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# 8 Diagnostics

The Diagnostics chapter explains how to monitor and check the operation of the instrument hardware, which can help determine if the instrument is operating properly. Use Diagnostics to check switches and solenoids and to monitor various system hardware parameters.

Ambient Monitor .....	8-3
Ambient Chart .....	8-3
Customizing Ambient Chart .....	8-4
Displaying Columns in the Ambient Chart .....	8-6
Ambient Monitor Parameter Definitions .....	8-7
Solenoids and Switches .....	8-8
Switch Condition Definitions .....	8-9
Piston Home .....	8-9
Oxygen Pressure .....	8-9
Autoloader .....	8-10
Leak Check .....	8-12
System Check .....	8-14
System Check Definitions .....	8-14
Furnace .....	8-16
Calibration .....	8-17
Set Bridge .....	8-17
Set Barometric Pressure for TC Cells .....	8-18
Setting Altitude for Ballast Pressure Target .....	8-19
Reduction Heater Calibration .....	8-19
Furnace Calibration .....	8-20
Backup Hardware Calibration .....	8-20
Backup Calibration Values .....	8-21
Restore Calibration Values .....	8-22
Set Oxygen Flow .....	8-23
How to Read Rotometers .....	8-24
Ballast Pressure Target .....	8-24
Network Diagnostics .....	8-25

Network Definitions ..... 8-26

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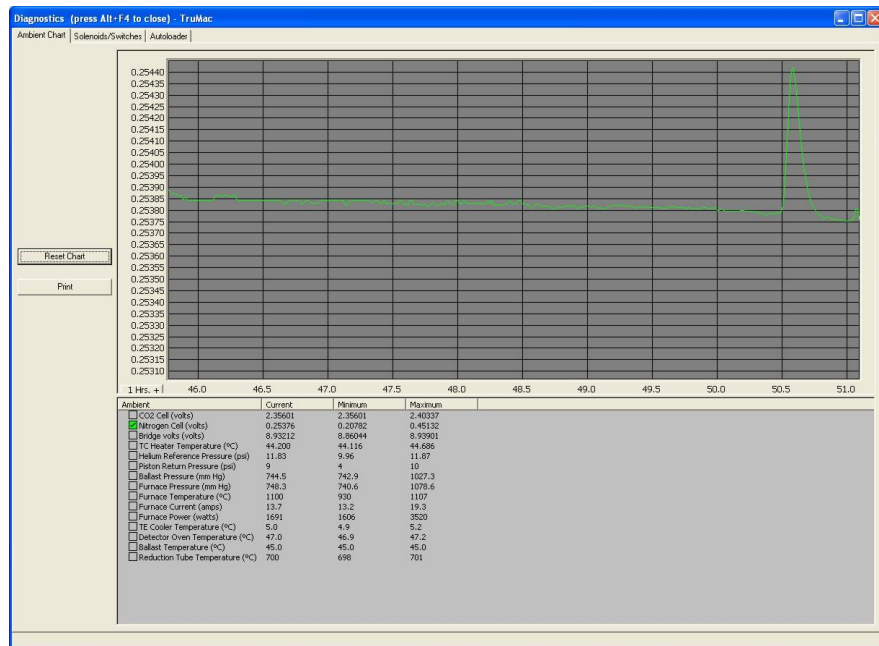
# Ambient Monitor

Use the Ambient Chart to monitor instrument parameters and determine their statuses. Ambient Chart provides all the system parameters on a chart and graph. The parameters that display on the Ambient Chart were selected by LECO as being the most critical to monitor.

Refer to [Ambient Monitor Parameter Definitions](#), page 8-7, for information concerning the parameters and values displayed on the Ambient Chart.

## Ambient Chart

1. Select Diagnostics and then select Chart to display the Ambient Chart.



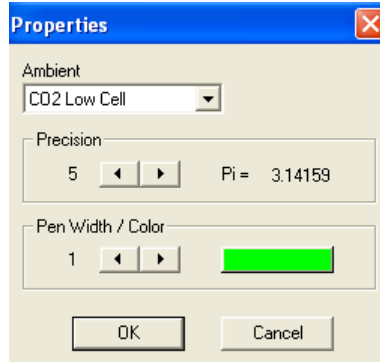
2. Select the checkbox to the left of the desired parameter to display the parameter value in the graph above the chart. More than one parameter can be displayed by holding down the CTRL Key and then selecting the checkboxes for all the desired parameters. A yellow circle to the left of the checkbox indicates the parameter value is outside the desired range of values.
3. Click the right mouse button, with the mouse pointer inside the graph, to reset, restore, zoom in, zoom out, and set the graph range. The parameter value is displayed on the vertical axis and the time is displayed on the horizontal axis. The box in the lower left corner of the graph displays the hours since the instrument was turned On or the graph reset. After 24 hours, the software will reset to zero.





4. Select Reset Chart to reset the parameter values and time on the chart and graph.
5. Select Print to print the parameter values on the system printer.

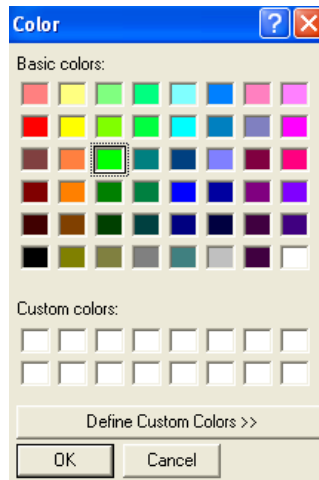
### Customizing Ambient Chart

The precision, line width, and line color for each ambient that displays in the Ambient Chart can be customized.

1. Double-click the desired ambient. The Properties dialog box will display.

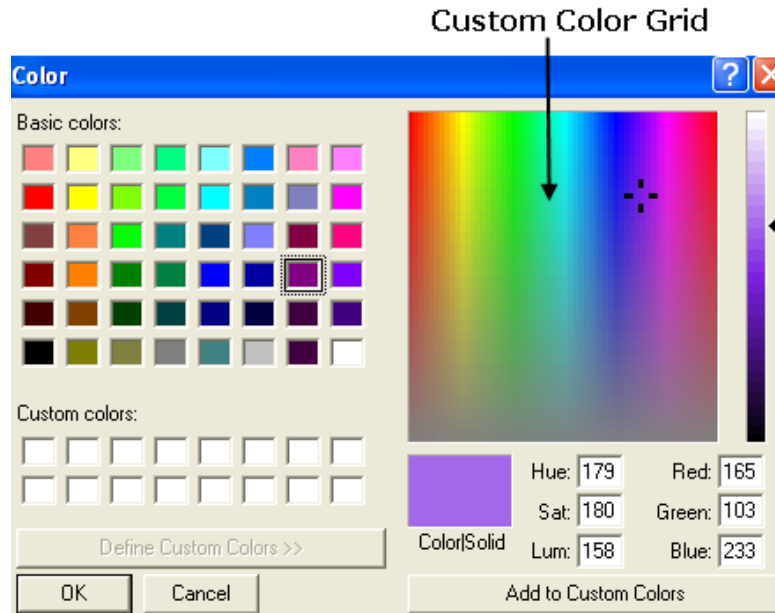



2. Determine the precision by selecting the arrows until the desired precision is achieved. Select  to decrease precision. Select  to increase precision.
3. Use the pen width to determine the thickness of the line that displays in the chart. Select  to decrease line thickness. Select  to increase line thickness.
4. Determine the color of the line by selecting the color button. The Color dialog box will display.



5. Select the desired color for the background by selecting a basic color or by adding a custom color.
6. To select a basic color, select the desired color and then select OK.

7. To select a custom color:
  - A. Select in one of the empty custom color selection boxes.
  - B. Select Define Custom Color. The Color Dialog Box expands to display the Custom Color Graph.



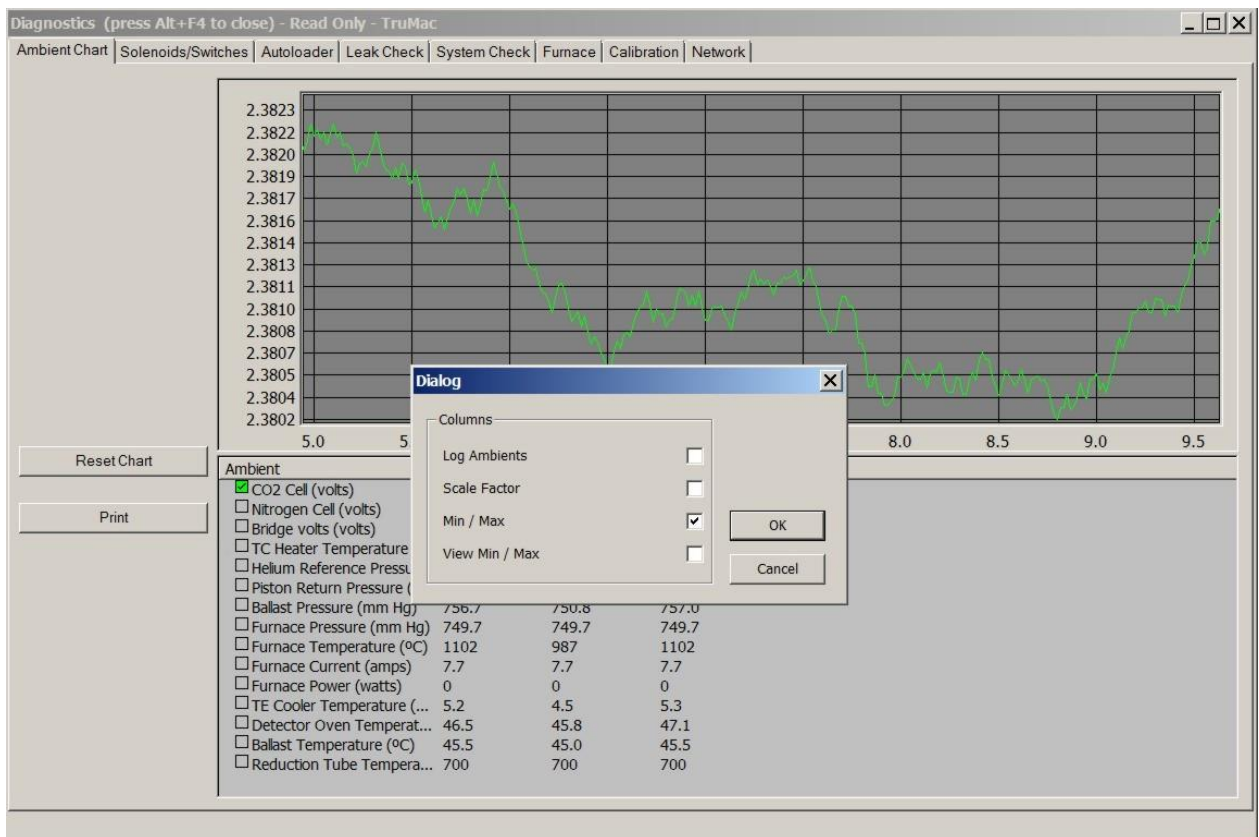
- C. Select the desired color range from the custom color graph. The range that falls under the selector (  ) will appear in the custom color selection grid.
  - D. Select the specific color from the custom color selection grid.
  - E. Select Add to Custom Colors.
  - F. Select OK. The color will appear in the custom color selection box as a new color choice.
8. To customize another ambient, select the arrow under Ambient in the Properties dialog box and then select the desired ambient from the list. Repeat steps 2 through 7.
9. Select OK. The selected precision, pen width, and color choice will display in the chart for all selected ambients. The checkbox for each ambient will also display the selected color choice.

## Displaying Columns in the Ambient Chart

**NOTE** → The following screenshot illustration is an example only and may vary depending on your instrument model.

The following steps explain how to determine the columns that display in the ambient chart.

1. Select a column heading in the ambient chart as illustrated in the following screenshot.
2. In the dialog box that displays, select in the desired checkboxes.
  - Select the Log Ambients checkbox to save the ambient data to a file.
  - Select the Scale Factor checkbox to show the scale factor.
  - Select the Min/Max checkbox to display the minimum value read and maximum value read.
  - Select View Min/Max to display the minimum current view and maximum current view.



## Ambient Monitor Parameter Definitions

**CO<sub>2</sub> Cell**—The voltage, in volts, of the infrared radiation cell output. Range: 1.0 to 5.0 volts. Nominal Value: Varies with TC cell. Applies to *TruMac* CN only.

**Nitrogen Cell**—The voltage, in volts, of the thermal conductivity (TC) cell output. Range: 0.0 to 0.4 volts. Nominal Value: Varies with TC cell.

**Bridge Volts**—The voltage, in volts, of the thermal conductivity Wheatstone bridge. Range: 0 to 15 volts. Nominal Value: Varies with TC cell.

**TC Heater Temperature**—The temperature, in °C, of the thermal conductivity cell. Range: 52.5 to 53.5°C. Nominal Value: 52.7°C. Some units will have a Range of 56.5 to 57.5°C with a Nominal Value of 57°C.

**Helium or Argon Reference Pressure**—Depending on the model, the helium or argon pressure, in psi, of the reference segment of the thermal conductivity cell. Range: 9.9 to 13.1 psi above the pressure measured when the gas is Off. Nominal Value: 12 psi.

\***Piston Return Pressure**—The pneumatic pressure, in psi, of the ballast-return segment. Range: 0 to 42 psi. Nominal Value: 9 psi.

\***Pneumatic Incoming Pressure**—The pressure, in psi, of the incoming pneumatic supply. Range: 0 to 42 psi. Nominal Value: 40 psi.

**Ballast Pressure**—The pressure, in mm Hg, of the ballast. Range: 720 to 1300 mm Hg. Nominal Value: Varies with analysis state.

**Furnace Pressure**—The pressure, in mm Hg, of the combustion furnace. Range: 720 to 1300 mm Hg. Nominal Value: Varies with analysis state.

**Furnace Temperature**—The temperature, in °C, of the combustion furnace. Range: 10 to 1470°C. Nominal Value: Varies with analysis state.

**Furnace Current**—The electrical current, in amps, flowing through the combustion furnace during an analysis. Range: 0 to 20.4 amps. Nominal Value: Varies with analysis state.

**Furnace Power**—The electrical power, in watts, consumed by the combustion furnace during an analysis. Range: 0 to 6740 watts. Nominal Value: Varies with analysis state.

**TE Cooler Temperature**—The internal temperature, in °C, of the thermoelectric cooler. Range: 1 to 5°C. Nominal Value: 5°C.

**Detector Oven Temperature**—The temperature, in °C, of the detector oven compartment. Range: 42 to 52°C. Nominal Value: 47°C.

**Ballast Temperature**—The temperature, in °C, of the ballast collection vessel. Range: 44 to 46°C. Nominal Value: 45°C.

**Reduction Tube Temperature**—The temperature, in °C, of the reduction tube. Range: 690 to 710°C. Nominal Value: 700°C.

\*Denotes that Piston Return Pressure or Pneumatic Incoming Pressure is displayed depending on the state of solenoid valve SV19 (Pneumatic Pressure Select Valve).

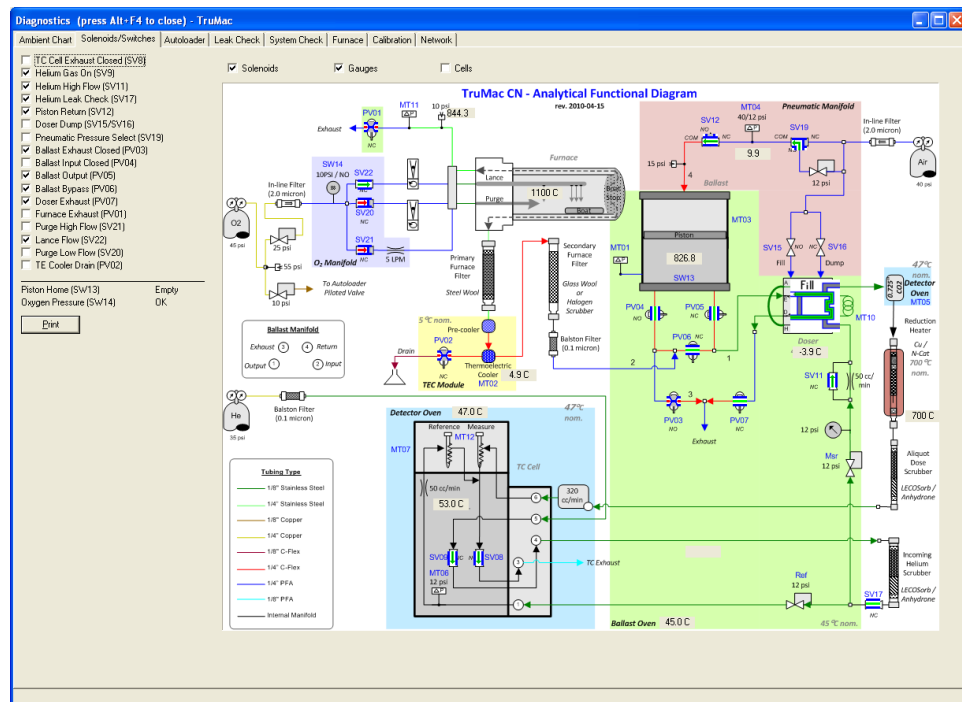
# Solenoids and Switches

The Solenoids and Switches tab toggles the solenoid valves either on or off. This is a diagnostic test to determine the condition of the valve and its result for operation of the system. To determine what each valve may affect, refer to the [Flow Diagram](#), page 9–46.

Switches are used throughout the instrument as sensors to determine the status of a condition. They are used to control the instrument, to prevent instrument damage, and to maintain safety.

None of the switch states can be changed from the Switches and Solenoids tab. Use this tab to determine the switch status. Refer to [Solenoids and Switches](#), page 8–8, to determine the meaning of each condition.

1. Select Diagnostics, select Systems Check, and then Solenoids and Switches.



2. Select the checkbox for the desired solenoid valve to turn it On or Off. A check mark in the box indicates that it is turned On.
3. Select Print to print the list of switches and their current statuses on the system printer.
4. Select Furnace or Analyzer to display the furnace or analyzer flow diagram.
5. Select Solenoids, Gauges or Cells to display the solenoids or pressures on the flow diagram.



## Switch Condition Definitions

### Piston Home

**Open**—The ballast piston is not on the home position. The home position is when the piston is at the bottom of the ballast tank.

**Closed**—The ballast piston is in the home position. The home position is when the piston is at the bottom of the ballast tank.

### Oxygen Pressure

**Open**—The oxygen pressure is low, below 10 psi. This can possibly indicate an empty tank.

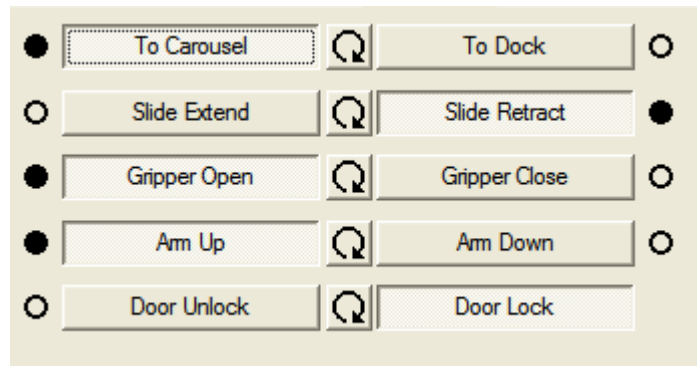
**Closed**—Oxygen pressure is above 10 psi, a normal condition.

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## Autoloader

Autoloader diagnostics can be used to manually move and test the autoloader motors and functions. Diagnostics can be used to determine the cause of a problem and correct it. If the problem persists, contact the LECO service department.

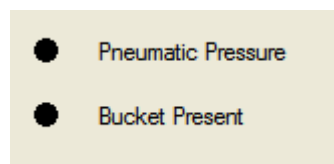
1. Select the Diagnostics menu and select Autoloader. The Autoloader Diagnostics screen will appear.
2. Select the buttons in the upper left of the screen to position the carousel, slide, gripper, arm, and door lock.



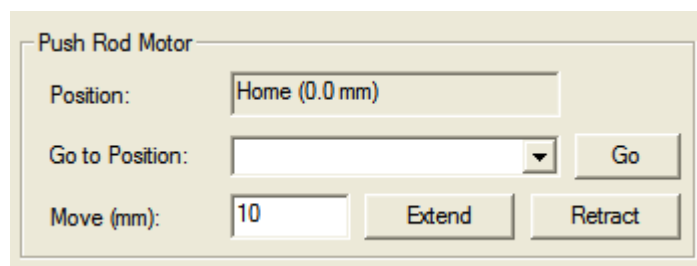
**NOTE** →

The circle next to the button will light red when the function is moving and green when the function is in position. A black circle indicates that the function is in position, based on previous instructions. An empty circle indicates the function is not in that position, based on previous instructions.

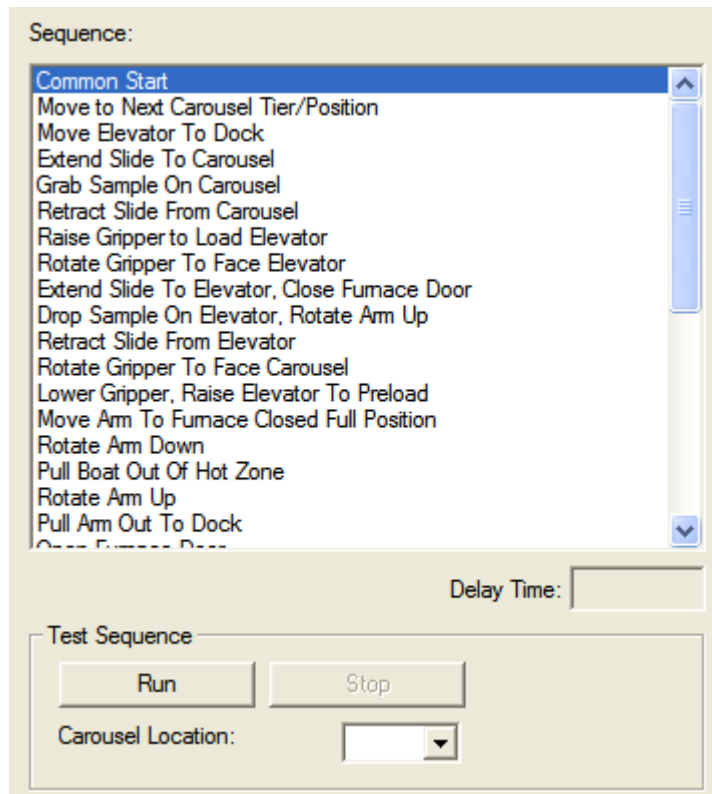
3. Pneumatic Pressure and Bucket Present are status indicators. A black circle indicates pneumatic pressure is applied and the bucket is in place.



4. The push rod motor, carousel motor, vertical motor, elevator motor, and furnace door motor position boxes are located in the lower section of the screen. Select the drop-down arrow to select a position to go to and select Go. As soon as Go is selected, the indicated position will disappear.



5. Select the Move buttons to move the motor by steps. Select the step rate box to the left of the move buttons to change the step rate. Depending on the motor, the steps are measured in millimeters or degrees.
6. Select the Carousel Location drop-down arrow to select the starting position of the carousel. Refer to the screenshot in step 8 .
7. Select the Run button to automatically sequence the autoloader through the indicated positions.
8. Select the Stop button to stop sequencing the autoloader.



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## Leak Check

This procedure automatically inspects the measurement system of the instrument for a gas leak. The oxygen, TC carrier gas (helium or argon), or the entire system can be checked. A leak can be isolated, by performing an oxygen or TC carrier gas (helium or argon) test, to determine which section leaks.

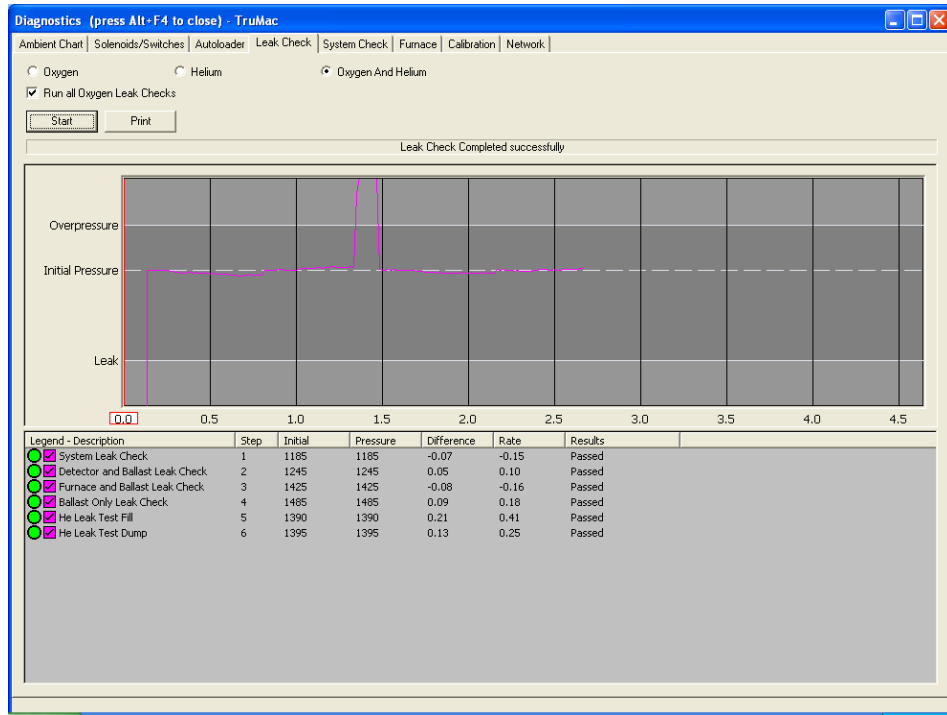
Perform a leak check at the start of each day and after any maintenance is performed on the instrument.

During a leak check, the system is pressurized to 500 mm Hg above current system furnace pressure and sealed. It is then permitted to equilibrate. For the next 60 seconds, the system pressure is measured.

Leak Indications:

- If the pressure remains within 1 mm Hg of the pressurized value, the system passes the leak check. If the pressure changes more than 1 mm Hg of the pressurized value, the leak check fails.
- In the Leak Check Progress box, the status of the leak check is displayed. If a leak check fails, it may be caused by gas leaking into or out of the system.
- If change in pressure has increased, atmosphere could be leaking into the system. If change in pressure has decreased, gas could be leaking out of the system.
- In the Results box, "Leak Check Failed" means the system has a leak while "Leak Check Passed" means the system does not have a leak.

1. Let the instrument warm up for a minimum of 30 minutes before performing a leak check.
2. Select Diagnostics and then select Leak Check.



3. Select Oxygen and Helium or Argon Leak Check to perform a leak check on the entire measurement system, or select Oxygen, Helium, or Argon Leak Check to perform a leak check of a section of the measurement system. The result of the leak check will display in the Results box.
4. Select Stop Leak Check to stop a leak check in progress.
5. Select Print to print the results of the leak check on the system printer.
6. To zoom in on a point on the graph, click the left mouse button and draw a box around the point on the graph to zoom in on. Unclick the mouse. To restore the graph, click the right mouse button and select Restore.
7. To reset the minimum and maximum parameter values, right-click the parameter to reset and select Reset Min / Max Value.

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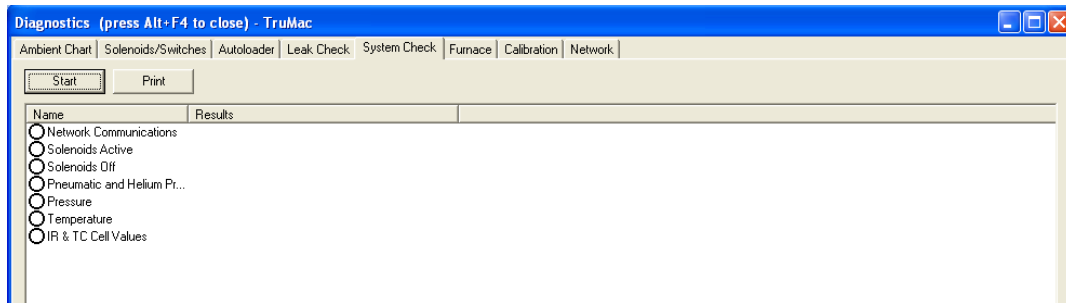
## System Check

System Check is a quick way to determine if major systems in the instrument are operating properly. All systems should have a green indicator beside them before the instrument is used for analysis.

The results of system check will be listed in the results column.

If a system fails system check, it will be necessary to correct the failure before analysis. Refer to [System Check Definitions](#), page 8–14.

1. Select Diagnostics and then select System Check.



2. Select Start to begin System Check and test the systems that display. Green indicates a pass; red indicates a fail. Passed or Failed also appears in the display box.
3. Select Print to print the results of the system check on the system printer.

## System Check Definitions

**Network Communications**—Communications between all electronic assemblies are checked and monitored. If any device on the network fails to communicate, this system check will fail. Refer to [Network Diagnostics](#), page 8–25.

**Solenoids Active**—Verifies that all solenoids can be turned On.

**Solenoids Off**—Verifies that all solenoids can be turned Off.

**Pneumatic and Helium or Argon Pressures**—The incoming pneumatic and helium or argon pressures are checked to determine if they have been turned on and set to their proper values. The pneumatic tank pressure must be set between 38 and 42 psi. If this check fails, check the gas tanks to determine if the gas has been turned On and the regulator properly set. The pneumatic pressure at the ballast must be between 6 and 12 psi. If it is not, this test will fail. The carrier gas pressure must be between 9.9 and 14.5 psi. If it is not, this test will fail.

**System Pressure**—The measurement system is pressurized and the system pressure is checked at the TC cell module for the proper value. If the system pressure falls outside the range of 600 and 900 Torr, this test will fail.

**Temperature**—Temperature verifies that the operating temperatures are in a valid range for the following assemblies:

- TE Cooler (range 2 to 10°C)
- Detector Oven Temperature (setpoint plus or minus 5°C, setpoint normally 45°C)
- Reduction Tube Temperature (setpoint plus or minus 10°, setpoint normally 700°C)
- Reduction Tube Over-Temperature (zero to setpoint plus 50°C)
- Ballast Temp (44 to 46°C)
- Ballast Oven-Temperature (setpoint plus or minus 5°C, setpoint normally 50°C)
- Furnace Temperature (setpoint plus or minus 25°C, setpoint normally 1100°C)
- Furnace Over Temperature (10°C to setpoint plus 50°C)

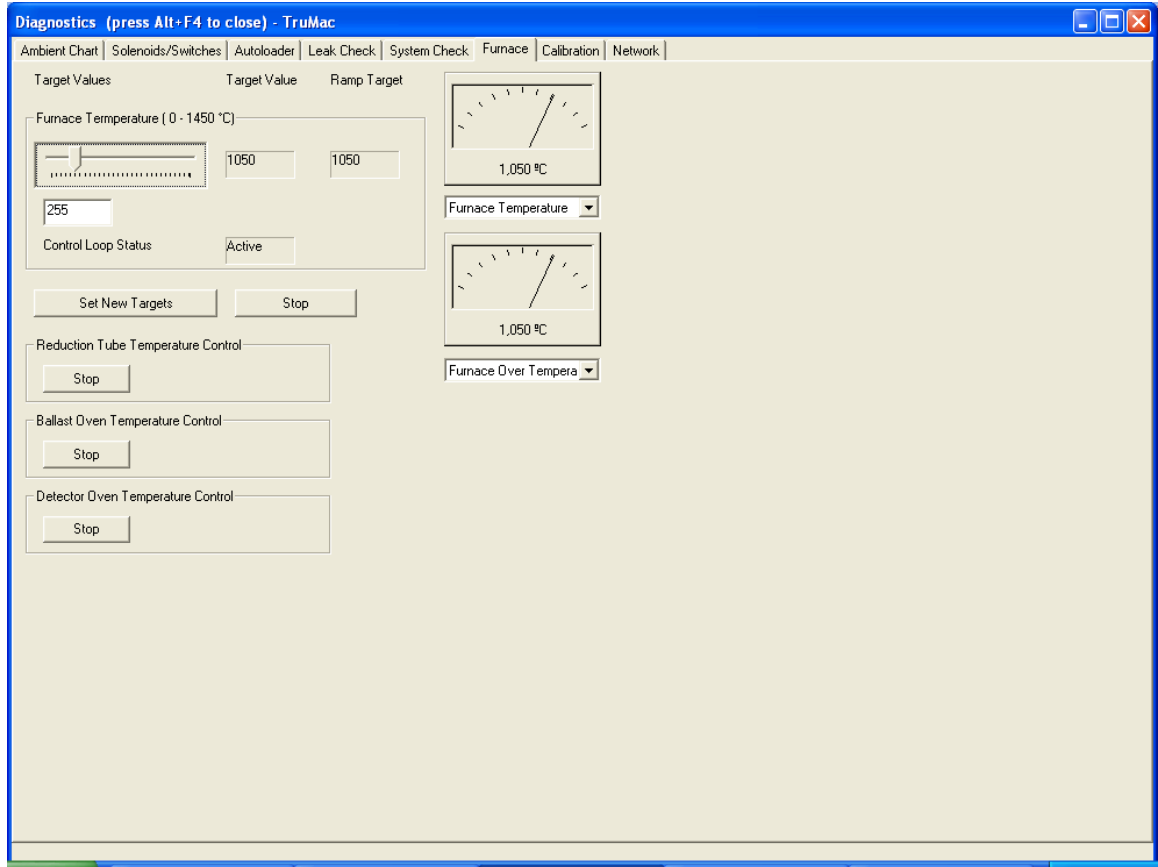
**TC Cell Output**—Checks the output voltage of the TC cell. If this test fails, the output voltage is outside the range of 0.01 to 0.4 volts.

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# Furnace

Use the Furnace tab to test the furnace, and verify proper operation using the following procedure.

1. From the Menu bar, select Diagnostics and then select the Furnace tab.



2. Move the furnace temperature slider, or enter a furnace temperature, and select Set New Targets. The furnace will ramp up or down to the set temperature. The temperature will only remain at this setting as long as Diagnostics remains open. This control is for testing the furnace.
3. The reduction tube heater, ballast oven heater, and detector oven can be stopped by selecting Stop. The temperature will ramp down to ambient. This is a test procedure. As soon as diagnostics is closed, the heaters will turn back On and ramp to their original settings. The stop button will turn to start after it is selected. The heaters can be restarted by selecting start.

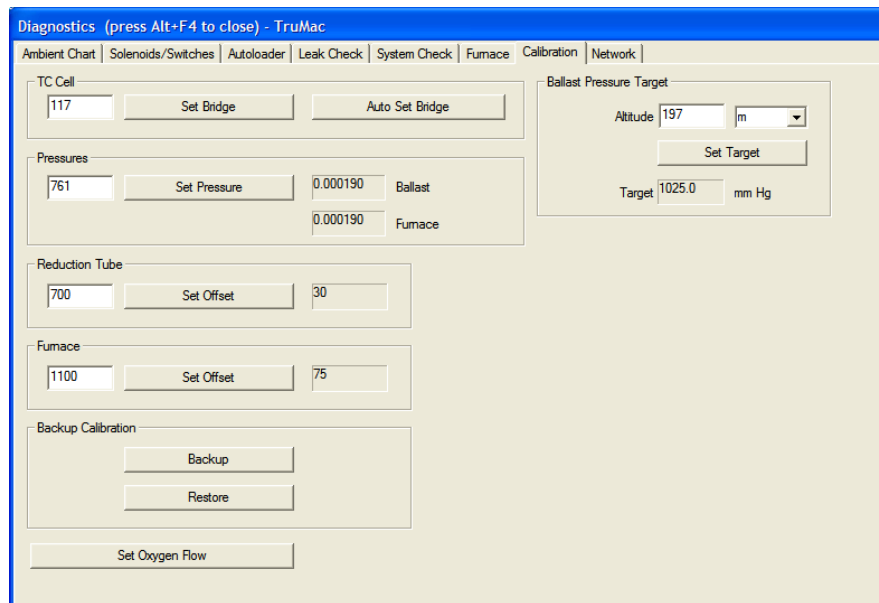


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## Calibration

The Calibration tab displays the Hardware Calibration procedures for the TC Cell, Reduction Tube (Catalyst Heater) temperature, and Combustion Furnace. It also permits the operator to back up the calibration to disk in the event calibration data is lost.

1. From the Menu bar, select Diagnostics, and then select the Calibration tab.
2. The Hardware Calibration screen will appear.



### Set Bridge

Set Bridge is a software adjustment that sets the gain of the TC Cell.

**NOTE** → The TC Cell gain has been set during the manufacturing process. It is not necessary to reset the gain unless the TC cell has been serviced or replaced.

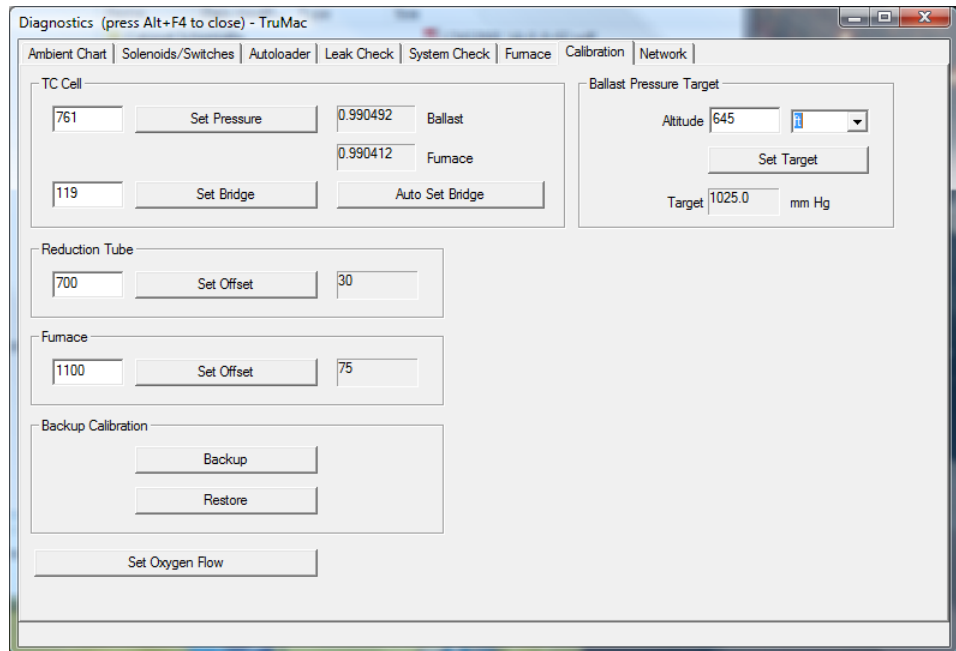
1. Select Auto Set Bridge to automatically set the gain of the TC Cell. The gain factor will appear in the edit box to the left of the set bridge button.
2. To manually set the gain, enter the gain factor in the edit box and select Set Bridge. The gain factor must be between 0 and 255. This can be used for troubleshooting or servicing the instrument.

## Set Barometric Pressure for TC Cells

Set Pressure permits the operator to calibrate the barometric transducer located in the instrument.

Calibration is necessary for proper analysis results and varies with the location of the instrument. This procedure must be done when the instrument is installed at location. For more information about barometric pressure, refer to [Barometric Pressure](#), page 7–10.

1. Determine the current barometric pressure at the location of the instrument. This can be done with an external barometer or via the Internet.
2. Select Diagnostics and then select Calibration. The Hardware Calibration screen will appear.



3. Enter the current barometric pressure determined in step 1 in the edit box to the left of Set Pressure in the TC Cell box.

**NOTE** → Use values in mm Hg for barometric pressure.

4. Select Set Pressure to set the pressure entered in the edit box.
5. Close the Hardware Calibration dialog box to exit this procedure and save the setting.

## Setting Altitude for Ballast Pressure Target

Ballast Pressure Target corrects the target pressure (in mm Hg) for the current elevation.

1. Determine the altitude at the location of the instrument. This can be done via the Internet.
2. Select Diagnostics and then select Calibration. The Hardware Calibration screen will appear.
3. Enter the altitude in the edit box to the right of Altitude in the Ballast Pressure Target box. Use the drop-down menu to select meters (m) or feet (ft).
4. Select Set Target to set the altitude entered in the edit box. The software will set the Target automatically, if necessary.
5. If the target pressure changes, a dialog box appears, recommending that the method(s) be recalibrated. Refer to [Creating and Modifying Methods](#), page 5-12.
6. Select Close to exit this procedure and save the setting.

## Reduction Heater Calibration

Reduction Heater Calibration is used to calibrate the temperature of the reduction tube (catalyst heater) heater.

**NOTE** →

The reduction heater was calibrated during the manufacturing process. It is not necessary to recalibrate the reduction heater unless it has been serviced or replaced.



**The reduction heater reagent tube may be hot. Permit the tube to cool to ambient temperature before removing it from the reduction heater.**

1. Remove the reduction heater reagent tube from the reduction heater and set it aside.
2. Insert a calibrated thermocouple into the center of the reduction heater or combustion furnace tube. Refer to [Packing the Reduction Heater Tube](#), page 2-41.
3. Allow the temperature, displayed on the thermocouple, to stabilize.
4. Enter the value measured on the thermocouple in the temperature edit box and select Set Offset to save the calibration.
5. Remove the thermocouple and reinstall the reduction heater reagent tube.

## Furnace Calibration

Calibration adjusts the furnace temperature to equal the temperature measured by an accurate thermometer or thermocouple.

### NOTES

- The combustion furnace was calibrated during the manufacturing process. It is not necessary to recalibrate unless the furnace has been serviced.
- An accurate thermocouple must be used for calibration to perform this procedure.



### SERIOUS BURNS

**The furnace and combustion tube will be hot. Do not touch any hot areas on or around the furnace or combustion tube.**

1. Select Configuration and then select Hardware Calibration. The hardware calibration dialog box will appear.
2. Insert an external thermocouple into the furnace combustion tube to measure the furnace temperature. The thermocouple should be inserted into the combustion tube until it touches the boat stop and then pulled back 1 inch.
3. Permit the temperature measured by the external thermocouple to stabilize.
4. Enter the temperature measured by the external thermocouple in the furnace dialog box.
5. Select Set Offset to calibrate the furnace.
6. Remove the external thermocouple from the furnace.

## Backup Hardware Calibration

Backup Calibration permits the operator to save hardware calibration parameter values in a designated file on the system hard drive. The file can be accessed at a later time to restore hardware calibration values that may have been lost or changed.

Backup Calibration saves the following parameter values:

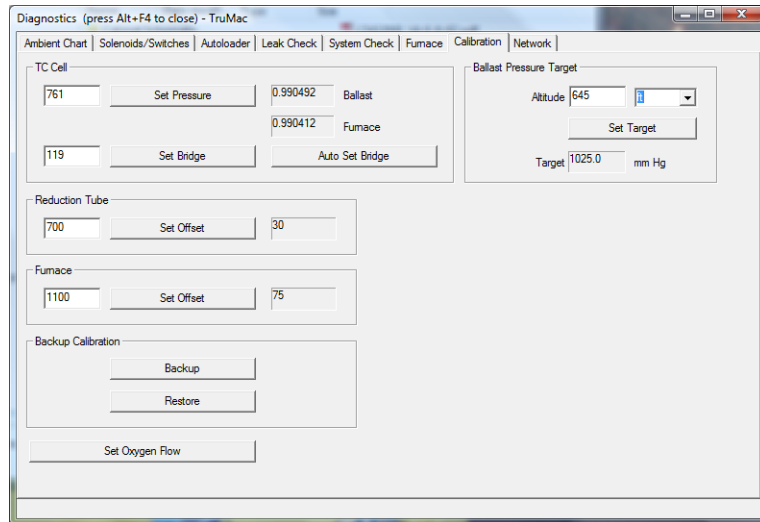
- Barometric Pressure Calibration
- Combustion Flow Calibration
- TC Bridge Value

### NOTE

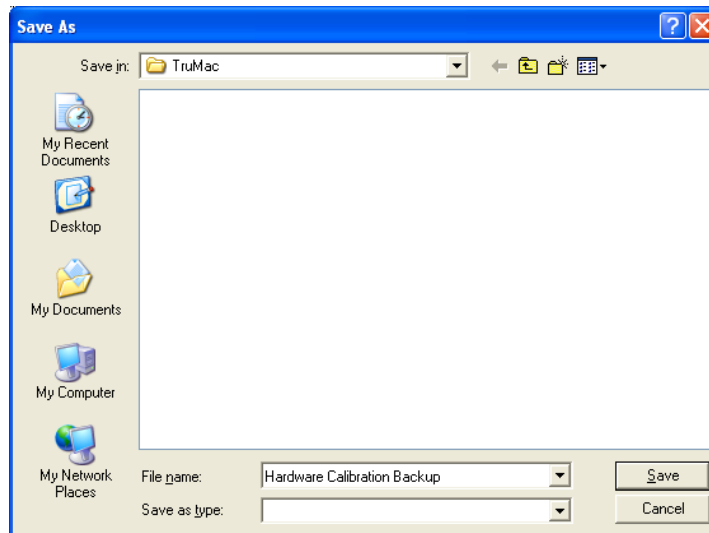
Perform this procedure if you feel it will be necessary to restore calibration values from disk at a later date. It is not necessary to perform this procedure to save the calibration values. The instrument automatically does this in a system file.

## Backup Calibration Values

1. Select Diagnostics and select Calibration. The Hardware Calibration screen will appear.



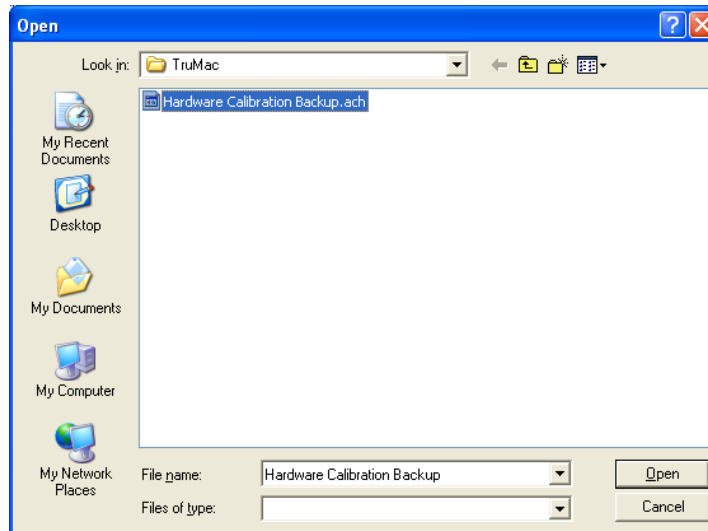
2. Select Backup to create a backup file of the hardware calibration parameter values. The file Save As dialog box will appear.



3. Enter the file name and folder location in the dialog box.
4. Select Save to save the backup file.

## Restore Calibration Values

1. Select Diagnostics and then select Calibration. The Hardware Calibration screen will appear.
2. Select Restore to load the hardware calibration values that have been saved in a backup file. The file open dialog box will appear.



3. Select the folder and backup file from the dialog box.
4. Select Open to load the calibration values from the selected backup file.

## Set Oxygen Flow

**NOTE** → This procedure provides a stable environment to accurately establish the flow rate.

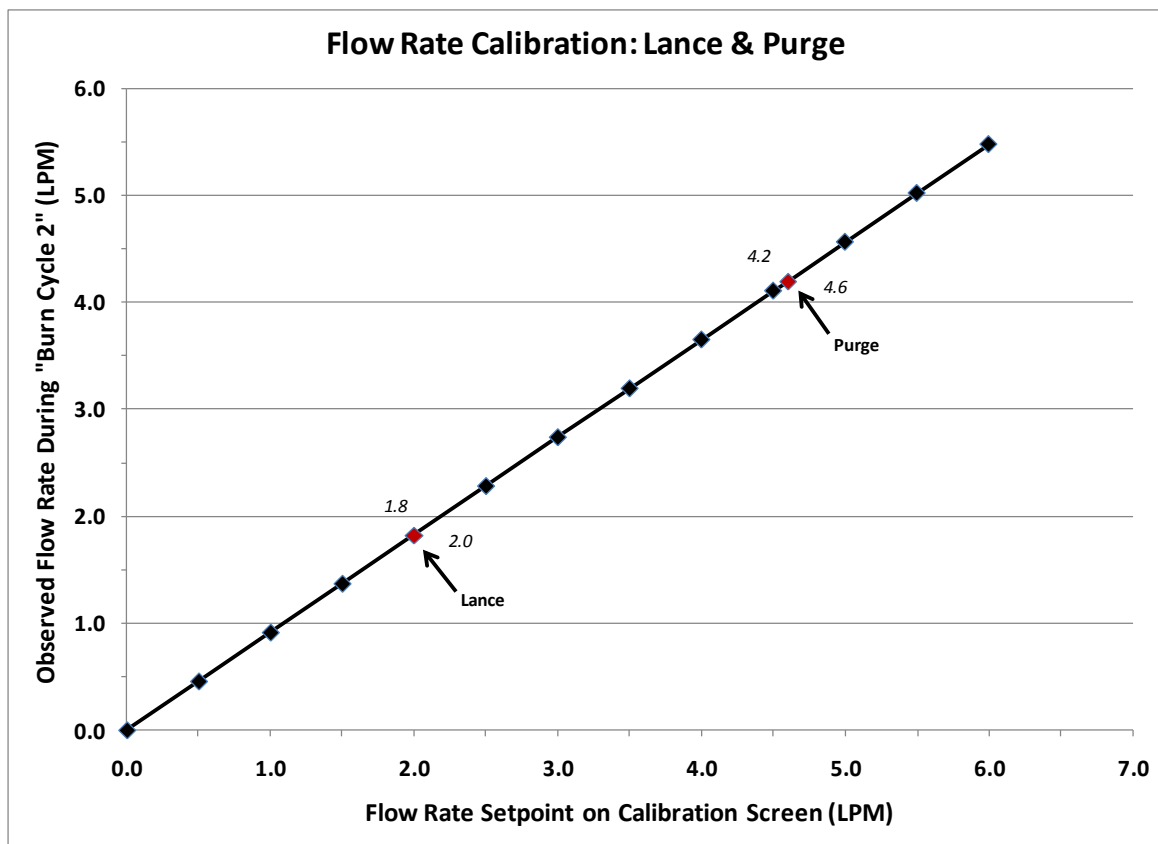
1. Select Set Oxygen Flow to set the instrument oxygen flow rate.
2. Set the flow rates to the following values as shown using the rotometers on the front panel of the instrument.

*Lance* – 2.0 LPM

*Purge* – 4.6 LPM

**NOTE** → These flow rate settings provide actual Lance, and Purge flow rates of approximately 1.8 LPM and 4.2 LPM, respectively, during the burn cycle as shown in the following plot.

After setting the flow rates in the calibration screen, the flows should be confirmed that they are actually 1.8 and 4.2 LPM at the beginning of Burn Cycle 2. Adjust the rotometers, if necessary, to achieve flow rates of 1.8 and 4.2 LPM during the first five seconds of Burn Cycle 2.



## How to Read Rotometers

The rotometers are used to set and monitor the measure flows. Turn the desired flow control knob clockwise to increase flow and counterclockwise to decrease flow. Refer to [Set Oxygen Flow](#), page 8-23, for correct flow rate settings. Readings should be taken from the center of the ball.



## Ballast Pressure Target

**NOTE** → This procedure ensures proper ballast pressure based on the altitude of the instrument. This procedure should be performed during installation.

1. Enter the altitude of the instrument's location. The altitude can be entered in meters or feet.
2. Select Set Target to automatically calculate the Target Pressure (mm Hg) for the ballast.



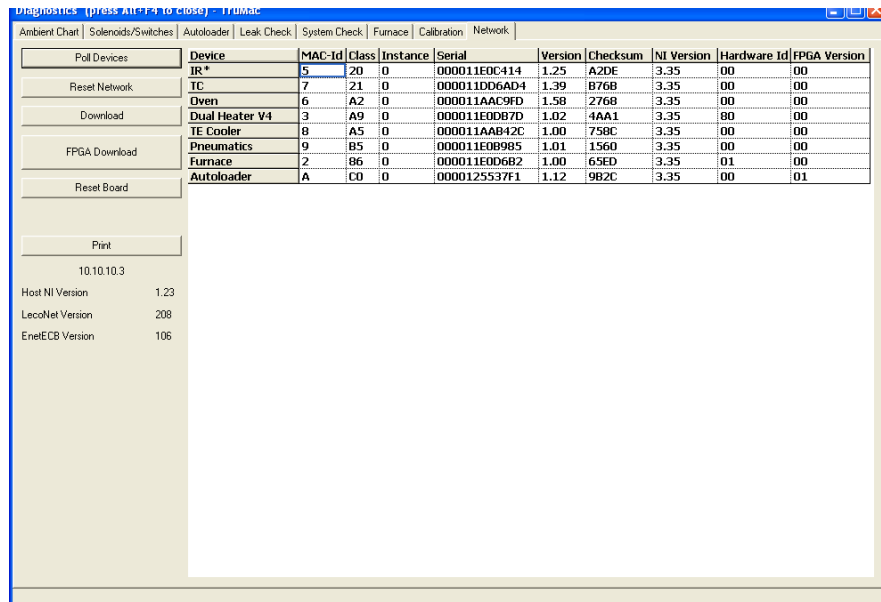
# Network Diagnostics

The electronic design of the instrument is modular. It consists of a main controller, similar to a host computer, and peripheral electronic assemblies, which are controlled from the main controller. During operation, all peripheral assemblies communicate with the main controller over a common electronic bus. Because of this arrangement, information can be displayed and assemblies controlled from the network screen.

The Network screen identifies the type of hardware installed, the version of firmware, and the operational status of the peripheral devices. The network can be reset, a network device can be reset, and the firmware can be upgraded.

The upper area of the screen lists the device, identification, classification, instance used, serial number, version number of the application software, checksum of the applications software, and the version of the network software. Refer to [Network Definitions](#), page 8–26.

1. Select Diagnostics and select Network. The Network screen will appear.



The screenshot shows the 'Network' tab selected in the 'Diagnostics' window. The window title is 'Diagnostics (press Alt+F4 to close) - TruMac'. The 'Network' tab is active, and a table of connected devices is displayed. The table has columns for Device, MAC-Id, Class, Instance, Serial, Version, Checksum, NI Version, Hardware Id, and FPGA Version. The devices listed are IR\*, Oven, Dual Heater V4, IE Cooler, Pneumatics, Furnace, and Autoloader. Below the table, there are buttons for 'Poll Devices', 'Reset Network', 'Download', 'FPGA Download', 'Reset Board', and 'Print'. The IP address is shown as 10.10.10.3. At the bottom, the Host NI Version is 1.23, LecoNet Version is 208, and EnetECB Version is 106.

Device	MAC-Id	Class	Instance	Serial	Version	Checksum	NI Version	Hardware Id	FPGA Version
IR*	5	20	0	000011E0C414	1.25	A2DE	3.35	00	00
Oven	6	A2	0	000011DD6AD4	1.39	B76B	3.35	00	00
Dual Heater V4	3	A9	0	000011A0C9FD	1.58	2768	3.35	00	00
IE Cooler	8	A5	0	000011E0DB7D	1.02	4AA1	3.35	80	00
Pneumatics	9	B5	0	000011AAB42C	1.00	758C	3.35	00	00
Furnace	2	86	0	000011E0B985	1.01	1560	3.35	00	00
Autoloader	A	C0	0	000011E0D682	1.00	65ED	3.35	01	00
Autoloader	A	C0	0	0000125537F1	1.12	9B2C	3.35	00	01

2. Select Poll Devices to determine what devices are connected to the network. Network hardware should appear under devices, indicating they are functioning and signing on to the network.

3. Select Reset Network to restart the network software. If some hardware or operation causes an error, this may correct it.
4. To upgrade a device with a new version of application firmware, select the Device to upgrade. Then select Download to download the new application firmware. Select FPGA Download to download the new FPGA firmware.
5. Select Reset Board to restart firmware application program on the circuit board.

## Network Definitions

**Device**—The name of the electronic assembly connected to the network. Example: TC Cell.

**MAC-id**—The network ID number assigned to the electronic assembly connected to the network. This number is assigned at power up and can vary.

**Class**—The type number of the electronic assembly signed on to the network. Example: 21 is the class number assigned to the TC Cell.

**Instance**—A unique number assigned to an electronic assembly. If two or more of the same type electronic assemblies are installed in the instrument, this number will be different for each assembly and is used by the controller to differentiate one from the other.

**Serial**—The hardware ID number assigned to the electronic assembly. This number is assigned during manufacturing and is unique to each electronic assembly. The serial number is stored on the circuit board in a PROM.

**Version**—The version number of the application software located on the electronic assembly. This software can be upgraded from the network procedure.

**Checksum**—A number unique to the application software to verify if the software was properly installed. There will be a checksum number supplied with any software upgrades. Make sure that the number appearing in the checksum cell is the same as the number supplied with the software upgrade.

**NI Version**—The version number of the network control software installed in the electronic assembly. This software is located in a PROM and cannot be upgraded from the network procedure.

**Hardware ID**—Additional circuit board hardware identification.

**FPGA Version**—The version of the FPGA (Field Programmable Gate Array) software.

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# 11 Schematics

The Schematics chapter provides electronic information for service of the instrument. For part numbers of circuit boards, assemblies, and components, refer to the schematic diagrams.

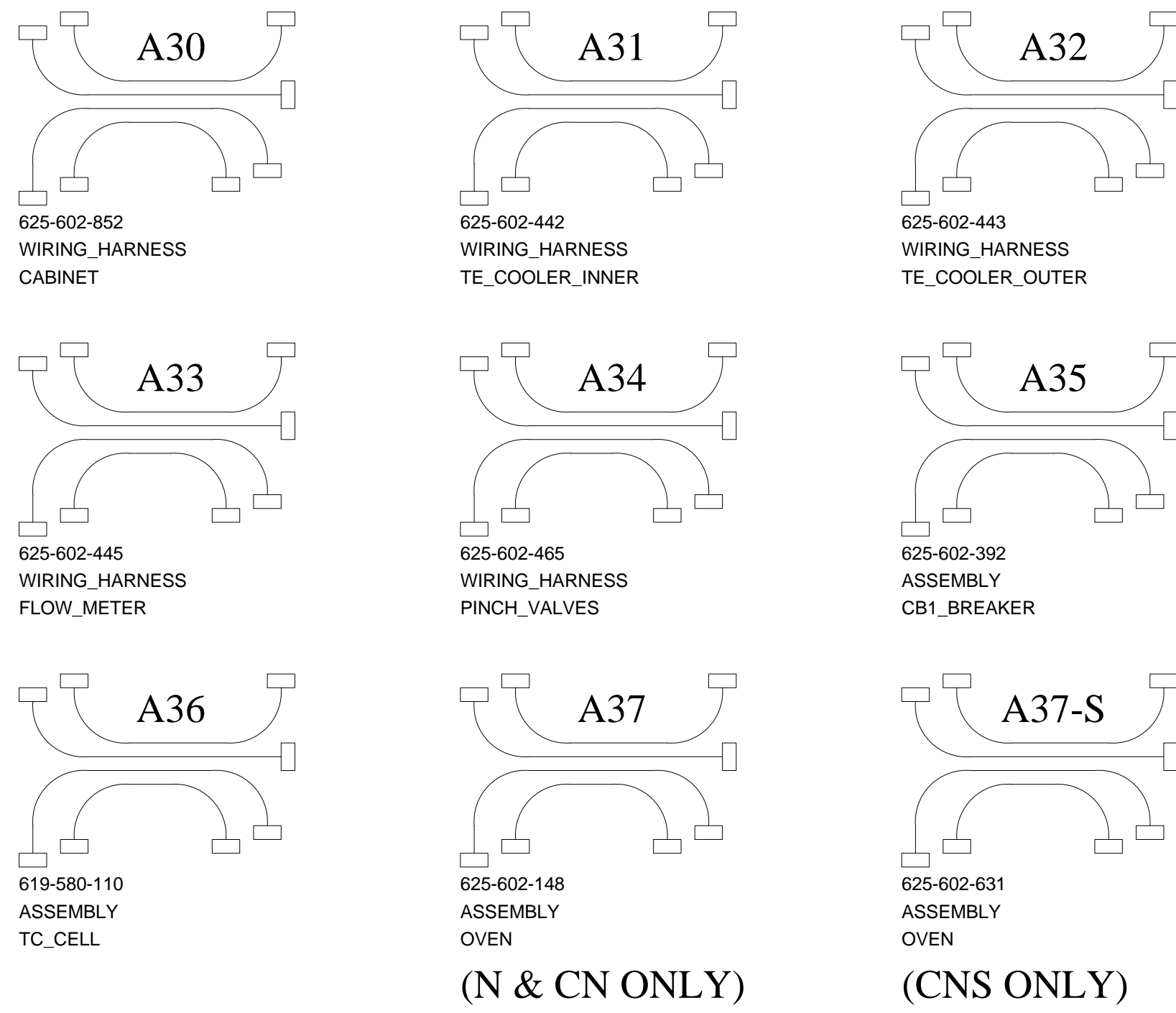
**NOTE** → This section includes pages only of the schematic drawing that are applicable for service of the instrument.

Figure 11-1 Distribution and Power Entry .....	11-3
Figure 11-2 Pneumatic Flow Controller .....	11-4
Figure 11-3 Thermal-Electric Cooler / Heater control / TC Cell.....	11-5
Figure 11-4 Furnace Controller.....	11-6
Figure 11-5 TruMac Autoloader .....	11-7

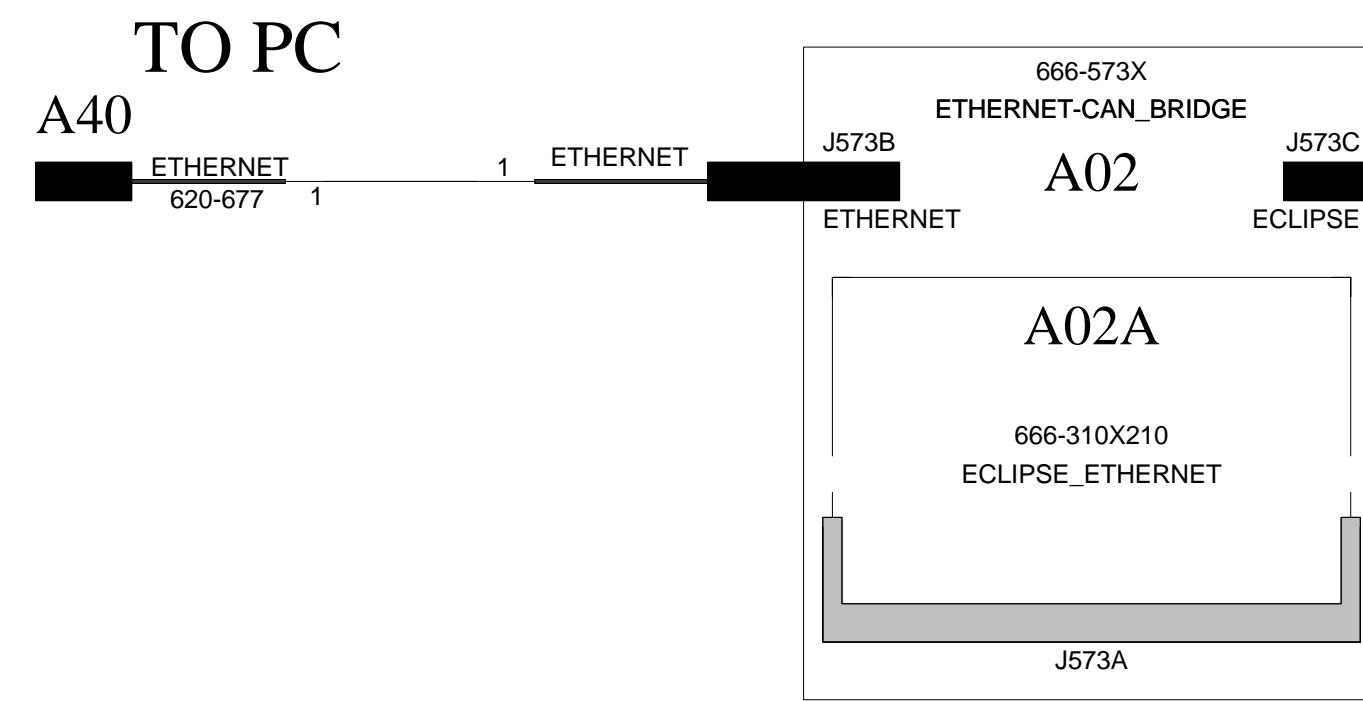
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# DISTRIBUTION & POWER ENTRY

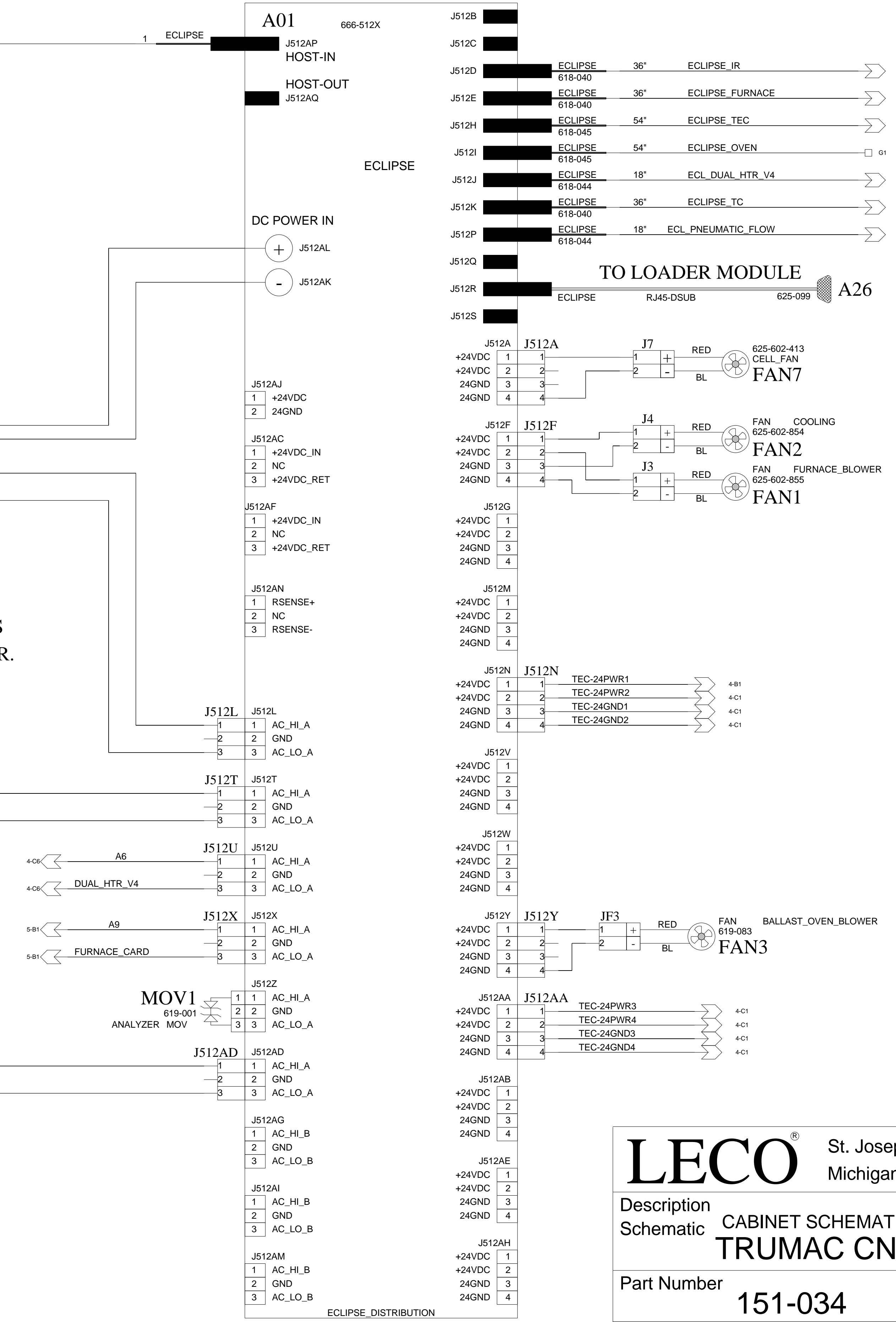
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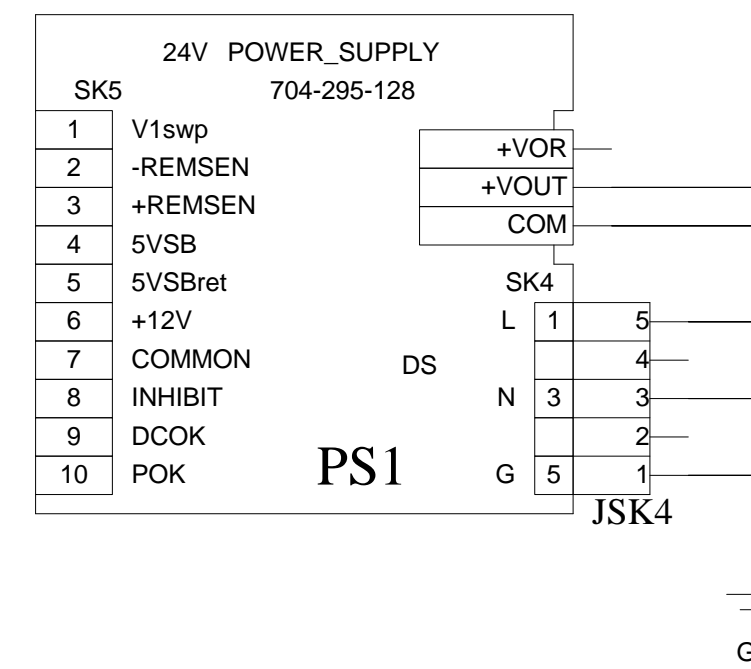
## ETHERNET



## ECLIPSE DISTRIBUTION

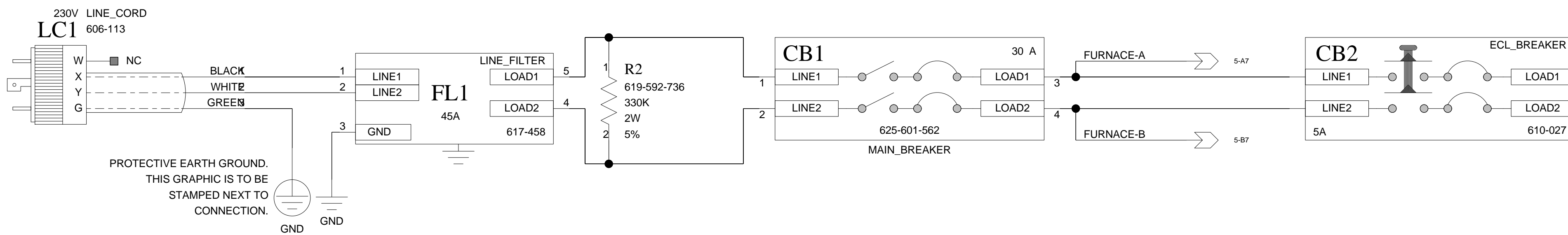


## POWER SUPPLY

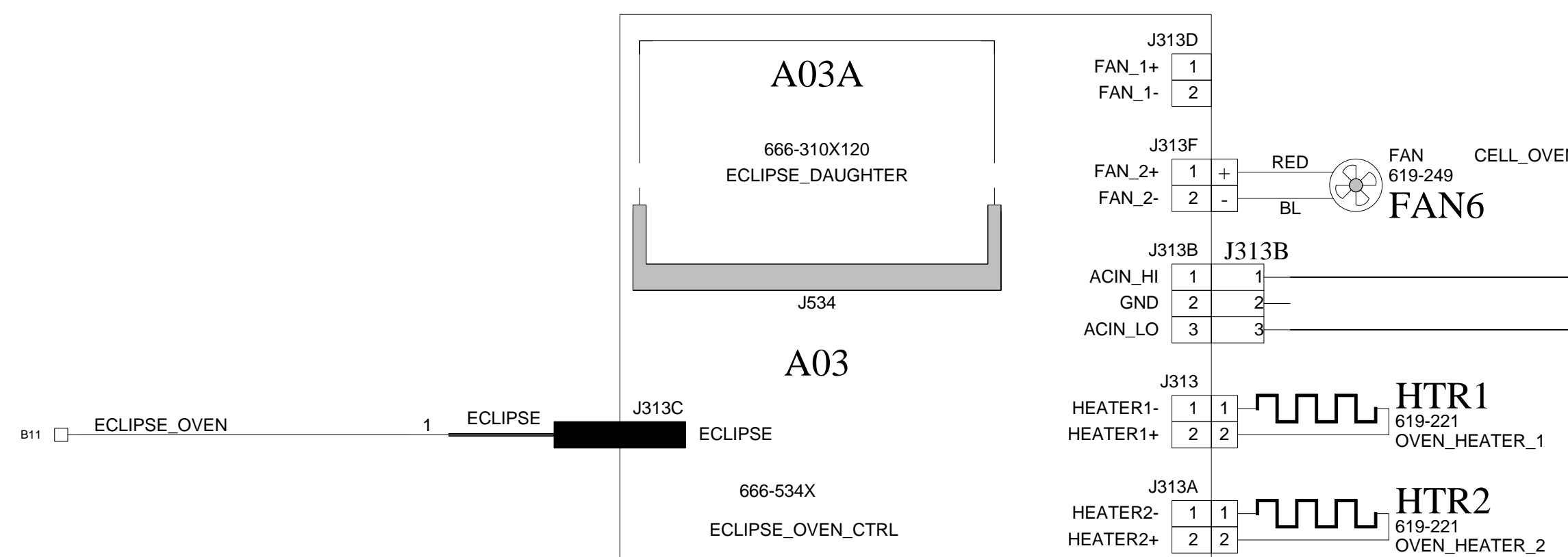


NOTE: THE PIN NUMBERING OF THE SUPPLY IS DIFFERENT THAN THAT OF THE CONNECTOR.

## POWER ENTRY



## DETECTOR OVEN



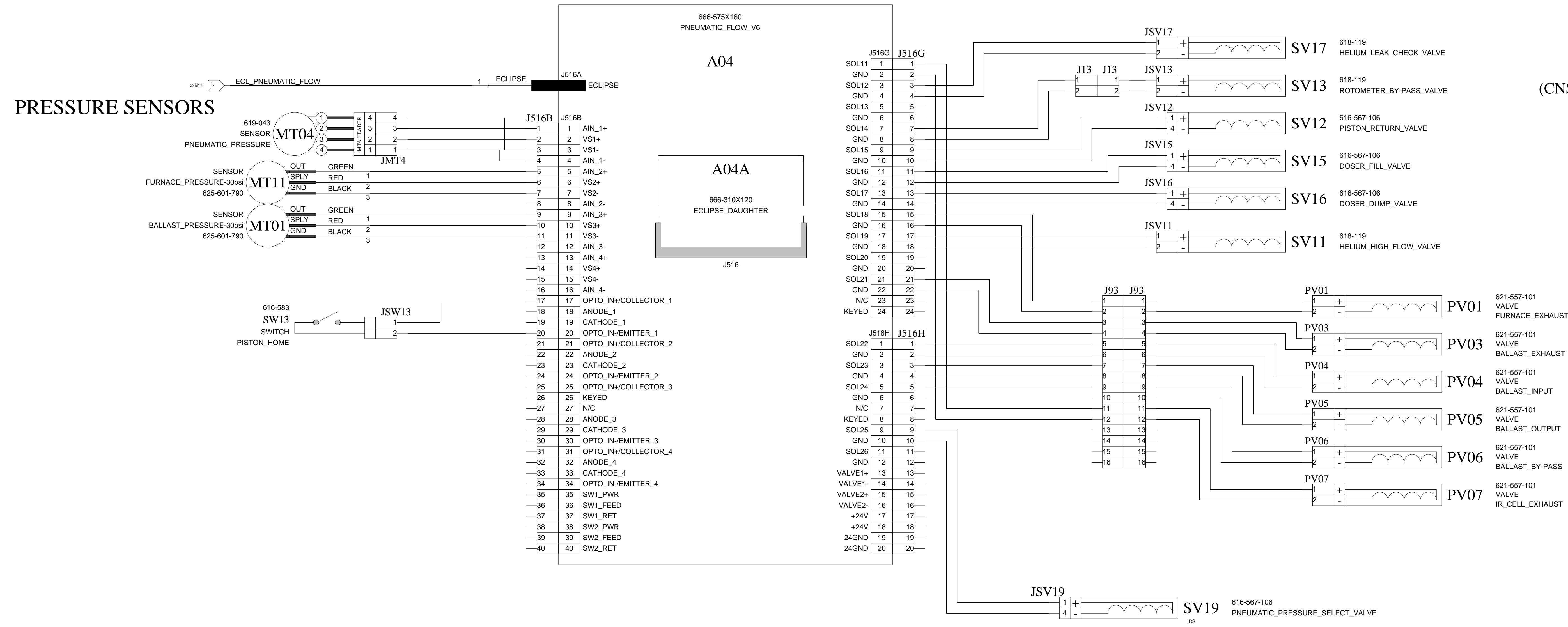
LECO® St. Joseph, Michigan USA

Description Schematic CABINET SCHEMATIC TRUMAC CNS

Part Number 151-034 Rev K

Date: 13/11/2015:13:52 Type M

# PNEUMATIC FLOW CARD



(CNS ONLY)

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 Schematic CABINET SCHEMATIC  
**TRUMAC CNS**

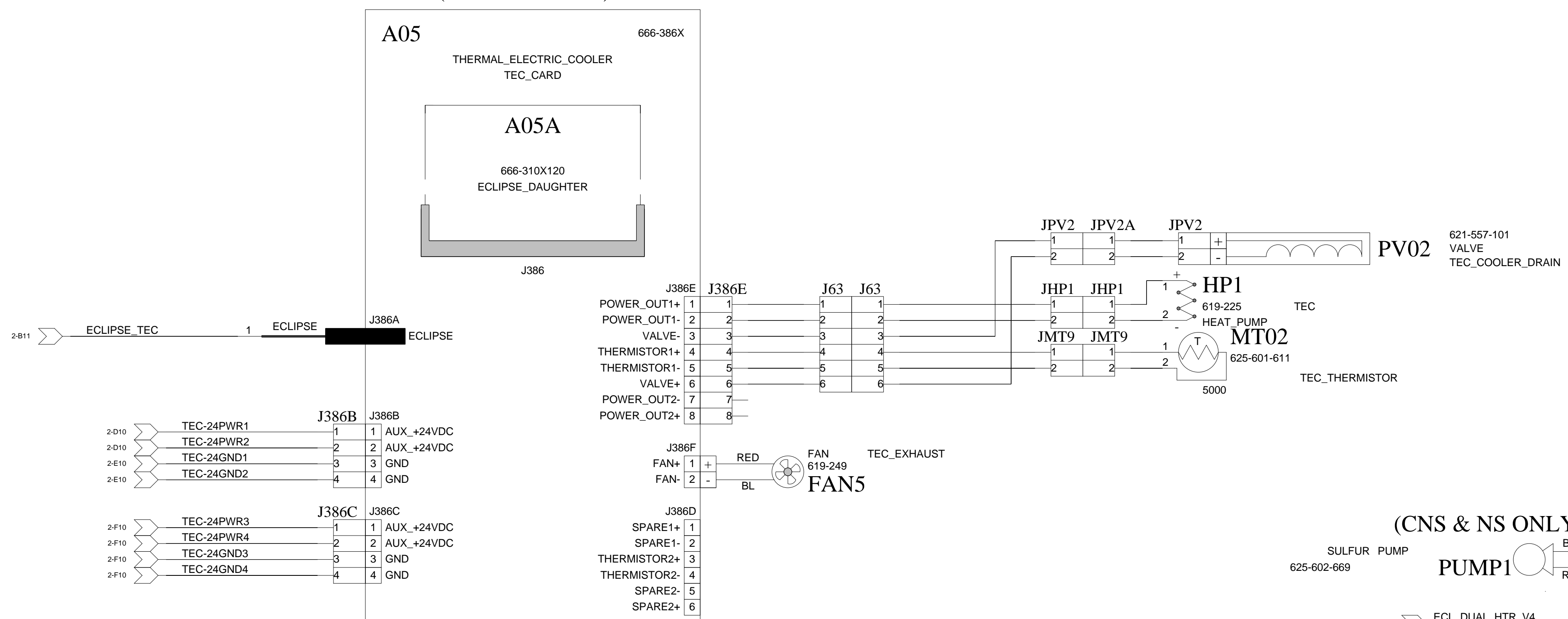
Part Number **151-034** Rev **K**

Date: 13/11/2015:13:52 Type M

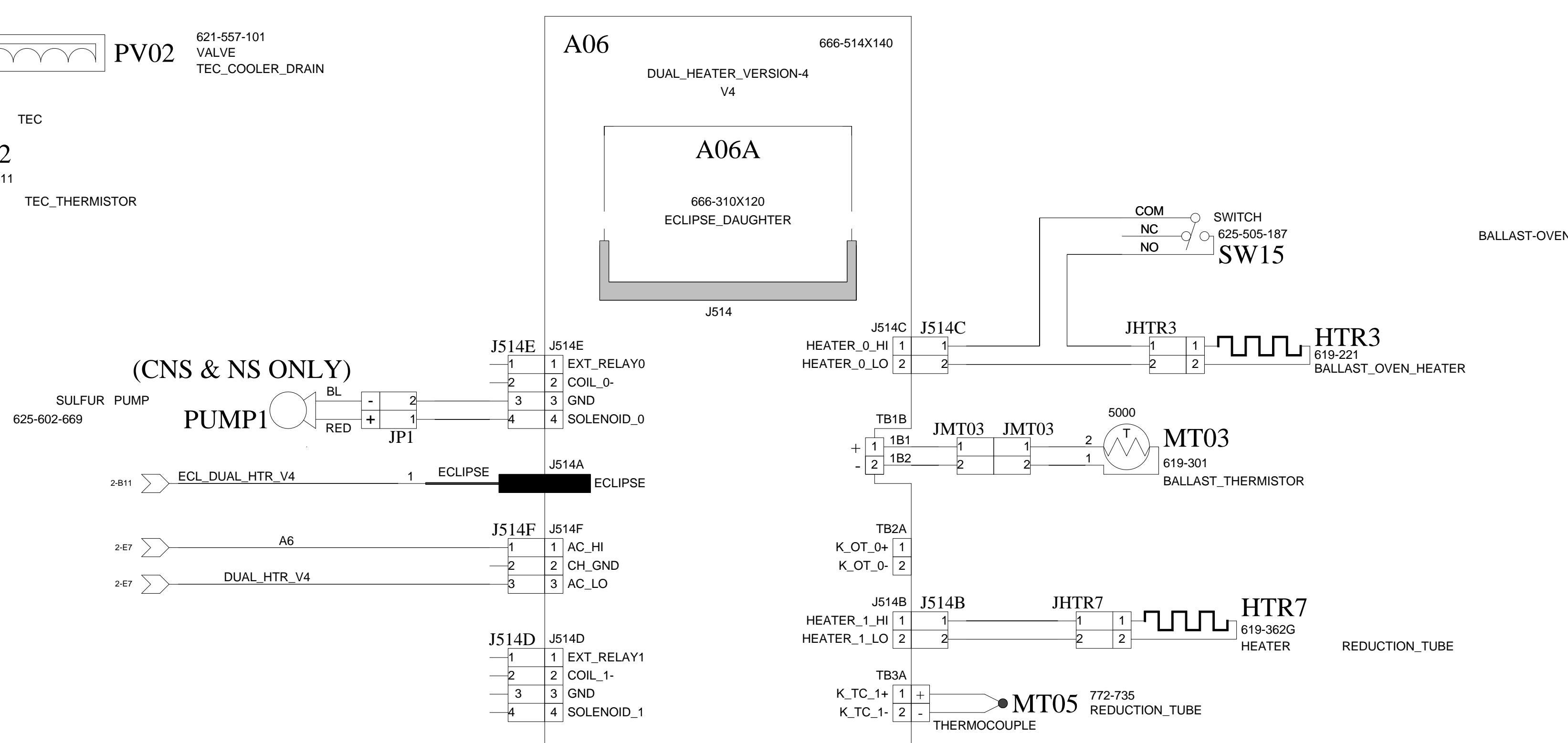
Schematic Sheet 3 OF 6

# THERMAL-ELECTRIC COOLER

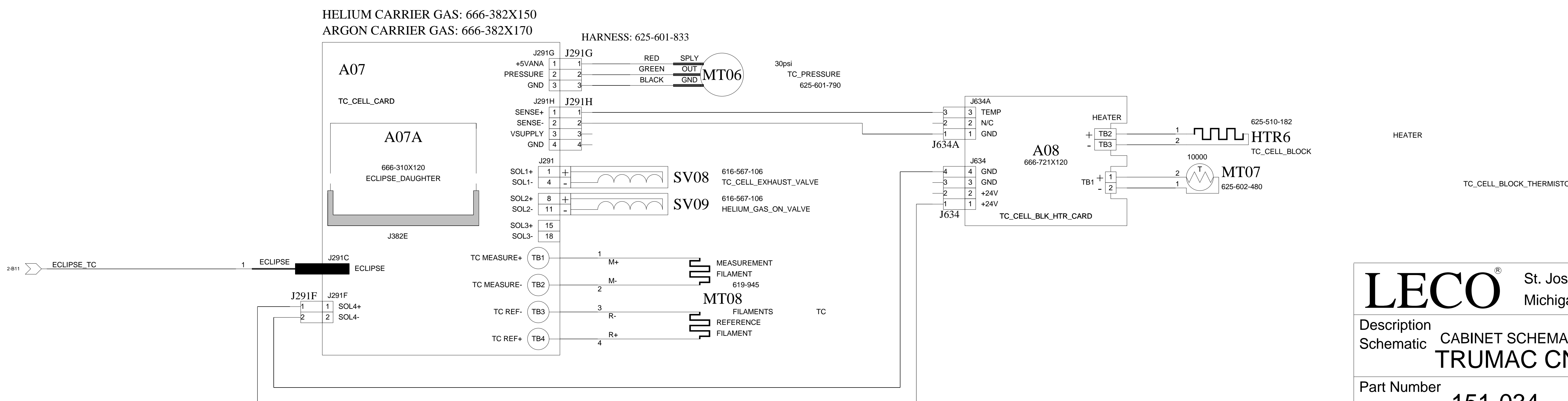
(FP & CN ONLY)



# HEATER CONTROL



# TC CELL



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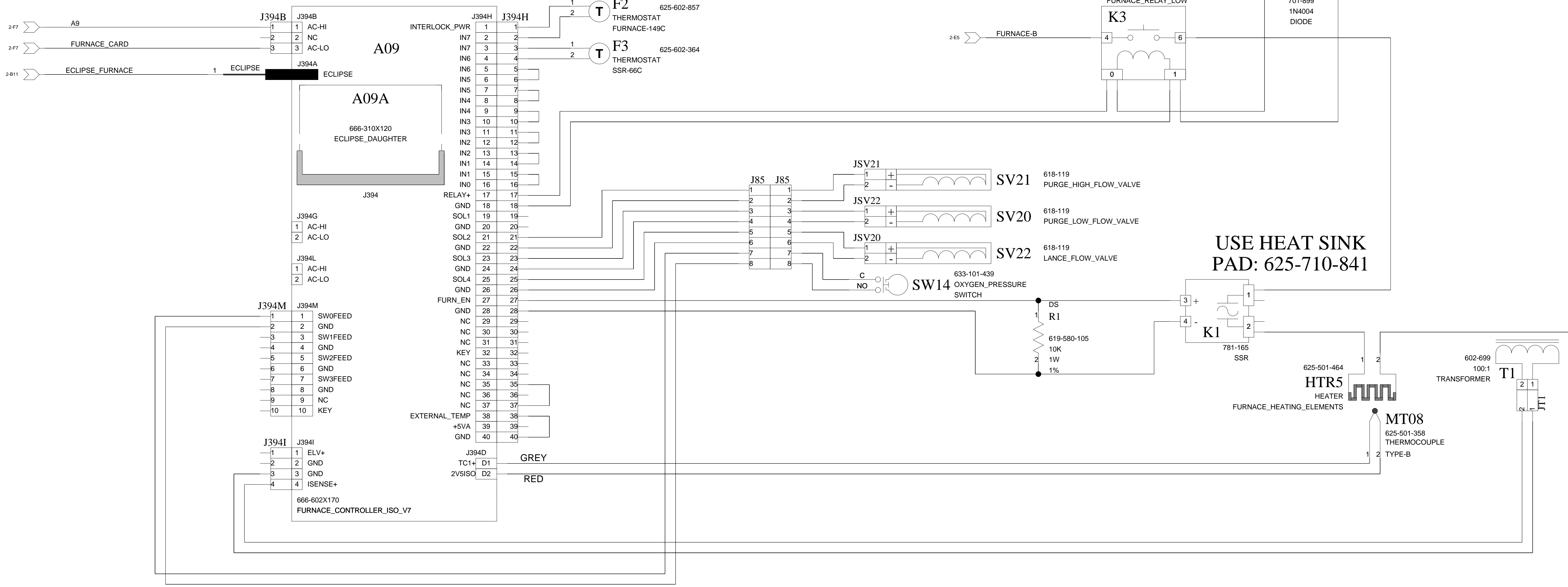
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**TRUMAC CNS**

Part Number  
**151-034**

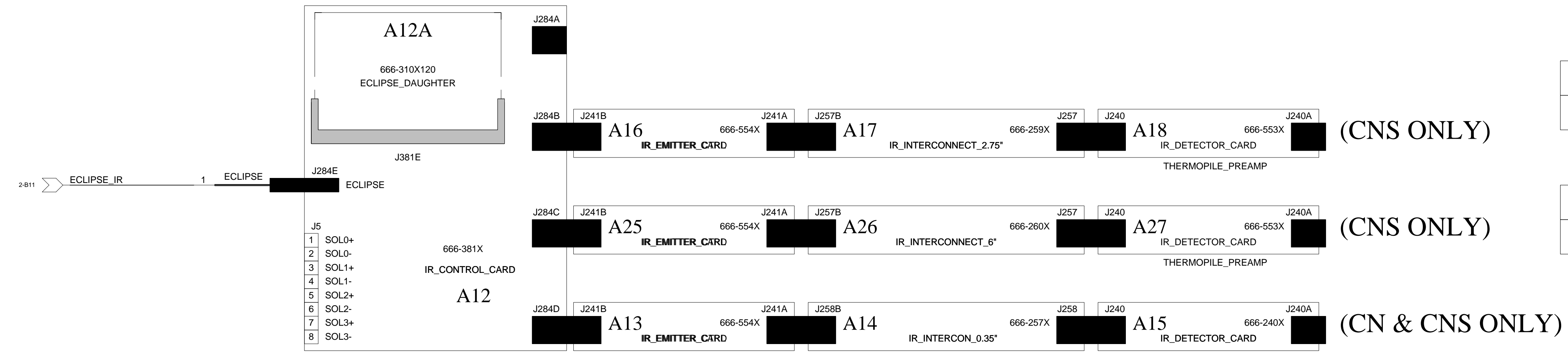
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Schematic Sheet 4 OF 6

Rev **K**  
Type M

# FURNACE CARD



## IR CELL (CN, NS & CNS ONLY)



## IR CELLS IN TRUMAC DERIVATIVES

J284A	UPPER LEFT	J284D	UPPER RIGHT
FP, NS, CN, CNS	NOT USED	FP, NS	CN, CNS
NOT USED		NOT USED	A22 625-030 IR_CELL_0.35"_CO2
J284B	LOWER LEFT	J284C	LOWER RIGHT
FP, CN	NS, CNS	FP, CN	NS, CNS
NOT USED	A23 625-346 IR_CELL_2.75"_SO2	NOT USED	A24 625-345 IR_CELL_6"_SO2

**LECO** St. Joseph, Michigan USA

Description  
 Schematic CABINET SCHEMATIC  
**TRUMAC CNS**

Part Number  
**151-034**

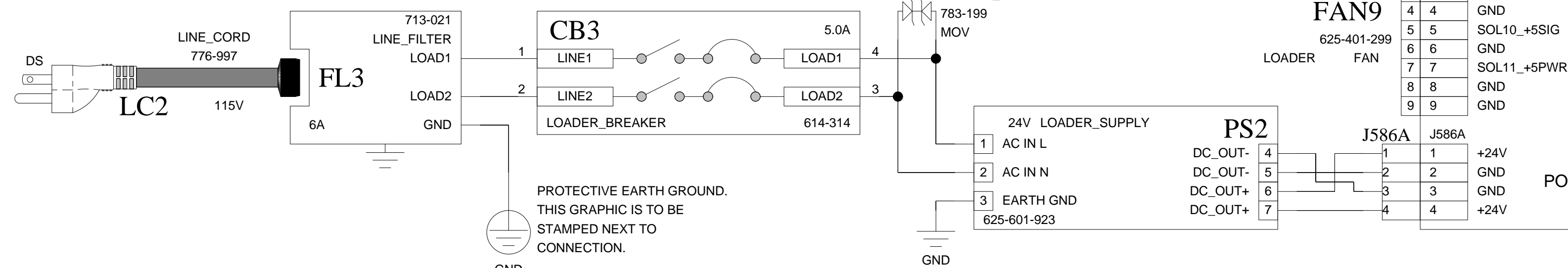
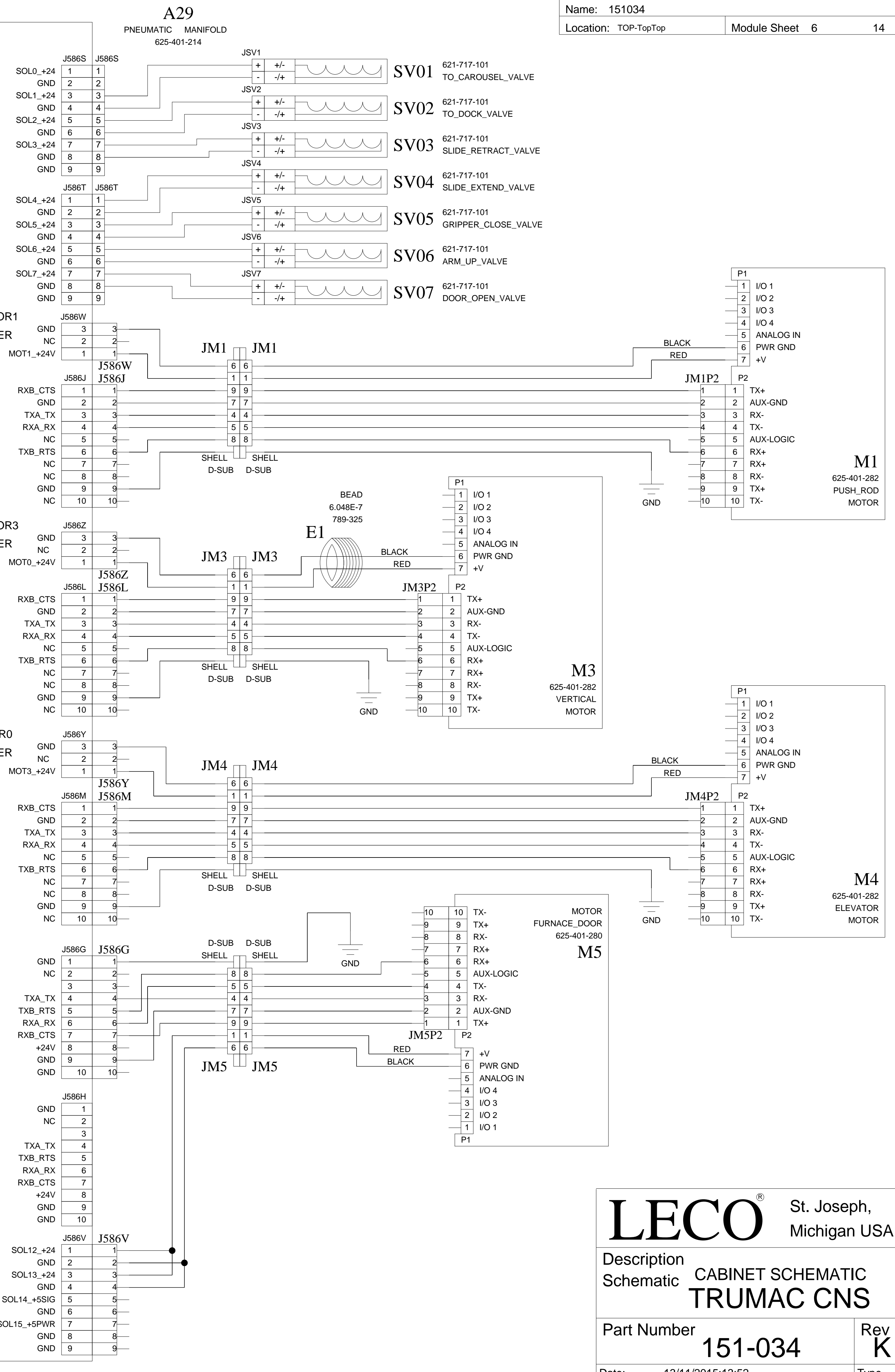
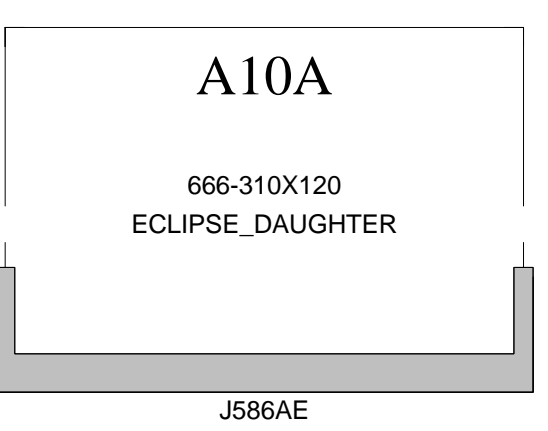
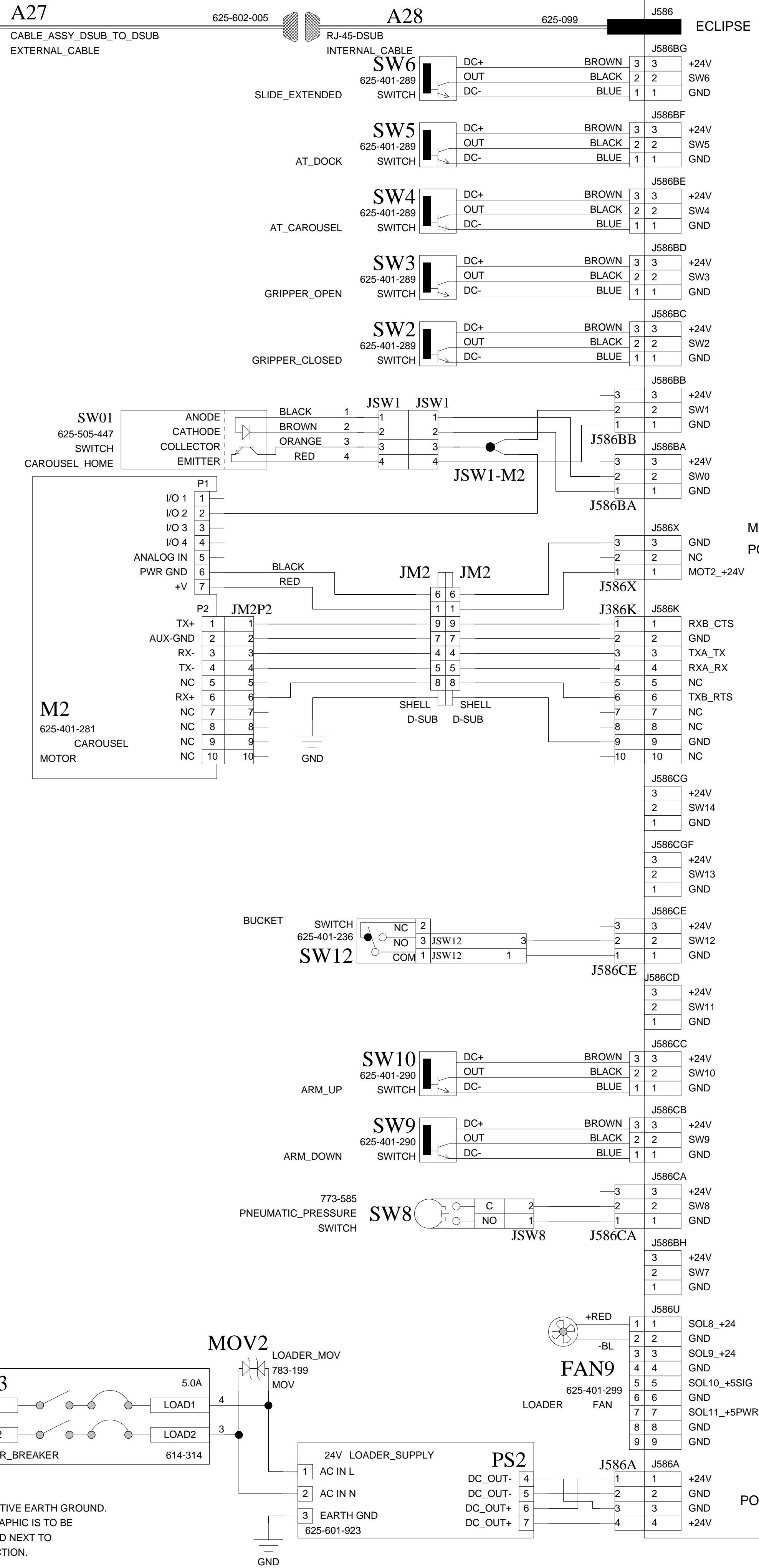
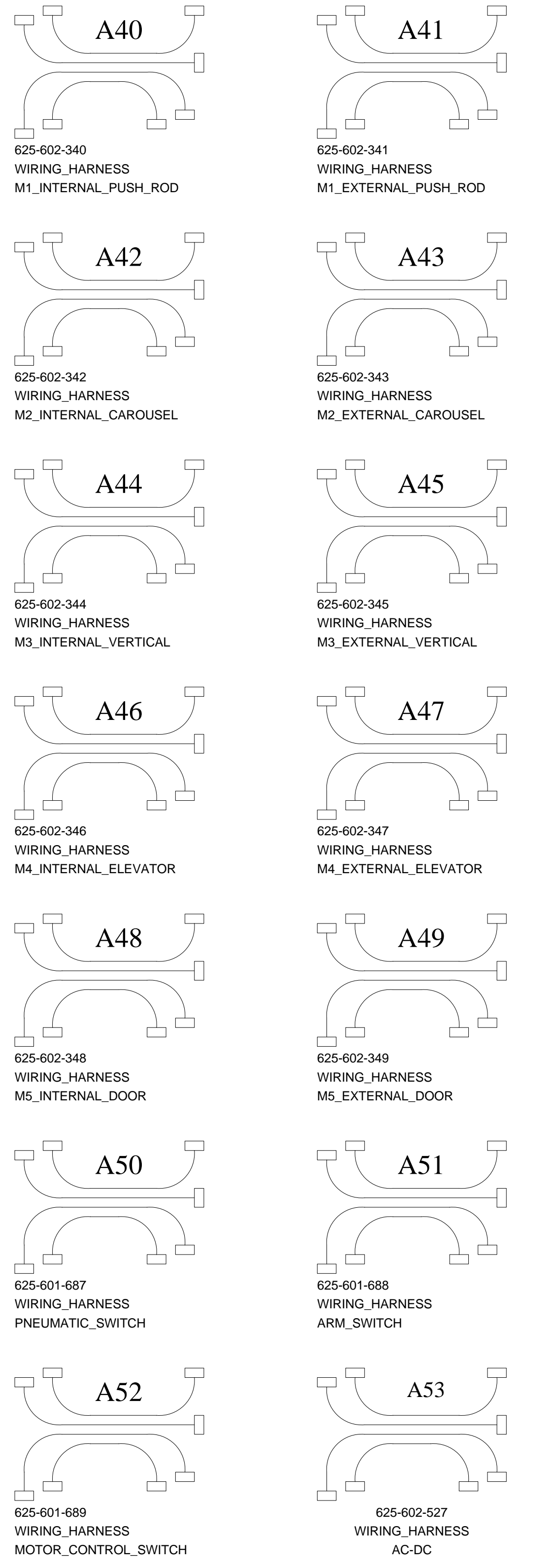
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 Schematic Sheet 5 OF 6

Rev **K**  
 Type M



# AUTO-LOADER

## WIRING HARNESSSES



**LECO** St. Joseph, Michigan USA

Description  
 Schematic CABINET SCHEMATIC  
**TRUMAC CNS**

Part Number  
**151-034**

Date: 13/11/2015:13:52  
 Schematic Sheet 6 OF 6

Rev **K**  
 Type M

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