iQA OPERATING MANUAL

THE INTERMODULATION TEST SYSTEM FOR PORTABLE USE

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1.1 INTRODUCTION

This manual describes the operation of the iQA (Interconnect Quality Analyzers) B-series of portable intermodulation test instruments developed by Kaelus. The main differences between the former A-series and the new B-series instruments are as follows:

- The B-series instruments offer an aesthetic upgrade from the A-series instruments
- The recessed touch panel on the B-series units offers a fresh, clean look
- Implementation of an upgraded front-panel PC allowing better support of swept (and future) applications
- The monitor port functionality is removed on the B-series units
- Recessed RF output connector with connector saver, to prolong product life

In addition to significant hardware upgrades, the new application software (Version 1.6.1) includes the implementation of swept mode capability. The modes of operation included are the Time Trace, Frequency Sweep and Spectrum Analyzer modes. This application software upgrade is backwards-compatible on the majority of A-series units. Service centers will be able to advice on software upgrades to former A-series units.

1.2 FUNCTIONAL DESCRIPTION

The iQA is designed to carry out reflected Passive Intermodulation (PIM) measurements in accordance with test setup one of IEC62037. PIM occurs in passive devices whenever two or more RF signals encounter non-linear electrical junctions or materials. The interference generated is mathematically related to the localized downlink frequencies and can result in a noise rise in the uplink band of one or more systems sharing the RF infrastructure. The impact of PIM on the network performance can be severe, especially for wideband systems such as CDMA, UMTS or LTE. PIM interference can lead to desensitization of the receiver causing increased dropped calls, increased access failures, pre-mature hand-offs, decreased data transmission rates and decreased system coverage and capacity. Any component in the RF path can be the source of the PIM interference including antennas, TMAs, diplexers, duplexers, surge arrestors, cables and connectors. In addition, loose mechanical connections or rusty surfaces external to the antenna system can generate PIM when subjected to high radiated RF power.

Two synthesized carriers can be placed at any frequency in the transmit band. With the RF output switched on, these tones will be present at the test port and stabilized to the predefined output level. The resulting 3^{rd}, 5^{th}, 7^{th} or 9^{th} order inter modulation product is automatically calculated and the receiver is tuned to the required product. The detected voltage is processed by a microcontroller and the relevant reading shown on the display unit.

1.3 FEATURES

- Highly durable, portable outdoor case
- 8.4” LCD with resistive touch screen
- Measures reflected PIM with greater than -153dBc when using two 20W carriers
- Internal detector circuits with narrow IF bandwidth provide low noise floor
- Internal carrier power monitors with Active Loop Control (ALC)
- Complete frequency agility in steps of 50 kHz to any frequency in the transmit band
- Automatic internal calculation of IM product frequencies for receiver tuning
- Onboard automatic report generation and exportation in PDF format
- All electronic systems are monitored and alarmed. This ensures that each measurement made is faultless
- The test set is capable of operating continuously into a poor VSWR load such as an open or short circuit

1.4 SPECIFICATIONS

Transmitter

Transmit band (frequency agile over whole band)	**Per product data sheet**
Channel steps	**50kHz**
Frequency accuracy	**± 5ppm (max), aging ± 1ppm (max) after first year**
Power per tone (adjustable)	**2 - 20W (+33 to +43dBm)**
Power accuracy/ALC leveling (per tone)	**± 0.5dB (max) across the full temperature range**

Receiver

Receive band (50kHz steps)	**Per product data sheet**
Receiver noise floor	**-128dBm typical**
Measurement range	**-50dBm to “Residual IM”**

System

Measurement method	**Reflected PIM**
Residual PIM	**< -110dBm max (-115dBm typ)**
Measurement accuracy	**± 1.5dB (max)**
Operating system	**Windows XPE**
Ports	**x2 USB, x1 LAN, RF Output Port (7-16/F)**

Electrical

Mains power	**115-230V, 50/60Hz AC**
AC power	**650W**
Power connector	**IEC mains connector**

Mechanical

Dimensions	**500 x 457 x 305mm**
Weight	**< 22.7kg**
Cooling	**Forced air**

Environmental

Max. operating temperature	**-10°C to +40°C (Operating)**
	-20°C to +60°C (Storage)
Ingress protection (IP)	**IP20 (with lid open)**
	IP21 (with lid closed)
Relative humidity	**5% to 95% RH non-condensing**
Rugged housing	**40G shock/vibrating rating**
MTBF	**75,000 hrs**

1.5 CONSTRUCTION AND LAYOUT

The front panel and external details of the test set are shown below in Figure 3 and Figure 4 respectively. Take note that the labeling of the front panel will vary from one frequency variant to the next.

Figure 1: Front Panel View

1. LCD Touch Screen

Care should be taken at all times to prevent accidental damage to the touch screen. At no time should any item be stored within the front panel space with the lid down.

2. iQA Model Designator

Label for showing the particular frequency model.

3. Red LED (RF on indicator)

The high intensity, red LED flashes when RF power is present on the RF output Port.

4. RF Output Port

The RF output port is used for all measurements. On the new B-series iQAs, the RF connector is recessed into the instrument front panel, to protect the connector and to allow for a connector saver to be fitted to the instrument.

5. AC Input

IEC connector for 115V or 230V mains operation, with the fuse rated at T6.3A 250V.

6. AC Power ON/OFF Switch

The green light around the AC power button will be illuminated when AC mains power is present. Pressing the AC power button will initiate the instrument's start-up procedure. During operation the instrument can be switched off by pressing this button (or by using the "Shut Down" button on the application button bar).

7. x2 USB Ports

Used for loading state files and upgrades, and downloading reports and states.

8. x1 RJ45 LAN Port

Service port – not for field use.

The iQA's external housing components are identified in Figure 2 below.

Figure 2: External Housing

9. Lid

The lid assembly includes the following:

Lid Position Control: Attached to the top of the lid, this is used to hold the lid wide open during bench-top use.

Lifting handle(s): A single handle on the lid and two handles fixed on either side of the instrument allow for lifting and carrying the instrument as necessary.

Lid Latches: The lid latches allow for tightly closing the lid against the main instrument case. The latches together with the lid hinges are extremely robust and are able to support the bulk of the instrument's weight. Before picking up the unit, users should ensure that these latches (double action clips) are properly clipped in place when the lid is closed.

10. Fold-Out Legs

The fold-out legs are used to raise the front panel of the instrument when bench mounted.

11. Telescopic Case Handle

The telescopic case handle allows the instrument to be towed over relatively smooth surfaces, and offers the convenience of not having to carry the bulk of the instrument's weight.

12. Cooling Fans

The instrument has numerous cooling fans mounted internally to facilitate cooling. In addition there are also fans fitted to the lower sides of the enclosure (one on each side). Care should be taken to not restrict airflow when the instrument is powered on.

13. Rugged Polycarbonate Case

The body of the test instrument is mounted in a solid shock-absorptive protective case, selected for its ability to withstand incidental knocks and vibrations associated with transportation to and from the BTS environment.

14. Wheels

A set of wheels is recessed into the instrument case and function when the instrument is "towed" by the telescopic case handle.

1.6 EQUIPMENT OPERATION – FIXED FREQUENCY MODE

The fixed frequency mode is the default measurement mode of the iQA. In this mode the two test frequencies remain fixed during the duration of the test. When the RF is switched on, the instantaneous PIM value will be displayed by the test equipment.

1.6.1 Starting the equipment

1. Connect the unit to the mains power. The green light around the AC power button will be illuminated. This indicates the presence of AC mains only.
2. Press the AC power button and the instrument will begin its start-up procedure. The boot and start-up process can take a few seconds. The start-up screen as per Figure 4 will be shown just before the instrument's fans switch on and the application starts.

Figure 3: iQA Start-up Screen

Note: *Users are encouraged to carefully review the safety information contained in the disclaimer on the start-up screen.*

1.6.2 The Main Application Window

When the instrument is ready to use, it will show the main application window, in the default measurement mode.

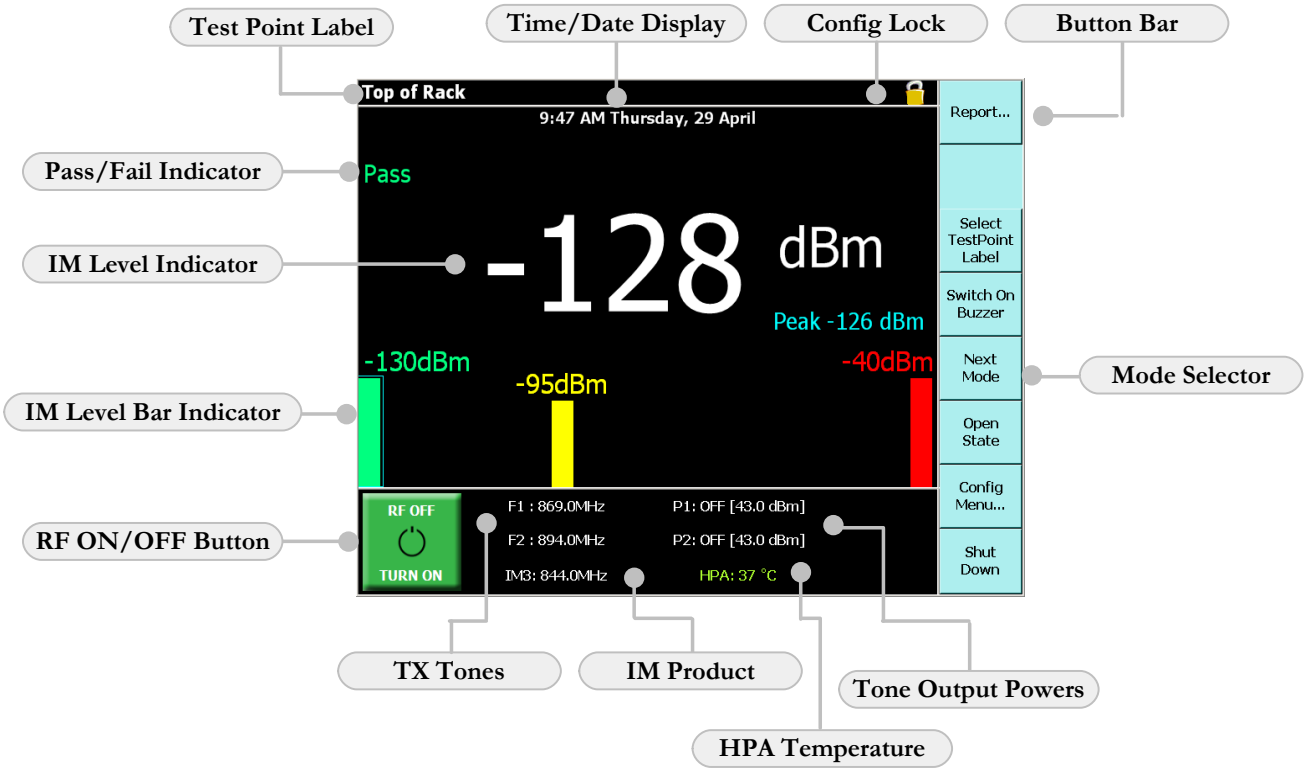

Figure 4: Main Application Window (Default Measurement Mode)

An added feature on the application screen is the Screen Capture Button. This button will be visible when the application screen starts up. When this button is pressed a screen capture is created as a *.png image and saved to the D:\ drive. The resulting graphic capture will remove the Screen Capture Button and show screen captures similar to the ones found in this document.

Figure 5: Screen Capture Button

Amongst others, this feature can be used for the following:

- Graphical capturing of interference anomalies on test sites
- Graphical capturing of measurements (or traces) for training purposes
- Graphical capturing of measurements to compliment reporting

The application interface, as per the tags in the Figure 5, is discussed hereafter.

RF ON/OFF Button

The RF ON/OFF button is used for switching the RF either on or off. As a visual aid, this button will turn red when the RF has been switched on. In the default state (RF off) this button will be green. Additional text appears on this button to show the state of the button (RF OFF or RF ON) and what will happen when the button is pressed (TURN ON or TURN OFF).

IM Level Bar Indicator

The IM Level Bar Indicator offers an additional visual aid in showing the measured IM level and the severity thereof. In addition to showing the measurement range of the instrument, it also shows a user-adjustable IM pass/fail limit.

IM Level Indicator

The IM Level Indicator shows the instantaneous IM level in numerical form. The large font size allows for easy reading of the IM level. In addition to the instantaneous IM level, the “peak” level is also displayed to the bottom-right of the instantaneous level.

Pass/Fail Limit

The Pass/Fail is a visual aid for showing when the set IM limit has been breached. The “Pass” text is green and the “Fail” text will be red.

Test Point Label

The user-changeable Test Point Label appears at the top left-hand corner of the application window. This label will appear in the test report when the associated test point is recorded. The default label is “Top of Rack”.

Time/Date Display

User-changeable time and date display.

Config Lock

The "Config Lock" icon shows whether the configuration mode is accessible or not.

Button Bar

The button bar is the main user-instrument interface.

Mode Selector

The mode selector ("Next Mode") button is used for toggling between the different measurement modes. These measurement modes are discussed in detail in sections to follow, but in summary:

Default Mode (Fixed Frequency)
This mode is used for measuring the instantaneous IM level of a device under test. The IM level is shown in numerical form and with a corresponding IM sliding bar

Time Trace
This mode shows a trace of the instantaneous IM level as it changes with time

Frequency Sweep
This mode incorporates swept TX tones, for a resulting swept IM trace

Spectrum Analyzer
This mode allows monitoring of the full RX band with TX powers on or off

Tone Output Powers

The default TX tone output power is 43dBm (20W) per tone, and the power is adjustable to as low as 33dBm (2W) per tone.

HPA Temperature

This temperature display area doubles as an alarm status indicator. As soon as an instrument alarm is triggered it will show an alarm message in red text in place of the temperature display. Press on the alarm message and the alarm screen will be displayed. The description of an alarm can be seen by pressing on the specific alarm indicator. The HPA temperature alarm is activated at 70ºC and a soft cut-out occurs at 75ºC, until temperature is restored to below 70ºC.

IM Product

The 3^{rd}, 5^{th}, 7^{th} or 9^{th} order IM product can be manually chosen. The IM frequency is automatically calculated and takes into account the TX tone frequencies, the desired order of the IM product and the instrument's RX band.

TX Tones

TX tones are user-adjustable and can be set to any frequency within the instrument's TX band. Note though, that not all TX tone combinations will generate an IM product of the desired order, in the instrument's RX band. An error message will appear when the associated IM product does not fall within the applicable RX band and the user will have the opportunity to correct the tone placement.

1.6.3 Recalling State Files

For quick and easy instrument configuration, a state file can be pre-loaded on a memory stick. The memory stick can be inserted into one of the USB ports and the file recalled for setting up the instrument. The setup information is stored in a *.sta file and contains:

- Frequency information for the two test tones
- IM order selection (3rd, 5th, 7th or 9th) ie., the frequency that the instrument's receiver will be tuned to
- Test tone RF power
- Pass/Fail thresholds
- Preconfigured test points
- Test timer setting

1. Insert the memory stick containing a state file into one of the USB interfaces.
Press the **Open State** button. A window will be displayed with a list of the states stored on the memory stick.

2.

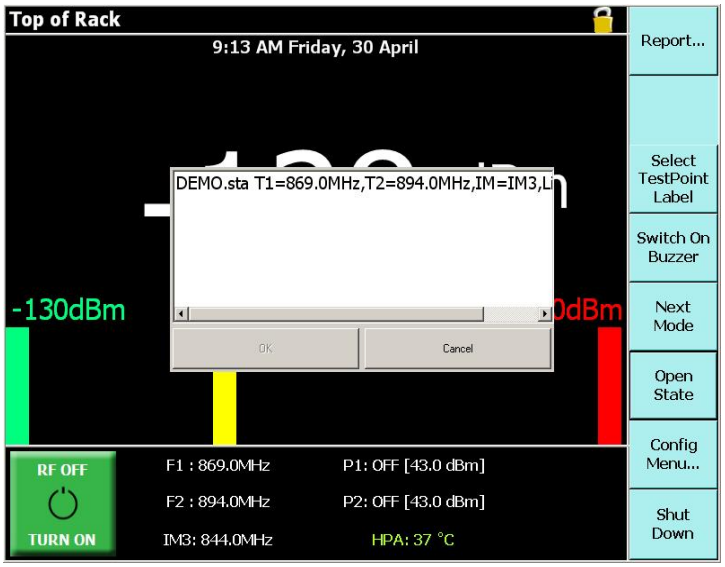

Figure 6: Test State Input Window

3. Select the state information required, and press **OK**. The instrument setup will be updated accordingly.

1.6.4 Setting up the Site Test Report

The site test report should be set up before any measurements are made.

1. Press the **Report** button. The Report window will be displayed.

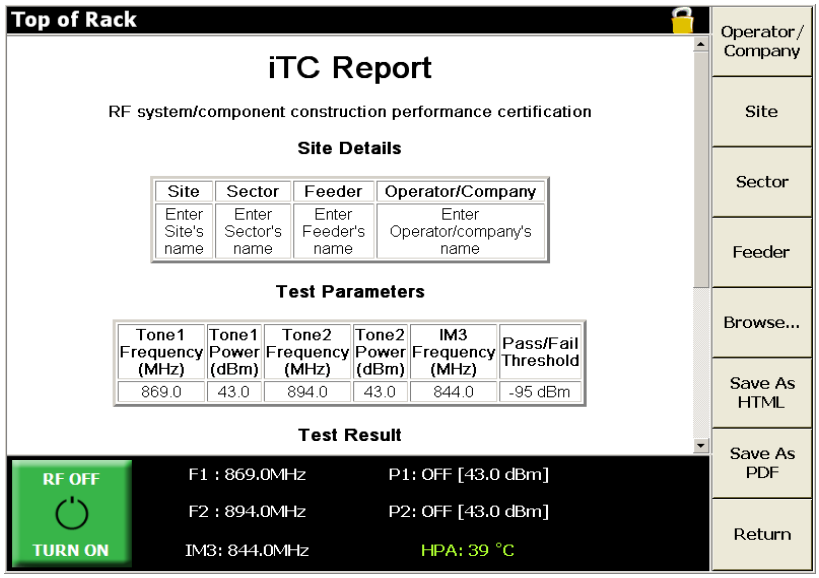

Figure 7: Report Window

2. Press the **Operator/Company** button. A keypad will be displayed.

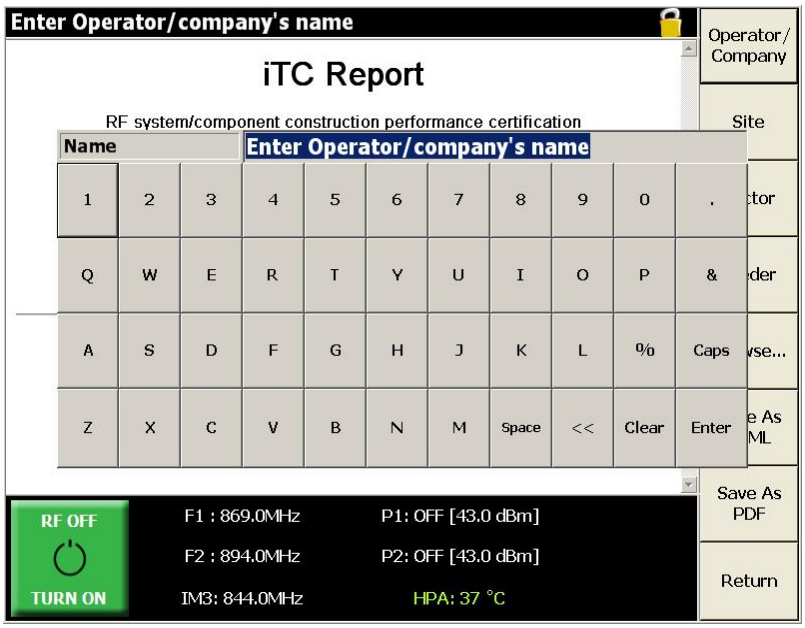

Figure 8: Keypad for Operator/Company Detail

3. Input the operators name to be listed on the report, and press **Enter**.
4. Repeat the process for adding:

   - Site name information
   - Site sector information
   - Site feeder information

5. Press the **Return** button when the report setup is complete.

1.6.5 Taking an RF Measurement

1. Before connecting the device under test to the Output Port, ensure that all mating surfaces are clean and free of physical defects. Ensure that the connection is adequately tightened.

2. Press the **Select Test Point Label** button. The Test Point Label window will be displayed.

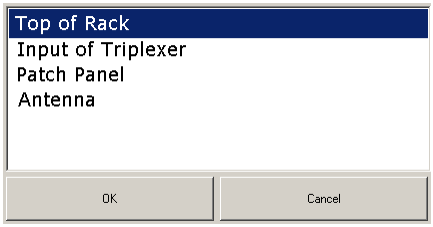

Figure 9: Test Point Label Input Screen

3. Choose the label for the point in the system at which you are doing the testing and press **OK**. The chosen Test Point label will be displayed at the top of the test screen, and in the report next to the associated measurements.

4. Press the green **RF ON/OFF** button. The button will turn RED, indicating that the RF is active. The level of the intermodulation product will be displayed on the IM level indicator and IM level bar indicator. The red RF ON LED Indicator situated immediately above the RF Output connector will flash showing RF is present. While the measurement is taking place, the instrument will take a peak measurement and indicate if the element under test has a Pass or Fail status. The 'Peak' result will, however, not be displayed until the ALC has set the output tone powers to within +/-0.5dB of the preset level.

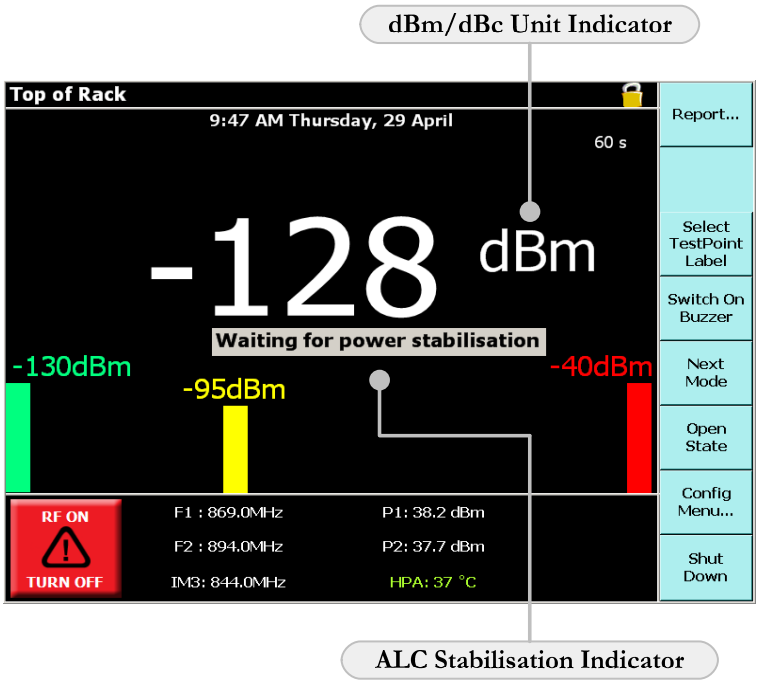

Figure 10: Power Stabilisation

The 'Record Test Point' button will only be visible (and active) after the peak value is displayed. The peak indication is held until the next RF power on event. Click on the **Unit Indicator** to toggle between dBm and dBc units.

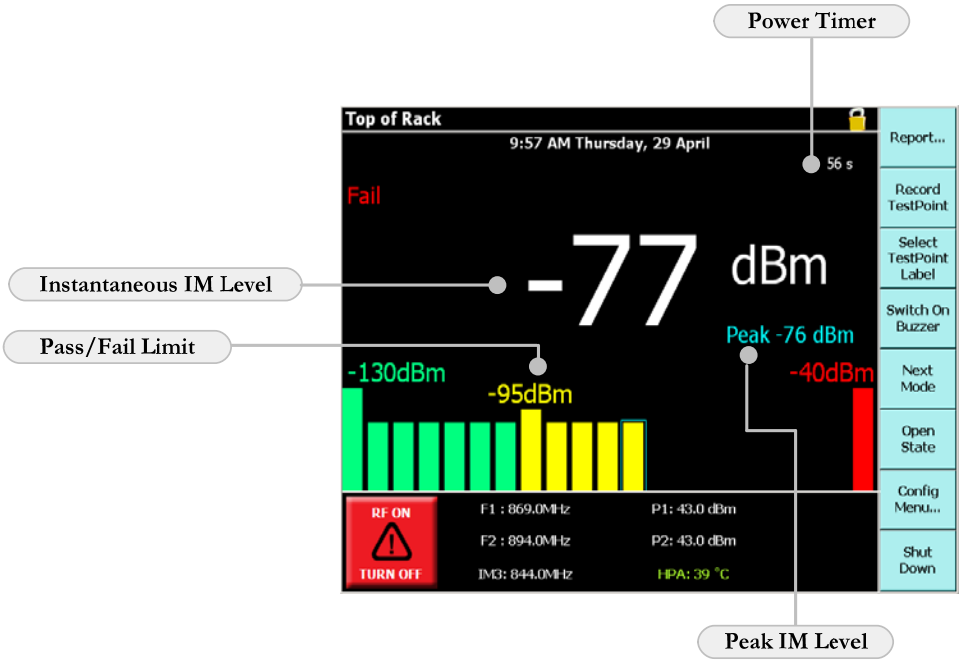

Figure 11: Default Measurement Window

The RF power can be switched off by either of the following methods:

- Press the red **RF ON** button and it will return to green. If you want to record the peak measurement on the report before switching off the RF, press the **Record Test Point** button
- The Power Timer times out (based on the time-out period set in the configuration). Once the timer has timed out, a Save Measurement prompt is displayed. The user can save the peak result to the report by pressing **Yes**

Note: *All test reports are marked with a Pass or Fail Certification stamp. The status of this stamp is determined by the results recorded when "Top of Rack" has been chosen as the test point, and a Pass will only occur when the Peak PIM reading is equal to or below the test state setting for the Pass/Fail threshold.*

1.6.6 Viewing a Test Report

Reports are automatically saved to the ***D:\Program Files\Kaelus\iQA\iQA Reports*** directory, in a compressed *.rpt format.

1. From the user screen, press the **Report** button. The report screen will be displayed. Press the **Browse** button. The directory screen will be displayed.

2.

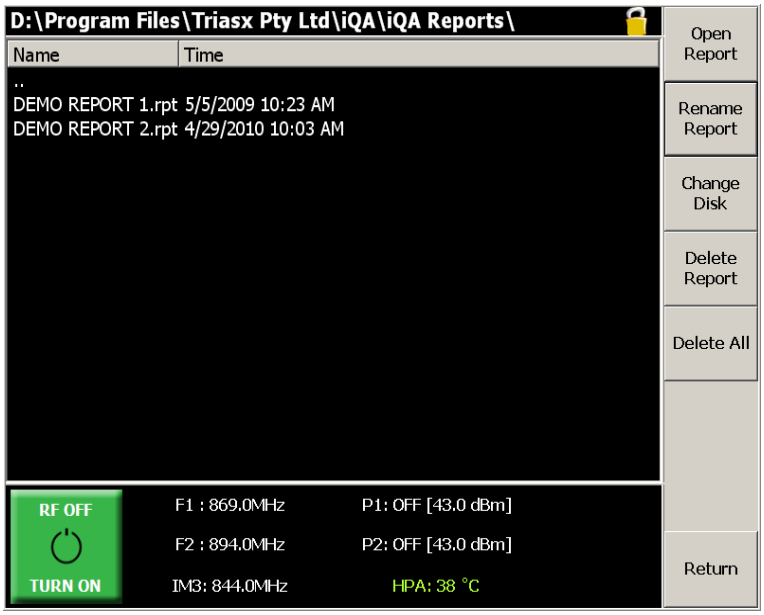

Figure 12: Report Browsing Window

- To move lower in the directory structure, click on '**..**'
- If the report is located on another disk press the **Change Disk** button to locate it
- To return to the report screen, press the **Return** button
- To delete a report, select the report name and press the **Delete Report** button

3. Select the report file required, and press the **Open** button. The report will be displayed.

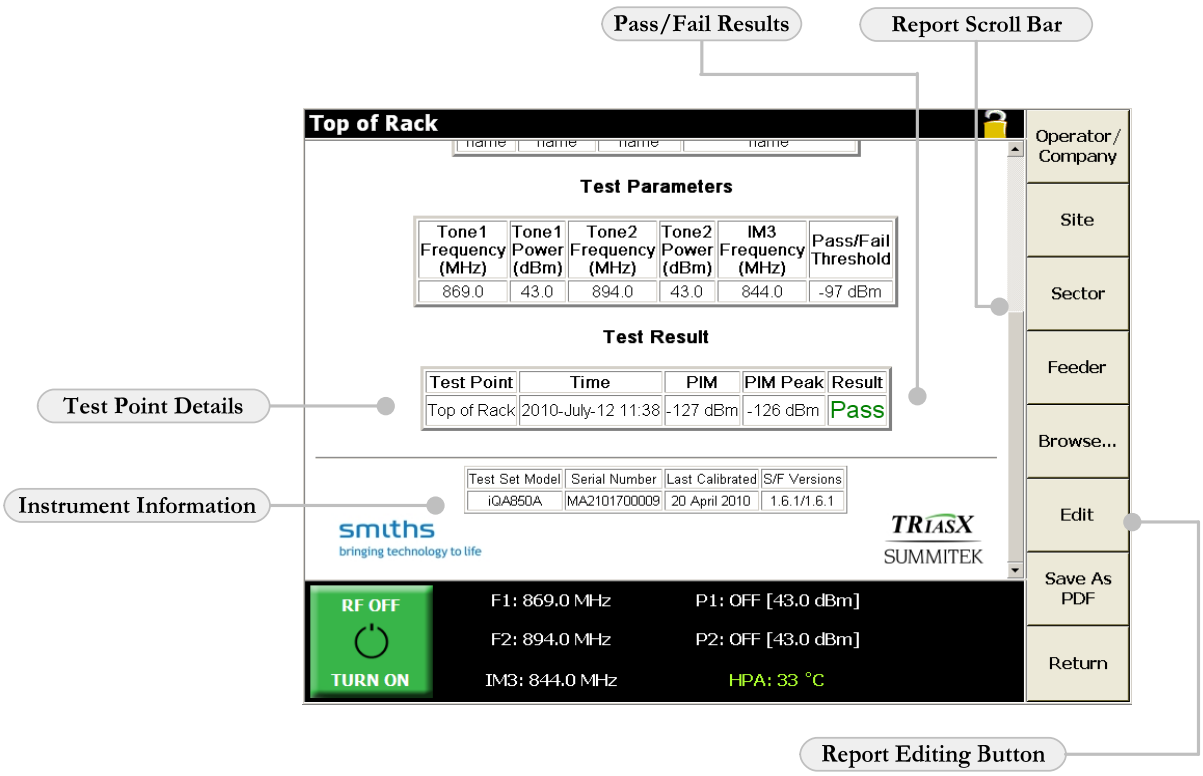

Figure 13: Report Window

4. Use the scroll bar on the right hand side to move up and down the report.

5. Press the **Return** button to go back to the main user screen.

1.6.7 Report Editing

A "Report Editing Button" has been added to the reporting menu. When this button is pressed, the "Edit Report" window as per Figure 14 is shown. In this window the user is allowed to select recorded points, delete them or change the test point name.

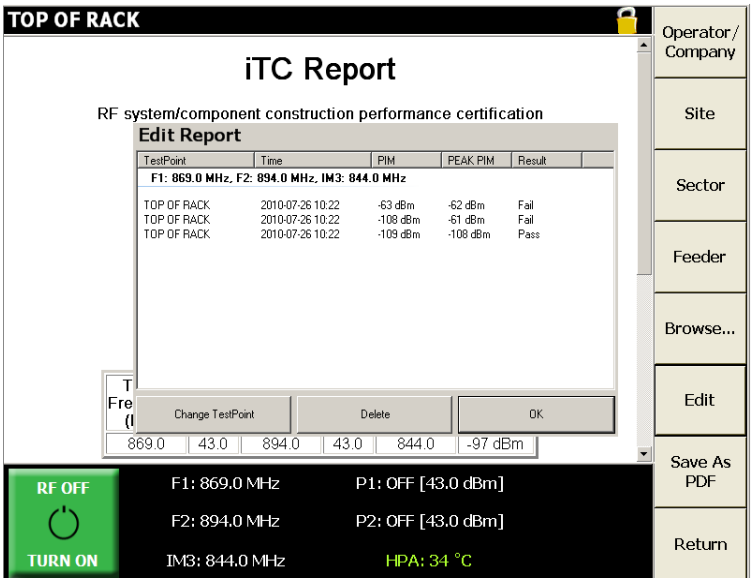

Figure 14: Report Editing Window

1.6.8 Saving Reports

Test reports can be saved to a USB memory stick in PDF format. Insert the USB memory stick. Press the **Save as PDF** button to save the report in *.pdf format on the memory stick.

1.6.9 Switching on the Buzzer

The iQA has an audible PIM indicator to assist the operator when they are not within viewing range of the screen. If activated, the inbuilt buzzer will emit an audible tone proportional to the PIM level (i.e a low PIM generates a slow beep, and a high PIM will generate a faster beep). Press the **Switch On Buzzer** button to activate the audible tone. The buzzer is switched off by using the **Switch Off Buzzer** button.

1.6.10 Shutting down the Instrument

1. To shut down the instrument, press the **Shut Down** button. A shut-down window will be displayed.

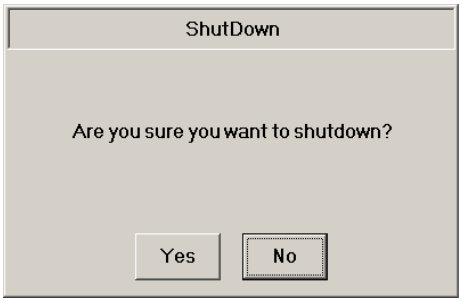

Figure 15: Shutdown Window

2. Press **Yes** to initiate the shut down procedure. The on-board computer will shut down all the internal modules automatically. The internal fans will remain active until the power cable is removed.

Note: Pressing the green AC Power button will prompt a windows shutdown, while pressing the shutdown button will turn off the whole unit.

1.7 EQUIPMENT OPERATION – CONFIGURATION MODE

1.7.1 Enabling Configuration Mode

The setup of the instrument can be modified via password access to the configuration mode. To access the configuration mode:

1. Press the **Config Menu** button. A keyboard will be displayed.
2. Type in the password and press **Enter**. The screen will now switch to Configuration Mode, indicated by the Config Unlocked indicator at the top of the screen.

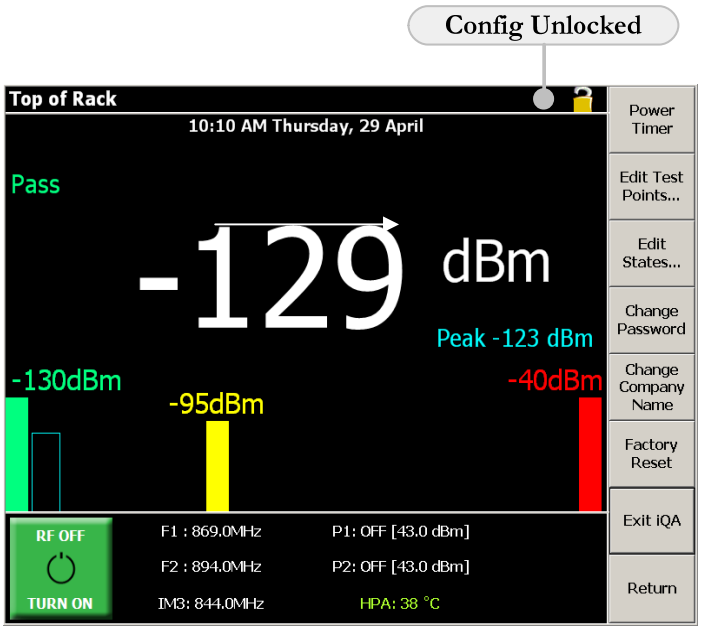

Figure 16: Configuration Mode Window

To return to User mode press the **Return** button, or the **Config Mode** indicator.

1.7.2 Change Configuration Mode Password

To change the password for Configuration mode access:

1. Press the **Config Password** button. A keyboard will be displayed.

Figure 17: Keyboard for password input

2. Enter the current Config password and press **Enter**. A keyboard will be displayed.
3. Enter the new password and press **Enter**. A keyboard will be displayed.
4. Confirm the new password by entering it again, and press **Enter**.

1.7.3 Modifying the Power Timer Period

The Power Timer is used to control the length of time the test tones are transmitted. The timer operates in seconds, and counts down until it reaches zero, at which point the user is prompted if they would like to record the measurement to the report.

1. Press the **Power Timer** button. A numeric keypad is displayed. (The current setting is displayed in the upper left hand corner.)

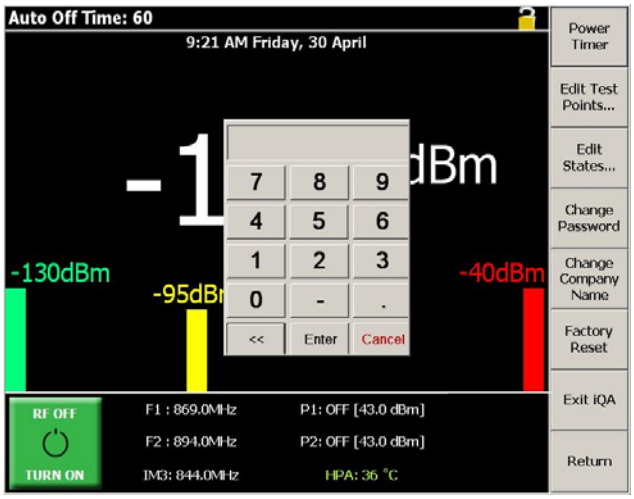

Figure 18: Keypad for Power Timer input

2. Input the timer period required in seconds, and press **Enter**.

1.7.4 Modify a Test Tone Frequency

1. Press a test tone frequency field (**F1** or **F2)**. A numeric keypad is displayed.
2. Input the new test tone frequency in MHz, and press **Enter**. If the user inputs a frequency that causes the IM product to be outside the instrument's receive band, a warning will be given to change the IM product (or to change the test tone frequency).

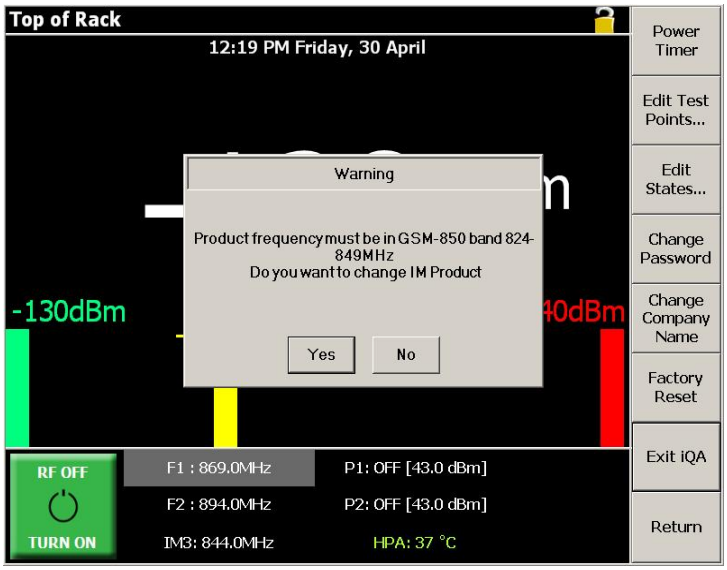

Figure 19: Test Tone Warning

1.7.5 Modify a Test Tone Power Level

1. Press a test tone power field (**P1** or **P2)**. A numeric keypad is displayed.
2. Input the new test tone power in dBm, and press **Enter**.

1.7.6 Modifying the Pass/Fail Threshold

1. Press the yellow bar in the IM Level Bar indicator. A numerical key pad will be displayed.
2. Input the IM threshold level (in dBc or dBm, depending on the units the equipment is using).
3. Press **Enter**. The yellow bar will move to the new threshold level and will show a corresponding numeric tag.

1.7.7 Modify the IM Receiver Frequency

1. Press the **IM Product** field. The instrument will calculate the various order IM frequencies and a window will be displayed with relevant options.

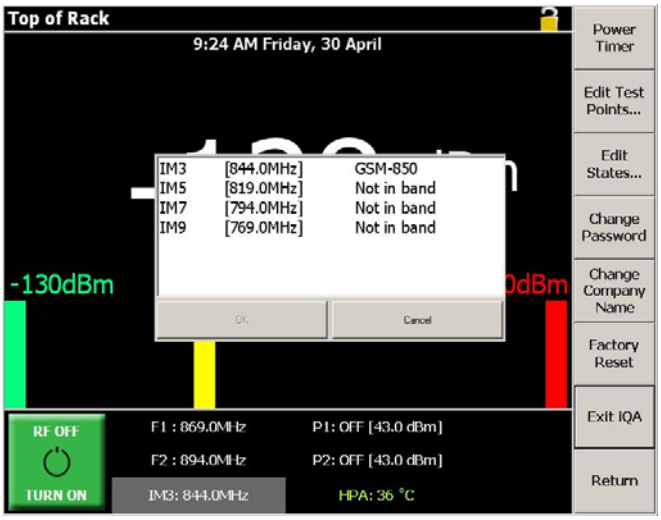

Figure 20: Calculated IM Products

2. Select the IM product to be measured and press **OK**. The IM receiver will be switched to the appropriate frequency.

1.7.8 Edit Test State

In Configuration mode, the user is able to create new states and recall, rename or delete states. Press the **Edit State** button and the Open State screen will be displayed.

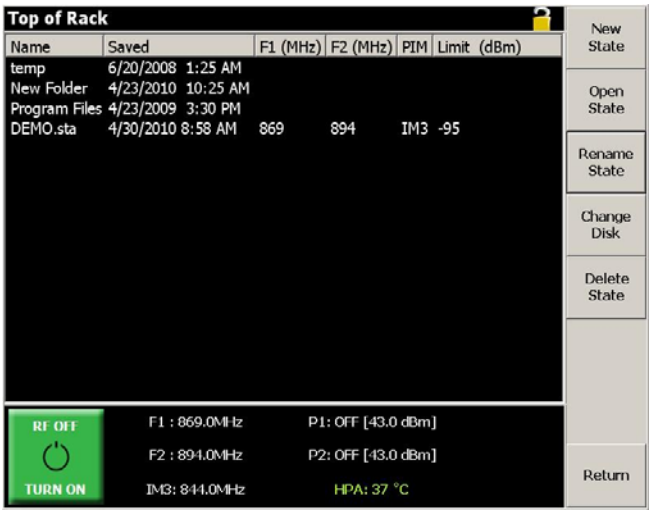

Figure 21: Open State Screen

Press the **Return** button to go back to the configuration screen.

1.7.8.1 Recall a State

The instrument setup can be changed by uploading a new state file from the local hard disk or a memory stick.

Select the file you wish to recall, and press the **Open State** button.

1.7.8.2 Change Disk

To toggle though the different drives, press the **Change Disk** button. Select the drive you wish to access.

1.7.8.3 Rename a State File

1. Select the file to be renamed, and press the **Rename State** button. A keyboard will be displayed.

2. Insert the new file name, and press **Enter**.

1.7.8.4 Create a New State File

The user can create a new state file from:

- The current instrument configuration, or
- The State File Editor application (see section 1.5)

To create a new state file from the instrument, having configured it as required in section 1.4.3 to 1.4.7, press the **New State** button, and the instrument setup will be saved in a *.sta status file.

1.7.8.5 Delete a State File

To delete a state file, select the file to be deleted, and press the **Delete State** button.

1.7.9 Editing Test Points

Test Point labels identify the physical point in the system that the measurement is taking place. In Configuration mode the user can add, delete or modify Test Point Labels.

1.7.9.1 Add a Test Point Label

1. Press the **Add Label** button. A 'new label' will be displayed.

2. Select the label title at the top of the screen. A keyboard will be displayed.

3. Enter the new title and press **Enter**.

Press the **Return** button to return to the main screen.

4.

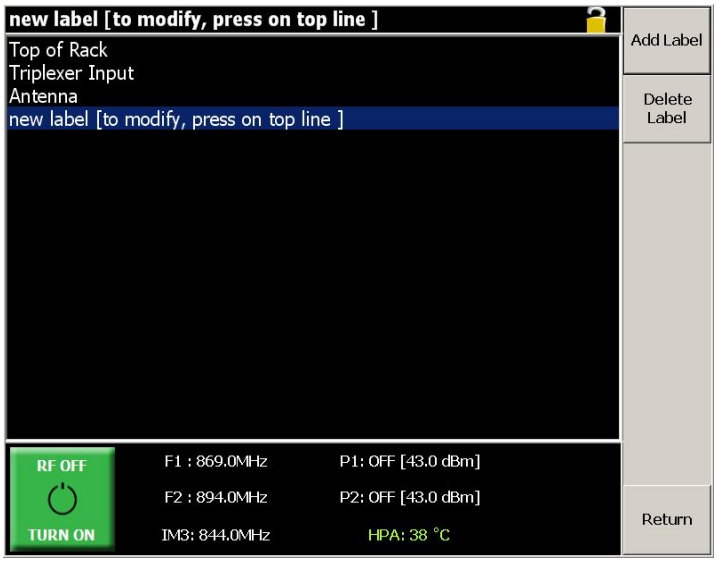

Figure 22: Changing the Test Point Label

1.7.9.2 Modify a Test Point Label

1. Select the label to be modified.
2. Select the label title at the top of the screen. A key board will be displayed.
3. Enter the new title and press **Enter**.
4. Press the **Return** button to return to the main screen

1.7.9.3 Delete a Test Point Label

1. Select the label to be deleted.
2. Press the **Delete Label** button.
3. Press the **Return** button to return to the main screen.

1.7.10 Change Company Name

The user is able to change the company name that appears on the test report.

1. Press the **Change Company Name** button. A keyboard will be displayed.
2. Insert the new file name, and press **Enter**.

1.7.11 Applying the Factory Reset

To reset the instrument to the default factory setup, press the **Factory Reset** button.

1.7.12 Returning to User Mode

To return to User mode press the **Return** button, or the **Config Mode Indicator** button.

1.8 EQUIPMENT OPERATION – SWEPT MEASUREMENT MODES

The swept measurement modes offer added IM measurement and diagnostics capability. The three modes offered are the Time Trace mode, Frequency Sweep mode and Spectrum Analyzer Mode.

1.8.1 Time Trace

The Time Trace mode is particularly useful for illustrating IM performance during a set time interval and under percussive testing. The measurement trace gives a "historic view" on how the IM level changed within the set time interval. As with the default measurement mode, the TX tones remain fixed whilst the IM measurement is taken at the corresponding IM frequency. Before the IM measurement is shown, a "waiting for power stabilization." message will appear. This is done to allow the ALC to set the output tone powers to within +/-0.5dB of the preset level.

The features offered by this mode are as follows:

- A peak level marker highlights the peak IM level and at what time instance this measurement was taken
- The time axis is automatically scaled as per the Power Timer setting mentioned earlier
- User adjustable Pass/Fail limit line
- An IM Level Bar indicator corresponds with the peak level measurement. Once the pass-fail limit is breached, this bar changes color. Red indicates a failed IM result and green indicates a passed IM result
- Measurement recording – either manual or prompted

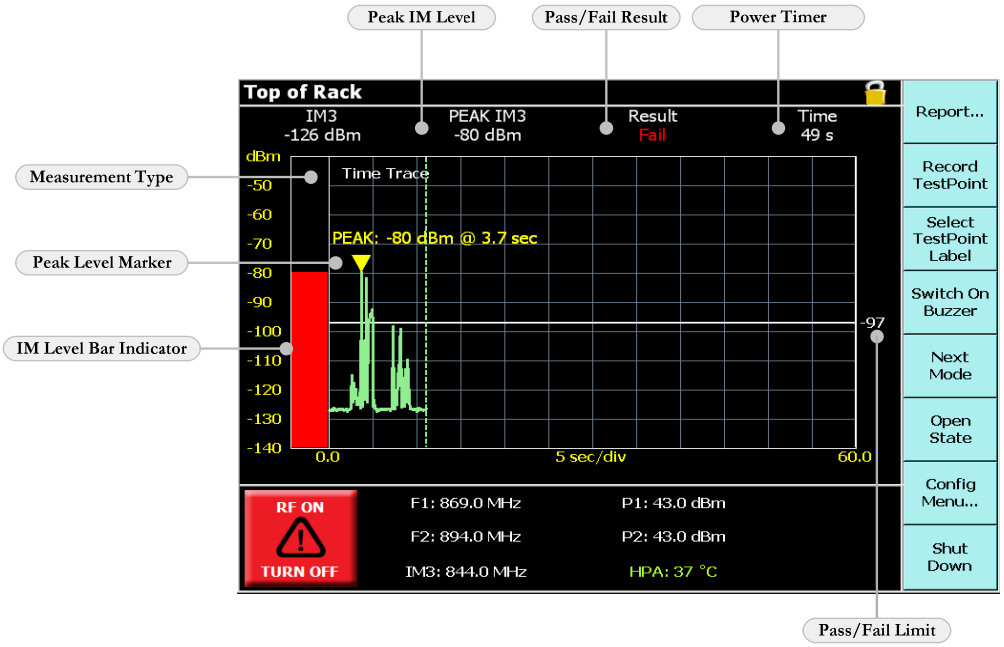

Figure 23: Time Trace Measurement Window

The foregoing figure shows a screen shot of the time trace measurement window. The shown trace is typical of a loose connector under percussive testing. If the RF is switched off before the set measurement interval expires, the user will be shown a scaled time trace per Figure 23.

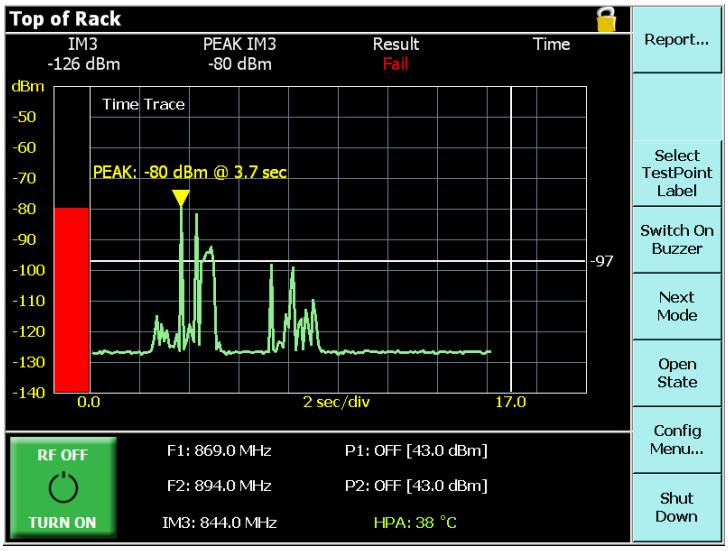

Figure 24: Scaled Time Trace

The user is at liberty to record the peak IM level of a test point at any time during the active time sweep. Alternatively, if the set measurement interval is allowed to expire, the user will have the option to save the peak result to the test report as per Figure 24.

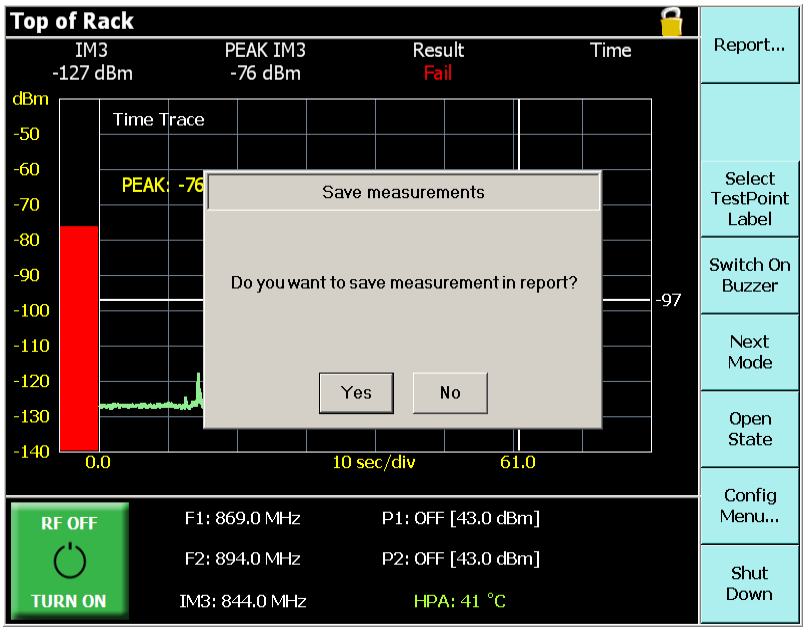

Figure 25: Saving the peak value of the time trace.

1.8.2 Frequency Sweep

The Frequency Sweep mode is particularly useful for highlighting anomalies in IM performance within a specific receive band. The instrument measures the vector sum of all PIM sources present on an RF path. If two PIM sources of approximately equal magnitude are present on the RF path *and* are physically separated in such a way that the two signals arrive at the PIM test equipment exactly 180º out of phase, the two PIM signals will cancel and the PIM problem may not be evident. Changing the test frequencies will change the generated PIM frequency and the phase relationship between multiple PIM signals on the line, if they exist. “Sweeping” across multiple test frequency combinations provides a range of data points to accurately characterize the PIM performance of the system.

With this measurement mode, the high power tones are swept across the transmit band in such a way that their IM products fall within the receive band. To optimize speed and efficiency only those pairs of transmit frequencies which create IM products in the receive band are swept. A unique feature is the use of dual-tone sweeps: the high-frequency tone is first swept towards the stationary low-frequency tone (Sweep:1/2) and then the low-frequency tone is swept upwards toward the stationary high-frequency tone (Sweep:2/2). The progress on any dual-tone sweep is shown by the sweep number as tagged in figure 26 below.

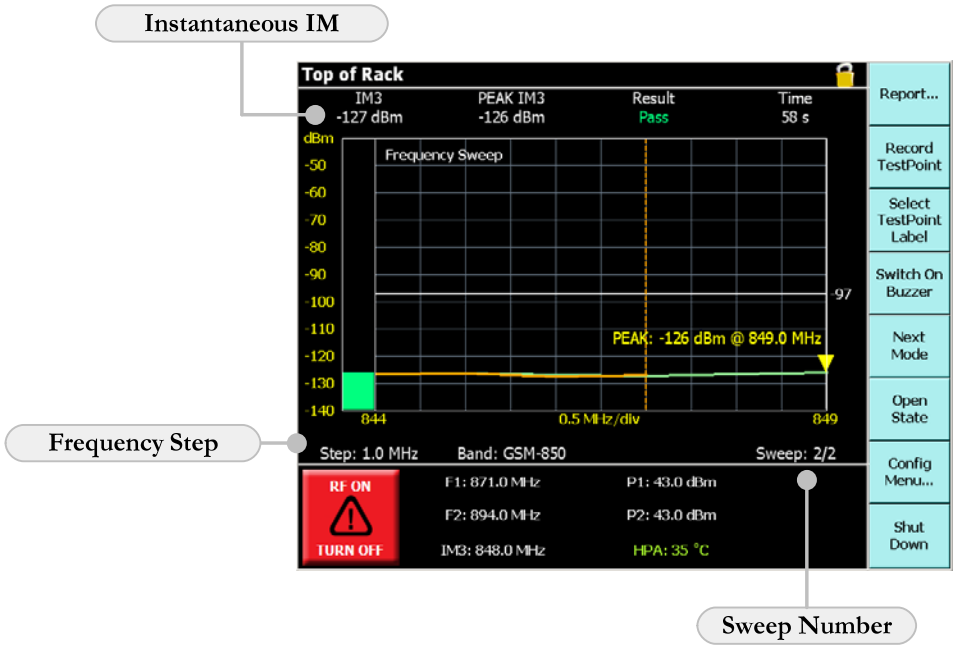

Figure 26: Frequency Sweep Measurement Window

Note: The instrument will complete as many dual-tone sweeps as possible within the preset time frame. Should the timer expire before the sweep, the sweep will be completed before the RF is switched off.

Note: The test equipment automatically changes the two test frequencies and displays the resulting IM frequency, when doing the frequency sweep.

The frequency step size is adjustable and directly impacts on the time it takes for a sweep to complete. Clicking on the frequency step label, will open a selection window with different frequency steps. The user can make a suitable selection based on the IM bandwidth in question.

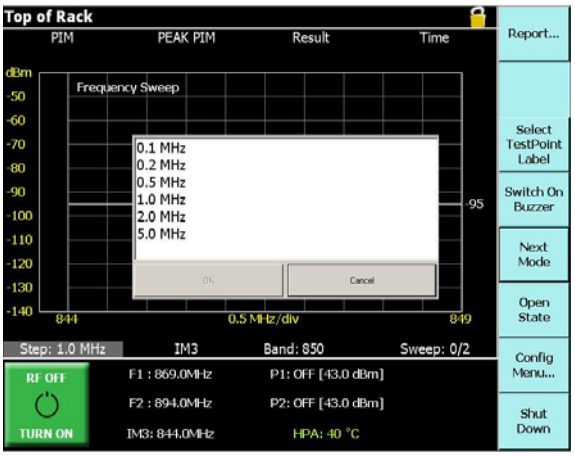

Figure 27: Frequency Step Selection Window

The figure below shows the IM order selection window. If a particular order IM band is present within the instruments receive band, it will be displayed.

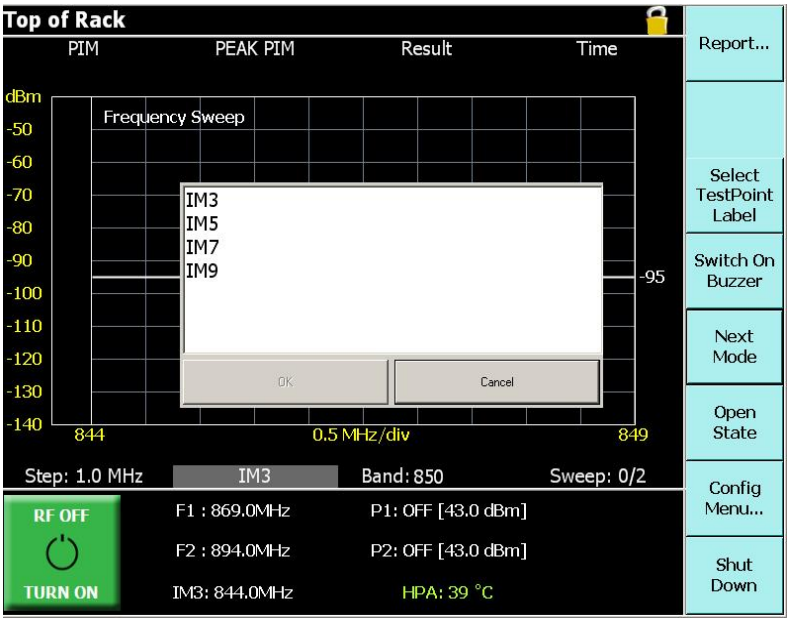

Figure 28: IM Order Selection Window

The user is at liberty to record the peak IM level of a test point at any time during the active frequency sweep. Alternatively, if the set measurement interval is allowed to expire, the user will have the option to save the peak result to the test report.

1.8.3 Spectrum Analyzer Mode

The Spectrum Analyzer mode offers an added analysis tool and is especially useful in detecting external interference introduced in the instrument's RX band. When the application starts up, a sweep is automatically initiated to detect interferers in the RX band of the instrument. In the default state, the two TX test tones will remain off, but the user also has the option for turning them "on". When "on" the operator will see all intermodulation products that fall within the receive band as well as wide band interference of whichever nature. A peak hold feature identifies the worst case value measured during each sweep.

The features offered by this mode are as follows:

- Adjustable sweep rate
- A peak level marker highlights the peak IM level and at what frequency this measurement was taken
- An IM Level Bar indicator corresponds with the peak level measurement
- Band select button on dual receive band units
- The option to have the RF on or off in this mode

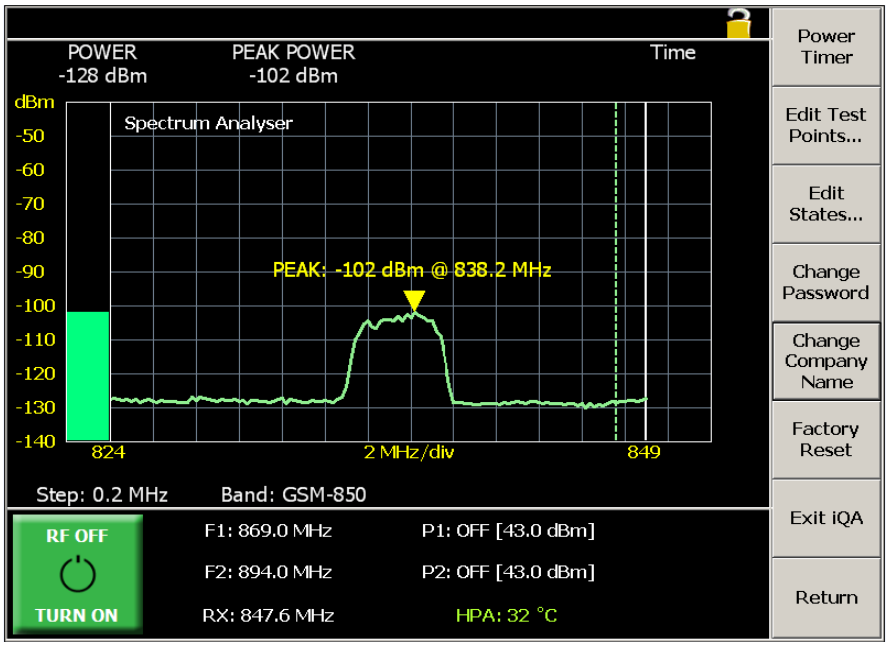

Figure 29: Spectrum Analyzer Measurement Window

The foregoing figure shows a typical spectrum analyzer trace. The interference seen in this example is due to a mobile phone ringing right next to the un-terminated RF port.

An added feature in the spectrum analyzer mode is the option to switch the RF on. Figure 30 shows, as example, the result of interference from a ringing mobile phone in the proximity of an open-ended cable load. In practical terms, this feature allows the user to see interference in the proximity of an IM signal.

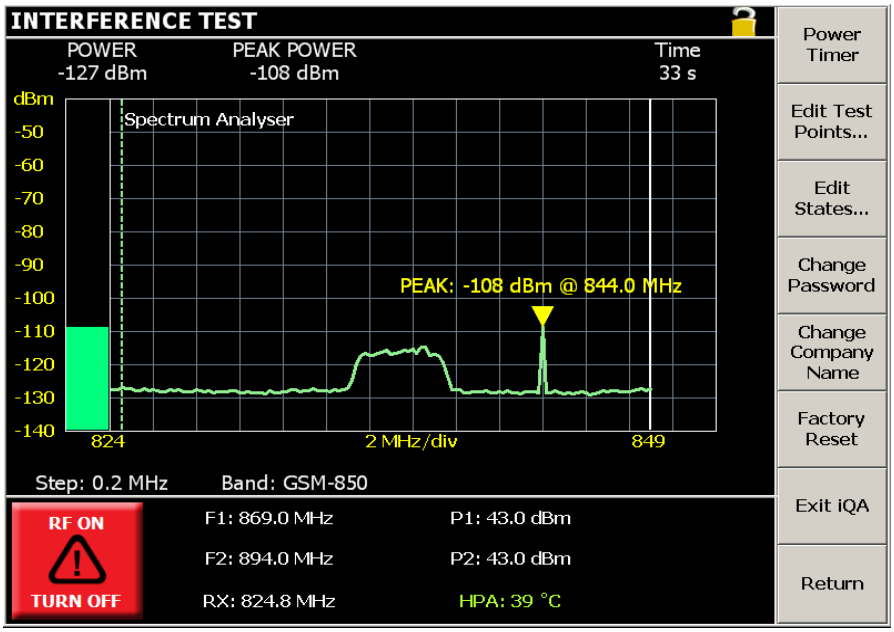

Figure 30: Interference pick-up in the spectrum-analyzer mode.

Note: The user needs to take due care in ensuring that no unlicensed broadcasting of the TX carriers occurs. In this regard it is best practice to ensure that the device under test is always terminated in a low PIM cable load.

1.9 TEST STATE EDITOR

The test set is supplied with a Test State Editor application that can be used to prepare, view or modify test parameters independent of the test instrument. This tool is particularly useful for preparing customized test plans for the BTS site in advance of the site visit.

By storing these on a USB key, the test set operators operational scope may be limited to the following.

- Physical set up of the test instrument to the device or system to be tested
- Retrieval of the applicable test state
- Preparation and saving of test reports
- Selecting test point data and performing the test

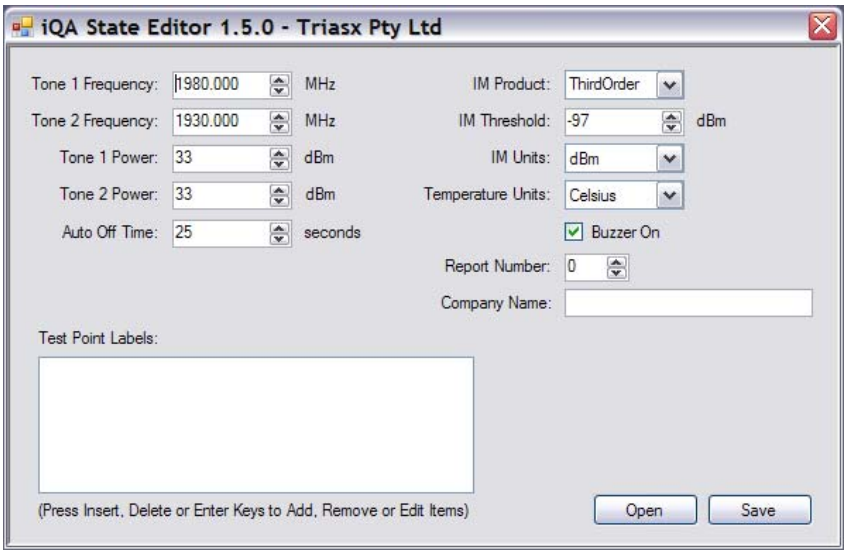

Figure 31: iQA State Editor Interface

The following elements can be setup in the Test State Editor tool:

- Test tone frequency
- Test tone output power levels
- IM product selection
- Pass/Fail threshold
- Power timer time-out
- Company name
- Report number
- Buzzer on
- A list of test points that can be selected by the instrument operator during testing

2. GENERAL DETAIL

2.1 GETTING THE BEST FROM THE TEST EQUIPMENT

There are a number of practices that will allow the best to be gained from the IM test system, especially for taking PIM measurements.

Connector & Cable Care

- Good quality connectors and test cables are essential for making PIM and return loss measurements
- Take good care of the RF connectors on the test port and the test cable. Avoid damaging the connectors in transit
- Remove O-rings from all test equipment adapters and test leads. This will reduce the torque required to achieve a tight, low PIM connection during test and extend the life of the connectors. (Do not remove O-rings from the site jumper cables)
- Care should be taken when mating a cable to the test port on the test set. Ensure the mating surfaces line-up correctly, and the coupling nut does not cross thread. Tighten the locking nut by hand initially, and then only do a final torque using a spanner. If a torque spanner is used, torque the 7-16 connector to a maximum of 25Nm; otherwise ensure that the connector is firmly fastened. DO NOT allow the body of the connector to rotate. DO NOT over-torque these as this can cause permanent damage to the connector.
- Ensure that the relevant connectors are cleaned regularly as lack of cleanliness can cause PIM problems
- A cleaning kit is supplied within the accessories kit for this purpose. Clean connector mating surfaces using a cotton bud and an isopropyl wipe to remove dirt, dust & small metal filings
- The connection of the cable screen to the connector is a major cause of PIM problems, so observe connector assembly instructions closely if constructing your own
- Do not allow the body of the connector to rotate while tightening
- Keep protective caps installed on RF connectors whenever they are not in use
- RF connectors have a finite life and are typically rated for 500 mate / de-mate cycles by connector manufacturers. Longer life is achievable with proper care

Making PIM Measurements

- PIM measurements made by the test set are affected by all items attached to the test port. This includes the test cable, the device under test and any terminations.
- Be aware that high power resistive loads are known to have poor PIM in the region of 80 to 120dBc for two 43dBm tones. Choice of RF load type is important and cable loads are preferred for good PIM performance.
- Not all test cables are suitable for taking good quality PIM measurements.
- All isolators and circulators are known to be a source of poor PIM performance in the region of 100dBc for two 43dBm tones.
- If constructing your own cables, the major sources of PIM are in the connectors, the connection of the screen of the coax to the connector and the screen itself. Observe connector assembly instructions closely.
- PIM measurement must be taken under conditions that simulate the physical stresses that apply in the installation environment, and the recorded results can only be regarded as relevant if this stress is applied during the test sequence. International standard IEC37065 provides guidance on this matter.

General Tips and Caution

- Correctly terminate components to measure best return loss
- When not carrying out measurements, switch the RF Output Power OFF, for safety reasons
- When connecting or disconnecting from the measurement port, switch the RF Output Power OFF
- Do not restrict air flow of fans and vents

2.2 SAFETY FEATURES

There are several features to enhance the tester's safety and prevent damage to the instrument. It is important that the operator is aware of these built-in features.

1. Auto-Power Off

The RF power is on a 'Power Timer' which is set up in the configuration menu. The maximum time the power can be on at any time is 500 seconds. This is an added feature to prevent power being left on for an indefinite time.

2. Power Present Indicator

Whenever AC is applied the green power button surround will illuminate.

3. Fuses

External (T6.3A, 250V) & internal (DC bus). If the external fuse blows twice in succession or the internal fuse blows once then return the unit to the manufacturer.

4. Over-temperature shutdown

When the internal heat sink temperature rises above 70°C, the unit power amplifier enters sleep mode. It is turned on automatically when the temperature drops below 65°C.

2.3 ACCESSORIES KITS

Accessory kits are provided with iQAs and include the basic tools, cables, connectors, and adapters etc. to do PIM testing in the field. Users are encouraged to contact iQA service centers do discuss the specific requirements and configurations of these accessory kits.

2.4 HANDLING AND TRANSPORT

- The equipment is designed for rugged handling, but it remains a precision test instrument and should be handled with care
- Do ship the equipment in a padded external box where possible
- Use a lock or external straps to secure both IM tester and accessories kit
- Airfreight is allowed as there are no dangerous items
- Transport via road freight is preferred to air freight due to care of handling

2.5 CLEANING THE EQUIPMENT

Before commencing any cleaning, switch off the equipment and disconnect it from the supply. We recommend that the exterior surface of the equipment case is cleaned using a soft cloth moistened in water. Do not use aerosol or liquid solvent cleaners.

To prevent damage to the internal panel and instruction sheets, care should be taken not to scratch the surface during use and also when cleaning. To prevent the access of moisture and lint into the device, we recommend that the internal panels and instruction sheets should be cleaned by wiping with a slightly damp, lint-free cloth gently over the surface.

2.6 TROUBLESHOOTING GUIDE

If the remedies indicated in the chart below do not solve the problem, consult the manufacturer for further instructions.

AC Power

No light on AC switch

- Insert the mains lead securely into a known active AC mains socket.
- Check and replace fuse if necessary
- If the above action does not fix the problem of the test instrument, it should be returned to a Kaelus approved service facility

Operation

PIM measurements are worse than expected.

- Tester may be defective. Perform RF self check using PIM standard from accessories kit. Check PIM of an external cable load
- Confirm all test rig components are in good condition by separately testing the device or system under test
- Device under test may have poor PIM. Test a device with known PIM performance.
- RF cable may be defective. Try another RF cable or attach an external cable load directly to test port to confirm
- Benchmark against another IM tester

Carrier frequencies are not suitable for antenna feeders using Tower Mounted Amplifiers (TMAs).

- Bypass TMA using cable tail with known PIM and retest PIM
- Consult manufacturer. Other frequencies can be supplied

Carrier frequencies cause interference or regulatory problems.

- Consult manufacturer. Other frequencies can be supplied

2.7 END OF LIFE STATEMENT

Equipment marked with the symbol below (Crossed Out Wheelie Bin) complies with the European Parliament and Council Directive 2002/96/EC (the "WEEE Directive") in the European Union.

Please contact your local Kaelus representative (see next section) at the end of the product's useful life to arrange its disposal in accordance with your local regulations.

2.8 CONTACTS

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Centennial, 80111, CO
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Facsimile: +1.303.768.8181
www.Kaelus.com

When ringing, ask for IM tester support (technical or otherwise) & quote the relevant part numbers.

Send feedback to: info@Kaelus.com