OPERATOR'S MANUAL

Model CYD201 and CYD208

Digital Thermometer

OMEGA ENGINEERING, INC.

An OMEGA Technologies Company

M789-038A 15 June 1999

WARRANTY

OMEGA warrants this unit to be free of defects in materials and workmanship and to give satisfactory service for a period of 13 months from date of purchase. OMEGA Warranty adds an additional one (1) month grace period to the normal one (1) year product warranty to cover handling and shipping time. This ensures that our Customers receive maximum coverage on each product. If the unit should malfunction, it must be returned to the factory for evaluation. Our Customer Service Department will issue an Authorized Return (AR) Number immediately upon phone or written request. Upon examination by OMEGA, if the unit is found to be defective, it will be repaired or replaced at no charge. However, this WARRANTY is VOID if the unit shows evidence of having been tampered with or shows evidence of being damaged as a result of excessive current, heat, moisture, vibration, or misuse. Components which wear or which are damaged by misuse are not warranted. These include contact points, fuses, and triacs.

THERE ARE NOT WARRANTIES EXCEPT AS STATED HEREIN. THERE ARE NO OTHER WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING BUT NOT LIMITED TO THE IMPLIED WARRANTIES OF MERCHANTABILITY AND OF FITNESS FOR A PARTICULAR PURPOSE. IN NO EVENT SHALL OMEGA ENGINEERING, INC. BE LIABLE FOR CONSEQUENTIAL, INCIDENTAL, OR SPECIAL DAMAGES. THE BUYER'S SOLE REMEDY FOR ANY BREACH OF THIS AGREEMENT BY OMEGA ENGINEERING, INC., OR ANY BREACH OF ANY WARRANTY BY OMEGA ENGINEERING, INC., SHALL NOT EXCEED THE PURCHASE PRICE PAID BY THE PURCHASE TO OMEGA ENGINEERING, INC. FOR THE UNIT OR UNITS OR EQUIPMENT DIRECTLY AFFECTED BY SUCH BREACH.

RETURN REQUESTS / INQUIRIES

Direct all warranty and repair requests/inquiries to the OMEGA Customer Service Department.
Call toll free in the USA and Canada: 1-800-622-2378; FAX: 203-359-7811.
International: 203-359-1660; FAX; 203-359-7806.

BEFORE RETURNING ANY PRODUCT(S) TO OMEGA, **OBTAIN AN AUTHORIZED RETURN (AR) NUMBER FROM OUR CUSTOMER SERVICE DEPARTMENT IN ORDER TO AVOID PROCESSING DELAYS**. The assigned AR number should then be marked on the outside of the return package and on any correspondence.

FOR WARRANTY RETURNS: Please have the following information available BEFORE contacting OMEGA:

1. P.O. Number under which the product was PURCHASED.
2. Model and serial number of the product under warranty.
3. Repair instruction and/or specific problems you are having with the product.

FOR NON-WARRANTY REPAIRS OR CALIB4RATIONS: Consult OMEGA for current repair/calibration charges. Have the following information BEFORE contacting OMEGA:

1. Your P.O. Number to cover COST of the repair/calibration..
2. Model and serial number of the product under warranty.
3. Repair instruction and/or specific problems you are having with the product.

Every precaution for accuracy has been taken in the preparation of this manual, however, OMEGA ENGINEERING, INC. neither assumes responsibility for any omissions or errors that may appear nor assumes liability for any damages that result from the use of the products in accordance with the information contained in the manual.

OMEGA policy is to make running changes, not model changes, whenever an improvement is possible. That way, our Customers get the latest in technology and engineering.

OMEGA is a registered trademark of OMEGA ENGINEERING, INC.

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CHAPTER 1

INTRODUCTION

1.0 GENERAL

This chapter covers a general description of the Model CYD201/CYD208 (Paragraph 1.1), Handling Liquid Helium and Liquid Nitrogen (Paragraph 1.2), Electrostatic Discharge (Paragraph 1.3), Safety Summary (Paragraph 1.4), and Safety Symbols (Paragraph 1.5).

Due to the OMEGA commitment to continuous product improvement, modifications may occur to the Model CYD201/CYD208 software with time. Some of these changes result from Customer feedback about operation on various cryogenic systems. We encourage comments or suggestions regarding this instrument. Please return the instrument warranty card to ensure receipt of future software updates.

1.1 MODEL CYD201/CYD208 GENERAL DESCRIPTION

Model CYD201/CYD208 Digital Thermometers are ideal to monitor critical temperatures in chemical and materials research, superconductivity measurements, and low temperature physics. The units feature:

- Broad Temperature Range: 1.4 K to 475 K (–272 °C to 202 °C).
- Single Channel (CYD201) and Eight Channel (CYD208) Models.
- For use with CY-7 Series, DT-500 Series, and other Silicon Diode Sensors.
- System Accuracy (Instrument with Sensor) with SoftCal™ to within ±0.1 °C or better.
- Temperature display in °C, °F, K, or Sensor Voltage.
- High/Low Alarm Setpoint with Interfacing Alarm Contacts.
- Standard RS-232C Output of Temperature, Input of Settings, and Alarm Status for Remote Operation.

Table 1-1. Model CYD201/CYD208 Specifications

Display: Four-digit LED display

Resolution: 0.1 for values > 100 or < –100
0.01 for values between -100<T<100

Temperature Range: 1.4 K to 475 K without probe
23 K to 473 K with probe

System Accuracy: To within ±0.1K from 177 K to 313 K.
To ±0.2 K or better from 30 K to 373 K.
±1.0 K above 373 K.

Sensor Excitation: 10 µA constant current

Repeatability: <50 mK

Input Range: 0 to 3 volts with a resolution of 0.1 mV

Hi/Lo Alarm Setpoint: 0.1° resolution

Alarm Relay: Single SPDT relay, rated 28 VDC or Peak AC, 0.25 A (3 W max.)

Scan/Dwell: The Model CYD208 automatically scans all eight channels with selectable dwell times of 0 (skip), 5, 10, 30 and 60 seconds for each channel.

Connections: Four-lead sensor connection (2 current, 2 voltage).

Response Curves*: Standard Curve 10, DT-500DI-8A (also -8B and -8C), DT-500DRC-D, DT-500DRC-E1, and CTI Curve C.
* SOFTCAL™ qualified only for CY-7 Series diode sensors.

COMPUTER INTERFACE

Type: RS-232C Serial Three Wire (Refer to Table 4-1).

MECHANICAL

Ambient Temperature Range: 18 to 28 °C (64 to 82 °F), or 15 to 35 °C (59 to 95 °F) with reduced accuracy.

Power Requirements: 90-125 or 210-250 VAC, 50/60 Hz, 3 watts.

Dimensions: 41 x 106 x 164 mm (1.61 x 4.18 x 6.45 inches).

Weight: 0.5 kilogram (1.1 Pounds)

NOTES

1. Product Specifications subject to change without notice.
2. System electronic temperature accuracy in a given temperature range is the sum of the specifications given for input and output. Sensor calibration errors are not included.

1.2 HANDLING LIQUID HELIUM AND LIQUID NITROGEN

Helium and Nitrogen are colorless, odorless, and tasteless gases. They liquefy when properly cooled. Liquid helium (LHe) and liquid nitrogen (LN_2) may be used in conjunction with the Model CYD201 or CYD208. Although not explosive, there are certain safety considerations in the handling of LHe and LN_2.

1.2.1 Handling Cryogenic Storage Dewars

Operate all cryogenic containers (dewars) in accordance with manufacturer instructions. Safety instructions are normally posted on the side of each dewar. Keep cryogenic dewars in a well-ventilated place, protected from the weather, and away from heat sources. Figure 1-1 shows a typical cryogenic dewar.

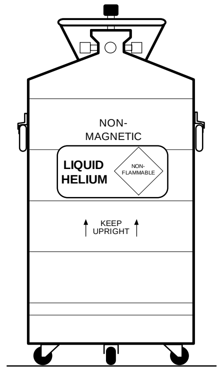


Figure 1-1. Typical Cryogenic Dewar

1.2.2 LHe and LN_2 Safety Precautions

Transfer LHe and LN_2 and operate storage dewar controls in accordance with manufacturer/supplier instructions. During transfer, follow all safety precautions written on the storage dewar and recommended by the manufacturer.

WARNING

- **Liquid helium is a potential asphyxiant and can cause rapid suffocation without warning. Store and use in an adequately ventilated area. DO NOT vent the container in confined spaces. DO NOT enter confined spaces where gas may be present unless area is well-ventilated. If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention.**
- **Liquid helium can cause severe frostbite to exposed body parts. DO NOT touch frosted pipes or valves. For frostbite, consult a physician immediately. If a physician is unavailable, warm the affected parts with water that is near body temperature.**

Two essential safety aspects of handling LHe are adequate ventilation and eye and skin protection. Although helium and nitrogen gases are non-toxic, they are dangerous because they replace air in a normal breathing atmosphere. Liquid helium is an even greater threat because a small amount of liquid evaporates to create a large amount of gas. Store and operate cryogenic dewars in open, well-ventilated areas.

When transferring LHe and LN_2, protect eyes and skin from accidental contact with liquid or the cold gas issuing from it. Protect eyes with full face shield or chemical splash goggles; safety glasses (even with side shields) are inadequate. Always wear special cryogenic gloves (Tempshield Cryo-Gloves® or equivalent) when handling anything that is, or may have been, in contact with the liquid or cold gas, or with cold pipes or equipment. Wear long sleeve shirts and cuffless trousers long enough to prevent liquid from entering shoes.

1.2.3 Recommended First Aid

Post an appropriate Material Safety Data Sheet (MSDS) obtained from the manufacturer/distributor at every site that stores and uses LHe and LN_2. The MSDS specifies symptoms of overexposure and first aid.

If a person exhibits symptoms of asphyxia such as headache, drowsiness, dizziness, excitation, excessive salivation, vomiting, or unconsciousness, remove to fresh air. If breathing is difficult, give oxygen. If breathing stops, give artificial respiration. Call a physician immediately.

If exposure to cryogenic liquids or cold gases occurs, restore tissue to normal body temperature (98.6°F) by bathing it in warm water not exceeding 105 °F (40 °C). DO NOT rub the frozen part, either before or after rewarming. Protect the injured tissue from further damage and infection and call a physician immediately. Flush exposed eyes thoroughly with warm water for at least 15 minutes. In case of massive exposure, remove clothing while showering with warm water. The patient should not drink alcohol or smoke. Keep warm and rest. Call a physician immediately.

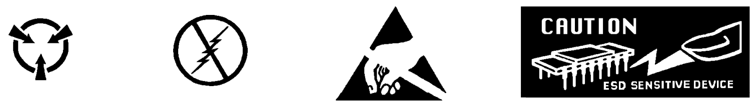
1.3 ELECTROSTATIC DISCHARGE

Electrostatic Discharge (ESD) may damage electronic parts, assemblies, and equipment. ESD is a transfer of electrostatic charge between bodies at different electrostatic potentials caused by direct contact or induced by an electrostatic field. The low-energy source that most commonly destroys Electrostatic Discharge Sensitive (ESDS) devices is the human body, which generates and retains static electricity. Simply walking across a carpet in low humidity may generate up to 35,000 volts of static electricity.

Current technology trends toward greater complexity, increased packaging density, and thinner dielectrics between active elements, which results in electronic devices with even more ESD sensitivity. Some electronic parts are more ESDS than others. ESD levels of only a few hundred volts may damage electronic components such as semiconductors, thick and thin film resistors, and piezoelectric crystals during testing, handling, repair, or assembly. Discharge voltages below 4000 volts cannot be seen, felt, or heard.

1.3.1 Identifying ESDS Components

Below are some industry symbols used to label components as ESDS:



1.3.2 Handling ESDS Components

Observe all precautions necessary to prevent damage to ESDS components before installation. Bring the device and everything that contacts it to ground potential by providing a conductive surface and discharge paths. At a minimum, observe these precautions:

1. De-energize or disconnect all power and signal sources and loads used with unit.

2. Place unit on a grounded conductive work surface.

3. Ground technician through a conductive wrist strap (or other device) using 1 MΩ series resistor to protect operator.

4. Ground any tools, such as soldering equipment, that will contact unit. Contact with operator's hands provides a sufficient ground for tools that are otherwise electrically isolated.

5. Place ESDS devices and assemblies removed from a unit on a conductive work surface or in a conductive container. An operator inserting or removing a device or assembly from a container must maintain contact with a conductive portion of the container. Use only plastic bags approved for storage of ESD material.

6. Do not handle ESDS devices unnecessarily or remove from the packages until actually used or tested.

1.4 SAFETY SUMMARY

Observe these general safety precautions during all phases of instrument operation, service, and repair. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of design, manufacture, and intended instrument use. OMEGA assumes no liability for Customer failure to comply with these requirements.

Ground The Instrument
To minimize shock hazard, connect instrument chassis and cabinet to an electrical ground. The instrument comes with a 3-conductor AC power cable. Plug it into an approved three-contact electrical outlet or use a three-contact adapter with the green ground wire firmly secured to an electrical ground (safety ground) at the power outlet. The power cable jack and mating plug meet Underwriters Laboratories (UL) and International Electrotechnical Commission (IEC) safety standards.

Do Not Operate In An Explosive Atmosphere
Do not operate the instrument in the presence of flammable gases or fumes. Operation of any electrical instrument in such an environment constitutes a definite safety hazard.

Keep Away From Live Circuits
Operating personnel must not remove instrument covers. Refer component replacement and internal adjustments to qualified maintenance personnel. Do not replace components with power cable connected. To avoid injuries, always disconnect power and discharge circuits before touching them.

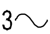
Do Not Substitute Parts Or Modify Instrument
Do not install substitute parts or perform any unauthorized modification to the instrument. Return the instrument to an authorized OMEGA Cryotronics, Inc. representative for service and repair to ensure that safety features are maintained.

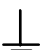
1.5 SAFETY SYMBOLS

 Direct current (power line).

 Alternating current (power line).

 Alternating or direct current (power line).

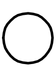
 Three-phase alternating current (power line).

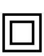
 Earth (ground) terminal.

 Protective conductor terminal.

 Frame or chassis terminal.

 On (supply)

 Off (supply)

 Equipment protected throughout by double insulation or reinforced insulation (equivalent to Class II of IEC 536 - see annex H).

 Caution: High voltages or temperatures. Background color: Yellow; Symbol and outline: Black.

 Caution or Warning - See instrument documentation. Background color: Yellow; Symbol and outline: Black.

CHAPTER 2

INSTALLATION

2.0 GENERAL

This chapter covers Inspection and Unpacking (Paragraph 2.1), Repackaging for Shipment (Paragraph 2.2), Sensor Installation Recommendations (Paragraph 2.3) Power and Ground Requirements (Paragraph 2.4), Sensor Curve Definitions (Paragraph 2.5), and Rack Mounting (Paragraph 2.6).

2.1 INSPECTION AND UNPACKING

Remove packing list and verify receipt of all equipment. For question about the shipment, please call OMEGA Customer Service Department at 1-800-622-2378 or (203) 359-1660.

Upon receipt, inspect container and equipment for damage. Note particularly any evidence of freight damage. Immediately report any damage to the shipping agent

NOTE: The carrier will not honor any claims unless all shipping material is saved for their examination. After examining and removing contents, save packing material and carton in the event reshipment is necessary.

2.2 REPACKAGING FOR SHIPMENT

To return the Model CYD201/CYD208, sensor, or accessories for repair or replacement, obtain a Authorized Return (AR) number from Technical Service in the United States, or from the authorized sales/service representative from which the product was purchased. Instruments may not be accepted without a RGA number. When returning an instrument for service, OMEGA must have the following information before attempting any repair.

1. Instrument model and serial number.
2. User name, company, address, and phone number.
3. Malfunction symptoms.
4. Description of system.
5. Authorized Return (AR) number.

Repack the system in its original container (if available). Write AR number on the outside of the container or on the packing slip. If not available, consult OMEGA for shipping and packing instructions.

2.3 POWER AND GROUND REQUIREMENTS

The Model CYD201/CYD208 requires a power source of 90 to 125 or 210 to 250 VAC, 50 or 60 Hz, single phase, 3 Watts. Three-prong detachable power cord for 120 VAC operation included. Connect to rear panel UL/IEC/ICEE standard plug. See Table 2-1 for fuse rating.

WARNING: To prevent electrical fire or shock hazards, do not expose this instrument to rain or excess moisture.

CAUTION: Verify proper fuse installation and AC Line Voltage Selection Wheel on the Model CYD201/CYD208 rear panel set to available AC line voltage before inserting power cord and turning on the instrument. Refer to Chapter 5 to change voltage configuration.

NOTE: Do not attach the shield to earth ground at the sensor end. It may introduce noise at the measurement end.

Table 2-1. Line Voltage and Fuse Rating Selection

Select	Range	Fuse
115 230	90 – 125 VAC 210 – 250 VAC	0.2 A (Slow Blow) 0.1 A (Slow Blow)

To protect operating personnel, the National Electrical Manufacturer's Association (NEMA) recommends, and some local codes require, grounded instrument panels and cabinets. The 3-conductor power cable, when plugged into an appropriate receptacle, grounds the instrument.

Grounding and shielding signal lines are major concerns when setting up any precision instrument or system. The CYD201/CYD208 includes ground isolation of sensor excitation to allow 4-wire measurement of diode voltage and resistance. Improperly grounding sensor leads and shields can defeat this feature.

Model CYD201/CYD208 digital logic ties directly to earth ground for interface communication. The low side of the heater output connects directly to earth ground. Shield sensor cables whenever possible. Attach the shields to the connector shield pin.

2.4 SENSOR INSTALLATION RECOMMENDATIONS

See the OMEGA Product Catalog for sensor installation and specifications. Call OMEGA for copies of application notes or sensor installation questions. Below are general recommendations on sensor installation:

1. Do not ground the sensor.
2. Shield leads and connect shield wire to SHIELD on screw terminal connector only. Do not connect shield at other end of cable.

3. Keep leads as short as possible.
4. Use twisted-pair wire. Use Duo-Twist™ wire (or equivalent) for two-wire, or Quad-Twist™ wire (or equivalent) for four-wire applications.
5. Thermally anchor lead wires.

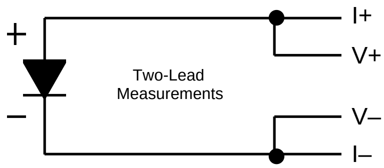
2.4.1 Two-Lead Vs Four-Lead Measurements

In two-lead measurement, the leads that measure sensor voltage also carry the current. The voltage measured at the instrument is the sum of the temperature sensor voltage and the IR voltage drop within the two current leads. Since heat flow down the leads can be critical in a cryogenic environment, wire of small diameter and significant resistance per foot is preferred to minimize this heat flow. Consequently, a voltage drop within the leads may exist.

Four-lead measurement confines current to one pair of leads and measures sensor voltage with the other lead pair carrying no current.

2.4.1.1 Two-Lead Measurement

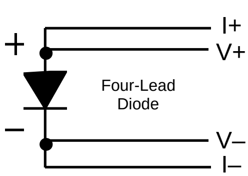
Sometimes system constraints dictate two-lead measurement. Connect the positive terminals (V+ and I+) together and the negative terminals (V– and I–) together at the instrument, then run two leads to the sensor.



Expect some loss in accuracy; the voltage measured at the voltmeter equals the sum of the sensor voltage and the voltage drop across the connecting leads. The exact measurement error depends on sensor sensitivity and variations resulting from changing temperature. For example, a 10 Ω lead resistance results in a 0.1 mV voltage error. The resultant temperature error at liquid helium temperature is only 3 mK, but, because of the lower sensitivity (dV/dT) of the diode at higher temperatures, it becomes 10 mK at liquid nitrogen temperature.

2.4.1.2 Four-Lead Measurement

All sensors, both two-lead and four-lead devices, can be measured in a four-lead configuration to eliminate the effects of lead resistance. The exact point at which the connecting leads solder to the two-lead sensor normally results in a negligible temperature uncertainty.



2.4.2 Connecting Leads To The Sensor

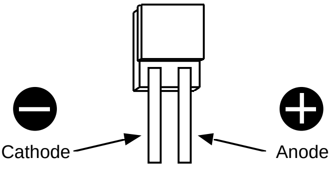
Excessive heat flow through connecting leads to any temperature sensor may differ the temperature between the active sensing element and the sample to which the sensor mounts. This reflects as a real temperature offset between what is measured and the true sample temperature. Eliminate such temperature errors with proper selection and installation of connecting leads.

To minimize heat flow through the leads, select leads of small diameter and low thermal conductivity. Phosphor-bronze or Manganin wire is commonly used in sizes 32 or 36 AWG. These wires have a fairly low thermal conductivity, yet electrical resistance is not large enough to create measurement problems.

Thermally anchor lead wires at several temperatures between room temperature and cryogenic temperatures to guarantee no heat conduction through the leads to the sensor.

2.4.3 Sensor Mounting

DT-470-SD
Diode Sensor Leads



Before installing a diode sensor, identify which lead is the anode and which is the cathode. When viewed with the base down and the leads towards the observer, the anode is on the right and the cathode is on the left. The OMEGA CY-7-SD silicon diode sensor lead configuration is shown to the right. For other sensors, read accompanying literature or consult the manufacturer to positively identify sensor leads. Lead identification should remain clear even after sensor installation. Record the sensor serial number and location.

On the CY-7-SD, the base is the largest flat surface. It is sapphire with gold metalization over a nickel buffer layer. The base is electrically isolated from the sensing element and leads; make all thermal contact to the sensor through the base. A thin braze joint around the sides of the SD package electrically connect to the sensing element. Avoid contact to the sides with any electrically conductive material.

When installing the sensor, make sure there are no electrical shorts or current leakage paths between the leads or between the leads and ground. If IMI-7031 varnish or epoxy is used, it may soften varnish-type lead insulations so that high resistance shunts appear between wires if *sufficient time for curing is not allowed*.

Slide Teflon® spaghetti tubing over bare leads when the possibility of shorting exists. Avoid putting stress on the device leads and allow for thermal contractions that occur during cooling which could fracture a solder joint or lead if installed under tension at room temperature.

For temporary mounting in cold temperature applications, apply a thin layer of Apiezon® N Grease between the sensor and sample to enhance thermal contact under slight pressure. The preferred method for mounting the CY-7-SD sensor is the OMEGA CO Adapter.

CAUTION: OMEGA will not warranty replace any device damaged by user-designed clamps or solder mounting.

For semi-permanent mountings, use Stycast epoxy instead of Apiezon® N Grease. **NOTE:** Do not apply Stycast epoxy over the CY-7-SD package: sensor stress may shift the readings. In all cases, periodically inspect the sensor mounting to verify good thermal contact to the mounting surface is maintained.

2.4.4 Measurement Errors Due To AC Noise

Poorly shielded leads or improperly grounded measurement systems can introduce AC noise into the sensor leads. In diode sensors, the AC noise shifts the DC voltage measurement due to the diode non-linear current/voltage characteristics. When this occurs, measured DC voltage is too low and the corresponding temperature reading is high. The measurement error can approach several tenths of a kelvin. To determine if this problem exists, perform either procedure below.

1. Place a capacitor across the diode to shunt induced AC currents. Capacitor size depends on the noise frequency. If noise is related to power line frequency, use a 10 µF capacitor. If AC-coupled digital noise is suspected (digital circuits or interfaces), use a 0.1 to 1 µF capacitor. In either case, if measured DC voltage increases, there is induced noise in the measurement system.

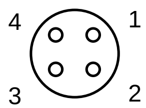
2. Measure AC voltage across the diode with an AC voltmeter or oscilloscope. Most voltmeters do not have the frequency response to measure noise associated with digital circuits or interfaces (which operate in the MHz range). For a thorough discussion of this potential problem, and the magnitude of error which may result, request the paper "Measurement System-Induced Errors In Diode Thermometry," J.K. Krause and B.C. Dodrill, Rev. Sci. Instr. 57 (4), 661, April, 1986.

To greatly reduce potential AC noise, connect twisted leads (pairs) between the measurement instruments and the diode sensors. Use 32 or 36 AWG OMEGA Duo-Twist™ Cryogenic Wire, which features phosphor bronze wire twisted at 3.15 twists per centimeter (8 twists per inch). See the OMEGA Product Catalog or contact OMEGA for further information.

2.5 SENSOR INPUT CONNECTIONS

The Model CYD201 has one rear panel 4-pin sensor input connector designated J1 INPUT 1. The connector pins, numbered 1 thru 4, are shown below.

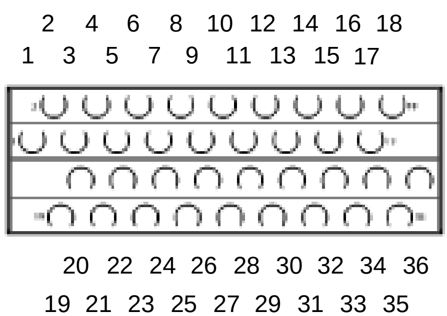
J1 INPUT 1



Terminal	Description
4	+ Current Out
1	– Current Out
2	– Voltage Sense
3	+ Voltage Sense
CASE	Shield

Figure 2-1. Model CYD201 Sensor Connector J1 Details

The Model CYD208 has a 36-pin "Miniature-D" style connector designated J1 INPUTS for inputs 1 thru 8. A Model CYD208-D connector is included to solder interfacing connections to J1. The pin configuration of the Model CYD208-D is shown below.



Terminal	Description
1	+V - Input 1
2	-V - Input 1
3	+V - Input 2
4	-V - Input 2
5	+V - Input 3
6	-V - Input 3
7	+V - Input 4
8	-V - Input 4
9	+V - Input 5
10	-V - Input 5
11	+V - Input 6
12	-V - Input 6
13	+V - Input 7
14	-V - Input 7
15	+V - Input 8
16	-V - Input 8
17	Shield
18	Shield
19	+I - Input 1
20	-I - Input 1
21	+I - Input 2
22	-I - Input 2
23	+I - Input 3
24	-I - Input 3

Terminal	Description
25	+I - Input 4
26	-I - Input 4
27	+I - Input 5
28	-I - Input 5
29	+I - Input 6
30	-I - Input 6
31	+I - Input 7
32	-I - Input 7
33	+I - Input 8
34	-I - Input 8
35	Shield
36	Shield

Figure 2-2. Model CYD208-D Sensor Connector Details

2.6 SENSOR CURVE DEFINITION

To display accurate temperature, select a response curve that matches the installed sensor. There are seven standard curves stored within the Model CYD201/CYD208 numbered 0 through 6 (see Appendix A). Different curves may be assigned to each channel of the Model CYD208. Find the unit factory curve configuration inside the front cover of this manual. Curve 6 (CY-7 Curve 10) is the standard curve configuration unless specified differently upon order.

To determine current curve selection, press and hold **UNITS** and turn on (1) the rear panel SET switch (DIP switch 3). Release **UNITS** key. The CYD201 displays the curve number in the display window. The Model CYD208 displays the curve number in the display window and the channel number in the channel window. To display curves for other channel numbers in the Model CYD208, press **CHANNEL** to scroll through the eight channels.

To change the curve, press **UNITS**. The instrument scrolls through curves 0 through 6. In the Model CYD208, press **CHANNEL** to select other channels, then press **UNITS** to scroll through the curves.

After the new curve selection, turn the SET switch on the rear panel off (0). The unit returns to normal operation.

Table 2-2. Model CYD201/CYD208 Temperature Curves

Curve No.	Range (K)	Description
0	0 – 324.9	DT-500DI-8B
1	0 – 324.9	DT-500DI-8A
2	0 – 324.9	DT-500DRC-D
3	0 – 324.9	DT-500TDC-E1
4	0 – 324.9	CTI Curve C
5	0 – 324.9	DT-500DI-8C
6	0 – 474.9	CY-7 Curve 10

2.7 RACK MOUNTING

The Models CYD201 and CYD208 can install in a standard "size" 1/4 panel EIA rack space. If you ordered a CYD208-DIN rack mounting adapter, follow the installation instructions below. See Figure 2-3.

1. Remove front feet on bottom of unit and attach lower rack piece by threading two of the four screws provided into the front feet holes.
2. Locate the two mounting hole access covers on the top of the unit. Attach the other rack with the remaining screws.

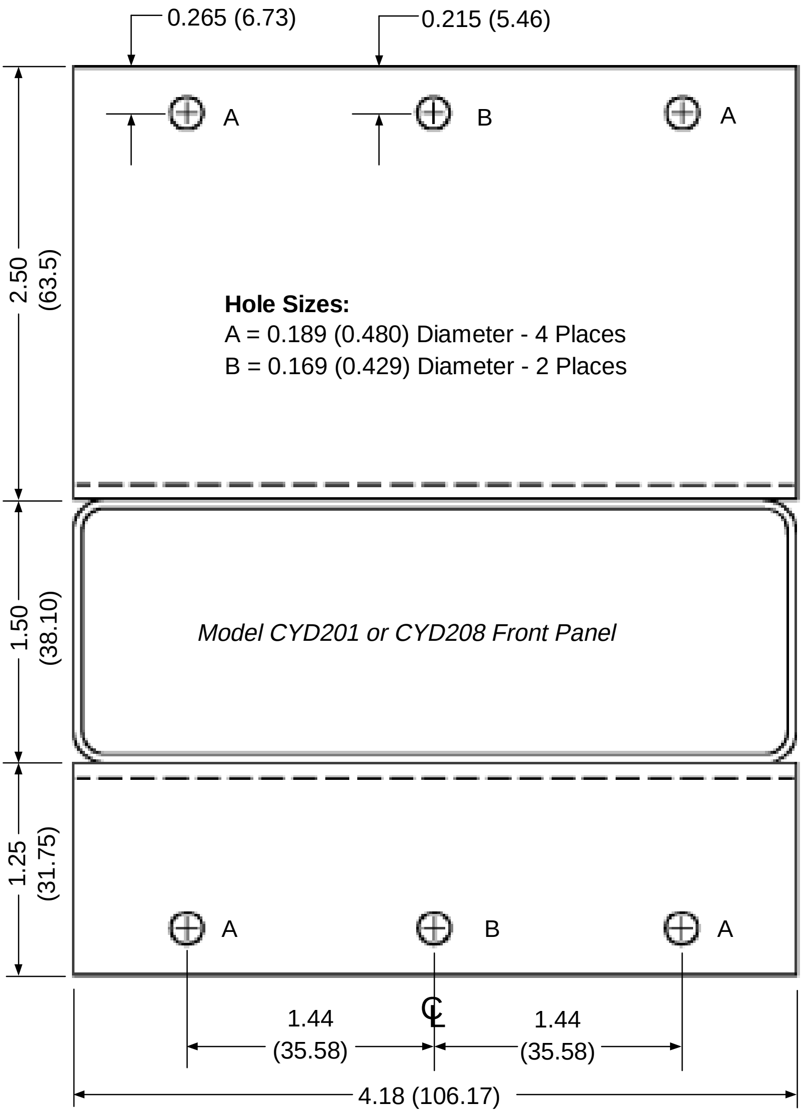


Figure 2-3. Model CYD208-DIN Rack Mounting

2.8 INITIAL POWER UP SEQUENCE

The test sequence below occurs at power up.

1. All display segments light.
2. The unit displays "-201-" or "-208-".
3. The instrument begins normal operation. Units currently selected flash. Model CYD208s also indicate the current channel selected.

2.9 POWER UP ERRORS

On power up, the CYD201/CYD208 checks internal memory. If a problem exists, an error message displays on the front panel of the instrument.

"**Er01**" indicates a hardware problem in the instrument memory. This error is not user-correctable. First perform the procedure in Paragraph 5.3. If unsuccessful, then call the factory.

"**Er02**" indicates a soft error in the instrument memory. To correct this error, close dip switch 1 on the rear panel for at least 5 seconds, then open it. Follow the calibration procedure described in Paragraph 5.3 after an error 2 reset.

"**OL**" indicates a voltage input overload. This can be caused by an open sensor or diode sensor wired backwards.

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CHAPTER 3

OPERATION

3.0 GENERAL

This chapter covers the Units Key (Paragraph 3.1), the Channel key (Paragraph 3.2), Scan Mode (Paragraph 3.3), Setting Dwell Times (Paragraph 3.4), Alarm Operation (Paragraph 3.5), SoftCal™ Compensations (Paragraph 3.6), Calibration (Paragraph 3.7), Verifying SoftCal™ Operation (Paragraph 3.8), and Erasing SoftCal™ Compensations (Paragraph 3.9).

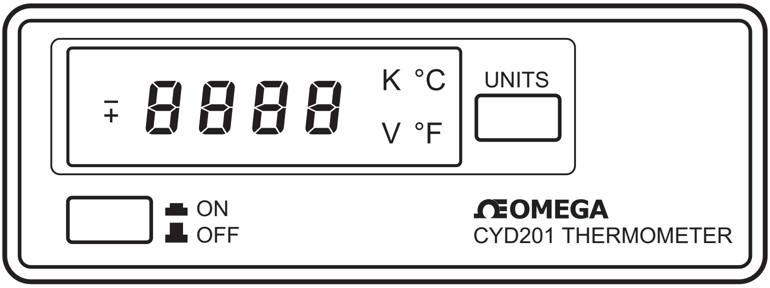

Figure 3-1. Model CYD201 Front Panel

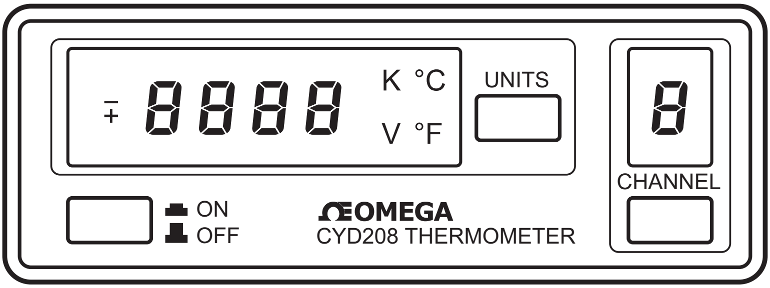

Figure 3-2. Model CYD208 Front Panel

3.1 UNITS KEY

UNITS selects different units of measurement. The thermometer reads in voltage or temperature (°C, °F, or K). Press **UNITS** to scroll through the various selections.

UNITS also determines if SoftCal™ is active. Press and hold **UNITS** for 3 seconds. If SoftCal™ is not active, -000- appears in the display.

3.2 CHANNEL KEY (Model CYD208 Only)

CHANNEL scrolls through the eight possible sensor channels. It also determines if scan mode is activated. Hold 1 to 2 seconds to toggle scan mode On or Off. A red light glows in the upper left channel display if scan mode is active.

3.3 SCAN MODE (Model CYD208 Only)

The thermometer can scan 8 channels or monitor 1 channel. To enable scan mode, press **CHANNEL** for 1 to 2 seconds to toggle scan mode On or Off. If a light appears in upper left of channel display window, then scan mode is On. If the light does not appear, the thermometer is in single-channel mode. Repeat action to reverse mode.

3.4 SETTING DWELL TIMES (Model CYD208 Only)

Set the time the thermometer pauses on each channel (dwell) for 5, 10, 30, or 60 seconds. A dwell time of 0 instructs the thermometer to skip that particular channel. To set the dwell:

1. Hold **CHANNEL** for 3 seconds. Do not release.
2. While still pressing **CHANNEL**, use **UNITS** to select the desired time; 0 (skip), 5, 10, 30, or 60 seconds.
3. Repeat procedure for each desired channel. Default channel dwell is 5 seconds.

3.5 ALARM OPERATION

This section covers Alarm Setpoint (Paragraph 3.5.1), Latched and Unlatched Alarms (Paragraph 3.5.2.), and the Alarm Fix Function (Paragraph 3.5.3).

3.5.1 Alarm Setpoint

The alarm setpoint is a temperature which activates the alarm relay. Set it to warn of temperatures rising above (high alarm) or falling below (low alarm) a certain point.

NOTE: Alarm setpoints work for temperatures, not voltage. If in voltage mode while setting an alarm setpoint, the thermometer defaults to kelvin for the alarm setpoint.

To display the alarm setpoint, move the SET switch on the rear panel to position 1. To change the setpoint:

1. Make sure the SET switch is in position 1.

2. Hold **UNITS** until the desired temperature displays. **UNITS** is a toggle; if it is released and pressed again, the temperature direction reverses. If the temperature display increases, the alarm is a high setpoint. If the temperature display decreases, the alarm is a low setpoint.
3. Release UNITS when the desired setpoint displays. For a Model CYD208, press **CHANNEL** to display the desired channel in the channel window and repeat the steps above to set the alarm for each channel
4. Move the SET switch back to position 0 to enable the alarm. When it triggers, an alarm status light appears in the upper left of the temperature display.

The alarm can be connected to another device which triggers when the alarm activates. The 3-contact terminal block is present on the rear panel as J3 ALARM. The alarm contacts are designated 1 COM 2 with 1 representing the normally open state and 2 representing the normally closed state.

3.5.2 Latched And Unlatched Alarms

Alarms are either latched or unlatched. The alarm is latched when the LATCH switch is in position 1: the alarm turns On when triggered by the alarm setpoint, but will *not* automatically turn Off when the temperature returns to within the high and low setpoint range. The alarm is unlatched when the LATCH switch is in position 0; the alarm turns On when triggered by the alarm setpoint, and automatically turns Off when temperatures return to within the high and low setpoint range.

3.5.3 Alarm Fix Function (Model CYD208 Only)

Set the FIX switch on the Model CYD208 rear panel to OFF (position 0) to continuously update the alarm relay, depending on the alarm setpoint and sensor temperature. If the FIX switch is ON (position 1), the relay updates only when channel 1 input is active.

3.6 SOFTCAL™ COMPENSATIONS

SoftCal™ is a simple, instrument-configured software calibration that improves system accuracy over a specified temperature range. It reduces the error between a CY-7 diode and the Standard Curve 10 used by the instrument. In short, SoftCal™ generates inexpensive calibrations for CY-7 sensors used with OMEGA temperature controllers and monitors.

SoftCal™ calibrations are made at three temperature points: liquid helium (4.2 K), liquid nitrogen (about 77 K), and 305 K. Below is the accuracy* of the CY-7-SD-13 sensor:

±0.5 K	2 K to <30 K	±0.25 K	345 K to <375 K
±0.25 K	30 K to <60 K	±1.0 K	375 K to 475 K
±0.15 K	60 K to <345 K		

* These values generally apply to all silicon diode sensors. Only two-point SoftCal™ calibrations appropriate for CY-7 series Band 11, 11A sensors.

This section covers the SoftCal™ Calibration Procedure (Paragraph 3.6.1), Verifying SoftCal™ Operation (Paragraph 3.6.2), and Erasing SoftCal™ Compensations (Paragraph 3.6.3).

3.6.1 SoftCal™ Calibration Procedure

1. Turn on thermometer 30 minutes prior to operation.
2. Place the SET switch in position 1.
3. Hold **UNITS** until 0 kelvin (or equivalent in °C or °F) displays. The key acts as a toggle. If the display rises, release and press again.
4. Press **CAL ENABLE** on rear panel with a pen tip. The display reads "-SOF-" to indicate the unit is ready to erase the current SoftCal™ calibration. Within 2 seconds press **UNITS** again. The temperature display changes from "-SOF-" to the current SoftCal™ setting.
5. Hold **UNITS** until the sensor temperature displays. For example, if setting SoftCal™ for liquid helium, the display reads 4.2 K. If setting for ice point, the display reads 0 °C.
6. Verify sensor stabilization at calibration temperature.
7. Press **CAL ENABLE** again. "-SOF-" again displays to indicate the unit is ready to accept the calibration point. Within 2 seconds, press **UNITS** to enter a new calibration point. (If **UNITS** is not pressed within 2 seconds, the display returns to the alarm temperature). After 15 seconds, the alarm setpoint temperature displays.
8. To enter more than one point, go back to step 5. **NOTE:** One point may be entered between 1.4 K to 9.9 K. No point may be entered between 10 K and 40 K. Two points may be entered above 40 K.
9. Return the SET switch to position 0.

3.6.2 Verifying SoftCal™ Operation

Check the status of SoftCal™ by holding **UNITS** for 2-3 seconds. If SoftCal™ is not in operation, "-000-" displays.

If the first digit of the display is 1, SoftCal™ is set for below 28 K. If either the second or third digit is 1, SoftCal™ is set for above 28 K.

3.6.3 Erasing SoftCal™ Compensations

When SoftCal™ compensations are erased, the thermometer returns to normal operation.

1. Move the SET switch to position 1.
2. Hold **UNITS** until the front panel displays 0. This key is a toggle. If the display moves in the wrong direction, release and press again.
3. Press **CAL ENABLE** on rear panel using a pen tip. The display changes from 0 to "-SOF-". The alarm setpoint displays after erasing SoftCal™ compensation.
4. Move the SET switch to position 0.

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CHAPTER 4

REMOTE OPERATION

4.0 GENERAL

The Model CYD201/CYD208 Digital Thermometer Serial Interface can be used for both operation and service. This chapter covers the Serial Interface (Paragraph 4.1) and Serial Interface Commands (Paragraph 4.2).

4.1 SERIAL INTERFACE

The Model CYD201/CYD208 has a serial interface for RS-232C communications with a host computer. RS-232C is an unbalanced (single ended), non-terminated line used over short distances (typically 10 feet or less). The Model CYD201/CYD208 serial interface complies with the electrical format of the RS-232C Interface Standard. The serial interface connector is a standard 6 wire RJ-11 modular (telephone) jack.

This section covers Serial Interface Specifications (Table 4-1), Serial Interface Connections (Paragraph 4.1.1), Serial Interface Hardware Configuration and Adapters (Figures 4-1 & 4-2), Serial Interface Operation (Paragraph 4.1.2), and Sample Basic and QuickBasic Programs (Paragraphs 4.1.3 & 4.1.4 respectively).

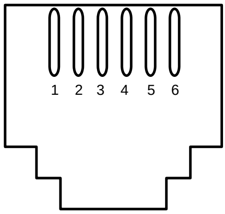
Table 4-1. Serial Interface Specifications

Transmission:	Three-Wire
Connector:	RJ-11 Modular (Telephone) Socket
Timing Format:	Asynchronous
Transmission Mode:	Half Duplex
Baud Rate:	300
Bits per Character:	1 Start, 7 Data, 1 Parity, 1 Stop
Parity Type:	Odd
Data Interface Levels:	Transmits/Receives Using EIA Levels
Terminator:	LF (0AH)

4.1.1 Serial Interface Connections

The serial interface connector is a standard 6 wire RJ-11 modular (telephone) jack. OMEGA Model CYD200-J10 data cables, which maintain pin 1 polarity, simplify interconnection. OMEGA offers the Model CYD200-D RJ-11 to DB-25 adapter and Model CYD200-B RJ-11 to DE-9 adapter to connect to the host computer. See Figure 4-2.

J2 SERIAL I/O



PIN	DESCRIPTION
1	RS-232C In (RxD)
2	RS-232C In (RxD)
3	RS-232C Ground
4	RS-232C Ground
5	RS-232C Out (TxD)
6	RS-232C Out (TxD)

Figure 4-1. Serial I/O (RJ-11) Connector Pin Definitions

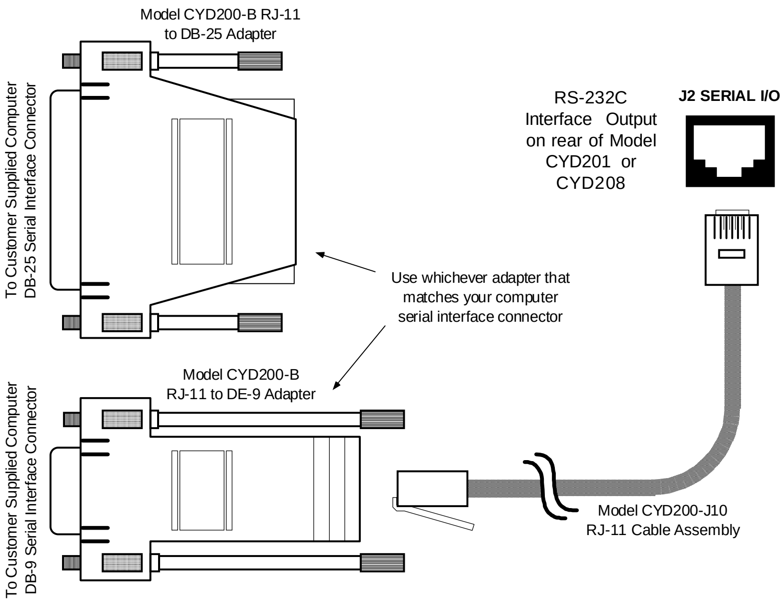


Figure 4-2. Serial Interface Connections

4.1.2 Serial Interface Operation

Remotely control all thermometer functions, except SoftCal™ compensations from a computer with communications software and modem. Located on the rear panel is a RJ-11 modular socket designated J2 SERIAL I/O for host computer connection. Accessories CYD200-J10 (RS-232C phone cord) and CYD200-D (RJ-11 to DB-25 adapter), as well as a null modem adapter may be required to link the serial port of the host computer directly to the thermometer. When programming a Model CYD201/CYD208 from the serial interface, consider the following:

- Type commands in all CAPS.
- The term **free field** indicates a floating decimal point placed any appropriate place in the string of digits.
- **[term]** in examples indicates terminating characters placed by the user or where they appear on a returning character string from the unit.
- Leading zeros and zeros following a decimal point are not needed in a command string, but they are sent in response to a query.
- Enter temperature to 0.1 degrees. Greater precision truncates. Temperature is limited from 0 to 475 K.
- Place no space between commands and the variable being sent.

4.1.3 Sample Basic Program

```
10 OPEN “COM1:300,O,7,1,RS” AS #1  ‘Open COM port
11 PRINT “TYPE ‘QUIT’ TO EXIT”      ‘Print QUIT message
12 PRINT                            ‘Print blank line
20 INPUT “ENTER COMMAND”;A$         ‘Get command to send
21 IF A$ = “QUIT” THEN GOTO 100     ‘Look for QUIT then quit
30 A$ = A$ +CHR$(13)+CHR$(10)       ‘Adding CR and LF
40 PRINT #1,A$;                     ‘Sending command string
45 R = INSTR(A$,”W”)                ‘Scan CMD for W/QUERRY
46 IF R = 0 THEN GOTO 90            ‘If not a QUERRY skip PRINT
50 FOR Z = 1 TO 500: NEXT Z         ‘Short delay
60 LINE INPUT#1,B$                  ‘Read back CYD201/CYD208 response
70 PRINT B$;                        ‘PRINT instrument response
90 GOTO 11                          ‘Jump back to the beginning
100 CLOSE #1                        ‘Close COM port
101 END                             ‘End program
```

4.1.4 Sample Quick Basic 4.0 Program

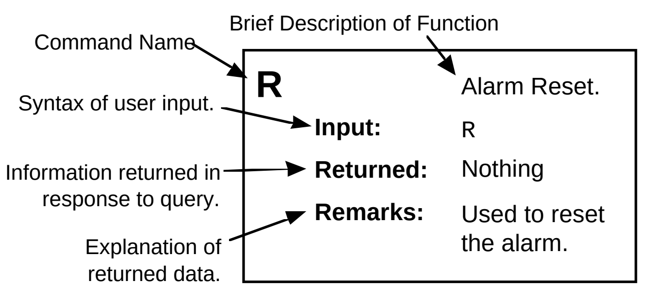
```
STARTUP:  OPEN "COM1:300,O,7,1,RS" FOR RANDOM AS #1
                                               'open the serial port
          PRINT "TYPE 'QUIT' TO EXIT"          'print 'QUIT' message
RESTART:  PRINT                                'print blank line
          INPUT "ENTER COMMAND"; A$            'get command to send
          IF A$ = "QUIT" THEN GOTO FINISH      'check for quit request
          A$ = A$ + CHR$(13) + CHR$(10)        'adding CR and LF
          PRINT #1, A$;                        'sending command string
          R = INSTR(A$, "W")                   'scan for W/query
          IF R = 0 THEN GOTO REJUMP            'if not query skip print
          FOR Z = 1 TO 500: NEXT Z             'short delay
          LINE INPUT #1, B$                    'read back CYD201/CYD208 response
          PRINT B$;                            'print instrument response
REJUMP:   GOTO RESTART                         'jump back to beginning
FINISH:   CLOSE #1                             'close serial port
          END                                  'end/exit program
```

4.2 SERIAL INTERFACE COMMAND SUMMARY

Command	Function	Command	Function
F0	Sensor Units for Setpoint	Y	Scan Dwell Time *
H	High Alarm Setpoint	YC	Scanner Channel Selection *
L	Low Alarm Setpoint	YH	Scan Disable *
R	Reset Alarm	YS	Scan Enable *
WA	Switch ID & Alarm Data Query	WY	Scan and Dwell Query *
WS	Sensor Reading & Alarm Status Query		

* Model CYD208 Only.

Below is an explanation of the command list structure.



F0 Sets Sensor Units for Temperature Display.

Input: **F0x**
Returned: Nothing
Remarks: Sets sensor units for the temperature display, where **x** = **C** (Celsius), **F** (Fahrenheit), **K** (kelvin), or **V** (volts).

H Select High Alarm Setpoint Value.

Input: **Hxxx.x**
Returned: Nothing
Remarks: Sets high alarm setpoint, where **xxx.x** = temperature setpoint in units specified by F0 command. If the instrument is set for volts, the alarm defaults to kelvin.
Example: **H300[term]** sets a high alarm setpoint of 300 degrees.

L Select Low Alarm Setpoint Value.

Input: **Lxxx.x**
Returned: Nothing
Remarks: Sets low alarm setpoint, where **xxx.x** = temperature setpoint in units specified by F0 command. If the instrument is set for volts, the alarm defaults to kelvin.
Example: **L31.2[term]** sets a low alarm setpoint of 31.2 degrees.

R Alarm Reset.

Input: **R**
Returned: Nothing
Remarks: Resets the alarm.

Y Channel Dwell Time **(Model CYD208 Only)**.

Input: **Yab**
Returned: Nothing
Remarks: Sets dwell time for a given channel, where **a** = channel 1 - 8, and **b** = the dwell time parameter as follows:

0 = zero seconds, **1** = 5 seconds, **2** = 10 seconds,
3 = 30 seconds, **4** = 60 seconds

Setting a dwell time of 0 skips the specified channel in the sequence.

Example: **Y23[term]** sets the dwell time for channel 2 to 30 seconds.

YC Channel Scanner Channel **(Model CYD208 Only)**.

Input: **YCx**
Returned: Nothing
Remarks: Asynchronously selects a scanner channel for readout independent of scan feature, where **x** = channel 1 - 8.

YH End Scanning **(Model CYD208 Only)**.

Input: **YH**
Returned: Nothing
Remarks: Halts input scan at current input channel. Place scanner on hold when sending any other commands to scanner or unpredictable results may occur.

YS Begin Scanning **(Model CYD208 Only)**.

Input: **YS**
Returned: Nothing
Remarks: Starts input scan from current input channel. The instrument skips every channel with a dwell time of zero.

WA Switch ID and Alarm Data.

Input: **WA**

Returned: For a Model CYD201, returns:
[switch ID],[high or low alarm],[alarm sign],[alarm setpoint](CR)(LF)

For a Model CYD208, returns:
[switch ID],[high or low alarm],[alarm sign],[alarm setpoint],[active channel number](CR)(LF)

Remarks: Provides the switch ID and alarm data. The switch ID parameter is 0 through 3 for the Model CYD201. It is the sum of 1 if the alarm set enable is set, plus 2 if relay latching is desired. The switch ID parameter is 0 through 7 for the Model CYD208. It is the sum of 1 if the alarm set enable is set, plus 2 if relay latching is desired, plus 4 if the alarm fix is enabled. High or Low Parameter: **H** = high alarm, **L** = low alarm.

WS Sample Sensor Reading and Alarm Status.

Input: `WS`

Returned: For a Model CYD201, returns:
[sign],[sensor reading],[units],[alarm status] (CR)(LF)

For a Model CYD208, returns:
[current channel],[sign],[sensor reading],[units], [alarm status](CR)(LF)

Remarks: Returns the sample sensor reading and alarm status, where **A** = active and **I** = inactive.

WY Scan Status **(Model CYD208 Only)**.

Input: `WY`

Returned: **[scan status],[current channel number],[channel which caused the alarm state], [channel 1 dwell time],[channel 2 dwell time],...[channel 8 dwell time](CR)(LF)**

Remarks: Returns instrument scan status (scanning or holding), channel dwell information, and scan position. Scan Status Parameter: **H** = holding, **S** = scanning. Channel Which Caused the Alarm State Parameter = 1 through 8 or "-" if alarm is inactive. Channel dwell times are in seconds. Sending this command with a Model CYD201 returns **N** to signify no scanner.

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CHAPTER 5

SERVICE

5.0 GENERAL

This chapter covers Model CYD201/CYD208 maintenance: Model CYD201 Rear Panel Connections (Paragraph 5.1), Model CYD208 Rear Panel Connections (Paragraph 5.2), Error Code Troubleshooting (Paragraph 5.3), General Maintenance (Paragraph 5.4), Fuse Replacement (Paragraph 5.5), Line Voltage Selection (Paragraph 5.6), Calibration (Paragraph 5.7), and Serial Interface Cable and Adapters (Paragraph 5.8).

5.1 MODEL CYD201 REAR PANEL CONNECTIONS

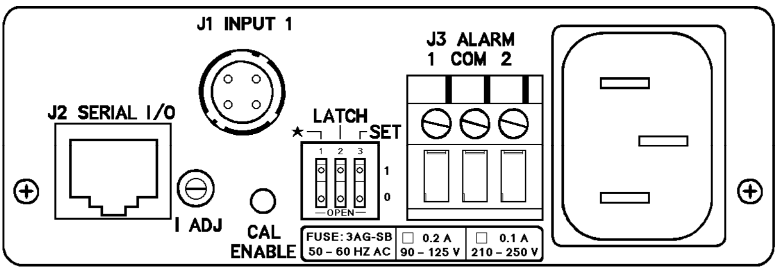


Figure 5-1. Model CYD201 Rear Panel Connections

J1 INPUT 1: Accepts circular 4-pin connector temperature sensor (201-MC).

J2 SERIAL I/O: RJ-11 jack for serial remote communications to a host computer. May require accessories CYD200-J10 (RJ-11 phone cord) and CYD200-D (RJ-11 to DB-25 adapter).

J3 ALARM: Relay responds to alarm setpoints and can trigger another device. Contact 1 is normally open, contact 2 is normally closed.

✰ **Switch**: Not used.

LATCH switch: When on (position 1), turns alarm on but not off (latched) as indicated by temperature change. When off (position 0), turns alarm off or on (unlatched).

SET switch: Used in setting alarm setpoints and recalibration.

CAL ENABLE (Calibration Enable) pushbutton: Used during A/D Converter Calibration. See Paragraph 5.7.2.

I ADJ (Current Adjust) trim potentiometer: Used during Current Source Calibration. See Paragraph 5.7.1.

5.2 MODEL CYD208 REAR PANEL CONNECTIONS

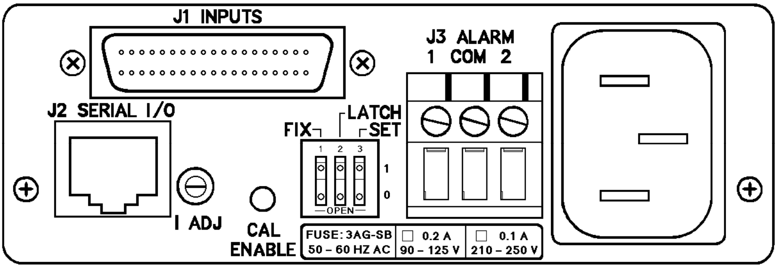


Figure 5-2. Model CYD208 Rear Panel Connections

J1 INPUTS: Accepts 36-pin "D" style connector (208-MC) and multi-sensor adapters. Adapter sits on top of thermometer and accepts up to 8 temperature sensors. Adapter designed for either circular 4-pin (2084) or stripped wire (2081) sensors.

J2 SERIAL I/O: RJ-11 jack for serial remote communications to a host computer. May require accessories CYD200-J10 (RS-232C phone cord) and CYD200-D (RJ-11 to DB-25 adapter).

J3 ALARM: Relay responds to alarm setpoints and can trigger another device. Contact 1 is normally open, contact 2 is normally closed.

FIX switch: Switches alarm functions between monitoring all channels (position 0) or monitoring channel 1 only (position 1).

LATCH switch: When on (position 1), turns alarm on but not off (latched) as indicated by temperature change. When off (position 0), turns alarm off or on (unlatched).

SET switch: Used in setting alarm setpoints and recalibration.

CAL ENABLE (Calibration Enable) pushbutton: Used during A/D Converter Calibration. See Paragraph 5.7.2.

I ADJ (Current Adjust) trim potentiometer: Used during Current Source Calibration. See Paragraph 5.7.1.

5.3 ERROR CODE TROUBLESHOOTING

On power up, the CYD201/CYD208 checks internal memory. If a problem exists, an error message displays on the front panel of the instrument.

Er01 indicates a hardware problem in the instrument memory. This error is not user-correctable.

Er02 indicates a soft error in the instrument memory. To correct this error, use the following procedure.

1. Power up the unit and allow it to display Er02.
2. Close DIP Switch 1 (top of the switch pressed in). Leave the switch closed for at least 5 seconds, then open DIP switch 1 (bottom of the switch pressed in).
3. Verify the Model CYD201/CYD208 display goes through a normal power up sequence and then displays 499.9 K.
4. The input(s) of the Model CYD201/CYD208 must now be recalibrated per in procedure in Paragraph 5.7 before the unit can be used.

OL indicates a voltage input overload. This can be caused by an open sensor or diode sensor wired backwards.

Before calling the factory about a persistent problem, try the procedure below:

WARNING: This procedure erases calibration constants stored in Non-Volatile RAM. If this procedure is used, recalibrate the instrument.

1. With power turned Off, press and hold **CAL ENABLE** on the back panel. While holding **CAL ENABLE**, turn instrument power On.
2. If the Model CYD201/CYD208 displays **Er02**, follow the Calibration procedure in Paragraph 5.7. If **Er01** still displays or if the Model CYD201/CYD208 does not respond, contact OMEGA Service.

5.4 GENERAL MAINTENANCE

Clean the CYD201/CYD208 periodically to remove dust, grease and other contaminants. Clean the front and back panels and case with a soft cloth dampened with a mild detergent and water solution.

NOTE: Do not use aromatic hydrocarbons or chlorinated solvents to clean the Model CYD201/CYD208. They may react with the silk screen printing on the back panel.

5.5 FUSE REPLACEMENT

WARNING: To prevent shock hazard, turn off instrument and disconnect it from AC line power and all test equipment before replacing fuse.

1. Turn POWER switch Off and disconnect power cord from unit. Disconnect all test equipment from unit.
2. Remove all screws from rear panel. Gently pull away rear panel and remove enclosure cover by sliding it to the back.
3. Remove fuse with a fuse puller. The fuse is located behind the transformer as shown in Figure 5.3.
4. Replace with a 0.2 A fuse for 110 V (115 VAC) operation or a 0.1 A fuse for 220 V (230 VAC) operation. Use slow blow fuses.

CAUTION: Replace fuse with the same type and rating as specified by the line voltage selected.

5. Replace enclosure cover, rear panel, and all screws.

5.6 Line Voltage Configuration

The rear-panel, 3-pronged line power connector permits Model CYD201/CYD208 operation at either 110 or 220 VAC. The configuration is indicated on rear panel in the Line Voltage Selection Block. Use the procedure below to change line voltage.

WARNING: To prevent shock hazard, turn off instrument and disconnect it from AC line power and all test equipment before changing line voltage configuration.

1. Turn power switch OFF and disconnect the power cord from the unit. Disconnect all test equipment from unit.
2. Remove all screws from rear panel. Gently pull away rear panel and remove enclosure cover by sliding it to the back.
3. Modify jumper configuration to desired line voltage (see Figure 5-3).
4. Replace fuse to match new voltage requirements.
5. Replace enclosure cover, rear panel and all screws.

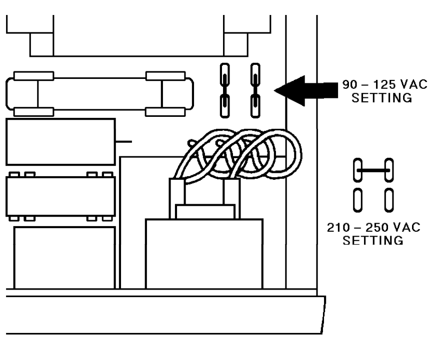


Figure 5-3 Line Voltage Jumper Configuration

5.7 RECALIBRATION

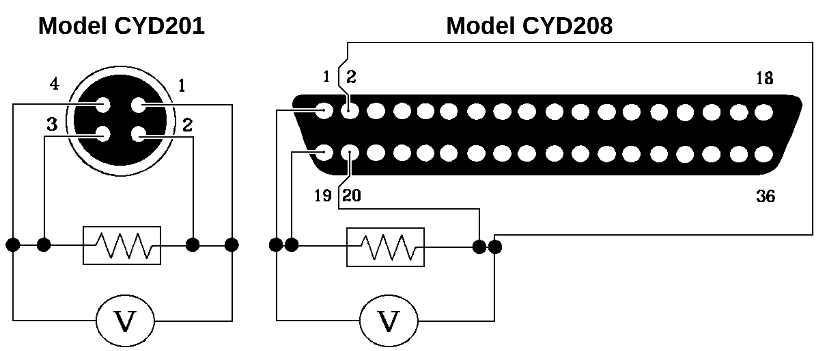
OMEGA calibrates and certifies thermometers to original factory specifications for a reasonable fee. You can recalibrate the thermometer to original specifications, but OMEGA will not warrant these calibrations.

Recalibration requires a digital voltmeter (DVM) with 4½ digit resolution or better; and 25 kΩ and 125 kΩ precision resistors with ±0.01% tolerance or better.

Recalibration involves current source and analog/digital (A/D) converter calibration. A/D calibration erases all SoftCal™ compensations; perform it after current source calibration, not before.

5.7.1 Current Source Calibration

1. Allow 30 minute warm-up to achieve rated specifications.
2. Configure 125 kΩ resistor as shown in Figure 5-4. Set Model CYD208 to channel 1.
3. Connect DVM voltage leads across the resistor and adjust the I ADJ trimpot (located on rear panel) until DVM displays a voltage of 1.2500 volts ±100 microvolts.
4. Remove DVM and resistor.



NOTE: Do not use a voltmeter for A/D Converter Calibration.

Figure 5-4. Calibration Connections

5.7.2 A/D Converter Calibration

NOTE: Current source calibration *must* be performed *before* A/D converter calibration.

1. Allow 30 minute warm-up to achieve rated specifications.
2. Perform current source calibration.
3. Configure 125 kΩ resistor as shown in Figure 5-4. Set Model 208s to channel 1.
4. Wait 10 seconds for resistor voltage to settle.
5. Press **CAL ENABLE**, then within 2 seconds press **UNITS**. The display window shows "-CAL-" for approximately 15 seconds.
6. Repeat procedure with 25 kΩ resistor.
7. For Model CYD208, repeat procedure for other 7 channels. See Figure 2-2 for pin assignments.

5.8 SERIAL INTERFACE CABLE AND ADAPTERS

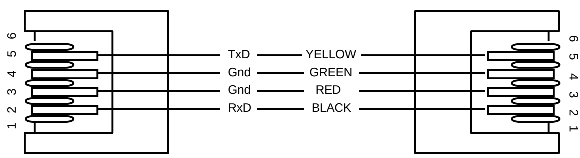


Figure 5-5. Model CYD200-J10 RJ-11 Cable Assembly Wiring Details

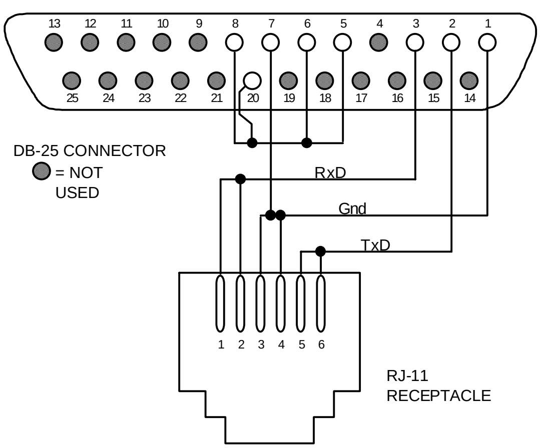


Figure 5-6. Model CYD200-D RJ-11 to DB-25 Adapter Wiring Details

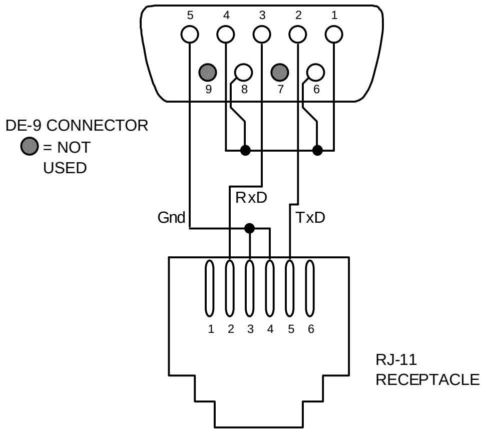


Figure 5-7. Model CYD200-B RJ-11 to DE-9 Adapter Wiring Details

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CHAPTER 6

OPTIONS AND ACCESSORIES

6.0 GENERAL

This chapter lists options, accessories, sensors, wires, and special equipment available for the Model CYD201/CYD208.

6.1 ACCESSORIES

MODEL	DESCRIPTION OF ACCESSORY
201-MC	4-pin Mating Connector for Model CYD201 and Model 2084.
208-MC	36-pin "D" Style Connector for Model CYD208.
CYD200-J10	RJ-11 to RJ-11 Phone Cord, 10 feet (3 meters). See Figure 6-1.
CYD200-D	RJ-11 to DB-25 Adapter. Connects RJ-11 to RS-232C Serial Port on rear of computer. See Figure 6-1.
CYD200-B	RJ-11 to DE-9 Adapter. Connects RJ-11 to RS-232C Serial Port on rear of computer. See Figure 6-1.
2010	Model CYD201 calibration connector.
2080	Model CYD208 calibration connector.
2081	Screw Terminal Adapter. Connects Model CYD208 to multiple sensor/probe assemblies with stripped ends and non- permanent wiring. Provision for attachment to top of thermometer. Fitted with "D" type mating connector.
2082-1	Stainless steel Sensor Probe with 6-foot (1.83 m) cable with 4 stripped ends. 4-inch (10 cm) long by $^{1}/_{8}$ inch (3.2 mm) diameter probe.
2082-2	Stainless steel Sensor Probe with 6-foot (1.83 m) cable with 4-pin 201-MC mating connector. 4-inch (10 cm) long by $^{1}/_{8}$ inch (3.2 mm) diameter probe.
2082-3	Stainless steel Sensor Probe with 12-foot (3.7 m) cable with 4 stripped ends. 6-inch (15 cm) long by $^{1}/_{8}$ inch (3.2 mm) diameter probe.
2082-4	Stainless steel Sensor Probe with 12-foot (3.7 m) cable with 4-pin 201-MC mating connector. 6-inch (15 cm) long by $^{1}/_{8}$ inch (3.2 mm) diameter probe.

ACCESSORIES (continued)

MODEL	DESCRIPTION OF ACCESSORY
2083-1	Sensor Probe. 12-foot (3.7 m) cable with CY-7-SD-13 sensor in CY mounting adapter, stripped ends. Temperature limit: 325 K (52 °C). Diode sensor epoxied (Stycast) into center of 0.564 inch (1.43 cm) diameter by 0.20 inch (5 mm) thick copper disk. 30 AWG copper leads anchored to disk. Mass (excluding leads): 4.3 grams.
2083-2	Sensor Probe. 12-foot (3.7 m) cable with CY-7-SD-13 sensor in CY mounting adapter, with 4-pin CYD201-MC mating connector. Temperature limit: 325 K (52 °C). Diode sensor epoxied (Stycast) into center of 0.564 inch (1.43 cm) diameter by 0.20 inch (5 mm) thick copper disk. 30 AWG copper leads anchored to disk. Mass (excluding leads): 4.3 grams.
2084	Multi-Connector Adapter. Required with Model CYD208 when using multiple probe/cable assemblies and Model 201-MC mating connectors.
CYD208 -DIN	Mounting Adapter for Rack Installation. For installation in a ¼ panel EIA rack space. See Figure 2-3.

6.2 MODEL CYD201/CYD208 WIRES

LSCI P/N	DESCRIPTION OF CABLE
9001-005	**Quad-Twist™ Cryogenic Wire.** Two twisted pairs, phosphor-bronze wire, 36 AWG, 0.127 mm (0.005 inch) diameter.
9001-006	**Duo-Twist™ Cryogenic Wire.** Single twisted pair, phosphor-bronze wire, 36 AWG, 0.127 mm (0.005 inch) diameter.
9001-007	**Quad-Lead™ Cryogenic Wire**. Phosphor-bronze wire, flat, 32 AWG, 0.203 mm (0.008 inch) diameter.
9001-008	**Quad-Lead™ Cryogenic Wire**. Phosphor-bronze wire, flat, 32 AWG, 0.127 mm (0.005 inch) diameter.
—	Any quality dual shield twisted pair wire for dewar to Model CYD201/CYD208 connector.

6.3 MODEL CYD201/CYD208 SENSORS

SENSOR NO.	DESCRIPTION OF SENSOR
Series DT-420	The smallest silicon diode Temperature Sensor available. Installs on flat surfaces. Same silicon chip as Series CY-7 and DT-471.
Series DT-450	Silicon Diode Miniature Temperature Sensor. Same silicon chip as CY-7 designed to install in recesses as small as 1.6 mm dia. by 3.2 mm deep.
Series CY-7	Silicon Diode Temperature Sensor. Repeatable, interchangeable, accurate, wide range, customized for cryogenics.
Series DT-471	An economical version of the CY-7 for applications where temperature measurements below 10 K are not required.

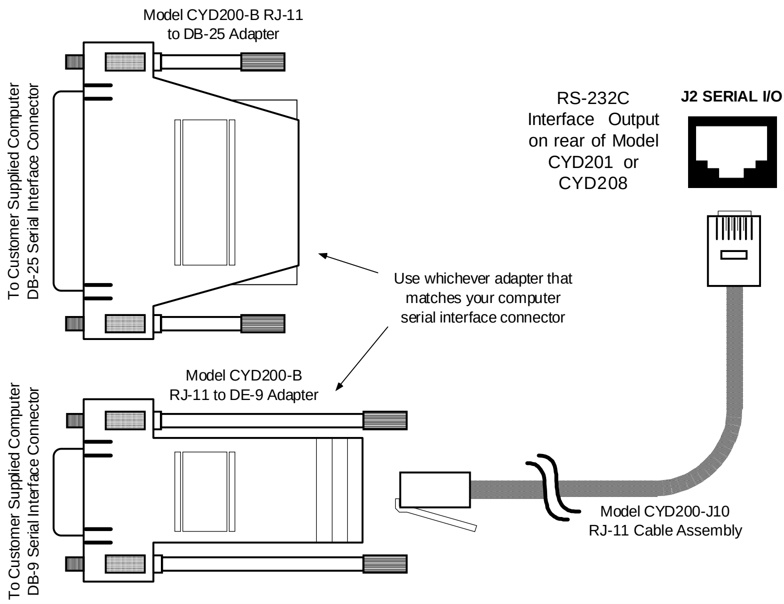

Figure 6-1. Serial Interface Adapters

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APPENDIX A

CURVE TABLES

A1.0 GENERAL

The following curve tables apply to the Model CYD201/CYD208: Curve 0 - DT-500DI-8B (Table A-1), Curve 1 - DT-500DI-8A (Table A-2), Curve 2 - DT-500DRC-D (Table A-3), Curve 3 - DT-500DRC-E1 (Table A-4), Curve 4 - CTI Curve C (Table A-5), Curve 5 - DT-500DI-8C (Table A-6), and Curve 6 - CY-7 Curve 10 (Table A-7).

Table A-1. Curve 0: DT-500DI-8B Voltage-Temp. Characteristics

BP #	Temp. (K)	PROM Voltage	BP #	Temp. (K)	PROM Voltage	BP #	Temp. (K)	PROM Voltage
29	4.0	2.41773	19	29.0	1.11353		170.0	0.73733
	4.2	2.40475	18	30.0	1.10729	7	175.0	0.72353
	4.4	2.39217	17	32.0	1.09810		180.0	0.70936
	4.6	2.37946	16	34.0	1.09125		185.0	0.69532
	4.8	2.36668	15	36.0	1.08547		190.0	0.68125
	5.0	2.35378		38.0	1.08038		195.0	0.66713
	5.5	2.32126	14	40.0	1.07549		200.0	0.65302
	6.0	2.28869		45.0	1.06400		205.0	0.63889
	6.5	2.25643	13	50.0	1.05273		210.0	0.62475
	7.0	2.22480		55.0	1.04123		215.0	0.61066
	7.5	2.19395	12	60.0	1.02954	6	220.0	0.59646
28	8.0	2.16053		65.0	1.01748		225.0	0.58262
	8.5	2.13552	11	70.0	1.00528		230.0	0.56877
	9.0	2.10809		75.0	0.99263		235.0	0.55504
	9.5	2.08197		77.4	0.98666	5	240.0	0.54136
	10.0	2.05687		80.0	0.97988		245.0	0.52801
	11.0	2.00852	10	85.0	0.96711		250.0	0.51469
	12.0	1.96003		90.0	0.95397	4	255.0	0.50155
	13.0	1.90579		95.0	0.94086		260.0	0.48815
27	14.0	1.85614		100.0	0.92767		265.0	0.47486
	15.0	1.80479		105.0	0.91443		270.0	0.46148
26	16.0	1.74703	9	110.0	0.90124		275.0	0.44800
	17.0	1.67479		115.0	0.88776	3	280.0	0.43451
	18.0	1.60665		120.0	0.87434		285.0	0.42064
	19.0	1.53675		125.0	0.86087		290.0	0.40675
	20.0	1.46370		130.0	0.84735		295.0	0.39274
	21.0	1.38832		135.0	0.83377	2	300.0	0.37875
25	22.0	1.31868	8	140.0	0.82032		305.0	0.36436
	23.0	1.26476		145.0	0.80647		310.0	0.35002
24	24.0	1.21712		150.0	0.79274		315.0	0.33559
23	25.0	1.17857		155.0	0.77896		320.0	0.32109
22	26.0	1.15106		160.0	0.76513		325.0	0.30656
21	27.0	1.13317		165.0	0.75125	1	330.0	0.29222
20	28.0	1.12169						

Table A-2. Curve 1: DT-500DI-8A Voltage-Temp. Characteristics

BP #	Temp. (K)	PROM Voltage	BP #	Temp. (K)	PROM Voltage	BP #	Temp. (K)	PROM Voltage
30	4.0	2.46386	17	29.0	1.11741	7	170.0	0.72739
	4.2	2.44821	16	30.0	1.11007		175.0	0.71308
	4.4	2.43188	15	32.0	1.09942		180.0	0.69891
	4.6	2.41500	14	34.0	1.09178		185.0	0.68469
	4.8	2.39781	13	36.0	1.08559		190.0	0.67043
29	5.0	2.37578	12	38.0	1.07992		195.0	0.65615
	5.5	2.33823		40.0	1.07502		200.0	0.64185
	6.0	2.29906		45.0	1.06307		205.0	0.62754
	6.5	2.26440		50.0	1.05136		210.0	0.61333
28	7.0	2.23248		55.0	1.03951	6	215.0	0.59901
	7.5	2.20480	11	60.0	1.02744		220.0	0.58502
	8.0	2.17716		65.0	1.01475		225.0	0.57099
	8.5	2.14994		70.0	1.00193		230.0	0.55715
27	9.0	2.12245	10	75.0	0.98892	5	235.0	0.54327
	9.5	2.10065		77.4	0.98264		240.0	0.52983
	10.0	2.07844		80.0	0.97557		245.0	0.51639
	11.0	2.03712		85.0	0.96216		250.0	0.50302
	12.0	1.99736		90.0	0.94877		255.0	0.48965
	13.0	1.95641	9	95.0	0.93535		260.0	0.47625
26	14.0	1.91202		100.0	0.92166	4	265.0	0.46292
	15.0	1.85236		105.0	0.90798		270.0	0.44925
	16.0	1.79177		110.0	0.89426		275.0	0.43559
	17.0	1.73193		115.0	0.88052		280.0	0.42178
25	18.0	1.66870		120.0	0.86676	3	285.0	0.40797
	19.0	1.59215		125.0	0.85298		290.0	0.39375
	20.0	1.51169	8	130.0	0.83936		295.0	0.37951
	21.0	1.43234		135.0	0.82531		300.0	0.36515
24	22.0	1.34993		140.0	0.81142	2	305.0	0.35078
23	23.0	1.28434		145.0	0.79749		310.0	0.33599
22	24.0	1.23212		150.0	0.78351		315.0	0.32121
21	25.0	1.18995		155.0	0.76950		320.0	0.30643
20	26.0	1.16027		160.0	0.75544		325.0	0.29159
19	27.0	1.14015		165.0	0.74135	1	330.0	0.27665
18	28.0	1.12689						

Table A-3. Curve 2: DT-500DRC-D Voltage-Temp. Characteristics

BP #	Temp. (K)	PROM Voltage	BP #	Temp. (K)	PROM Voltage	BP #	Temp. (K)	PROM Voltage
	1.4	2.5984	24	21.0	1.3505		180.0	0.70757
	1.5	2.5958		22.0	1.3006		185.0	0.69344
	1.6	2.5932	23	23.0	1.2507		190.0	0.67931
	1.7	2.5906		24.0	1.2114		195.0	0.65518
	1.8	2.5880	22	25.0	1.1720		200.0	0.65105
	1.9	2.5854	21	26.0	1.1486		205.0	0.63693
30	2.0	2.5828	20	27.0	1.1308		210.0	0.62280
	2.2	2.5735	19	28.0	1.1190		215.0	0.60867
	2.4	2.5643	18	29.0	1.1116	8	220.0	0.59455
	2.6	2.5551	17	30.0	1.1058		225.0	0.58080
	2.8	2.5458	16	32.0	1.0970		230.0	0.56707
29	3.0	2.5366	15	34.0	1.0902		235.0	0.55334
	3.2	2.5226		36.0	1.0850	7	240.0	0.53960
	3.4	2.5086		38.0	1.0798		245.0	0.52649
	3.6	2.4946	14	40.0	1.0746		250.0	0.51337
	3.8	2.4807		45.0	1.0633		255.0	0.50026
	4.0	2.4667		50.0	1.0520		260.0	0.48714
	4.2	2.4527	13	55.0	1.0407	6	265.0	0.47403
	4.4	2.4387		60.0	1.0287		270.0	0.46057
	4.6	2.4247		65.0	1.0166		275.0	0.44711
	4.8	2.4108	12	70.0	1.0046		280.0	0.43365
	5.0	2.3968		75.0	0.99172	5	285.0	0.42019
	5.5	2.3618		80.0	0.97890		290.0	0.40613
	6.0	2.3269		85.0	0.96609		295.0	0.39208
	6.5	2.2919	11	90.0	0.95327		300.0	0.37802
	7.0	2.2570		95.0	0.93987	4	305.0	0.36397
	7.5	2.2220		100.0	0.92647		310.0	0.34940
	8.0	2.1871		105.0	0.91307		315.0	0.33482
	8.5	2.1521		110.0	0.89966		320.0	0.32025
28	9.0	2.1172		115.0	0.88626		325.0	0.30568
	9.5	2.0909		120.0	0.87286		330.0	0.29111
	10.0	2.0646		125.0	0.85946		335.0	0.27654
	11.5	2.0119	10	130.0	0.84606		340.0	0.26197
	12.0	1.9592		135.0	0.83228	3	345.0	0.24739
27	13.0	1.9066		140.0	0.81850		350.0	0.23325
	14.0	1.8338		145.0	0.80472		355.0	0.21911
26	15.0	1.7610		150.0	0.79094		360.0	0.20497
	16.0	1.6984		155.0	0.77716	2	365.0	0.19083
25	17.0	1.6359		160.0	0.76338		370.0	0.17774
	18.0	1.5646		165.0	0.74961		375.0	0.16464
	19.0	1.4932	9	170.0	0.73582	1	380.0	0.15155
	20.0	1.4219		175.0	0.72170			

Table A-4. Curve 3: DT-500DRC-E1 Voltage-Temp. Characteristics

BP #	Temp. (K)	PROM Voltage	BP #	Temp. (K)	PROM Voltage	BP #	Temp. (K)	PROM Voltage
30	1.4	2.6591		18.0	1.6527		145.0	0.8035
	1.5	2.6567		19.0	1.5724		150.0	0.7896
	1.6	2.6542		20.0	1.4922		155.0	0.7758
	1.7	2.6518		21.0	1.4120		160.0	0.7620
	1.8	2.6494		22.0	1.3317		165.0	0.7482
	1.9	2.6470		23.0	1.2837	7	170.0	0.7344
29	2.0	2.6446		24.0	1.2357		175.0	0.7202
	2.2	2.6355	21	25.0	1.1877		180.0	0.7060
	2.4	2.6265	20	26.0	1.1559		185.0	0.6918
	2.6	2.6175	19	27.0	1.1365		190.0	0.6777
	2.8	2.6084	18	28.0	1.1239		195.0	0.6635
28	3.0	2.5994	17	29.0	1.1150		200.0	0.6493
	3.2	2.5868	16	30.0	1.1080		205.0	0.6351
	3.4	2.5742	15	32.0	1.0981		210.0	0.6210
	3.6	2.5616	14	34.0	1.0909		215.0	0.6068
	3.8	2.5490	13	36.0	1.0848	6	220.0	0.5926
27	4.0	2.5364		38.0	1.0797		225.0	0.5789
	4.2	2.5221	12	40.0	1.0746		230.0	0.5651
	4.4	2.5077		45.0	1.0630		235.0	0.5514
	4.6	2.4934		50.0	1.0515		240.0	0.5377
	4.8	2.4791		55.0	1.0399		245.0	0.5246
	5.0	2.4648	11	60.0	1.0284		250.0	0.5115
	5.5	2.4290		65.0	1.0159		255.0	0.4984
	6.0	2.3932		70.0	1.0035		260.0	0.4853
	6.5	2.3574		75.0	0.9911	4	265.0	0.4722
	7.0	2.3216		77.35	0.9849		270.0	0.4588
	7.5	2.2858		80.0	0.9780		275.0	0.4454
	8.0	2.2500		85.0	0.9649		280.0	0.4320
	8.5	2.2142		90.0	0.9518	3	285.0	0.4186
26	9.0	2.1784		95.0	0.9388		290.0	0.4045
	9.5	2.1516	9	100.0	0.9257		295.0	0.3904
	10.0	2.1247		105.0	0.9122		300.0	0.3763
	11.0	2.0708		110.0	0.8988	2	305.0	0.3622
	12.0	2.0170		115.0	0.8853		310.0	0.3476
25	13.0	1.9632		120.0	0.8718		315.0	0.3330
	14.0	1.9011		125.0	0.8584		320.0	0.3184
	15.0	1.8390	8	130.0	0.8449		325.0	0.3038
	16.0	1.7769		135.0	0.8311	1	330.0	0.2893
	17.0	1.7148		140.0	0.8173			

Table A-5. Curve 4: CTI Diode Voltage-Temp. Characteristics

BP #	Temp. (K)	PROM Voltage	BP #	Temp. (K)	PROM Voltage	BP #	Temp. (K)	PROM Voltage
29	10.0	1.4000		55.0	1.0235		190.0	0.6545
28	11.0	1.3850	21	60.0	1.0100	8	195.0	0.6408
27	12.0	1.3656	20	65.0	0.9958		200.0	0.6270
	13.0	1.3400		70.0	0.9822		205.0	0.6133
26	14.0	1.3161		75.0	0.9690		210.0	0.5995
	15.0	1.2750	19	77.4	0.9626		215.0	0.5858
	16.0	1.2350		80.0	0.9560		220.0	0.5720
	17.0	1.1910	18	85.0	0.9440		225.0	0.5583
25	18.0	1.1500	17	90.0	0.9314		230.0	0.5445
24	19.0	1.1290	16	95.0	0.9184		235.0	0.5308
23	20.0	1.1162	15	100.0	0.9049		240.0	0.5170
	21.0	1.1135		105.0	0.8907		245.0	0.5032
	22.0	1.1109	14	110.0	0.8769	7	250.0	0.4896
	23.0	1.1084	13	115.0	0.8625		255.0	0.4757
	24.0	1.1058		120.0	0.8500		260.0	0.4620
	25.0	1.1033	12	125.0	0.8376		265.0	0.4481
	26.0	1.1007	11	130.0	0.8245	6	270.0	0.4341
	27.0	1.0981		135.0	0.8109		275.0	0.4197
	28.0	1.0955	10	140.0	0.7971	5	280.0	0.4050
	29.0	1.0929		145.0	0.7828	4	285.0	0.3911
	30.0	1.0903		150.0	0.7685		290.0	0.3775
	32.0	1.0851		155.0	0.7543	3	295.0	0.3640
	34.0	1.0799		160.0	0.7400		300.0	0.3510
22	36.0	1.0747	9	165.0	0.7255	2	305.0	0.3382
	38.0	1.0693		170.0	0.7114		310.0	0.3243
	40.0	1.0640		175.0	0.6972		315.0	0.3106
	45.0	1.0505		180.0	0.6830	1	320.0	0.2968
	50.0	1.0370		185.0	0.6690			

Table A-6. Curve 5: DT-500DI-8C Voltage-Temp. Characteristics

BP #	Temp. (K)	PROM Voltage	BP #	Temp. (K)	PROM Voltage	BP #	Temp. (K)	PROM Voltage
29	4.0	2.6187	23	24.0	1.2317		135.0	0.8377
	4.2	2.6074	22	25.0	1.1900		140.0	0.8243
	4.4	2.5956	21	26.0	1.1602		145.0	0.8108
	4.6	2.5834	20	27.0	1.1402	7	150.0	0.7974
	4.8	2.5709	19	28.0	1.1269		155.0	0.7837
	5.0	2.5580	18	29.0	1.1173		160.0	0.7701
28	5.2	2.5484	17	30.0	1.1100		165.0	0.7564
	5.4	2.5312	16	31.0	1.1039		170.0	0.7427
	5.6	2.5173		32.0	1.0991		175.0	0.7289
	5.8	2.5033	15	33.0	1.0949	6	180.0	0.7152
	6.0	2.4890		34.0	1.0913		185.0	0.7013
	6.5	2.4524	14	35.0	1.0879		190.0	0.6874
	7.0	2.4151		36.0	1.0850		195.0	0.6734
	7.5	2.3773		37.0	1.0822		200.0	0.6595
	8.0	2.3394	13	38.0	1.0795		205.0	0.6455
27	8.5	2.2976		39.0	1.0770		210.0	0.6315
	9.0	2.2643		40.0	1.0746		215.0	0.6176
	9.5	2.2277		42.0	1.0697	5	220.0	0.6036
	10.0	2.1919	12	44.0	1.0649		225.0	0.5898
	10.5	2.1566		46.0	1.0603		230.0	0.5761
	11.0	2.1221		48.0	1.0558		235.0	0.5625
	11.5	2.0881		50.0	1.0512	4	240.0	0.5490
	12.0	2.0545		52.0	1.0467		245.0	0.5358
	12.5	2.0211		54.0	1.0421		250.0	0.5226
	13.0	1.9875		56.0	1.0376		255.0	0.4096
	13.5	1.9537		58.0	1.0330		260.0	0.4966
	14.0	1.9193	11	60.0	1.0285		265.0	0.4836
	14.5	1.8843		65.0	1.0168		270.0	0.4705
	15.0	1.8480		70.0	1.0049		275.0	0.4574
	15.5	1.8110	10	75.0	0.9930	3	280.0	0.4442
	16.0	1.7748		77.4	0.9870		285.0	0.4307
26	16.5	1.7441		80.0	0.9805		290.0	0.4171
	17.0	1.7047		85.0	0.9680		295.0	0.4035
	17.5	1.6702		90.0	0.9553	2	300.0	0.3898
	18.0	1.6361	9	95.0	0.9427		305.0	0.3758
	18.5	1.6022		100.0	0.9297		310.0	0.3618
	19.0	1.5676		105.0	0.9168		315.0	0.3477
	19.5	1.5316		110.0	0.9038		320.0	0.3336
	20.0	1.4950		115.0	0.8907		325.0	0.3194
	21.0	1.4218	8	120.0	0.8777	1	330.0	0.3054
25	22.0	1.3461		125.0	0.8643			
24	23.0	1.2840		130.0	0.8510			

Table A-7. Curve 6: CY-7 Voltage-Temp. Characteristics

BP #	Temp. (K)	PROM Voltage	BP #	Temp. (K)	PROM Voltage	BP #	Temp. (K)	PROM Voltage
29	1.4	1.69808	25	12.0	1.36687		70.0	1.03425
	1.5	1.69674		12.5	1.35647		75.0	1.02482
	1.6	1.69521		13.0	1.34530	13	77.4	1.02044
	1.7	1.69355		13.5	1.33453		80.0	1.01525
	1.8	1.69177		14.0	1.32412		85.0	1.00552
	1.9	1.68987		14.5	1.31403		90.0	0.99565
28	2.0	1.68912		15.0	1.30422	12	95.0	0.98574
	2.1	1.68574	24	15.5	1.29340		100.0	0.97550
	2.2	1.68352		16.0	1.28527		105.0	0.96524
	2.3	1.68121		16.5	1.27607		110.0	0.95487
	2.4	1.67880		17.0	1.26702	11	115.0	0.94455
	2.5	1.67632		17.5	1.25810		120.0	0.93383
	2.6	1.67376		18.0	1.24928		125.0	0.92317
	2.7	1.67114		18.5	1.24053		130.0	0.91243
	2.8	1.66845		19.0	1.23184		135.0	0.90161
	2.9	1.66571		19.5	1.22314	10	140.0	0.89082
	3.0	1.66292	23	20.0	1.21555		145.0	0.87976
	3.1	1.66009		21.0	1.19645		150.0	0.86873
	3.2	1.65721		22.0	1.17705		155.0	0.85764
	3.3	1.65430		23.0	1.15558		160.0	0.84650
	3.4	1.65134	22	24.0	1.13598	9	165.0	0.83541
	3.5	1.64833	21	25.0	1.12463		170.0	0.82404
	3.6	1.64529	20	26.0	1.11896		175.0	0.81274
	3.7	1.64219	19	27.0	1.11517		180.0	0.80138
27	3.8	1.64112	18	28.0	1.11202		185.0	0.78999
	3.9	1.63587		29.0	1.10945		190.0	0.77855
	4.0	1.63263		30.0	1.10702	8	195.0	0.76717
	4.2	1.62602	17	31.0	1.10465		200.0	0.75554
	4.4	1.61920		32.0	1.10263		205.0	0.74398
	4.6	1.61220		33.0	1.10060		210.0	0.73238
	4.8	1.60506		34.0	1.09864		215.0	0.72075
	5.0	1.59782		35.0	1.09675		220.0	0.70908
	5.2	1.59047	16	36.0	1.09477		225.0	0.69737
	5.4	1.58303		37.0	1.09309	7	230.0	0.68580
	5.6	1.57551		38.0	1.09131		235.0	0.67387
	5.8	1.56792		39.0	1.08955		240.0	0.66208
	6.0	1.56027		40.0	1.08781		245.0	0.65026
	6.5	1.54097		42.0	1.08436		250.0	0.63841
	7.0	1.52166	15	44.0	1.08105		255.0	0.62654
	7.5	1.50272		46.0	1.07748		260.0	0.61465
	8.0	1.48443		48.0	1.07402		265.0	0.60273
	8.5	1.46700		50.0	1.07053		270.0	0.59080
26	9.0	1.44850		52.0	1.06700		275.0	0.57886
	9.5	1.43488		54.0	1.06346	6	280.0	0.56707
	10.0	1.42013		56.0	1.05988		285.0	0.55492
	10.5	1.40615		58.0	1.05629		290.0	0.54294
	11.0	1.39287	14	60.0	1.05277		295.0	0.53093
	11.5	1.38021		65.0	1.04353		300.0	0.51892

Table A-7. Curve 6: CY-7 Voltage-Temp. Characteristics (Continued)

BP #	Temp. (K)	PROM Voltage	BP #	Temp. (K)	PROM Voltage	BP #	Temp. (K)	PROM Voltage
	305.0	0.50689		365.0	0.36110		425.0	0.21212
	310.0	0.49484		370.0	0.34881		430.0	0.19961
	315.0	0.48278		375.0	0.33650	3	435.0	0.18696
	320.0	0.47069		380.0	0.32416		440.0	0.17464
	325.0	0.45858		385.0	0.31180		445.0	0.16221
	330.0	0.44647	4	390.0	0.29958		450.0	0.14985
	335.0	0.43435		395.0	0.28700		455.0	0.13759
5	340.0	0.42238		400.0	0.27456	2	460.0	0.12536
	345.0	0.41003		405.0	0.26211		465.0	0.11356
	350.0	0.39783		410.0	0.24963		470.0	0.10191
	355.0	0.38561		415.0	0.23714	1	475.0	0.09032
	360.0	0.37337		420.0	0.22463			

ꕤ NOTES ꕤ

ꕥ NOTES ꕥ

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