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mks

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SERIES 49 THERMAL MANAGEMENT SYSTEM

User's Manual & Installation Guide



Warranty Information

MKS Instruments, Inc., warrants the Series 49 Heater System and its accessories to be free from defects in materials and workmanship for a period of two (2) years from the date of shipment by MKS or authorized representative to the original purchaser (PURCHASER). Any product or parts of the product repaired or replaced by MKS under this warranty are warranted only for the remaining unexpired part of its two (2) year original warranty period. After expiration of the applicable warranty period, the PURCHASER shall be charged MKS current prices for parts and labor, plus any transportation for any repairs or replacement.
ALL EXPRESSED AND IMPLIED WARRANTIES, INCLUDING THE WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE, ARE LIMITED TO THE WARRANTY PERIOD. NO WARRANTIES, EXPRESSED OR IMPLIED, WILL APPLY AFTER THIS PERIOD.

Warranty Service

The obligations of MKS under this warranty shall be at its option: (1) to repair, replace, or adjust the product so that it meets the applicable product specifications published by MKS; or (2) to refund the purchase price.

What Is Not Covered

The product is subject to the above terms only if located in the country of the seller from whom the product was purchased. The above warranties do not apply to:

I. Damages or malfunctions due to failure to provide reasonable and necessary maintenance in accordance with MKS operating instructions.
II. Damages or malfunctions due to chemical or electrolytic influences or use of the product in working environments outside the specification.
III. Fuses and all expendable items, which by their nature or limited lifetime may not, function for two (2) years. If such items fail to give reasonable service for a reasonable period of time within the warranty period of the product; they will, at the option of MKS, be repaired or replaced.
IV. Defects or damages caused by modifications and repairs affected by the original PURCHASER or third parties not authorized in the manual.
V. Improper Use or Operation:
    a. High temperature operation or exposure, either by high set point or external heat source. Operation outside the recommended temperatures resulting in damage to the system.
    b. Poor thermal contact between heater and heated surface.
    c. Operating a ripped or torn heater jacket.
    d. Operating a heater jacket with punctures or cuts in the external jacket surface.
    e. Tampering with control electronics, power cords, or warranty tags.
    f. Removing or cutting the snaps, straps, or connectors.
    g. Operating the system from an incorrect or unstable supply voltage.
    h. Chemical exposure or contamination.
    i. Modifications to any component of the system without direct approval from MKS.
    j. Return of heaters that have failed during the warranty period, but not reported or returned to MKS during the warranty period.
    k. This list should not be construed to be all-inclusive.

Condition of Returned Products

MKS will not accept for repair, replacement, or credit any product which is asserted to be defective by the PURCHASER, or any product for which paid or unpaid service is desired, if the product is contaminated with potentially corrosive, reactive, harmful, or radioactive materials, gases, or chemicals.
When products are used with toxic chemicals, or in an atmosphere that is dangerous to the health of humans, or is environmentally unsafe, it is the responsibility of the PURCHASER to have the product cleaned by an independent agency skilled and approved in the handling and cleaning of contaminated materials before the product will be accepted by MKS for repair and/or replacement.

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1. Agency Listing

The Series 49UL Thermal System complies with the requirements of the following directives:

Electromagnetic Conformance: EN 61326-1

Safety: EN 61010-1

RoHS Compliant

UL Component Recognition

UL File E510879

Refer to the Series 49 Declaration of Conformity MKS P/N 20003858-001 for additional compliance information.

2. Standards and Symbols



Electrical shock hazard warning



Hot surface hazard warning



General warning or critical instruction, important procedure, practice, or condition



Failure to follow instruction will void warranty and may result in product or personal damage



Contact MKS

3. General Safety Precautions

	Failure to follow instruction will void warranty and may result in product or personal damage.
	Use in an Explosive Environment may lead to direct ignition of explosive vapor or particulate in the environment.
	Standard systems are designed for use on steel piping. Designed power output and/or operating temperatures may not be suitable for use with other materials. Installation and use of system with other materials may result in irreversible damage to those materials and/or the S49UL Thermal System.
	For product installed on metal piping, ground the piping system in accordance with U.S NEC standard, local governing standard, or both.
	Areas near the S49UL Thermal System may be hot, and caution should be observed when touching these areas
	A Ground Fault Equipment Leakage Circuit Interrupter (GFELCI) should be used with the S49UL Thermal System. Although grounded piping is not required for system functionality, grounding will allow for full performance of the GFELCI and greatly reduce the risk of electrical shock.
	Individual components of the S49UL Thermal System meet the requirements of reinforced and double insulation and are not required to carry an individual ground.
	For standard systems, individual devices must be installed and secured to the piping or material to be heated before being powered.
	Running a device without the proper thermal load (whether due to improper installation, application, failure to properly secure, use on geometry other than the design intent etc.) may result in overheating of the device leading to permanent irreversible damage.
	For applications where devices are directly or indirectly heating hazardous materials, follow the hazardous material safety procedures specified by local governing body or chemical supplier
	MKS offers custom system design for a wide array of applications, is there is any questions on system design or use consult MKS customer service for guidance.

4. Storage and Cleaning

	Devices should be stored in their original packaging in a dry, mild temperature environment out of exposure to direct sunlight.
	Internal electronics are sensitive and may be damage by exposure to high humidity or ambient temperatures in excess of 50°C
	The external surfaces of System components may be cleaned with a damp cloth and mild detergent
	Do not immerse in liquid. Immersion in water or other liquid may result in electric shock or irreversible damage to the device
	Do not use solvents. Materials used in manufacture of the system may be irreversibly damaged by exposure to solvents
	Do not open or remove control housing in an attempt to clean internal features. Opening of the control housing will void product warranty and may lead to risk of electrical shock or irreversible damage.

5. General Specifications

Controller Parameter	Specification
Housing Material	Polycarbonate
Electrical Rating	100-120 VAC, 50/60 Hz 200-240 VAC, 50/60 Hz
Maximum Supply Current	10 Amps
Maximum Output Current	5 Amps Resistive Load
Environment	0°C to 50°C Indoor Use Only
Relative Humidity	0% to 95% non-condensing
Temperature Setting Range	35°C to 200°C **
Temperature Setting Resolution	1C Increments
Enclosure Rating	Unvented
Digital Communications	Modbus RTU over RS485 Half-Duplex
Communication Data Rate	115200 Baud

**Temperature setting range is dependent on heater jacket construction
Operating heater jacket above rated temperature will void all warranties

LTA Parameter	Specification
Housing Material	Polycarbonate
Electrical Rating	100-120 VAC, 50/60 Hz 200-240 VAC, 50/60 Hz
Maximum Supply Current	10 Amps
Maximum Contact Output	30VDC 1A Resistive Load
Environment	0°C to 50°C Indoor Use Only
Relative Humidity	0% to 95% non-condensing
Enclosure	Unvented
Digital Communications	Modbus RTU over RS485 Half-Duplex
Communication Data Rate	115200 Baud

Heater Jacket	Specification
Jacket Material	PTFE Coated Polyimide (Tan Jacket) PTFE Woven Cloth (White Jacket)
Insulating Material	Polyimide Foam (Tan Jacket) Fiberglass Batting (White Jacket)
Maximum Supply Current	5 Amps
Maximum Power Output	600 Watts @ 120VAC 1200 Watts @ 240VAC
Maximum Operating Temperature	200°C Continuous
Environment	0°C to 60°C Indoor Use Only
Relative Humidity	0% to 95% non-condensing

Contact Information MKS Instruments, Inc.
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Boulder, Co. 80301

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Toll-Free (800)345-1967 (USA Only)

6. S49UL System

S49UL System Description:
The MKS S49UL Thermal Management System is the 6th generation of MKS thermal product. The focus of S49UL is product Safety (UL Certification, improved insulation), simple and robust communications (out of box RS485 Modbus ready), and high temperature heating (200°C continuous). The new heater jacket construction options are polyimide (polyimide fabric woven shell with open cell polyimide foam insulation) and PTFE (polytetrafluoroethylene woven fabric shell with fiberglass batting insulation). Both products offer continuous operation up to 200°C.

S49UL Thermal System Components:

1. S49UL Heater Controller: Regulates power to the heater jacket.
2. S49UL Heater Jacket: Generates active heat.
3. Power Adapter. Supplies power to the chain of heaters and provides for communications pass thru (adjacent upstream and downstream chain of heaters).
4. Input Power cable. Standard IEC input cable, supplies input power to the Power Adapter.
5. LTA+ Controller (optional): Provides centralized visual indication and Digital Process Control Output for the Heater Network.
6. Communications cable (optional). Provides access to the RS485 network communications, terminating in either 2 wire flying leads or a USB Type A connection.
7. Network terminator Plugs (optional). Installed at the ends of the S49UL network to provide termination of the RS485 bus. Recommended for use anytime active Modbus Communications or a LTA+ controller is installed on the network.
8. Tablet or Peripheral device (User Supplied). Connected to the S49UL Communications Network via the Communications Cable and Power Adapter.

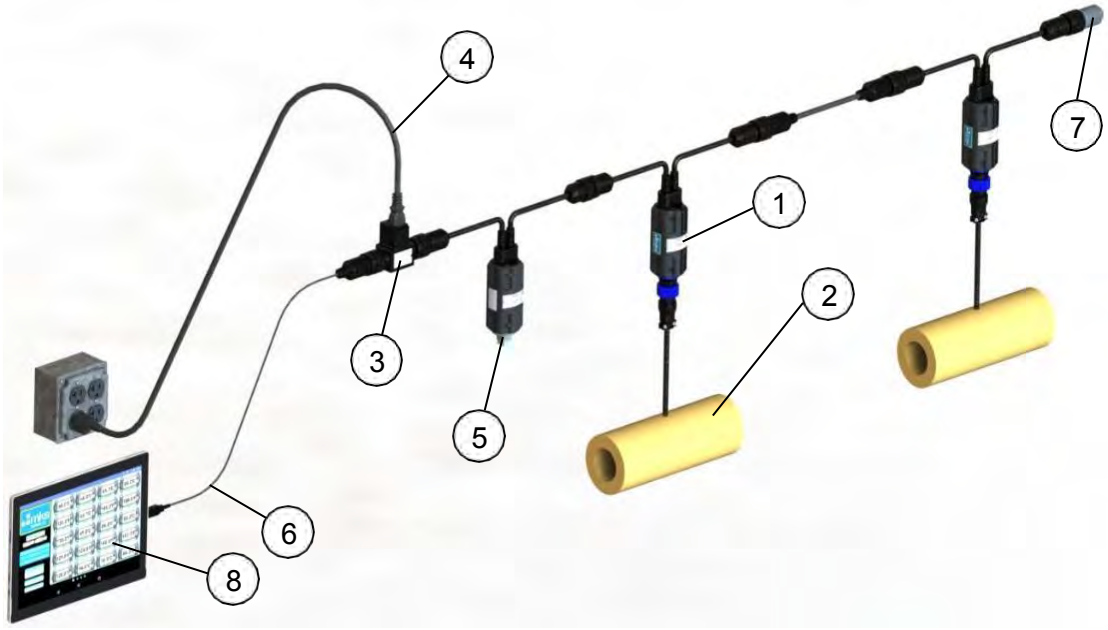


Figure 1: Typical Series 49 System Components

All interconnects within the system use custom hybrid connectors (Power + Signal). Because of the proprietary connectors to power the Series 49UL System a MKS supplied Power Kit is required. The S49UL Power Kit allows for power injection and communications pass thru, this feature allows for continuous communications on large or high-power installations that require multiple power drops.
Each Power Kit includes the following items:

1. Power Adapter (10 amp fused)
2. Input Power Cable
3. Upstream terminating plug
4. Downstream terminating plug

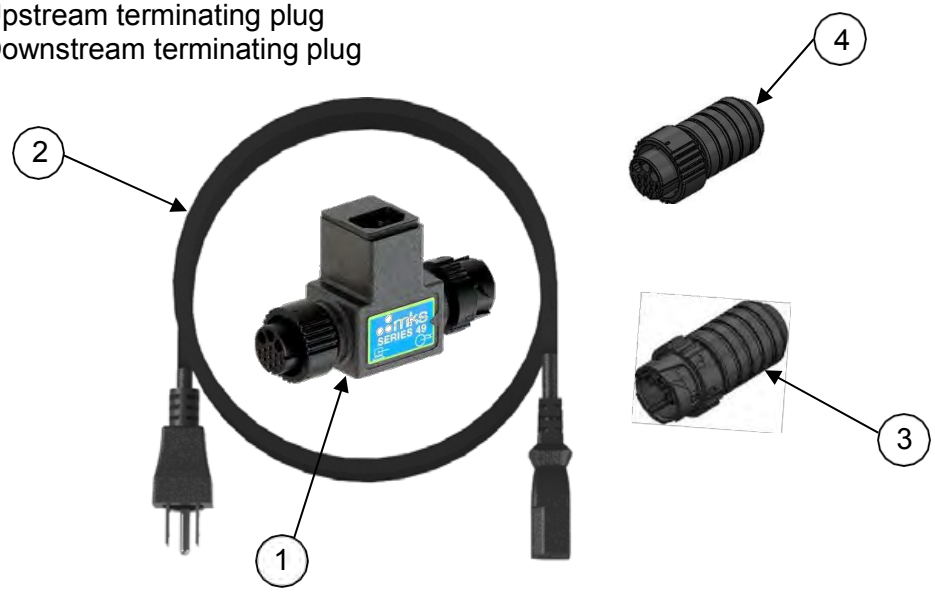


Figure 2: Power Adapter Kit Contents

The pass thru for RS-485 communications on the Power Adapter is shown below in Figure 3. Note that there is no connection to AC voltage passed to the male pins- its purpose is solely to provide communications connectivity upstream of the power injection block.

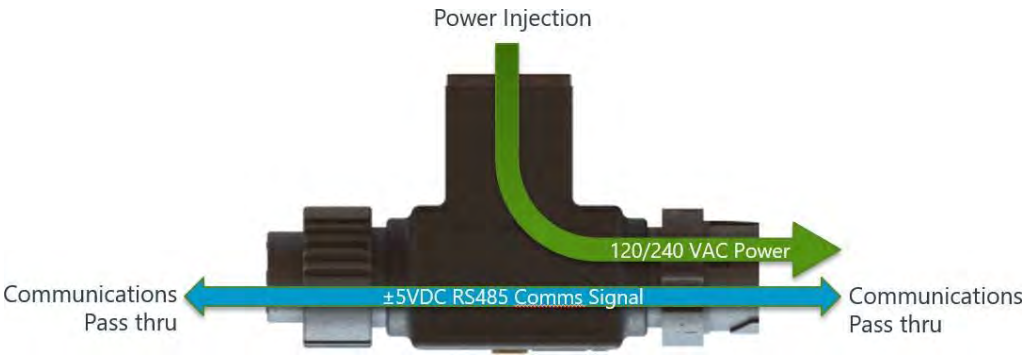


Figure 3: Power Adapter Power Injection and RS-485 Communications Pass Thru

The S49UL Heater Controller manages temperature regulation thru a basic On/Off control algorithm. Overtemperature protection is handled by redundant temperature sensing and power switching circuitry with a failsafe hardware backup. Control status, alerts, and error conditions are indicated by a set of LEDs.

The S49UL Thermal Management System also includes an optional Line Temperature Alert or LTA+. This device is similar in function to the legacy MKS Low Temperature Alert or LTA. Installed at the front end of the controller network the S49UL LTA+ aggregates network information providing the user with single point Visual and Analog Process Control indication of network status.

The S49UL Heater Control and S49UL LTA+ Control carry a 50°C ambient environmental temperature rating. Should the internal temperature of the controller exceed 50°C, normal operation will continue however relay endurance (cycle life) and general system performance may suffer.

Note: The device will enter the Lock State if the internal temperature of the control assembly exceeds 85°C.

The S49UL Heater Control offers several user adjustable parameters that are accessed through RS485 Modbus RTU communication. The adjustable parameters include temperature control set-point, alarm set-points, an overtemperature safety limit, and other advanced features. For a comprehensive list of available user adjustable parameters and diagnostic data information refer to the Modbus Register Map in the Appendix.

To access the RS485 communications terminals two communications kits are available. The first kit terminates in flying leads and is intended for customers requiring a direct connection to an existing customer supplied communications system. The second kit terminates in a Type A USB and is intended for use with the MKS supplied Android App. The Android based user interface application is the only MKS supported S49UL software interface, no other MKS supported software is available at this time.

The S49UL Thermal Management System is plug and play out of box. For the average installation there is no calibration, configuration, or setup required aside from connecting to mains power. The S49UL Thermal System is not intended to be field serviceable. Opening the control housing, modifying the heater jackets, or altering other system hardware in any way will void all product warranties.

7. S49UL Installation

The following guidelines are based on a typical installation of S49UL Thermal System, some installations could be different.

	Caution- The PTFE heater utilizes a fiberglass insulation. While the insulation is contained by the heater shell, use caution if shell is damaged.
	Caution- The internal surface of the heater (equipment contact side) may be hot.
	Caution- Do not operate heaters unless they are properly installed and in good thermal contact with part to be heated. Operating the device on a system with a different thermal load than intended could result in damage to the product or user system.
	Caution- The element inside the heater can become a shock hazard if the heater jacket is damaged. Visually confirm the integrity of the heater jacket before installation.
	Caution- Never place combustibles, sensitive equipment or parts that may be damaged by excessive heat in close proximity to the internal surface of the heater jacket.
	Caution- powering a damaged device may create a safety hazard.
	Each power adapter is capable of providing a maximum of 10 amps to a particular heater chain. Do not connect heaters which result in current draw in excess of 10A.
	Follow all local wiring standards when connecting mains power to this product.
	Disposal of this product must conform to all appropriate local codes.

The Series 49 Thermal Management System is not field-serviceable. Do not attempt to install or operate any component with visible damage. Unpack and verify that there is no damage to any of the heater jackets, controllers, or cables and accessories. If there is any question as to the quality or construction of the product contact MKS immediately.

Installation area
Inspection of parts and area to be heated for combustibles, sensitive equipment or parts that may be damaged by excessive heat.

Inspect areas where heaters will be installed. Look for sharp metal edges or protrusions such as ground lugs, bolts, burrs or brackets that could abrade or tear the heater jacket. Features that may inhibit performance such as un-even surfaces or profiles that do not match the profile of the heater jacket should be avoided.

The external surface of the heaters remains below 80C during normal operation. Check for surrounding parts that could potentially be damaged if contacting the heater outer shell.

Power connections
Each heater jacket has a label clearly marking the design full load current draw. A series of heaters (add current draw values together) should not exceed **10 amps for a single power drop**. Verify with the local electric authority any limitations on current supply at the facilities connection. Again, the full load current (experienced when the controller is supplying power to the heater jacket) is listed on the label of the heater jacket.

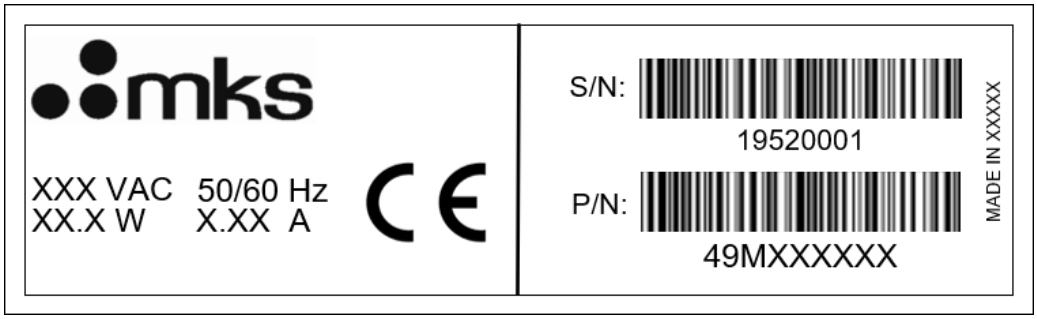


Figure 4: Image of Heater Label Indicating Design Voltage and Current Draw

Installation of S49UL Heater Jacket
The S49UL Heater Assembly typically ships with the heater jacket and heater controller already mated. The heater jacket is tailor fit to the shape of the heated part. When installed the fit of the heater on the part should be snug ensuring full and uniform contact and good thermal distribution. Poor contact or improper fit of the heater jacket may lead to poor performance and premature heater failure.

Un-fasten the securing straps and gently open the heater jacket along the parting line(s). Install the jacket onto the part to be heated fastening the securing straps. The securing straps are designed for moderate compression of the jacket insulation and some force may be required to properly secure the straps.

Under no circumstances should devices other than those supplied with the heater be used to secure the heater jacket on the part.

It is acceptable to slightly compress the insulation to ensure proper installation, but never cut or modify the heater jacket.

Heaters for bellows, flexible hose, and flanges as well as some custom application heaters are designed for a loose fit to allow for flex and movement of the bellows and for rotation in the case of the flange heaters.

Connection of Series 49 Heater System

To ensure performance and UL Compliance use only MKS supplied cables to connect the heater system. Failure to use MKS supplied cables may result in damage or failure of the heater system and will void any and all warranty claims.

Individual control devices are designed to be daisy chained together, however care should be taken to ensure the current draw on a single power adapter does not exceed 10 Amps. MKS provided power adapters use a 10 Amp slow blow inline fuse.

Begin connecting the system at the first power adapter and ensure the power adapter is not connected to facilities power supply. The female socket connections will transmit power to the first heater in the line, power is then transmitted thru each additional controller connected to the chain until the last heater is reached or another power adapter is installed (required anytime more than 10Amps of current is needed). The labels of the power adapter clearly mark the power output connection and the communications connection with ISO standard symbols

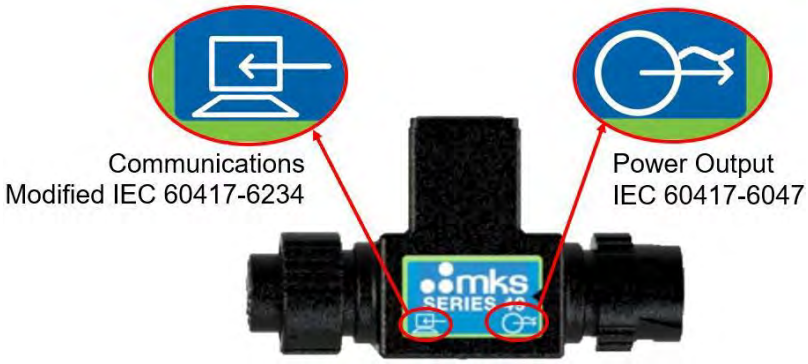


Figure 5: Power Adapter with Communications and Power Connection Callouts

All S49UL interconnections are designed with a keying feature and positive twist lock engagement. When mating connections ensure the male and female connectors are properly aligned, axially rotate the male and female connectors while applying a slight lateral force to locate the keying position. Once aligned press the connectors together while turning the twist locking bale. Turn the bale until you hear or feel a click, this will ensure the bale is locked in place and a full connection is made.

Figure 6: Align keys as close as possible and gently push and rotate the connectors until the two halves engage.





Figure 7: Twist the bale on the female connector until it locks into place.

Take the first heater in the heater system and connect the male (power accepting) connector of the heater jacket into the female (power output) connector of the Power Adapter. (Refer to section 7.2.2. for power adapter details.)



Figure 8: Mate Input power block to the first heater in the line

For daisy chain applications continue by taking the male (power accepting) connector of the next heater in the chain and connecting it to the female (power output) connector of the previous heater.

Continue connecting the heaters in this manner until either the last heater in the chain is reached or the chain nears the 10 Amp per power adapter limit.

Note that the power adapter contains a 10 Amp fuse.

If the daisy chain nears 10 Amps of current draw, and there are still additional heaters to be connected to the system, an additional Power Adapter is required. Multiple Power Adapters may be used on a single Heater System or daisy chain line to add as many power drops as necessary.

To install additional Power Adapters, make sure the Power Adapter is not connected to the facilities supply power. Starting with the last heater in the previous power zone, mate the female (power output) connector of that heater controller to the male (power accepting) connector of the Power Adapter. Continue connecting the remaining heater controllers until the current draw of this string approaches 10 amps, repeat the addition of Power Adapters as necessary

Note: For networks running a LTA+ Controller or RS485 Modbus Communications the network must be limited to 64 heater controllers.

Note: To limit inrush current on networks with multiple Power Adapters the Power Adapters should be connected to the mains power in sequence rather than powering all from a single switch.



Figure 9: Daisy Chain Heater Application, Dual/Multiple Power Drops

If no external communications or alerts signals are required, the system is ready to be powered. If desired, terminating plugs can be installed on the first power adapter and last heater in the chain to prevent dust and debris from entering the interconnect connections. Terminating plugs are supplied as part of the power kit (see Figure 2).

Ensure that the system is properly grounded. This is accomplished by verifying that a ground line (user supplied) is connected from the ground lug on the power adapter to a conductive metal part of the line to be heated.

Powering the Series 49 System

Before powering the system ensure that the correct facilities supply voltage for the heater system is being used. Each S49UL controller is clearly marked with a silver label (see Figure 4) showing the correct voltage and power requirements for the heater jacket. Connection of the heater jacket to the wrong supply voltage will cause an Error at the S49UL Heater Controller and the unit will not allow power to the heater jacket. With the supply voltage verified, connect the Power Adapter to the input power cable then connect the input power cable to the facilities mains supply power.

8. S49UL Heater Controller

Controller Architecture:
The S49UL Heater Controller utilizes single microprocessor control with a backup hardware safety. During normal operation both the Primary Control Circuit and the Hardware Safety Circuit are driven by the microprocessor. Downstream of the processor there are two power control relays wired in series, the series configuration provides both the Primary Control Circuit and the Hardware Safety Circuit the ability to directly cut power to the heater jacket. While the Primary Control Circuit can command both the Control and Safety Relay the Hardware Safety Circuit can only open the Safety Relay. In the event the microprocessor has a catastrophic failure the Hardware Safety Circuit takes over and shuts down power to the heater jacket by opening the Safety Relay. The main purpose of the Hardware safety circuit is to provide protection from an over-temperature event, replacing the thermal fuse or thermostat used in early generation products.

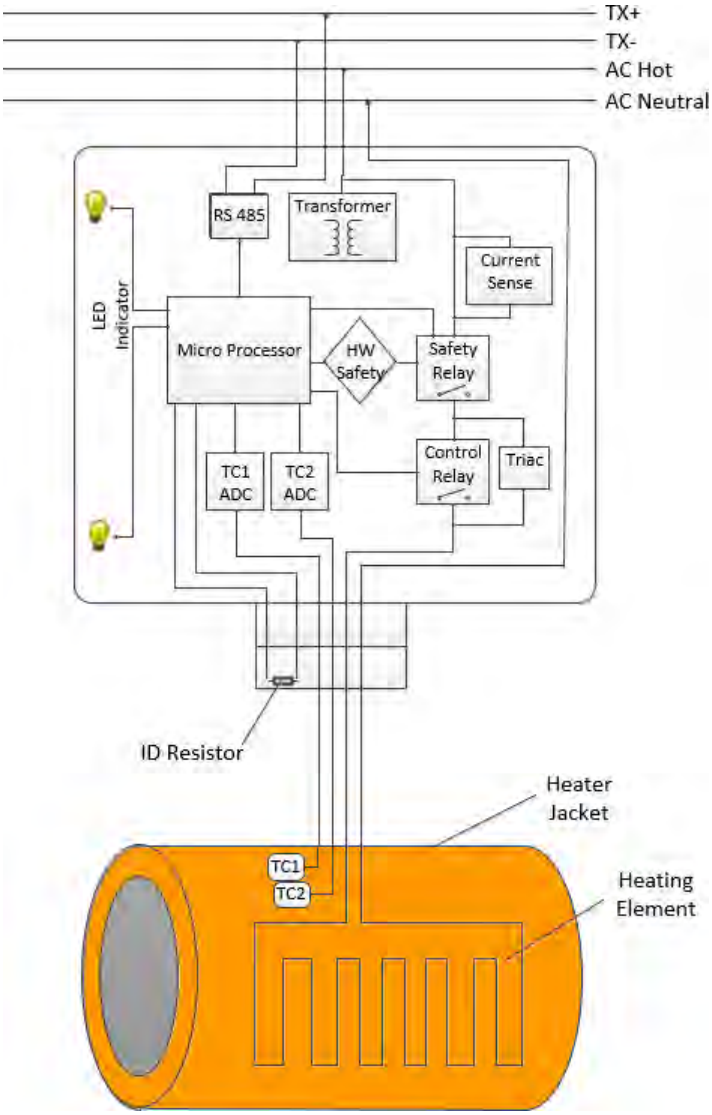
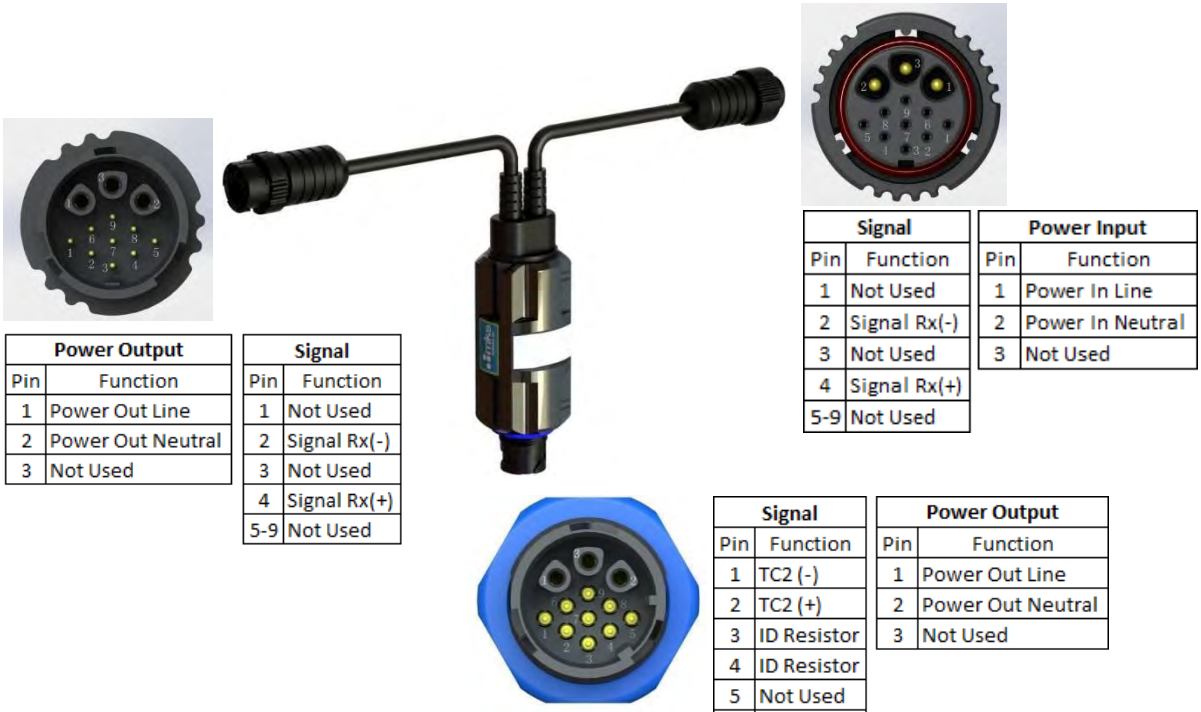


Figure 10: S49UL Controller Architecture

Wiring details

The S49UL Heater Controller utilizes a hybrid power and communications interconnect cable. The cable contains the AC power delivery conductors as well as RS485 communications lines. The input and output connector pin outs for the hybrid power and communications line are shown in Figure 11 below.

The S49UL Heater Controller connects to the heater jacket via a bulkhead connection. Several embedded safety features exist preventing the controller from supplying power unless the heater jacket is properly connected, see Table 4: S49UL Troubleshoot Guide towards the end of the document for details on possible Error indication. The pin out for the heater output connector is shown below.



Power Output	
Pin	Function
1	Power Out Line
2	Power Out Neutral
3	Not Used

Signal	
Pin	Function
1	Not Used
2	Signal Rx(-)
3	Not Used
4	Signal Rx(+)
5-9	Not Used

Signal	
Pin	Function
1	Not Used
2	Signal Rx(-)
3	Not Used
4	Signal Rx(+)
5-9	Not Used

Power Input	
Pin	Function
1	Power In Line
2	Power In Neutral
3	Not Used

Signal	
Pin	Function
1	TC2 (-)
2	TC2 (+)
3	ID Resistor
4	ID Resistor
5	Not Used
6	TC1 (-)
7	TC1 (+)
8-9	Not Used

Power Output	
Pin	Function
1	Power Out Line
2	Power Out Neutral
3	Not Used

Figure 11: Heater Controller pin-outs

Note: Interconnect and heater output connectors are keyed to prevent cross mating

Visual Indication

The S49UL Heater Controller has two sets of LED indicators, the Status LEDs and the Diagnostic LEDs. Status LED's are located near the heater jacket connection and provide indication of control status. Diagnostic LED's are located towards the interconnect cable and provide information related to control alerts and errors. The Status indicators are visible from both sides of the controller allowing for 360° visibility.



Figure 12: LED Location on Series 49 controller

The most common display indications are shown in Figure 13 below, for a full list of display indicators and definitions see Table 4: S49UL Troubleshoot Guide near the end of the document

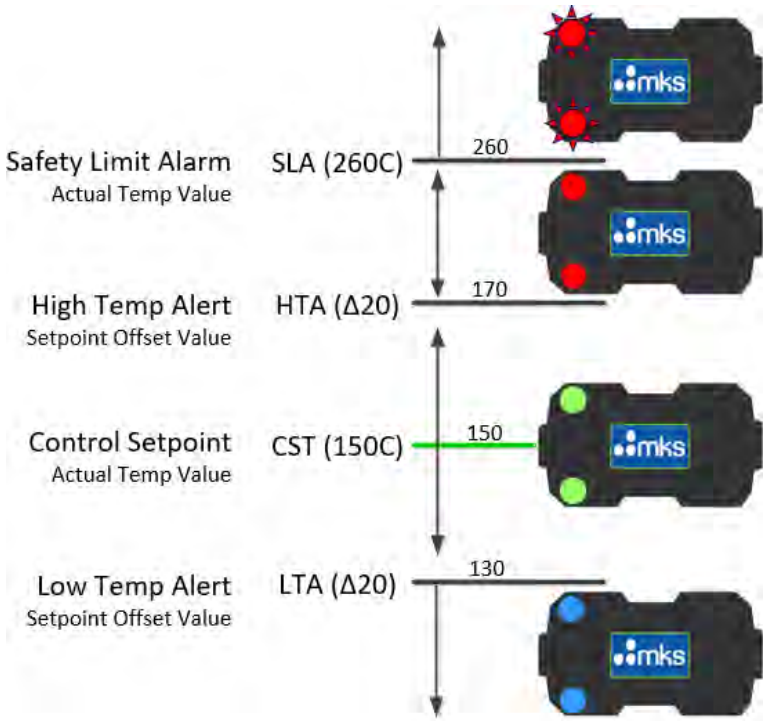


Figure 13: Series 49 LED 1 Display- most common conditions

Stand-Alone Operation:
The S49UL Thermal System is designed to operate independently without external input or intervention. When power is supplied to the heater controller the device initializes and temperature control operations begin. Basic diagnostics are provided by visual LED indicators (refer to ***Table 4: S49UL Troubleshoot Guide*** near the end of this document).

Factory settings:
The S49UL Heater Controller ships with the factory default parameters listed below.

Parameter	Callout	Factory Default Setting
Control Setpoint	CST	150°C
Safety Limit Alarm	SLA	260°C
High Temperature Alert	HTA	20°C
Low Temperature Alert	LTA	20°C

Table 1: Factory Default Settings

The all parameters shown in Table 1 above are user adjustable via the RS485 Modbus communications. If the parameters are changed from the Factory Default setting the new modified parameter value will be stored in Non-Volatile memory and retained during all operation events including power loss or power cycle, soft restart, error events, etc. The only time a user adjusted parameter value will be cleared is if the controller is sent a Restore Factory Defaults command via the RS485 Modbus communications (Refer to the **Appendix** for Modbus Command definitions).

Custom settings:
Custom Factory Settings are available upon request, contact your MKS representative for further details.

General operating behavior

- When powered from a cold start the S49UL Heater Controller will initialize with both the Status and Diagnostic LED's briefly illuminating violet. The LED sets will then go dark for a short period before normal operation begins:

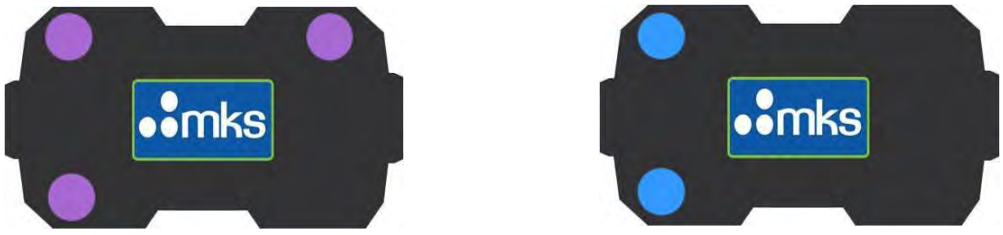


Figure 14: Initialization and Low Temperature Condition Display

- Before allowing power to pass to the heater jacket the S49UL Controller identifies its input voltage then checks the ID resistor installed in the heater jacket connector, see Figure 10. If the heater jacket design voltage does not match the supply voltage the controller will post a voltage mismatch error (Status and Diagnostic LED's solid Yellow).
- If the design voltage and mains input voltage match, there are no other Alert or Errors detected in the system, and the heater jacket is registering a temperature below the At-Temperature range (as defined by the CST, LTA and

HTA parameters – see Figure 13 above), the controller will then indicate a Low Temperature Alert (Status LED's illuminated solid Blue).

- Once the heater is in the At-Temperature range (default: within 20°C of set-point), the Status LED will change from solid Blue to solid Green.
- If the heater's reported temperature exceeds the High Temperature Alert limit (default: 20°C over set-point) the Status LED will change from solid Green to solid Red.
- If the heater's reported temperature exceeds the Safety Limit Alarm (default: 260°C) the heater will register a Safety Limit Alarm, and the Status LED's will flash Red.

See Figure 10 and Table 4 for details on visual indications.

Control Operational States and Error Classes

The S49UL Heater Control has four main operational states

- Normal
  Control is operating independent of any user intervention. Normal temperature control is active, Alert Conditions can be posted but are self-healing once the condition is removed
- Lock
  An Error has occurred that puts the controller in a Locked State where temperature control operations have been halted, both the Control and Safety Relay have been commanded open. User intervention is required to exit this state
- Fatal
  An Error has occurred that prevents the controller from re-entering normal operation. There is no way to clear this type of error, the best course of action is to remove power from the unit and let the device cool, then re-power. If the unit enters the Fatal State again the controller must be returned to the factory for replacement
- Standby
  Standby can only be entered and exited by RS485 Modbus Communication Command. This state is intended as an energy saving mode where temperature control operations have been halted. The controller is in an idle state until commanded to resume normal operation.

  See the Appendix for details on Controller States and Modbus Communications Commands

9. S49UL LTA+ Controller

General Information

The S49UL LTA+ Controller provides a centralized Low Temperature Alert function similar to the MKS Series 46 and Series 48 Legacy LTA (Low Temperature Alert) module. When the S49UL LTA+ is connected to the heater network an addressing algorithm is automatically initiated. The S49UL LTA+ will assign a network address to each connected S49UL Heater Controller. The addressing algorithm will take approximately 30 seconds to complete.

During normal operation the S49UL LTA+ controller will initiate an addressing cycle once every 3 minutes, while addressing the S49UL LTA+ controller is not actively polling the connected S49UL Heater Network and discrepancies between the network status and the S49UL LTA+ reported status may exist.

The S49UL LTA+ controller will illuminate a small green LED during the addressing cycle, as soon as the addressing cycle is complete the small green addressing LED will shut off.



Figure 15: S49UL LTA+ during the addressing cycle, showing a small green addressing LED

Note: A maximum of 64 individual S49UL Heater Controllers can be connected to a single S49UL LTA+ Controller).

Note: When connecting a large network with multiple power drops for the first time it is recommended that you power and address each segment of the network in sequence. If this is not done it may take more than one addressing cycle to detect and address all controllers on the network.

For the initial connection of a large network the communications network can be complete while this process is performed. With a fully connected network (all heater controllers and power adapters connected but main power not supplied), connect the first Power Adapter to the mains supply. On bring up the LTA+ will begin to address the powered segment of the network. Once the Addressing LED goes from ON to OFF addressing is complete and you can connect the second Power Adapter to the mains supply. Once the Addressing LED comes on again the new segment will address. Continue this process until all segments have been powered and addressed.

Once addressing is complete the S49UL LTA+ will begin polling the S49UL Heater Network querying each individual controller for its operational state and LTA status. If one or more controllers on the network reports an LTA condition, LTA active in the Error Register (See the **Appendix**) the S49UL LTA+ will generate an LTA condition. Additionally, if one or more controllers on the network is reporting a Current State other than Normal (i.e. Fatal, Bootloader, Standby, etc. - See the **Appendix**) the LTA+ will report an LTA condition.

As the LTA+ generates status based on information transferred over the RS485 communications, any controller incapable of RS485 communications will not be detected and reported by the LTA+ controller.

Note: Each controller in a Network must have a discrete address, putting 2 or more controllers with the same Modbus Device Address on a network will cause communications collisions and poor communications performance.

Installation

The S49UL LTA+ Controller is typically installed at the front end of the heater network, between the Power Adapter and the first heater in the line, see Figure 16. For best performance both ends of the RS485 communications network should be terminated by installing the RS485 terminating plugs included with the power kit. A single LTA+ controller can support connection of up to 64 individual heater controllers.

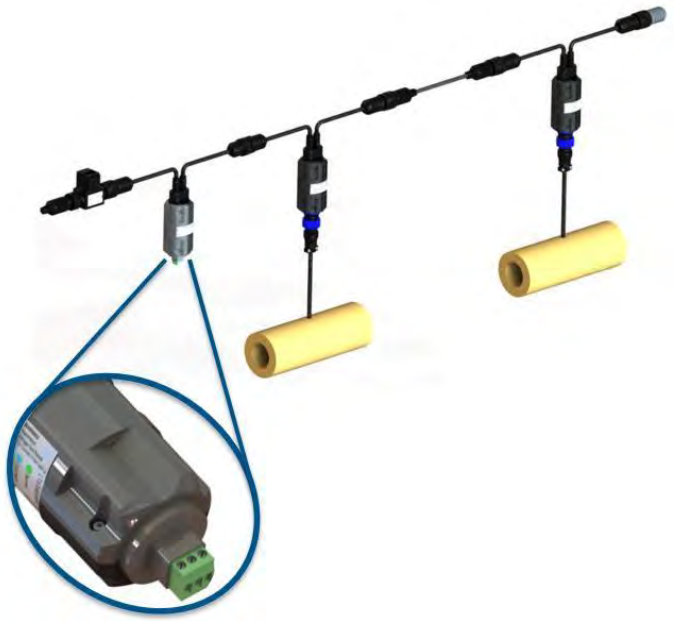


Figure 16: LTA+ Installation at the front end of the network, process control connection in detail

Display Indicators

The S49UL LTA+ Controller visual indication is limited to Low Temperature Alert status. The S49UL LTA+ will generate a Low Temperature Alert visual indication any time one or more heaters in the network is registering a local Low Temperature Alert. The S49UL LTA+ also generates a Low Temperature Alert visual indication anytime one or more heaters in the network is reporting a Current State other than Normal. Even if the heater is not actually in a Low Temperature condition the unit is not functional and the Low Temperature Alert indication at the LTA+ is generated.



Figure 17: LTA+ LED Indications

Condition	Detail	Definition	Status Indicator	Diagnostic Indicator
At Temperature	All network heater controllers are operational and within the normal operating temperature range	Normal	Solid GREEN	Solid GREEN
Low Temperature Alert	One or more of the network heater controllers is reporting a low temperature condition	Cold Heater	Solid BLUE	Solid BLUE

Table 2: LTA+ Indication Chart

Process Control Output

In addition to the Visual Indication, the S49UL LTA+ Controller includes a Process Control Circuit used to notify the user when one or more heaters in the networked system is reporting an LTA+ condition.

The process control consists of three contacts labeled Normally Closed (N.C.), Normally Open (N.O.), and Common (Comm). Depending on the user needs two of the three contacts can be connected to configure a normally open or normally closed signal. In the Normally Open (N.O.) configuration the process control relay is Open when the S49UL LTA+ is registering a "Normal" state for the attached heater network. The relay is Closed when the S49UL LTA+ is registering one or more heaters in the network with an active LTA+ condition. The function is opposite the above for a Normally Closed (N.C.) configuration. The S49UL LTA+ Process control contacts are rated for 1A 30V Max.

Condition	Detail	Definition	N.C. and Comm Connected	N.O. and Comm Connected
At Temperature	All network heater controllers are operational and within the normal operating temperature range	Normal	Relay Closed	Relay Open
Low Temperature Alert	One or more of the network heater controllers is reporting a low temperature condition	Cold Heater	Relay Open	Relay Closed

Table 3: LTA+ Process Control Output

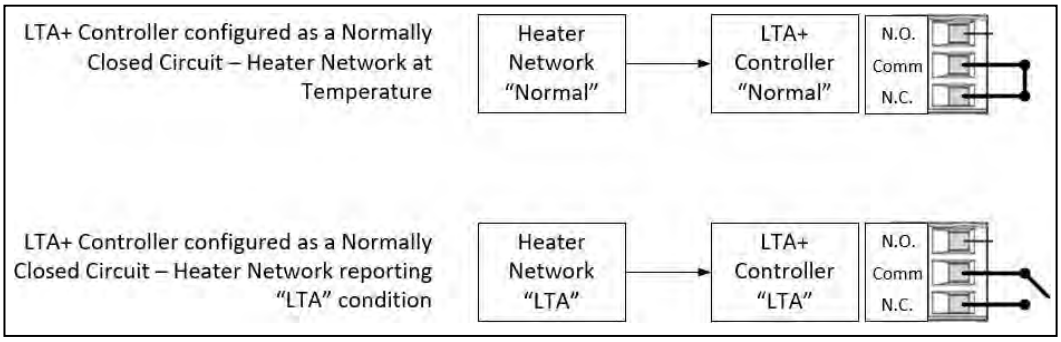


Figure 18: LTA+ Controller Process Control - Normally Closed Configuration

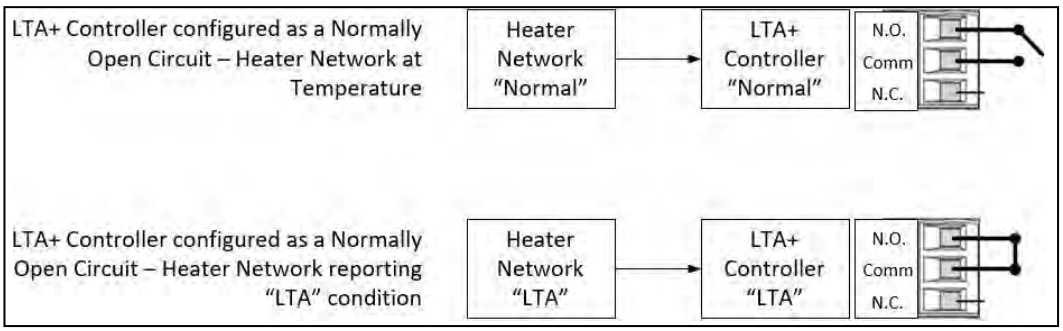


Figure 19: LTA+ Controller Process Control - Normally Open Configuration

10. S49UL User Interface Software

General Information

MKS has developed the ***S49UI*** user interface application for user-friendly communication with controllers over Modbus RTU. This application is compatible with Android operating system version 5.0/5.1, commonly referred to as "Lollipop" (API Levels 21/22). The application was optimized for use on a tablet with an 8” screen, such as the Acer Iconia One 8 model. Function and performance for subsequent versions of the Android operating system will be addressed on an as need basis. Please check the MKS website for updated support.

The S49UI App can be used to configure controller temperature, high temperature alert, and low alert set points, as well as view error and alert conditions and edit the user-defined controller identification tag. Controllers on the network can also be selected for temperature graphing.

Installation

If this is the first time an application is being installed on the tablet

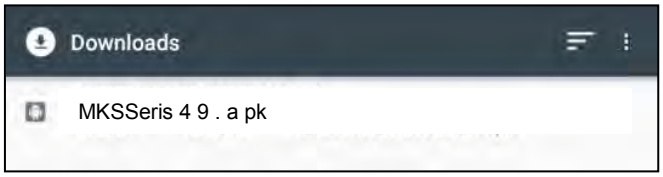
- Go to Settings->Unknown sources on the tablet.
- Tap the selector to toggle the “on” position.
- Read the warning and tap “OK” to install the application.

The application can be downloaded from the MKS website at the following URL:
https://www.mksinst.com/MKSSeries49/MKSSeries49.apk

Once the application is downloaded to the tablet go to the “Downloads” folder where the file was stored.



Select the S49UI *MKSSeries49.apk*



Select “Install” to complete the installation and then “Open” to open the application Main Screen.

Main Screen

The S49UI application can be found in the app by tapping the launcher button from the home screen and navigating to the screen containing the S49UI launcher icon:



Tap the S49UI launcher icon to start the application. Plug in a controller network to the

Figure 20: S49 UI Launcher Icon

tablet. If prompted, allow the application to access the detected USB device by selecting "OK" this allow the app to access the USB power and identify the connected network.

The S49UI is divided into two areas, on the left is the General Status Window, and on the right is the Network Window as shown in Figure 21.

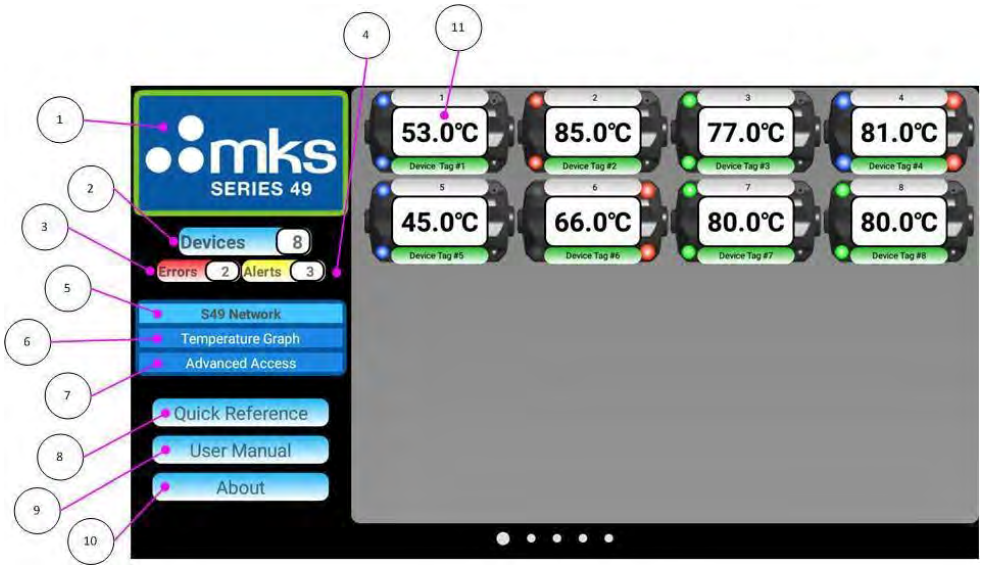


Figure 21: S49 Status and Network Windows

General Status Window

The General Status Window displays active buttons for the user to select and get further information about the MKS S49 Series controller and S49UI application. The General Status Window is always visible and accessible. Using the swiping gesture from right-to-left or left-to-right from any window accesses a next or previous window respectively within the application. Each button can be selected with either a tap or long press to access features according to the descriptions below, See Figure 21 for visual reference.

1. MKS logo: Display the MKS S49 web page when an internet connection is available.
2. Devices: Indicates the number of enumerated controllers on the network. Tap this button to display the network when viewing an alternate window. A long press re-initializes controllers on the network visible in the Network

Window. If no controllers are connected a long press of the Devices button enters “Demo” mode.

3. Errors: Indicates the number of controllers on the network with an error condition. Tap this button to display only the controllers with error conditions in the Network Window.
4. Alerts: Indicates the number of controllers on the network with an alert condition. Tap this button to display only controllers with alert conditions in the Network Window.
5. S49 Network: Display all connected controllers in the Network Window.
6. Temperature Graph: Display a temperature graph of selected controllers in the Network Window. A controller can be selected for graphing with a long press on a single controller’s temperature. See Figure 21, Item 11.
7. Advanced Access: Password-protected display of Modbus registers for each controller. Provides access to additional control and diagnostic registers and editing of some parameters.
8. Quick Reference: Describes application features and use. An internet connection is required initially to link to and download the document. After it is downloaded it is available offline.
9. User Manual: View the S49 User Manual (this document) on the device. An internet connection is required initially to link to and download the document. After it is downloaded it is available offline.
10. About: View S49UI application version.
11. The network window displays information about S49 controllers on the network. Controllers are displayed in this window (as shown), indicating controller temperature and LED status. The list can be scrolled if there is a large number of heater controllers in the connected network.

For any controller in the Network Window:

- A tap on a single controller’s temperature reading will display a window with the selected controller where the temperature, high alert, and low alert set points, and a user-defined tag can be changed.
- A long press selects a controller for graphing and will be indicated by a magenta border.

Note: Each controller in a Network must have a discrete address, putting 2 or more controllers with the same Modbus Device Address on a network will cause communications collisions and poor communications performance.

11. S49UL Basic Communications

General Information
The S49 Controllers use Modbus RTU communications over a 2-wire serial interface

Communications Settings:
The communication data Rate is fixed at 115200 Baud
Parity should be set to None
Stop Bits set to 1
Each S49UL Heater Controller ships with a default Modbus Device Address of 246
Each S49UL LTA+ Controller ships with a default Modbus Device Address of 247

Two communications cables are offered depending on the termination type required. The USB Communications Kit terminates in a USB Type A connection while the Generic Communications Kit terminates in bare leads which can be wired into a terminal block or other connector as required. When using a direct connection to the S49UL communications network (No LTA+ Controller) the individual controllers must be manually addressed before being connected as a networked system. For details on manual addressing see the outline below.

Manual Addressing:
Manual addressing of the S49UL controllers is required when direct connection to the S49UL network is required and a Tablet App or LTA+ Controller is not used to first automatically address the network.

To Manually address a network

1. Connect the S49UL Controller to the Power Adapter and facilities mains as outlined in Section 7 above.

2. Connect the communications cable to the Power Adapter on the network side and to the Modbus Master Device on the external interface side.

3. Establish communications with the S49UL controller at the factory Modbus Device Address (MDA) of 246.

4. Re-Assign the Modbus Device Address (MDA) by writing the desired address value to holding register 16. Valid Modbus Device Addresses are 1 thru 245 (246 is reserved for the factory setting and 247 is reserved for the S49UL LTA+ Controller).

5. Lock the new Modbus Device Address (MDA) by writing a value of “0” to holding register 37.
6.
7. Now the controller has been manually addressed and is ready for installation to the network.

8. Repeat steps 1 thru 6 above for subsequent controllers.

Note: Each controller in a Network must have a discrete address, putting 2 or more controllers with the same Modbus Device Address on a network will cause communications collisions and poor communications performance.

Installation:

When using the USB Communications Kit connect the USB communications cable to the first power adapter in the line. Next connect the USB to your Modbus Master Device

Both the S49UL Controller and the LTA+ Controller follow standard Modbus Protocol with the exception of the Master/Slave handoff when communications is accessed on a network running a S49UL LTA+ Controller, details described below.

Only Holding Registers are used (No Coils or Inputs)

The following function codes are supported.
Function Code 03 - Read Holding Registers
Function Code 06 - Write Single Holding Registers
Writes to the Broadcast Slave address 0 are also supported

When Accessing communications on a network using an LTA+ Controller the Tablet Software or other Modbus Master Device will halt the function of the S49 LTA+. A proprietary implementation of the Modbus Protocol allows the S49UL LTA+ to switch from a Master to a Slave device when a second Modbus master is connected to the S49UL Thermal System Network. When this hand off happens the LTA+ controller will continue to report its last know state (Normal or LTA) regardless of the reported status of the network. Once the Upstream Master Device is removed from the network the LTA+ Controller will resume polling the network and reporting the active network condition.

The only supported MKS Instruments communications software interface is the S49UI Tablet Application detailed in Section 10 above. Direct connection to a PC, Laptop, PLC, or other Modbus Master Device requires the user to provide their own interface.

12. Troubleshooting

This manual covers basic troubleshooting, which allows the user to determine common issues that may occur during the installation and operation of the Series 49 heater system. If the issues cannot be remedied from the steps listed below, please contact MKS for further support.

Installation Issues and Common Concerns

Components do not mate

- Confirm connections are mate compatible.
- Check to ensure pin terminals are not bent or damaged.
- Check to ensure there is no debris or material blocking the connector body, sockets, locking bail, etc.

System does not power

- Check to ensure all electrical connections are properly made.
- Check input power source.
- Check fuse in power injection module (no more than 10 amps of heaters can be connected into a single power drop).

Heater Jacket does not heat

- Confirm connection between heater jacket and controller is complete (Solid Yellow LEDs may indication a disconnect).
- Check to ensure pin terminals are not bent or damaged.
- Check to ensure the input supply voltage matches the heater jacket design voltage.
- Disconnect heater jacket from Controller and verify resistance across power contacts matches the specification printed on the label.

Issues with a single controller

- Most issues with a single controller will be visually displayed through LED indication (refer to Table 4: S49UL Troubleshoot Guide).

Note: Only the highest priority Error or Alert condition will be visually displayed.

Error Handling for Stand Along Networks (No Communications connection)

For detailed error conditions and related error handling refer to the S49UL Troubleshooting Guide.

For any errors that do not self-clear, the only way to reset the controller is to perform a hard power cycle and restart the controller. This operation is performed by disconnecting the mains power supply until the controller LEDs go dark then repowering the device. Note that if the Error Condition still exists after the hard power cycle the controller will re-enter the error state

Error Handling for Communication Networks (RS485 Modbus Comms connected)

For detailed error conditions and related error handling refer to the S49UL Troubleshooting Guide.

For any errors that do not self-clear there are multiple methods to exit the error state and resume normal operation using commands sent via RS485 Modbus Communications.

1. Clear Errors by applying a Command Reset

   A Command Reset will reset the Microprocessor, similar to a hard power cycle the processor will re-initialize and attempt normal operation. This command is applied by writing value “3” to holding register “54”

   Note that if the Error Condition still exists after the Reset the controller will re-enter the error state

2. Clear Errors by applying a Command Clear Errors

   A Command Clear Errors first requires the User to enter the Advanced Access Password, this is applied by writing value “291” to holding register “0” then writing value “9” to holding register “54”.

   Note that a Clear Errors Command cannot clear a Fatal Error Condition

If the Microprocessor itself has experienced a catastrophic failure and is no longer operational the HW Safety Circuit will trip and the controller will indicate the failure by continuously illuminating a small red LED.

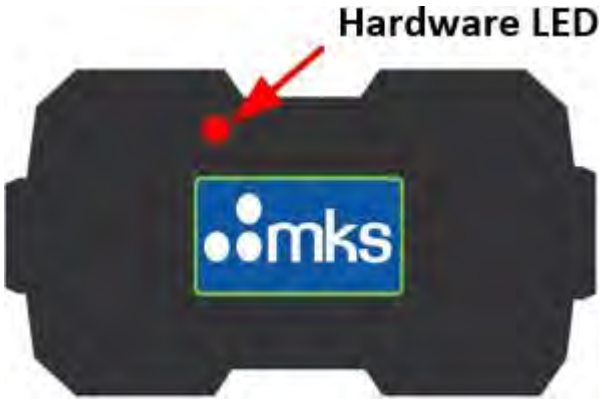
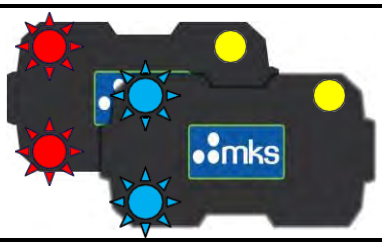
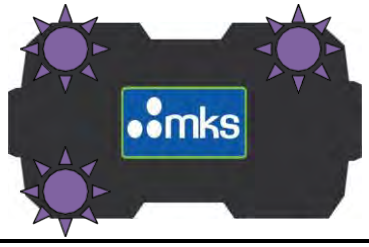
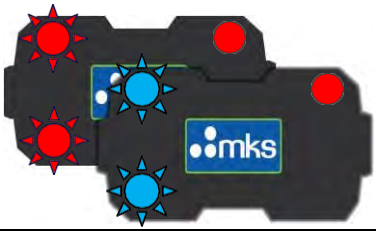
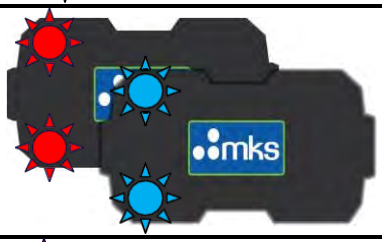
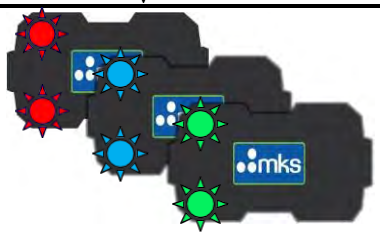
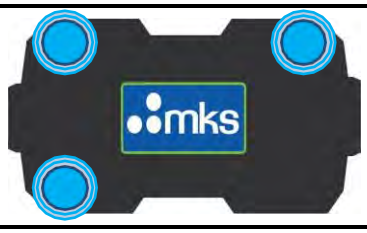


Figure 22: Hardware Failure Hardware LED

S49UL Troubleshooting Guide

Status LED / Diagnostic LED	Condition	Solution
	Device is at temperature - Solid Green.	No Issue - System is operating correctly.
	Safety Limit Alarm - Red Flash. The temperature has exceeded the SLA setting. Verify that the SLA is not set too close to the setpoint. The controller is in a lock state and requires a power reset to clear the error and attempt normal operation.	Power-cycle the heater. If the condition returns, the system may have a heat source exceeding the safety threshold; allow the system to cool and re-install the heater. If the condition returns again, the heater may needs to be replaced; Contact MKS for further support.
	Fatal Error - Solid Red. Conditions leading to this type of Error are not field-serviceable and are "Return-To-Factory Errors".	Contact MKS for assistance. The unit is no longer operational and requires replacement. The unit has entered a non-recoverable state. Power-cycling the heater may clear the error and allow normal operation, but the likelihood is low.
	High temperature alert - Solid Red. The temperature has exceeded the HTA setting.	No immediate action required - this may be caused by internal heating of the system.
	Low temperature alert - Solid Blue. The temperature is below the LTA setting.	Immediate action may not be required. The controller will enter this condition on initial heat-up. If the thermal load on the system is preventing the heater from reaching operating temperature, the condition will be persistent. Contact MKS for further support..
	Thermocouple Comparison Error - Sequntial Flash with Solid Yellow. The difference between the two thermocouples is outside the expected range.	Power-cycle the heater. If the condition persists, disconnect the heater jacket from the controller and inspect for damage. If no damage is found, connect heater jacket to controller and apply power. If the condition still persists, contact MKS for further support.

	Mains Voltage Error/Heater Error - Solid Yellow. The detected mains supply voltage does not match the heater jacket design voltage or the heater jacket cannot be detected by the controller.	Confirm the heater jacket is properly connected to the heater controller. Inspect signal contacts for damage. Verify the mains supply voltage at the source and confirm compatibility of the heater jacket design voltage on the product label.
	Application Error - Flashing Violet. An error with the controller firmware has occurred.	Reset device by cycling power. If error persists, update product firmware via the MKS Tablet App. Contact MKS for assistance.
	Current Draw Error - Sequential Flash with Solid Red. Current Output is outside the expected range.	Power-cycle the heater. If the condition persists, disconnect the heater jacket from the controller and inspect for damage. If no damage is found, connect heater jacket to controller and apply power. If the condition still persists, contact MKS for further support.
	Low Temperature Threshold Error - Flashing Blue. The measured temperature has dropped below the Low Temperature Threshold.	Disconnect the heater jacket from the controller and verify thermocouple wiring. Error is indicative of a thermocouple wired in reverse polarity. Check ambient temperature; if ambient temperature is below the Low Temperature Threshold value (Default = -10°C), the controller will not function normally.
	Ambient Temperature Alert - Sequential Flash. The controller has been exposed to an ambient temperature outside its safe operating range.	Power-cycle the heater. If the condition persists, contact MKS for further support.
	Ping - Sequential Flash. The LED indication will be active for 30 seconds to enable identification of the controller on the network. This function is available only through the use of external communications.	No Issue - System is operating correctly.
	Standby Mode - Pulsing Blue. The controller has been commanded into Standby Mode, opening the power control relays and halting all temperature control function.	Exit Standby Mode by sending command via Tablet App (See User Manual for details).

	Boot Mode - Solid Violet. Control has entered Boot Mode.	Boot Mode can be entered either via command during a Firmware Update or due to a corrupt Firmware Image. If this ocurrs and a Firmware Update is not being applied, reset power to the device. If the error persists, update device firmware or contact MKS for assistance.

Table 4: S49UL Troubleshoot Guide

13. Accessories and Component Parts

Below are the available accessories for the Series 49 thermal management system:

	Description	Part Number
Power Kits	120VAC 8 ft	20021379-001
	120VAC 15ft	20021380-001
	240 VAC 8ft	20021381-001
	240VAC 15ft	20021382-001

All Power Kits include a Power Supply cable, Tee Block Power Adapter, Upstream terminating plug, and a downstream terminating plug.
120VAC Power Kits use a NEMA 5-15P to C15 A-Lock Connector
240VAC Power Kits use a NEMA L6-15P to C15 A-Lock Connector

	Description	Part Number
LTA+ Kit	LTA+ Kit	20014267-001

The LTA+ Kit includes an S49UL LTA+ Controller and 50ft of 24AWG wire for connecting the process control signal.

	Description	Part Number
Communication Kits	USB Communications Kit (USB Type A with Micro Adapter)	20014265-001
	General Communications Kit (50ft Flying Lead)	20015929-001

The USB Communications Kit includes a 6ft communications cable terminating in a USB Type A connector and a USB A to Micro adapter cable.

The General Communications Kit includes a 50ft communications cable terminating in bare wire leads. Before connecting into the user system leads must be stripped and terminated as required.

	Description	Part Number
Spare Straps	Spare Speed Strap (Large)	20018033-001
	Spare Speed Strap (Small)	20002133

Replacement speed straps are purchased as single items (Qty. 1 ea) and used to replace damaged or broken securing straps on the heater jackets.

In addition, the Series 49 power adapter uses a 10A fuse, 250 VAC, 5x20mm. This can be ordered from MKS (part number 100020028) or sourced locally.

14. Appendix

S49UL Heater Controller - Modbus Register Map

Modbus Register Map - S49UL								
Register	**Symbol**	**Access**	**Default Value**	**Configurable Range**	**User level**	**Definition**	**Units**	**Notes**
0	PSWW	RW	0	-	0	User Level Select	-	advanced (level 1) set Register to 0x0123 Binary (291 Decimal); normal (level 0) set to 0
6 - 13	TAG[1 - 8]	RW	-	ascii pair	0	Tag string ascii pair (lsb=first char; msb=next char)	-	String (no ascii terminator; fill with spaces). Characters must be 0x20 - 0x7E (ASCII non-control, printable characters)
14	FW_VER[1]	RO	-	-	0	Firmware version	-	0xMMmm: MM=major version; mm=minor version
15	FW_VER[2]	RO	-	-	0	Firmware version	-	0xnnBB: nn = maintenance version; BB is the build number
16	MDA	RW	246	1 – 246	1	Modbus Device Address	-	
17	MAINS_V	RO	-	-	0	Read the mains voltage sense port	-	0 = 110-120VAC; 1 = 220-240VAC
18	TOD[1]	RO	-	-	0	Elapsed seconds since reset/power-on (lower 16-bits)	s	Rolls over after 4,294,967,295
19	TOD[2]	RO	-	-	0	Elapsed seconds since reset/power-on (upper 16-bits)		
20	TMEASURED	RO	-	-	0	Heater Temperature (average of adjusted thermocouple temperatures)	0.1 °C	(TADJ1 + TADJ2) / 2
21	TDELTA	RO	-	-	0	Thermocouple Temperature Difference	0.1 °C	|TADJ1 - TADJ2|
22	CST	RW	150	0 – MAX_CST	0	Controller Setpoint Temperature	°C	MAX_CST determined by heater jacket material
23	SLA	RW	260	0 – MAX_SLA	1	Safety Limit Alarm Threshold	°C	SLA active if TMEASURED > SLA. MAX_SLA determined by heater jacket material
24	HTA	RW	20	5 – 99	0	High Temperature Alert Limit	°C	HTA active if TMEASURED > CST + HTA
25	LTA	RW	20	5 – 99	0	Low Temperature Alert Limit	°C	LTA active if TMEASURED < CST - LTA
28	HYS	RW	3	1 – 28	1	Hysteresis Value	°C	Degrees below CST that triggers heater on
35	TCR	FTY	20	0 – 20	Factory	Temperature Comparison Range (Threshold)	°C	Condition exists if TDELTA > TCR
37	STT	RW	60	0 – 65535	1	Modbus Slave Communication Timeout Timer (Orphan Timeout)	s	0=no timeout; 65535=no timeout

40	EOT[1]	RO	-	-	0	Equipment on time (hours, lower 16-bits)	hr	Values saved every 5 minutes
41	EOT[2]	RO	-	-	0	Equipment on time (hours, upper 16-bits)		
54	CMD	RW	-	-	(see)	System Command	-	(see CMD page) In: integer command. Out: 0 always
55	TAS	RO	-	-	0	Temperature Ambient Sensor	°C	a.k.a. Cold-junction temperature, a.k.a Electronics Temperature. (TCJ1 + TCJ2) / 2
56	TADJ1	RO	-	-	0	Thermocouple 1 Temperature (adjusted)	0.1 °C	TC1 + TC1 *(CCG/100) + CTO
57	TADJ2	RO	-	-	0	Thermocouple 2 Temperature (adjusted)	0.1 °C	TC2 + TC2 *(CCG/100) + CTO
60	CUS	RO	-	-	0	Current Device State	-	(see CUS page)
61	CDS	RO	-	-	0	Controller Diagnostic Status	-	(see CDS page)
62	ERR[1]	RO	-	-	0	Error Event Register 1	-	(see ERR_Low page)
63	ERR[2]	RO	-	-	0	Error Event Register 2	-	(see ERR_High page)

S49UL Modbus Command Functions

CMD - System Command - Holding Register 54			
Value	**Command**	**User level**	**Description**
2	Enter standby mode	0	Device enters standby mode - Relays open, Temperature Control ceases
3	Reset Device	0	Device undergoes a software reset
4	Ping	0	Device displays ping response, initiates a 30sec Ping LED display sequence
9	Clear Errors	1	Clears non-fatal errors in ERR register; if in locked mode, returns to normal mode
10	Restore Factory Config Defaults	1	Restores all registers except MDA, STT, and TAG to factory defaults
11	Restore Factory Operational Defaults	1	Restores all registers to factory defaults
12	Exit standby mode	0	Device enters standby mode - Temperature Control Resumes
100	Clear network address	1	Sets MDA to 246 and STT to 60
101	Cancel ping	0	If in ping mode, cancels response

Commands are Read/Write functions handled at Modbus Holding Register 54
For example, sending a Write command value 3 to Register 54 will “RESET” the microprocessor of the S49UL Controller re-initializing the device.

S49UL Controller Diagnostic Status

CDS – Controller Diagnostic Status – Holding Register 61	
Bit	**Description**
0	SLA active
1	LTA active
2	HTA active
3	ADC error
4	LTT active
5	Under-current
6	Over-current
7	TC1 Malfunction
8	TC2 Malfunction
9	Safety Relay State (1=closed)
10	Control Relay State (1=closed)
11	(reserved)
12	(reserved)
13	Ambient temperature warning
14	Ambient temperature alert
15	(reserved)

The CDS Register (Holding Register 61) contains a 16 Bit Binary Word
This register is a Read Only register that contains controller status information
Any Bit within the register displaying a "1" is showing an "Active" condition
Any Bit within the register displaying a "0" is showing an "Inactive" condition

S49UL Error Event[1] Register

Error Low - Holding Register 62	
Bit	**Description**
0	At-temperature active
1	SLA1 event
2	SLA2 event
3	TC1 Malfunction
4	TC2 Malfunction
5	SLA event
6	HW-FW mismatch
7	HTA active
8	LTA active
9	TDELTA Comparison error
10	CJDELTA Comparison error
11	MAINS_V-heater mismatch error
12	Heater missing error
13	Application load error
14	(reserved)
15	Missing application image

The Error Low Register (Holding Register 62) contains a 16 Bit Binary Word
This register is a Read Only register that contains controller error information
Any Bit within the register displaying a "1" is showing an "Active" condition
Any Bit within the register displaying a "0" is showing an "Inactive" condition

S49UL Error Event[2] Register

Error Low - Holding Register 63	
Bit	**Description**
0	Over current event
1	EEPROM i/o error
2	EEPROM checksum error
3	Previous watchdog reset
4	Under current event
5	LTT event
6	(reserved)
7	Ambient temperature alert
8	(reserved)
9	5V rail fault
10	ADC error
11	Relay failed in closed state
12	Relay failed in open state
13	(reserved)
14	(reserved)
15	Ambient temperature warning

The Error High Register (Holding Register 63) contains a 16 Bit Binary Word
This register is a Read Only register that contains controller error information
Any Bit within the register displaying a "1" is showing an "Active" condition
Any Bit within the register displaying a "0" is showing an "Inactive" condition

S49UL Current State

CUS - Current State - Holding Register 60	
Value	**Description**
0	Normal
1	Locked
2	Standby
3	Fatal
4	Bootloader
5	Boot fault
99	Debugging

The CUS Register (Holding Register 60) displays the current operational state of the controller
This register is a Read Only register

15. Contact

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