8X
- Appendix: Buzzer and LED Indicator
- Appendix: PFC AC Motor Controller Error Description
- Appendix: Speed Fault Test Setup

Each fault category will contain the different fault within that category.

Common Nucleus Faults

Any Nucleus based equipment will support a subset of the Nucleus faults listed in this document by default. The faults are listed below:

- CN00: EEPROM checksum failed
- CN05: Lower board not connected
- CN06: Lower board configuration mismatch
- CN10: Safety Circuit Failure
- CN33: EEPROM access failed
- CN04: Lower board communication timeout
- CN31: USB connection terminated
- CN32: Communication watchdog timeout
- CN36: USB connection terminated
- CN37: Communication watchdog timeout

Product Specific Nucleus Faults

Equipment that use the Nucleus system may only need to support a subset of the Nucleus faults listed in this document and is dependent on the type of equipment (i.e. treadmill, bike, elliptical, stepmill). The following is a list of Nucleus based equipment and their applicable Nucleus faults.

Alpine Runner: TI1000

- CN09: E-Stop
- IN01: Incline stall
- IN02: Incline ADC range fault [Not complete]
- IN03: Incline run fault
- IN04: Incline ADC short to ground [Not complete]
- IN05: Incline ADC short to rail [Not complete]
- SP01: Under-speed
- SP02: Over-speed

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- SP03: Over-acceleration
- SP04: RPM signal timeout
- SP05: Dead sled fault
- SP06: Drive motor run fault [Not Complete]
- SP07: Static brake command fault
- A101: 2.5 VDC Ref Status
- A102: 1.65 VDC Ref Status
- A103: Phase B Current Sensor
- A104: Phase A Current Sensor
- A105: Phase C Circuit Open
- A106: Phase B Circuit Open
- A107: Phase A Circuit Open
- A108: DCLink Bus Overvoltage (MAX_VDC1)
- A109: Critical DCLink Bus Overvoltage (MAX_VDC2)
- A110: DCLink Bus Under Voltage
- A111: Illegal Speed Command
- A112: Phase over current(RMS)
- A113: Faulty Speed Sensor
- A114: Heat Sink Over Temperature
- A115: Over Temperature on Motor Drive
- A117: Brake Gate Driver Fault
- A118: Phase A low Gate Driver Fault
- A119: Phase B low Gate Driver Fault
- A120: Phase C low Gate Driver Fault
- A121: Output Peak Over Current
- A122: Phase A High Gate Driver Fault
- A123: Phase B High Gate Driver Fault
- A124: Phase C High Gate Driver Fault
- A125: DCLink Bus Overvoltage
- A126: Phase C Current Sensor
- A127: PFC Driver Fault
- A130: Elevation Peak Over Current
- A131: PFC Over Temperature
- A132: Elevation Issue
- A133: AC Line Error

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Core

The faults in the Core category are faults that indicate either a hardware failure on the nucleus board, or a configuration issue. Most of these faults are detected after a power up and before communications are established with the console.

The faults in this category are list below:

- CN00: EEPROM checksum failed
- CN05: Lower board not connected
- CN06: Lower board configuration mismatch
- CN10: Safety Circuit Failure
- CN33: EEPROM access failed

CN00: EEPROM checksum failed

Trigger Condition

This gets triggered when the data blocks that are read during start up from the EEPROM do not pass the validation test. The test is attempted 3 times before this fault gets triggered.

Displayed Fault Code/Message

Code	CN00
Message	EEPROM checksum failed

Possible Causes

- Blank EEPROM
- EEPROM memory corruption

Recovery Strategy

This fault is a permanent fault and the Nucleus board will not attempt any automatic recovery strategy.

The only way to recovery from this fault is to configure the Nucleus board using the Nucleus Configuration Tool.

Verification Plan

Use the Nucleus service application to erase the EEPROM memory, the power on the Nucleus board.

CN05: Lower board not connected

Trigger Condition

This gets triggered when there is no lower board detected during start up.

Displayed Fault Code/Message

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Code	CN05
Message	Lower board not connected

Possible Causes

- The data cable that connects the Nucleus board to the lower board is not connected at the Nucleus board.
- The data cable that connects the Nucleus board to the lower board is not connected at the lower board.
- The data cable that connects the Nucleus board to the lower board is faulty.

Recovery Strategy

This fault is a permanent fault and the Nucleus board will not attempt any automatic recovery strategy.

The only way to recover this fault is to:

- Make sure the data cable is connected at the Nucleus board.
- Make sure the data cable is connected at the lower board.
- Replace the data cable

Verification Plan

Power the machine with the data cable disconnected from either the Nucleus board or the lower board.

CN06: Lower board configuration mismatch

Trigger Condition

This gets triggered when the machine type and connected lower board data cable do not match. For example, this gets triggered when a treadmill lower board data cable is connected to the nucleus board and the nucleus board is configured as a fixed stride elliptical machine type.

Displayed Fault Code/Message

Code	CN06
Message	Lower board configuration mismatch

Possible Causes

- Incorrect lower board connected to the nucleus system.
- The data cable that connects the Nucleus board to the lower board is faulty.

Recovery Strategy

This fault is a permanent fault and the Nucleus board will not attempt any automatic recovery strategy.

The only way to recover this fault is to:

- Use the correct data cable for the machine type that the Nucleus board is configured for.
- Replace the data cable

Verification Plan

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Connect a BLCB011 (Chihua lowerboard) to a nucleus board that is configured as a TI1000 and power cycle the machine.

CN10: Safety Circuit Failure

Trigger Condition

This gets triggered when there is a hardware issue with the safety circuit and thus fails the safety circuit validation test. This fault is only applicable to Nucleus boards configured as treadmills.

Displayed Fault Code/Message

Code	CN10
Message	Safety Circuit Failure

Possible Causes

- Faulty components in the safety circuit hardware on the Nucleus board.

Recovery Strategy

This fault is a permanent fault and the Nucleus board will not attempt any automatic recovery strategy.

The only way to recover this fault is to:

- Replace the faulty components in the safety circuit hardware
- Replace the Nucleus board.

Verification Plan

- Short pin 2 and 3 of Q10 on the Nucleus board and attempt to operate the machine.
- Short pin 2 and 3 of Q11 on the Nucleus board and attempt to operate the machine.
- Short pin 2 and 3 of Q5 on the Nucleus board and attempt to operate the machine.

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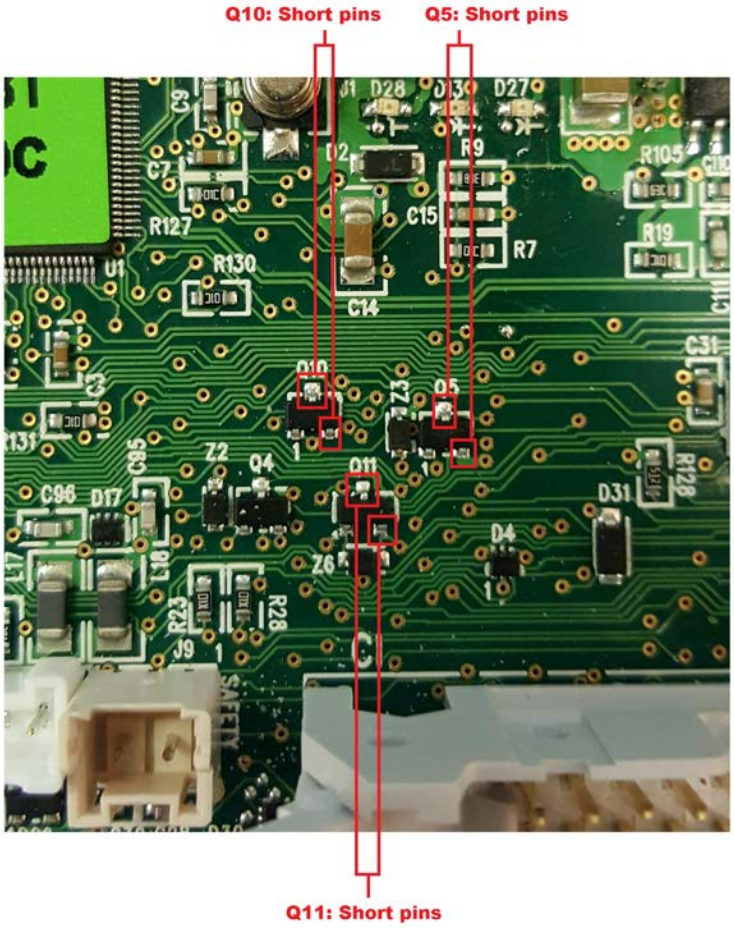

CN33: EEPROM access failed

Trigger Condition

This get triggered when communications with the EEPROM fail.

The following figure shows the location of the EEPROM on the Nucleus board.

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Displayed Fault Code/Message

Code	CN33
Message	EEPROM access failed

Possible Causes

- Faulty EEPROM
- Communication signal lines between EEPROM and microcontroller may be shorted or open.

Recovery Strategy

This fault is a permanent fault and the Nucleus board will not attempt any automatic recovery strategy.

The only way to recover from this fault is to:

- Replace the EEPROM device
- Fix any short or open signal lines

Verification Plan

Short communication lines on the EEPROM device together or to ground.

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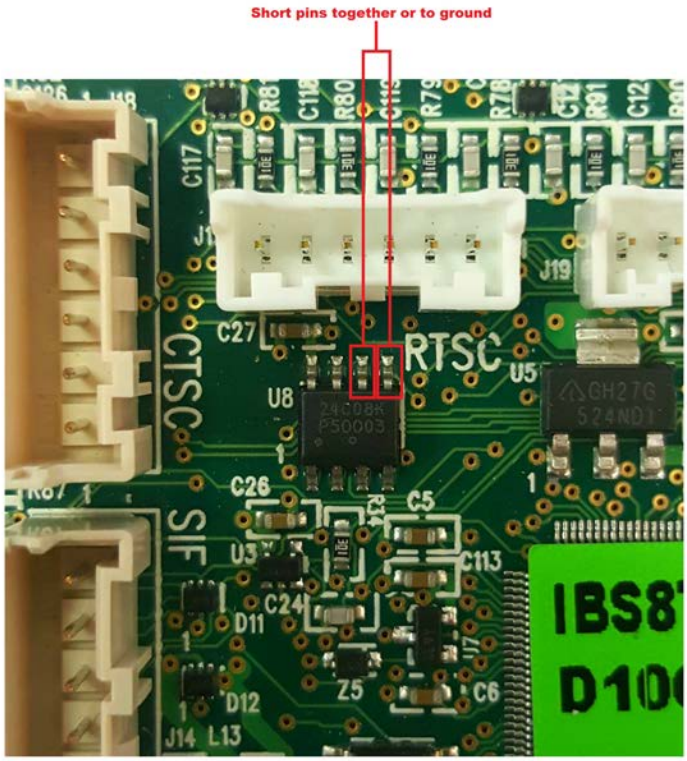

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Communication

The faults in the Communication category are faults that indicate a failure in communication between:

- the console and nucleus board
- the nucleus board and the lower board

The faults in this category are list below:

- CN04: Lower board communication timeout
- CN31: USB connection terminated
- CN32: Communication watchdog timeout
- CN36: USB connection terminated
- CN37: Communication watchdog timeout

CN04: Lower board communication timeout

Trigger Condition

This gets triggered when the Nucleus board sends a packet to the lower board, and the Nucleus board does not receive any responses after a number of retries.

Displayed Fault Code/Message

Code	CN04
Message	Lower board communication timeout

Possible Causes

- The data cable between the Nucleus board and the lower board became disconnected
- Faulty data cable
- Software bug in the lower board causes the lower board to not repsond to commands from the Nucleus board
- Hardware components on the Nucleus board related to the communication channel between the Nucleus board and lower board became faulty
- Hardware components on lower board related to the communication channel between the Nucleus board and lower board became faulty

Recovery Strategy

When this fault is triggered, the Nucleus board will attempt to bring the machine to a safe state by:

- Commanding all motors to stop
- If applicable, open the safety circuit to remove power from motors
- If applicable, engage any brake mechanism to prevent any motor movements

This is a permanent fault. The only way to recover from this fault is to:

- Make sure the data cable between the Nucleus board and lower board is connected
- Replace the data cable
- Fix the software bug in the lower board
- Replace the Nucleus board
- Replace the lower board

Verification Plan

- Pull Data Cable While Machine is Powered And Idle

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- Pull Data Cable While Machine is Powered And Motors Are In Use

CN31: USB connection terminated

Trigger Condition

This gets triggered when the Nucleus board detected that the USB connection is lost for more than 3 seconds while in Safety Critical states. See Communication Watchdog for definition of safety critical states

Displayed Fault Code/Message

Code	CN31
Message	USB connection terminated

Possible Causes

- Vibrations acting on machine causes the USB cable to become unplugged
- Someone unplugs the USB cable
- An ESD/electrical event causes the USB detect line to malfunction

Recovery Strategy

When this fault is triggered, the Nucleus board will attempt to bring the machine to a safe state by:

- Commanding all motors to stop
- If applicable, open the safety circuit to remove power from motors
- If applicable, engage any brake mechanism to prevent any motor movements

Once the Nucleus has determined that it is in a safe state, it will wait until the console is reconnected. Once the console has been detected to be reconnected, the Nucleus board will clear the fault condition.

Verification Plan

Operate the machine such that motors are running. While the motor is running, unplug the USB cable from either the console USB port, or from the nucleus board USB port.

CN32: Communication watchdog timeout

Trigger Condition

The Nucleus board triggers this fault if the console fails to send a valid packet within 3 seconds of the last valid packet, while the machine is in a safety critical state. See Communication Watchdog section in the Nucleus Control Protocol for more information.

Displayed Fault Code/Message

Code	CN32
Message	Communication watchdog timeout

Possible Causes

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- Software bug in console causes console to stop sending command packets to nucleus
- Console USB hardware module is faulty
- Nucleus USB hardware module is faulty
- An ESD/electrical event caused a disruption is the USB communication line

Recovery Strategy

When this fault is triggered, the Nucleus board will attempt to bring the machine to a safe state by:

- Commanding all motors to stop
- If applicable, open the safety circuit to remove power from motors
- If applicable, engage any brake mechanism to prevent any motor movements

Once the Nucleus has determined that it is in a safe state, the Nucleus board will clear the fault condition and place itself in a state where it can be initialized.

Verification Plan

Use a touch screen console to communicate with the Nucleus board while the machine is being operated. Manually terminate the console software while any of the motors are running.

CN36: USB connection terminated

Trigger Condition

- Triggered when the console detects that the USB connection with the Nucleus board is not present on power up. This is not applicable to console that support the 50-pin interface and Nucleus system.
- Triggered when the console detects that the USB connection is lost for 3 seconds or more while in a Safety Critical state. See Nucleus Control Protocol document for definition of safety critical states.

Displayed Fault Code/Message

Code	CN36
Message	USB connection terminated

Possible Causes

- Nucleus board not connected
- The USB cable that connects the Nucleus board and the console is faulty
- Console USB hardware module is faulty
- Nucleus board USB hardware module is faulty
- An ESD/electrical event causes the USB detect line to malfunction
- Vibrations acting on machine causes the USB cable to become unplugged

Recovery Strategy

When this fault is triggered, the Nucleus board will attempt to bring the machine to a safe state by:

- Commanding all motors to stop
- If applicable, open the safety circuit to remove power from motors
- If applicable, engage any brake mechanism to prevent any motor movements

This is a recoverable fault. To recover from this fault:

- Make sure the USB cable between the Nucleus board and console is connected
- Replace the USB cable

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- Replace the Nucleus board
- Replace the console

Verification Plan

- Console-Nucleus USB is unplugged while machine is idle
- Console-Nucleus USB is unplugged while machine is running

CN37: Communication watchdog timeout

Trigger Condition

The console triggers this fault when it fails to receive at least one valid packet within a 3-second window while in one of the Safety Critical states. See Nucleus Control Protocol document for definition of safety critical states

Displayed Fault Code/Message

Code	CN37
Message	Communication watchdog timeout

Possible Causes

- Software bug in the Nucleus system causes it to stop responding to packets from the console
- Console USB hardware module is faulty
- Nucleus USB hardware module is faulty
- An ESD/electrical event caused a disruption is the communication line

Recovery Strategy

Verification Plan

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Treadmill

When configure as a treadmill, the nucleus board has the ability to monitor the operation of the machine to make sure that the machine operates safety and to stop the machine any time unsafe operations are detected. The Treadmill fault category contains the different types of faults that the nucleus monitors and reports to the console.

The faults in this category are listed below:

- CN09: E-Stop
- IN01: Incline stall
- IN02: Incline ADC range fault [Not complete]
- IN03: Incline run fault
- IN04: Incline ADC short to ground [Not complete]
- IN05: Incline ADC short to rail [Not complete]
- SP01: Under-speed
- SP02: Over-speed
- SP03: Over-acceleration
- SP04: RPM signal timeout
- SP05: Dead sled fault
- SP06: Drive motor run fault [Not Complete]
- SP07: Static brake command fault

CN09: E-Stop

Note: Superseded by CN10: Safety Circuit Failure, also see Safety Circuit section in the Nucleus Control Protocol document.

Trigger Condition

The nucleus board detected that the safety circuit is opened.

Displayed Fault Code/Message

Code	CN09
Message	E-Stop

Possible Causes

- Safety key was unplugged
- A connector or wire in the safety circuit loop became unplugged
- Hardware component in the safety circuit on the nucleus board became faulty

Recovery Strategy

When this fault is triggered, the Nucleus board will attempt to bring the machine to a safe state by:

- Commanding all motors to stop
- If applicable, open the safety circuit to remove power from motors
- If applicable, engage any brake mechanism to prevent any motor movements

Once the Nucleus has determined that it is in a safe state, it will wait safety key is reinserted. Once the nucleus board detected that the safety key is reinserted, the Nucleus board will clear the fault condition.

Verification Plan

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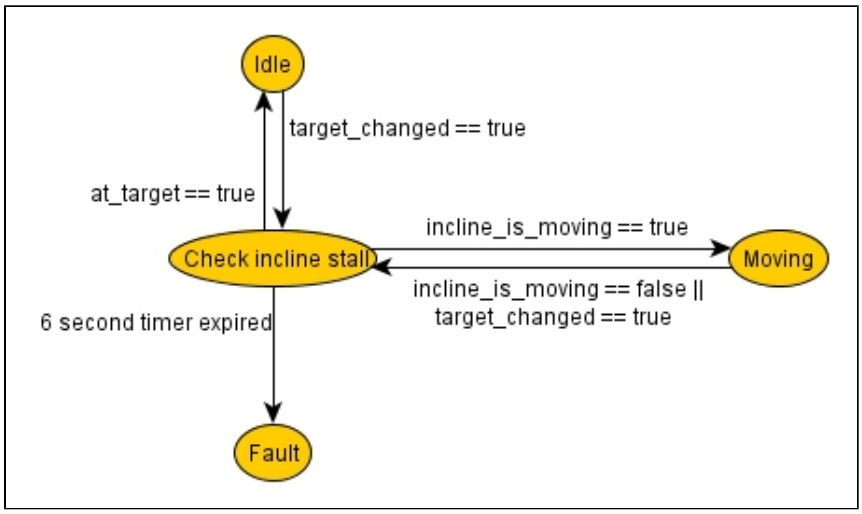
While console is operating machine, unplug the safety key.

IN01: Incline stall

Trigger Condition

The nucleus board detected that the incline motor ADC value changed less than 10 ADC counts 6 seconds after being commanded to a new target incline position.



Displayed Fault Code/Message

Code	IN01
Message	Incline stall

Possible Causes

- Mechanical jam in the incline mechanism
- Faulty incline motor

Recovery Strategy

When this fault is triggered, the Nucleus board will

- command the lower board to stop incline motor movement
- inhibit incline operation for 5 minutes.

After 5 minutes, incline operation will be restored and the Nucleus board will clear the fault condition.

Verification Plan

- Incline does not move when commanded
- Incline stops moving while approaching target incline

IN02: Incline ADC range fault [Not complete]

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Trigger Condition

The nucleus board detected that the incline motor ADC value is 2% above the maximum or below minimum of the calibrated range for more than 5 seconds. This fault is triggered only when the system is calibrated.

Displayed Fault Code/Message

Code	IN02
Message	Incline ADC range fault

Possible Causes

Recovery Strategy

Verification Plan

IN03: Incline run fault

Trigger Condition

The system detected that the incline motor ADC value changed more than 2% of the maximum ADC range for more than 4 seconds when the incline target was not set to a new position.

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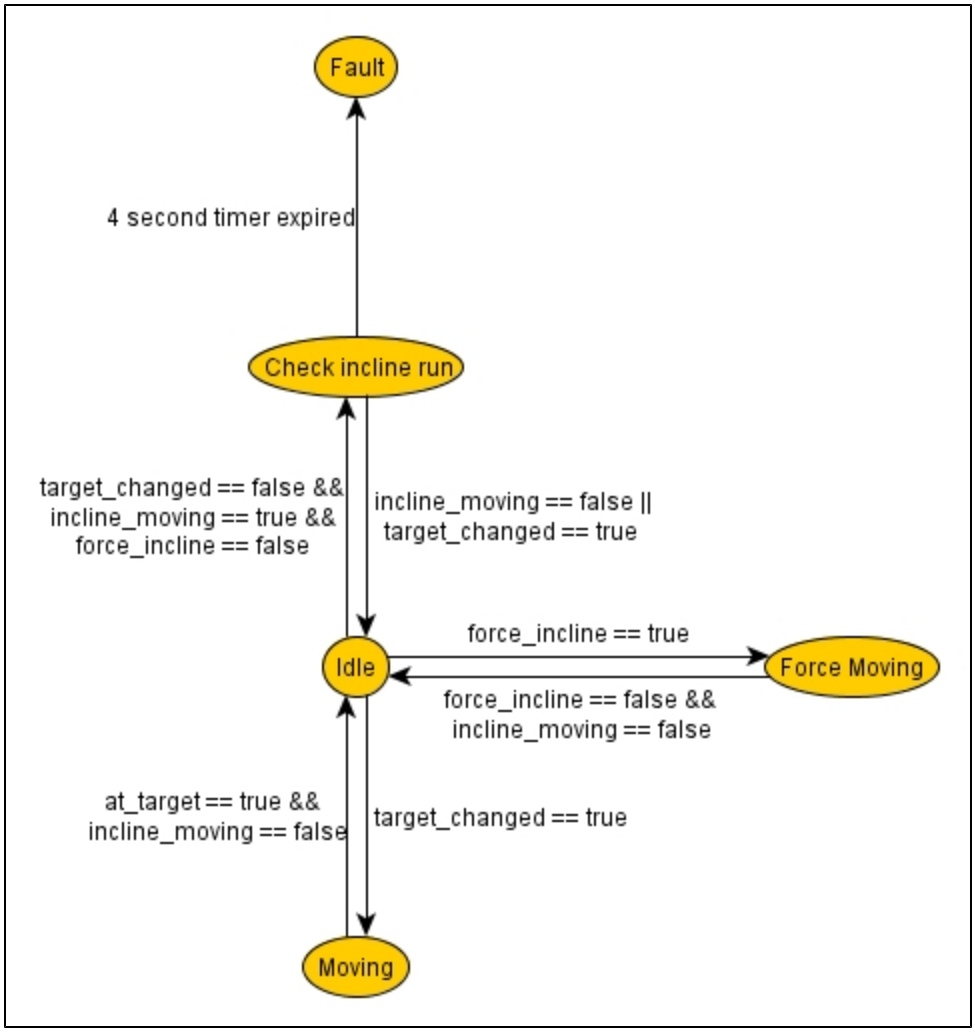

Displayed Fault Code/Message

Code	IN03
Message	Incline run fault

Possible Causes

Recovery Strategy

When this fault is triggered, the Nucleus board will attempt to bring the machine to a safe state by:

- Commanding all motors to stop
- If applicable, open the safety circuit to remove power from motors
- If applicable, engage any brake mechanism to prevent any motor movements

Once the Nucleus has determined that it is in a safe state, the Nucleus board will clear the fault condition.

Verification Plan

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- Random user incline changes

IN04: Incline ADC short to ground [Not complete]

Trigger Condition

The system detected that the incline ADC signal has been shorted to ground for more than 1 second.

Displayed Fault Code/Message

Code	IN04
Message	Incline ADC short to rail

Possible Causes

Recovery Strategy

Verification Plan

IN05: Incline ADC short to rail [Not complete]

Trigger Condition

The system detected that the incline motor ADC signal has been shorted to the power supply rail for more than 1 second.

Displayed Fault Code/Message

Code	IN05
Message	Incline ADC short to ground

Possible Causes

Recovery Strategy

Verification Plan

SP01: Under-speed

Trigger Condition

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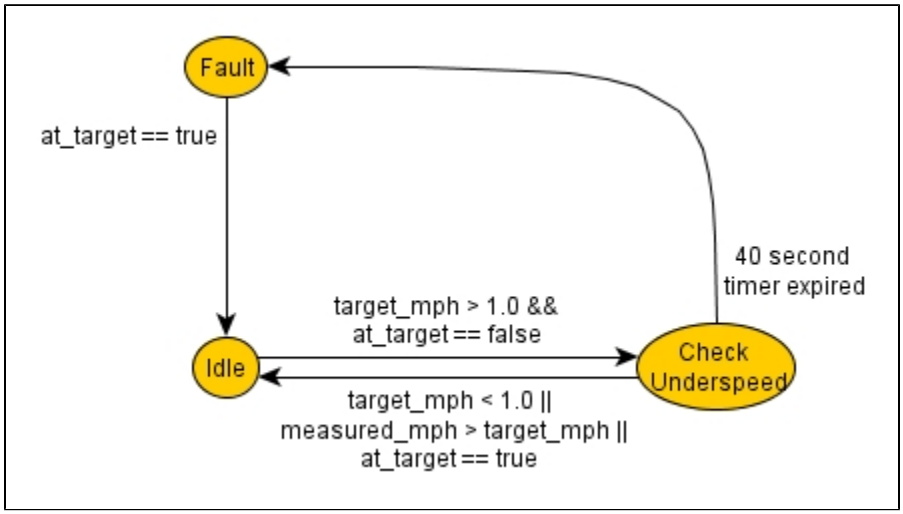
The nucleus board detected that the drive motor speed is 1.0 mph less than the target speed 40 seconds after the target speed is changed. This fault is triggered only when the target speed is greater than 1.0 mph.



Displayed Fault Code/Message

Code	SP01
Message	Under-speed

Possible Causes

- Motor control board is not providing enough power to regulate speed.
- Mechanical friction is causing motor to not reach target speed.

Recovery Strategy

When this fault is triggered, the Nucleus board will continue to allow the machine to operate.

Once the Nucleus has determined that it is in a safe state, the Nucleus board will clear the fault condition.

Verification Plan

- Measured speed is increasing but stops before measured speed reaches target speed
- Speed is increased but measured speed does not change

SP02: Over-speed

Trigger Condition

The nucleus board detected that the drive motor speed is 1.0 mph greater than the target speed for more than 3 seconds after reaching within 0.5 mph of the target speed.

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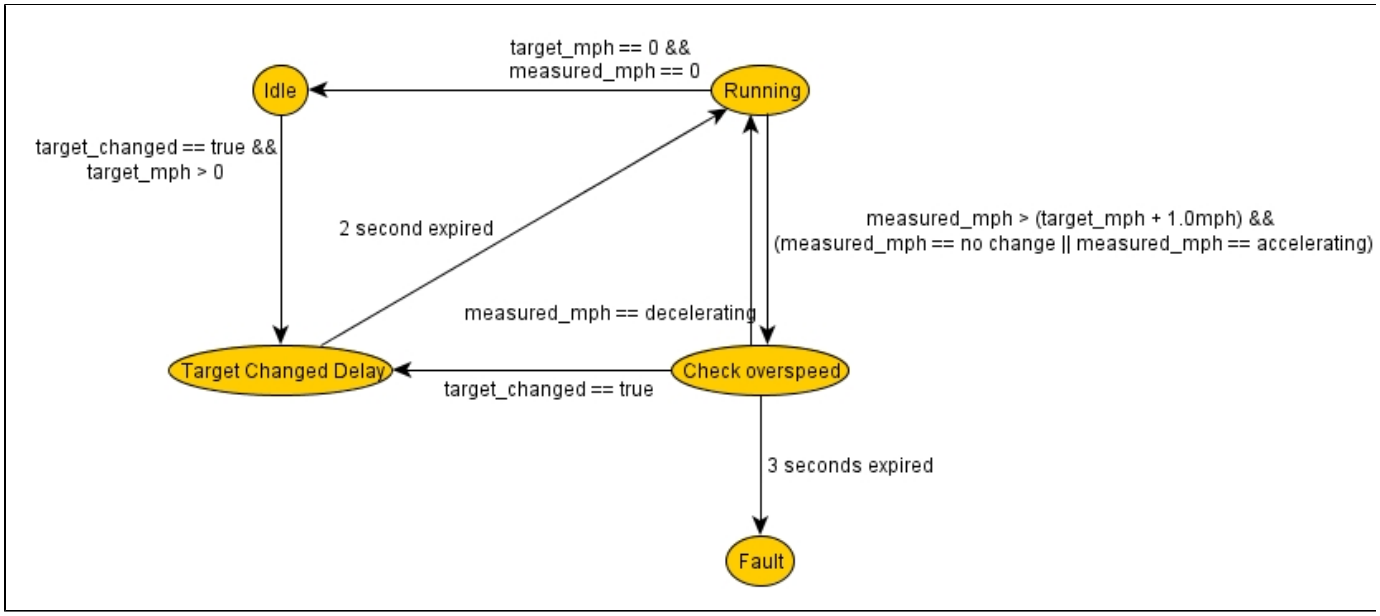

Displayed Fault Code/Message

Code	SP02
Message	Over-speed

Possible Causes

Recovery Strategy

When this fault is triggered, the Nucleus board will attempt to bring the machine to a safe state by:

- Commanding all motors to stop
- If applicable, open the safety circuit to remove power from motors
- If applicable, engage any brake mechanism to prevent any motor movements

Once the Nucleus has determined that it is in a safe state, the Nucleus board will clear the fault condition.

Verification Plan

- Random user speed changes
- Speed is at target and speed starts increasing when not commanded
- Speed is changed to a lower target speed, but speed continues to increase
- Speed reaches target speed and continues to increase

SP03: Over-acceleration

Trigger Condition

The nucleus board detected that the drive motor speed has changed more than 1.6 mph over 1 second.

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Displayed Fault Code/Message

Code	SP03
Message	Over-acceleration

Possible Causes

Recovery Strategy

When this fault is triggered, the Nucleus board will attempt to bring the machine to a safe state by:

- Commanding all motors to stop
- If applicable, open the safety circuit to remove power from motors
- If applicable, engage any brake mechanism to prevent any motor movements

Once the Nucleus has determined that it is in a safe state, the Nucleus board will clear the fault condition.

Verification Plan

- Speed descrease more than 1.6 MPH within 1 second
- Speed increases more than 1.6 MPH within 1 second

SP04: RPM signal timeout

Trigger Condition

The nucleus board detected that the speed sensor has not provided speed data for more than 5 seconds while the target speed is greater than 0 mph.

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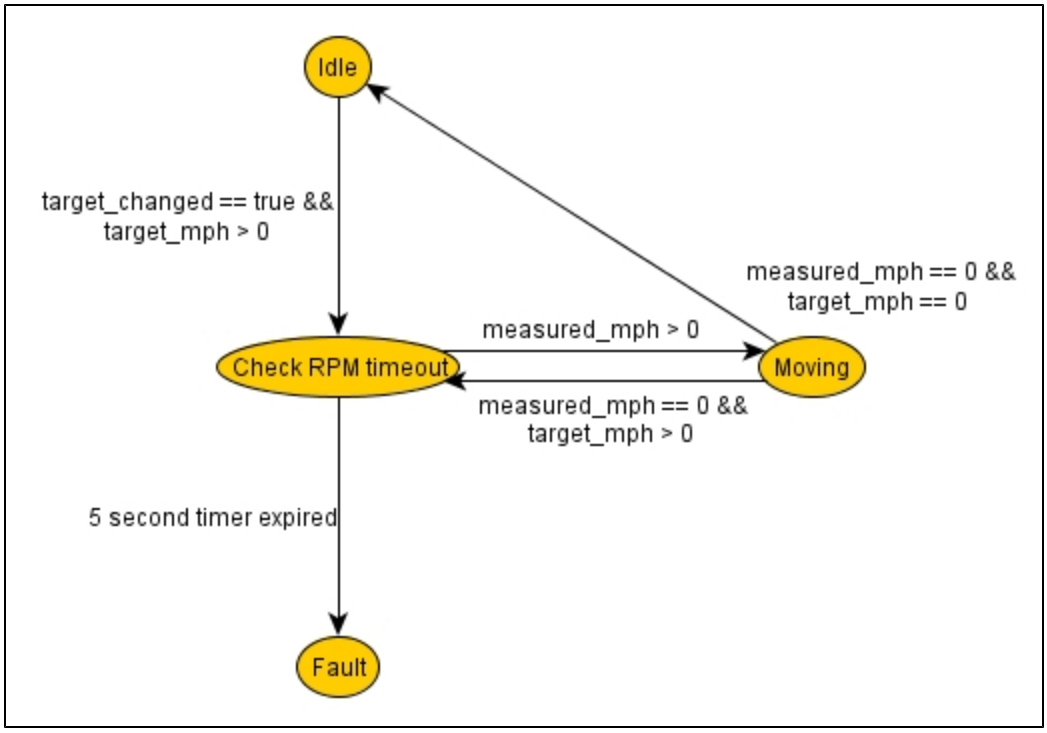

Displayed Fault Code/Message

Code	SP04
Message	RPM signal timeout

Possible Causes

- The data cable that sends RPM information to the nucleus board is not connected at the lower board.
- The data cable that sends RPM information to the nucleus board is faulty
- Software bug in lower board caused the lower board to not respond to speed commands from the nucleus board
- Hardware on lower board that senses RPM is faulty
- Hardware on the nucleus board that receives RPM information from the lower board is faulty

Recovery Strategy

When this fault is triggered, the Nucleus board will attempt to bring the machine to a safe state by:

- Commanding all motors to stop
- If applicable, open the safety circuit to remove power from motors
- If applicable, engage any brake mechanism to prevent any motor movements

Once the Nucleus has determined that it is in a safe state, the Nucleus board will clear the fault condition.

If this fault continues to occur, it may mean that there are some hardware issues that will require additional steps to recover from this fault. They may be resolve by doing some of the following:

- Make sure the data cable that sends RPM information to the nucleus board is connected at the nucleus board and at the lower board
- Replace the data cable that sends RPM information
- Replace lower board
- Replace nucleus board

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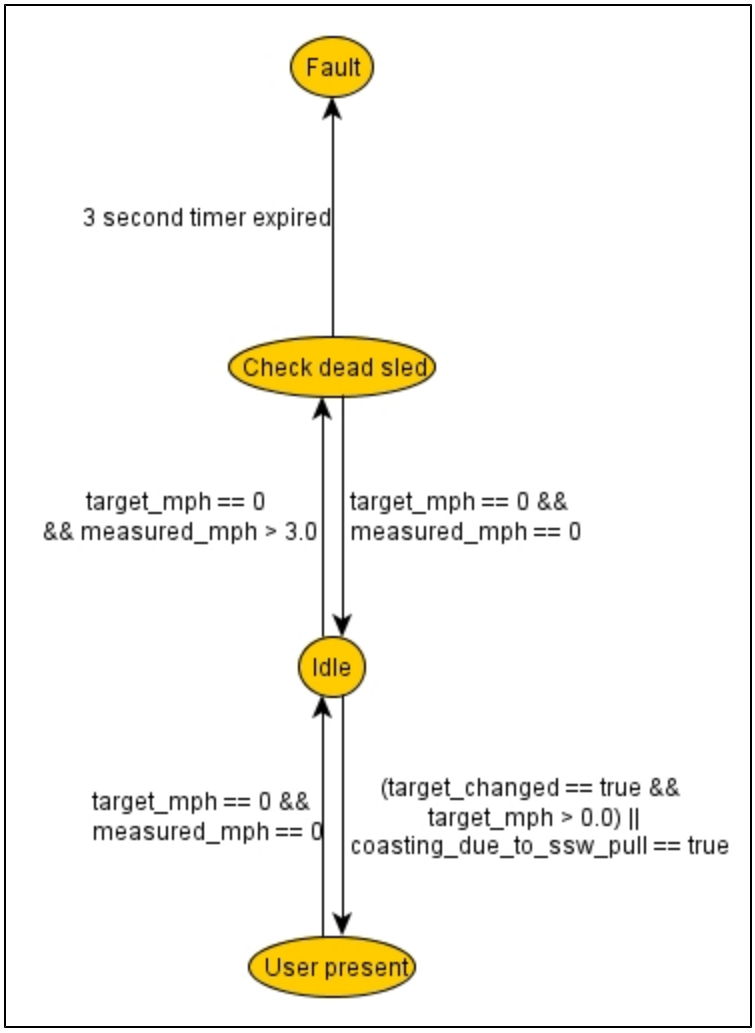
Verification Plan

- RPM signal is lost while speed is non-zero.
- Speed is changed from a target speed of 0.0 MPH to a non-zero speed with the RPM sensor disconnected

SP05: Dead sled fault

Trigger Condition

The nucleus board detected that the drive motor speed is greater than 3.0 mph for 3 second or more when the target speed is 0 mph.



Displayed Fault Code/Message

Code	SP05
Message	Dead sled fault

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Possible Causes

- Someone is intentionally pushing the belt

Recovery Strategy

When this fault is triggered, the Nucleus board will attempt to bring the machine to a safe state by:

- Commanding all motors to stop
- If applicable, open the safety circuit to remove power from motors
- If applicable, engage any brake mechanism to prevent any motor movements

Once the Nucleus has determined that it is in a safe state, the Nucleus board will clear the fault condition.

Verification Plan

- Speed is more than 3.0 MPH for more than 3 seconds while treadmill is not in use

SP06: Drive motor run fault [Not Complete]

Trigger Condition

The nucleus board detected that the drive motor speed is not slowing to a stop when the safety circuit is open.

Displayed Fault Code/Message

Code	SP06
Message	Drive motor run fault

Possible Causes

Recovery Strategy

Verification Plan

SP07: Static brake command fault

Trigger Condition

The nucleus detected that the static brake is not functioning correctly. This fault is triggered when the state of the static brake feedback from the static brake board does not match the state of the static brake command from the Nucleus board for 2 seconds or more.

Displayed Fault Code/Message

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Code	SP07
Message	Static brake command fault

Possible Causes

- The cable that connects the static brake board to the nucleus board is disconnected
- The cable that connects the static brake board to the nucleus board is faulty
- The static brake board loses power
- The mechanical brake is faulty
- Hardware on the static brake board is faulty
- Hardware on the nucleus board is faulty

Recovery Strategy

When this fault is triggered, the Nucleus board will attempt to bring the machine to a safe state by:

- Commanding all motors to stop
- If applicable, open the safety circuit to remove power from motors
- If applicable, engage any brake mechanism to prevent any motor movements

Once the Nucleus has determined that it is in a safe state, the Nucleus board will clear the fault condition.

If this fault continues to occur, it may mean that there are some hardware issues that will require additional steps to recover from this fault. They may be resolve by doing some of the following:

- Make sure the cable that sends static brake commands and feedback information to the nucleus board is connected at the nucleus board and at the static brake board.
- Replace the cable that sends static brake commands and feedback information
- Make sure the static brake board has power
- Replace the power supply that powers the static brake board
- Replace the mechanical brake
- Replace the static brake board
- Replace nucleus board

Verification Plan

- Start treadmill with brake coil connector unplugged
- Start treadmill with brake command connector unplugged
- Start treadmill with power supply connector unplugged
- Unplug the brake coil connector while treadmill is running
- Unplug the brake command connector from the static brake board while the treadmill is running
- Unplug the static brake power supply connector while treadmill is running

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Lower board: IBK2T

The IBK2T lower board, also known as the PFC AC Motor Controller is a lower board supplied by DCI and it is used mainly in the TI1000 treadmills. The following section describes how each fault that is reported by the lower board is triggered and some possible cause for each fault.

- A101: 2.5 VDC Ref Status
- A102: 1.65 VDC Ref Status
- A103: Phase B Current Sensor
- A104: Phase A Current Sensor
- A105: Phase C Circuit Open
- A106: Phase B Circuit Open
- A107: Phase A Circuit Open
- A108: DCLink Bus Overvoltage (MAX_VDC1)
- A109: Critical DCLink Bus Overvoltage (MAX_VDC2)
- A110: DCLink Bus Under Voltage
- A111: Illegal Speed Command
- A112: Phase over current(RMS)
- A113: Faulty Speed Sensor
- A114: Heat Sink Over Temperature
- A115: Over Temperature on Motor Drive
- A117: Brake Gate Driver Fault
- A118: Phase A low Gate Driver Fault
- A119: Phase B low Gate Driver Fault
- A120: Phase C low Gate Driver Fault
- A121: Output Peak Over Current
- A122: Phase A High Gate Driver Fault
- A123: Phase B High Gate Driver Fault
- A124: Phase C High Gate Driver Fault
- A125: DCLink Bus Overvoltage
- A126: Phase C Current Sensor
- A127: PFC Driver Fault
- A130: Elevation Peak Over Current
- A131: PFC Over Temperature
- A132: Elevation Issue
- A133: AC Line Error

A101: 2.5 VDC Ref Status

Trigger Condition

2.5 Vdc Ref. validated by ADC0 is out-of-tolerance and the controller will not operate. See Appendix: PFC AC Motor Controller Error Description f or more information about this fault.

Displayed Fault Code/Message

Code	A101
Message	2.5 VDC Ref Status

A102: 1.65 VDC Ref Status

Trigger Condition

2.5 Vdc Ref. validated by ADC1 and ADC10 is out-of-tolerance and the controller will not operate. See Appendix: PFC AC Motor Controller Error Description for more information about this fault.

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Displayed Fault Code/Message

Code	A102
Message	1.65 VDC Ref Status

A103: Phase B Current Sensor

Trigger Condition

Phase B current sensor is out-of-tolerance and the controller will not operate. See Appendix: PFC AC Motor Controller Error Description for more information about this fault.

Displayed Fault Code/Message

Code	A103
Message	Phase B Current Sensor

A104: Phase A Current Sensor

Trigger Condition

Phase A current sensor is out-of-tolerance and the controller will not operate. See Appendix: PFC AC Motor Controller Error Description for more information about this fault.

Displayed Fault Code/Message

Code	A104
Message	Phase A Current Sensor

A105: Phase C Circuit Open

Trigger Condition

The current on Phase C of the motor is being monitored by the motor controller. This fault is triggered when the motor controller is driving the motor and the current drops below a predefined threshold. See Appendix: PFC AC Motor Controller Error Description for more information about this fault.

Displayed Fault Code/Message

Code	A105
Message	Phase C Circuit Open

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Possible Causes

- A loose wire, broken wire or poor connection to the motor will cause this fault.

Recovery Strategy

When this fault is triggered, the Nucleus board will attempt to bring the machine to a safe state by:

- Commanding all motors to stop
- If applicable, open the safety circuit to remove power from motors
- If applicable, engage any brake mechanism to prevent any motor movements

Once the Nucleus has determined that it is in a safe state, the Nucleus board will clear the fault condition.

However, if this fault persists, it indicates that there may be a hardware issue. To prevent this fault from reoccurring, one should:

- Check that the connectors along the motor cable between the motor and lower board are intact
- Check that the motor cable connector on the lower board is seated securely and that there are no loose connectors
- Replace the motor cable
- Replace the lower board

Verification Plan

A106: Phase B Circuit Open

Trigger Condition

The current on Phase B of the motor is being monitored by the motor controller. This fault is triggered when the motor controller is driving the motor and the current drops below a predefined threshold. See Appendix: PFC AC Motor Controller Error Description for more information about this fault.

Displayed Fault Code/Message

Code	A106
Message	Phase B Circuit Open

Possible Causes

- A loose wire, broken wire or poor connection to the motor will cause this fault.

Recovery Strategy

When this fault is triggered, the Nucleus board will attempt to bring the machine to a safe state by:

- Commanding all motors to stop
- If applicable, open the safety circuit to remove power from motors
- If applicable, engage any brake mechanism to prevent any motor movements

Once the Nucleus has determined that it is in a safe state, the Nucleus board will clear the fault condition.

However, if this fault persists, it indicates that there may be a hardware issue. To prevent this fault from reoccurring, one should:

- Check that the connectors along the motor cable between the motor and lower board are intact
- Check that the motor cable connector on the lower board is seated securely and that there are no loose connectors

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- Replace the motor cable
- Replace the lower board

Verification Plan

A107: Phase A Circuit Open

Trigger Condition

The current on Phase C of the motor is being monitored by the motor controller. This fault is triggered when the motor controller is driving the motor and the current drops below a predefined threshold. See Appendix: PFC AC Motor Controller Error Description for more information about this fault.

Displayed Fault Code/Message

Code	A107
Message	Phase A Circuit Open

Possible Causes

- A loose wire, broken wire or poor connection to the motor will cause this fault.

Recovery Strategy

When this fault is triggered, the Nucleus board will attempt to bring the machine to a safe state by:

- Commanding all motors to stop
- If applicable, open the safety circuit to remove power from motors
- If applicable, engage any brake mechanism to prevent any motor movements

Once the Nucleus has determined that it is in a safe state, the Nucleus board will clear the fault condition.

However, if this fault persists, it indicates that there may be a hardware issue. To prevent this fault from reoccurring, one should:

- Check that the connectors along the motor cable between the motor and lower board are intact
- Check that the motor cable connector on the lower board is seated securely and that there are no loose connectors
- Replace the motor cable
- Replace the lower board

Verification Plan

A108: DCLink Bus Overvoltage (MAX_VDC1)

Trigger Condition

DC Bus voltage is greater than 450Vdc -- Warning but no shutdown. See Appendix: PFC AC Motor Controller Error Description for more information about this fault.

Displayed Fault Code/Message

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Code	A108
Message	DCLink Bus Overvoltage (MAX_VDC1)

A109: Critical DCLink Bus Overvoltage (MAX_VDC2)

Trigger Condition

DC Bus voltage is greater than 460Vdc (S/W) -- Critical and controller is shutdown. See Appendix: PFC AC Motor Controller Error Description for more information about this fault.

Displayed Fault Code/Message

Code	A109
Message	Critical DCLink Bus Overvoltage (MAX_VDC2)

A110: DCLink Bus Under Voltage

Trigger Condition

DC Bus voltage is too low and controller is shutdown. See Appendix: PFC AC Motor Controller Error Description for more information about this fault.

Displayed Fault Code/Message

Code	A110
Message	DCLink Bus Under Voltage

A111: Illegal Speed Command

Trigger Condition

This a fault that gets triggered by the motor controller. See Appendix: PFC AC Motor Controller Error Description for more information about this fault.

Displayed Fault Code/Message

Code	A111
Message	Illegal Speed Command

A112: Phase over current(RMS)

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Trigger Condition

Motor's Phase current (RMS) is too high and the controller will shutdown. See Appendix: PFC AC Motor Controller Error Description for more information about this fault.

Displayed Fault Code/Message

Code	A112
Message	Phase over current(RMS)

A113: Faulty Speed Sensor

Trigger Condition

Motor controller no longer detects speed feedback and the controller will shutdown. See Appendix: PFC AC Motor Controller Error Description for more information about this fault.

Displayed Fault Code/Message

Code	A113
Message	Faulty Speed Sensor

A114: Heat Sink Over Temperature

Trigger Condition

Inverter's heatsink is too hot. The controller will shutdown. See Appendix: PFC AC Motor Controller Error Description for more information about this fault.

Displayed Fault Code/Message

Code	A114
Message	Heat Sink Over Temperature

A115: Over Temperature on Motor Drive

Trigger Condition

Motor is too hot. The controller will shutdown. See Appendix: PFC AC Motor Controller Error Description for more information about this fault.

Displayed Fault Code/Message

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Code	A115
Message	Over Temperature on Motor Drive

A117: Brake Gate Driver Fault

Trigger Condition

This a fault that gets triggered by the motor controller. See Appendix: PFC AC Motor Controller Error Description for more information about this fault.

Displayed Fault Code/Message

Code	A117
Message	Brake Gate Driver Fault

A118: Phase A low Gate Driver Fault

Trigger Condition

This a fault that gets triggered by the motor controller. See Appendix: PFC AC Motor Controller Error Description for more information about this fault.

Displayed Fault Code/Message

Code	A118
Message	Phase A low Gate Driver Fault

A119: Phase B low Gate Driver Fault

Trigger Condition

This a fault that gets triggered by the motor controller. See Appendix: PFC AC Motor Controller Error Description for more information about this fault.

Displayed Fault Code/Message

Code	A119
Message	Phase B low Gate Driver Fault

A120: Phase C low Gate Driver Fault

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Trigger Condition

This a fault that gets triggered by the motor controller. See Appendix: PFC AC Motor Controller Error Description for more information about this fault.

Displayed Fault Code/Message

Code	A120
Message	Phase C low Gate Driver Fault

A121: Output Peak Over Current

Trigger Condition

Main Inverter Peak Over-Current. The controller will shutdown. See Appendix: PFC AC Motor Controller Error Description for more information about this fault.

Displayed Fault Code/Message

Code	A121
Message	Output Peak Over Current

A122: Phase A High Gate Driver Fault

Trigger Condition

This a fault that gets triggered by the motor controller. See Appendix: PFC AC Motor Controller Error Description for more information about this fault.

Displayed Fault Code/Message

Code	A122
Message	Phase A High Gate Driver Fault

A123: Phase B High Gate Driver Fault

Trigger Condition

This a fault that gets triggered by the motor controller. See Appendix: PFC AC Motor Controller Error Description for more information about this fault.

Displayed Fault Code/Message

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Code	A123
Message	Phase B High Gate Driver Fault

A124: Phase C High Gate Driver Fault

Trigger Condition

This a fault that gets triggered by the motor controller. See Appendix: PFC AC Motor Controller Error Description for more information about this fault.

Displayed Fault Code/Message

Code	A124
Message	Phase C High Gate Driver Fault

A125: DCLink Bus Overvoltage

Trigger Condition

DC Bus voltage is greater than 460Vdc (H/W) -- Critical and controller is shutdown. See Appendix: PFC AC Motor Controller Error Description for more information about this fault.

Displayed Fault Code/Message

Code	A125
Message	DCLink Bus Overvoltage

A126: Phase C Current Sensor

Trigger Condition

Phase C current sensor is out-of-tolerance and the controller will not operate. See Appendix: PFC AC Motor Controller Error Description for more information about this fault.

Displayed Fault Code/Message

Code	A126
Message	Phase C Current Sensor

A127: PFC Driver Fault

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Trigger Condition

PFC Peak Over-Current or PFC Gate Fault. The controller will shutdown. See Appendix: PFC AC Motor Controller Error Description for more information about this fault.

Displayed Fault Code/Message

Code	A127
Message	PFC Driver Fault

A130: Elevation Peak Over Current

Trigger Condition

Incline Inverter Peak Over-Current. The incline inverter disabled. See Appendix: PFC AC Motor Controller Error Description for more information about this fault.

Displayed Fault Code/Message

Code	A130
Message	Elevation Peak Over Current

A131: PFC Over Temperature

Trigger Condition

PFC's heatsink is too hot. The controller will shutdown. See Appendix: PFC AC Motor Controller Error Description for more information about this fault.

Displayed Fault Code/Message

Code	A131
Message	PFC Over Temperature

A132: Elevation Issue

Trigger Condition

Could be POT unplugged or no feedback, Timed-out (running for greater that 40 seconds), Stall, Reverse direction. See Appendix: PFC AC Motor Controller Error Description for more information about this fault.

Displayed Fault Code/Message

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Code	A132
Message	Elevation Issue

A133: AC Line Error

Trigger Condition

Valid on PFC controller type. Indicates AC Line Voltage is out of range. Lost power or dropping too many cycles. See Appendix: PFC AC Motor Controller Error Description for more information about this fault.

Displayed Fault Code/Message

Code	A133
Message	AC Line Error

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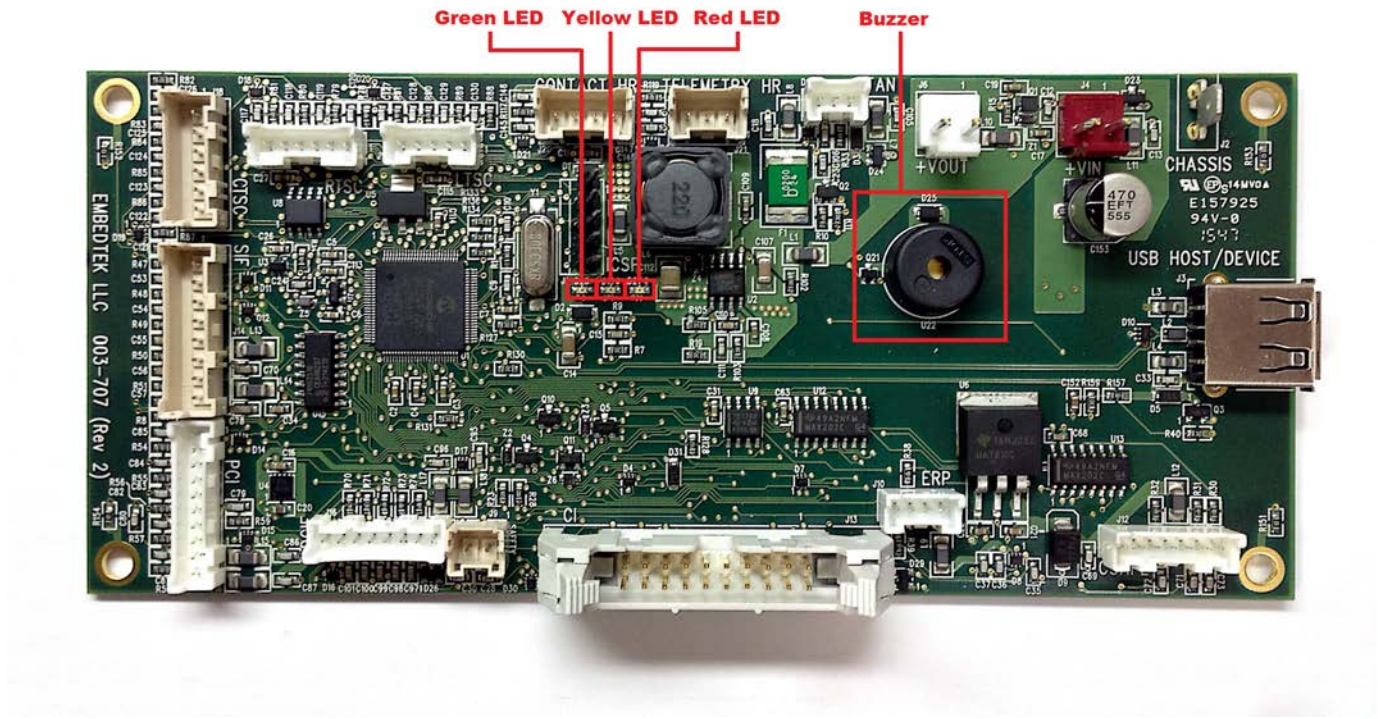
Appendix: Buzzer and LED Indicator

The Nucleus board is equipped with a buzzer and 3 LEDs to provide audible and visual feedback to the user regarding the state of the Nucleus board. The following figure shows the location of the 3 LEDs and the buzzer.



Blink Codes

Blink codes on the Nucleus board allow a service technician to visually determine the state of the Nucleus board during service operations or normal operations. The following table lists the different blink codes and their corresponding meaning.

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Green LED	Yellow LED	Red LED	Description
On	Blinking	Off	Exporting of EEPROM data in progress
On	Off	On	Exporting of EEPROM data complete
Blinking	On	Off	Importing of EEPROM data in progress
Off	On	On	Importing of EEPROM data complete
Fast blinking	Off	Fast blinking	Flash programming in progress
Off	Blinking	Blinking	Checksum of firmware in flash memory failed validation test, currently in device bootloader mode
Off	Off	Blinking	Application running, but the Nucleus board is in a fault condition
Blinking	Off	Off	Application running, but no communication detected on USB port due to following reason(s): • no console connected to the Nucleus board • console is connected to the Nucleus board but USB cable is faulty • console is connected to the Nucleus board but the console is not actively communicating to the Nucleus board due to a software bug on the console • console is connected to the Nucleus board but the console USB port hardware is faulty • console is connected to the Nucleus board but the Nucleus board USB port hardware is faulty
Blinking	Fast blinking	Off	Application running and console is communicating with the Nucleus board
Blinking	Off	Blinking	Application running, but the Nucleus board had a fault condition and is currently recovering from the fault.

Beep Codes

In the event that the Nucleus board is being service and the technician can not see the LEDs, the Nucleus board have beep codes that allow the technician to receive feedback regarding the state of the Nucleus board while being serviced. Each beep code is distinguished by the number of beeps, the length of each beep, and the pitch of the beep.

The length of a beep is described as either long or short, with long meaning a duration of around 1 second, while short meaning a duration of around half a second.

The pitch of the beep is described as being high or low.

Success

The following table lists the beep codes for service operations that have succeeded.

Beep Count	Beep Duration	Tone Pitch	Description
1	Short	High	Flash programming started
2	Short	High	One of the following • Flash programming successful and starting application • Starting application without console connected
3	Short	High	Boot loader started
4	Short	High	Export of EEPROM data successful
5	Short	High	Import of EEPROM data successful

Failures

The following table lists the beep codes for service operations that have failed.

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Beep Count	Beep Duration	Tone Pitch	Description
1	Long	Low	Checksum of firmware in flash memory not valid due to following reason(s): • firmware has not been loaded into flash memory • firmware in flash memory is corrupted
2	Long	Low	Hex file not found on USB drive
5	Long	Low	Flash programming failed due to following reason(s): • hex file on USB drive cannot be opened • hex file on USB drive is corrupted
1	Short	Low	EEPROM access failed
2	Short	Low	EEPROM checksum failed
3	Short	Low	No lower board detected
4	Short	Low	The configure machine type and connected lower board do not match

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Appendix: PFC AC Motor Controller Error Description

The information in this section is taken from the "PFC AC Motor Controller (120Vac/230Vac) Specification for TRUE FITNESS Treadmills" document from DCI.

Error Codes and Action

As with any controller faults will occur and when they do, the ACMCB detects, identifies, reacts and reports these out of range inputs or parameters and erroneous controller operation. The primary objective is to keep the user safe, followed closely by protecting the motor and system
electronics. While identifying errors is important, the action taken when they occur can be even more important in maintaining system safety but these action will be discuss as the errors are individually detailed. Finally once errors have been identified and the appropriate action taken, it is important to report these errors so they can be corrected. The mcb has several methods of reporting errors: visually, via a discrete interface and by serial communications link. The table below lists the errors the MCB identifies visually via 3 LEDs blinking out the codes.

AC Controller Error Blink Code

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Number of Blinks	Error/Function	Fault Type
1	2.5 Vdc Ref Status	Soft Fault
2	1.65 Vdc Ref. Status (n/a)	Soft Fault
3	Phase B Current Sensor	Soft Fault
4	Phase A Current Sensor	Soft Fault
5	Phase C Circuit Open	Soft Fault
6	Phase B Circuit Open	Soft Fault
7	Phase A Circuit Open	Soft Fault
8	DCLink Bus Overvoltage (MAX_VDC1)	Soft Fault
9	Critical DCLink Bus Overvoltage (MAX_VDC2)	Soft Fault
10	DCLink Bus Undervoltage	Soft Fault
11	Illegal Speed Command (not activated)	Soft Fault
12	Phase Over Current (RMS)	Soft Fault
13	Faulty Speed Sensor	Soft Fault
14	Heat Sink Over-Temperature (Inverter)	Hard Fault
15	Over-Temperature on Motor	Hard Fault
16	Reserved	N/A
17	Brake Gate Driver Fault (n/a)	Hard Fault
18	Phase A Low Gate Driver Fault (n/a)	Hard Fault
19	Phase B Low Gate Driver Fault (n/a)	Hard Fault
20	Phase C Low Gate Driver Fault (n/a)	Hard Fault
21	Output Peak Over Current	Hard Fault
22	Phase A High Gate Driver Fault (n/a)	Hard Fault
23	Phase B High Gate Driver Fault (n/a)	Hard Fault
24	Phase C High Gate Driver Fault (n/a)	Hard Fault
25	DCLink Bus Overvoltage	Hard Fault
26	Phase C Current Sensor	Soft Fault
27	PFC Driver Fault	Hard Fault
28	AC Line Power Error	Soft Fault
29	Elevation Issue	Soft Fault
30	Elevation Peak Over Current	Hard Fault
31	PFC Over Temperature	Soft Fault
32	Reserved N/A	N/A

These errors are visually annunciated to the technician or user by 3 LEDs (LED1, LED2 and LED3) which simultaneously blink out the error codes listed in the table above.

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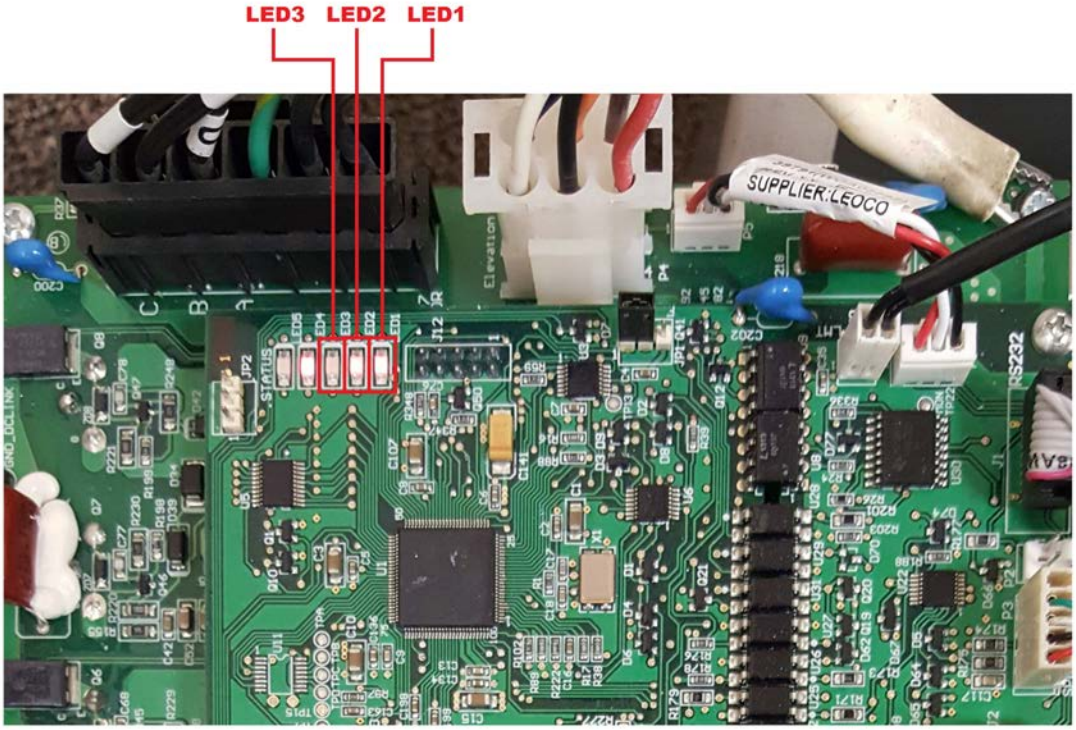

Normally these same 3 LEDs would sequence back and forth to indicate the operational health of the processor; however, once an error occurs their function switches to error reporting. These LEDs will simultaneously blink ON and OFF with a 50% duty cycle, an on-time and off-time of 600ms each. Each code sequence is followed by a dead-time of 2.4 seconds after which the next error code sequence is blinked out. If only one error is identified, the same error code sequence will be repeated.

These same errors codes are sequenced out at a faster rate via the discrete signal named ERROR SIGNAL (J2-17) to the upper console. Again the error codes are blinked or pulsed out with a 50% duty cycle with on-times and off-times of roughly 17 ms each. The dead-time between codes is roughly 66.7ms. All identified error codes will be transmitted with the deadtime separating each code until all have been transmitted then the process will repeat.

These error codes are also available via the serial communications link (RS232). They are packed into 2-16bit data words with each bit representing an error or reserved flag.

Error Codes Definitions

The errors identified in the table above are more specifically defines as follows:

2.5 Vdc Reference Status Error (Blink Code 1)

Shortly after power-up or reset, the 2.5Vdc reference voltage is checked to ensure that it and the ADCs are in range and working correctly. If it is out-of-range, then the controller is not allowed to control the motor but this error is annunciated. With the PFC controller, this refers to the 12-Bit ADC Unit 0's 2.5V reference.

1.65 Vdc Reference Status Error (Blink Code 2)

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Used as a 1.65Vref with the TI processors but the Renesas controller as a secondary 2.5Vref – Shortly after power-up or reset, the 1.65 Vdc reference voltage is checked to ensure that it and the ADCs are in range and working correctly. If it is out-of-range, then the controller is not allowed to control the motor but this error is annunciated. With the PFC and switched doubler controllers, this refers to the 12-Bit ADC Unit 1's and the 10-bit ADC's 2.5V reference.

Phase B Current Sensor Error (Blink Code 3)

Shortly after power-up or reset, the Phase B current sensor circuits offset voltage is checked to ensure that it and the ADCs are in range and working correctly. If it is out-of-range, then the controller is not allowed to control the motor but this error is annunciated.

Phase A Current Sensor Error (Blink Code 4)

Shortly after power-up or reset, the Phase A current sensor circuits offset voltage is checked to ensure that it and the ADCs are in range and working correctly. If it is out-of-range, then the controller is not allowed to control the motor but this error is annunciated.

Phase C Circuit Open Error (Blink Code 5)

When the motor controller is driving the motor, the Phase C current is monitored and if it drops below a predefined threshold, the motor's speed is ramped to zero and this error is annunciated. A loose wire, broken wire or poor connection to the motor will cause this fault.

Phase B Circuit Open Error (Blink Code 6)

When the motor controller is driving the motor, the Phase B current is monitored and if it drops below a predefined threshold, the motor's speed is ramped to zero and this error is annunciated. A loose wire, broken wire or poor connection to the motor will cause this fault.

Phase A Circuit Open Error (Blink Code 7)

When the motor controller is driving the motor, the Phase A current is monitored and if it drops below a predefined threshold, the motor's speed is ramped to zero and this error is annunciated. A loose wire, broken wire or poor connection to the motor will cause this fault.

DC Link Bus Overvoltage Error (Blink Code 8)

When the controller is driving the motor, it continuously monitors the DC Bus voltage. If the software measures the DC Bus voltage above 450Vdc for the PFC and 415Vdc for the switched-doubler, this error is annunciated but no shutdown action is taken; however, as a precaution the deceleration rate is slowed to minimize energy pumped back into the system when slowing to a stop. This error is more of a warning to indicate that a dynamic brake resistor should be considered for the application. If this is the only error identified, it is cleared once the commanded speed is returned to zero.

Critical DC Link Bus Overvoltage Error (Blink Code 9)

When the controller is driving the motor, it continuously monitors the DC Bus voltage. If the software or independent hardware measures the DC Bus voltage above 460Vdc for the PFC and 425Vdc for the switched doubler, the safety relay is opened, all of the Inverter outputs are shut-off and this error is annunciated. The motor will coast to a stop. Note that either the software or hardware or both can shut the system down in the event of the critical overvoltage. This error is the software error.

Note: DC Link Bus Over-Voltage (8 Blinks), Critical DC Link Bus Over-Voltage (9 Blinks) and DC Link Bus Over-Voltage (25 Blinks) all mean roughly the same thing; the DC bus voltage is increasing to higher than acceptable levels. The 8 and 9 blink errors are both detected and acted upon by software. The 25 blink is the same as the 9 blink error expect that it is detect and acted upon by hardware. This way the software and hardware back each other up to avoid a catastrophic failure of the board. While error codes 9 and 25 are critical, error code 8 is more of a warning to let you know that your braking resistor may be inadequate. If the input voltage is with the design limits, the DC link voltage can only be increased when the treadmill is attempting to slow a person that is operating on an incline. This energy is normally bled off through the braking resistor. Error codes 9 or 25 result in the systems immediate shutdown. Error code 8 is reported but no action is taken and is cleared by the next valid operational cycle.

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DC Link Bus Under-Voltage Error (Blink Code 10)

When the controller is power and/or driving the motor, it is continuously monitoring the DC voltage. If at anytime the DC voltage drops below a predefined level for a predefined time, the controller is ramped to zero and this error is annunciated. This error is reported when the DC inverter voltage is inadequate for proper operation. This can be cause by AC line droop or brownout conditions.

Illegal Speed Command Error (Blink Code 11) (Not Enabled)

When the controller receives a discrete speed command before the safety relay is turned ON, this error is annunciated.

Phase Over-Current (RMS) Error (Blink Code 12)

When the controller is driving the motor, software continuously monitors the phase currents. If the motor's phase RMS current goes above the motor's nameplate rated current for a predefined time, its speed is ramped to zero and this error is annunciated.

Faulty Speed Sensor Error (Blink Code 13)

When the controller is driving the motor and has switched to speed feedback/Field Oriented Control (FOC), if the speed sensor signal is lost for a predefined period of time, the controller will attempt to switch over to volts-hertz operation, attempt to ramp to zero and annunciate this error. In most cases, the switch-over fails and the controller faults out with a bus over-voltage or peak over-current but the faulty speed sensor will still be flagged.

Heat Sink Over-Temperature Error (Blink Code 14)

When the controller is powered, it continuously monitors the temperature of the heat-sink via a thermal-couple. If the temperature goes above a predefined software threshold, the motors speed (if running) is ramped to zero and this error is annunciated.

Over-Temperature on Motor (Blink Code 15)

When the controller is powered, it continuously monitors the motor's bi-metallic thermal switch. If the motor's bi-metallic thermal switch opens, the motor's speed (if running) is ramped to zero and this error is annunciated.

Reserve (Blink Code 16)

Should not occur.

Brake Gate Driver Fault (Blink Code 17)

No longer applicable.

Phase A Low Gate Driver Fault (Blink Code 18)

No longer applicable.

Phase B Low Gate Driver Fault (Blink Code 19)

No longer applicable

Phase C Low Gate Driver Fault (Blink Code 20)

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No longer applicable.

Output Peak Over-Current (Blink Code 21)

When the controller is driving the motor, the inverter stage gate drivers are protected from an over-current by circuitry. If an over-current occurs on any of the inverter legs, the circuitry will immediately shut the inverter stage off, flag an error to the microcontroller and open the safety relay. The motor will coast to a stop. The microcontroller will annunciate this error.

Phase A High Gate Driver Fault (Blink Code 22)

No longer applicable.

Phase B High Gate Driver Fault (Blink Code 23)

No longer applicable.

Phase C High Gate Driver Fault (Blink Code 24)

No longer applicable.

DC Link Bus Over-Voltage (Blink Code 23)

When the controller is driving the motor, it continuously monitors the DC Bus voltage. If the software or independent hardware circuitry measures the DC Bus voltage above 460Vdc for the PFC and 425Vdc for the switched doubler, the safety relay is opened, all of the Inverter outputs are shut-off and this error is annunciated. The motor will coast to a stop. Note that either the software or hardware or both can shut the system down in the event of the critical over-voltage. This error is the hardware error.

Phase C Current Sensor (Blink Code 26)

Shortly after power-up or reset, the Phase C current sensor circuits offset voltage is checked to ensure that it and the ADCs are in range and working correctly. If it is out-of-range, then the controller is not allowed to control the motor but this error is annunciated.

PFC Drive Fault (Blink Code 27)

When the PFC is active and experiences a Peak Over current or a driver fault, the safety relay is opened, all of the Inverter outputs are shut-off and this error is annunciated. The motor will coast to a stop. Note that either the software or hardware or both can shut the system down in the event of the PFC Drive Fault. This error is the hardware error. Note: A line surge can also trip this error as demonstrated by the surge testing at DCI.

AC Line Power Error (Blink Code 28)

When the controller is powered it actively monitors the AC line voltage. If the voltage cannot be sensed for 100ms, the controller is shutdown and this error is annunciated.

Elevation Issue (Blink Code 29)

This error/warning indicates something is wrong with the elevation. Among the possible problems which are flagged the microcontroller are POT Unplugged, No Movement, Out-of-Range on the POT, running opposite the commanded direction, timed out (ran too long), or running when not commanded. If the Elevation flag is issued, the “elv_error” flags need to be checked to determine which issue occurred.

Elevation Peak Over-Current (Blink Code 30)

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When the controller is driving the elevation motor, the elevation inverter stage's gate drivers are protecting it from an overcurrent. If an over-current occurs on any of the inverter legs, the circuitry will immediately shut the inverter stage off and flag the microcontroller with a fault. The microcontroller will attempt to clear the fault, reset the power stage and again attempt to drive the elevation motor. If the microcontroller fails to clear the fault, the gate driver will again flag the fault to the microcontroller and open the safety relay. The motor will coast to a stop. The microcontroller will annunciate this error.

PFC Over-Temperature Error (Blink Code 31)

When the controller is powered, it continuously monitors the temperature of the PFC power device and heat-sink via a thermal-couple. If the temperature goes above a predefined software threshold, the motors speed (if running) is ramped to zero and this error is annunciated.

Reserve (Blink Code 32)

Should not occur.

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