Model 66322 Temperature Test Chamber with Integral Power Supplies, Multiplexers and Control Signals

Rectangular shaped chamber with temperature equalized air flow, DUT power supplies and signal multiplexing that tests up to 1152 SMD oscillators placed in 3 Test Cards

Features:

- **Four independent DUT power supplies for each Test Card position**
- **Holds DUTs in a rectangular array pallet ideal for holding SMD units**
- **Ample space so Test Cards can hold leaded devices**
- **Power Distribution for high current OCXO testing**
- **Multiple signal control paths to test electronic assemblies**
- **Fast computer interface to enhance speed of testing**
- **RF signal paths can be greater than 10GHz bandwidth**
- **RF signal paths for Crystal Pi Network Testing**
- **Electronic multiplexing of the DUT signals**
- **CO_2, LN_2 or compressor cooled**
- **Air flow control to each pallet for excellent uniformity**
- **Enhanced PID Controller with 8 RTD temperature sensors**
- **RS232 COM port interface**
- **Multiple chambers are daisy chained by RS485**

PRA Inc.
4821 226th Place NE
Arlington, WA 98223 U.S.A.
Tel: 360-435-0484
e-mail:info@praínctest.com
www.praínctest.com

Description

The Model 66322 is an integrated temperature test chamber including power supplies, stimulus signals and needed signal multiplexing. The chamber has three Test Card positions to accept the test fixtures. At the back of the Test Card position are connectors for powering and measuring the devices under test (DUTs).

The chamber is designed for stability and uniformity of temperature, and has minimal mass to enhance the speed of temperature change.

The chamber temperature controller is separate from the power supply controllers. The data rate to the temperature controller is minimal so a separate interface is used. Each of the Test Cards has individual controllers for the power supplies and multiplexer circuits; these controllers share the same high speed serial interface to the controlling computer.

Power Supplies:

There are four optional user programmable linear output power supplies at each Test Card position. These are intended to power the DUTs during testing. These supplies are fully isolated from the chamber's ground and from each other; thus minimizing ground loops and other deleterious effects on testing. The DUT supplies can be programmed for a maximum current limit and the turn on and turn off slew rates can be remotely programmed.

There are optionally four fixed supplies for each Test Card position to power the logic on the Test Cards. There are +15V, +5V, -5V and -15V voltages available. These are fully isolated from the chamber's ground and between Test Cards. These can be remotely switched on and off.

The DUT and Test Card logic power supplies all obtain power from a common 24V DC source that is powered from the mains power. This has these advantages:

• Minimal mains line voltages in the power supply area of the chamber.
• The central 24V supply can be switched off to minimize system power requirements when the system is not testing.
• The DUT and Test Card Logic supplies all have DC to DC converters to permit isolation of all the Test Card power supplies.
• Minimal chance to inject into the power mains or have injected interfering RFI onto the Test Cards.
• Single commercially available power supply to interface to the power mains that is designed to meet all the CE requirements.

All the power supplies are short circuit current protected to avoid damage if a DUT fails.

The fourth supply is intended for very high current applications such as Ovenized Crystal Oscillators (OCXOs) where the requirement for each DUT could be as high as 2 Amps. Each Test Card is capable of 120 Amps of power if the high current option is selected.

The high current part of the fourth power supply is external to the Model 66322 chassis and is volt/volt programmed by the isolated internal low current power supply (there is one of these for each Test Card).

The high current supply is connected to the Test Card through the most right hand connector. There are 60 each DUT paths for each Test Card (180 high current DUTs per chamber). Each DUT path is fused at 2 Amps to protect from a fail shorted DUT. Each path to the DUT has a very low ohmic value sensing resistor so the current to each DUT can be read. This permits measuring start-up current on OCXOs for example.

DUT Power Supply being assembled into the chamber. Opto isolation control section, DC-DC converter and linear output section are visible

Power Supplies
Chamber side removed, showing the 9 supplies and the air ducts and power supply heat sinks.

Chamber top with the 9 power supplies mounted (the control boards are not present). The triple board vertical back plane assembly from the chamber innards is visible

Chamber Temperature Control:

The chamber temperature controller has unique features:

• Fast responding RTD type temperature sensors, each calibrated to an NIST traceable temperature sensor.

•There are 8 each RTD temperature sensors, 4 each on the inlet side of the chamber and 4 each on the outlet side of the chamber. Each is located near one of the four plenums.

• Temperature control is based on the outlet side RTDs.

• The combination of the inlet and outlet side provide the information needed to control the chamber over a wide range of DUT power dissipation.

• A PID (proportional-integrating-differential) type controller function is used. The PID controller also manipulates the integrator to avoid "integrator windup" so overshoot and stabilization time are minimized.

• The controller function also can provide excellent temperature control for a no load to kilowatts of load by adjusting the feedback gain automatically.

The operating status of the controller is shown on the annunciators on the chamber's front panel.

The controller takes into account that the coolant sources many times will have boiled and become gaseous with very limited cooling ability. The controller will attempt to open the valves longer to attempt to purge this condition and then recover when liquid coolant arrives at the valves and full cooling is realized.

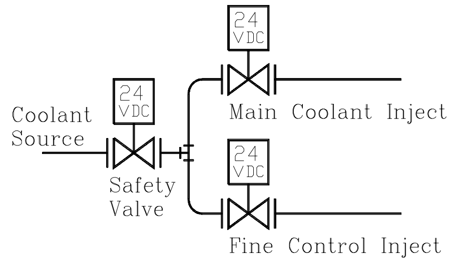
Chamber Cooling:

The chamber cooling can be performed by evaporation of liquid CO_2 or LN_2. These provide the fastest cooling rates. For high power loads, this will be the only solution available. Mechanical refrigerant compressor cooling is also available for locales that can not get good supplies of CO_2 or LN_2. The cooling rate is significantly slower and the heating rate is also less for the refrigerant compressors.

The liquid injection is controlled by three valves. These valves are low voltage DC operated. The low voltage has safety advantages because normally some water condenses around the valves. The valves are also faster acting because they do not have to follow the AC Mains.

There are two valves for coolant injection. One is the coarse inject used to slew the chamber quickly and as required for the higher wattage loads. The other valve is the fine inject which is used to maintain the fractional degree stability of the chamber.

The third valve is a fail-safe valve. If either of the other two valves should fail open, the third valve can be closed to stop the flow of coolant liquid.



Coolant inject valves

If mechanical compressor cooling is selected, a separate compressor assembly is supplied and this connects to the rear of the chamber. The operation of the compressor is controlled from the chamber.

Air Flow Optimization:

The critical part of any rectangular chamber is the uniformity of temperature. The chamber has the air flow patterns optimized to correct for:

• DUTs down stream must have minimal heating from previous devices.

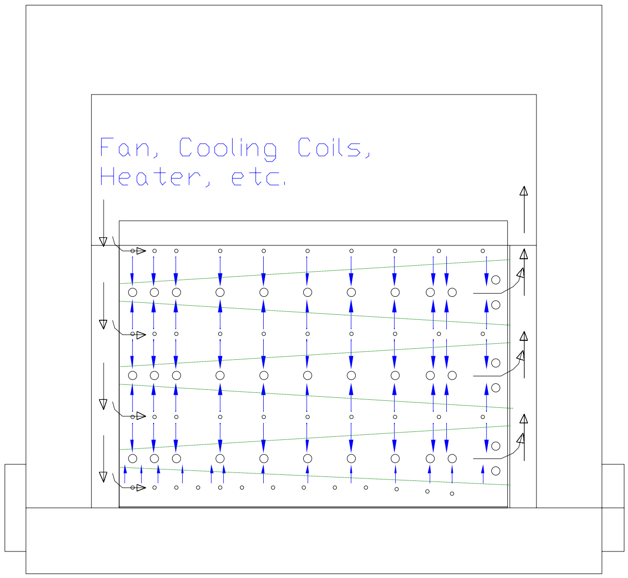
• DUTs must not shadow the next DUT from the air flow.

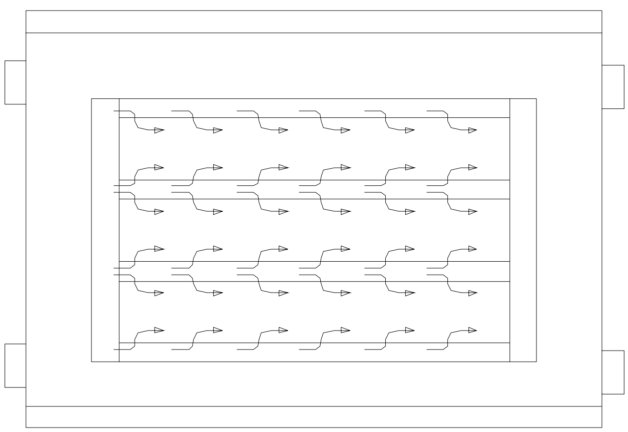
• The chamber's internal corners must not create difficulty in obtaining good circulating air flow, which leads to non uniform temperatures.

The conditioned temperature controlled air is cycled through air plenums that go between the Test Cards. Each of these plenums is separated into inlet and outlet sections. There are holes in the plates above and below the DUTs that let the inlet and outlet air circulate over the DUTs in a controlled pattern. These holes are trimmed for the application to set the air flow pattern across the DUTs. The air flow pattern these plenums and control plates create results in a very short air path across and around each DUT.

The chamber is also designed with very high air flows which assists in maintaining excellent uniformity and also helps maximize the slew rate and reduces the time it takes each DUT to reach a stable temperature condition.

For a specific type of DUT, the chamber can be optimized to provide good uniformity. This is done by adjust-





Air flow pattern across the DUTs

ing the air flow across each DUT. The air control plates can be easily changed if the chamber needs to be used for a radically different type of test card.

Test Cards:

The test cards slide in rails that are located on the sides of the chamber walls. The Test Card plugs into connectors located on the rear chamber wall. There are three connectors on the Test Card, of which two are optional: Center: basic control, power, etc.; Left (optional): DMM Multiplex option; Right (optional): High Current and RF I/O.

Each Test Card has a separate RS232 Serial Link to the controlling computer. The interface is 38,400 baud with CTS/RTS handshake. The Test Card is controlled by a microprocessor located on each Test Card. Each Test Card has a unique serial number.

See the Model 2212 Test Card Data Sheet for more details.

Multiplexing and Measurement Control Signals:

The control board has an optional 93 input MUX to the DMM. This can also have stimulus signals to permit measuring zener diodes, thermistors, RTDs, etc.

The center connector has connection paths for the DMM, has a counter output path, and has over 40 user definable input and output pins, including extra power supply connections.

The DMM multiplexer also controls connections to the high current OCXO current sense circuitry.

Chamber Interior - Test Card tracks with ejector pivots installed. Back panel visible with both upper and lower interface connectors

Chamber and Supply Fail Safe Capabilities:

The chamber has two modes of temperature protection. 1) The chamber is monitored by the control circuitry. If the chamber exceeds the upper limit or is below the lower limit the heater is turned off, all the coolant valves are closed and the temperature controlling mode is terminated. 2) There is a thermal fuse located in the chamber near the heater. If the limit temperature of about 185°C is exceeded, the fuse opens and the heater can no longer be turned on. The thermal fuse has to be replaced to restart chamber operation.

Example of an OCXO Test Card

Remote Control of the Chamber, Multiplexer and Supplies:

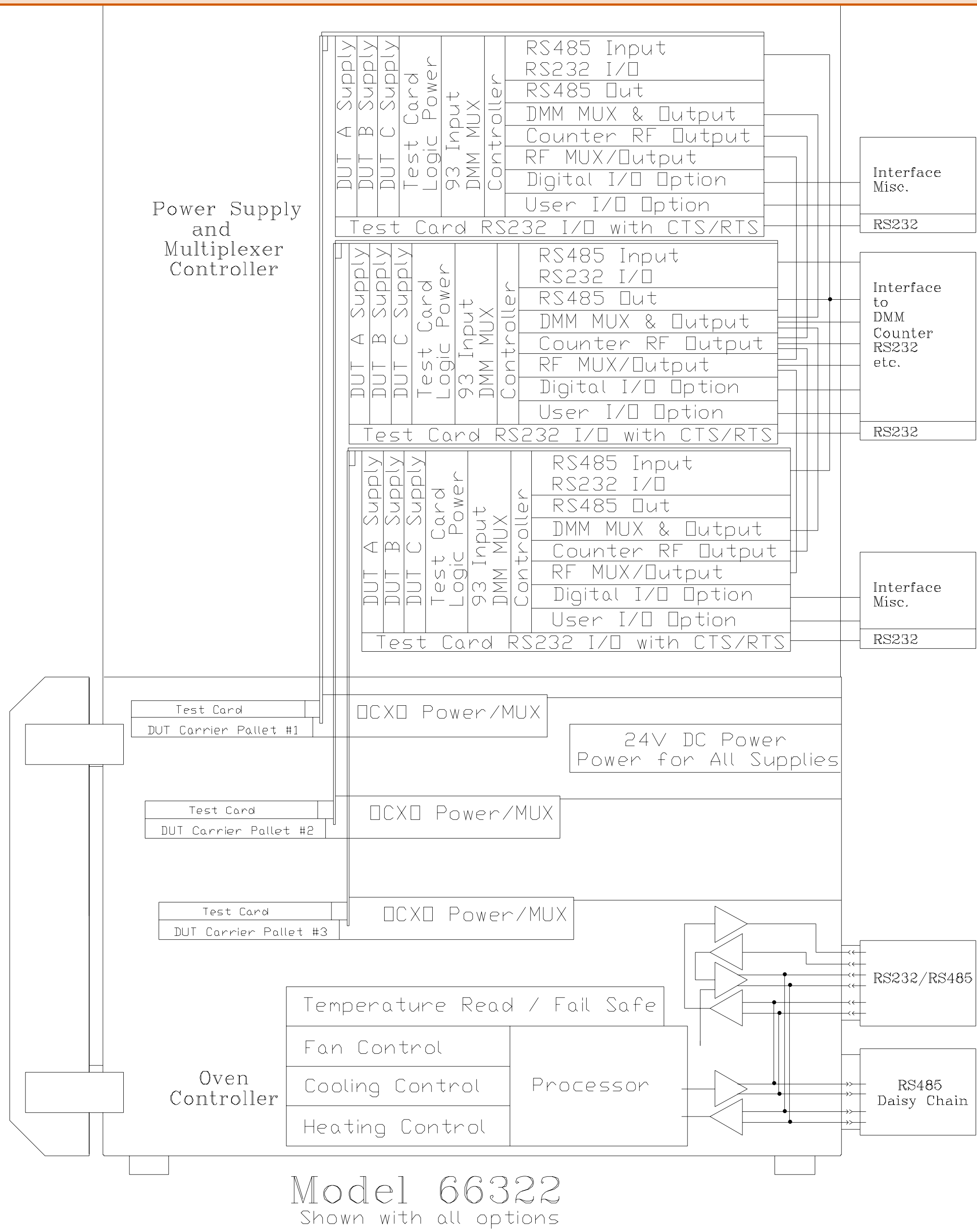
The Model 66322 has 2 serial port interfaces for control. One is at 9,600 baud for the temperature control. The other is the control of the power supplies, multiplexers, etc. and this is at 38,400 baud. The power supply controller is three processors that share a multi drop full duplex RS485 connection where each Test Card position has a unique address.

The interfaces permit "daisy chain" connections to other chambers with the RS485 portion which can connect up to 4 chambers together.

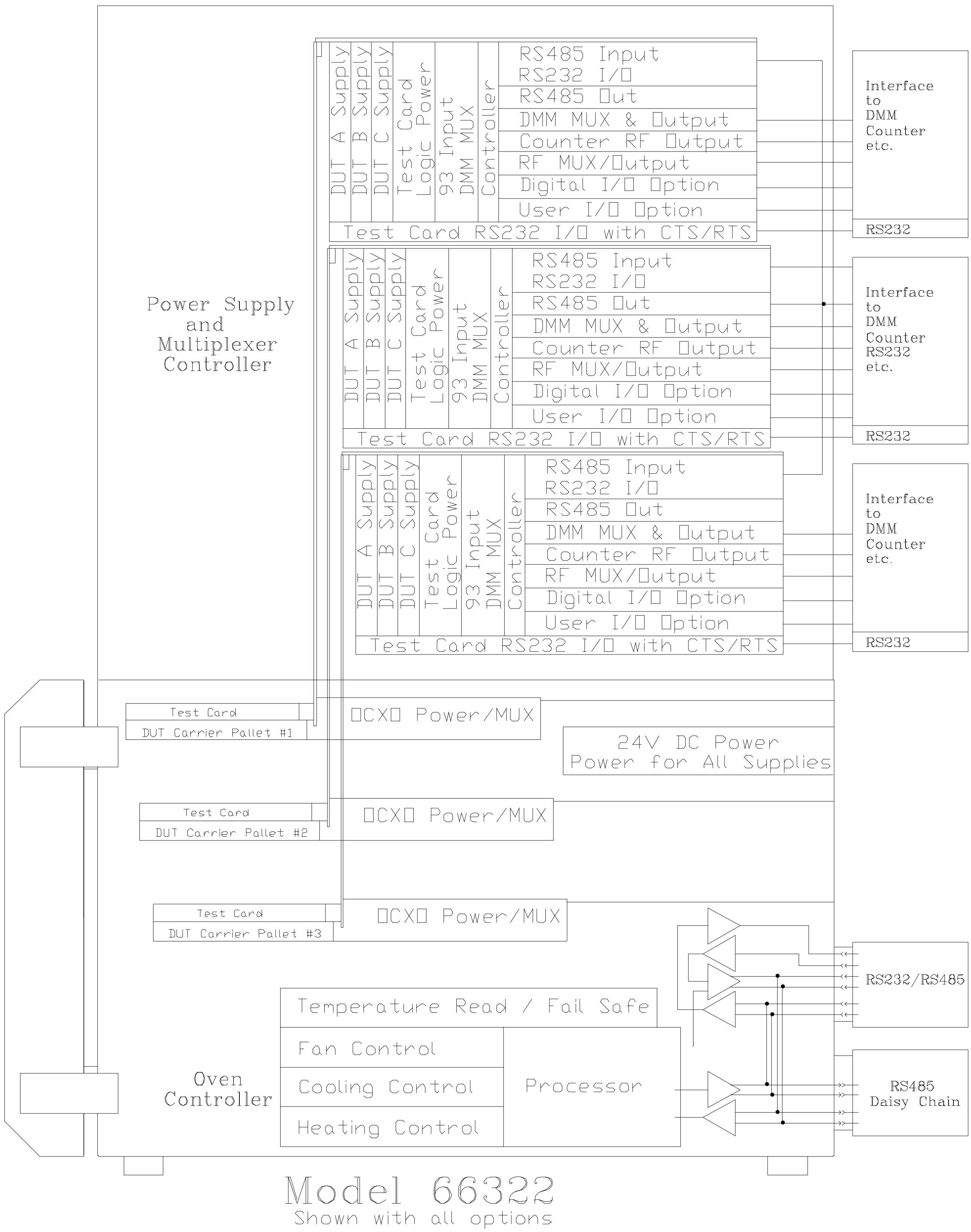
Each Test Card has its own interface to the controlling computer. The interface is a serial RS232 interface at 38,400 baud with full RTS/CTS date flow control.

The multi RS232 ports can be realized with COM port additions to any standard PC. PRA uses an 8 port RS232 expansion card from RocketPort. This PCI bus expansion card is easy to install and program and lets the ports operate in parallel at very high speeds.

Block Diagram for One Counter/DMM/RF



Block Diagram for Multi Counter/DMM/RF



Specifications

Chamber size:	Interior: 483mm W x 305mm H x 330mm D (19w x 12h x 13d) Exterior: 686mm W x 660mm H x 851mm D (27w x 26h x 33.5d) Dimensions are for the case, latches and hinges make the chamber 38mm (1.5") wider Holds 3 each Test Boards

Chamber Range:

Chamber Range:	-65°C to 200°C	for CO_2 and LN_2 cooled chambers without test boards and test board control connections.
Chamber Range:	-55°C to 125°C	for compressor cooled chambers without test boards and test board control connections. Based on a two stage cascade compressor system being supplied.
System Range:	-55°C to 125°C	Limited by the PCB and connectors.

Set point: User setting to 0.01°C resolution.
User sets the new temperature and the maximum slew rate to follow to the new set temperature.

Accuracy:

Absolute:	±0.25°C
Uniformity:	±0.30°C
Stability:	±0.15°C
Repeatability:	±0.05°C
Reading resolution:	±0.01°C

Slew Rate: Maximum rate of change for the chamber. These are typical amounts to be used for throughput computations.

CO_2 and LN_2 cooling rate will exceed 15°C per minute under full load.
CO_2 and LN_2 heating rate will exceed 10°C per minute under no load.

The heating rate is adversely affected by the compressor, the rate is degraded by the mass of the evaporator in the chamber and the compressor runs constantly so some coolant flow is present during heating. These numbers are based on a refrigeration system maintained in excellent condition and properly charged.

Cascade Compressor:	Heating rate	6°C per minute
	Cooling rate below -20°C	3°C per minute
	Cooling rate above -20°C	5°C per minute

Coolant: One type must be ordered for each chamber

Liquid CO_2 supplied at approximately 0°C and a maximum of 300 psig (typically 200 to 300 psig [13.8 to 20.7 bar]).

— OR —

Liquid CO_2 supplied at room temperature and a maximum of 800 psig [55.2 bar].

— OR —

Liquid N_2 maximum of 30 psig [2.0 bar].

— OR —

Compressor cooling. Cascade compressor supplied by a third party connected to PRA chamber's built in evaporator assembly. PRA is responsible for the whole assembly.

Heater: Long life, grounded sheath heater

Temperature Controller: Microprocessor controlled chamber.
Calibration and setup parameters are stored in a protected serial eePROM. This permits later update of operation parameters if required to satisfy a future application.
Temperature control using the enhanced PID algorithm to minimize stabilization time and minimize overshoot.

Fail Safe: The user sets the high and low temperature limits (last settings are permanently stored in the controller [eePROM]).
Range of low limit setting: -70°C to 200°C
Range of high limit setting: -70°C to 200°C
Exceeding the limits automatically turns the heater, coolant/compressor and circulating air fan OFF.
Upper temperature protection also includes a Thermal Fuse safety device (approximate trip temperature is +225oC) (user replaceable).
Signals are output to turn the DUT power supplies off.

Front Controls: The chamber is controlled by the measurements computer only. (remote control port). The front panel has one dual function button.

- Abort — Requires 2 presses that are synchronized with the controlling computer to abort the testing. The controlling computer can then turn off all the supplies and temperature controller.
- Start — Used to begin the testing sequence when the chamber is idle

Panel Indicators: There are 16 indicators on the front panel.

- Coolant
  - Enabled: Indicates the cooling system (main coolant injection valve if cryogenic cooling) is enabled.
  - Coarse: Indicates the coarse coolant valve is injecting into the chamber.
  - Fine: Indicates the fine coolant valve is injecting into the chamber.
- Heater: Indicates the heater is on.
- Fan: Indicates the fans is on.
- Communication: Indicates when the chamber is receiving control commands (stays on for 1S after any communication with the chamber controller).
- Power Supply 1 Overload: Indicates the supply for Test Card 1 is in overload condition.
- Power Supply 2 Overload: Indicates the supply for Test Card 2 is in overload condition.
- Power Supply 3 Overload: Indicates the supply for Test Card 3 is in overload condition.
- Test Card 1 Loaded: Indicates if a card is loaded in the position.
- Test Card 2 Loaded: Indicates if a card is loaded in the position.
- Test Card 3 Loaded: Indicates if a card is loaded in the position.
- Testing: Indicates if a run is in progress.
- Done: Indicates a test has been completed (opening the door extinguishes this indicator).

Remote Control of the Chamber: Control is by a single RS232 serial port, 9,600 baud, 8 bit, no parity.
Multiple chambers can be connected together on a single computer. The chamber interconnection is RS485 with the single RS232 port connection. See the PRA Model 6200 chamber data sheet for more details.

Power: 190-245VAC 50/60Hz

- Cryogenic Cooled — Maximum power is 7KVA.
- Compressor Cooled — Maximum power is 13KVA (estimated for a cascade compressor system).
The installation of the compressor cooled option requires special wiring . considerations. The high inrush current to start the compressors requires at least two wire size numbers larger wire than needed for continuous operation.

Chamber Calibration:

An optional calibration Test Card is available for the system. The calibration board is supplied with software for a PC to utilize the calibration Test Card. This test board has:

1. 16 each NIST traceable RTD units evenly dispersed on the board surface.
2. The RTDs are mounted into screw terminals to permit easy replacement and sending the RTDs for appropriate calibration.
3. The needed multiplexer to select one of the 16 RTDs.
4. A fixed precision voltage reference to bias the RTDs.
5. A connection to the chamber's voltage measuring function.

POWER SUPPLIES FOR DUT TEST:

The DUT Power Supplies are supplied as part of the chamber. There are programmable and fixed supply voltages that power the DUTs and the multiplex circuitry on the Test Cards.

All power supplies use PCB trace size and wire diameters capable of operating properly to the following specifications. The connector pins to the DUT test boards are appropriately sized and when possible, multiple pins will be operated in parallel.

Control Interface: Control is by a single RS232 serial port, 38,400 baud, 8 bit, no parity
Multiple chambers can be connected together on a single computer. The chamber interconnection is RS485.

DUT Power

All of the DUT supplies are isolated from ground and isolated from each other. They may operate up to 50V from ground.

DUT A Power Supply (optional) ±16.5 Volt power supply
Maximum current per supply 8 Amps or a power of 80 watts which ever is less. Can be set to a resolution of ±100 uV accuracy

DUT B Power Supply (optional) ±16.5 Volt power supply
Maximum current per supply 8 Amps or a power of 80 watts which ever is less. Can be set to a resolution of ±100 uV accuracy

DUT C Power Supply (optional) ±16.5 Volt power supply
Maximum current per supply 2 Amps. Can be set to a resolution of ±100 uV accuracy

DUT D Power Supply (optional) 0 to 25V Volt power supply for programming an external supply
Maximum current is 15 mAmps. Can be set to a resolution of less than 10mV accuracy

Test Card Control Logic Power:

Each board position has the following power available to power multiplexers, control logic, etc. Four switching power supplies operating from the main 24V DC supply provides the following voltages. These supplies are options.

1 each +5.00 ±0.25 volt 5.0 Amp maximum

1 each -5.00 ±0.25 volt 3.0 Amp maximum

1 each +15.00 ±1.0 volt 1.7 Amp maximum

1 each -15.00 ±1.0 volt 1.0 Amp maximum

OCXO Testing Capabilities:

Each test card has available 60 each 2 Amp connections to the power supply. These lines are fused and have a small sense resistor in series to permit monitoring the OCXO's current.

On the chamber rear panel are 3 pairs of AMP/Tyco Industries round high current connectors that permit connecting to the large system owner supplied power supplies.

The system has a floating volt/volt programming signal that can be used to program the external supply.

The actual OCXO supplies are external to the system.

Voltage Monitor Function:

The chamber can have an optional DMM multiplexer function added at the Test Card position. The multiplexer permits selecting 1 of 93 connections and 1 of 3 common points. The controller protects the reed relays from improper closure selections. The signals to be monitored are selected remotely.

The signals can also have a stimulus voltage applied. The signal can be 5.000V or Supply DUT C. The stimulus voltage can be supplied via a 100 ohm 1%, 1K ohm 0.1%, 10K ohm 0.1%, 100K ohm 0.1% or a 1 M ohm 1% resistor. The voltage on both ends of the resistor can be measured with the system DMM.

Voltages are output to the back panel where the system DMM is used to monitor all chamber voltage functions. All power supplies, DUT and control voltages are monitored.

Model 66322 Chamber Compressor Cooling Option:

PRA uses a third party to provide compressor cooling for the Model 66322 chambers. PRA Inc. is responsible for the operations of the compressor configured chamber.

Model 66322 Configuration Options

Option	Description
8	Basic chamber with no cooling capabilities. Used for Aging applications. The options below can be placed on this chamber
---	Basic CO2 or LN2 cooled chamber
1A	The DUTA supply, +/-15V 8amps or 80 watts whichever is less. There are 3 of these in a system, one per test card position. Normally needed to power DUTs for most systems. May not be needed for OCXOs power by option 1D
1B	The DUTB supply, +/-15V 8amps or 80 watts whichever is less. There are 3 of these in a system, one per test card position.
1C	The DUTC supply, +/-15V 2amps. There are 3 of these in a system, one per test card position.
1D	The External DUTD supply control. This is an isolated voltage programmable output that is used to set the signal from an analog volt/volt programmable power supply. There are 3 of these in a system, one per test card position. This is normally used for programming the high current OCXO power supplies.
2	This is a built in DMM multiplexer for each test card position. There are 93 selectable connections from the test card to the DMM + input. This is intended for users that need to measure up to 93 analog nodes on a test card. A typical use would be monitor power nodes for OCXO testing.
3	Computer connection that permits 30 parallel I/O signals directly from the controlling PCs PCI I/O bus to each test card. Used for those who need to write a fast parallel word to the DUTs. Could be used for devices needing a fast wide bit signal pattern to test modulation. In most cases the test card be designed to perform this function.
4	External power supply D distribution. Connects 60 DUTs for each test card to the external supply. Each of the 60 connection are fused, capable of 2 amps continuous each connection, the current in each lead can be measured with an accuracy of 4%. This is for 3 each test cards. Normally intended for OCXO or other high current oscillators such as 2.48GHz clocked modules. Includes a single 3GHz BW RF connection to each test card.
5A	1GHz bandwidth 50 ohm RF analog output connection for each test card position. Includes MUX for one output per chamber (3 to 1 RF MUX). SMB connector output on the chamber rear. Can be ordered when option 4 is not ordered. Order when measurement of the RF signal on the test card is needed. For example: Scope, spectrum analyzer, prescaled counter input, phase noise measurements, etc.
5B	3 each 1GHz bandwidth 50 ohm RF analog input/output connection for each test card position. Includes MUX for one output per chamber (3 to 1 RF MUX). SMB connectors chamber rear. Can be ordered when option 4 is not ordered. Order when measurement of the RF signal on the test card is needed. For example: Scope, spectrum analyzer, network analyzer, prescaled counter input, phase noise measurements, crystal IEC444 Pi Network measurements, etc.
5C	10GHz bandwidth 50 ohm RF analog output connection for each test card position. Requires external RF MUX. Can be ordered when option 4 is not ordered.
6	Add +15V test card logic power supply. Used to power measurement circuitry on the test card. One power supply per test card.
7	Add -15V test card logic power supply. Used to power measurement circuitry on the test card. One power supply per test card.

NOTE: PRA Inc. reserves the right to make changes to the product contained in this data sheet in order to improve the design or performance and to supply the best possible product. PRA Inc. reserves the right to make these changes without notice.

Revised 9/22/07