



INSTRUCTION MANUAL

BALDWINTM - Series
CLASSIC THERMO-ELECTRIC COOLERS
Model M225

Version 4.07

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A: SPECIFICATIONS

Physical Description

Single (Series) / Dual (Parallel) Channel System
2 x 5" Heat Exchangers connected in series or parallel
2 Active (cooled to 4°C) Heat Exchangers
LCD temperature display (optional)

Operating Specifications

Sample Gas Flow Range	3-5 LPM 6.5-10.8 SCFH
Inlet Dew Point at Rated Flow	140°F @ 20% H ₂ O, 5 LPM 60°C
Maximum Cooling Rate	112 BTU/Hr 118kJ/Hr
Dimensions	11.20 x 7.25 x 11.20 in. HWD 28.5 x 18.4 x 28.5 cm
Weight	17 lbs 7.7 kg
Maximum Inlet Sample Temperature	392°F (200°C) SS, Glass Impingers 280°F (138°C) Kynar Impinger
Maximum Inlet Pressure	45 psig 3 bar / 2250 mmHg
Maximum Heat Exchanger Pressure Drop	<+1 in. H ₂ O
Ambient Temperature Range	33-104°F 0.56-40°C
Outlet Sample Gas Dew Point	41°F 5°C
Inlet Tubing Connection	3/8 in. FPT
Outlet Tubing Connection	1/4 in. FPT
Drain Tubing Connection	3/8 in. FPT
Voltage	110 (220 optional) VAC 50/60 Hz
Thermoelectric Elements	40 mm
Power Supply	250W
Cooling Down Time	Less than 3 minutes

B: LIMITED WARRANTY

Perma Pure LLC WARRANTY and DISCLAIMERS

Perma Pure (Seller) warrants that product supplied hereunder shall, at the time of delivery to Buyer, conform to the published specifications of Seller and be free from defects in material and workmanship under normal use and service. Seller's sole obligation and liability under this warranty is limited to the repair or replacement at its factory, at Seller's option, of any such product which proves defective within one year after the date of original shipment from seller's factory (or for a normal usable lifetime if the product is a disposable or expendable item) and is found to be defective in material or workmanship by Seller's inspection.

Buyer agrees that (1) any technical advice, information, suggestions, or recommendations given to Buyer by Seller or any representative of Seller with respect to the product or the suitability or desirability of the product for an particular use or application are based solely on the general knowledge of Seller, are intended for information guidance only, and do not constitute any representation or warranty by Seller that the product shall in fact be suitable or desirable for any particular use or application; (2) Buyer takes sole responsibility for the use and applications to which the product is put and Buyer shall conduct all testing and analysis necessary to validate the use and application to which Buyer puts the product for which Buyer may recommend the use or application of the product by others; and (3) the characteristics, specifications, and/or properties of the product may be affected by the processing, treatment, handling, and/or manufacturing of the product by Buyer or others and Seller takes no responsibility for the nature or consequence of such operations or as to the suitability of the product for the purposes intended to be used by Buyer or others after being subjected to such operations.

SELLER MAKES NO OTHER WARRANTY, EXPRESS OR IMPLIED, OF THE PRODUCT SUPPLIED HEREUNDER, INCLUDING, WITHOUT LIMITATION, IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR PARTICULAR PURPOSE, AND ALL SUCH WARRANTIES ARE HEREBY EXPRESSLY EXCLUDED. SELLER SHALL HAVE NO LIABILITY FOR LOSS OF PROFITS, OR SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES UNDER ANY CIRCUMSTANCES OR LEGAL THEORY, WHETHER BASED ON NEGLIGENCE, BREACH OF WARRANTY, STRICT LIABILITY, TORT, CONTRACT, OR OTHERWISE. SELLER SHALL IN NO EVENT BE LIABLE IN RESPECT OF THIS ORDER AND OR PRODUCT DELIVERED ON ACCOUNT OF THIS ORDER FOR ANY AMOUNT GREATER THAN THAT PAID TO SELLER ON ACCOUNT OF THIS ORDER.

C: PRINCIPLE OF OPERATION

Thank you for purchasing the Perma Pure Baldwin™ Classic Series Thermo-Electric Cooler. Our Classic Model M225 features a unique slim design leaving additional space to install or access other sample conditioning system components. A unique drop-down door on the M225 provides easy access to electronic boards and the power supply. The electronic control board is mounted on the door for easy access.

The process of sampling combustion product stack gas or exhaust from internal combustion engines requires a method to remove the moisture from the sample, without removing the gas components of interest. The Baldwin-Series Classic Thermo-Electric Cooler is an ideal way to decrease the dew point of combustion gases to a repeatable, stable, constant low dewpoint. This cooler prevents water condensation in sample pre-filters, sample pumps, and gas analyzers. For gas analyzers where water vapor is an interferent, a stable, repeatable dewpoint becomes a part of the gas analyzer performance specification. Perma Pure coolers provide this constant low water concentration, resulting in an accurate component gas measurement.

All Baldwin-Series coolers use thermo-electric elements (Peltiers) to cool the sample gas to the desired dew point temperature. A Classic Thermo-Electric Cooler is best illustrated as a small heat pump with no moving parts. The Peltiers operate on direct current and may be used for heating or cooling by reversing the direction of current flow. This is achieved by moving heat from one side of the module to the other with current flow and the laws of thermodynamics. A typical single stage Peltier (Figure 1) consists of two ceramic plates with p- and n-type semiconductor material (bismuth telluride) between the plates. The elements of semiconductor material are connected electrically in series and thermally in parallel.

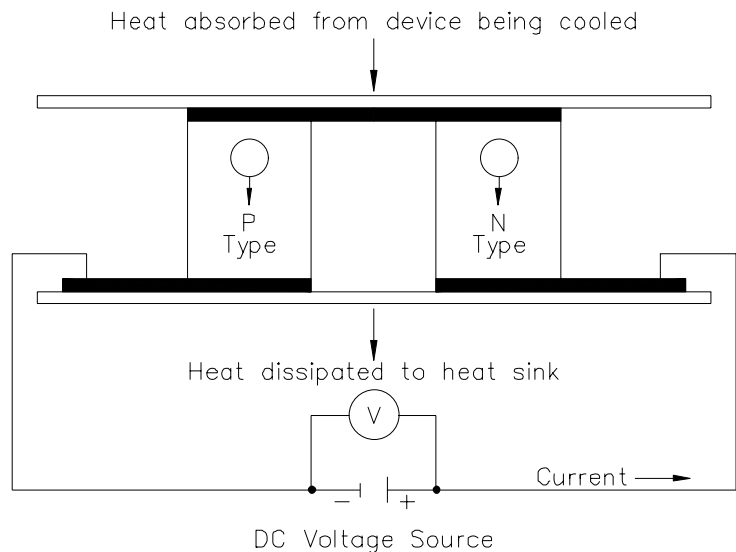


Figure 1: Thermo-electric element (Peltier)

When a positive DC voltage is applied to the n-type thermo-electric element, electrons pass from the p- to the n-type thermo-electric element and the cold side temperature will decrease as heat is absorbed. The heat absorption (cooling) is proportional to the current and the number of thermo-electric elements. This heat is

transferred to the hot side of the Peltier element where it is dissipated into the heat sink and surrounding environment.

Baldwin-Series Classic Thermo-Electric Coolers remove the moisture from the sample gas by cooling the gas as it passes through a laminar impinger (heat exchanger). A diagram showing the gas flow path through an impinger is shown in the Appendix. The heat exchanger, made of 316L stainless steel, Durinert[®] (a corrosion-resistant inert coating over 316L stainless steel), PVDF (Kynar), or glass, is mounted within a thermally insulated heat transfer block bored to receive the heat exchanger without a mechanical lock. This assembly allows the easy removal of any heat exchanger simply by slipping it out of the cooling block by hand. The heat transfer block cools the heat exchanger through the heat pumping action of the peltier element. The heat transfer block is on the cold side of the thermo-electric element and the heat sink is on the hot side of the thermo-electric element. The heat from the heat transfer block is pumped to the heat sink where it is then dissipated into the air by the heat sink fan. See Figure 2. The desired temperature is maintained by a closed loop control system, which is implemented through an analog proportional controller. The controller uses a type K thermocouple in the heat transfer block located very close to the cold side of the peltier element as the input sensor.

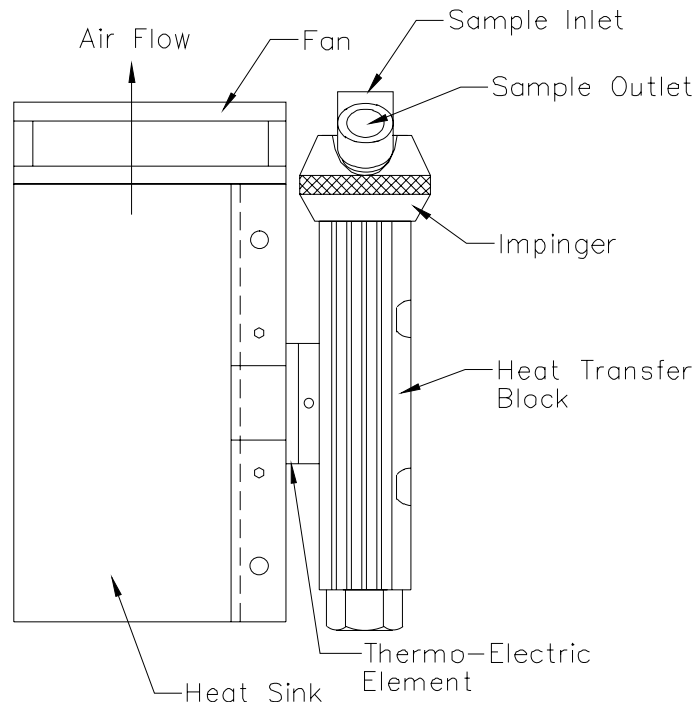


Figure 2: Heat Exchanger, Impinger and Heat Sink Assembly

The sample gas is passed to the Classic Thermo-Electric Cooler via the heated filter sample probe and heated sample line. The Classic Thermo-Electric Cooler lowers the sample dew point to 5° C (41° F). As the gas cools and the moisture vapor

condenses, the condensate exits the heat exchanger through the bottom drain connection. Particulate matter passing through the sample cooler is removed by an optional Perma Pure pre-filter, located downstream from the cooler along with an optional water slip sensor. The conditioned sample gas can then be directed to the gas analyzers.

D: INSTALLATION

The Model M225 should be installed away from heat sources in a well ventilated area of an instrument rack or enclosure. The more stable the ambient temperature environment around the Model M225, the better the output dew point stability.

Sample tubing connections to the Model M225 depend on the heat exchanger material of construction. A cooler with a stainless steel heat exchanger uses a stainless steel inlet fitting. The outlet is Kynar[®] standard compression type tube fitting with Teflon[®] ferrules. A PVDF (Kynar[®]) heat exchanger uses Kynar[®] standard compression type tube fittings with Teflon[®] ferrules. Perma Pure cannot warrantee against damage to the Peltier element or heat exchanger if our supplied Kynar[®] tube fittings are not used.

The inlet and outlet tubing for all metal or Kynar heat exchangers is 1/4" NPT; the user should always use the compression type fittings provided for that purpose by the factory. The inlet of the Channel 1 heat exchanger uses a 3/8" tube x 1/4" MNPT fitting to mate with most standard 3/8" sample lines.

The condensate drain connection is a Kynar[®] elbow (or straight), 3/8" MNPT x 1/4" barbed tube fitting. An automatic condensate drain, Perma Pure Model 3KPB-003 Peristaltic Pump, dual head, is recommended for water removal. This pump uses size 17 tubing.

CAUTION: Do no reduce the size of the condensate tubing since doing so restricts water flow resulting in water slip (moisture carryover) in the sample.

CAUTION: If using a stainless steel sample line, place 2 inches of Teflon[®] tubing in between the exchanger inlet fitting and the heated line. This prevents the sample cooler from heat sinking the incoming heated line, which adds undue load to the cooler.

E: START-UP PROCEDURE

Plug in the power cord to a properly grounded main circuit. The Ready Green LED will come on within 3 minutes, indicating the relay temperature (10°C) has been achieved. After approximately 3 minutes, the set point of +5°C. (41°F) is achieved. The sample gas flow may be started immediately after the READY Green LED comes on.

The Model M225 is virtually maintenance free. However, in the event of electrical problems, refer to the troubleshooting guide in this manual. All voltages can be read at the PCB terminal strip. Any deviations from the correct voltages indicate a problem.

F: LED INDICATORS

The Model M225 has four green and two red LED operating indicators. These indicators are arranged vertically on the front of the cooler with the right side corresponding to CH1 and the left to CH2. The bottom green LED's indicate the READY operating temperature status, normally set for 10°C (50°F). After the set-point temperature is reached, the sample pump may be turned on by other devices. When the impinger temperature is below 10°C (50°F) the ready LED's will be on. Above this temperature, the ready LED's will be off. The middle green LED's (applicable when the alarm relay option is installed) are ON when there is NO water carry over and OFF when there IS water carry over. The red LED's at the top are the thermocouple failure indicators. When this occurs, the red LED stays illuminated.

The M225 cooler has an analog voltage output. This output is factory standard at 0-2.5 VDC = 0-25°C. The connector for this output is located on the bottom of the cooler. It is labeled "Analog Out" (TB1).

G: I/O TERMINAL BLOCK DESCRIPTION

The I/O terminal blocks are found on the bottom panel of the cooler:

TB1 TB1 is the standard analog output (low voltage DC output) for all Classic Series Thermo-Electric Coolers. Model M225 has two active 5" heat exchangers. The output is 0vdc to 2.5vdc for a temperature range of 0°C to 25°C.

- Terminal 1 is earth ground. This terminal should be used to ground the shield of the shielded twisted pair cable that is used to connect the analog output to a receiving instrument.
- Terminal 2 is the signal return.
- Terminal 3 is the channel 1 output.
- Terminal 4 is the channel 2 output.

TB2 TB2 is the I/O terminal block (low level DC voltage or current or no voltage contact) used for all installed options, such as the alarm relay/water slip option or auxiliary analog output option.

- Terminal 1 is earth ground. This terminal should be used to ground the shield of the shielded twisted pair cable that is used to connect the analog output board of the auxiliary analog output to a receiving instrument.
- Terminal 2 is the signal return for the auxiliary analog voltage output.
- Terminal 3 is the auxiliary analog voltage output.
- Terminal 4 is the negative side of the auxiliary analog 4-20mA output.
- Terminal 5 is the positive side of the auxiliary analog 4-20mA output.
- Terminals 6 & 7 are the dry contact form A relay output used for computer sense for the alarm relay/water slip option.
- Terminals 8 & 9 are the water slip sensor input for the alarm relay / water slip (moisture carryover) option.
- Terminal 10 is earth ground. This terminal should be used to ground the shield of the twisted pair cable that is used to connect the water slip sensor to terminals 8 & 9.

TB3 TB3 is the switched AC terminal block (line AC voltage output) used for sample pump control when the alarm relay/water slip option is installed.

- Terminal 1 is the AC LINE voltage.
- Terminal 2 is the AC NEUTRAL.
- Terminal 3 is the EARTH GROUND.

TB4 **Note:** The description for TB4 is the same as for TB2. TB4 is used for Channel 2's I/O.

TB5 **Note:** The description for TB5 is the same as for TB3. TB5 is used for Channel 2's switched AC.

H: TEST & ADJUSTMENT PROCEDURES

NOTE: All test and adjustment procedures have been performed at the factory. Therefore, no adjustment should be necessary.

A. Main Control board

(1) **WARNING:** Before connecting power to the cooler, be aware of the HAZARDOUS LIVE VOLTAGE on the control board. Disconnect power from the cooler before opening the swing-down "L-door". **Note:** The auxiliary output board must be removed if the cooler is so equipped. Remove the thermocouples from TB1 and TB2. The thermocouple generator should not be connected to either of the thermocouple inputs at this time. Connect power to the cooler. After 10 to 20 seconds, the red LED(s) (thermocouple failure indicators) should be on.

(2) Connect the thermocouple generator to the Channel 1 thermocouple input, (TB1 terminal), inserting the yellow wire into the terminal marked Y and the red wire into the terminal marked R. Turn on the generator. The red LED should turn off. Connect a voltmeter between the ground test point, TP7 and TP1, the red lead to TP1 and the black lead to TP7. Set the thermocouple generator to 0°C. Set the voltmeter to 20vdc range.

(3) Adjust POT1 (the zero pot) to obtain a 0vdc reading on the voltmeter.

(4) Set the thermocouple generator to 10°C.

(5) Adjust POT3 (the span pot) to obtain a 1.0vdc reading on the voltmeter.

(6) Move the positive lead (red lead) of the voltmeter to TP5.

(7) Adjust POT8 (the ready pot) to obtain a 1.0vdc reading on the voltmeter.

(8) Move the positive lead (red lead) of the voltmeter to TP3.

(9) Adjust POT5 (the set pot) to obtain a 0.5vdc reading on the voltmeter.

(10) Set the thermocouple generator to 11°C. The bottom green LED should be off.

(11) Set the thermocouple generator to 8°C. The bottom green LED should be on.

B. Display Board (not standard on the Model M225)

(1) **WARNING:** Before connecting power to the cooler, be aware of the HAZARDOUS LIVE VOLTAGE on the control board. Disconnect power from the cooler before opening the swing-down "L-door". Remove display cover from the front of the swing-down "L-door". Connect a voltmeter between the ground test point, TP7 on the main control board and TP1 on the display board, the red lead to TP1 and the black lead to TP7.

(2) Connect power to the cooler and allow the temperature of the cooler to stabilize around 5°C.

(3) Adjust POT1 on the display board so the display corresponds to the voltmeter reading. That is, if the voltmeter reads 0.5vdc, adjust the pot so that the display reads 0.5.

C. Auxiliary Analog Output Board (not standard on the model M225)

(1) **WARNING:** Before connecting power to the cooler, be aware of the HAZARDOUS LIVE VOLTAGE on the control board. Disconnect power from the cooler before opening the swing-down "L-door". Remove the thermocouples from TB5 and TB6 on the auxiliary analog output board. The thermocouple generator should not be connected to either of the thermocouple inputs at this time. Connect power to the cooler. After 10 to 20 seconds, the red LED(s) (thermocouple failure indicator) on the auxiliary analog output board should be on.

(2) Connect the thermocouple generator to the Channel 1 thermocouple input (TB5 terminal), inserting the yellow wire into the terminal marked Y and the red wire into the terminal marked R. Turn on the generator. The red LED (CR5) should turn off. Set the thermocouple generator to 0°C.

For Voltage Output

(3) If the auxiliary analog output board is set for voltage output, set the voltmeter to 20vdc range. Connect the voltmeter to TB2 (the channel 1 voltage output terminal), the black lead to the negative (-) terminal and the red lead to the positive (+) terminal.

(4) Adjust POT4 (the zero pot) to obtain a 0vdc reading on the voltmeter.

(5) Set the thermocouple generator to 25°C.

(6) Adjust POT1 (the span pot) to obtain a full scale voltage reading on the voltmeter. This value will depend on the gain that was specified for the cooler at the time of manufacture. Available gains are 0-1.0vdc, 0-2.5vdc, 0-10.0vdc for a 0°C-25°C temperature range.

For Current Output

(3a) If the auxiliary analog output board is set up for current output, set the ammeter to 200ma range. Connect the ammeter to TB1 (the channel 1 current output terminal), the black lead to the negative (-) terminal and the red lead to the positive (+) terminal.

(4a) Adjust POT4 (the zero pot) to obtain a 4mA reading on the ammeter.

(5a) Set the thermocouple generator to 25°C.

(6a) Adjust POT1 (the span pot) to obtain a 20mA reading on the ammeter.

I: DESCRIPTION OF OPTIONS

Baldwin™-Series Classic Series Thermo-Electric Coolers have three available options: (1) temperature display; (2) alarm relay/water slip, and (3) auxiliary analog output. Classic Series Coolers may be equipped with any one or all of the options. All external I/O connections for these options are available through the terminal blocks on the bottom of the cooler.

1. Display Option

The display option is a secondary board that is mounted on the main control board. This board has a three-digit LCD display that displays the temperature (in degrees C) of the active channel(s). If the cooler has two active channels, there will be a toggle switch installed to select Channel 1 or 2.

2. Alarm Relay/Water Slip Option

The alarm relay/water slip option is a secondary board that is mounted on the main control board. This board has two inputs and three outputs per channel. The first input, which comes from the main control board, is the ready input. The second input, which comes from the water slip sensor, is the water slip input. The first output, which is fed back to the main control board, controls the ready and water slip LED(s). The second output is a 1/4 amp SPST form A dry contact relay. This relay is used for computer sensing and is **NOT** intended for the controlling of electrical loads. The third output is a 6-amp DPST form C dry contact relay. This relay can be used for sample pump or other heavier electrical load control. This relay output terminal is normally wired for a 120vac sample pump (ground, neutral, and line). If there is water carry over (water slip LED), computer sense and load control relays will be turned off. If the temperature of the cooler rises above 10°C (50°F), the ready LED, computer sense and load control relays will be turned off. This means that the relays operate in a fail-safe manner.

Note: If the alarm relay/water slip option is not installed, the SLIP LED(s) on the front of the cooler will be off.

3. Auxiliary Analog Output Option

The auxiliary analog output option is a secondary board that is mounted on the main control board. This board has one input and two outputs per channel. The input is for a K type thermocouple. The first output is an analog voltage output that can be configured for either 0vdc to 2.5vdc or 0vdc to 10vdc for a 0°C (32°F) to 25°C (77°F) temperature range. The second output is a 4-20 mA for the same temperature range. The K type thermocouple is normally a 1/32-inch diameter hypodermic type thermocouple that is installed in a special impinger so the actual sample dew point temperature can be measured.

Note: This option is sometimes referred to as the New Jersey thermocouple outlet temperature option.

J: “NEW JERSEY” THERMOCOUPLE OPTION

Some air quality management districts (e.g., those in New Jersey and Southern California) require temperature measurement of the gas stream at the outlet of the last heat exchanger on the cooler. Baldwin offers a 1/32-inch diameter hypodermic-style type K thermocouple that can be inserted into a special heat exchanger (i.e., it has a small port for insertion of the thermocouple) so the actual sample dew point temperature can be measured. This is sometimes referred to as the New Jersey thermocouple outlet temperature option.

The second 5” heat exchanger on the M225 can be upgraded to include the New Jersey thermocouple option. This heat exchanger will have a New Jersey thermocouple to sense the temperature inside the heat exchanger (upgrade option: 4C-NJ/K-5). In the part number, the “NJ” identifies the upgrade for a NJ type thermocouple. The “K” identifies the thermocouple itself as a type “K” thermocouple. The “-5” is the height of the heat exchangers.

In addition, Perma Pure offers an optional temperature transmitter board for signal or voltage temperature output. This board has one input and two outputs per channel. The input is for the type K thermocouple. The first output is an analog voltage output that can be configured for either 0-2.5vdc or 0-10vdc for a 0°C (32°F) to 25°C (77°F) temperature range. The second output is a 4-20mA for the same temperature range. The M225 utilizes a single-channel NJ thermocouple transmitter board (3CCB-012).

Model M225 New Jersey Thermocouple Option

Part No.	Description
4C-NJ/K-5	Heat exchanger upgrade to include NJ thermocouple port
3CXS-002	Heat exchanger, 5” SS w/ NJ thermocouple port
3CXD-002	Heat exchanger, 5” Durinert [®] w/ NJ thermocouple port
3CXK-002	Heat exchanger, 5” Kynar [®] w/ NJ thermocouple port
3CCB-012	Temperature transmitter board, single stream
3KTC-001	Thermocouple, Type K, replacement kit

K: TROUBLESHOOTING

<i>Symptom</i>	<i>Check</i>	<i>Action</i>
No LED(s) and no fan.	AC power input.	Ensure that AC power is connected.
No LED(s) and fan on.	AC input fuse on control board. DC output fuse on control board. VC on control board.	Replace fuse as necessary. Replace fuse as necessary. Replace control board.
LED(s) on and no fan.	AC input fuse on power supply. +12vdc TB4 on control board.	Replace fuse as necessary. Replace power supply.
Impinger remains at ambient temperature.	Peltier current draw. Should be above 6 amps.	Replace Peltier element.
Thermocouple failure LED is on.	Thermocouple connection TB1, 2.	Ensure proper connection. Replace thermocouple.
Impinger frozen and cooler indicates ambient temperature.	Thermocouple placement in heat exchanger block.	Ensure proper placement. Replace control board.
Impinger does not reach set temperature, but is below ready temperature.	System loading. Calibration and set temperature adjustment.	Ensure system loading is not exceeding cooler capacity. Adjust as necessary.
Impinger temperature cycles up and down.	Peltier connections on control board.	Ensure a firm connection on flag connectors on control board. Ensure system loading is not exceeding cooler capacity.
Ready LED does not come on when impinger is below 7°C.	Ready temperature adjustment.	Adjust as necessary.
Water carryover in system.	Impinger temperature. Should be below 6°C.	Ensure system loading is not exceeding cooler capacity.
Slip LED does not come on (<i>alarm relay/water slip option installed</i>).	Water carryover in system. Water slip sensor connections.	Ensure system loading is not exceeding cooler capacity. Ensure that all water slip sensor connections are made. Clean tip of sensor. Replace alarm relay/water slip board.
Pump does not start. Ready and slip LED(s) are on (<i>alarm relay/water slip option installed</i>).	Pump electrical connections.	Ensure proper connections. Replace board.

For further service assistance, contact:

Perma Pure LLC

P.O. Box 2105

8 Executive Drive (08755)

Toms River, NJ 08754

Tel: 800-337-3762 (toll free U.S.)

Tel: 732-244-0010

Fax: 732-244-8140

Email: info@permapure.com

or your local representative

L: SPARE PARTS

Classic Model M225

Part No.	Description
2FAN-004	Fan: Muffin, 4" x 1 1/2", 12 VDC
3CXD-001	Heat Exchanger: 5" Durinert®
3CXG-005	Heat Exchanger: 5" Glass, threaded w/ fittings
3CXK-001	Heat Exchanger: 5" Kynar
3CXS-001	Heat Exchanger: 5" Stainless Steel
3KPE-004*	Peltier Element Kit, 40 mm
1PSD-027*	Power Supply: 240 W, 15 VDC
3TCB-002*	Temperature Control Board: Dual Channel
1TTC-003	Thermocouple, Temperature, Control, Type K 36"

* Recommended Spares

Sample Conditioning Systems w/ Model M225 Classic Thermo-Electric Cooler

Model C1 (Model 4S-M225-9AC1, 4S-M225-9DC1)

Part No.	Description
3KFA-001	Filter Assembly, Sample in-line, 2-micron
3FHG-001	Filter Bowl, Glass
3FEC-002**	Filter Element: Ceramic, 2-micron
3KPB-003	Peristaltic Pump: Dual, Kit, 115V Complete w/ Enclosure
2PBM-003	Peristaltic Pump: Head Only, Standard
2PBM-001	Peristaltic Pump: Motor Only, 115V AC 60 Hz
2PBT-002PK*	Peristaltic Pump: Tubing, Norprene, Size 17 (10 feet)
3KPA-001*	Sample Pump: Assembly, Single Head w/ Check Valve, 115V
2PAS-008	Sample Pump: Single Head, Mini-Dia-Vac, 115V (bare)
2PAM-001*	Sample Pump: Repair Kit, Single

* Recommended Spares **Consumables

Model CD (Models 4S-M225-9ACD, 4S-M225-9DCD)

Part No.	Description
3KFA-001	Filter Assembly, Sample in-line, 2-micron
3FHG-001	Filter Bowl, Glass
3FEC-002*	Filter Element: Ceramic, 2-micron
3KPB-003	Peristaltic Pump: Dual, Kit, 115V Complete w/ Enclosure
2PBM-003	Peristaltic Pump: Head Only, Standard
2PBM-001	Peristaltic Pump: Motor Only, 115V AC 60 Hz
2PBT-002PK*	Peristaltic Pump: Tubing, Norprene, Size 17 (10 feet)
3KPA-002*	Sample Pump: Assembly, Dual Head w/ Check Valve, 115V
2PAD-006	Sample Pump: Dual Head, Mini-Dia-Vac, 115V (bare)
2PAM-002*	Sample Pump: Repair Kit, Dual

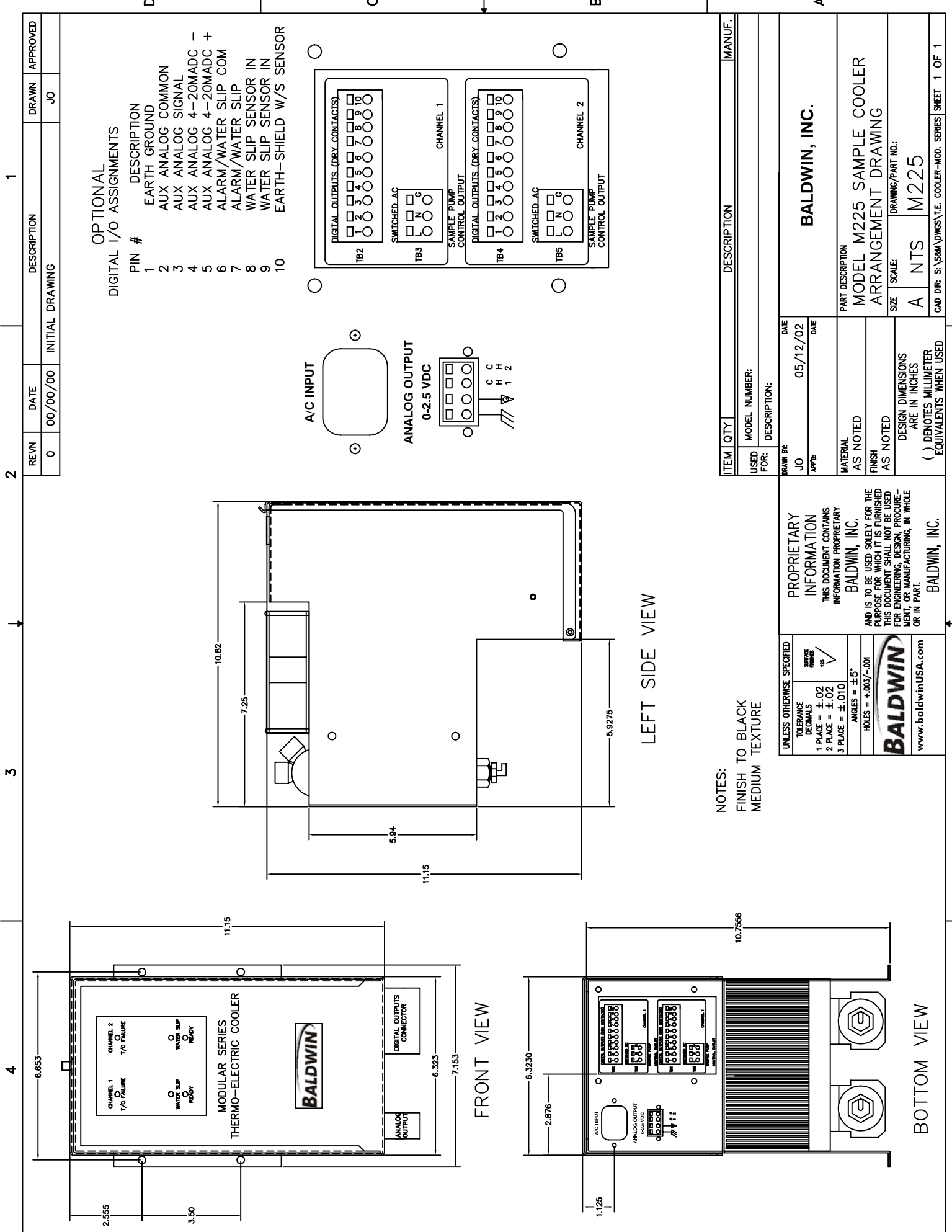
* Recommended Spares **Consumables

Model CD2 (Models 4S-M225-9ACD2, 4S-M225-9DCD2)

Part No.	Description
3KFA-001	Filter Assembly, Sample in-line, 2-micron
3FHG-001	Filter Bowl, Glass
3FEC-002**	Filter Element: Ceramic, 2-micron
3KPB-003	Peristaltic Pump: Dual, Kit, 115V Complete w/ Enclosure
2PBM-003	Peristaltic Pump: Head Only, Standard
2PBM-001	Peristaltic Pump: Motor Only, 115V AC 60 Hz
2PBT-002PK	Peristaltic Pump: Tubing, Norprene, Size 17 (10 feet)
3KPA-002*	Sample Pump: Assembly, Dual Head w/ Check Valve, 115V
2PAD-006	Sample Pump: Dual Head, Mini-Dia-Vac, 115V (bare)
2PAM-002*	Sample Pump: Repair Kit, Dual

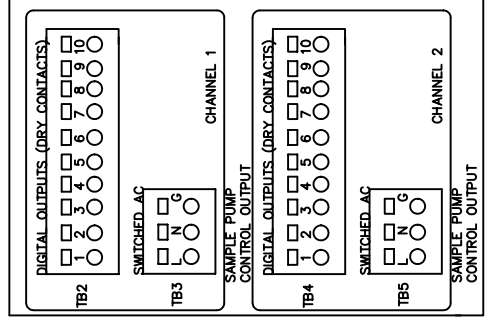
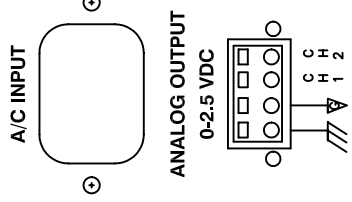
* Recommended Spares **Consumables

APPENDIX A: CLASSIC MODEL M225



OPTIONAL DIGITAL I/O ASSIGNMENTS

PIN #	DESCRIPTION
1	EARTH GROUND
2	AUX ANALOG COMMON
3	AUX ANALOG SIGNAL
4	AUX ANALOG 4-20MADC -
5	AUX ANALOG 4-20MADC +
6	ALARM/WATER SLIP COM
7	ALARM/WATER SLIP
8	WATER SLIP SENSOR IN
9	WATER SLIP SENSOR IN
10	EARTH-SHIELD W/S SENSOR



NOTES:
FINISH TO BLACK
MEDIUM TEXTURE

UNLESS OTHERWISE SPECIFIED

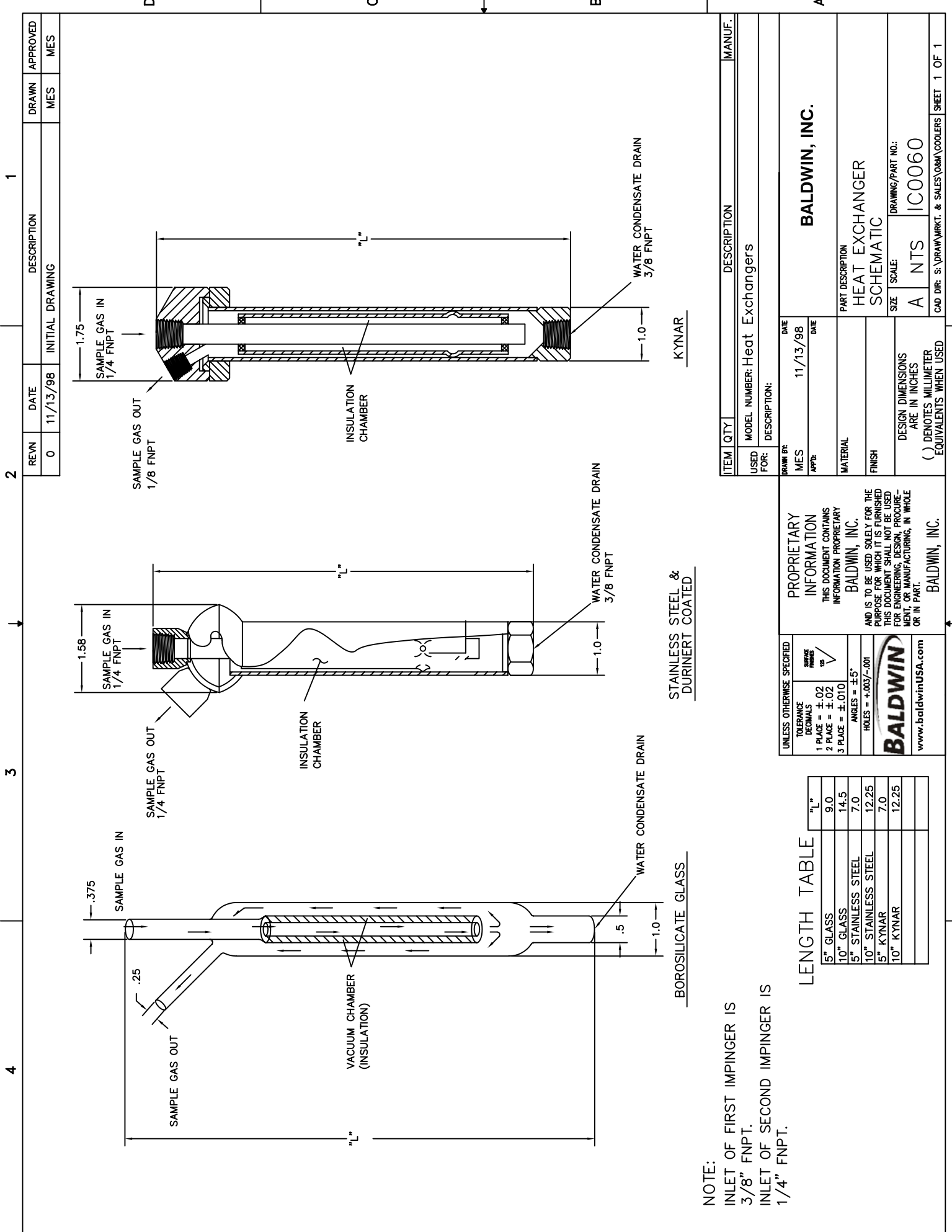
TOLERANCE	DECIMALS
1 PLACE	= ±.02
2 PLACE	= ±.02
3 PLACE	= ±.010

ANGLES = ±5°
HOLES = ±.003/- .001

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ITEM	QTY	DESCRIPTION	MANUF.
MODEL NUMBER:			
USED FOR:			
DESCRIPTION:			
DATE	DATE		
JO	05/12/02		
APPR:			
PART DESCRIPTION			
MODEL M225 SAMPLE COOLER ARRANGEMENT DRAWING			
DRAWING/PART NO.:			
SIZE	SCALE:		
A	NTS	M225	
DESIGN DIMENSIONS ARE IN INCHES			
() DENOTES MILLIMETER EQUIVALENTS WHEN USED			
CAD DIR: S:\SRM\DWGS\T.E. COOLER-MOD. SERIES			
SHEET 1 OF 1			



REV#	DATE	DESCRIPTION	DRAWN	APPROVED
0	11/13/98	INITIAL DRAWING	MES	MES

NOTE:
 INLET OF FIRST IMPINGER IS
 3/8" FNPT.
 INLET OF SECOND IMPINGER IS
 1/4" FNPT.

LENGTH TABLE

	"L"
5" GLASS	9.0
10" GLASS	14.5
5" STAINLESS STEEL	7.0
10" STAINLESS STEEL	12.25
5" KYNAR	7.0
10" KYNAR	12.25

UNLESS OTHERWISE SPECIFIED
 TOLERANCE DECIMALS
 1 PLACE = ±.02
 2 PLACE = ±.02
 3 PLACE = ±.010
 ANGLES = ±5°
 HOLES = +.003/- .001

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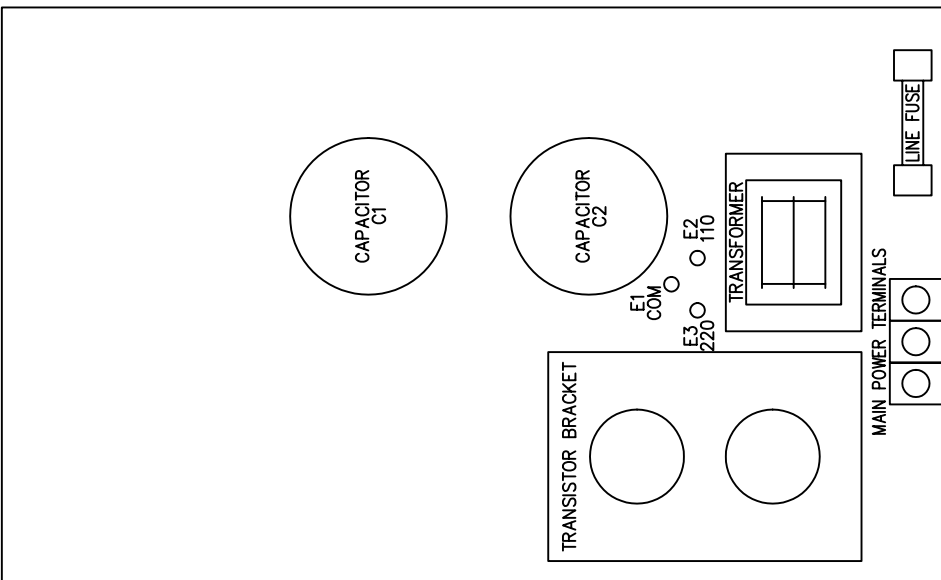
ITEM	QTY	DESCRIPTION	MANUF.
USED FOR:		MODEL NUMBER: Heat Exchangers	
DESCRIPTION:			
DRAWN BY:	DATE	DATE	
MES	11/13/98		
APPR:			
MATERIAL:			
FINISH:			
DESIGN DIMENSIONS ARE IN INCHES () DENOTES MILLIMETER EQUIVALENTS WHEN USED	SIZE	DRAWING/PART NO.:	
	A NTS	IC0060	
	PART DESCRIPTION		
	HEAT EXCHANGER SCHEMATIC		
	CAD DIR: S:\DRAW\MRKT. & SALES\OBM\COOLERS		SHEET 1 OF 1

STAINLESS STEEL &
 DURINERT COATED

BOROSILICATE GLASS

KYNAR

REV#	DATE	DESCRIPTION	DRAWN	APPROVED
0	00/00/00	INITIAL DRAWING	LD	RD



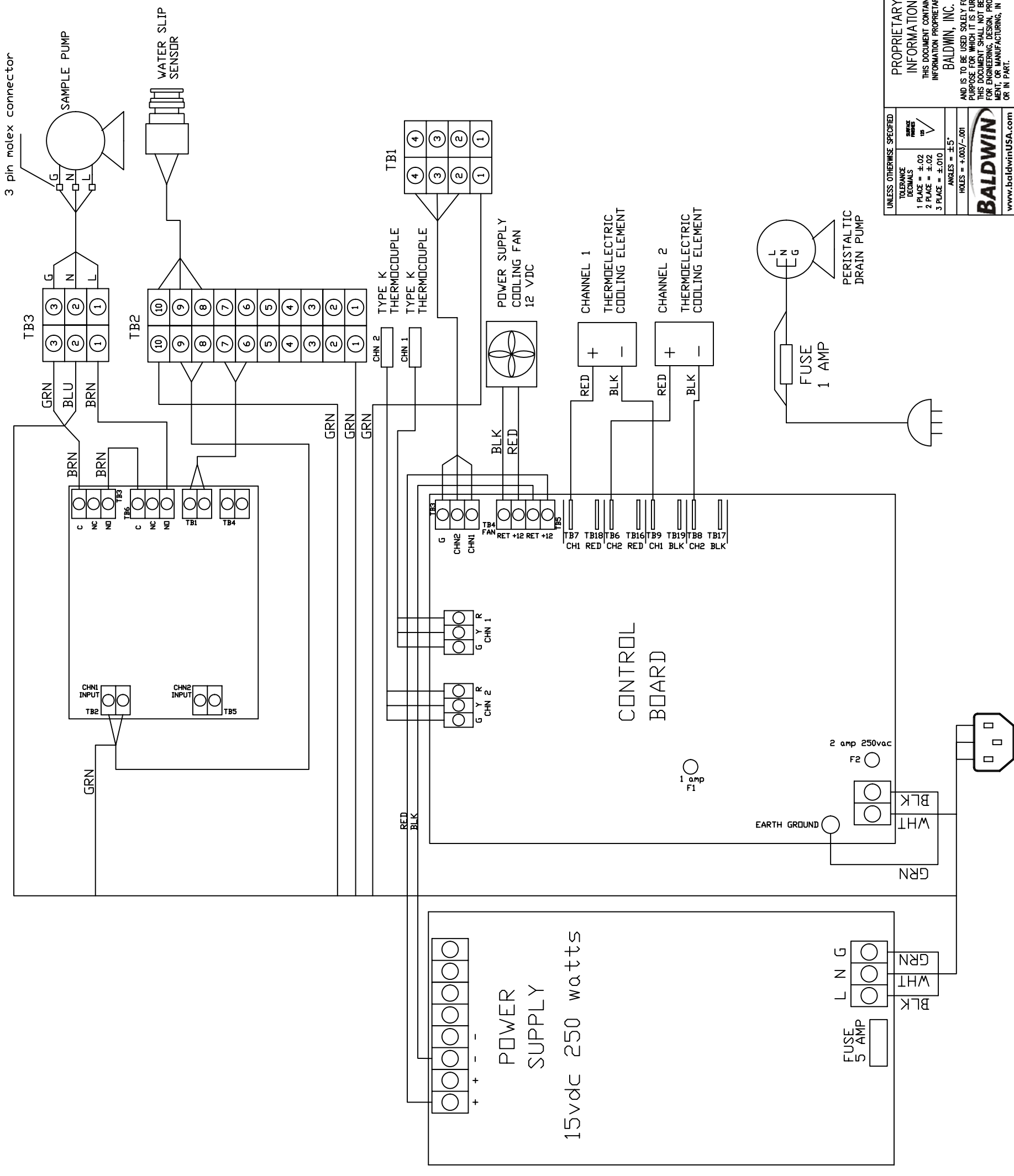
- POWER SUPPLY MAINS JUMPER PROCEDURE:
1. FOR 110VAC 60Hz JUMPER COMMON (E1) TO 110 (E2).
 2. FOR 220VAC 50Hz JUMPER COMMON (E1) TO 220 (E3).

ITEM	QTY	DESCRIPTION	MANUF.
USED FOR:		MODEL NUMBER: All Baldwin Thermo-Electric Coolers	
DESCRIPTION:		POWER SUPPLY	
DRAWN BY:	DATE		
RAW	04/28/97		
APP'D:	DATE		
MATERIAL			
FINISH			
DESIGN DIMENSIONS ARE IN INCHES		SIZE	SCALE:
() DENOTES MILLIMETER EQUIVALENTS WHEN USED		A	NTS
		DRAWING/PART NO.:	5C-P JUMP
		CAD DIR:	S:\DRAW\SCHEMATICS\ELECTRICAL

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UNLESS OTHERWISE SPECIFIED:	
TOLERANCE DECIMALS	ANGLE DIMENSIONS
1 PLACE = ±.02	IS
2 PLACE = ±.02	
3 PLACE = ±.010	
ANGLES = ±5°	
HOLES = +.003/-001	
www.baldwinUSA.com	

REV#	DATE	DESCRIPTION	DRAWN	APPROVED
0	00/00/00	INITIAL DRAWING	DWM	DWM



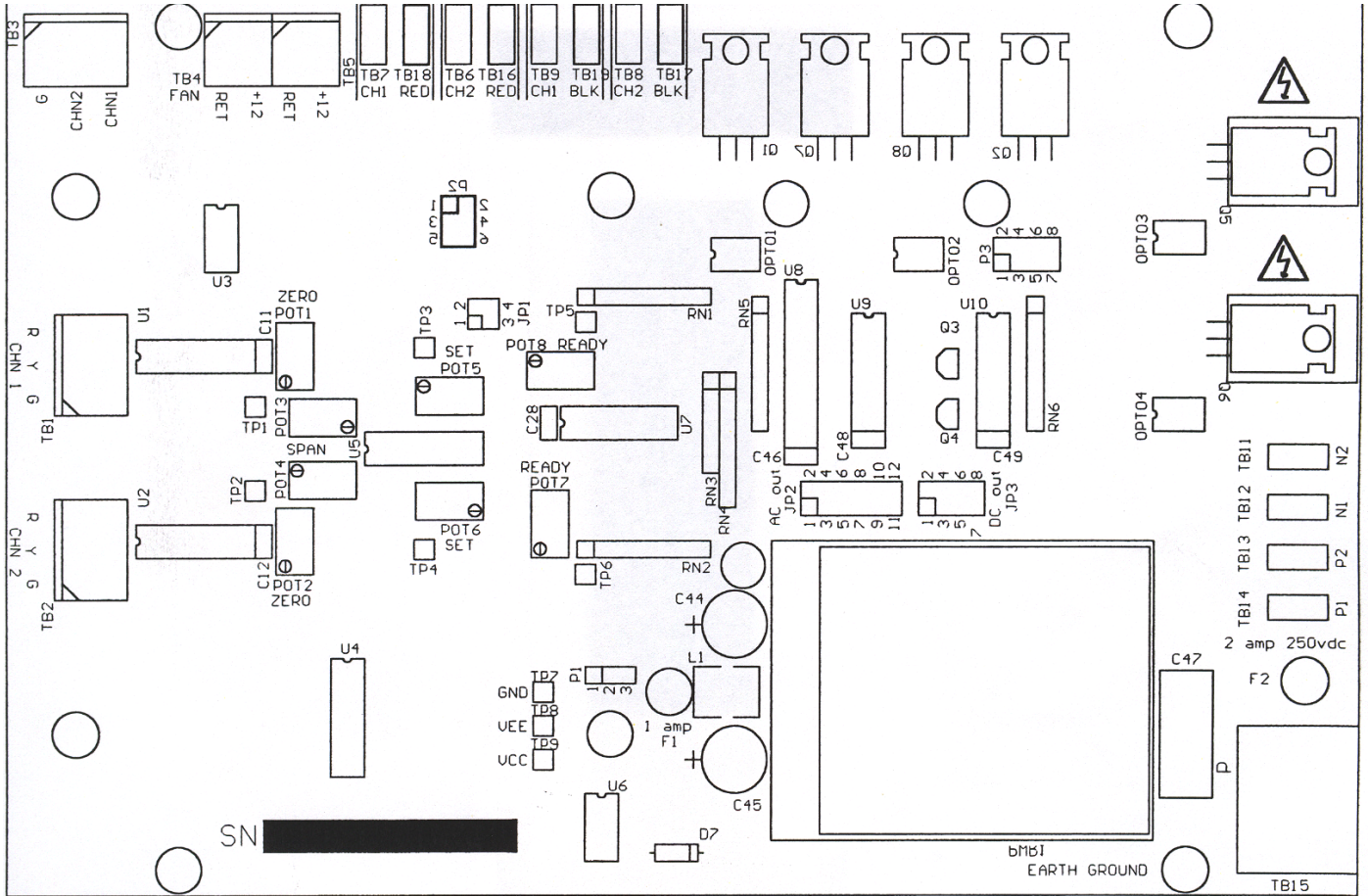
UNLESS OTHERWISE SPECIFIED
 TOLERANCE DECIMALS
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 2 PLACE = ±.02
 3 PLACE = ±.010
 ANGLES = ±5°
 HOLES = +.003/- .001

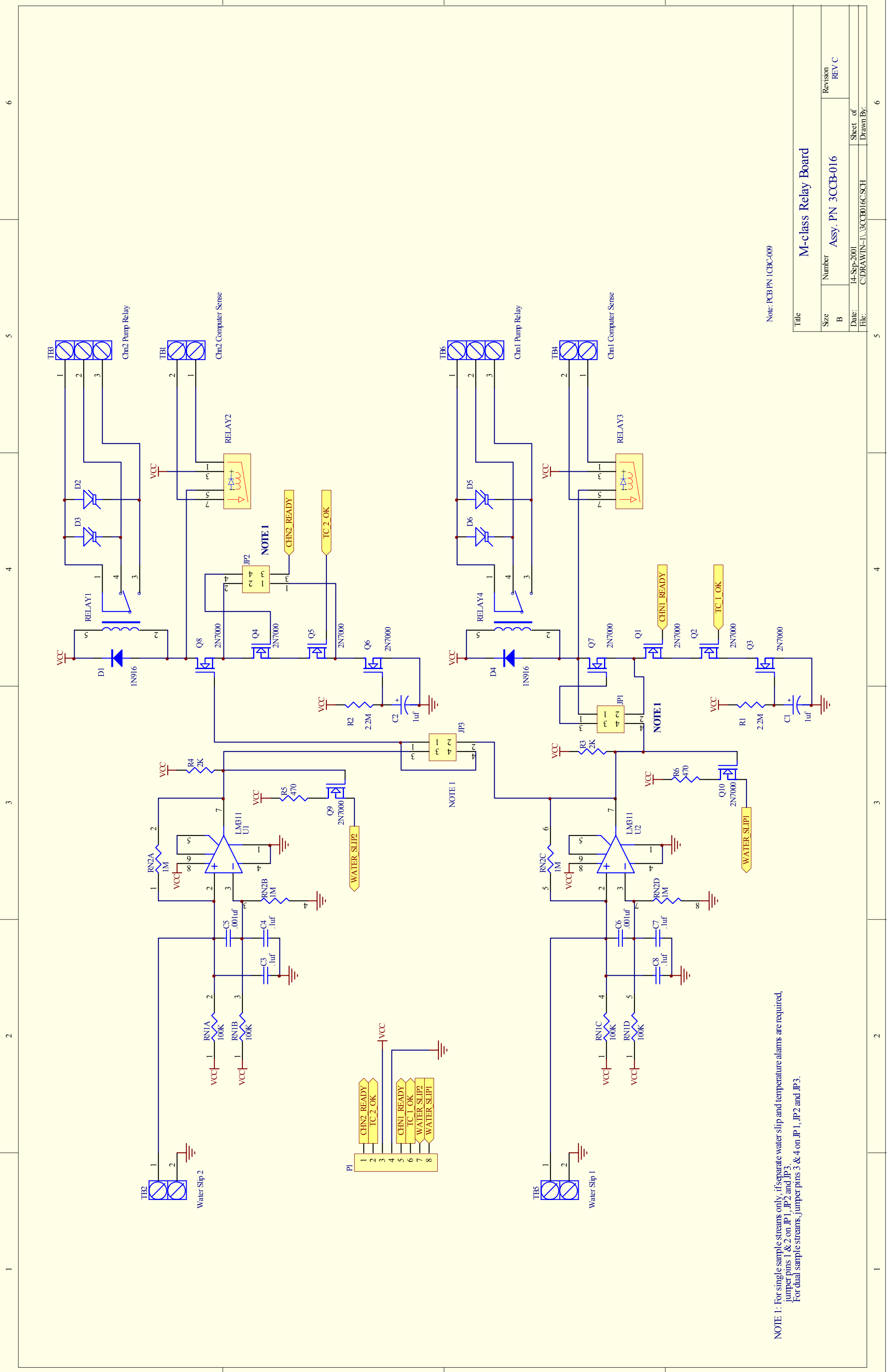
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 BALDWIN, INC.

ITEM	QTY	DESCRIPTION	MANUF.
USED FOR:	MODEL NUMBER: M425		
FOR:	DESCRIPTION:		
DRAWN BY:	DWM	DATE: 09/15/98	
APP'D:		DATE:	
MATERIAL:		PART DESCRIPTION:	BALDWIN, INC.
FINISH:		M425 DUAL CHN. RELAY BOARD	
		ONE PUMP ELECTRICAL INTERCON	
		SIZE: B	
		SCALE: NTS	
		DRAWING/PART NO: M425SELE	
		DESIGN DIMENSIONS ARE IN INCHES	
		() DENOTES MILLIMETER EQUIVALENTS WHEN USED	
		CAD DIR: S:\DRAW\SCHMATIC\ELECTRICAL	SHEET 1 OF 1

Modular Series Thermo-Electric Coolers Control Board



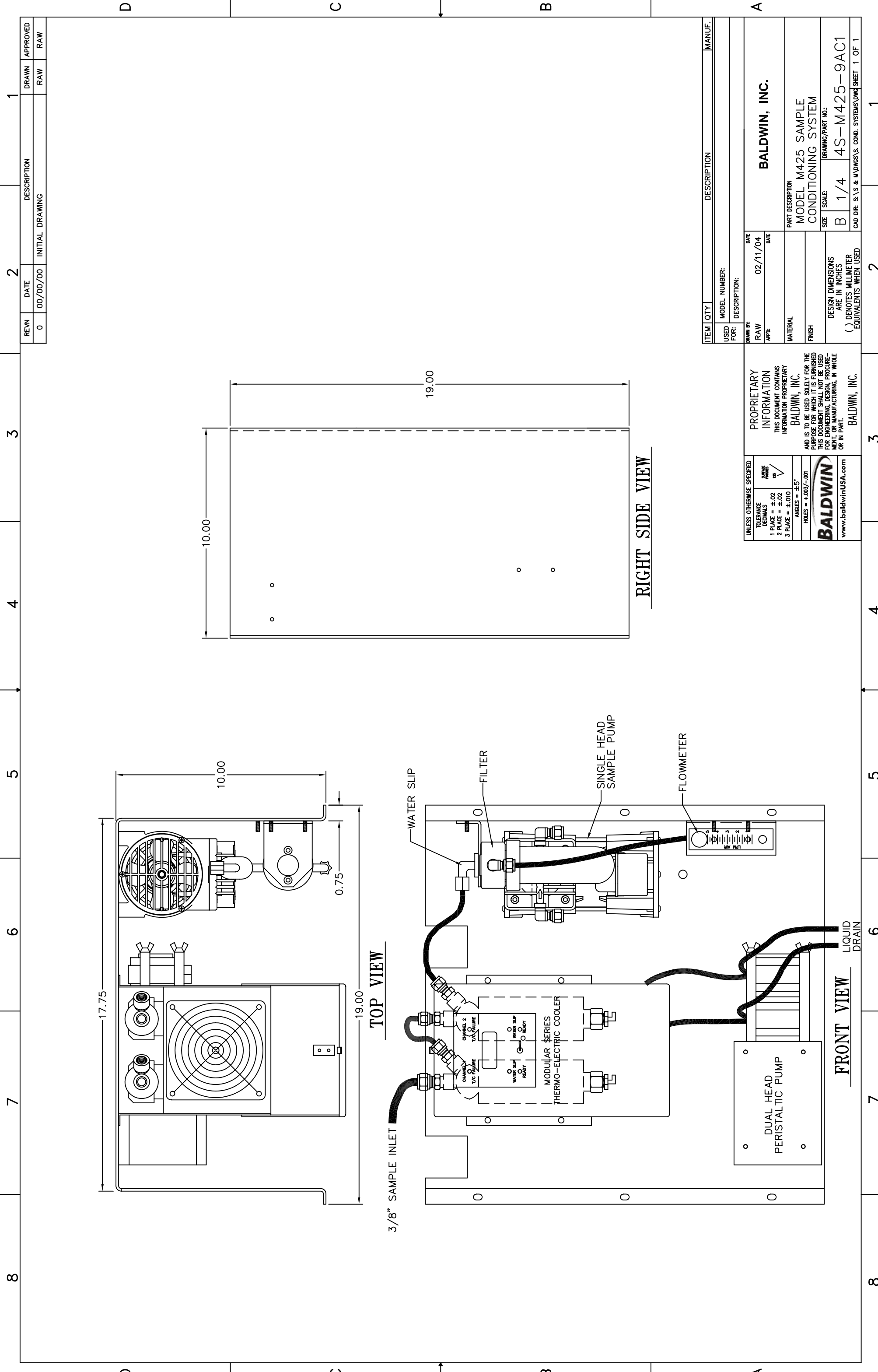


Note: PCB PN 1/CBC-009

NOTE 1: For single sample streams only, if separate water slip and temperature alarms are required, jumper pins 1 & 2 on JP1, JP2 and JP3. For dual sample streams, jumper pins 3 & 4 on JP1, JP2 and JP3.

Title		M-class Relay Board	
Size	Number	Assy. PN	3CCB-016
B			Revision
			REV C
Date:	14-Sep-2001		
File:	C:\DRAWING\1\3CCB016.SCH		
	Sheet of	6	
	Drawn By:		

APPENDIX B: SAMPLE CONDITIONING SYSTEM



REV#	DATE	DESCRIPTION	DRAWN	APPROVED
0	00/00/00	INITIAL DRAWING	RAW	RAW

ITEM	QTY	DESCRIPTION	MANUF.
MODEL NUMBER:			
DESCRIPTION:			
RAW	DATE	DATE	
APP'D	02/11/04		
PART DESCRIPTION			
BALDWIN, INC.			
MODEL M425 SAMPLE CONDITIONING SYSTEM			
DRAWING/PART NO.:			
SIZE	B 1/4	4S-M425-9AC1	
DESIGN DIMENSIONS ARE IN INCHES			
() DENOTES MILLIMETER EQUIVALENTS WHEN USED			
CAD DIR: S:\S & M\DWG\S.S. COND. SYSTEMS\DWG SHEET 1 OF 1			

UNLESS OTHERWISE SPECIFIED

TOLERANCE DECIMALS

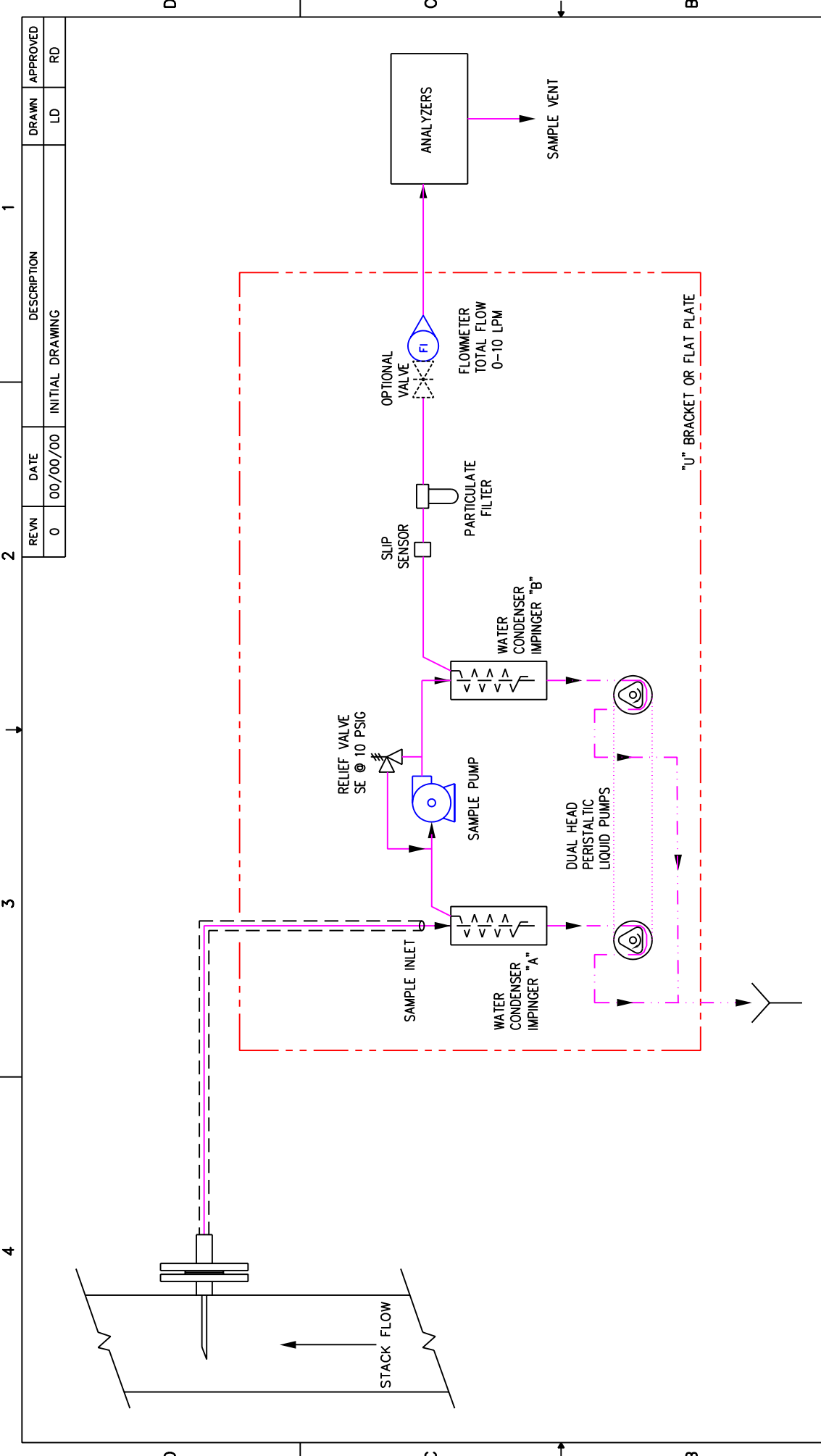
1 PLACE = ±.02
2 PLACE = ±.02
3 PLACE = ±.010

ANGLES = ±5°

HOLES = +.003/-0.01

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ITEM	QTY	DESCRIPTION	MANUF.
USED FOR:		MODEL NUMBER: M425, 8210	
DESCRIPTION:			

DRWN BY: MES	DATE:
APP'D:	DATE:
MATERIAL:	
FINISH:	
DESIGN DIMENSIONS ARE IN INCHES () DENOTES MILLIMETER EQUIVALENTS WHEN USED	
PART DESCRIPTION	
ACTIVE/ACTIVE SAMPLE CONDITIONING SYSTEM FLOW DIA.	
SIZE	SCALE:
A	NTS
ACTIVE/ACTIVE	
CAD DIR: S:\\$B&M\DWGS\S&M. COND. SYSTEM.DWG	
SHEET 1 OF 1	

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- NOTES:**
- ALL COMPONENTS WETTED BY SAMPLE AND CALIBRATION GASES SHALL BE STAINLESS STEEL, BOROSILICATE GLASS, TEFLON OR VITON.
 - TOTAL FLOW SHALL BE RATED CAPACITY OF SAMPLE CHILLER.

1

2

3

4

D

C

B

A

1

2

3

4

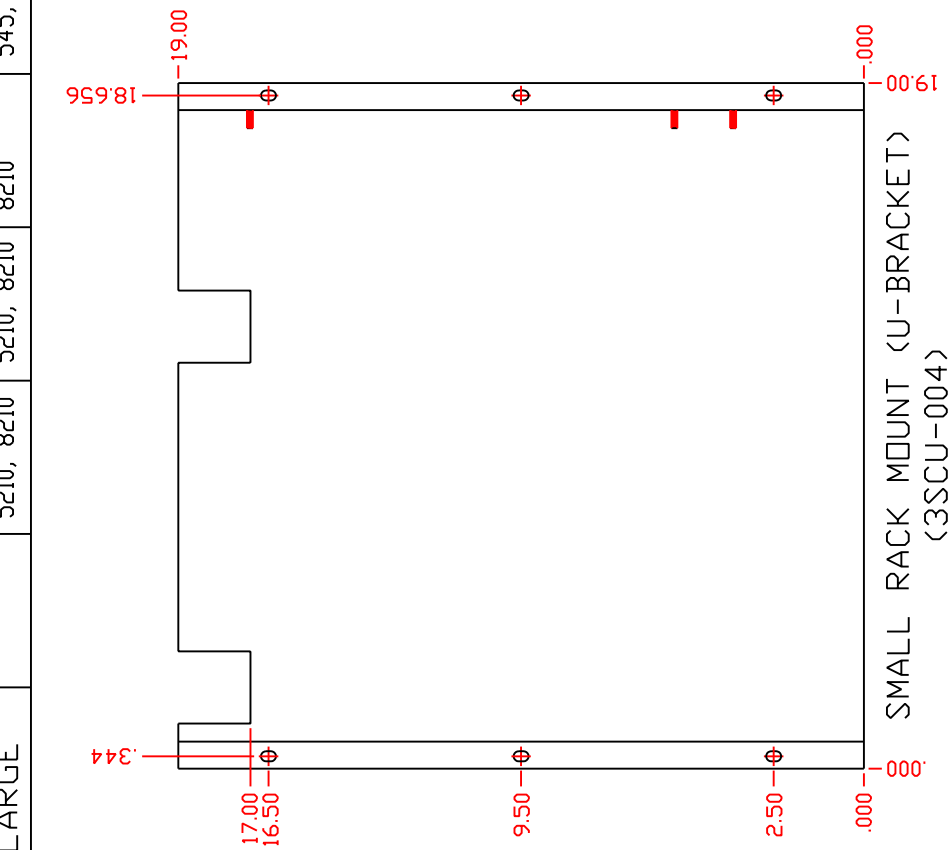
D

C

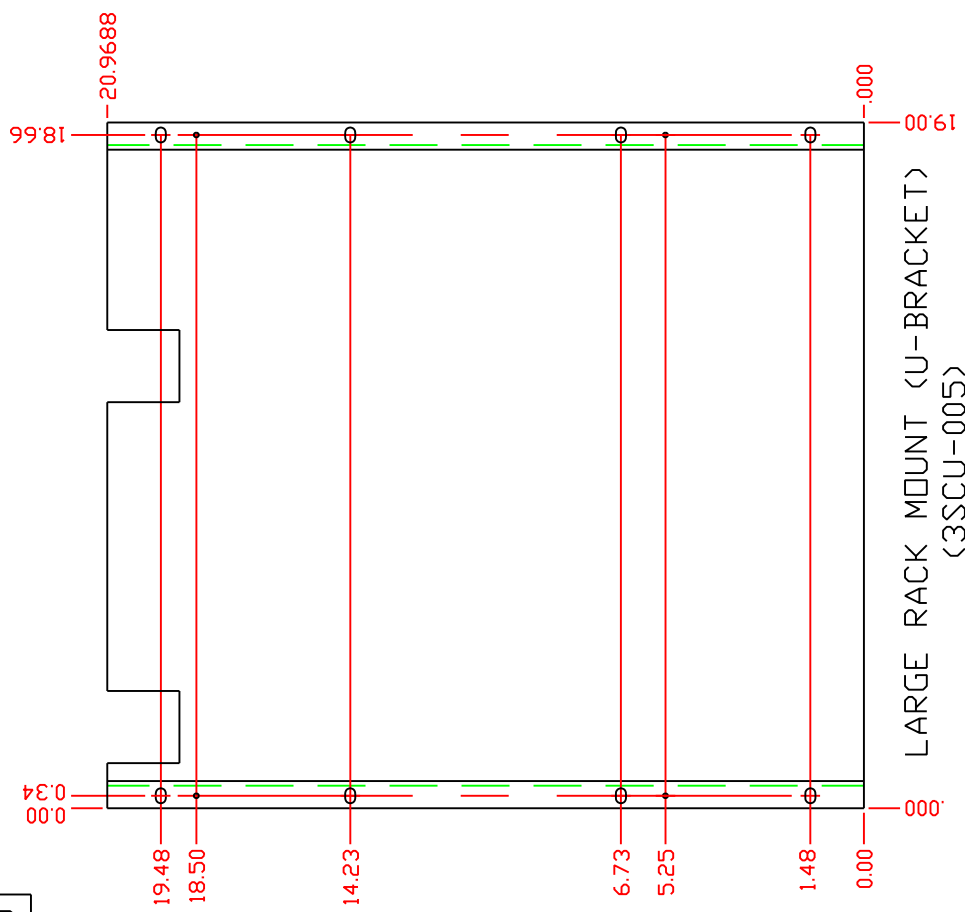
B

A

BRACKET	MODEL C	MODEL C1	MODEL CD	MODEL CD2	MODEL 5
SMALL	M115	M325	M425	M425	
LARGE		5210, 8210	5210, 8210	8210	545, 10410



SMALL RACK MOUNT (U-BRACKET)
(3SCU-004)



LARGE RACK MOUNT (U-BRACKET)
(3SCU-005)

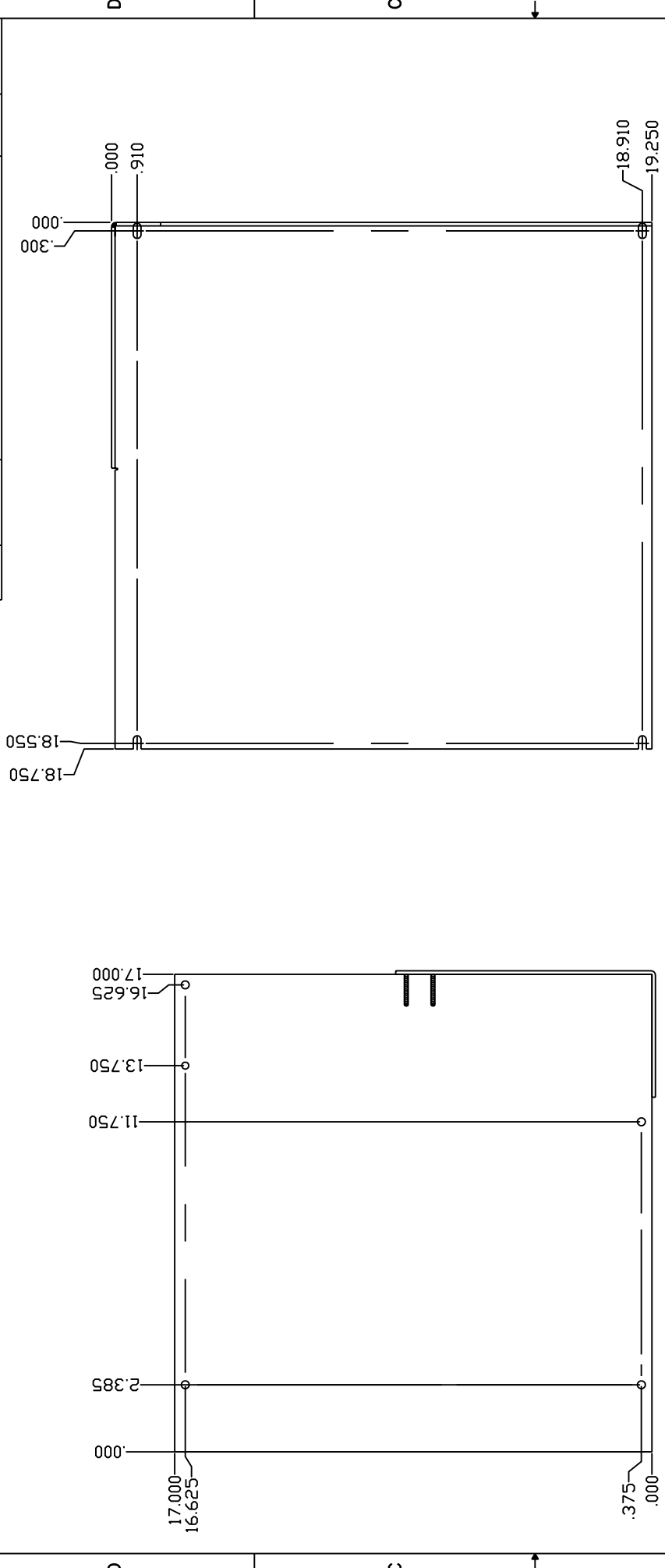
REV/N	DATE	DESCRIPTION	DRAWN	APPROVED
0	00/00/00	INITIAL DRAWING	JD	

ITEM QTY	DESCRIPTION	MANUF.
USED FOR:	MODEL NUMBER:	
DATE:	DATE:	

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UNLESS OTHERWISE SPECIFIED TOLERANCE DECIMALS 1 PLACE = ±.02 2 PLACE = ±.02 3 PLACE = ±.010 ANGLES = ±5° HOLES = +.002/- .001	AMERICAN PRACTICE AS Y	 www.baldwinUSA.com
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REV/N	DATE	DESCRIPTION	DRAWN	APPROVED
0	00/00/00	INITIAL DRAWING	JD	



LARGE WALL MOUNT (FLAT PLATE)
(33CP-001)

SMALL WALL MOUNT (FLAT PLATE)
(33CP-002)

BRACKET	MODEL C	MODEL C1	MODEL CD	MODEL CD2	MODEL 5
SMALL	M115	M325	M425	M425	
LARGE		5210, 8210	5210, 8210	8210	545, 10410

ITEM QTY	DESCRIPTION	MANUF.
USED FOR:	MODEL NUMBER:	
DESCRIPTION:		
DRAWN BY:	DATE	
JD	06/19/02	
APPR:	DATE	
MATERIAL	PART DESCRIPTION	
AS NOTED	SAMPLE CONDITIONER WALL MOUNT MOUNTING DIMENSIONS	
FINISH	SIZE	DRAWING/PART NO.:
AS NOTED	A	3/16 WALL MOUNT
DESIGN DIMENSIONS ARE IN INCHES	SCALE:	
() DENOTES MILLIMETER EQUIVALENTS WHEN USED		
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<p>BALDWIN, INC.</p>		



MINI DIA-VAC®

MAINTENANCE AND DISASSEMBLY INSTRUCTIONS

A. General Operations Characteristics

1. Normal motor coil temperatures may be 160 - 180 degrees F. Winding insulation is Class B. Please note the two fans are different, so before removing the fans, note which side they belong on.
2. To check pumping efficiency, employ suitably damped gauges connected so as to dead-end either pressure or vacuum.
NOTE: Check each separately, One or the other port must be open during this test.
Use 0-60 PSI pressure gauge and 0-30 inch hg. vacuum gauge, (or mercury manometer).
Maximum pressure should be at least 33 PSIG for the .160 eccentric.
Maximum vacuum should be 21 inches Hg when using the .160 eccentric.
3. Match electrical power to motor
4. Do not start pump and motor with load of pressure or vacuum on pump head.
5. Pumps are intended for gaseous operation, eliminate liquids entering pump.
6. Nominal running amps for Mini Dia-Vac® at 115/230 volts are 1.7/0.8

B. Maintenance Procedures

1. Motor oiling - No oiling or other lubrication addition is necessary at all. All bearings are pre-lubricated and shielded from external contamination.
2. Diaphragm Replacement (also see Maintenance Procedure Below):
 - a. Standard EPDM (part 4302 or kit 11309) - Operating life can be five years or more under conditions of light pressure or vacuum loads and infrequent operation. Over 20 PSI and constant operation may require 3 month diaphragm inspection procedure. High ambient conditions over 100 degrees F may also decrease diaphragm life.
 - b. Teflon coated EPDM (part 4301 or kit 11305) - Satisfactory operation can be attained for periods of 12 months or more under conditions of light pressure of vacuum loads.
 - c. Viton/Nomex (part 4303 or kit 11307) - same as b above.

Where critical processes may involve the pumping of corrosive or toxic gas media, it is recommended that a monthly check of the diaphragm be part of a scheduled maintenance procedure.

Air Dimensions Inc. will supply recommendations on the choice of diaphragm material and or pump head construction on request.

*Diaphragms require close precision tolerance, therefore only ADI diaphragms should be used as replacements.

C. Disassembly of Head Section and Service Diaphragm

1. Remove head section by unscrewing the four large bolts. A flat-bladed screw driver may be needed to gently pry the head free of the service diaphragm. **If you have Teflon coating on the heads use caution not to scratch the surface.
2. The valve body can then be removed by unscrewing the two smaller screws (also accessible on the top of the head section). This part may be freed by gently tapping on these two screws after they have been loosened about three or four turns. When the valve body is removed, check all internal surfaces for any accumulation of dirt. The two valve discs can be wiped clean and replaced as long as they appear unaffected by usage. The valve gasket can be easily removed and should be inspected. As a matter of good practice, the valve discs and valve gasket should be replaced during any routine maintenance check of the head section. A once a year routine procedure is recommended.
3. The service diaphragm is secured by the single screw in its center. Remove this screw with a 5/32" Allen wrench. The diaphragm and its clamping plate should be easily lifted off. Some slight adherence to the metal may occur if the diaphragm has been in use for a long period.
4. When replacing the service diaphragm, a Teflon washer (part# 23001) should be inserted under the head of the diaphragm cap screw. This is added insurance against small gas leaks through screw heads and may be essential in vacuum applications where outside air contamination cannot be tolerated. After tightening the screw, the excess Teflon should be trimmed away.

NOTE: When replacing the service diaphragm, be sure the four projecting studs of the base casting are properly located in the four outer holes provided in the diaphragm before the part is clamped in place. Be sure the diaphragm plate is firmly replaced with its center screw.

D. Disassembly and Replacement of the Connecting Rod

1. Remove head section and service diaphragm as described in (C) above. When this is done and the front screen has been removed, the connecting rod assembly may be taken out (refer to exploded view drawing). Gently pry up and remove the connecting rod cap (part# 3301) which is held in place by the diaphragm screw.
2. Loosen but do not remove the counterweight screw. This is accessible from the top of the pump base casting and will require a 5/32" hex allen wrench. The connecting rod eccentric assembly, including counterweight and fan, will then slide off the motor shaft.
3. When replacing the eccentric assembly, be careful to align the flat section on the motor shaft with the counterweight screw. The eccentric assembly should be aligned so the fan is on the outer side from the motor. Slide this assembly as far onto the motor shaft as it will go before tightening the counterweight screw onto the flat of the motor.

NOTE: After prolonged use, the eccentric assembly may freeze up on the motor shaft. A wheel puller may be needed to free the part. When replacing the eccentric assembly, the motor shaft should be lightly coated with a graphite or MDS based lubricant.

E. Related Torque Values

1. Head bolts - 110 inch pounds.
2. Valve body screws and Diaphragm plate screws - 70 inch pounds

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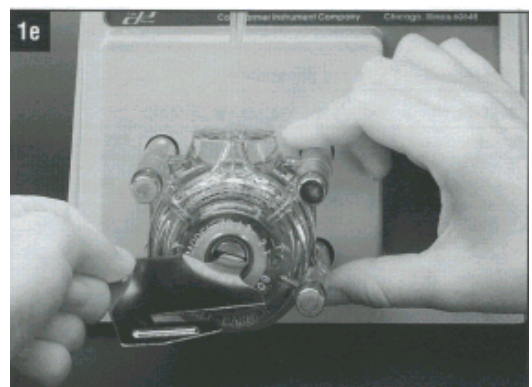
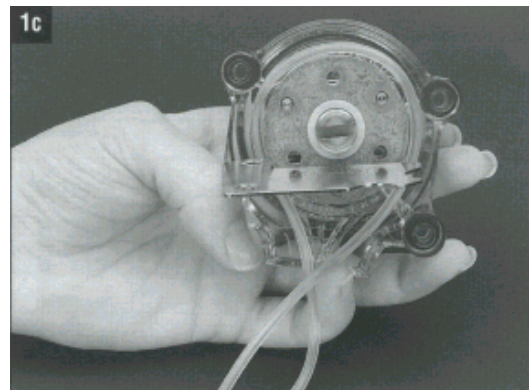
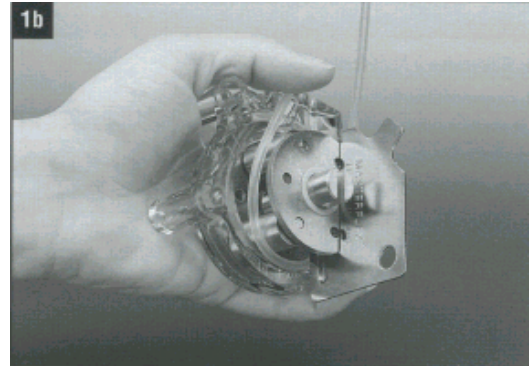
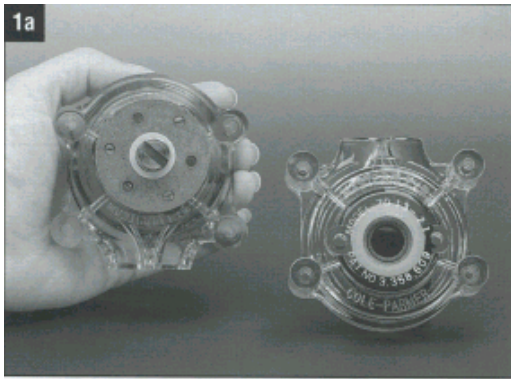
1. Single Pump Head Loading

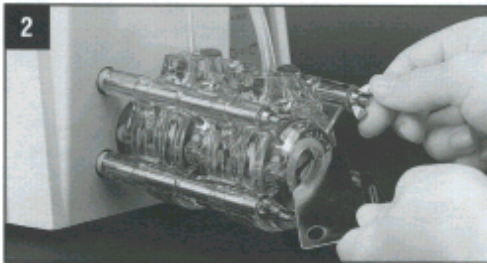
Note: Use only MASTERFLEX Precision Tubing with MASTERFLEX Pumps to insure optimum performance. Use of other tubing may void applicable warranties.

Contents: One pump head, one 15 in (38 cm) length of silicone tubing, one mounting hardware package, manual and tubing loading key.

Supplied tubing loading key required for assembly.

- a) Separate the end bells (the pump head halves). Hold the end bell containing the rotor as shown with the tubing retainer grooves facing down.
- b) Place tubing in the right groove and against the first two rollers. Hold tubing with thumb. Near groove, insert smaller prong of loading key between the top of the rotor and tubing. Push key in as far as possible.
- c) Push down and turn key counterclockwise (ccw) completely around the rotor. The key will push the tubing uniformly into the end bell assembly. Hold the second end of tubing. Remove key.
- d) Position the other end bell on top and press the end bells together. Be careful not to pinch the tubing. If end bells do not snap tightly together, reload tubing. If necessary, turn key in slot on rotor shaft to adjust tubing (as in Step e).
- e) With key in slot on rotor shaft, turn key to align tang on rotor shaft with slot in motor drive shaft. Point tubing retainer grooves up. Shift the pump head slightly till it snaps on the alignment pins (if present). Secure with four provided screws. Tighten with fingers only.





2. Multi-Channel Mounting

Flat bladed screwdriver required for mounting.

Tubing loading key required for mounting.

Note: Other special mounting hardware for multi-channel pumping. See "3. Replacement Parts and Accessories".

- Load the pump heads with tubing.
- Install the four correct length-mounting screws in drive.
- Slide the first pump head into the mounting screws.
- Place key in slot on mounting shaft. Twist to align tang on rotor shaft with slot in motor drive shaft. Shift the pump housing around till it drops over the alignment pins (if present).
- Repeat for each additional pump head, aligning pump head tang with slot on previously mounted pump head.
- Slide the four flat washers onto screws and secure with the four wingnuts. Tighten with fingers only.
- A support bracket is supplied with 3 and 4 channel mounting hardware for additional support. Mount over bottom two screws. Inert one of the three different adjustments screws depending upon drive height.

3. Replacement Parts and Accessories

A. End Bells (order two end bells for a complete head assembly).

Pump Head #	PC Order number	Pump Head #	PC Order number
07013-00, -20	MN-07013-81	-	-
07013-10, -21	MN-07013-91	07013-50, -52	MN-07013-92
07014-00, -20	MN-07014-81	-	-
07014-10, -21	MN-07014-91	07014-50, -52	MN-07014-92
07015-00, -20	MN-07015-81	-	-
07015-10, -21	MN-07015-91	07015-50, -52	MN-07015-92
07016-00, -20	MN-07016-81	-	-
07016-10, -21	MN-07016-91	07016-50, -52	MN-07016-92
07017-00, -20	MN-07017-81	-	-
07017-10, -21	MN-07017-91	07017-50, -52	MN-07017-92
07018-00, -20	MN-07018-81	-	-
07018-10, -21	MN-07018-91	07018-50, -52	MN-07018-92
07024-00, -20	MN-07024-81	-	-
07024-10, -21	MN-07024-91	07024-50, -52	MN-07024-92
07035-02, -20	MN-07035-81	-	-
07035-12, -21	MN-07035-91	-	-

B. Rotor assemblies

Pump Head number	Pump Head suffix	Order number
07013, 07014, 07016 07018	-00	MN-07013-75
	-10, -50	MN-07013-76
	-20	MN-07013-80
	-21, -52	MN-07013-95
07015, 07024, 07035	-00, -02	MN-07013-75
	-10, -50, -12	MN-07013-76
	-20	MN-07013-80
	-21, -52	MN-07013-90

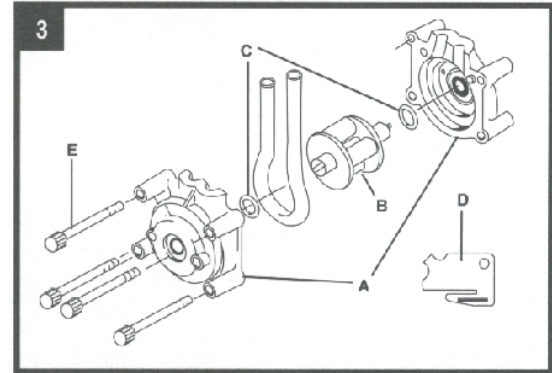
C. MN-07021-04 Thrust washers. Pack of 10.

D. MN-07013-90 Tubing loading key.

E. Mounting hardware for standard pump heads.

Set contains four #8-32 screws, four washers, and four wingnuts.

Number of heads To be mounted	Cold-rolled steel Order number	Stainless steel Order number
1	MN-07013-02	MN-07013-04
2	MN-07013-03	MN-07013-05
3	MN-07013-03	MN-07013-08
4	MN-07013-07	MN-07013-09



4. Specifications

	Thin wall*	Thick wall*
Maximum continuous discharge pressure-psi(bar):	20(1.4)	25(1.7)
Maximum intermittent discharge pressure-psi(bar):	35(2.4)	40(2.7)
Maximum vacuum:	660(510")m Hg	26(20")in Hg
Maximum suction lift:	8.8(6.7)m H2O	29(22')ft H2O
Number of rollers:	3	
Occlusion:	Standard fixed	
Maximum pump speed (rpm):	600	
Nominal torque load:	6.5 kg-cm(90 oz-in)	
Housing materials:	Polycarbonate (PC) all models, or Polyphenylene sulfide (PPS) all models except 07035	
Roller/rotor materials:	Cold rolled Stl (CRS) or Stainless Stl (SS)	
Operating temperature:	0 to 40° (32 to 104°F)	
*Thin wall: tubing 13, 14, 16, 17, 18	Thick wall: tubing 15, 24, 35	
†With tubing 17 & 18		
‡ Use in this temperature range for continuous duty operation with no decrease in performance or product life. Pump heads will work outside this range with some possible reductions in performance or product life.		

5. Warranty and Return Items

Warranty

Use only MASTERFLEX Precision Tubing with MASTERFLEX Pumps to insure optimum performance. Use of other tubing may void applicable warranties.

The manufacturer warrants this product to be free from any significant deviations from published specifications. If repair or adjustment is necessary within the warranty period, the problem will be corrected at no charge if it is not due to misuse or abuse on your part, as determined by the manufacturer. Repair costs outside the warranty period, or those resulting from product misuse or abuse, may be invoiced to you. The warranty period for this product is noted on the Warranty Card.

Product Return

To limit charges and delays, contact the seller or manufacturer for authorization and shipping instructions before returning the product, either within or outside the warranty period. When returning the product, please state the reason for the return. For your protection, pack the product carefully and insure it against possible damage or loss. Any damages resulting from improper packaging are your responsibility.

Technical Assistance

If you have any questions about the use of this product, contact the manufacturer or authorized dealer.

**CHART OF VOLUME PERCENT WATER CONCENTRATIONS
AT SATURATION FOR VARIOUS TEMPERATURES
AT STANDARD PRESSURE (ATMOSPHERIC PRESSURE)**

DEGREES C	DEGREES F	VOLUME %	DEGREES C	DEGREES F	VOLUME %
+100	+ 212	100.00	+ 2	+ 36	0.696
+ 90	+ 194	69.20	+ 1	+ 34	0.649
+ 80	+ 176	46.70	0	+ 32	0.602
+ 75	+ 167	38.70	- 1	+ 30	0.555
+ 70	+ 158	30.70	- 2	+ 28	0.510
+ 65	+ 149	25.20	- 3	+ 27	0.469
+ 60	+ 140	19.70	- 4	+ 25	0.431
+ 55	+ 131	15.50	- 5	+ 23	0.396
+ 50	+ 122	12.20	- 6	+ 21	0.363
+ 45	+ 113	9.45	- 7	+ 19	0.333
+ 40	+ 104	7.25	- 8	+ 18	0.305
+ 35	+ 95	5.55	- 9	+ 16	0.281
+ 30	+ 86	4.19	- 10	+ 14	0.256
+ 29	+ 84	3.95	- 11	+ 12	0.234
+ 28	+ 82	3.73	- 12	+ 10	0.214
+ 27	+ 81	3.62	- 13	+ 9	0.196
+ 26	+ 79	3.32	- 14	+ 7	0.179
+ 25	+ 77	3.13	- 15	+ 5	0.163
+ 24	+ 75	2.94	- 16	+ 3	0.148
+ 23	+ 73	2.77	- 17	+ 1	0.135
+ 22	+ 72	2.61	- 18	0	0.123
+ 21	+ 70	2.46	- 19	- 2	0.112
+ 20	+ 68	3.31	- 20	- 4	0.102
+ 19	+ 66	2.17	- 22	- 8	0.084
+ 18	+ 64	2.04	- 24	- 11	0.069
+ 17	+ 63	1.91	- 26	- 15	0.057
+ 16	+ 61	1.79	- 28	- 18	0.046
+ 15	+ 59	1.68	- 30	- 22	0.038
+ 14	+ 57	1.58	- 32	- 26	0.031
+ 13	+ 55	1.48	- 34	- 30	0.025
+ 12	+ 54	1.38	- 36	- 34	0.019
+ 11	+ 52	1.29	- 38	- 37	0.016
+ 10	+ 50	1.21	- 40	- 40	0.013
+ 9	+ 48	1.13	- 42	- 44	0.011
+ 8	+ 46	1.06	- 44	- 47	0.008
+ 7	+ 45	0.988	- 46	- 51	0.006
+ 6	+ 43	0.922	- 48	- 54	0.005
+ 5	+ 41	0.861	- 50	- 58	0.004
+ 4	+ 39	0.803	- 52	- 62	0.003
+ 3	+ 37	0.751	- 54	- 65	0.002

MOISTURE CONVERSION TABLE

DEWPOINT		VAPOR PRESSURE (WATER/ICE in EQUILIBRIUM) mm MERCURY	PPM on VOLUME BASIS at 760 mm of Hg PRESSURE	RELATIVE HUMIDITY at 70 F	PPM on WEIGHT BASIS in AIR
F	C				
-110	-166	.000010	.00132	.0000053	.00082
-108	-162	.000018	.00237	.0000096	.0015
-106	-159	.000028	.00368	.000015	.0023
-104	-155	.000043	.00566	.000023	.0035
-102	-152	.000065	.00855	.000035	.0053
-100	-148	.000099	.0130	.000053	.0081
-98	-144	.00015	.0197	.000080	.012
-96	-141	.00022	.0289	.00012	.018
-94	-137	.00033	.0434	.00018	.027
-92	-134	.00048	.0632	.00026	.039
-90	-130	.0007	.0921	.00037	.057
-88	-126	.0010	.132	.00054	.082
-86	-123	.0014	.184	.00075	.11
-84	-119	.0020	.263	.00107	.16
-82	-116	.0029	.382	.00155	.24
-80	-112	.0040	.562	.00214	.33
-78	-108	.0056	.737	.00300	.46
-76	-105	.0077	1.01	.00410	.63
-74	-101	.0105	1.38	.00559	.86
-72	-98	.0143	1.88	.00762	1.17
-70	-94	.0194	2.55	.0104	1.58
-68	-90	.0261	3.43	.0140	2.13
-66	-87	.0349	4.59	.0187	2.84
-64	-83	.0464	6.11	.0248	3.79
-62	-80	.0614	8.08	.0328	5.01
-60	-76	.0808	10.6	.0430	6.59
-58	-72	.106	13.9	.0565	8.63
-56	-69	.138	18.2	.0735	11.3
-54	-65	.178	23.4	.0948	14.5
-52	-62	.230	30.3	.123	18.8
-50	-58	.295	38.8	.157	24.1
-48	-54	.378	49.7	.202	30.9
-46	-51	.481	63.3	.257	39.3
-44	-47	.609	80.0	.325	49.7
-42	-44	.768	101	.410	62.7
-40	-40	.966	127	.516	78.9
-38	-36	1.209	159	.644	98.6
-36	-33	1.507	198	.804	122.9
-34	-29	1.873	246	1.00	152
-32	-26	2.318	305	1.24	189
-30	-22	2.859	376	1.52	234
-28	-18	3.51	462	1.88	287
-26	-15	4.30	566	2.30	351
-24	-11	5.26	692	2.81	430
-22	-8	6.40	842	3.41	523
-20	-4	7.76	1020	4.13	633
-18	0	9.39	1240	5.00	770
-16	+3	1.132	1490	6.03	925
-14	+7	1.361	1790	7.25	1110
-12	+10	1.632	2150	8.69	1335
-10	+14	1.950	2570	10.4	1596
-8	+18	2.326	3060	12.4	1900
-6	+21	2.765	3640	14.7	2260
-4	+25	3.280	4230	17.5	2680
-2	+28	3.880	5100	20.7	3170
0	+32	4.579	6020	24.4	3640
+2	+36	5.294	6970	28.2	4330
+4	+39	6.101	8030	32.5	4990
+6	+43	7.013	9230	37.4	5730
+8	+46	8.045	10590	42.9	6580
+10	+50	9.029	12120	49.1	7530
+12	+54	10.52	13840	56.1	8600
+14	+57	11.99	15780	63.9	9800
+16	+61	13.63	17930	72.6	11140
+18	+64	15.48	20370	82.5	12650
+20	+68	17.54	23080	93.5	14330
+22	+71	19.827	26088		16699
+24	+75	33.377	29443		18847
+26	+79	25.209	33169		21232
+28	+8				