

LLD Control Rack Design

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12/16/08

Outline

- Overview
- Electrical Power Circuits
- Heater Power Control System
- Data Acquisition System
- Gas Cooling System
- Conclusion

- Attachment: Component Descriptions

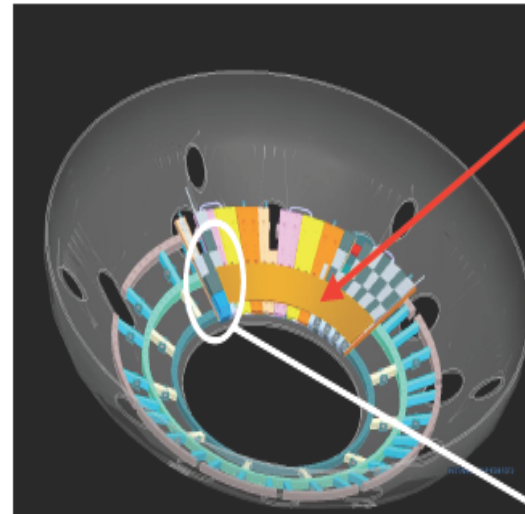
Overview

- Description of an LLD Quadrant
- Basic LLD Control Rack Requirements
- Facility Interfaces
- Block Diagram of LLD Rack Systems
- LLD Control Rack Physical Layout
- SNL Procurement, Construction, and Testing Schedule

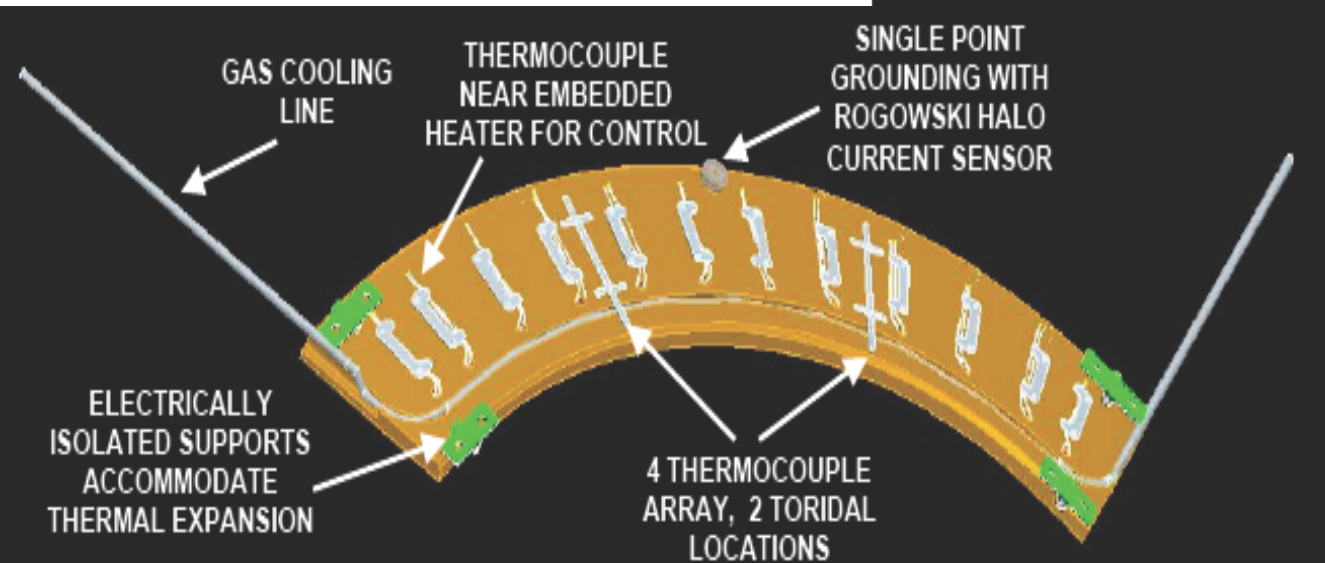
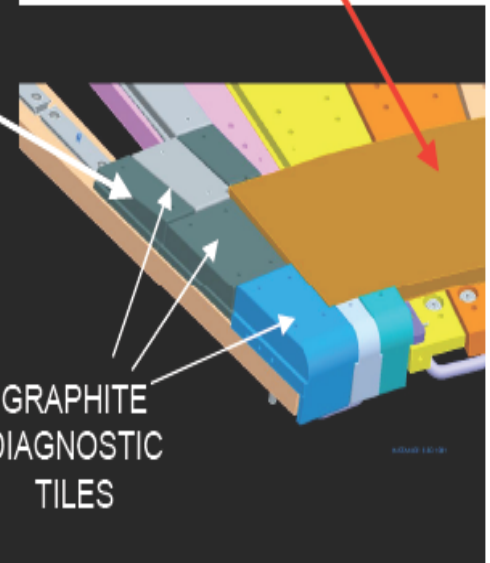
Description of an LLD Quadrant

An LLD Quadrant Includes

- 12 electrical cartridge heaters
- 32 thermocouples
- a gas cooling loop



- 4 Toroidal 90° segments separated by graphite Diagnostic Tiles
- Each copper substrate segment is clad with a thin stainless steel barrier with a front face of porous flame sprayed Mo



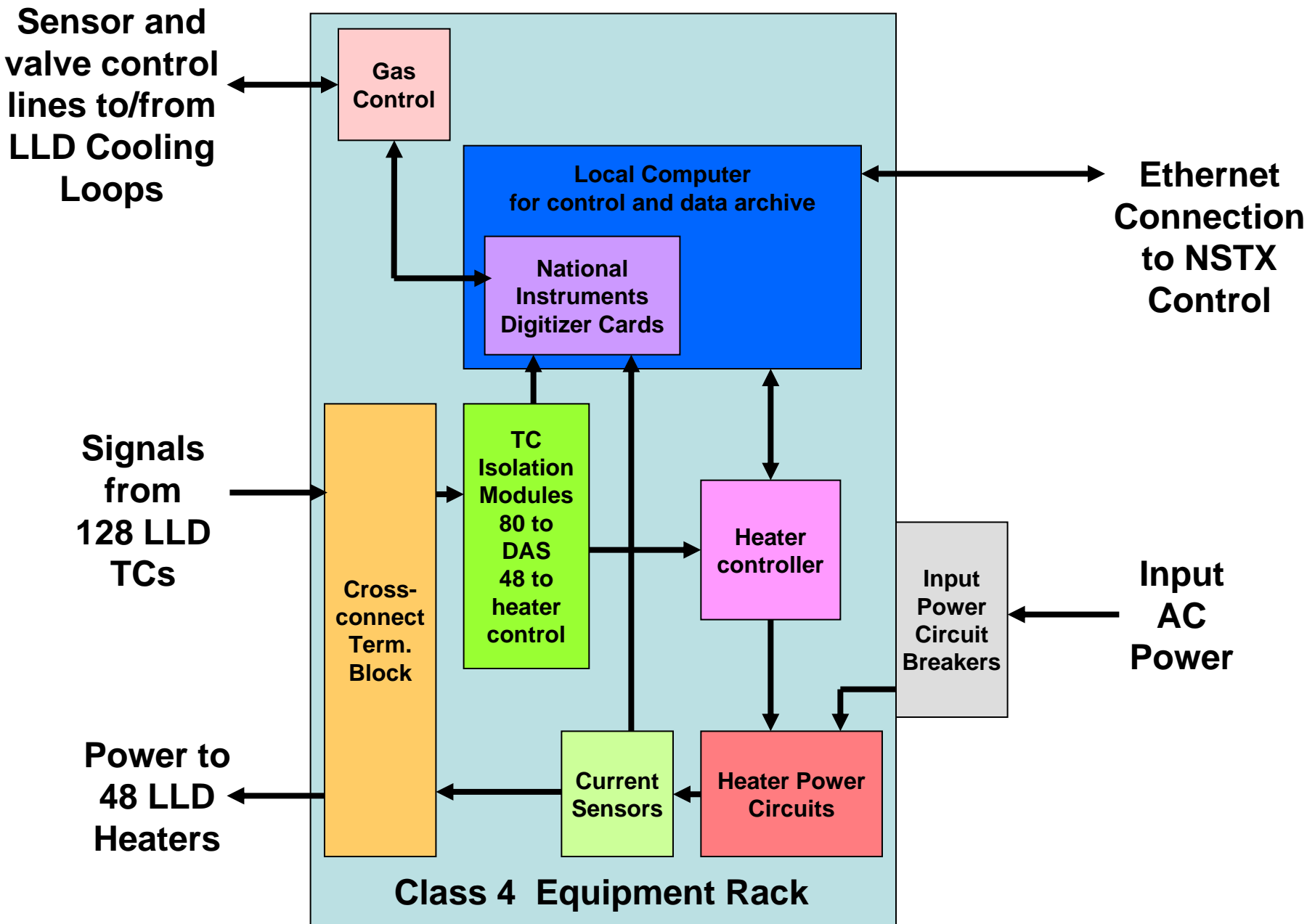
Basic LLD Control Rack Requirements

- Provide and control electrical power for 48 heaters
- Control cooling gas to the LLD
- Monitor 80 TC signals from the LLD
- Monitor 48 heater current signals
- Monitor 10 gas system signals (pressure, flow, temperature)
- Local computer with software for system control, data archive, and NSTX network communication
- Provide options for full local or remote control

Facility Interfaces

- Location for 1 full size equipment rack (~22"x30"x80")
- Input power: 3 phase, 208 V, 30 kW
Circuit breaker panel box on side of rack
Isolation transformer / line filter in control power line for EMI protection
Contacts provided to interlock heater power circuit
- Gas supply will be 90 psi house air system
- Gas lines, Heater and TC Cabling to LLD provided by facility
Cross-connects in rack for connection to TC and heater lines
- Communication compatibility with NSTX Ethernet network

Block Diagram of LLD Rack Systems



LLD Control Rack Physical Layout

(useable volume ~ 19"x72"x29")

main relay, circuit breakers,
Iso. Transformer , fan
(on side/ top of rack)

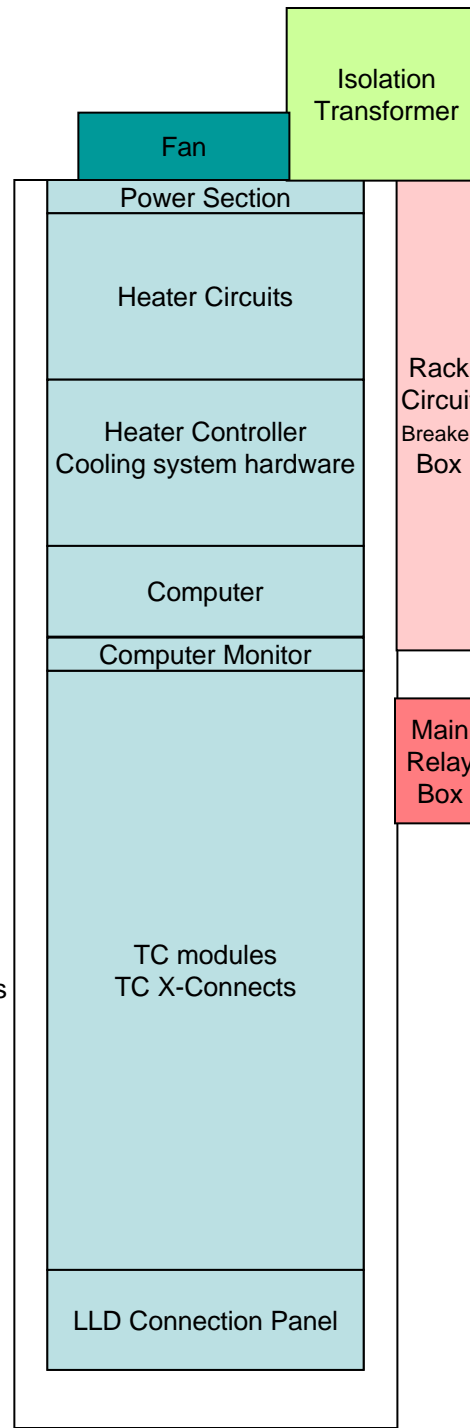
Line filter, Indicator lights, terminal blocks

Solid state relays, output relays, current
sensors,

heater controller w PS, cooling
system hardware in the back and on
sides

computer, communication hardware

TC isolation modules, cross-connect banks



Fan

Isolation
Transformer

Power Section

Heater Circuits

Heater Controller
Cooling system hardware

Computer

Computer Monitor

TC modules
TC X-Connects

LLD Connection Panel

Rack
Circuit
Breaker
Box

Main
Relay
Box

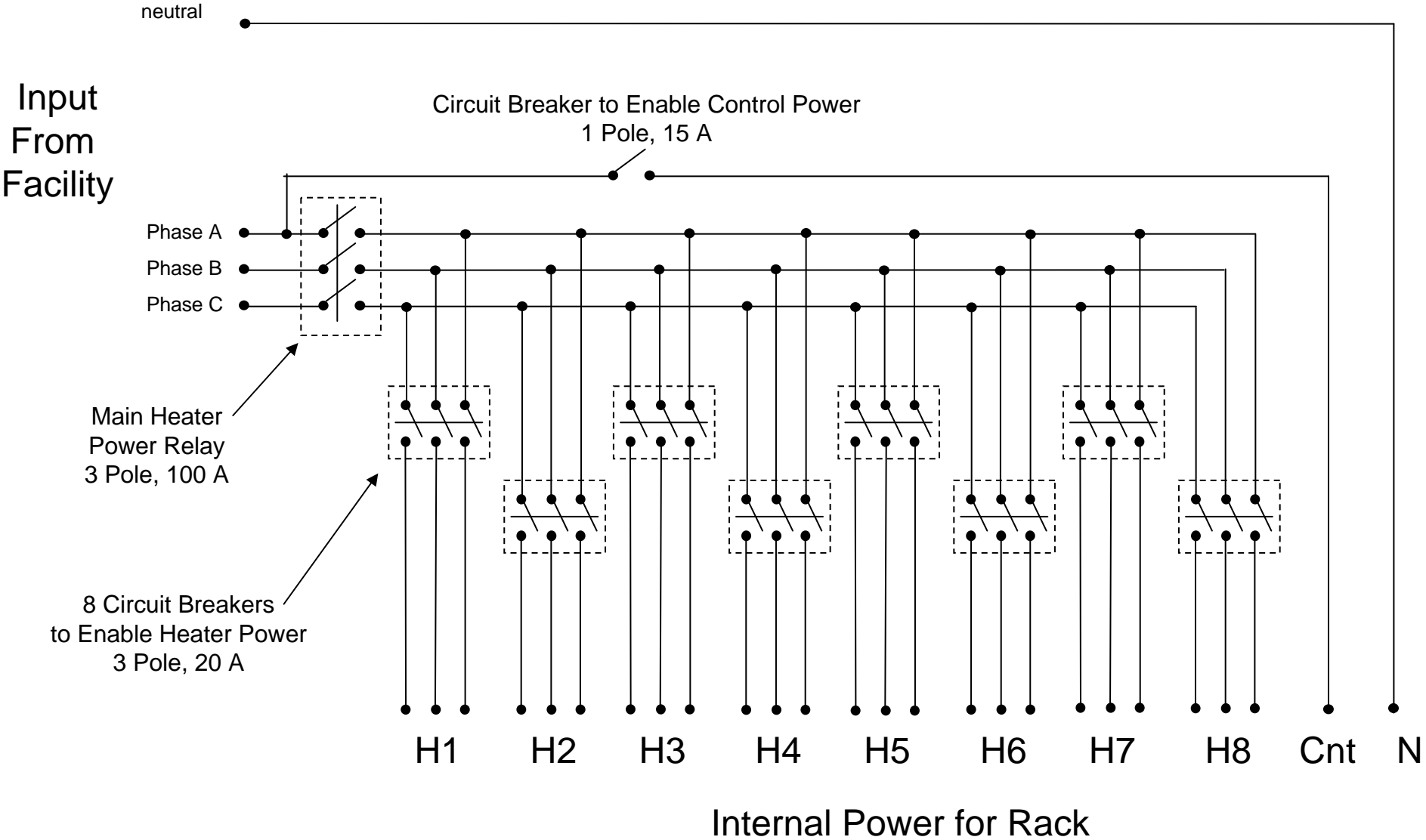
SNL Procurement, Construction, and Testing Schedule

Task	December				January				February				March			
Design and Specifications Developed	█	█														
Order Parts			█	█	█	█										
Receive Parts					█	█	█									
Assembly					█	█	█	█	█	█						
Software Development					█	█	█	█	█	█	█	█				
Testing													█	█	█	█
Shipping																█

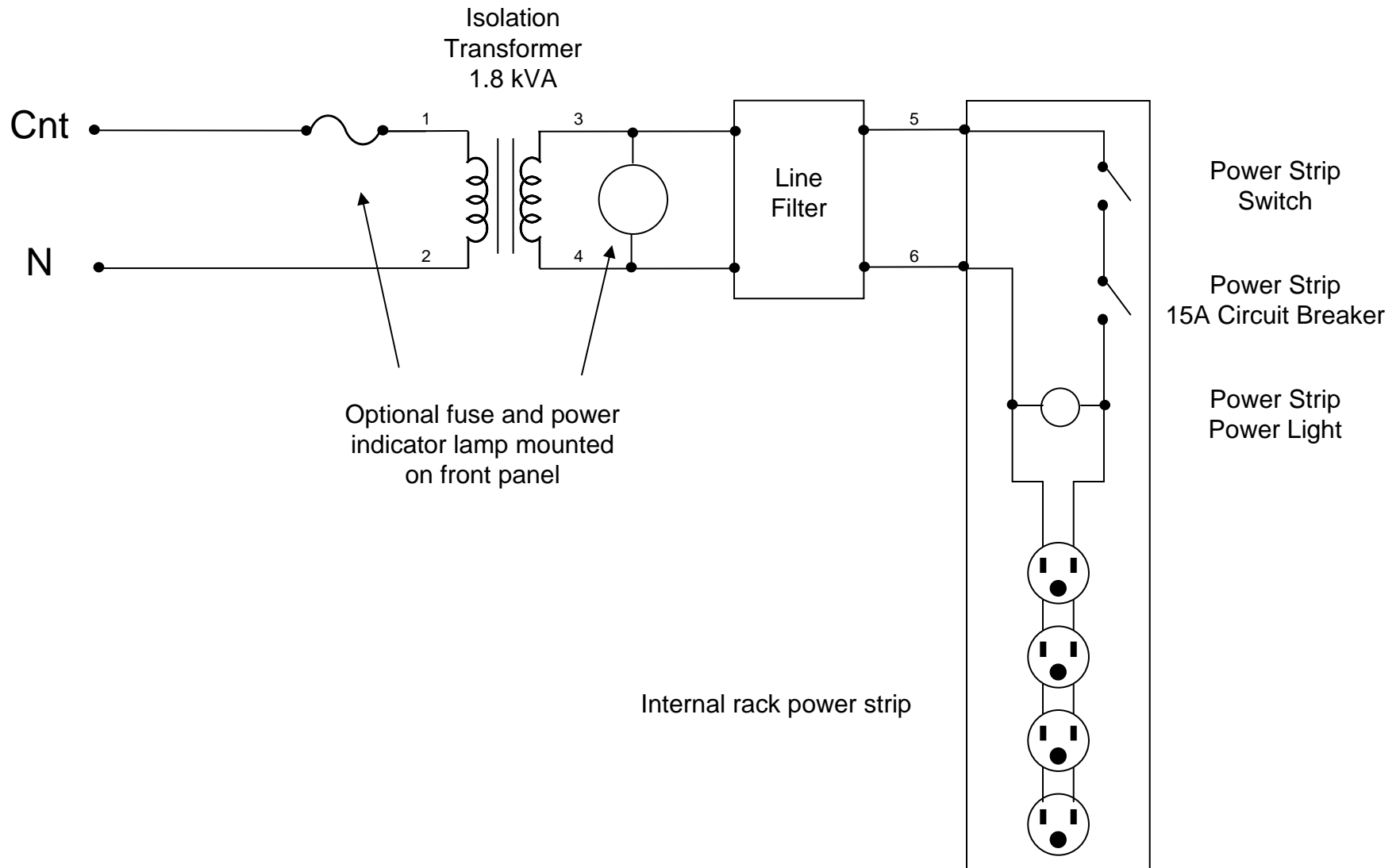
Electrical Power Circuits

- Prime Power Control Circuit
- Control Power Circuit
- Basic Heater Power Supply Circuit Block Diagram
- Heater Power Enable Circuit
- Heater Circuit from First Circuit Breaker
- Power Section Physical Layout
- Physical Layout of a Heater Relay Unit for one LLD Quadrant

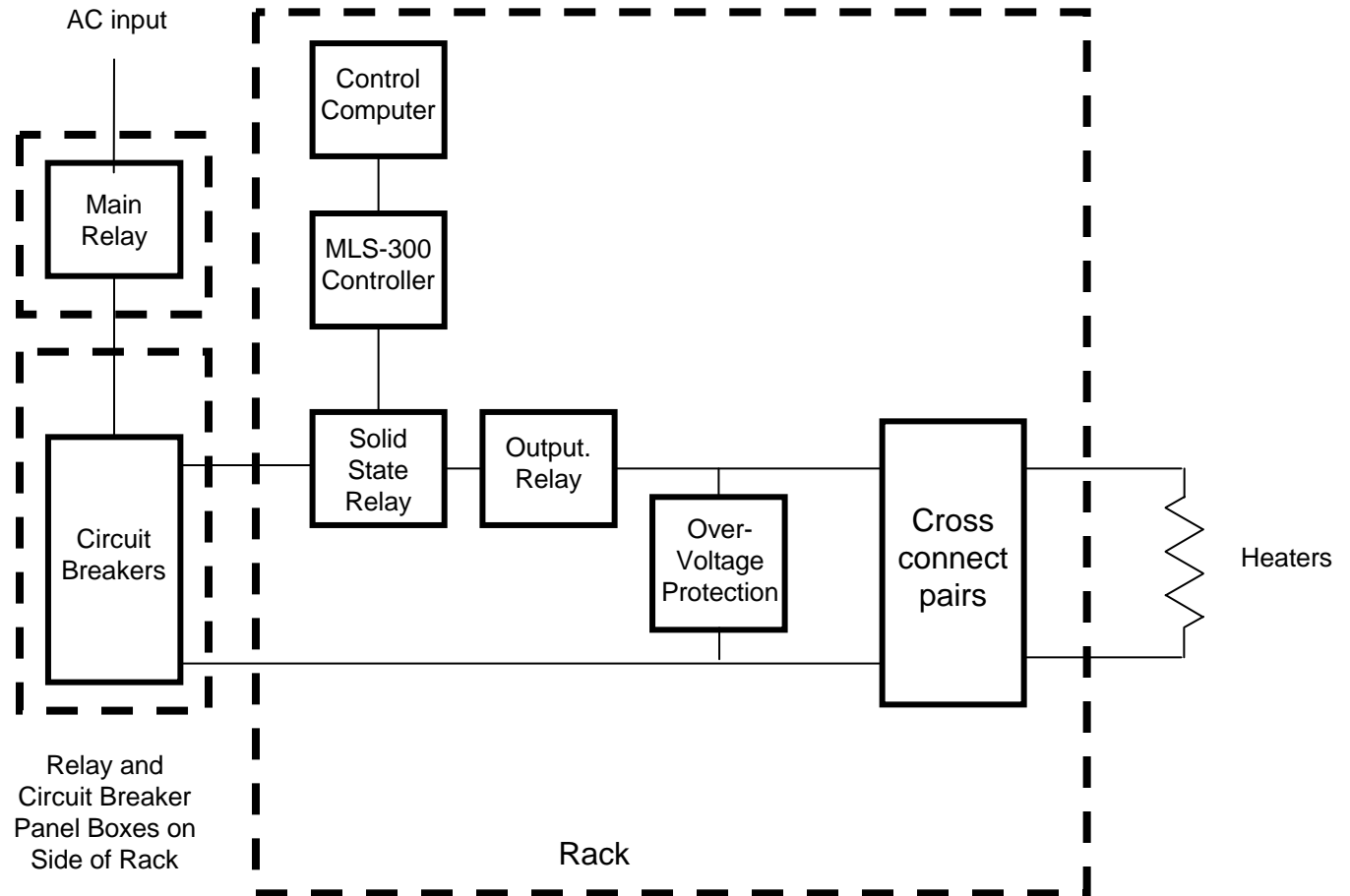
Prime Power Control



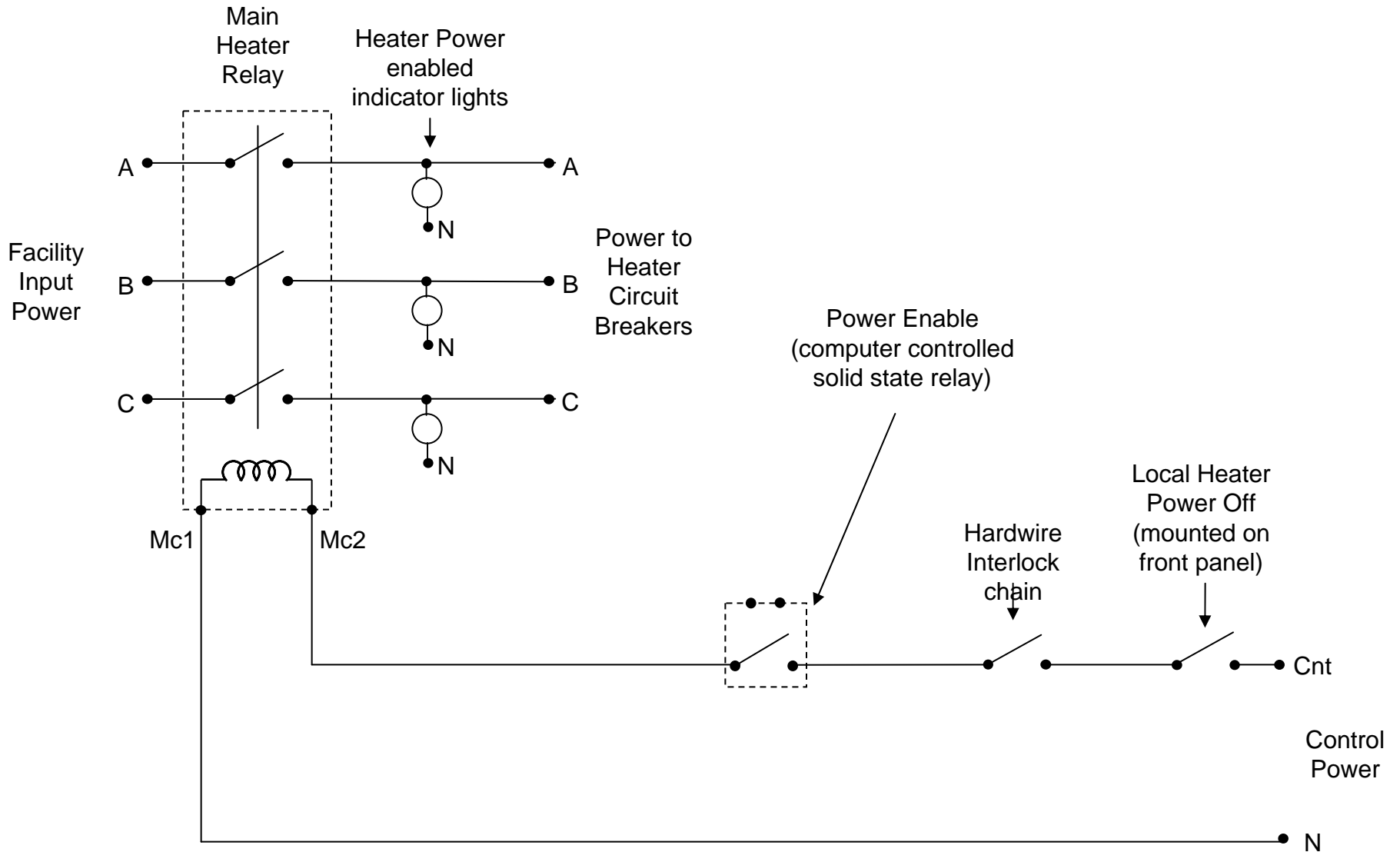
Control Power



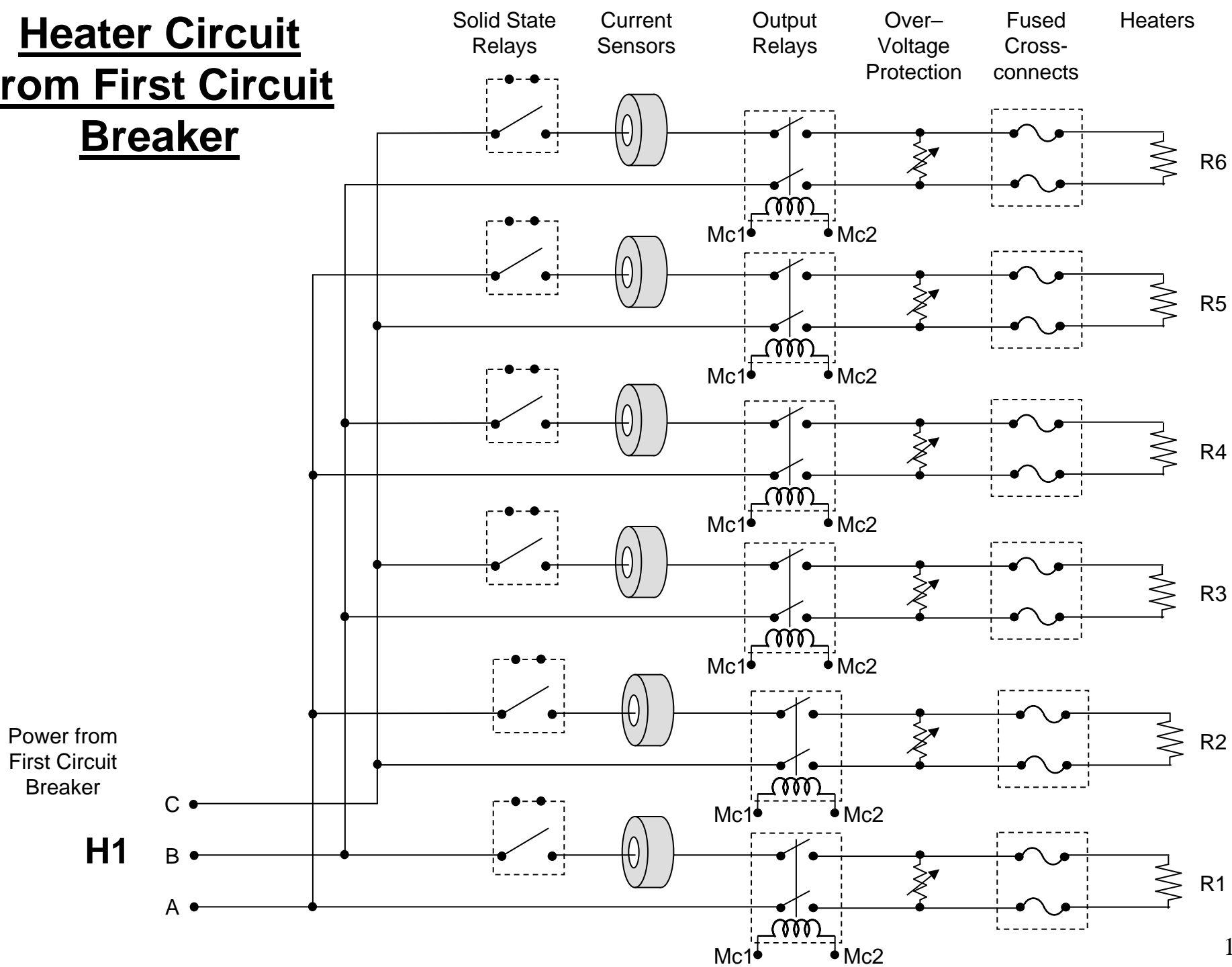
Basic Heater Power Supply Circuit Block Diagram



Heater Power Enable Circuit

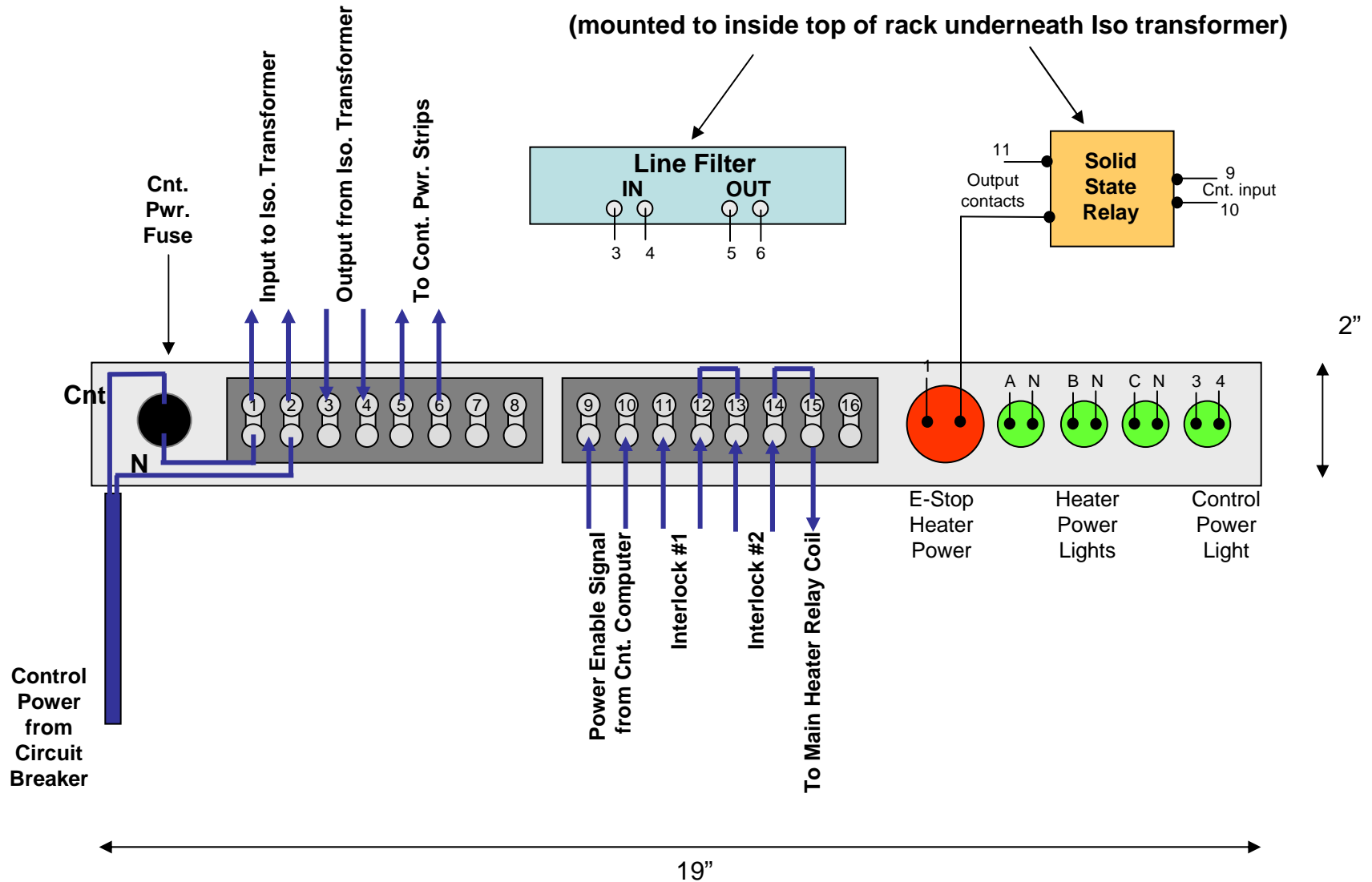


Heater Circuit from First Circuit Breaker

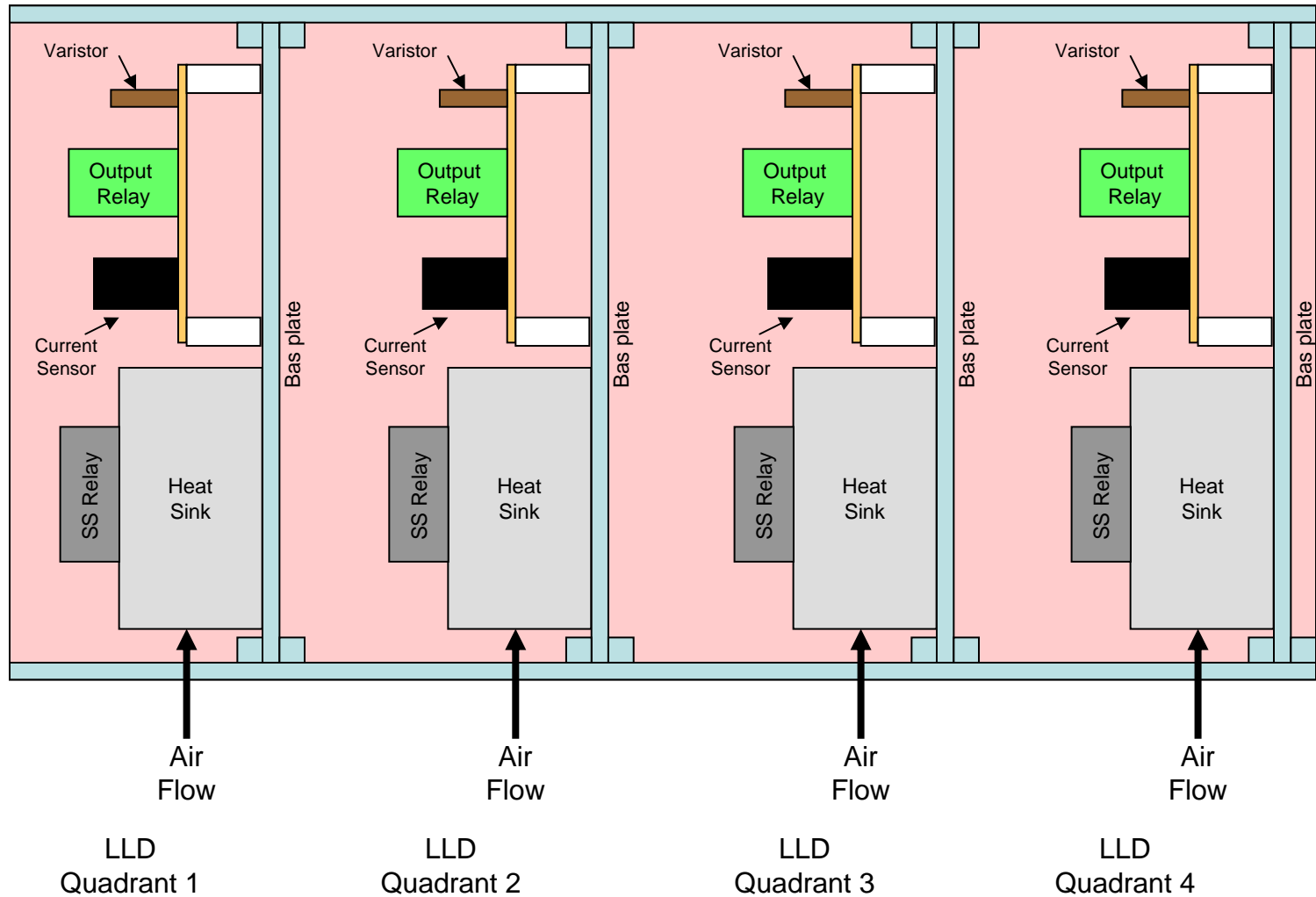


Power Section Physical Layout (back view)

Max. height < 2"

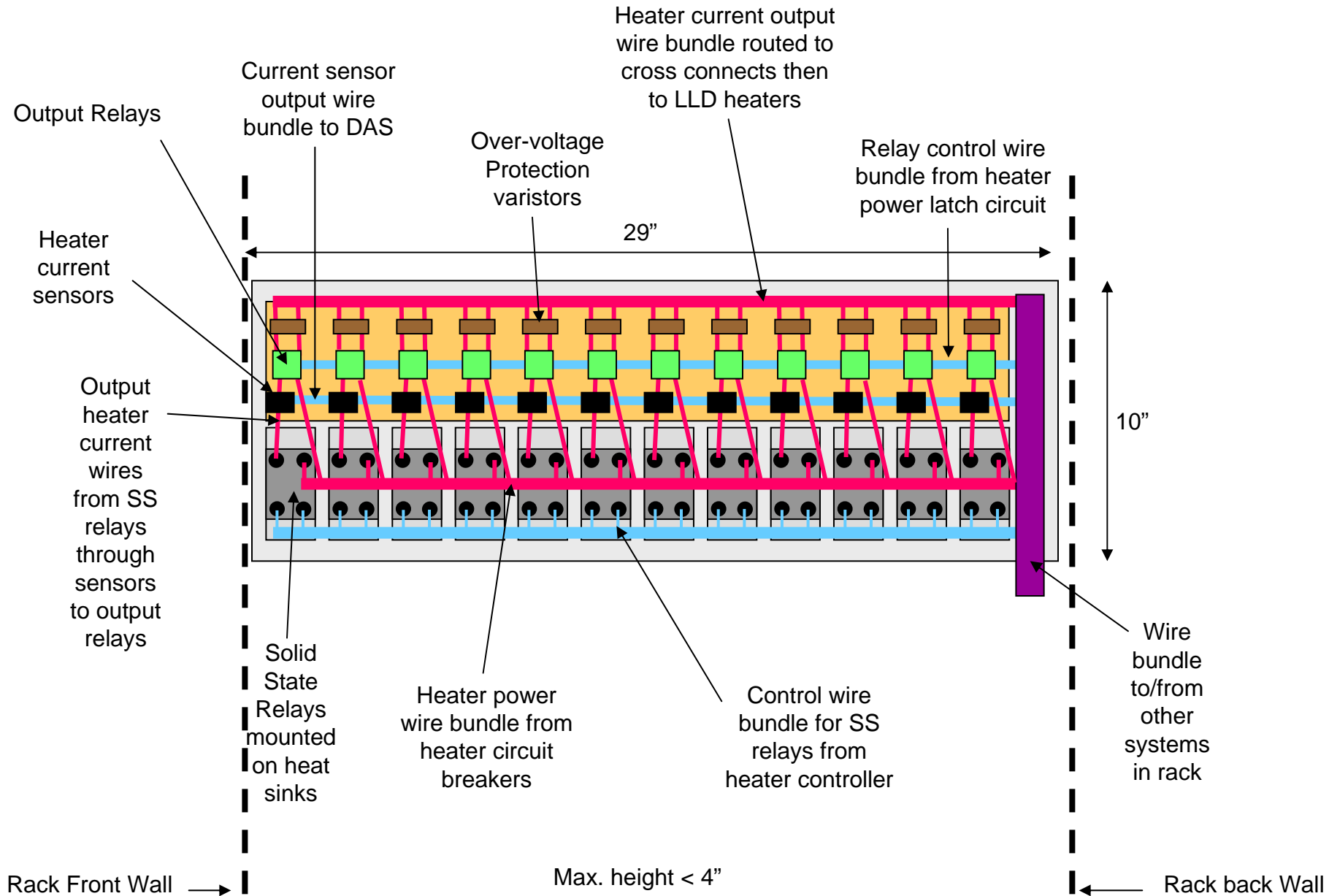


Physical Layout of a Heater Relay Unit (back view)



Components for each LLD quadrant mounted on aluminum base plates which slide into the crate from the back.
Top and bottom plates of the crate perforated to allow air flow through the heat sinks.

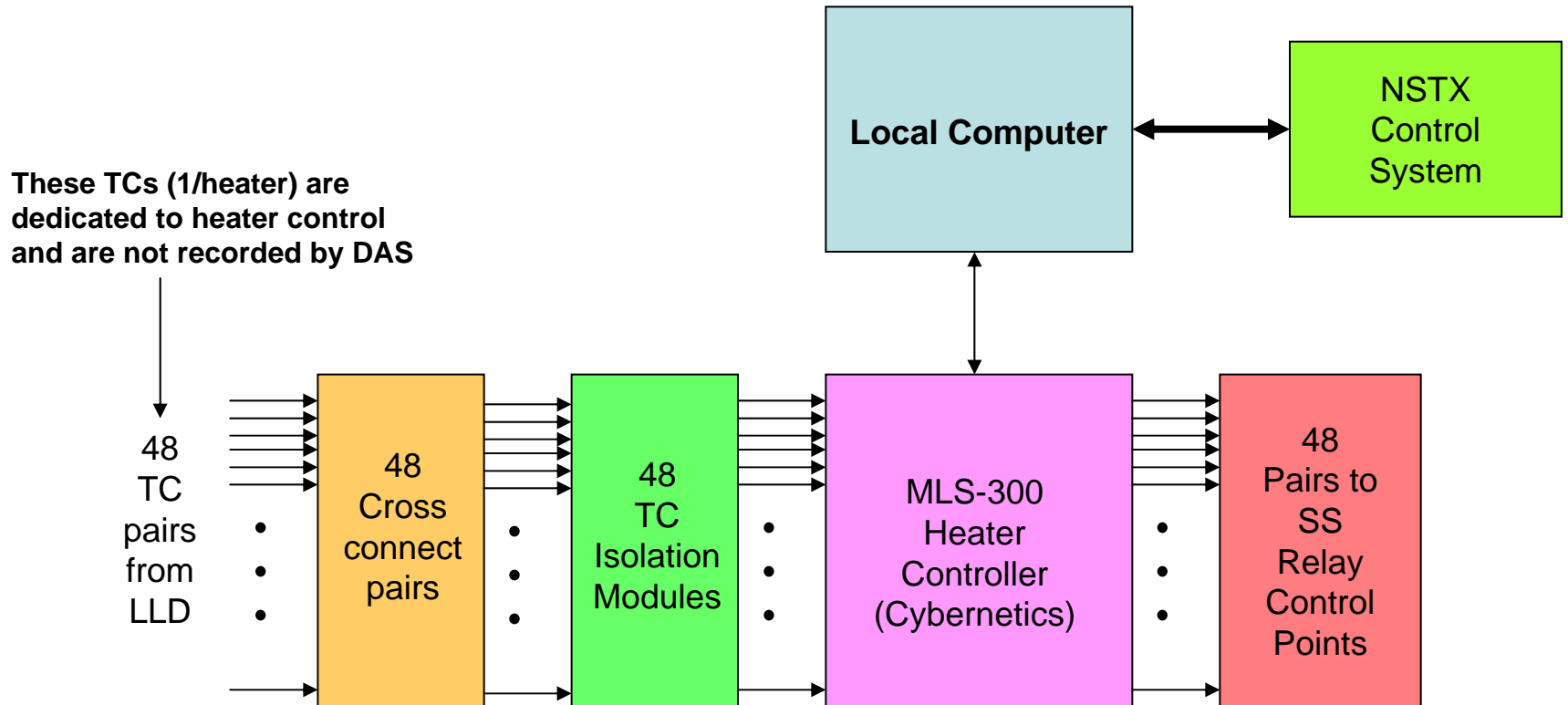
Physical Layout of a Heater Relay Unit for one LLD Quadrant



Heater Power Control System

- Heater Power Control System Block Diagram
- Operational Philosophy of LLD Heater Circuit
- Fault Handling Philosophy
- Interlocks
- Failure Mode Analysis
- Heater Controller Section Physical Layout

Heater Power Control System Block Diagram



Operational Philosophy of LLD Heater Circuit

1. The circuit is initially disconnected from AC power by the Main relay and disconnected from the LLD by the output relays.
2. To enable heater power, the operator must activate the power enable circuit either locally via the control computer terminal or remotely via communication to the control computer.
3. Once power is enabled, the solid state relays control power flow to the heaters. The solid state relays are controlled by the MLS-300 heater controllers. It will be programmed to operate much like a thermostat. A control TC (one assigned to each heater) provides heater temperature data to the controller. The control computer provides the heater controller with a target temperature for each heater. The controller then activates the solid state relay to provide heater power to follow a prescribed heat up curve. Once the target temperature is attained, the controller will only provide enough power to maintain the temperature.
4. When instructed by the NSTX control system to turn off heater power, the LLD control computer will instruct the MLS-300 controllers to stop triggering the solid state relays and then deactivate the power enable circuit to disconnect the heater circuit at the input and the outputs. In an emergency condition (an interlock or the emergency stop switch opening in the heater power enable circuit), the main heater power relay and the outputs relays will be opened immediately.

Fault Handling Philosophy

- Level 1. The control computer will continuously monitor all of the 80 LLD TC temperatures. Each TC signal will be assigned an alarm level where the control program will automatically notify the operator. The operator can then take the appropriate action (ignore, change a set point, gracefully disable all heater power, etc.). If a significant number of the TC readings do not appear reasonable, power should be disabled until the problem is resolved.

- Level 2. Each TC signal will also have a trip point value assigned. If the trip point is attained, the control program will gracefully disable all heater power. In addition, any software interlocks required by the NSTX control system to turn off heater power will cause the control program to gracefully disable all heater power.

- Level 3. Some of the 80 TC signals can be routed through special TC modules which include a switch which opens when a trip point is attained. These switches could be connected in series and put in the power enable interlock chain so that if any one of them trips, an emergency heater power shut down would occur. In addition, any other trip switches required by NSTX can be hardwired into the interlock chain which when opened would cause an emergency heater power shut down.

Interlocks

HARDWIRED – (into the interlock chain in the heater power enable circuit)

NSTX VACUUM	If NSTX Vacuum > 900mT Disable LLD Heaters and Enable LLD Cooling for all 4 quadrants.
NSTX CONFIGURE	If NSTX Not Configured for LLD Operation Disable LLD Heaters and Enable LLD Cooling.
WATCH DOG TIMER	If the LLD Controller fails to update the Timer Disable LLD Heaters and Enable LLD Cooling.
TC OVER TEMP.	If any LLD quadrant TC > 395 degrees C Disable LLD Heaters and Enable LLD Cooling.

SOFTWARE – (via communication with the control program)

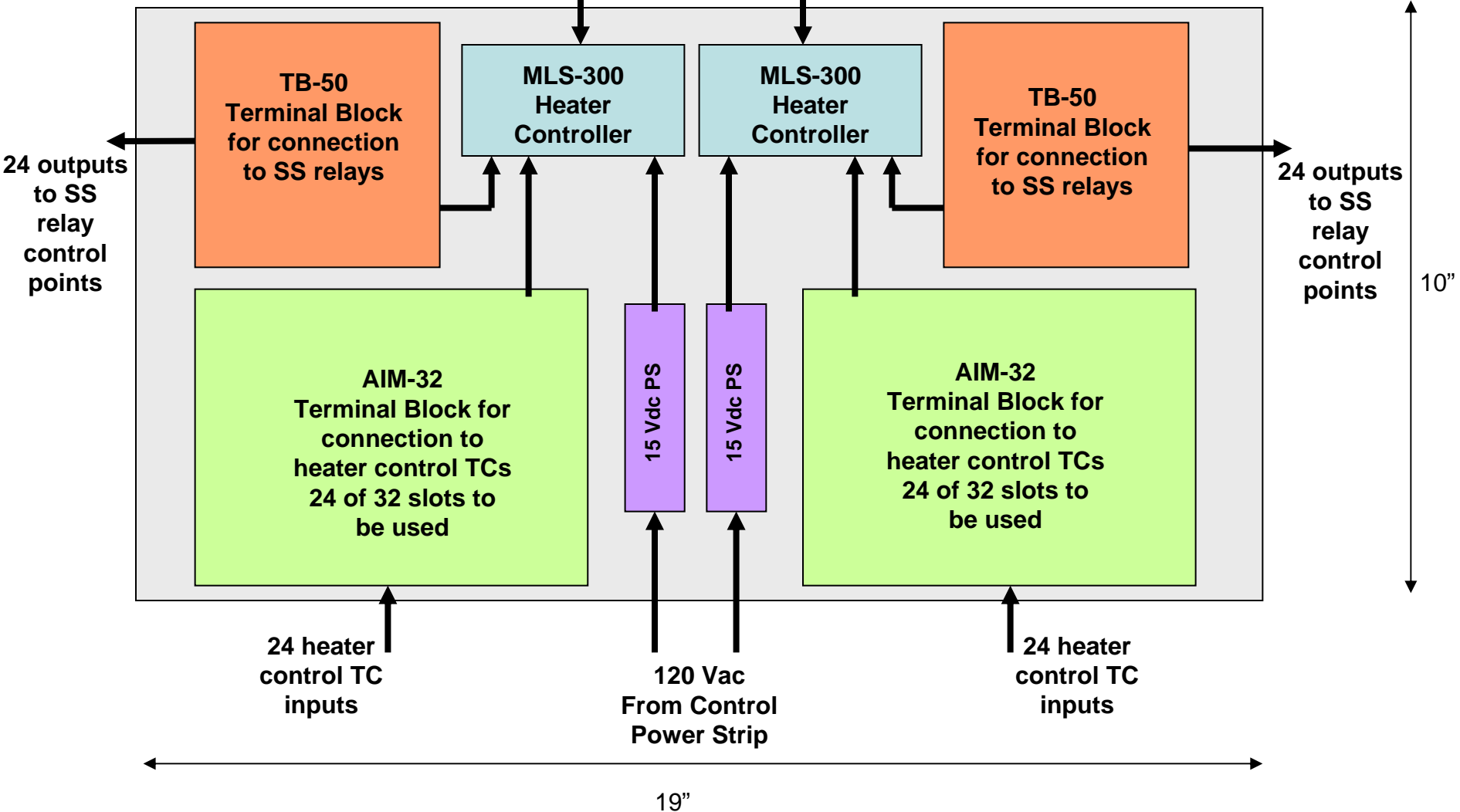
TC OVER TEMP.	If any LLD quadrant TC or Heater Control TC > 375 C, Disable LLD Heaters and Enable LLD Cooling.
COOL. GAS PRES.	If Cooling Gas Pressure is < TBD psi, Disable LLD Heaters and Enable LLD Cooling.
NETWORK COMM.	If loss of LLD – EPICS Communication, Disable LLD Heaters and Enable LLD Cooling.
EPICS	If loss of EPICS – Vacuum System PLC Communication, Disable LLD Heaters and Enable LLD Cooling.
SHOT TIME	If Shot Time > T- 90 Seconds or < T+ 20 Seconds, Disable All Heaters.

Failure mode analysis?

Heater Controller Section Physical Layout

Max. height < 8"

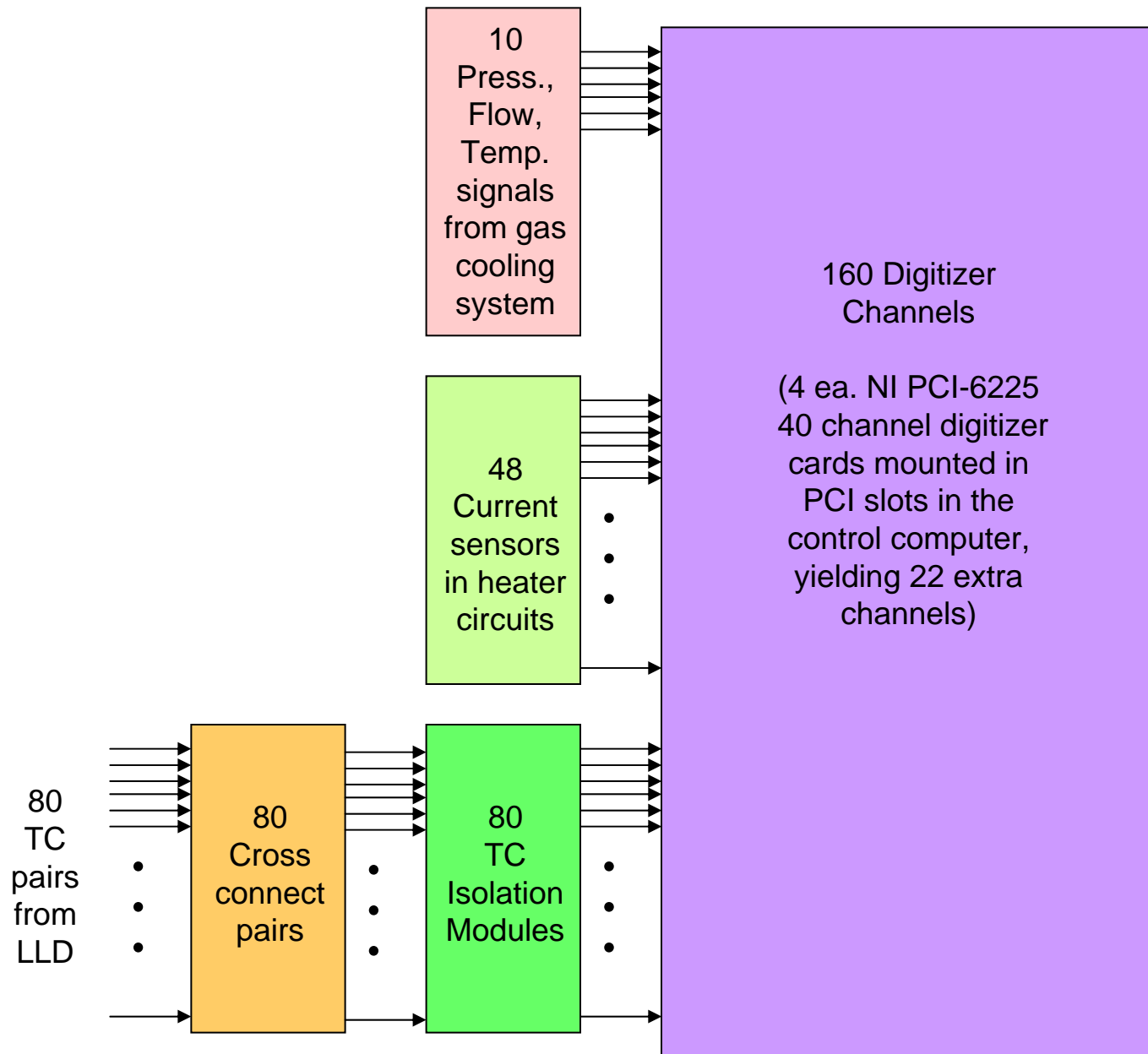
EIA/TIA-232 connections
to control computer



Data Acquisition System

- Data Acquisition System Block Diagram
- Data Handling Philosophy
- LLD Control Computer will be Similar to Other NSTX Test Cell Computers
- Computer Block Diagram
- LLD Rack Back View Showing Locations for TC Modules and X-connects

Data Acquisition System Block Diagram



Data Handling Philosophy

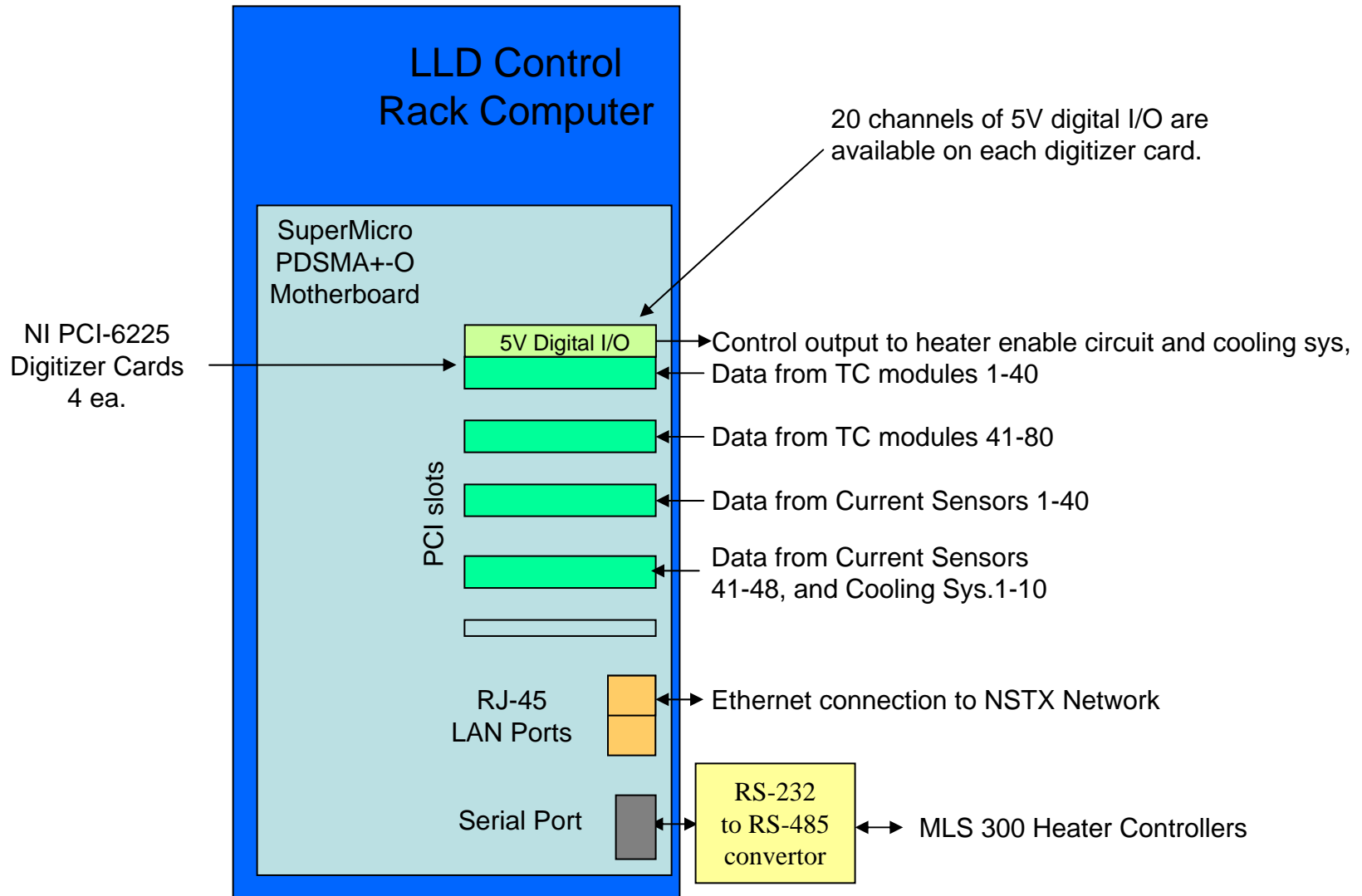
1. All data lines from the LLD will be electrically isolated from the digitizers; the TCs by the FC-T1 modules (1500 V) and the heater currents by the CST-1010 transformers (>1500 V).
2. Outputs from the isolation devices will be connected to the inputs of the digitizer channels in the control computer (or in the case of the heater control TCs connected to sensor inputs of the MLS-300 heater controllers). All data will be available to the control program via communication with the digitizers and the controllers.
3. The data acquisition program on the computer will be part of the overall control program and will likely be written in Labview. The program will analyze in real time some data as part of the control process, archive all data at some selectable sampling rate, and display selected data to the console at an operator selected rate (like 1 Hz).
4. The control computer will be connected via Ethernet to the NSTX network. The archived data from any shot would be available to anyone with network access to the control computer.

LLD Control Computer will be Similar to Other NSTX Test Cell Computers

4U; DualCore; 3GB(8GB Max) ECC Mem; 36GB/150GB 10K drives; 5:PCI, 1:PCI-X 64bit 133MHz, 1:PCIe x8

Description	Mfrgr	Model	Qty	Unit Cost	Cost	Vendor	Vendor p/n
Processor	Intel	Core 2 Duo E7300 2.66GHz 3MB	1	\$139.99	\$139.99	www.newegg.com	N82E16819115132
Memory	Kingston	2GB Kit 1GB PC2-5300 ECC UnReg	1	\$48.99	\$48.99	www.newegg.com	N82E16820134337
Memory	Kingston	1GB Kit 1GB PC2-5300 ECC UnReg	1	\$29.99	\$29.99	www.newegg.com	N82E16820134336
Motherboard	SuperMicro	PDSMA+-O	1	\$241.99	\$241.99	www.newegg.com	N82E16813182118
Power Supply	Seasonic	S12 Energy plus SS-550HT	1	\$135.99	\$135.99	www.newegg.com	N82E16817151027
DVD Burner	LG	GSA-H55NK	1	\$27.99	\$27.99	www.newegg.com	N82E16827136117
CPU Heatsink	Scythe	SCMNJ-1000 Ninja Mini CPU Cooler	1	\$29.99	\$29.99	www.newegg.com	N82E16835185046
60mm Fan	Rexus	Panaflo 60mm x 25mm 3-pin fan	2	\$7.99	\$15.98	www.newegg.com	N82E16835705022
92mm Fan	Rexus	Panaflo 92mm x 25mm 3-pin fan	2	\$7.99	\$15.98	www.newegg.com	N82E16835705008
74GB Hard Drive	WesternDig	WD740ADFD 74GB SATA	2	\$139.99	\$279.98	www.newegg.com	N82E16822136033
LCD Console	ATEN	CL1000M 17" LCD Console	1	\$557.12	\$557.12	www.provantage.com	ATEN08C
4U Rack Mount Case	AIC	EJ-RMC4S	1	\$115.00	\$115.00	www.mypccase.com	EJ-RMC4S
Rack Mount Rails	AIC	EJ-SL8101220	1	\$32.00	\$32.00	www.mypccase.com	EJ-SL8101220

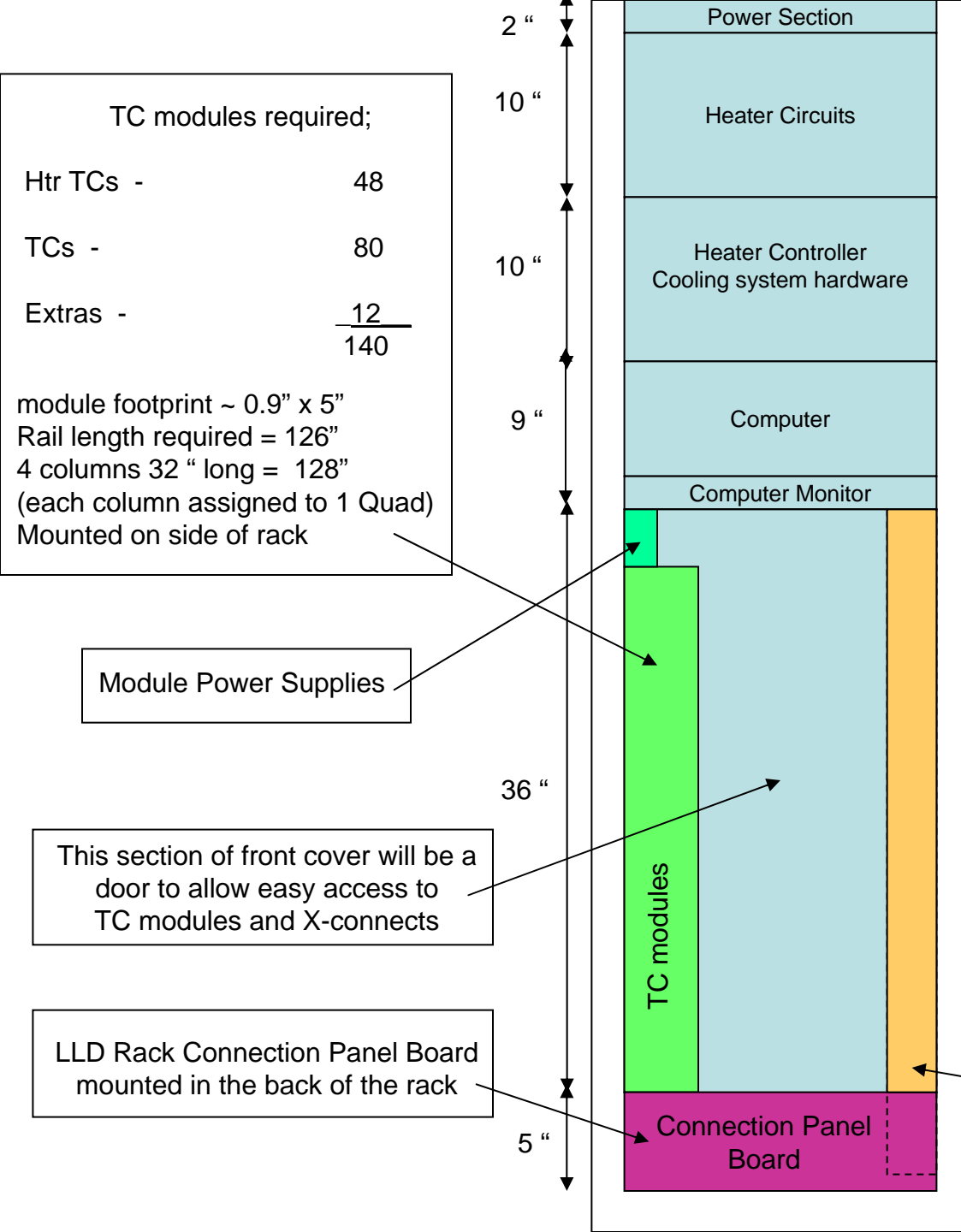
Computer Block Diagram



LLD Rack Back View Showing Locations for TC Modules and X-connects

TC modules required;	
Htr TCs -	48
TCs -	80
Extras -	$\frac{12}{140}$
module footprint ~ 0.9" x 5"	
Rail length required = 126"	
4 columns 32" long = 128"	
(each column assigned to 1 Quad)	
Mounted on side of rack	

X-connects required;			
Heaters -	$48 \times 2 =$	$96 + 4 \text{ ex} =$	100
Htr TCs -	$48 \times 2 =$		96
TCs -	$80 \times 2 =$		160
Extras -			$\frac{24}{380}$



X-connect footprint ~ 1 cm x 5 cm

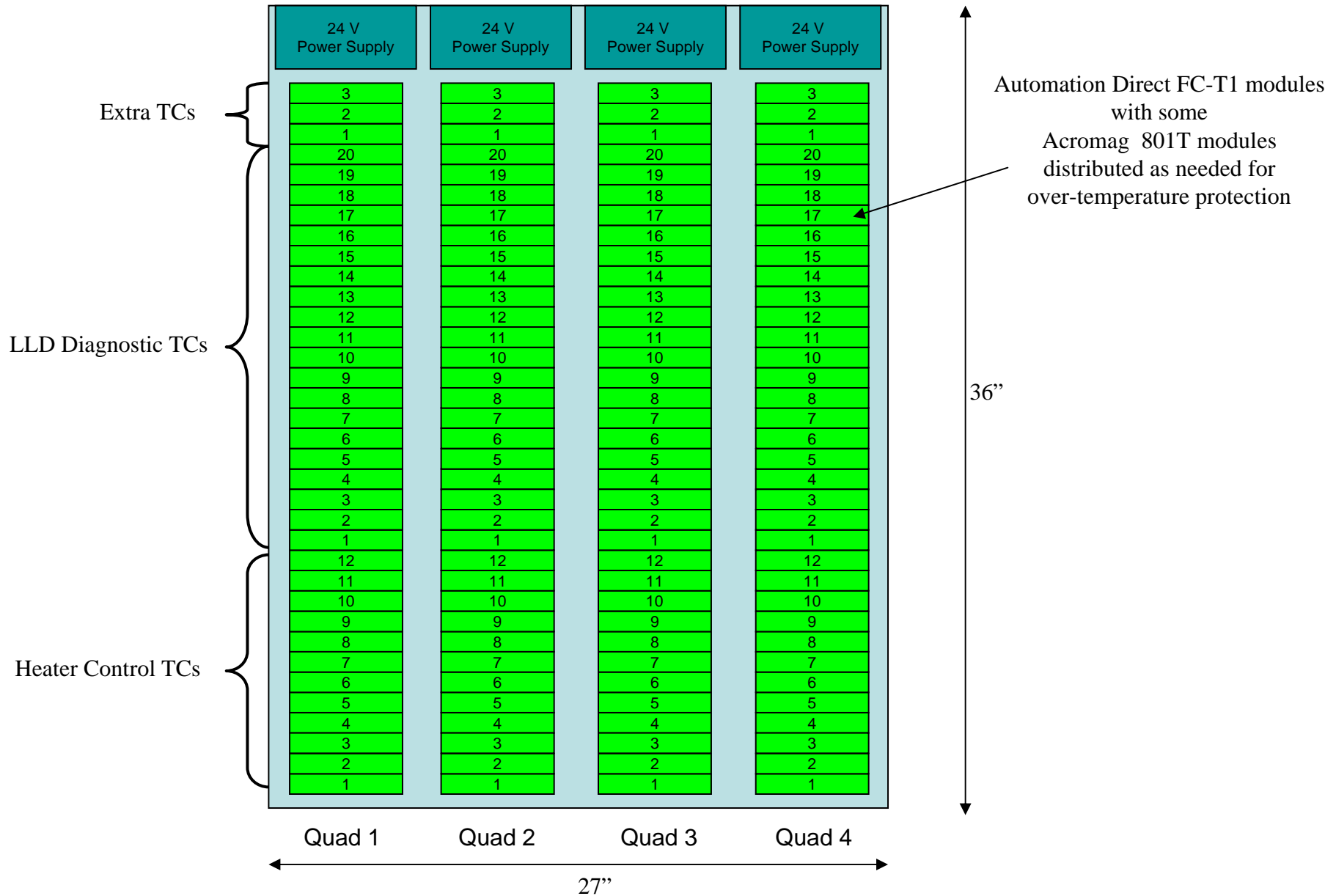
Heaters – 1 column 100 ea. 40" long
(4 groups 1/Quad)

Htr TCs – 1 column 100 ea. 40" long
(4 groups 1/Quad)

TCs – 2 columns 90 ea. 36" long
(2 groups / column
each group assigned to 1Quad)

Mounted on side of the rack
40" columns located near front
of rack to avoid interference with
connection Panel Board

TC Module Physical Layout (side view)



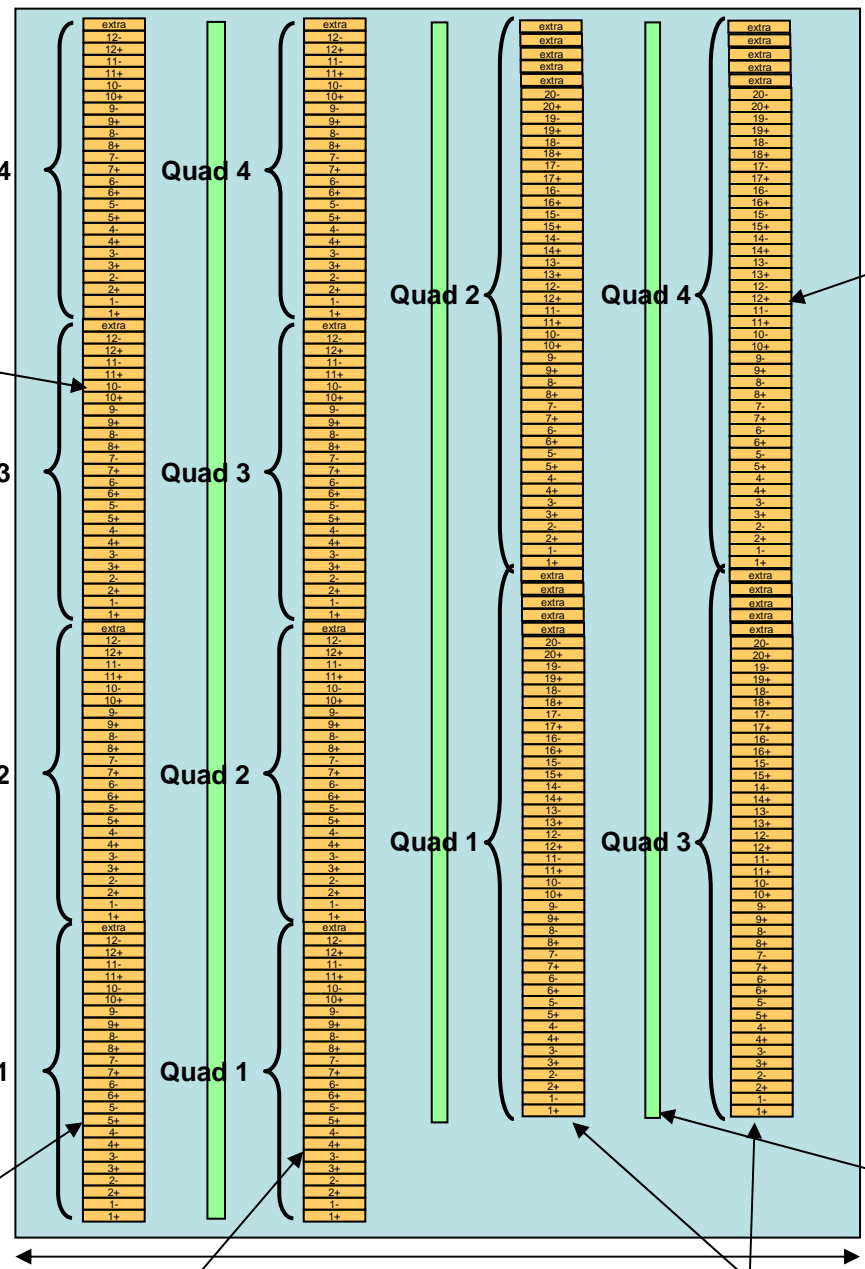
Cross Connects Physical Layout (side view)

Heater Cross Connects
Weidmuller - 5A fused
WSI 4/LD 60-150V AC/DC
1886570000
100 ea.

TC Cross Connects
Weidmuller – type K
WDU 2.5/TC TYP K
1024100000
280 ea.

41"

TC Shield buss mounted
on standoffs to base plate



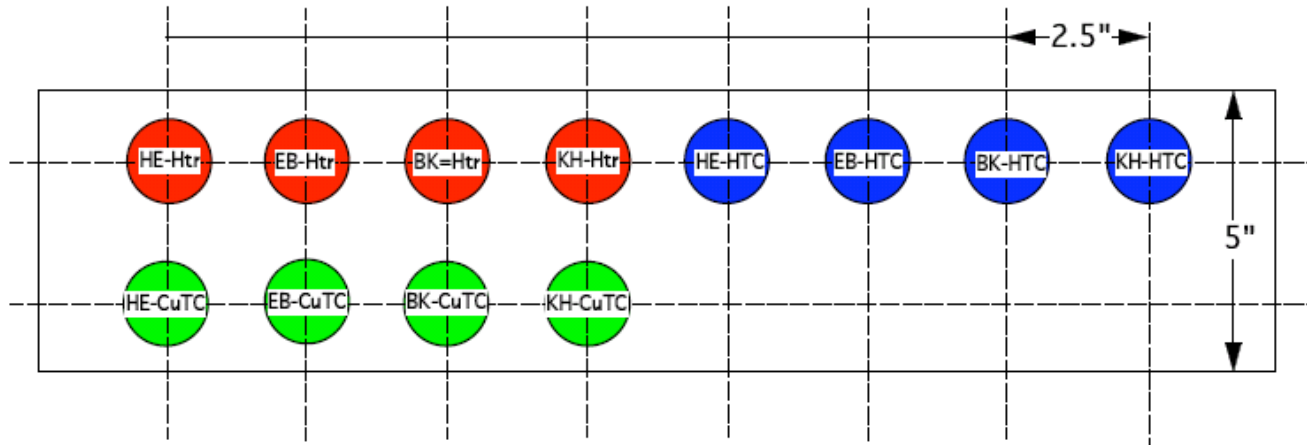
Heater Connections
96 + 4 extra

Heater Control TCs
96 + 4 extra

27"

LLD Diagnostic TCs
each column 80 + 10 extra

LLD Control Rack Panel Board Layout



BULKHEAD PANEL CONNECTOR, HEATER POWER (Htr). SEE FEEDTHRU LAYOUT.



BULKHEAD PANEL CONNECTOR, HEATER THERMOCOUPLES (HTC). SEE FEEDTHRU LAYOUT.



BULKHEAD PANEL CONNECTOR, COPPER THERMOCOUPLES (CuTC). SEE FEEDTHRU LAYOUT.

NOMENCLATURE: "HE" = THE LLD SEGMENT BETWEEN BAY-H AND BAY-E

LLD CONTROL RACK PANELBOARD
REV: 07-NOV-08-A-HK/LR

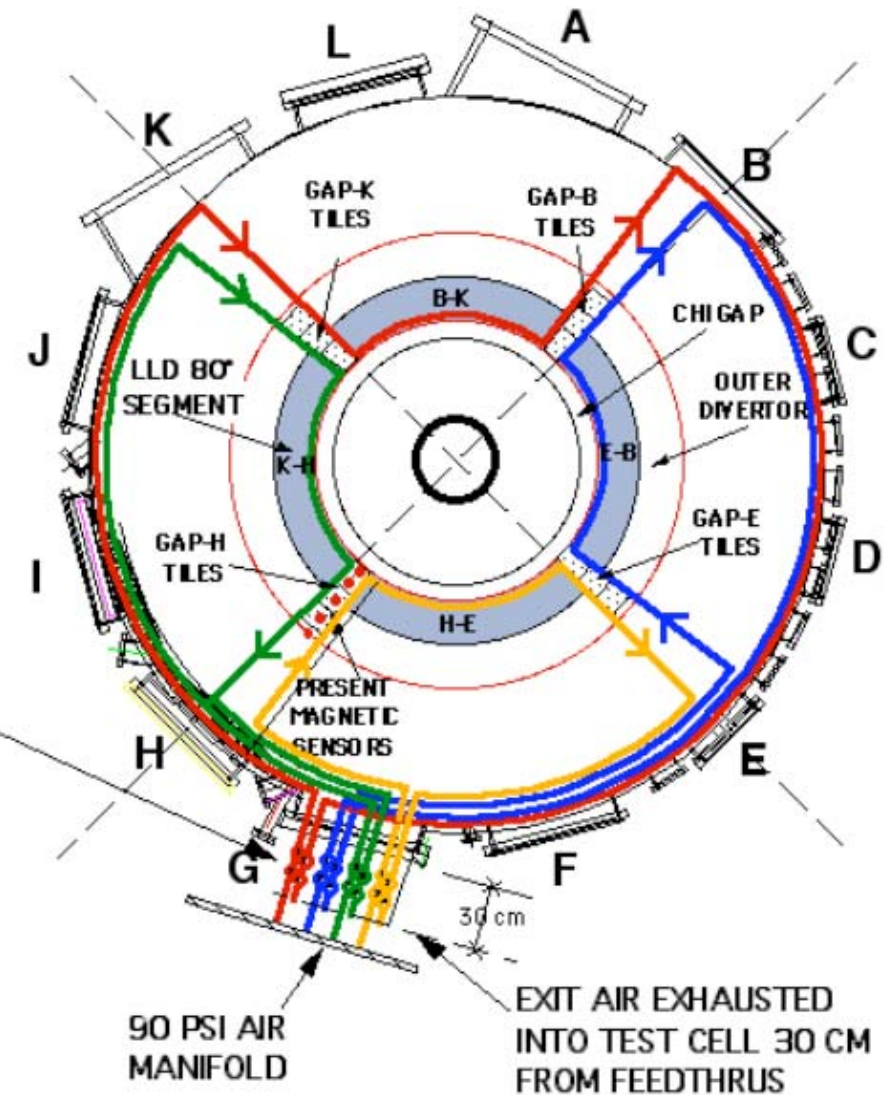
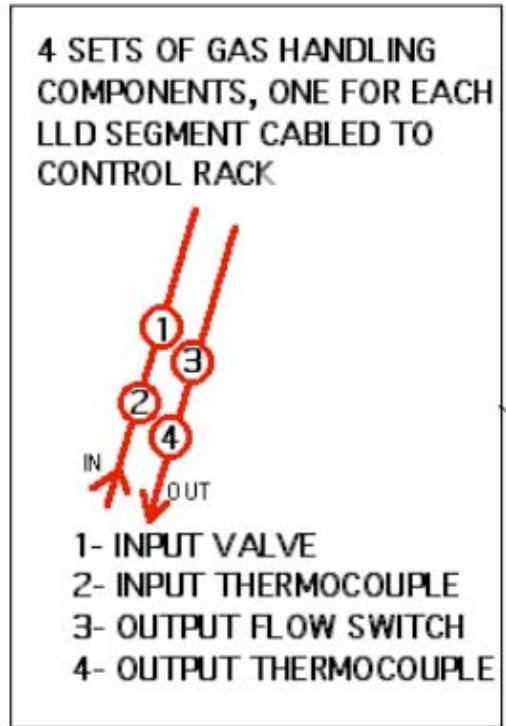
Gas Cooling System

- Description of the Cooling System
- Gas Tubing Physical Layout
- LLD Gas Cooling System Block Diagram

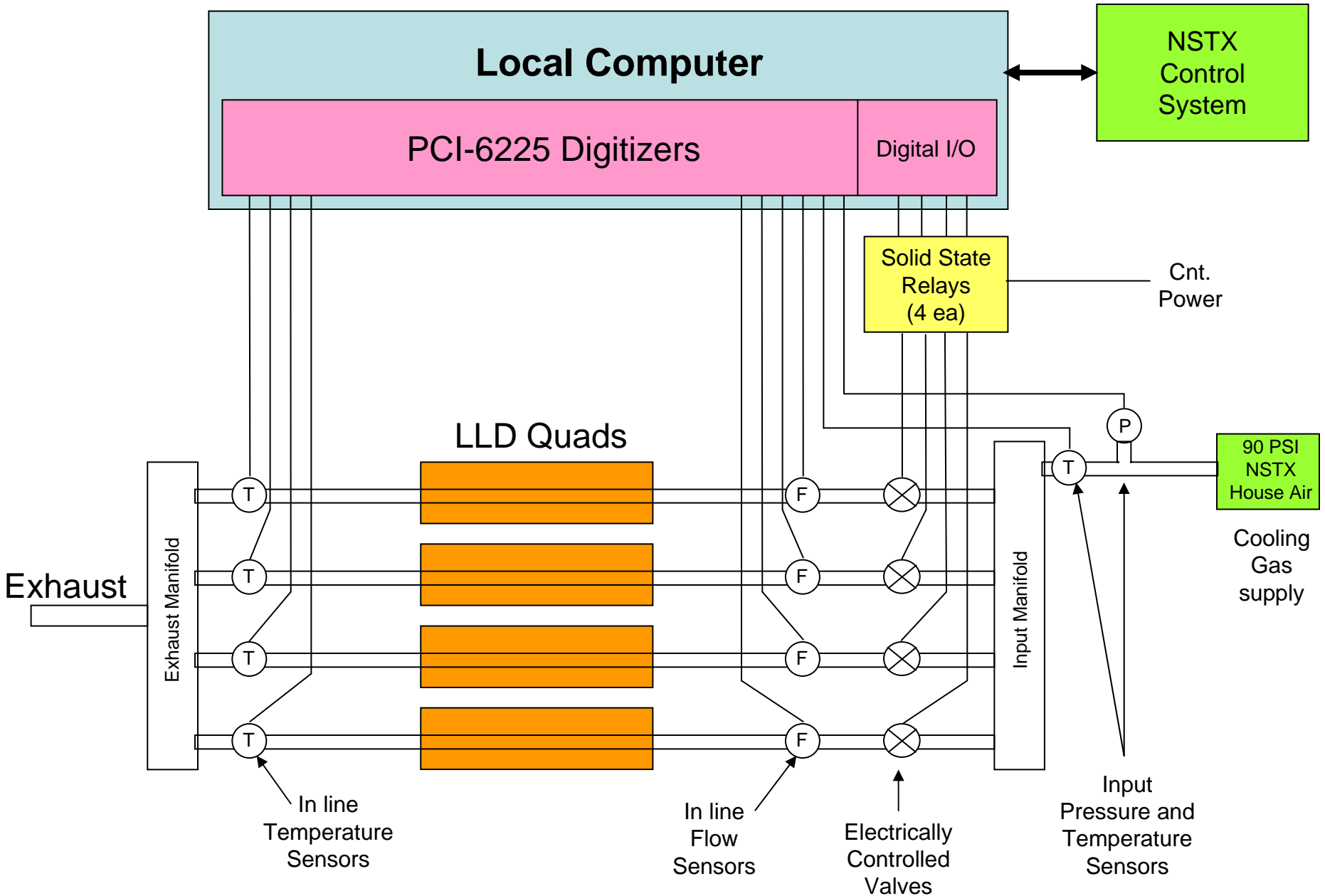
Description of the Cooling System

- The Purpose of the gas system is to provide cooling of the LLD plates between shots.
- A layout of the tubing runs inside the Vacuum Vessel has been developed.
- Mass flow rate calculations for this layout are now being done at SNL.
- The manifolds, valves, and sensors in the cooling system will be located near the feed through bulkheads (Mark Cropper PPPL).
- Electrical cabling will be run from the sensors and valves to the control rack.

Gas Tubing Physical Layout



LLD Gas Cooling System Block Diagram



Conclusion

- A Design for the LLD Control Rack Which Meets Requirements has been Developed
- Pending FDR Approval Procurement is Ready to Begin
- Assembly, Software Development, and Testing Should be Completed in March 09

Back-up slides follow

LLD Rack Component Descriptions

- LLD Control Rack Parts List
- Photographs and descriptions of most components

LLD Control Rack Parts List

item #	part	qity. req.	supplier	model	unit cost	tot. cost	lead time	description
1	rack	1	Newark	93B7076	924	924		full size equipment rack with fan
2	relay box	1	Newark	06B6142	74	74		Hoffman 8"x8"x6" NEMA 1 box
3	main relay	1	Kilovac	FM200	300	300		3 pole, 208 V, 200 A, 120 V control relay
4	breaker panel box	1	Siemens	G3030MB3100cu		0		EQIII 3 phase Load Center 30"x15"x4"
5	3ph. cir. Breaker	8	Siemens	Q320	241.0	1928		3 phase 20 A circuit breaker
6	1ph. cir. Breaker	1	Siemens	Q115	32.00	32		1 phase 15 A circuit breaker
7	iso. transformer	1	MGE Inc	T100R-1800	800	800		1800 kVA 120-120 V Iso. Transformer
8	line filter	1	SCHAFFNER	FN 2060B-20-06	50	50		20 A, 120 V, line filter
9	solid state relay	1	Newark	87F089	45	45		10 A, 280 V, 24 V control SS relay
10	ss relays	48	Cybernetics	SSR-2490-10A-DC1	31	1488		10 A, 240 V, 5 V control SS relay
11	htr. output relays	48	DURAKOOL	D2-2012-23-5120-WTL	6	288		12 A, NO, DPST, 120 V control relays
12	current monitors	48	TRIAD	CST-1010	5	240		10A AC current sensors
13	varistor	48	Newark	57K2415	0.3	14.4		275 Vrms varister
14	htr. X-connectors	100	Weidmuller	1886570000		0		cross connectors for htrs - fused 5A
15	TC X-connectors	280	Weidmuller	1024100000		0		cross connectors for TCs - black
16	TC Modules	140	automationdirect	FC-T1	120	16800		TC isolation modules (1900 V, 4-20 mA out)
17	TC Modules w trip	10	Acromag	811T	400	4000		TC iso. Module with trip switch
18	Module PS	4	Newark	77M9132	55	220		24 V, 2 A DC power supply for TC modules
19	digitizer card	4	National Inst.	NI PCI-6225	1750	7000		40 channel digitizer card with 20 digital I/O channels
20	htr. Controller	2	Cybernetics	MLS300	5265	10530		32 channel SS relay controller (PS & commun.)
21	solid state relay	5	Newark	87F089	45	225		in line cooling gas temperature sensors
22	computer	1	Newegg		1700	1700		computer for control, communication, & data archive
23	software htr. cnt.	1	Cybernetics	HM! Standard edition	995	995		HMI MLS300 controller software
24	software DAS	1	National Inst.	Labview		0		National Instruments Labview software
25	miscellaneous	1			5000	5000		
	TOTAL					47653		

Full Size Equipment Rack



Manufacturer: [BUD INDUSTRIES](#)

Newark Part Number: 93B7076, \$924

Manufacturer Part No: ER-16625-BT

[RoHS Compliance](#) : Yes No

Description

- Cabinet Rack
- External Height: 75.31"
- External Width: 22"
- External Depth: 30.75"
- Panel Space: 70"
- Drop Ship: Yes
- Enclosure Color: Black
- Enclosure Material: Steel
- Internal Depth: 29.25"
- Internal Width: 19"
- Panel Width: 19.00" RoHS Compliant: Yes

Cost ~ \$1000 ea.

Enclosure for Heater Power Main Relay



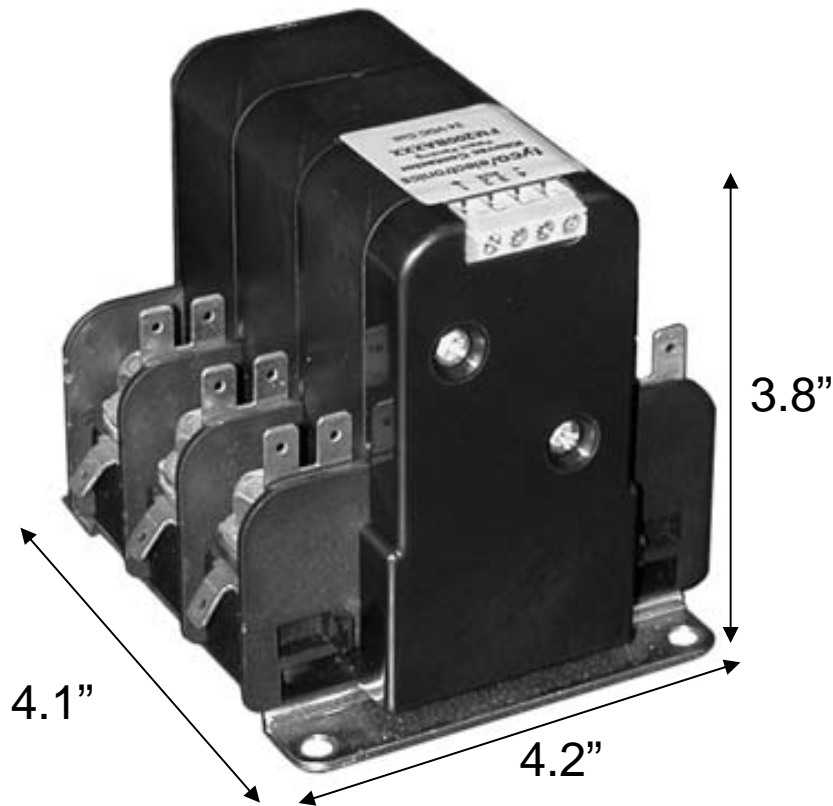
8" x 8" x 6"

Newark Electronics, Inc.
www.newark.com

Hoffman - NEMA type 1 steel enclosure
Manufacturer part # - A8N86
Stock # - 06B6142
Price - \$73.80

Main Power Relay

**KILOVAC FM200 (“FLATMAN”) Series 1-, 2- or 3-pole Contactor
With Contacts Rated 200 Amps, 480Vac (50/60 Hz.) or 48Vdc**



Product Facts

Multi-pole configurations

Normally open, normally closed & mixed contact arrangements

Optional quick connect tabs for sensing

Small, lightweight & cost effective

– designed to be the smallest, lowest cost contactor in the industry with its current rating

Standard models available

with 12VDC, 24VDC and 115 VAC coils.

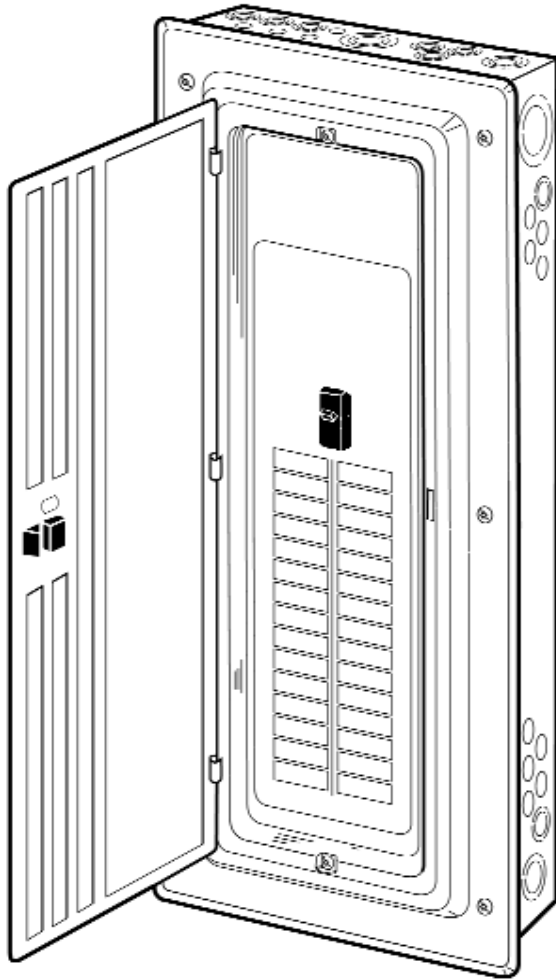
Consult factory for 240VAC coil models.

1 Form A auxiliary contacts

Cost ~ \$300 ea.

LLD Power Pannel Box for Circuit Breakers

Siemens Energy and Automation, Inc.
www.siemens.com



30" x 14.4" x 3.94"

EQIII 3-Phase Load Centers G3030MB3100cu

General Information

UL Listed.

- Copper bus bars.
- Rigid trim with trim mounting tabs which free up both hands for driving trim screws.
- Circuit directory labels are included and can be applied next to branch breakers.
- Type QP circuit breakers from 60 to 100 amps can be installed as backfed main breakers using the ECMBR1 hold down kit.
- Type QPJ circuit breakers are not acceptable for use in EQIII load centers.
- Type QN circuit breakers are acceptable for use in EQIII load centers.
- The neutral tie strap can be removed, when replaced by the ECINTS kit, to make the left side neutral bar into a ground bar.

LLD Control Rack Circuit Breakers



Heater power circuit breakers

Manufacturer: **Siemens**

Part Number: Q320

3 phases 20 A / phase

Cost ~ \$241 ea.



Control power circuit breaker

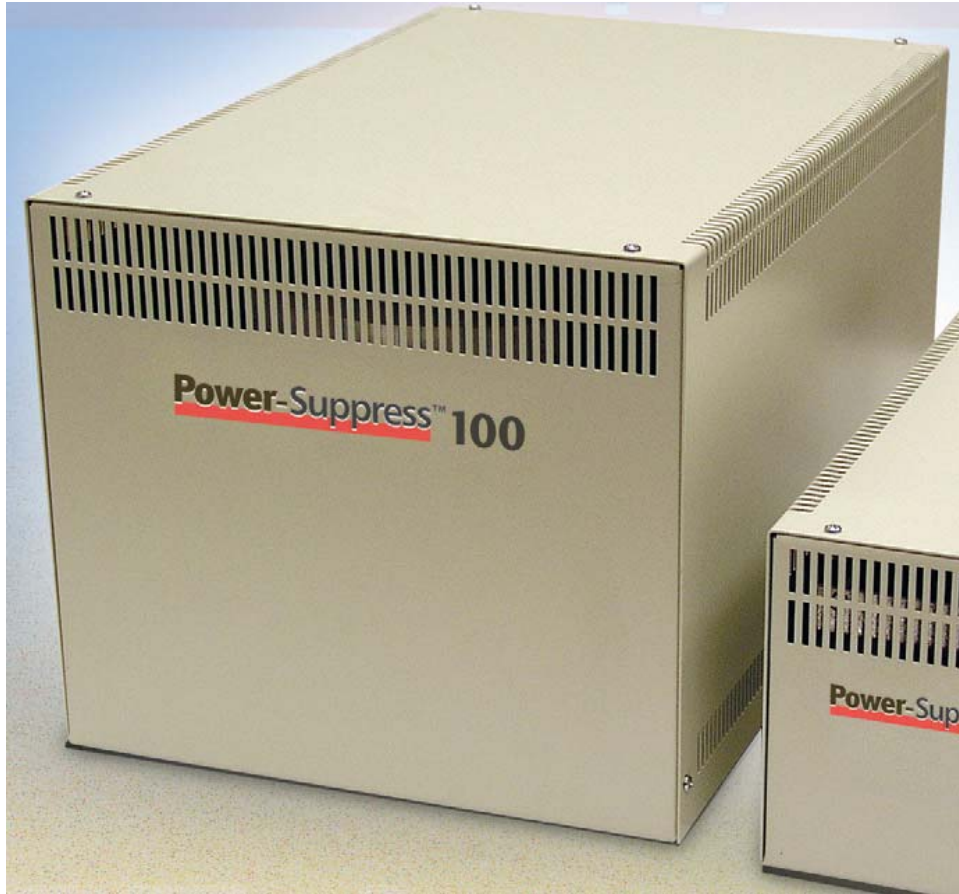
Manufacturer: **Siemens**

Part Number: Q115

1 phase 15 A

Cost ~ \$31.50 ea.

Isolation Transformer for Control Power



MGE UPS SYSTEMS, INC.

www.mgeups.com

Power-Suppress™ 100

Characteristics

Input voltage/Frequency	120, 240, 480V*/60 Hz
Common-mode noise	140dB @ 100kHz
Normal-mode noise	65dB @ 100kHz
Overload capacity	600% for 1 cycle 300% for 30 seconds
Dielectric strength	2,500 VAC minimum
Frequency	60 Hz ±5%
Impedance	2 – 5% typical
Efficiency	93 – 97% typical
Input voltage range	±10% of nominal rated voltage
Load regulation	2 – 5% or less no load to full load, unity power factor
Harmonic distortion	Adds less than 1% THD, under linear loading
Coil insulation	200°C
Temperature Rise	115°C max rise above a 40°C ambient
Electro-magnetic interference	<0.2 gauss @ 36 inches

Environments

Audible noise	<50dB measured 3' from noise suppressor
Operating temperature	0°C to 40°C
Storage temperature	-20°C to 50°C
Operating altitude	Up to 12,000 feet with derating
Operating humidity	95% relative (non-condensing)

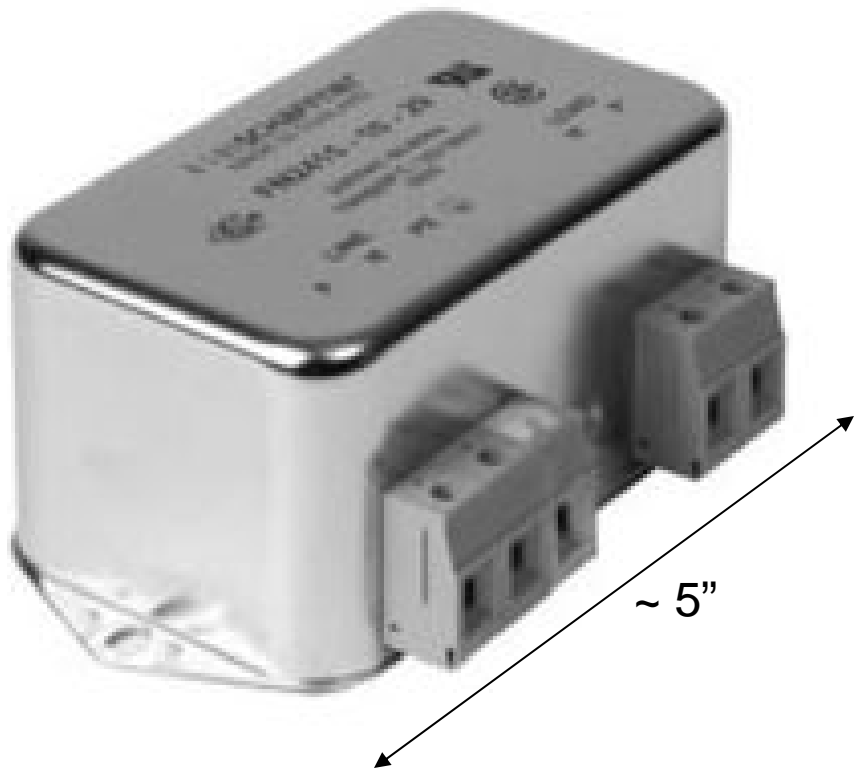
Standards

Safety Agency UL 1012, UL 1449, cUL listed, ANSI/IEEE C57.12.91
Meets FCC Category A, IEEE C62.41 Category A3
Warranty 2 years, 5 years for core and coil

Model #	T100R-1800
Voltage Input/Output	120 / 120
Power Rating	1800 VA
Dimensions (HWD/in.)	11" x 17" x 10.5"
Weight	54 lbs

Cost ~ \$ 800 ea.

Line Filter for Control Power



Manufacturer: [SCHAFFNER](#)

Newark Part Number: 01C7576

Manufacturer Part No: FN 2060B-20-06

[RoHS Compliance](#): Yes

Description

- EMC/RFI Filter
- Filter Type: EMI
- Current Rating: 20A
- Voltage Rating: 250VAC
- Capacitance: 1uF
- Inductance: 0.6mH
- Terminal Type: Quick Connect RoHS

Solid State Relay for Heater Power Enable Circuit



Manufacturer: [CRYDOM](#)
Newark Part Number: 87F089
Manufacturer Part No: DSD2410
[RoHS Compliance](#) : _ YesX

Description

Solid-State Panel Mount Relay
Control Voltage Type:DC
Load Current RMS Max:10A
Control Voltage Max:15V
Control Voltage Min:3.5V
Load Voltage 48 – 280 Vrms
Output Current Max:10Arms
Output Current Min:0.04Arms
Output Device:SCR
Output Type:SCR

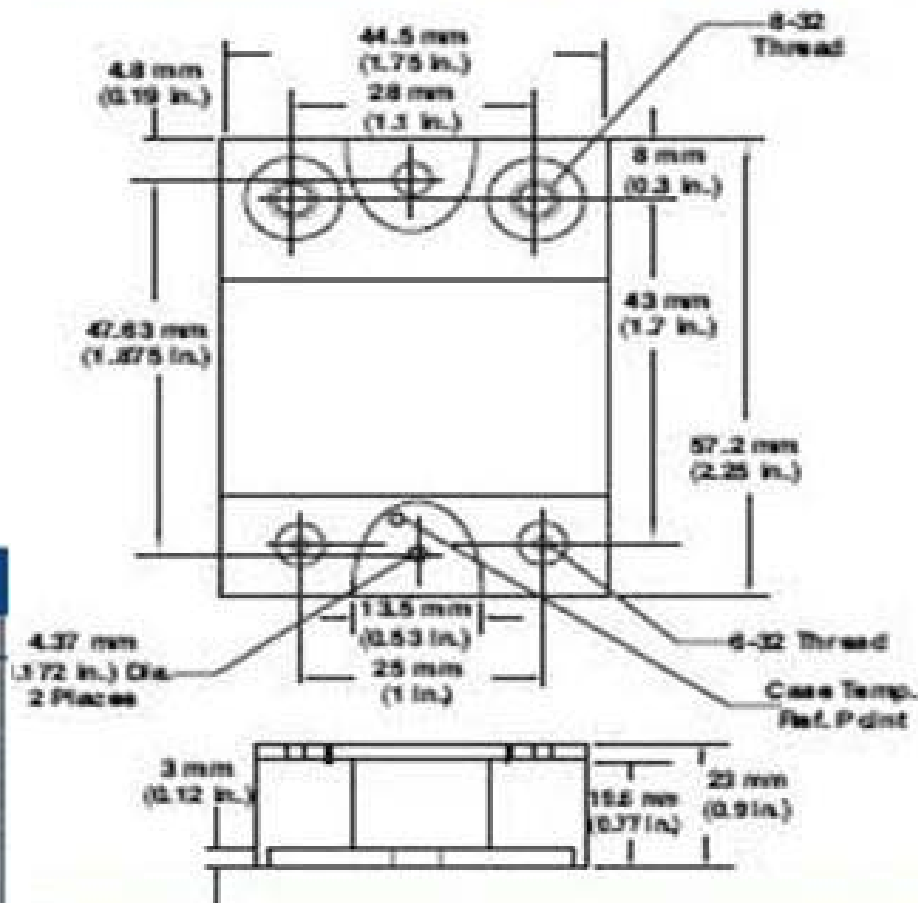
Cost ~ \$45.00

Watlow SSR-240-10A Solid State Relay



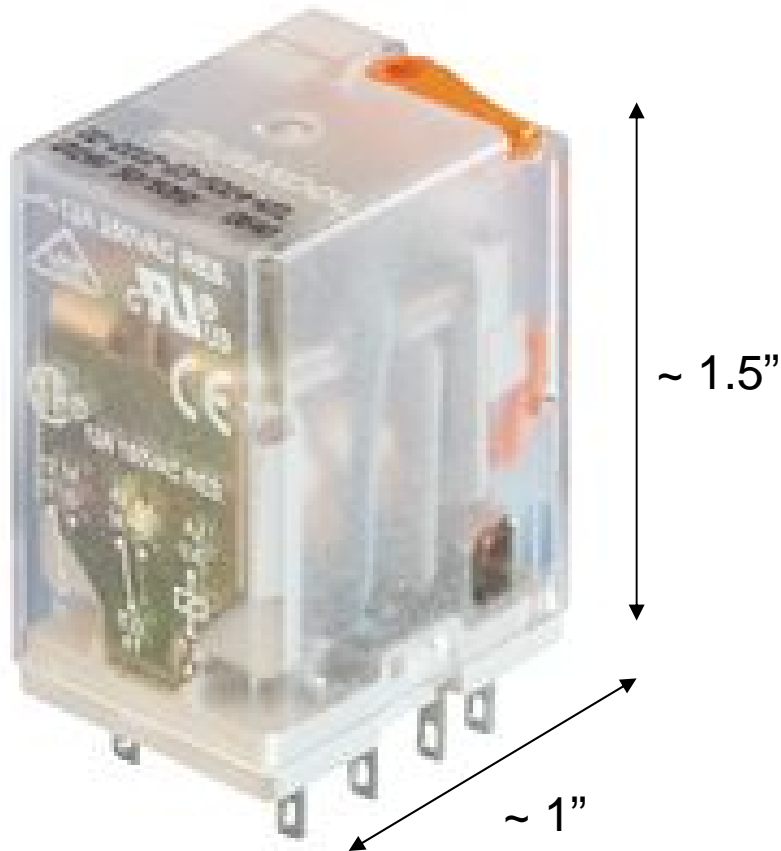
Cost: ~ \$31 ea.

Dimensions - Solid State Relay



120/240V~(ac)	
Model Number	SSR-240-10A-DC1
Current output	10A
Nominal voltage	120/240V~(ac)
One cycle surge current	120A
Max. I ² t for fusing	60A ² seconds
Thermal resistance	1.48° C/W
Base plate temperature	-40 to 75°C (-40 to 167°F)
Output (Max.)	
Voltage range	48-280V~(ac)
Over voltage rating	600V (peak)
Off state leakage	10mA

Heater Output Relay



Manufacturer: [DURAKOOL](#)

Newark Part Number: 78M6817

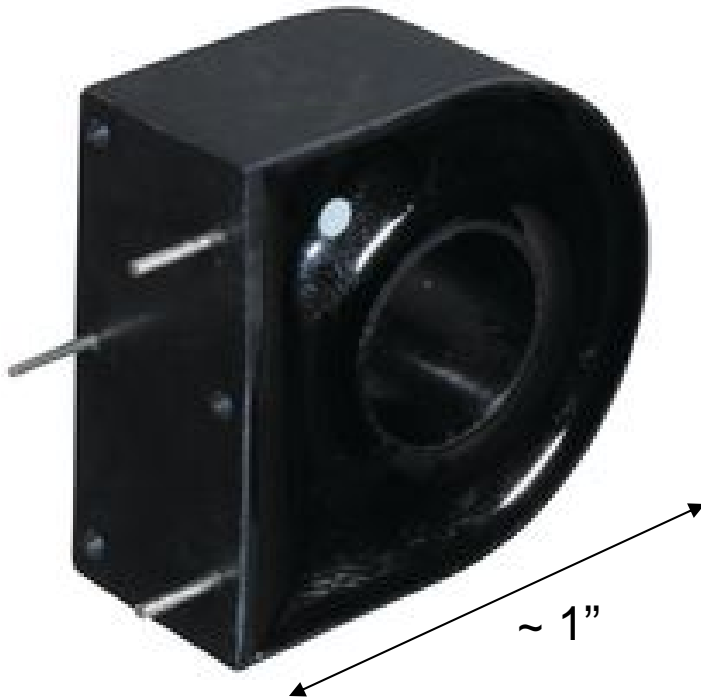
Manufacturer Part No: D2-2012-23-5120-WTL

Cost: ~ \$6 ea.

Description

- Industrial Relay
- Coil Resistance: 3770ohm
- Contacts: DPST-2C/O
- Relay Mounting: Plug-In
- Coil Power VAC: 1.6VA
- Coil Voltage AC Max: 120V
- Contact Carry Current: 12A
- Relay Terminals: Plug-In

Heater Current Sensors



Manufacturer: [TRIAD MAGNETICS](#)

Newark Part Number: 89M4937

Manufacturer Part No: CST-1010

Cost: ~ \$5 ea.

Description

- Current Sense Transformer
- DC Resistance Max: 40ohm
- Leaded Process Compatible: Yes
- Mounting Type: PC Board
- Series: CST
- Turns Ratio: 1000: 1
- Weight: 20g RoHS Compliant: Yes

Heater Circuit Transient Voltage Protection



Metal Oxide Varistor (MOV)

Newark part # 57K2415

Manufacturer LITTELFUSE - V275LA20AP

Voltage Rating AC, Vrms:275Vrms;

Suppressor Type:Transient Voltage;

Voltage Rating, VDC:369V;

Peak Surge Current @ 8/20uS:4500A;

Clamping Voltage 8/20us Max:710V;

Cost ~ \$0.30 ea.

Weidmuller Cross Connects for Heater Lines

Weidmuller USA:
www.weidmuller.com



Fused terminal block with LED and 5a fuse

Order No. 1886570000

Part designation WSI 4/LD 60-150V AC/DC

Version Fuse terminal, 4 mm², Screw connection,
Wemid,

black, TS 35

Dimensions

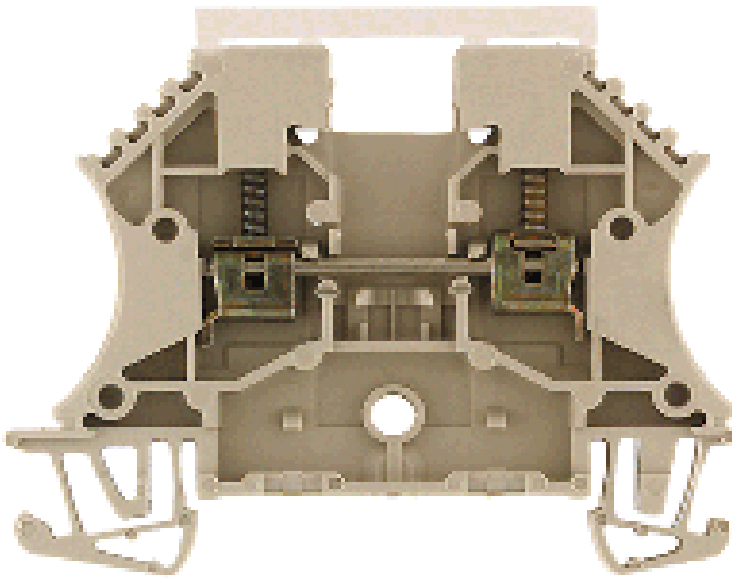
Width 9.1 mm

Height of lowest version 54 mm

Length 50.7 mm

Weidmuller Cross Connects for TC lines

Weidmuller USA:
www.weidmuller.com



Order No. 1024100000

Part designation WDU 2.5/TC TYP K

Version Special terminal, special connections, 2.5 mm²,

Screw connection, Wemid, dark beige, TS 35

Dimensions

Width 10.2 mm

Height of lowest version 50.5 mm

Length 60 mm

FC-T1 Thermocouple/mV Input Isolated Signal Conditioner

Automation Direct

Output Range 4 to 20 mA

External Power Supply 15 mA, 22 to 26 VDC

Input Impedance >5 M

Absolute Maximum Rating Fault protected input ± 50 V

Maximum Inaccuracy $\pm 3^{\circ}\text{C}$, Temperature Input, $\pm 0.01\%$, Voltage In

Linearity Error 0.1%

Over Temperature Error $0.1 \times 10^{-5}\%$ (10 ppm)/ $^{\circ}\text{C}$

Insulation Resistance 100 Mr with 500 VDC (Input to output power)

Isolation 1500 VAC @ 1 Sec. (Input to output commons)

Sample Duration Time 120 mS Voltage Input, 250 mS TC Input

Common Mode Rejection -100 dB @ DC, -90 dB @ 50/60 Hz

Input Filter (FIR) -3 dB @ 15 Hz, -100 dB @ 50 Hz, -100 dB @ 60Hz

Broken Thermocouple Up/Down Scale, Red/Green LED

Over Range Up Scale

Under Range Down Scale

Burnout Time 3 Seconds

Cold Junction Compensation Automatic

Warm-up Time 30 min. typical $\pm 1^{\circ}\text{C}$ repeatability

Operating Temperature 0 to 60°C (32 to 140°F)

Cost ~ \$120 ea.



Acromag 801T Universal Temperature Input Transmitter with Alarm



Acromag Inc. 811T

Operation

INPUT: thermocouple (types J, K, T, R, S, E, B, N),
RTD (Pt, Ni, Cu), millivolt ($\pm 100\text{mV DC}$), 0 to 500 ohms input
OUTPUT: 0 to 20mA DC, 0 to 10V DC
ALARM: mechanical relay (25V @ 5A)
POWER: 10-36V DC

Special Features

Advanced internal microcontroller
Windows® software configuration
User-programmable input/output ranges
Push button field calibration
High-resolution Sigma-Delta A/D converter
Intelligent signal processing functions
(linearization, averaging, square root)
Limit alarm capability with relay output option
Self-diagnostics
4-way isolation 1500 V
Input excitation supply for a 2-wire transmitter or relay input

Cost

~ \$400 ea.

Power Supply for TC Modules



Manufacturer: [XP POWER](#)
Newark Part Number: 77M9132
Manufacturer Part No: AEB70US24

Description

- External Power Supply
- No. of Outputs: 1
- Output Current: 3A
- Output Power Max: 72W
- Output Voltage: 24V

- Cost ~ \$55.00

NI Digitizer Cards for Computer PCI Slots

National Instruments Corporation
www.sine.ni.com

NI PCI-6225



- 16-Bit, 250 kS/s, 80 Analog Inputs Multifunction DAQ
- Two 16-bit analog outputs (833 kS/s)
- 24 digital I/O; two 32-bit counters; digital triggering
- Select high-speed M Series for 5x faster sampling rates or high-accuracy M Series for 4x resolution
- NIST-traceable calibration and more than 70 signal conditioning options
- Correlated DIO (8 clocked lines, 1 MHz)
- Includes NI-DAQmx, LabVIEW SignalExpress LE data-logging software, and other measurement services



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www.ni.com

Chuck Harjes
Sandia National Laboratories
Bldg 962
Rm 1411
1515 Eubank Blvd SE
ALBUQUERQUE, NM 87123

Quotation Date : 12/01/2008

Phone : 505 845-7106
Fax :

Quotation No. 1208889

Please indicate the above quote number when ordering for faster processing.

Item	Qty.	Part Number	Description	List Price	Disc. %	Net Price
1	4	776295-01 (GSA)	NI PCI-6225, M Series DAQ (80 Analog Inputs, 24 Digital I/O, 2 Analog Outputs) with NI-DAQmx driver software.	\$ 1,179.00	3.24%	\$ 4,563.08
Estimated Delivery Days : 1 - 3 business days ARO. Country of Origin : Hungary						
2	8	192061-02	SHC88-88-EPM Shielded Cable, 88-D-Type to 88 VHDCI Offset, 2 m	\$ 129.00		\$ 1,032.00
Estimated Delivery Days : 1 - 3 business days ARO. Country of Origin : China						
3	8	776944-01 (GSA)	SCB-88 Noise Rejecting, Shielded I/O Connector Block	\$ 289.00	3.24%	\$ 2,314.40
Estimated Delivery Days : 1 - 3 business days ARO. Country of Origin : Hungary						
Shipping and Handling:						\$ 17.90
Total:						\$ 7,927.38

Currency quoted in : U. S. Dollars

To ensure the highest quality service in order processing and support after delivery, please provide end-user information with your purchase order.

Payment Terms : Net 30
Quote Valid Until : 31-DEC-08
Freight Terms : NI Weight Based Shipping

All sales are subject to the enclosed National Instruments terms and conditions of quotation and sale. National Instruments shall not be bound by any conflicting or additional Terms and Conditions. Standard shipping dates are based on product availability at time of quotation and are subject to change without notice. Not all products produced by National Instruments are made in the U.S.A.

Yours sincerely,
National Instruments Corporate
Allan, Geoffrey Scott

Modular Loop System Providing up to 32 Zones of Control

Features and Benefits

PID control of up to 16 heat and cool loops or 32 heat loops

- Minimizes panel space per loop
- Reduces installation time
- Increases reliability, fewer parts mean fewer failures

Auto-tune

- Requires less time tuning
- Achieves excellent control with less expertise

Menu guided operation with full text display

- Allows quick setup of the controller
- Simplifies operation

Store and recall eight jobs

- Changes quickly from one process to another

Multiple and mixed inputs

- Accepts combinations of thermocouples, RTDs, linear dc voltage and linear dc current sensors
- Reduces learning curve and inventory

Sensor fail detection

- Reduces time troubleshooting reversed, shorted and open sensors

High/low process and deviation alarms for each input

- Integrates as needed with PLC and other control elements

34 digital outputs

- Provides flexible configuration
- Allows use of outputs as needed for control and alarms

TIA/EIA-232 and 485 communications

- Connects to software for easy configuration and operation
- Allows integration with controllers and software

CIM300 option

- Small footprint per loop
- Reduces installation time

UL® and C-UL® are registered trademarks of Underwriter's Laboratories, Inc.



The SERIES MLS300 is a powerful line of controllers that combines performance and flexibility with compact design. The 16 and 32 loop versions provide complete control solutions for a broad range of applications. Support for multiple types of sensor inputs is available; including thermocouples, RTDs, linear voltage, current and frequency. Each controller can operate as a stand-alone system, and includes built-in serial communications for computer interface and data acquisition. Optional, programmable ramp and soak features allow complex batch processing and sequencing. The enhanced features option offers cascade, ratio and differential control, process variable retransmit and remote analog set point.

The remote analog input options allow for shorter sensor wires and flexible mounting which reduces sensor cost and installation time. Watlow offers two input modules. The analog input module (AIM) provides screw terminations for sensors. The compact input module (CIM) provides connector terminations in a compact size, which saves OEMs space and labor costs. This innovation allows users to construct a wiring harness to attach sensors via a connector instead of connecting individual wires to the controller.

The SERIES MLS300 controllers are UL® and C-UL® listed, meet the requirements of the European Community EMC Directive and carry the CE mark.

 **WATLOW**
Better Thermal Solutions...Faster
 1241 Bundy Boulevard
 Winona, Minnesota 55987-5580 USA
 Phone: +1 (507) 454-5300
 Fax: +1 (507) 452-4507
 Internet: www.watlow.com
 E-mail: info@watlow.com

WIN-MLS-0307



WATVIEW Software

WATVIEW is an optional, Windows®-based Human-Machine Interface (HMI) program that can be used as the primary interface to one or more Watlow controllers. WATVIEW provides channel setup and monitoring of multiple controllers at the same time. The easy-to-use Graphical User Interface (GUI) allows you to set control parameters, create user-defined recipes, view and manage alarms, set up and view trend plots and real-time data and export logged data to spreadsheet applications. WATVIEW requires less configuration time than other more expensive packages, because it is designed specifically for Watlow controllers.

DAC and SDAC Modules

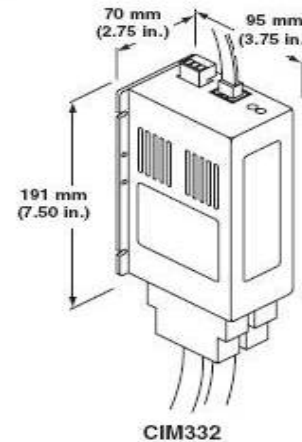
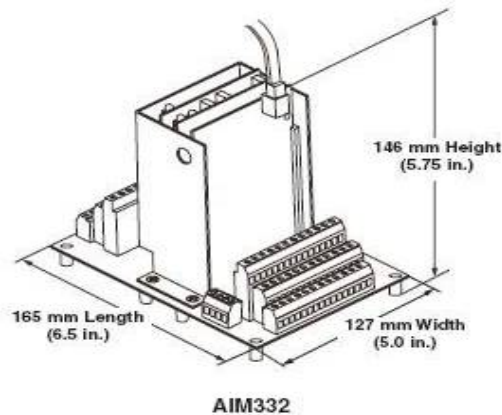
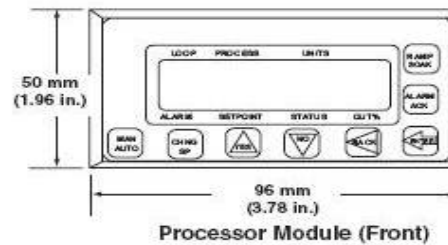
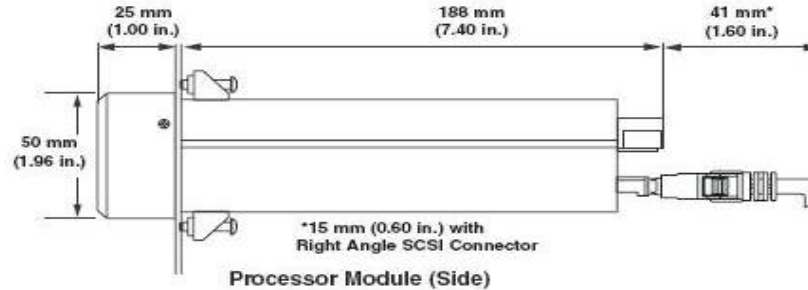
The optional DAC and SDAC modules are available for Watlow's SERIES MLS300 controllers.

DAC

The DAC (digital to analog converter) converts one or two of the controller's distributed zero crossing (DZC) output signals to analog signals. Each output is field configurable for 4-20mA=(dc), 0-5V=(dc) or 0-10V=(dc).

SDAC

The SDAC (serial digital to analog converter) converts one controller output to a precise analog voltage or current signal. The unit is typically used for process variable retransmit, open-loop control, motor or belt speed control or phase-angle fired SCR power controllers. The SDAC bears the CE mark and is UL® and C-UL® listed.



MLS300 Specifications

Operator Interface

- 32-character vacuum fluorescent display
- 8-key keypad to access guided menus and prompts, enter passkey sequence, set values, switch between single channel and multiple channel displays
- Controller's configuration can be loaded through the standard serial port

Analog Inputs

- SERIES MLS316 16 differential
- SERIES MLS332 32 differential

Noise Rejection

- 120dB at 60Hz

Temperature Coefficient

- 40 ppm/°C

Temperature Sensors

- Thermocouples: User selectable type, direct connection, linearization, reference junction compensation, reversed and shorted thermocouple detection and upscale break protection with output averaging.
- RTD: 2- or 3-wires, platinum, 100Ω @ 0°C, DIN 0.003850Ω/Ω/°C curve, user-selectable range. Two user-selectable ranges offer different resolutions. Requires special inputs. See ordering information.

Input Range and Accuracy

Sensor	Range (°C)	Range (°F)	Accuracy
Type B	66 to 1760°C	150 to 3200°F	±4.0°C
Type E	-200 to 787°C	-328 to 1448°F	±1.0°C
Type J	-212 to 760°C	-350 to 1400°F	±1.2°C
Type K	-268 to 1371°C	-450 to 2500°F	±1.3°C
Type R	-18 to 1766°C	0 to 3210°F	±2.8°C
Type S	-18 to 1760°C	0 to 3200°F	±2.8°C
Type T	-268 to 399°C	-450 to 750°F	±1.6°C
RTD1	-100 to 275°C	-148 to 527.0°F	±1.1°C
RTD2	-120 to 840°C	-184 to 1544°F	±1.6°C

Note: Accuracy @ 25°C (77°F) ambient. Valid for 10 to 100 percent of span except Type B, which is specified for 427°C (800°F) to 1760°C (3200°F). RTD is for 100 percent of span.

Linear Voltage and Current Inputs

Requires special inputs. See Ordering Information.

- 0-10mA=(dc)
- 0-20mA=(dc)/4-20mA=(dc)
- 0-100mV=(dc)
- 0-500mV=(dc)
- 0-1V=(dc)
- 0-5V=(dc)
- 0-10V=(dc)
- 0-12V=(dc)

Other ranges available. Consult factory.

Pulse Input

One TTL-level square wave input up to 2kHz

Input Sampling Rate at 60Hz

Each channel has the following scans per second:

- SERIES MLS316: 1.5 samples per second, (update time: 0.667 sec.)
- SERIES MLS332: 0.75 samples per second, (update time: 1.33 sec.)

Internal Measurement Resolution

- 0.006 percent, greater than 14 bits

Calibration

- Automatic zero and full scale

Digital Inputs

- TTL level used for selecting recipes or jobs, or R/S triggers
- 8 inputs and one pulse input with 50-pin terminal board option

Digital Outputs

- 34 outputs available with 50-pin terminal board option
- 1 or 2 control outputs are user assigned for each loop
- Each control output can be configured for on-off, time proportioning or distributed zero crossing
- Outputs sink up to 60mA each at 5V=(dc)

Alarm Outputs

- Independent process and deviation alarms for each channel
- Alarms can operate any output not used for control
- Programmable deadband, delay and startup suppression
- Global alarm output activates when any alarm occurs
- Watchdog output indicates controller is functioning correctly

Serial Interface

- EIA/TIA-232 or EIA/TIA-485

Baud Rate

- 2400, 9600 or 19200, user-selectable

Communication Protocol

- Modbus[®] RTU

Line Voltage/Power

- 15 to 24V=(dc) ± 3V=(dc) @ 1A

Agency Approvals

- UL*, C-UL* listed: UL* 61010-1 safety requirements for measurement, control and laboratory equipment
- CE Mark: See Declaration of Conformity for details

Firmware Options

Choose firmware with the features needed for the application:

- Standard—includes closed-loop PID controller, auto-tune, alarms, job memory and failed sensor detection.
- Extruder—includes the standard firmware features, with PID control specifically adapted for plastic extruders.
- Ramp and Soak—includes the standard firmware features with the addition of ramp and soak and process variable retransmit. Each channel can be configured for standard PID control or ramp and soak operation. Unused control outputs on any channel can be configured for retransmit.
- Enhanced Features—includes the standard firmware features with the addition of process variable retransmit, remote analog set point, cascade control, ratio control and differential control algorithms. Each channel can be configured for standard PID control or one of the other control algorithms. Each channel of cascade control or remote analog set point requires two controller channels. Unused control outputs on any channel can be configured for retransmission.

Because the SERIES MLS300 has no onboard analog outputs, applications that use process variable retransmit typically require one SDAC module per retransmitted signal.

Input Module Options

Choose the input module appropriate for the application:

- AIM316 and AIM332 provides screw terminations for 16 or 32 sensors
- CIM316 and CIM332 provides DB-50 connector terminations for 16 or 32 sensors in a compact size

Ordering Information

SERIES MLS300 Code Number

Input Module

- 16 = 16 channel analog input module (AIM316)
- 32 = 32 channel analog input module (AIM332)
- C1 = 16 channel compact input module (CIM316)
- C2 = 32 channel compact input module (CIM332)

Processor Module (MLS300-PM)

- 0 = Input module only (No MLS300-PM)
- 1 = MLS300-PM with standard firmware
- 2 = MLS300-PM with extruder firmware
- 3 = MLS300-PM with enhanced features firmware
- 4 = MLS300-PM with ramp and soak firmware

Terminal Board

- 0 = SCSI connector only, user supplies cable and terminal board
- 1 = 50-pin terminal board, includes 3 foot SCSI cable

Power Supply

- 0 = None
- 3 = 120/240V~(ac) 50/60Hz power supply adapter (15V=[dc] @ 1.2A) (CE, UL* Class 2 approved)

SCSI Cables (For use with 50-pin terminal board)

- 0 = 3 foot SCSI cable with terminal board option 2 (no cable with option 0)
- 1 = 6 foot SCSI cable
- 2 = 3 foot right angle SCSI cable
- 3 = 6 foot right angle SCSI cable

Serial Communication Cables

(For communications with computer)

- 0 = No serial comm. cable
- 1 = 10 foot RS-232 comm. cable, DB-9 female/RJ12 phone plug
- 2 = 25 foot RS-232 comm. cable, DB-9 female/RJ12 phone plug
- 3 = 50 foot RS-232 comm. cable, DB-9 female/RJ12 phone plug
- 7 = RS-485 terminal block with 2 foot cable
- 8 = RS-485 terminal block with 4 foot cable

Module Interconnect Cables

- 0 = 4 foot cable, RJ45 connector/RJ45 connector
- 1 = 10 foot cable, RJ45 connector/RJ45 connector
- 2 = 25 foot cable, RJ45 connector/RJ45 connector

Serial Communications Jumper

- 0 = EIA-TIA-232
- 1 = EIA-TIA-485
- 2 = EIA-TIA-485 Terminated

Special Inputs

(Standard unit is configured for thermocouples and -10 to 60mV linear inputs. For other sensors, order special inputs.)
00 = Thermocouples and -10 to 60mV inputs only
XX = Number of current, voltage, or RTD inputs. Include leading zero as needed.

Special Input Type

- 20 = RTD 1: 0.1" Platinum, -100 to 275°C (-148 to 527°F)
- 21 = RTD 2: 1" Platinum, -120 to 840°C (-184 to 1544°F)
- 43 = 0-10mA=(dc)
- 44 = 0-20mA=(dc)/4-20mA=(dc)
- 50 = 0-100mV=(dc)
- 52 = 0-500mV=(dc)
- 53 = 0-1V=(dc)
- 55 = 0-5V=(dc)
- 56 = 0-10V=(dc)
- 57 = 0-12V=(dc)

Start Channel

XX = Channel Number XX

End Channel

XX = Channel Number XX

MLS300SI

Accessories

The following accessories are available for the SERIES MLS300.

Software Ordering Information

WATVIEW HMI Software

Run-time Edition includes spreadsheet display, setup screens, recipe manager with calendar-start, alarm management, event log, data logging and trend graphing.

WV00-R0U0-000 - (USB key)

WV00-R0P0-000 - (Parallel key)

Developer Edition includes all the features of the Run-time edition plus capability of developing custom screens.

WV00-D0U0-000 - (USB key)

WV00-D0P0-000 - (Parallel key)

Ordering Information

DAC/SDAC

Code Number

D A C -

DAC/SDAC Type

- 1 = DAC with 2 each 0 to 5V=(dc) outputs
- 2 = DAC with 2 each 0 to 10V=(dc) outputs
- 3 = DAC with 2 each 4 to 20mA=(dc) outputs
- 4 = Serial digital to analog converter (SDAC)

Power Supply

A = None

H = 120/240V~(ac), 50/60Hz power supply adapter, (15V=[dc] @ 1.2A) powers up to 12 dual DAC modules

L = 120/240V~(ac), 50/60Hz power supply adapter, (5V=[dc] @ 3A) powers up to 10 SDAC modules

Your Authorized Watlow Distributor Is:

To be automatically connected to the nearest North American Technical and Sales Office call:

1-800-WATLOW2

International Technical and Sales Offices: Australia, +61-3-9395-6449 • China, +86-21-3950-9510 • France, +33 (0) 3073-2425 • Germany, +49 (0) 7253-9400-0 • Italy, +39 (0) 2 458-8841 • Japan, +81-3-3518-6630 • Korea, +82-2-575-9904 • Malaysia, +60-3-7980-7741 • Mexico, +52 (442) 217-6235 • Shanghai, +86-21-3950-9504 • Singapore, +65-6773-9469 • Spain, +34 91 675 1292 • Sweden, +46 35-27-11-66 • Taiwan, +886-7-288-5168 • United Kingdom, +44 (0) 115-964-0777

Cybernetics, Inc.

11024 Montgomery Blvd, NE #267
 Albuquerque, NM 87111-3962
 USA

Voice: 505-856-1500
 Fax: 505-856-9620

QUOTATION

Quote Number: q953

Quote Date: May 1, 2008
 Page: 1

Quoted To:
Sandia National Laboratories Accounts Payable, MS1385 P.O. Box 5130 Albuquerque, NM 87185-1385

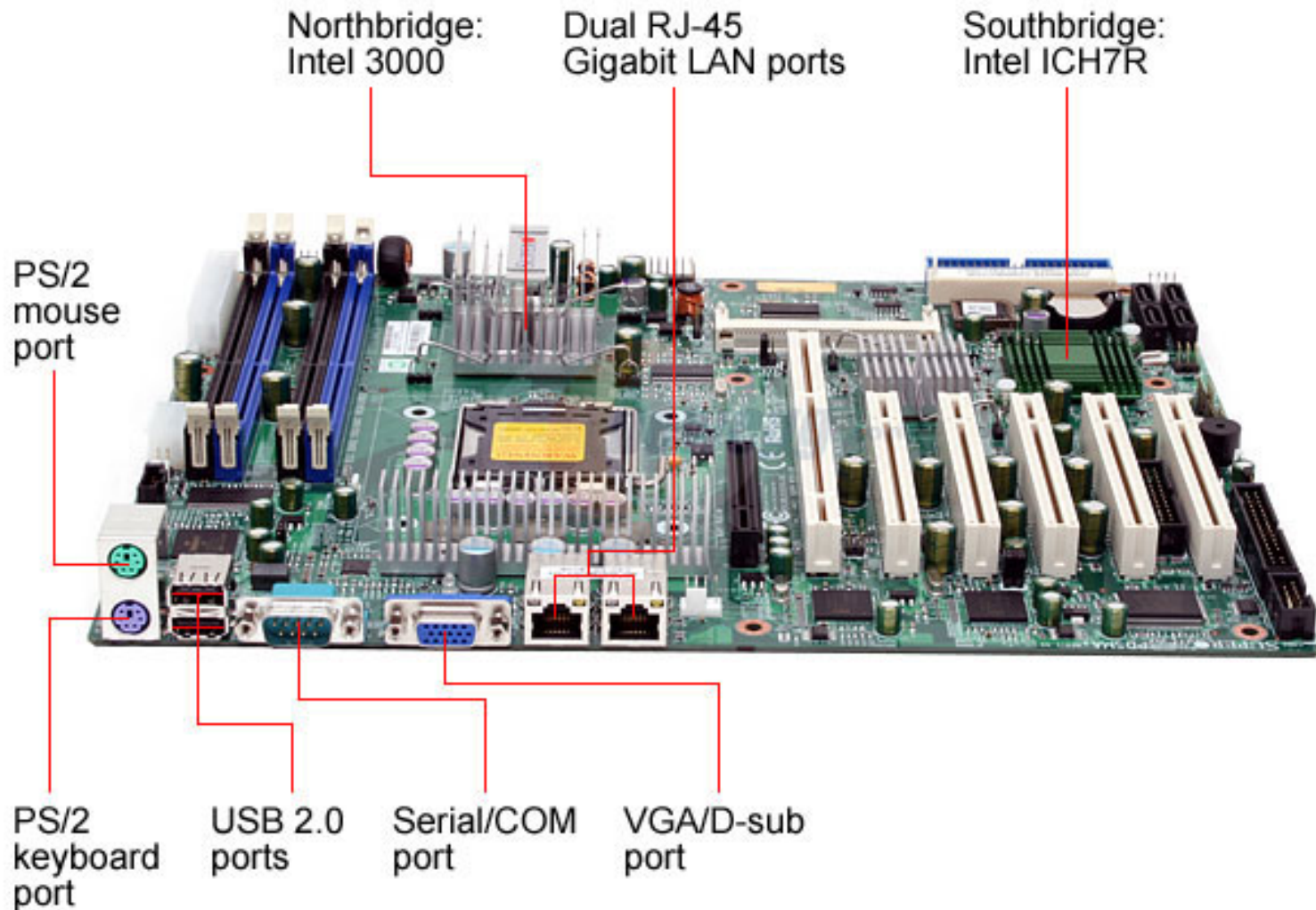
Ship To:
Attn: Chuck Harjes 1515 Eubank Blvd, SE, Bldg 957 Albuquerque, NM 87123

Customer ID	Good Thru	Payment Terms	Lead Time
SANDIA/PC	5/31/08	Net Due	3 Business Days

Quantity	Item	Description	Unit Price	Amount
1.00	332-113000100	Controller, Model MLS300, 32 Loop-Diff, 32 PID, Thermocouple Inputs, Jumper set for RS-485, TB-50, 50 Pin Terminal Board, 15V Power Supply	4,625.00	4,625.00
1.00	316-113000100	Controller, Model MLS300, 16 Loop-Diff, 16 PID, Thermocouple Inputs, Jumper set for RS-485, TB-50, 50 Pin Terminal Board, 15V Power Supply	3,775.00	3,775.00
48.00	SSR-240-10A-DC 1	Relay, Solid State, 10 Amp, 24-280V, 1 Phase, DC Contactor (3-32V) Input	31.00	1,488.00
1.00	WV00-R0U0-0000	Software, HMI, Run-Time Edition; For Watlow Controllers Series SD, #96, #97, F4, CLS, MLS, CPC, CAS; For Windows 95, 98, NT 4.0, ME, 2000 or XP, USB Key	635.00	635.00
Subtotal				10,523.00
Sales Tax				
TOTAL				10,523.00

Lead Time: 3 Days

SuperMicro PDSMA+-O Motherboard



LLD Control Computer will be Similar to Other NSTX Test Cell Computers

Description	Mfgr	Model	Qty	Unit Cost	Cost	Vendor	Vendor p/n
Processor	Intel	Core 2 Duo E7300 2.66GHz 3MB	1	\$139.99	\$139.99	www.newegg.com	N82E16819115132
Memory	Kingston	2GB Kit 1GB PC2-5300 ECC UnReg	1	\$48.99	\$48.99	www.newegg.com	N82E16820134337
Memory	Kingston	1GB Kit 1GB PC2-5300 ECC UnReg	1	\$29.99	\$29.99	www.newegg.com	N82E16820134336
Motherboard	SuperMicro	PDSMA+-O	1	\$241.99	\$241.99	www.newegg.com	N82E16813182118
Power Supply	Seasonic	S12 Energy plus SS-550HT	1	\$135.99	\$135.99	www.newegg.com	N82E16817151027
DVD Burner	LG	GSA-H55NK	1	\$27.99	\$27.99	www.newegg.com	N82E16827136117
CPU Heatsink	Scythe	SCMNJ-1000 Ninja Mini CPU Cooler	1	\$29.99	\$29.99	www.newegg.com	N82E16835185046
60mm Fan	Rexus	Panaflo 60mm x 25mm 3-pin fan	2	\$7.99	\$15.98	www.newegg.com	N82E16835705022
92mm Fan	Rexus	Panaflo 92mm x 25mm 3-pin fan	2	\$7.99	\$15.98	www.newegg.com	N82E16835705008
74GB Hard Drive	WesternDig	WD740ADFD 74GB SATA	2	\$139.99	\$279.98	www.newegg.com	N82E16822136033
LCD Console	ATEN	CL1000M 17" LCD Console	1	\$557.12	\$557.12	www.provantage.com	ATEN08C
4U Rack Mount Case	AIC	EJ-RMC4S	1	\$115.00	\$115.00	www.mypccase.com	EJ-RMC4S
Rack Mount Rails	AIC	EJ-SL8101220	1	\$32.00	\$32.00	www.mypccase.com	EJ-SL8101220
				total =	\$1,670.99		