Model 2212
Oscillator and Crystal
High Speed Fully Integrated
Temperature Test System

Features:

- **Smart test cards to perform ASIC TCXO compensation and programming.**
- **Option testing of high current OCXOs**
- **DUT measurements to 1 GHz:**
  - **Supply current**
  - **Frequency**
  - **Pullability**
- **Permits fast crystal screening for perturbations and angle**
- **Electronic multiplexer of the DUT signals.**
- **Optional waveform measurements to over 1 GHz**
- **Holds DUTs in a rectangular array pallet ideally holding SMD units**
- **Leaded parts are plugged into sockets**
- **CO_2, LN_2 or compressor cooled**
- **Special air flow control to each pallet for excellent uniformity**

System shown on optional racks with one chamber having OCXO power supplies

PRA Inc.

4821 226th Place NE

Arlington, WA 98223 U.S.A.

TEL:360-435-0484

e-mail:sales@prainctest.com

www.prainctest.com

System Features

The PRA Model 2212 Oscillator Temperature Test System is designed to measure various types of crystal oscillators.

The chamber holds three each test boards. The test board fixtures and holds the parts to be tested. The test boards are intended to evolve for the various kinds of oscillators and products to be measured. The intention is the test boards provide the flexibility needed to permit longevity of this testing system configuration.

-A group of chambers is controlled from a single master controller. The system is operated on an Ethernet LAN using the MicroSoft™ Network. (This LAN can be part of the company network, if the protocols are compatible and the user deems the traffic is at an acceptable level.) The network cards supplied will be 10/100baseT dual frequency compliant.

The master controller position has the needed hardware and fixturing that will accept a test board and operate the test board at room ambient.

The full function master controller:
•User sets up measurement procedures.
•User connects the test board, indicates to the PC the board is loaded. The PC then reads the serial number and looks up the characteristics of the test board (multiplexing, DUT position names, typical supply limits, etc.)
•Test card is set up
-serial number of the card is read
-serial number of the DUTs are entered by the user
-each oscillator position has the frequency read and validated
-each oscillators test procedure will be user set
-test information and parameters are stored on the test system's network server.
•The user can monitor the status of any chamber in the system at any time.
•The measurement data (completed or partial) can be accessed at any time.
•All completed measurements will be transferred to the master controller.
•Operating system Windows NT 2000 Professional
•Programmed in MicroSoft™ C, MicroSoft™ Visual BASIC for Windows XP Pro.

The master controller - reduced function:

In the case were only one Model 66322 chamber is used, the PC on the chamber or any PC on a network could be used as a master controller. This controller would not be able to pretest the DUT test cards.

Chamber controlling computer:
•Controls the chamber via a COM port
•Controls each test card via a COM port
•Interfaces the system's master controller via the MicroSoft™ Network LAN connection.
•Stores the most recent test data on the hard disk.
•Operating system, Windows NT 2000 Pro or Windows XP Pro

Typical sequence to operate a chamber (System has simplified this step to minimize the skills needed by production operators.
• Test cards are put into the test chamber
• The door is closed and checked by the controller
• The operator presses the "Start" button on the front panel of the chamber. The next steps occur automatically.
• The chamber controlling computer checks the test board serial number and then checks the master controller and determines if the test board has been set up to be tested.
• The parts in the test board are checked to make sure the same measurements occur that were read at the system control position.

•Temperature or aging run begins
- measurements are made, immediate measurement data being stored locally.
- at the conclusion of any measurement sequence the block of data is transferred to the system server.
- status updates of the chamber to the system server are done about once per minute if all is proceeding normally and immediately when any not normal operation occurs.

•Temperature or aging run ends
- final test data is written to the server.
- server status files are updated
- display on the oven indicates the run is done

System Measurement software

•user defines a temperature sequence that the chamber will follow. There can be nearly unlimited points (limited to hard disk drive file restrictions).
•Each DUT has a test specification that tells what measurements to make, the temperature range and limit (Pass/Fail) information.

•Multiple types of DUTs can be mixed together in a test run. The DUT is only read at temperatures that are within that DUTs own temperature range.

•The specification also sets the counter resolution, supply voltages and any needed wait times.

•All test data is stored in ASCII text files.

•The types of measurements are determined by the Test Card capabilities and the measurement equipment on the system.

Typical measurements are:
-Frequency
-Current of the DUT
-VCO measurement of pull and sensitivity
-Uncompensated TCXO parameters such as voltage to put the oscillator on frequency, sensitivity of the setting in ppm/V, thermistors can be made.
-Voltages at user specified nodes
-If a digital oscilloscope is present and the test board has the multiplex capabilities, waveform parameters such as rise time, fall time, duty cycle, logic levels, pulse width, Peak to Peal levels, RMS levels can be made.

•Each DUT is stored in that DUTs own test file.

Voltage Monitor Function:

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 are monitored.

Chamber Multiplexing, DUT data and Frequency Measurements:

All control and DUT selection signals are sent to the chamber via the RS232 or RS485 connection. The worst case time for a complex command send would be 5mS or less, this is deemed a minimal time compared to the measurement and settling time for very precise measurements.

DUT Selection:

DUT selection is performed by simple processors mounted on the test boards. Position information is sent serially to the chamber multiplexer, then buffered and then via the back plane to the test board.

Counter:

The counter is a GPIB interfaced HP53132. The counter requires a precision 10MHz external standard, the accuracy of the counter is completely determined by the external standard and the waveform quality from the oscillator to the counters input. The multiplexer is capable of waveform integrity to 0.0001ppm (0.1ppb).

DUT Signal to the Counter:

The signal to the counter is by a coaxial cable and is terminated in 50ohm. The highest frequency from a test board is 125MHz. For higher frequency appropriate prescaling will be done on the test board.

The signal will be prescaled to always be less than 50MHz.

The DUTs will be nested in a pallet that mates to the multiplexer and makes contact to the oscillators with pogo pins. The assembly will plug into the center MUX control in the chamber's back.

Measuring Oscillator Waveforms

Any of the system configurations can have a digital scope added. This would permit measuring Tr, Tf, Vhigh, Vlow, Duty Cycle, V PP, Vrms, overshoot, undershoot, pulse widths, and with some restrictions jitter. The signals will be electronically multiplexed. The current state of the art permits a 750 to 900MHz electronic multiplexer for a reasonable cost and sufficiently small so that an acceptable number of units can be tested. Waveform capability can be added to any of the systems and can be added at a later date as a system upgrade.

PRA suggests two scopes for this application:
-Tektronix TDS series
-Agilent-Acqiris DP214/DP240, 1GHz BW, high speed measurements.

Multiplexers and Carrier Plates

The test boards are slid in tracks into the chamber. These test boards or cards have a microprocessor on each card, this performs multiplexing and other measurement control. These processors assist in special functions such as programming the PROM controlled TCXOs.

•Test Board size 304mm x 457mm (12" x 18") that can contain the Devices Under Test (DUTs).

•OCXO DUTs

The test boards can hold up to 60 OCXO

The total supply current per test board is 180 Amps

• Simple oscillators

The test board can hold up to 384 5x7mm oscillators

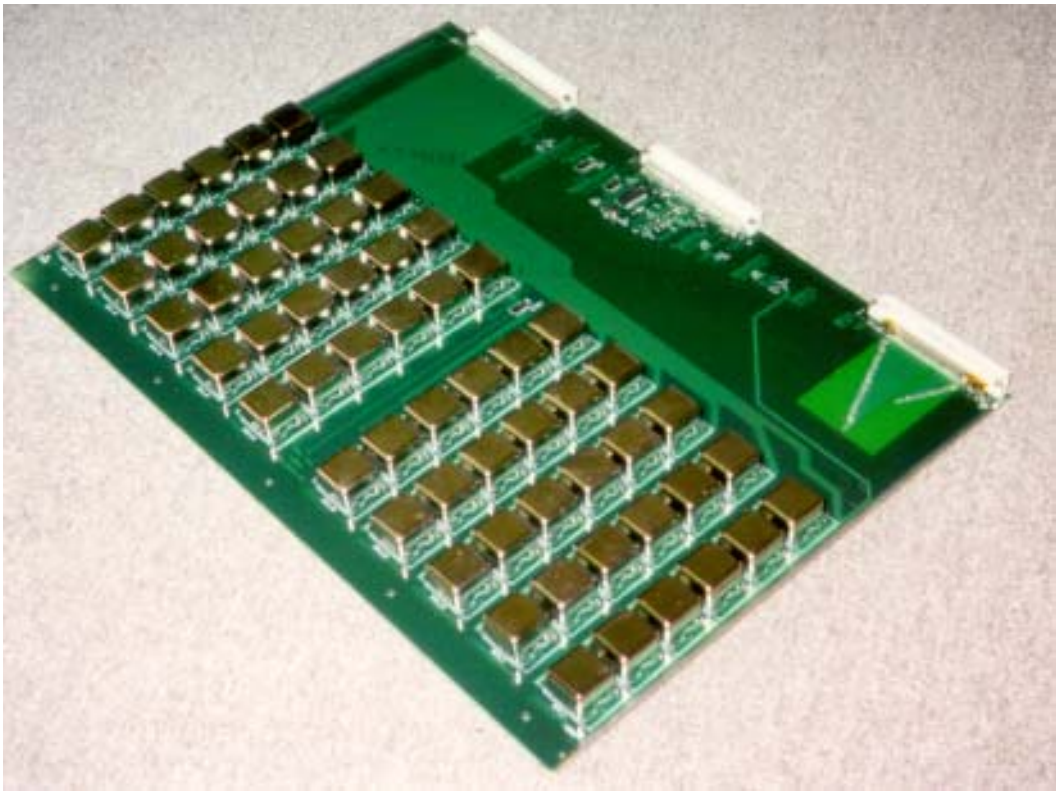
• PROM programmed TCXOs

The test board can hold 256 AKM, Kawatetsu or MAS oscillators. Each type of IC does require a specific test board, because of different programming needs a common board is not feasible.

•Precompensation TCXO DUTs

The test boards can contain as many DUTs that can be powered by the power supply and fit on the test board. The addressing for a DUT is a 20 bit address (selection of 1 of 1,048,576).

Measurements of internal oscillator nodes can be made.



Test board for OCXOs. Contains 60 DUTs and permits testing the electronics frequency adjust function

•Crystal Oscillator DUTs (VCXOs also)

The control voltage function can be measured

•Leaded DUTs plug into sockets on the test board.

•SMT DUTs can be mounted in sockets or placed in pockets with pogo pin contacts and a single cover board to hold the SMT parts in place.

•DUT selection is performed by a simple processor on each test board

•The selection processor is accessed via a serial signal from the Measurement PC.

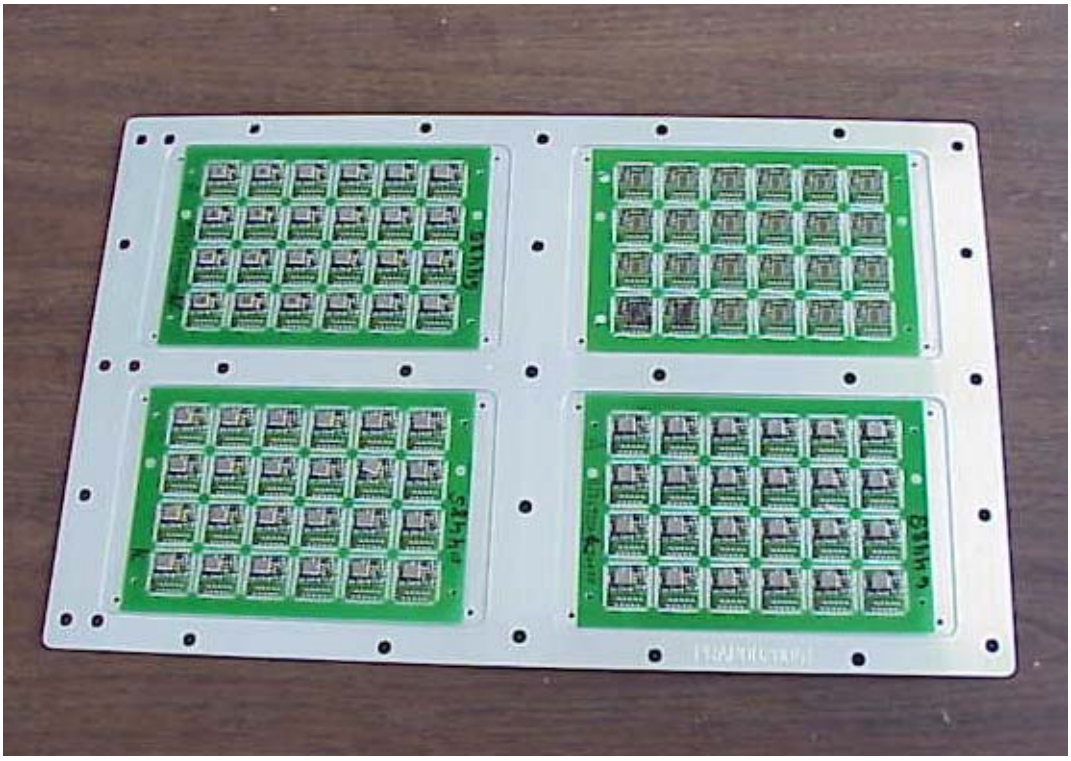
•System provides various power sources to the test board to power the DUTs and any measurement logic on the Test Card, all supplies are floating isolated supplies.

•The test board has a single output coaxial connector that connects to any external instrumentation, for example an oscilloscope. The bandwidth is greater than 2 GHz.

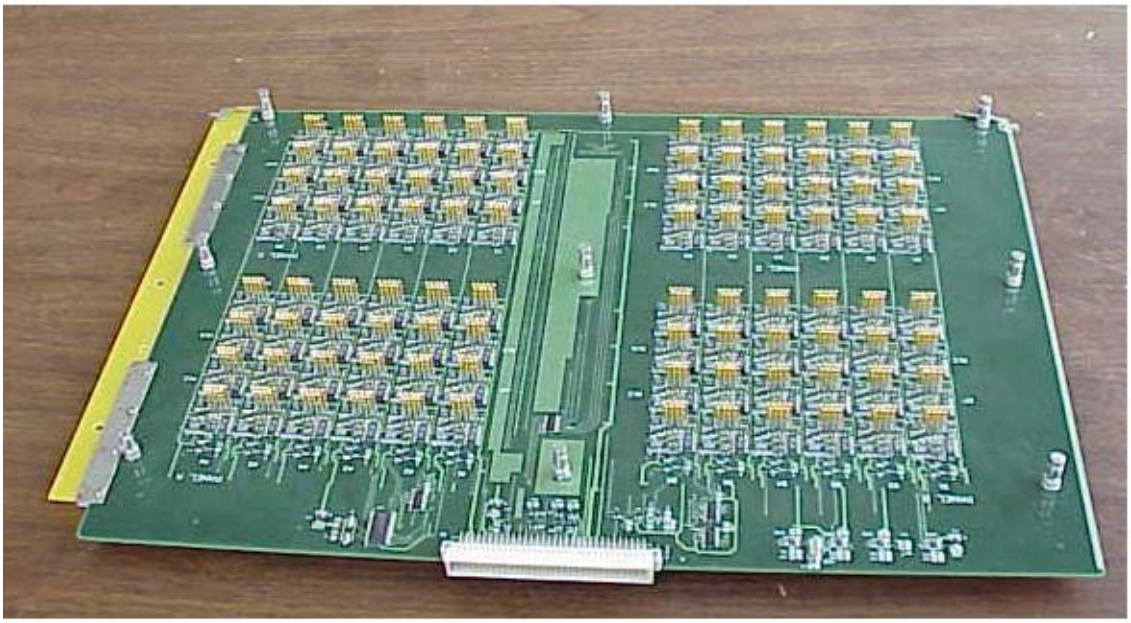
•Connector: DIN 41612 3 x 32 in chamber center for general testing. This would all that is needed for TCXO testing.

•Connector: DIN 41612 3 x 32 in chamber left for miscellaneous testing. This is will be used for the precision Vcontrol (Vtune) needed for OCXO testing.

•Connector: DIN 41612, located on the chamber right side, will have an direct RF output and power for 60 OCXOs.



Carrier pallet for array of ASIC TCXOs. The array will be separated into individual TCXOs later in the process. The carrier pallet will nest the individual TCXOs also.



Test board for ASIC TCXOs. Contains the needed multiplexers and buffer ICs to measure the customer specified nodes.

ASIC Test Board for with support pallet. One of many options to hold DUTs.

Temperature Chamber

The system uses the PRA Model 66322 Multiplexer, Power Supply and Temperature Chamber. The 66322 provides the controlled temperature environment and well as the power to the DUTs. This well integrated temperature chamber enhances the speed of testing as all parts are optimized for the testing to crystals and oscillators.

The Model 66222 was derived from the very successful Model 66222 chamber that has been in production for over 3 years prior to the design of the Model 66322 Many parts are interchangeable between the 66222 and the 66322.

System Documentation and Options

PRA Inc. will supply the following information. Most of this information will be supplied on CD-ROM. For example the manuals will be supplied in Adobe Acrobat© PDF file form.

- All software source code. The code will be documented liberally with comments.
- The description of the development environment used to compile the software.
- All compiled operating programs.

This information package is intended to be a complete set of information needed to maintain the current systems. The system documentation remains the property of PRA Inc. and may not be distributed or sold by the system owner to anyone without the permission of PRA Inc. The system owner is free to use and copy this information for their own internal use as needed.

This information will be updated as additional changes to the systems are made. When changes are made PRA will supply an update via CD-ROM or via e-mail.

Maintenance Test System

This is an optional feature to assist in maintaining temperature test systems operating in a production area. The maintenance system permits rapid validation of proper system operations and assists in troubleshooting the test system.

This is a PC and associated test equipment that permits checking of the 2212 system for proper operation. There is a special test board that plugs into the chamber. All test signals are monitored, voltages are checked, measure nodes of the 2212 system have signals present to check operation.

The system will be mounted on a wheeled cart so the system can be easily wheeled up to the chamber to service.

The system owner can optionally supply their own PC, DMM and wheeled test stand.

Pre Test System

This is an optional room temperature system that is essentially one test slot of the Model 66322 chamber. This is used to check the parts prior to loading them in the chamber. This system can perform all the same functions as the complete system can except it can not set temperature.

Load Station

Simple PC that optionally can read the test board serial numbers (electronic RS232 interface to the test boards). Permits defining the needed information for a test board to be tested in the system. Minimizes the time the system is idle with operator input.

Also, means the test system operators are not required to perform any operation at the test system PC.

Digitally Programmed Analog TCXOs

This configuration can be one or two chambers per computer. The minimum configuration per chamber is 1 each Counter and 1 each DMM. The fastest configuration per chamber (this is the times PRA supplied examples for) is 3 each Counters and 3 each DMMs per chamber.

Manufacturing Steps to Make Digitally Programmed Analog Compensated TCXOs

There are four companies now making circuits that permit making TCXOs that require no component adjusting during the compensation steps. These circuits use analog internal switches that are set by a PROM to output the proper compensation voltage to the varactor that controls the crystal frequency. This is the classic Indirect Compensated TCXO circuit with the proper component values set by a PROM.

The four companies have very similar solutions for the TCXO circuit, the key difference is the PROM used by each is significantly different.

•AKM, Japan
The PROM is eePROM technology, moderate voltage and low programming current are required.

• Panasonic, Japan
The PROM is fusible link technology, low voltage and high programming currents are required.

• Kawatetsu, Japan
The PROM is ePROM technology, high voltage and low programming currents are required.

•MAS, Finland
The PROM is ePROM technology, high voltage and low programming currents are required.

Because of the dissimilarity of the programming requirements, PRA supplies different test fixturing for each IC manufacturers type of TCXO solution.

The requirement of a TCXO requires very stable and spurious free crystals. These newer integrated circuits do not lessen the need for these conditions. The new integrated circuits do permit wider angle spreads to be successfully compensated.

Crystal Production:

Only separately sealed crystals have proven to have good enough aging to be used as TCXOs.

Crystal sawing, lapping and polishing require quality control of the angle spread and the blank preparation must lead to spurious free crystals.

Crystal plating must be of the highest quality. TCXO require excellent crystal aging characteristics. The platers and vacuum systems must be carefully chosen and operated with good process control to be sure the crystals have these required characteristics.

- Consistent motional parameters
- Good angle control
- Spurious free
- Excellent aging

Crystal Sealing, must be clean process that does not add to the crystals aging process.

Crystal Aging.
The crystals must be baked for a long enough period to be sure all the infantile aging is eliminated.

Crystal should be checked on a PRA Model 2360 Aging System. At least on a lot sample basis and for the better TCXOs, 100% of the crystals should be aged in this type of system.

Crystal Testing - Room Temperature
All crystals must be tested for motional parameters, resistance and drive level dependency. This should be done after the aging period.

Crystal Testing - Usable Temperature Range
All of the crystals need to be tested over the temperature range to insure each unit is spurious free and to confirm the crystal angle. Ideally the crystal will be tested at small temperature steps, 1°C or less to be sure of no spurious responses.

The PRA Model 2511 system provides a solution and provides low cost per unit tested. This systems tests 1024 crystals per run.

The PRA Model 2212 with crystal test boards can test 1152 crystals per run. The system permits screening crystals for angle and perturbations. The system can test 1152 every 0.5°C from -40°C to +85°C in approximately 2 hours.

Crystals that have met all of these testing steps are now suitable for use in a TCXO.

Oscillator Production:

Successful TCXO production with high yields of compensation mandates that the crystals must have excellent aging. If the crystal change during these process steps, the manufacturing yields will be poor and the end use rejects will be high.

Packaging, the IC, typically 2 or 3 capacitors, possibly a varactor need to be assembled into the TCXO package. This is typically a ceramic package with screened pattern to accommodate these components. The IC needs to be die attached to the package, then wire bonded and then

protectively sealed. These are standard process steps in hybrid IC manufacturing.

Crystal Mounting, the previously tested and qualified crystal needs to be mounted to the assembly.

Testing and compensation

The steps described here are for the PRA Model 2212 System configured for TCXO production. The Test Cards will hold the oscillator, making the needed contacts to the PROM writing/ control circuits as well as the oscillators, Vcontrol, Supply, Ground and output contact.

The steps to use this system are:

• Load Pallet/Test Card with the TCXO assemblies. Depending on packaging the number units would be 256 per test card (5x7 and 9x14 SMD parts will number 256)

• Go to a PC on a LAN with the Model 2212 system and tell the computer the target frequency and specification for the oscillators loaded in the Test Card. Each Test Card has a unique serial number. Place the Pallet/Test Card assembly in a queue waiting for testing time in the chamber.

• When space is available in the chamber load up to three Test Cards. The systems does permit mixed frequencies and temperature ranges. (NOTE: Mixing temperature ranges can lengthen the testing time, yet still being more efficient than making multiple separate tests.)

• Press the Start Button on the chamber front after closing the chamber door and the testing begins automatically. The prior entered information about each Test Card is found over the LAN and the assigned tests are started.

• During testing, the PC's monitor shows the status of run, no operator interventions is needed.

• At the completion of the run the measured data is analyzed and the Test Card may be removed from the chamber, this makes the chamber immediately available to start another group of devices.

• Go to a PC on the LAN and display or print the location of the good devices for each Test Card/Pallet.

The testing time for 768 parts for a -20°C to 70°C compensation will be typically 3.5 hours or less than 17 seconds per oscillator. This is the total time for compensation, programming and final testing. (Based on cryogenic gas cooling, compressor cooling will add about 1 hour to the process).

What occurs during temperature testing (the Test Card/Pallet assemblies remain in the chamber during these steps)?

1) Precompensation testing over the temperature range- At each temperature the IC for each TCXO is exercised for the ICs function on the crystal. The PROM circuits are "soft" programmed and the TCXO's performance is logged. Each TCXO circuit and the crystal are analyzed together.

2) Compensation- The parameters from step 1) are analyzed and the best programming conditions are determined for the PROM. (Remember all these conditions have already been logged, so when programming is done we can be very confident that the TCXO will perform the best compensation possible.)

3) Chamber returns to about room temperature for proper PROM programming while the compensation computations are completed.

4) Programming- Each TCXO that will meet specification has its PROM permanently programmed.

5) The Test Card /Pallet are tested over temperature to verify proper operation.

The actual precompensation, compensation, programming and final test, all are essentially one process step in the manufacturing area.

Marking and shipping, the good units are now ready to be marked and shipped.

Failed oscillators may be passed through the Testing and Compensation step one additional time. This would assure that the first failure was not due to contact or fixturing issues. After the second failure, the assembly may be salvaged but there are not steps to recover the unit. PRA compensation technique exhausted all the possible compensation options and additional testing will not improve the compensation.