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# Telegesis ZigBee RangeFinder

## Product Manual


Rev: 8

Date: Sept 2014

Guide for firmware versions: R311 and R211

Patent pending: GB1222898.7

# Table of Contents

# Table of Figures

# Package Contents

The package contains the following items,

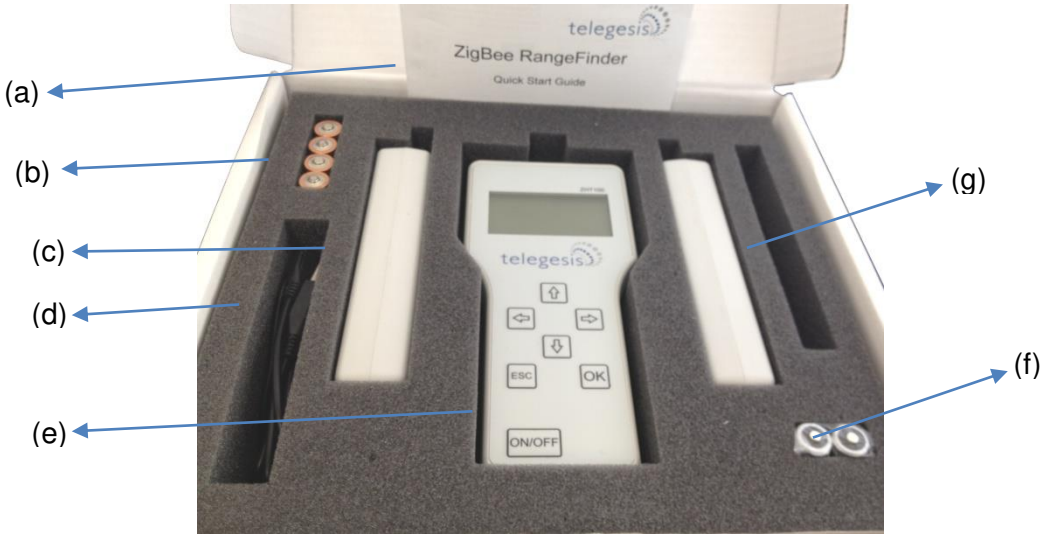



**Figure 1: Package Contents**

a) 1x Quick Start Guide
b) 4x 1.5V AA Alkaline Batteries
c) 2x Satellite Units SAT100
d) 1x USB A to USB Micro Cable
e) 1x Handheld Terminal ZHT100
f) 2x 1.2V AA 2000mA Rechargeable Batteries
g) 3x 2.4GHz Half-wave Antennas

# Specifications

## Handheld Terminal (HHT)

| | |
|---|---|
| Model Number | ZHT100 |
| RF Interface | 2.4GHz IEEE802.15.4 |
| RF Output Power | -9dBm to +8dBm (Standard Version) |
| | 20,19,18,16,15,13,10,7,1dBm (Long Range Version) |
| Antenna | Half-wave Dipole Antenna 2dBi Gain |
| Battery | 2x 1.2V 2000mAH NiMH Rechargeable |
| Charging | 5Volts @ 300mA via USB Micro Connector |
| Operating Temperature | 0 to 50C |
| Humidity | 95% TH Non-condensing |
| IP Rating | IP54 (subject to testing) |

## Satellite (SAT-x)

| | |
|---|---|
| Model Number | SAT100 |
| RF Interface | 2.4GHz IEEE802.15.4 |
| RF Output Power | -9dBm to +8dBm (Standard Version) |
| | 20,19,18,16,15,13,10,7,1dBm (Long Range Version) |
| Antenna | Half-wave Dipole Antenna 2dBi Gain |
| Battery | 2x 1.5V AA Alkaline  Batteries |
| Operating Temperature | 0 to 50C |
| Humidity | 95% TH Non-condensing |
| IP Rating | IP54 (subject to testing) |

# Handheld Terminal Unit

## Layout

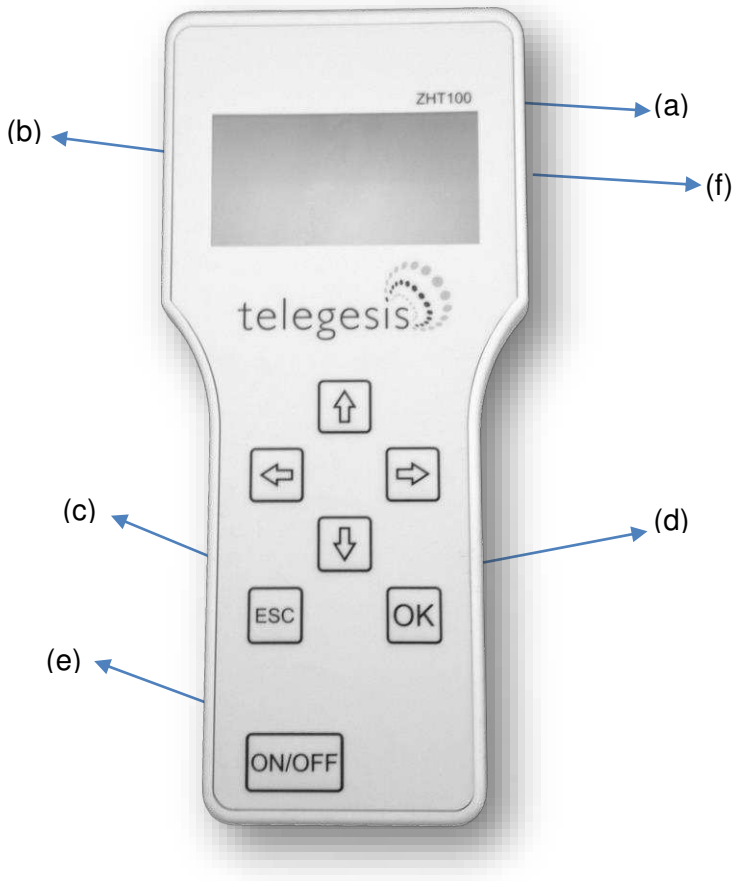



Figure 2: Handheld Terminal Front

Handheld Terminal Front

(a) Product Model Number
(b) LCD Display
(c) Escape (Back) Key
(d) Enter (Activate) Key
(e) Power On/Off Key
(f) USB-B Micro Connector

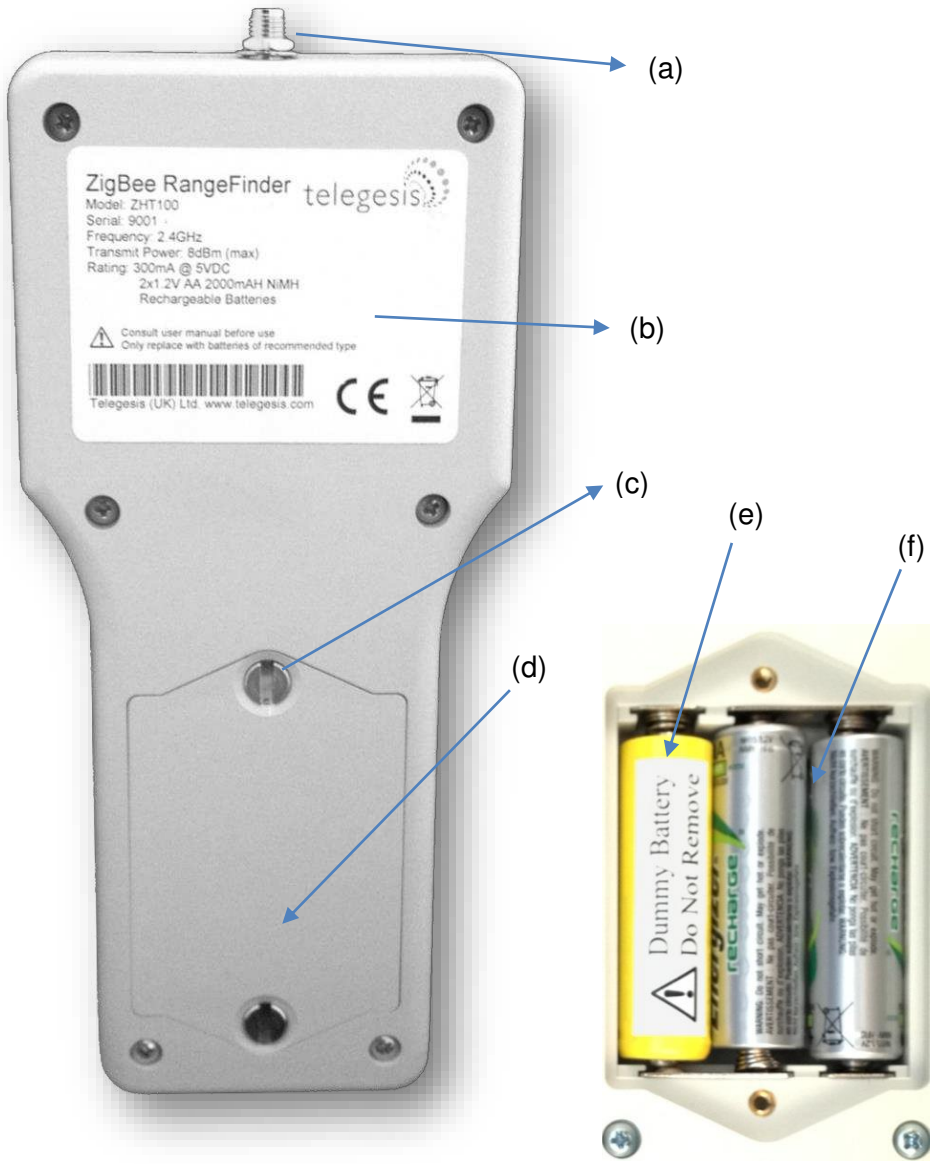



Figure 3: Handheld Terminal Back

Handheld Terminal Back

(a) SMA Connector for Antenna
(b) Product Label
(c) 2x Screw for Battery Compartment
(d) Battery Compartment
(e) Dummy Battery (non-removable)
(f) 2x Rechargeable Batteries

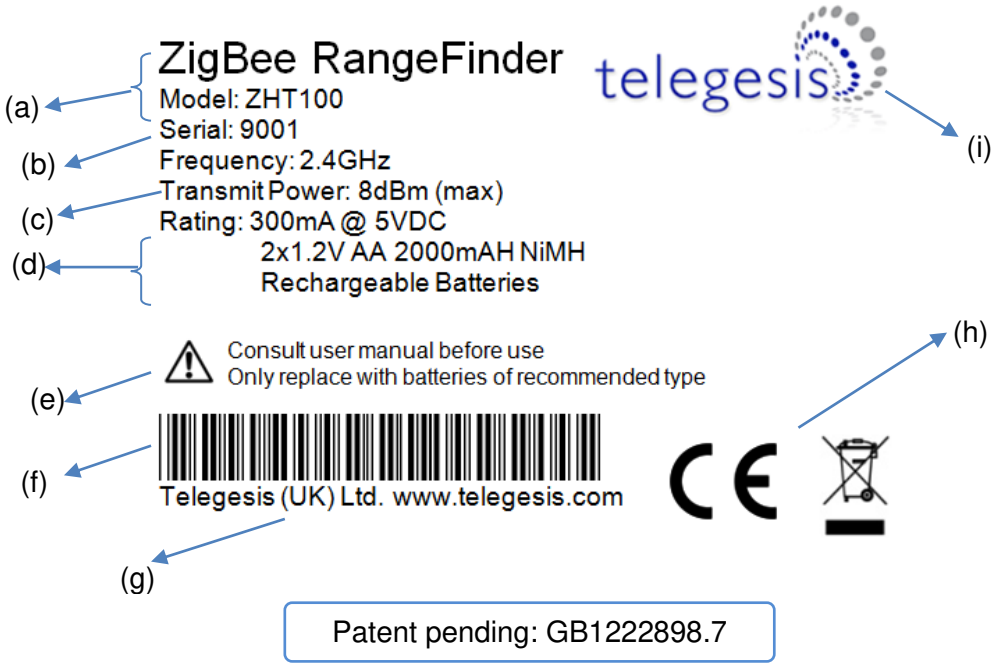



**Figure 4: Product Label**

Handheld Terminal Label

(a) Product name “ZigBee RangeFinder” and product model number “ZHT100”
(b) Serial number of the product
(c) Operating parameters of the product
(d) Maximum RF Transmit power
- 8dBm for standard version
- 20dBm forLong Range version

(e) Warning
(f) Barcode with following content:
<Model>/L<Serial>
e.g. ‘ZHT100/L9001’
(g) Compliance marking for CE and WEEE

# Functionality

The Hand-Held Terminal (HHT) is the centre point of the system and all communication in the system is with respect to the HHT. The operator can set up parameters for tests, perform the tests and configure other test settings from the HHT. Below are the explanations of various options and output screens one can use on the HHT.

## Start-up:

Upon pressing the power button ON/OFF for four seconds the following screen will be displayed. This screen has useful information about the product such as the serial numbers of device and the firmware version of HHT. This screen is displayed upon power up and by Device Info option on Menu screen 3.

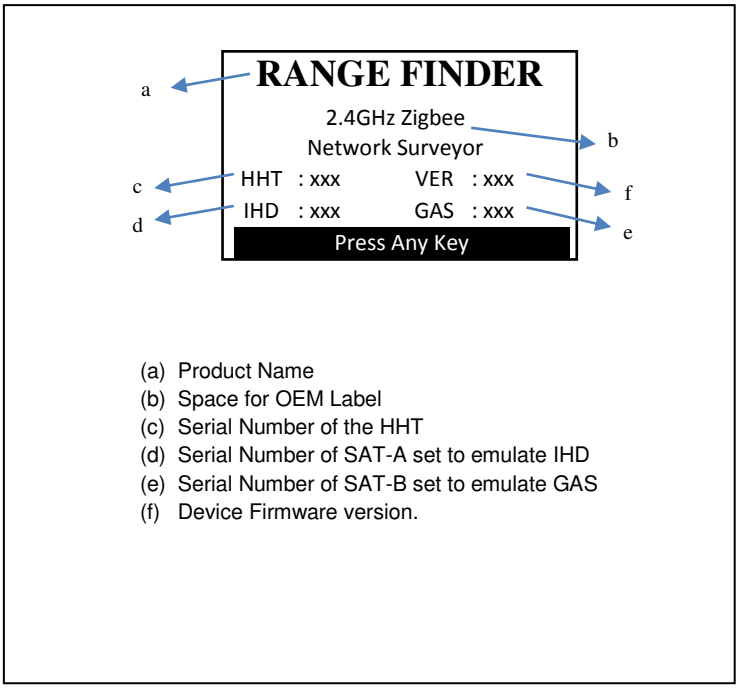



Figure 5: Start-up Screen

## Menu Screens:

Menu items can be scrolled through using the navigations keys ⇦ ⇨ ⇧ and ⇩ to navigate through options and press OK button to enter the selected menu item. The battery symbol shows the current battery status.

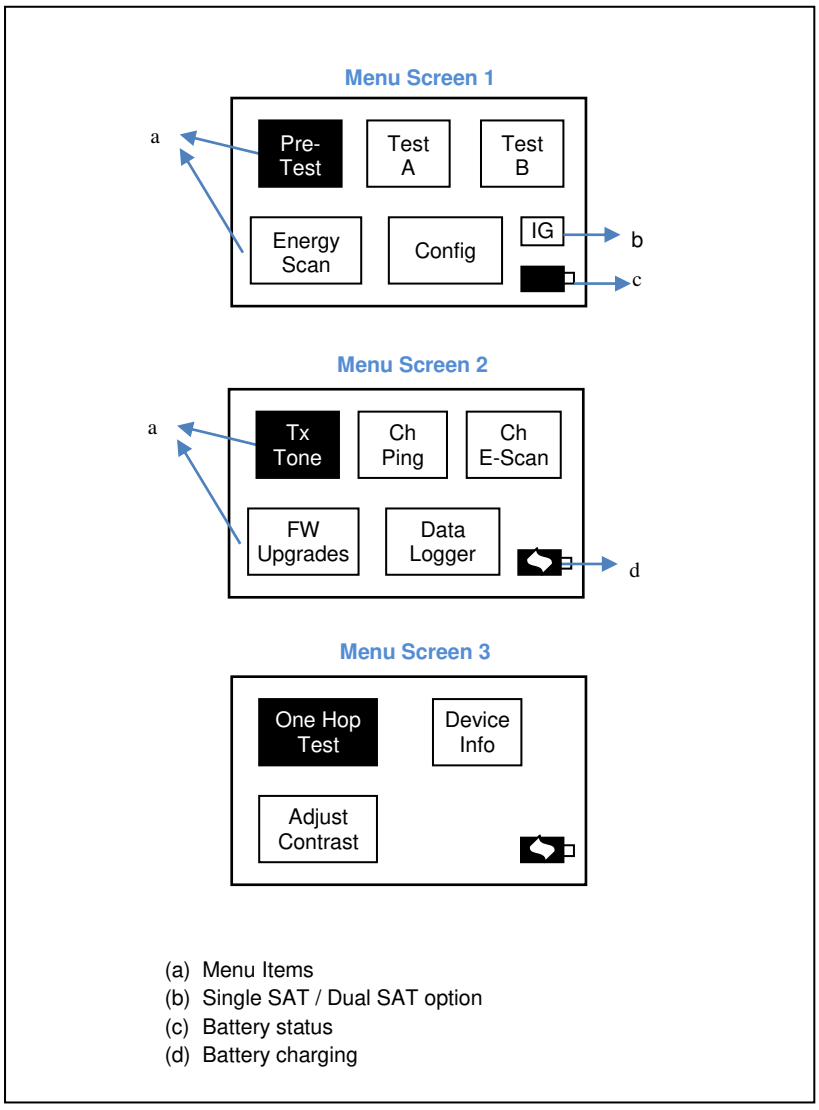
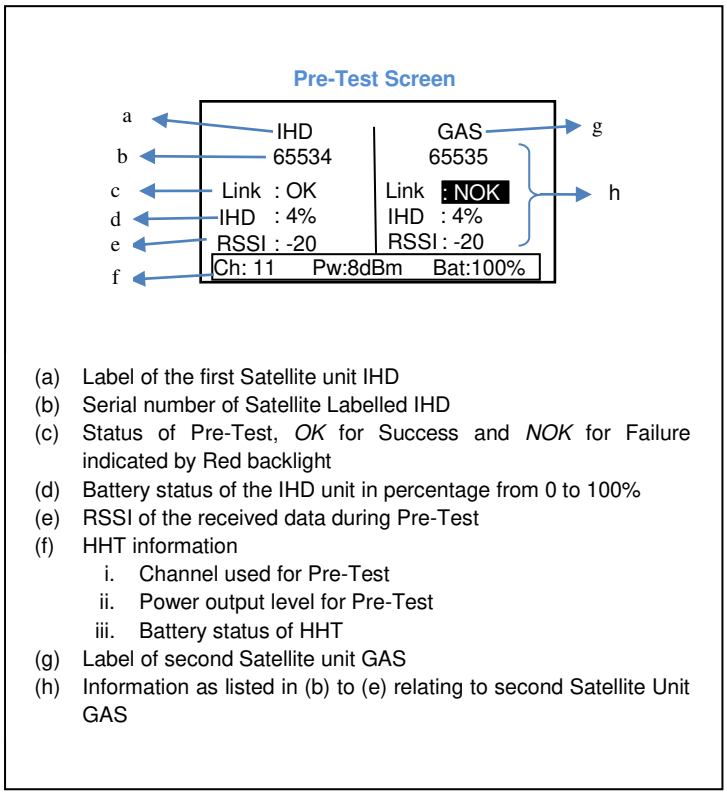



**Figure 6: Start-up Screen**

## Normal Test Modes:

### Pre-Test:

A Pre-Test is required before the 'Test A' or 'Test B' can be performed. The Pre-Test has the function of sanity checking the link between the HHT and the SAT units. Also performing Pre-Test will configure the current test settings in SAT units. A test carried out without running a Pre-Test may **NOT** present valid results. Any change in the Configuration settings should be followed by a Pre-Test.




(a) Label of the first Satellite unit IHD
(b) Serial number of Satellite Labelled IHD
(c) Status of Pre-Test, *OK* for Success and *NOK* for Failure indicated by Red backlight
(d) Battery status of the IHD unit in percentage from 0 to 100%
(e) RSSI of the received data during Pre-Test
(f) HHT information
  i. Channel used for Pre-Test
  ii. Power output level for Pre-Test
  iii. Battery status of HHT
(g) Label of second Satellite unit GAS
(h) Information as listed in (b) to (e) relating to second Satellite Unit GAS

**Figure 7: Pre-Test Screen**

The completion of the Pre-Test is indicated by a short beep from the built-in buzzer. To return to the main menu from the Pre-Test Screen please press ESC

### Test A / Test B:

Telegesis Range Finder tests are designed to evaluate the suitability of deployment of a Smart Energy device which is why they focus on the ZigBee Smart Energy recommended RF channels in the 2.4GHz spectrum. Tests A and B are performed on ZigBee SE channels 11, 14, 15 and 19 during Test-A, while the remaining of SE channels 20, 24 and 25 are tested in Test-B.

Although the Rangefinder is designed to assist with ZSE installations, the Continuous test and Energy scan can be used to analyse the entire ZigBee 2.4GHz spectrum.

At the start of each test-A/B, countdown is activated to give a chance for the operator to put the HHT in place of simulated test device such as electricity meter and move away from the meter housing if necessary. This timer is configurable in the Configuration Menu.

To perform tests A or B, navigate to the menu item on Menu Screen 1 using ⇦ and ⇨ keys and press OK button for the test start screen to appear. Continuous and

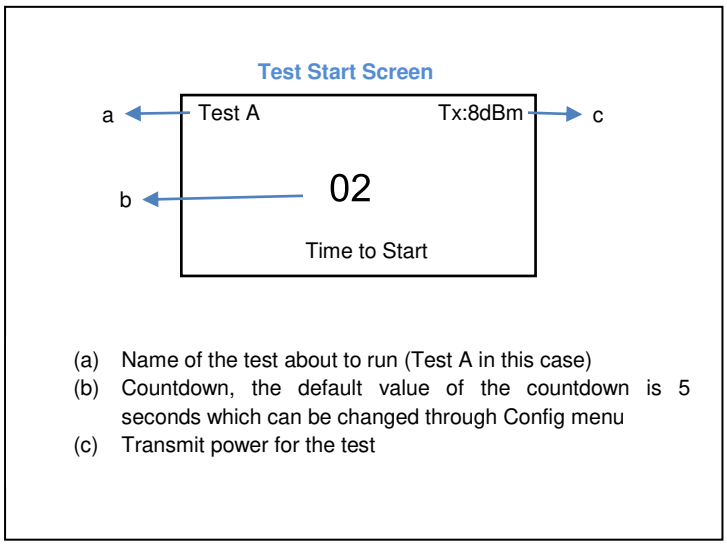
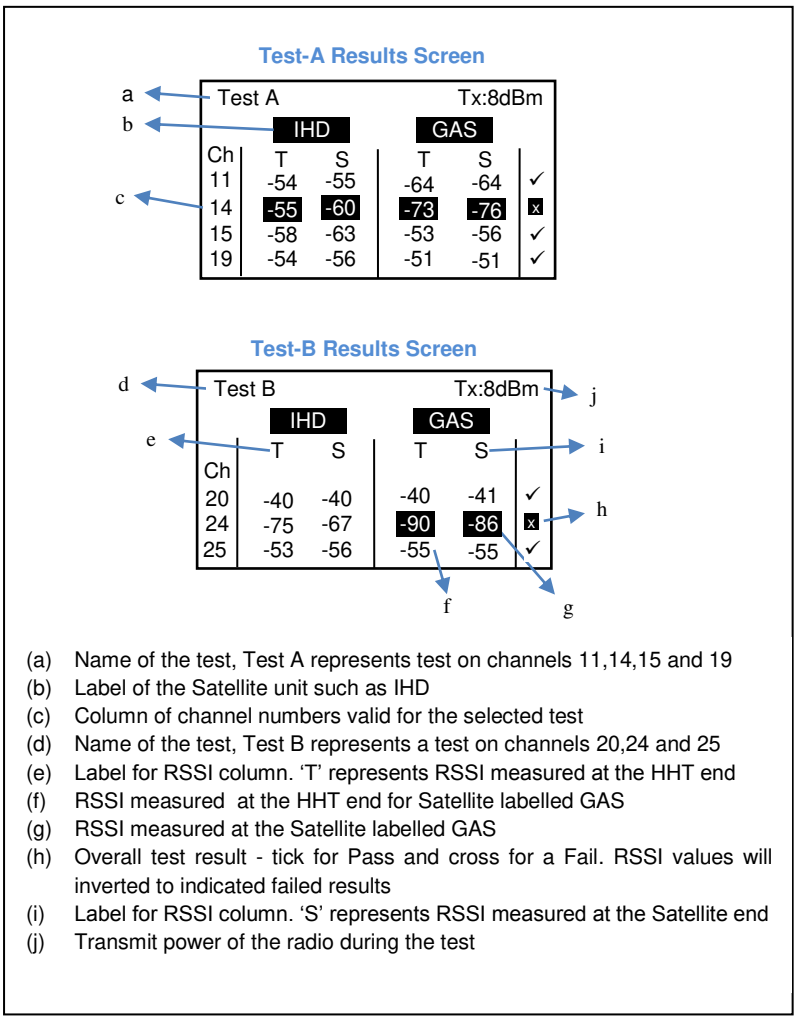



**Figure 8: Test Start Screen**

Once the countdown has elapsed, the test starts and the test results are displayed for each channel for the test as the test progresses. The completion of the test is indicated by a short beep from the built-in buzzer. The display backlight changes to Red for test failure and to Blue colour if the test is a pass. Also the failed values will be inverted. For details of the Pass/Fail criteria please see section “Interpreting Test Results”.




(a) Name of the test, Test A represents test on channels 11,14,15 and 19
(b) Label of the Satellite unit such as IHD
(c) Column of channel numbers valid for the selected test
(d) Name of the test, Test B represents a test on channels 20,24 and 25
(e) Label for RSSI column. 'T' represents RSSI measured at the HHT end
(f) RSSI measured at the HHT end for Satellite labelled GAS
(g) RSSI measured at the Satellite labelled GAS
(h) Overall test result - tick for Pass and cross for a Fail. RSSI values will inverted to indicated failed results
(i) Label for RSSI column. 'S' represents RSSI measured at the Satellite end
(j) Transmit power of the radio during the test

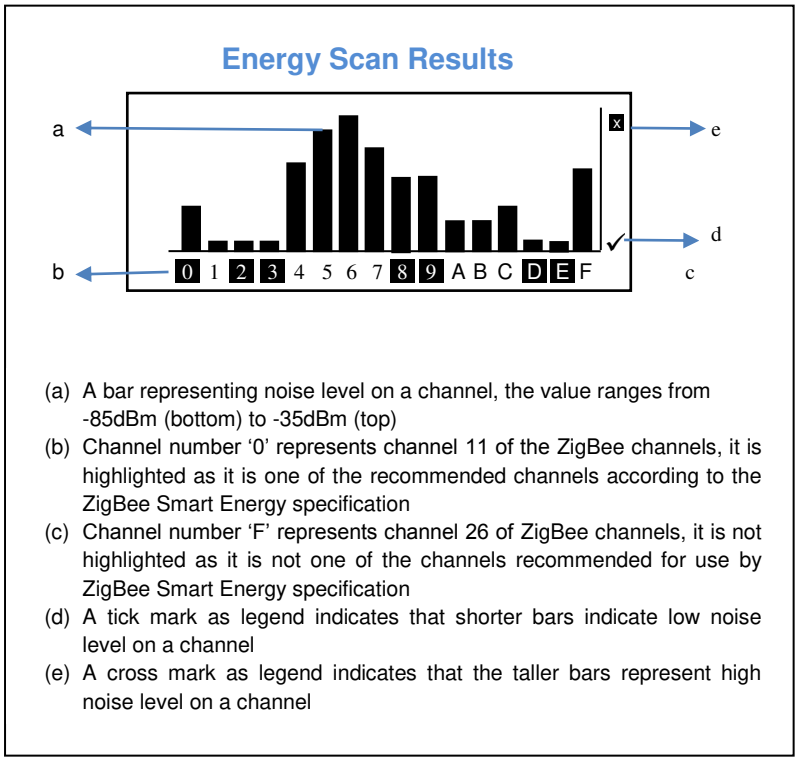
**Figure 9: Screen for Test A and B**

The completion of the Test-A/B is indicated by a short beep from the built-in buzzer. To return to the menu screen press ESC

### Energy Scan:

The operator can make use of the Energy Scan of the network to get a measure of the noise or traffic present on a channel. Due to the dynamic nature of protocols (Wi-Fi, Bluetooth, ZigBee) each scan may show a different noise level even when done back to back. Each channel is scanned for noise for about 260mS. The results are painted for each channel as they become available.

-35dBm is considered to be very noisy and -85dBm is considered very quiet. The channels preferred by the ZigBee Smart Energy standard are highlighted in the test results. A sample of the test screen is shown below. To perform the Energy Scan, navigate to the Energy Scan menu item on Menu Screen 1 using ⇦ and ⇨ keys and press OK for the energy scan result graph as shown below to appear on screen.




(a) A bar representing noise level on a channel, the value ranges from -85dBm (bottom) to -35dBm (top)
(b) Channel number '0' represents channel 11 of the ZigBee channels, it is highlighted as it is one of the recommended channels according to the ZigBee Smart Energy specification
(c) Channel number 'F' represents channel 26 of ZigBee channels, it is not highlighted as it is not one of the channels recommended for use by ZigBee Smart Energy specification
(d) A tick mark as legend indicates that shorter bars indicate low noise level on a channel
(e) A cross mark as legend indicates that the taller bars represent high noise level on a channel

**Figure 10: Energy Scan Screen**

## Continuous Test Modes:

### Tx Tone

The Transmit Tone option can be useful in situations in which one has to test immunity of the existing ZigBee network against noise from other devices operating on the same channel. This option will transmit a continuous tone on the user selected channel and power level. To transmit a tone on a channel, navigate to the Tx Tone menu option on menu screen 2 using ⇦ and ⇨ keys and press OK for following screen to appear.

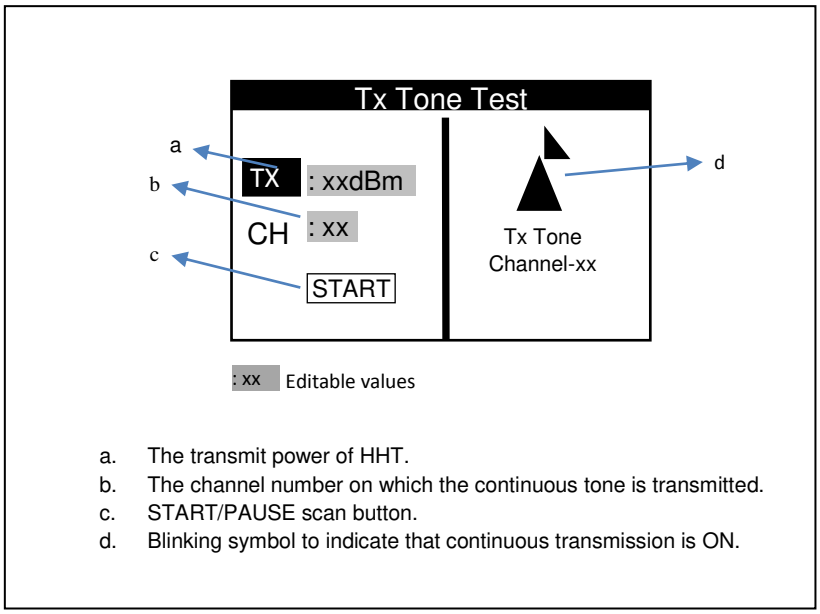


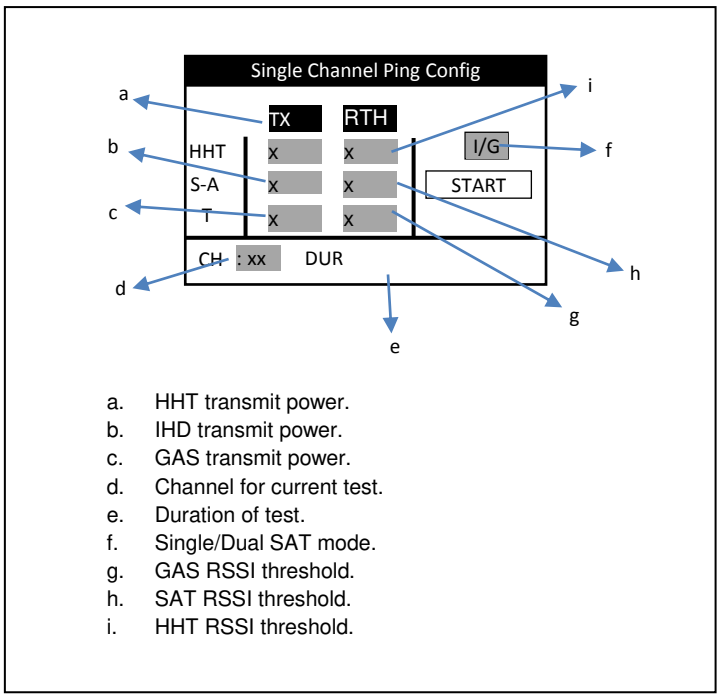

**Figure 11: Tx tone**

Once on this screen, the user can scroll through parameters using the ⇦ and ⇨ keys, press OK to be able to edit the transmit power and channel number on which to transmit a continuous tone which can be done using the ⇧ and ⇩ keys and again press OK to set the new value.

After setting all the parameters, user will navigate to START option and press OK to start transmitting the tone. The symbol on the right will start blinking to indicate that the tone is being transmitted on the set channel.

### Ch Ping

This is another continuous mode tests which can be used whenever the user wants to find the best location to position the IHD and GAS units to get the optimum signal strength that can be achieved.




a. HHT transmit power.
b. IHD transmit power.
c. GAS transmit power.
d. Channel for current test.
e. Duration of test.
f. Single/Dual SAT mode.
g. GAS RSSI threshold.
h. SAT RSSI threshold.
i. HHT RSSI threshold.

**Figure 12: Continuous Ping Configuration**

The main advantage of this test is the ability to set different test parameters such as Tx Power and RSSI threshold limits in all three (IHD; GAS and HHT) devices. This gives the operator flexibility to emulate different devices with different settings which can be the case in an actual ZigBee network.

This option can be used to measure the RSSI between the HHT and the IHD and/or GAS units. As with the other options navigate to the Ch Ping option on menu screen-2 using ⇦ and ⇨ keys and select the option using OK key. The single channel Ping Config screen as shown above will appear. There are different parameters as shown in the figure above which are to be set according to test requirements. To scroll through list of parameters, use ⇦ and ⇨ arrow keys. Press OK to edit, ⇧ and ⇩ to edit values and again press OK to set the parameter value for the continuous Ping test to be performed.

Once all the parameter values are set press navigate to START and press OK to start the test. Now the test will run for the time in sec set for DUR parameter. If the time set is 0 then the test will keep on running and updating the display with the Single Channel Ping Results screen unless stopped manually by pressing ESC key.

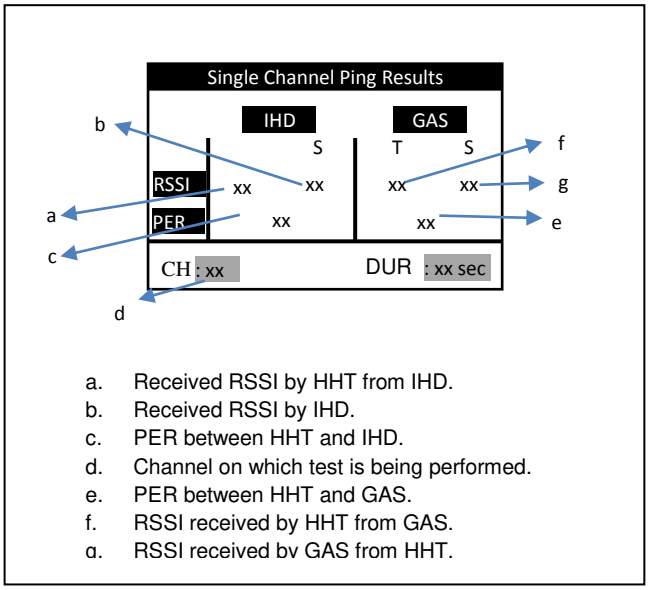



**Figure 13: Continuous Ping Results**

### Ch E-Scan

This channel scan will show the dynamic values of the current noise levels in the selected channel. To select this single channel E-Scan option, navigate to the option on menu screen 2 using ⇦ and ⇨ keys and press OK. The following screen will appear.

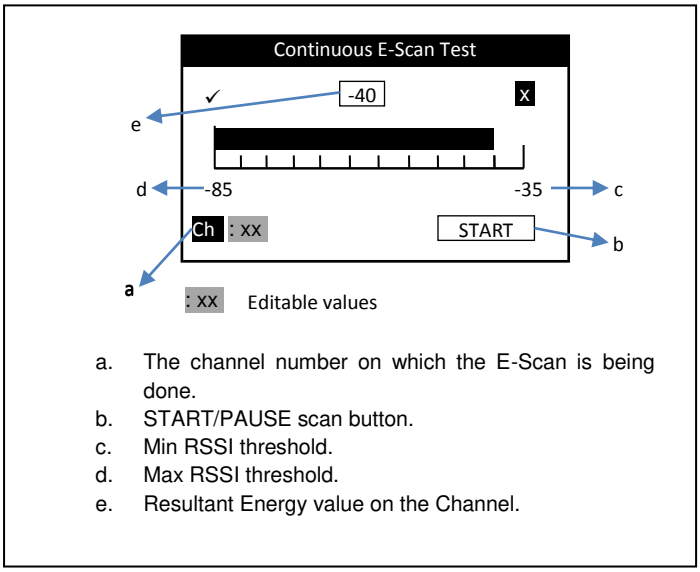



**Figure 14: Single Channel E-Scan**

Once on this screen, scroll through the list of channels (from CH-11 to CH-26) on which the noise scan is to be done by using ⇧ and ⇩ keys and again press OK to set the desired channel. The scan is started by navigating to START and pressing OK. The dynamic energy levels on that channel will be displayed on the screen as shown in the figure above.

### One Hop Test

The One Hop test is a very useful test in systems that require a repeater in between two nodes. The IHD will operate as a repeater (RTR) between the HHT and GAS. All messages from the HHT which are directed towards GAS will be relayed by the RTR. This test will help finding the best possible location for the repeater to be placed and simultaneously tests the link between nodes through the repeater. The following configuration screen is displayed when the one hop test option is selected. The configuration screen allows the operator to modify the test parameters like Tx Power, RSSI threshold, Channel used for test and the duration of test. To scroll through list of parameters, use ⇦ and ⇨ arrow keys. Press OK to edit, ⇧ and ⇩ to edit values and then press OK to set the parameter value for the current session of test.

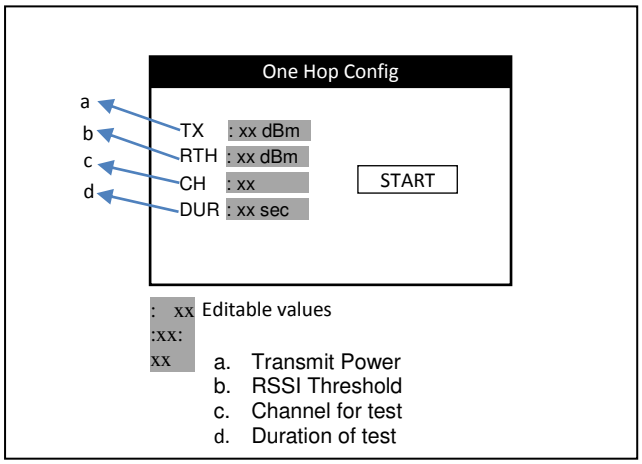



Figure 15 One hop configuration screen

Once parameters are set navigate to the start button on the screen and press OK to start the test. At this point the one hop results screen as shown below will be displayed on screen. Depending on the test state one of the following result screens will be displayed.

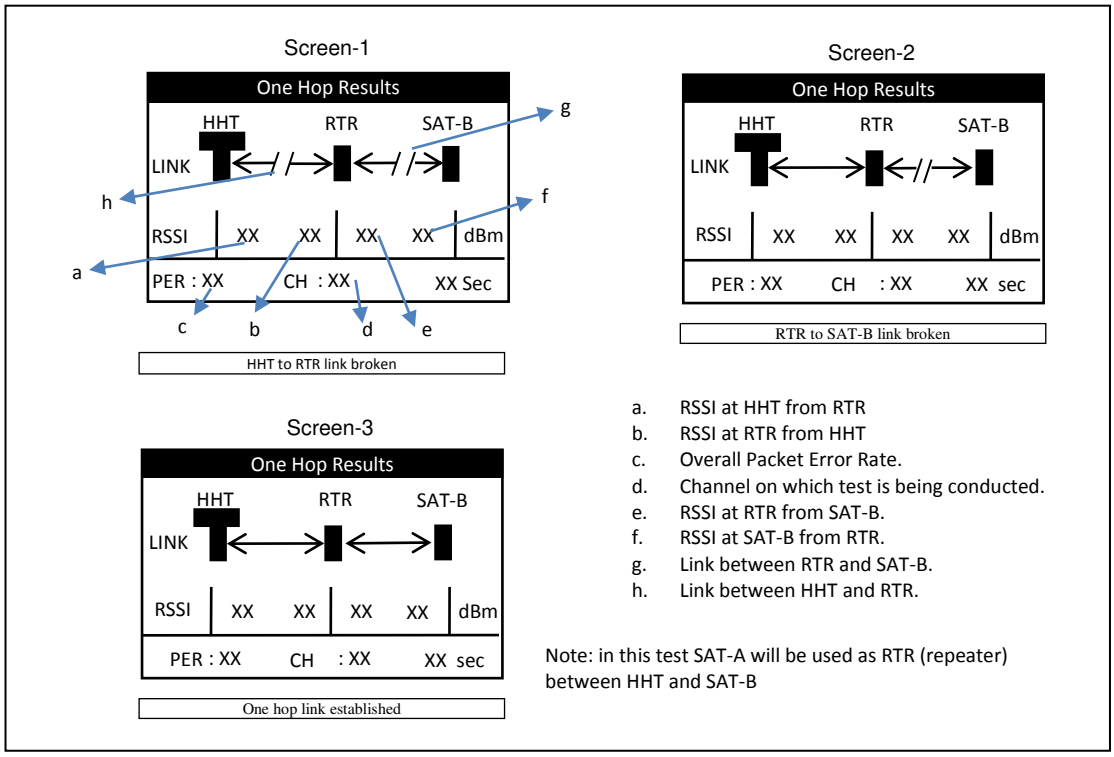



**Figure 16 One Hop Test Result Screens**

**Screen-1:**
This is the initialization state of the test when there is no one hop link established between HHT and GAS as shown in Screen-1. Initially when the devices (RTR or SAT) are out of range of the HHT or are not turned on the HHT cannot pass on the message to the GAS. Hence the link status shows a broken link between the HHT and RTR and GAS.

**Screen-2:**
The test will remain in the initialization state and periodically retry to establish the link (indicated by periodic beeps). To run the test, turn on the RTR and bring it closer to the HHT until you see Screen-2. When the HHT can communicate with RTR Screen-2 will be displayed which indicates that the link between HHT and RTR is established but the link between HHT and GAS is not established as the RTR cannot pass on the messages to the GAS. The HHT will try to continuously establish one hop link until successful when screen 3 is displayed.

**Screen-3:**
When Screen-2 appears, turn on the GAS and bring it closer to the RTR so that it can get the messages for the RTR. Once that happens Screen-3 will appear and the HHT will set the test channel on all devices and start pinging messages to GAS for the set test duration and update the RSSI values.

As the test is running the operator can move the devices to get a measure of the optimum range between devices. If any of the devices move outside the pre-configured RSSI limits or if some packets are missing the HHT will beep to indicate this and the operator can react accordingly.

To end the test press ESC key and the HHT will send a message to end the test on both RTR and GAS units. Until both units are in range the end message will not carry forward to GAS and the HHT will keep retrying which is indicated by periodic beeps on the HHT.

## Device Configurations:

### Single Satellite Configuration:

In some cases it may be necessary to run the test using only one Satellite unit. Such a situation might exist where only an electricity meter is being installed together with an IHD. In such cases it is possible to select the Satellite unit labelled IHD only to be used for test. To do so one has to go to the Home Screen and scroll to (using ⇦ and ⇨ ) item I G and press keys ⇧ or ⇩ to select between I or I G and press OK to save the setting. This setting is volatile and will revert to I G once the device is turned off.

### Configuration Settings:

The Configuration Settings are the important device settings that are used by the HHT and SAT units while performing the tests. The Telegesis Range Finder is designed to be able to simulate any actual ZigBee SE device – such as IHD's, GAS meters, ESI's etc. All these devices may operate at different power levels and may be able to operate at different RSSI thresholds in an actual SE network. The Configuration Settings menu provides the way to introduce different settings for different devices settings at the time of test.

There are 10 pre-stored device profiles that can be used by the operator on site. The values within these settings cannot be changed without inputting a PIN number which is a 4 digit code. This pass code can be restricted to authorised technicians to prevent accidental entering of incorrect parameters by the operator in the field.

The Configuration Settings screen provides options for the user to change the test parameters. The Operator can navigate through the options using ⇦ and ⇨ keys may press OK to modify a setting. The Configuration screen is shown below,

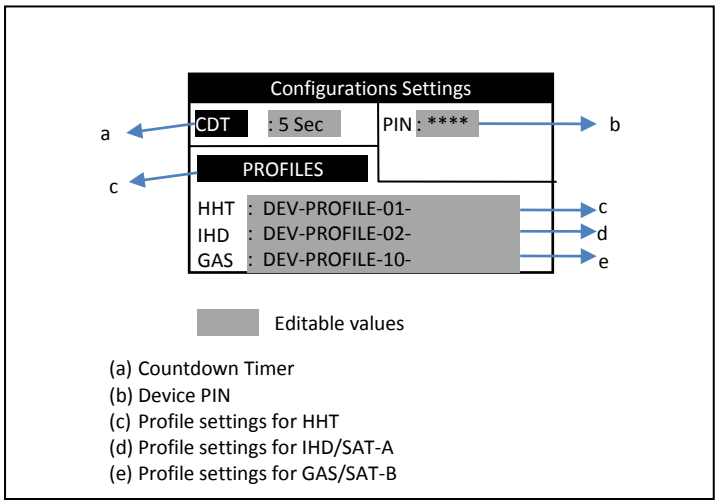



**Figure 17: Configurations Screen**

(a) The Countdown Timer value is set to a default of 5 seconds; the operator can change it to values between 10 and 120 seconds. The change made is volatile and will revert back to the default value[1] after power-off.

(b) A four digit PIN code allows access to advanced settings. The factory programmed PIN code is *1985* which can be entered using keys ⇦, ⇨, ⇧ and ⇩ and submitted using the OK key. This PIN can be reset to default or changed to a new PIN via a serial command.

(c) The Operator can select the configurations settings from previously stored settings. Memory required for 10 profiles reserved in non-volatile memory. These profiles can be edited and stored by PIN protected serial commands. To set configuration a particular settings from a particular profile and navigate to the profile for device using ⇦, ⇨, and then press OK. Then scroll through list of profile and press OK to set the device with settings from selected profile.

[1] The default CDT value can be changed in the advance configuration settings.

### Advanced Configurations Settings:

The Advance Configurations Settings Screen is visible only after entering the correct device PIN.

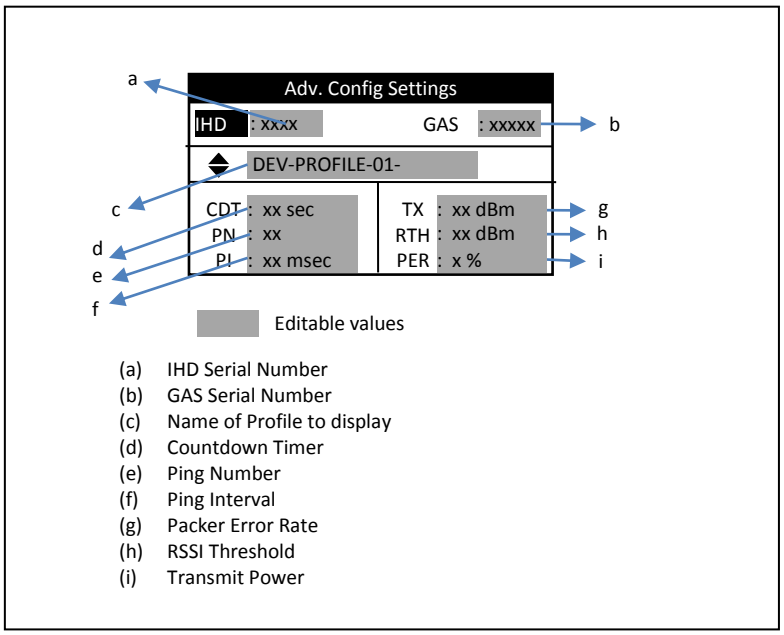



Figure 18: Advanced Configurations Screen

To display the settings of different profiles stored in the HHT navigate to the Profile section using ⇦ and ⇨ keys, then use ⇧ and ⇩ keys to scroll through the 10 profile settings stored into HHT. To change a particular parameter of the displayed profile use keys ⇦, ⇨ to navigate to the parameter and then press OK to start modifying it using keys ⇦, ⇨, ⇧ and ⇩, and press OK to save the settings. To cancel the changes while modifying press ESC. The parameters are explained below.

(a) IHD Serial: Serial number of Satellite unit labelled as IHD. Only the Satellite with matching serial number will be used in the test.
(b) GAS Serial: Serial number of Satellite unit labelled as GAS. Only the Satellite with matching serial number will be used in the test.
(c) Profile Name: Is the name of the profile out of the 10 stored profiles, whose settings are currently displayed on screen.
(d) Countdown Timer: This is the default setting of the Countdown time which is non-volatile and will be used each time the unit is turned on. The valid limit for the timer is 5 to 120 seconds.