QAM Snare Navigator Plus User Manual

QS-NAVPLUS-v1.12

January 29, 2020

This document details the functions and operation of the QAM Snare Navigator Plus leakage detector configured with firmware version **N3.70.11 and above**. Some features described in the manual may not be available in lower firmware revisions.

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Overview

The QAM Snare Navigator Plus is designed for the line technician as a find and fix tool, and can also perform leakage rideouts while the vehicle is driving around the system . When the unit is placed in the cradle, it utilizes the external whip antennas on the roof of the vehicle. Leaks are recorded real time in the database in up to three frequency bands, along with drive routes and LTE downlink signal level. When pulled from the cradle it automatically switches to the loop antenna connected to the unit, and can be used by the technician to freely move to the leak source. Since it does not utilize any ISM band communication there is no distance limit as to how far it can operate away from the vehicle. The Navigator Plus is a Wi-Fi device that requires Wi-Fi connectivity for QAM detection.

The Navigator Plus also contains OFDM, pilot and analog detector modes with buffering such that continuous communication with the server is not required. This can be used as an alternative to QAM detection in any desired band or with Remote PHY nodes.

The device will display maps of the flagged leak location and provides the user with feedback as to the flagged leak location.

Screen Navigation

The Navigator Plus keyboard has several types of buttons designed for simple navigation. Turn on the Navigator by pressing and holding the ON/OFF power button for a few seconds.

Hot keys are the four buttons located just below the display. Their function is attached to menu selection items as indicated on the display. **Navigation keys** are used to highlight required menu items and for moving markers and cursors around the screen. The **Enter button** is used to confirm a selection. **Exit button** returns to the previous menu, and in some screens the ***Back*** hot key takes you one step back in the menu.

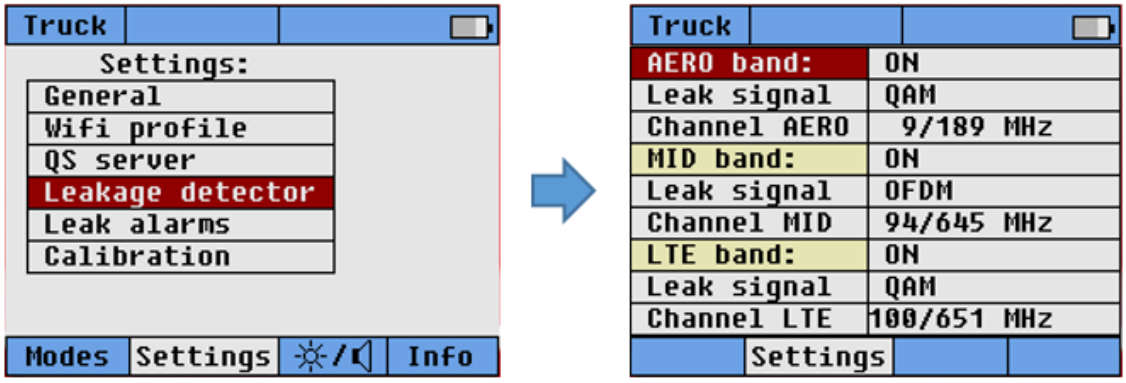
Hot Keys – correspond to the menu item immediately above each key

Navigation Keys

On/Off –

Detector Profiles

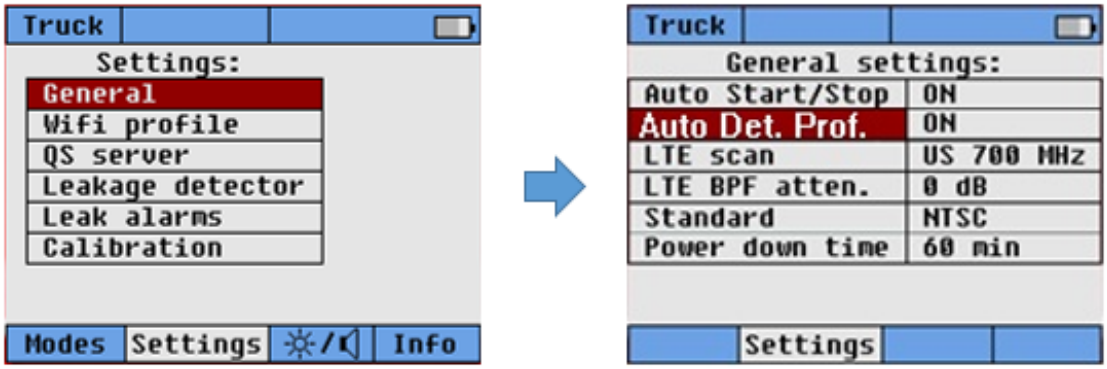
A Detection Profile is a group of signal combination settings (QAM, OFDM, Pilot or Analog) used for leak detection in the Aero, Mid and LTE bands. The Leakage Detector Profile can be found in the settings menu.



All Navigator Plus devices have at least one local Leakage Detector Profile. Firmware versions N3.15.3 through N3.35.9 have four, which the operator can preset and select as required.

With the current migration to DOCSIS 3.1, some hubs now include OFDM signals in the LTE band while lower bands still contain QAM signals. Now with the migration to Remote-PHY specification, additional switching between Analog, QAM and Pilot/QAM detection in Aero and Mid bands will be required. This has created a need for automatic configuration of detection profile when the Nav+ moves from hub to hub.

Version N3.38.9 and above contain one local detector profile, and an Auto Detection Profile. Auto Detection must be turned on in the General Settings:



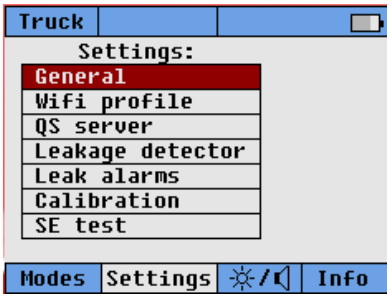
The Auto Detection Profile Server Setup requires QS Manager 7.2.1.15 or higher. With Auto Detection enabled, based on the GPS location of the Nav+ relative to hub boundaries – the server will instruct the Nav+ which detection profile and configuration it needs, and the Nav+ will switch to this profile automatically without any input from the user.

Settings

The Settings button is used to select all the various configuration options. Since the Navigator Plus does not have a keyboard, settings related to the QAM Snare server and the Wi-Fi profiles that the device attaches to **MUST** be configured through the Q-browser software program. After they are configured, if multiple servers or Wi-Fi profiles were entered, the existing profiles can be selected through the settings button.

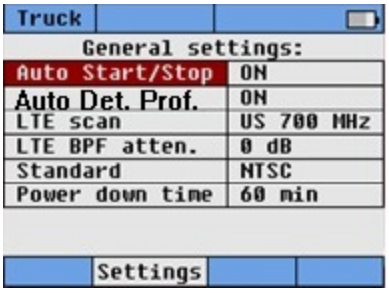
General

The General settings button provides for access to several miscellaneous configuration items which are detailed below.

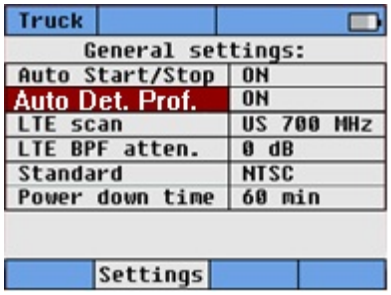


Auto Start/Stop

The Autostart on setting allows for the unit to enter Detector mode automatically when the unit is manually turned on. It will connect according to the last configured settings. This setting also controls the automatic turn off counter feature.



Auto Detector Profile

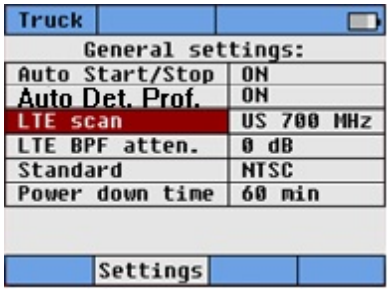


The “Auto Detect Profile” feature enables the Server to set up specific detection peramiters depending on location. When “ON” the server wil determine via GPS the location of and which Hub the NavPlus is located in, and send the Detector settings to the NavPlus for that Hub. This feature of alowing the NavPlus to be automatically set up by the server eliminates the need for a technician to select a specific detection profile for a specific Hub

The details of the detection profile are entered into the server Hub using Qam Snare Manager.

When “OFF”, the NavPlus will only use the local Detector Settings installed in the “Leakage Detector” menu.

LTE scan



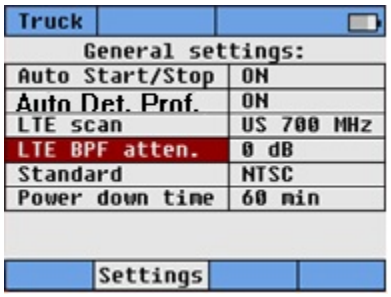
The LTE scan setting configures the LTE band in which the LTE signal strength scan is measured. In North America the setting should be US 700MHz. Other parts of the world should select either 700MHz or 800MHz to match the local LTE standard.

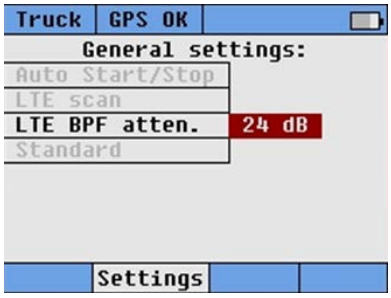
The LTE signal strength measurement is performed each second that the device operates while cradled. This information is updated into the QAM Snare database and is used to help in the prioritization of repair.

Press enter to select the LTE scan menu item, then press the right or left arrow to change the selection, then press enter to confirm.

LTE BPF

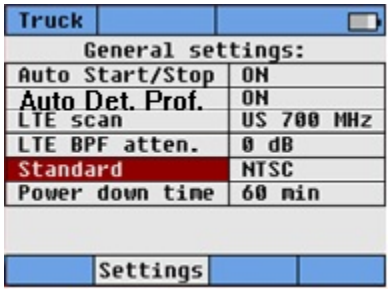
In certain installations it may be desirable to utilize an LTE pre -selector filter at the antenna combiner input to eliminate interfering signals. The LTE BPF setting compensates for the presence of the filter such that the LTE scan measurement is accurate, it essentially adds the filter loss to the scanned result. If an LTE band pass filter is utilized, this setting should be set to a value corresponding to the pre-selector filter loss. The filter loss number is labeled on the supplied filter. If a band pass filter is not utilized, the attenuation setting should be set to 0dB.

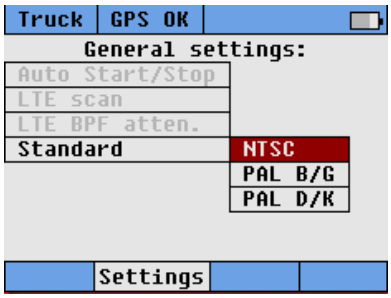




Standard

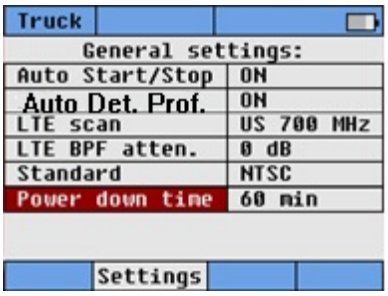
The television standard in the country it is being used is configured here. Options are NTSC, PAL B/G, and PAL D/K.

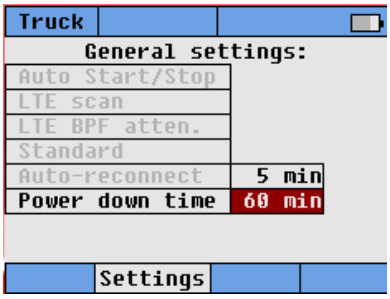




Power Down Timer

The Power Down Timer sets the amount of time the Navigator Plus will power down after the vehicle has been turned off. In order to save battery for extended use, it is highly recommended to select 5 minutes as the power down duration.



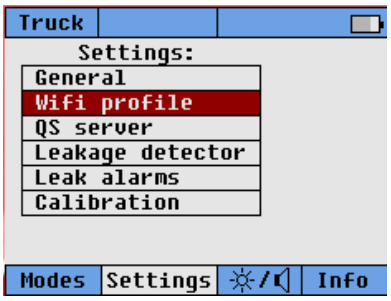


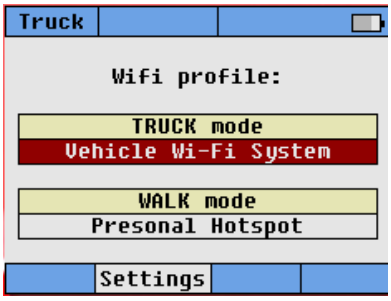
Wi-Fi Profile

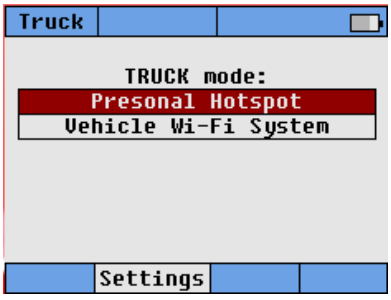
The Navigator Plus is a Wi-Fi enabled device that requires connectivity to operate in the QAM Leakage Detector Mode. Periodic connectivity is required in other modes in order to record leakage data on the server.

Profiles that were previously entered into the device through the Q-browser are selected through this menu item. Multiple profiles may be stored in device, and additionally they may be selected such that one Wi-Fi profile is used while in Truck mode (detection while driving and the Navigator Plus seated in the cradle utilizing the roof mount RF antenna(s)), and a different Wi-Fi profile is used while in Walk mode (un-cradled with the technician moving around). **If only one Wi-Fi profile was entered through the Q-browser, then it is not necessary to select Truck and Walk profiles as the will both default to the one entered profile.**

After entering a new Wi-Fi profile, power cycle the unit prior to use.





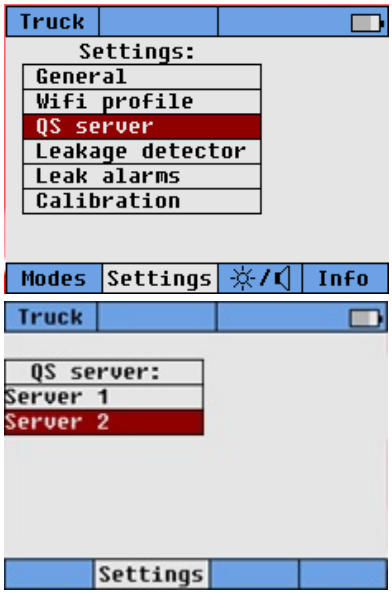


Truck and Walk Mode Wi-Fi Selection

The Truck mode (cradled) and Walk mode (uncradled) Wi-Fi profile must be selected from the list of entered profiles. They can be either the same or different from each other. If the desired profile is not displayed, use the arrow keys to scroll down the list, and press enter at the desired selection to confirm your choice. The selected profile for truck and walk mode are displayed on the screen.

QS Server

The QAM Snare Server which the device needs to connect to is selected here. Press enter and the profiles of servers previously configured through the Q-browser are displayed, with the server name displayed. To select a different server, scroll down the desired server and press enter.



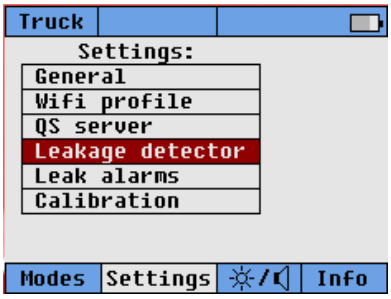
If the required server is not displayed it must be configured through the Q-browser.

Multiple server profiles would only be necessary for the technician that works in areas covering more than one server.

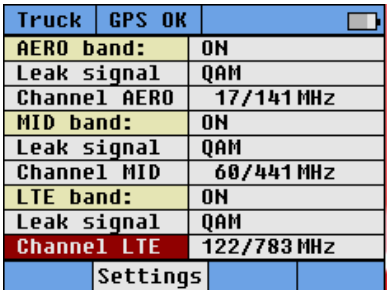
For clarification, a typical QAM Snare installation will have multiple hubs connected to one server that covers a broad area. One signal processor hardware device is required in each QAM hub, and the signal processors communicate with the QAM Snare server.

The server monitors the GPS location of each connected field device and coordinates that each device receives signal samples appropriate for the hub the field device is currently located. This setting has nothing to do with signal processors as that is managed by the server – just multiple server addresses.

Leakage Detector



Settings related to the leakage channel for detection, the type of signal to be detected, and the configuration for 1, 2, or 3 channel detection is established here. For each band, Aero, Mid, and LTE – detection for the band has to be either turned ON or OFF, the type of signal on the selected channel is specified, and the channel within the band is selected.



The Aero band has various channel and frequency setting availability:

- QAM = 14/123 MHz to 10/195 MHz.
- Analog = 14/121.25 MHz to 20/157.25 MHz + 100 MHz to 190 MHz custom adjustment.
- Pilot = 97/105 MHz to 10/195 MHz + Custom two carrier frequencies within any 6 MHz channel. (Code #8)

The Mid band is fixed to channels between 201MHz and 645MHz, and the LTE band is fixed to channels between 651MHz and 999MHz.

For the Aero band, QAM, Analog and Pilot/QAM detection are selectable options. For Mid and LTE bands, QAM, OFDM and Pilot/QAM are selectable options.

To navigate menu items, simply scroll down to the line item you wish to change, press enter, and again scroll to select the desired menu item, then press enter and the selection will be made.

Leakage Detector analog mode – frequency settings

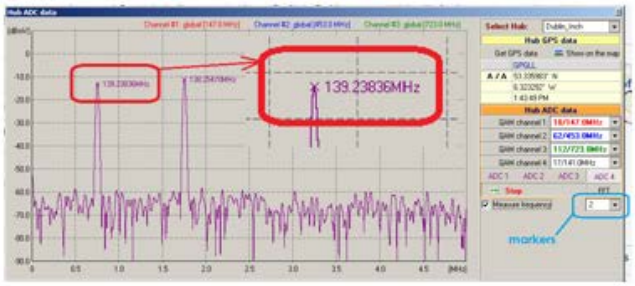
The analog signal detector mode utilizes a very fast narrow band spectrum analyzer. For proper operation, the analog carrier frequency must be within 1 kHz bandwidth relative to the nominal channel frequency. If the actual analog carrier has off-set > 1 kHz, then it is necessary to utilize a customized channel wherein any frequency with accuracy of 100Hz within Aero band can be setup. **This customized channel option is accessed at the very bottom of the Aero band channel list**. Before setting the required frequency into the Navigator Plus, it has to first be precisely measured using the tools in the QAM Snare Manager's Hub Signals viewer.

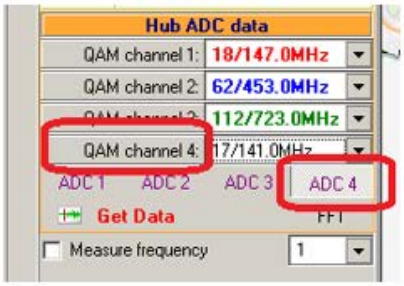
For measuring frequency select the hub site, then select the channel frequency and activate the corresponding ADC.

Then click Get Data and watch the signal in FFT mode. Activate 'Measure frequency' once the signal spectrum is visible with peaks, and the marker should automatically jump to the highest peak.

When there is more than one peak on the screen, use additional markers that are selectable from the pull-down menu.

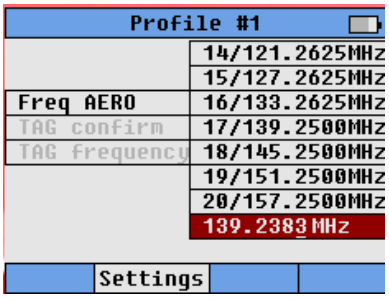
Note: when you switch to view other hub site signals, you must again select the QAM channel for measuring frequency or the displayed signal will not be valid.



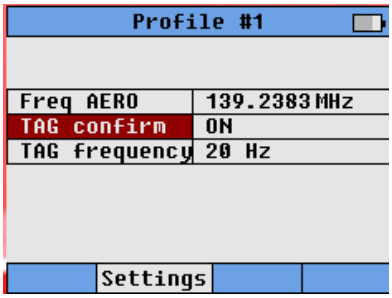


After reading the required precise frequency number, please write it down. This will be the frequency that must be entered into the customized channel settings on the meter.

When signal tagging is used, it can be activated by turning ON the TAG confirm item on the settings screen. TAG frequency must match the frequency that is actually being used for tagging.

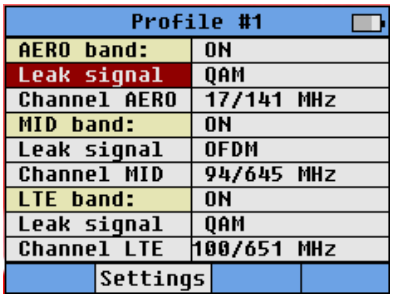


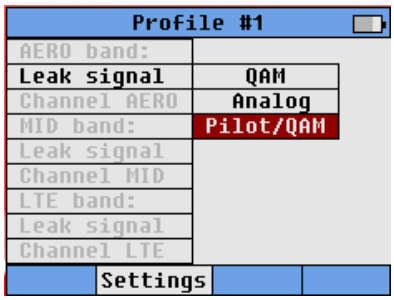
TAG doesn't have to be used. However, using TAG will help minimize false detections.

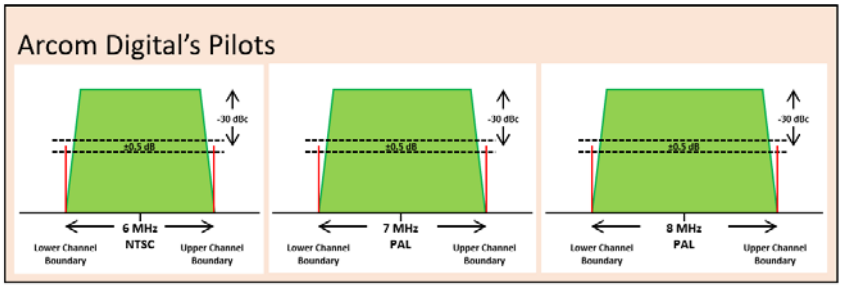


Leakage Detector Pilot/QAM mode detector settings

The Pilot/QAM feature is used to detect a leakage test signal comprised of a pair of low-level CW carriers separated by 6 MHz, with one of the carriers injected at the channel boundary on the lower edge of the Single Carrier QAM (SC-QAM) signal, and the second CW carrier injected at the channel boundary on the upper edge of the same SC-QAM signal. The Pilot/QAM carriers are precisely placed at the QAM band edge, ± 5 kHz for NTSC and PAL standards. This setting is typically utilized in Remote-PHY systems.

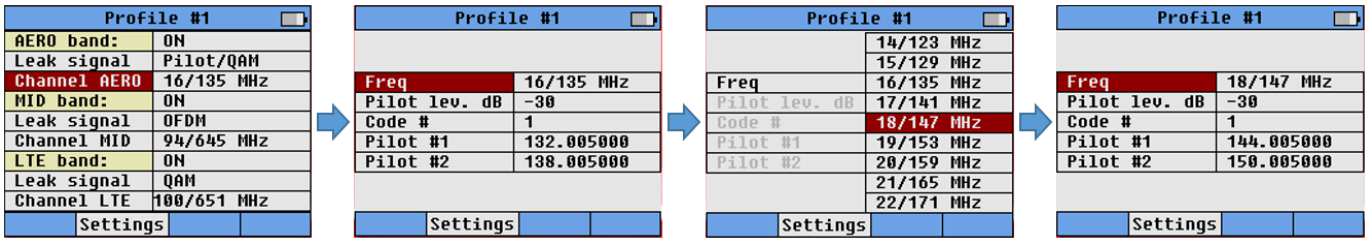






Leakage Detector Pilot/QAM mode Channel and Frequency Selection

Once Pilot/QAM mode has been selected it is necessary adjust frequency and level parameters for detection. Using the Arrows and Enter keys, select “Channel AERO” or “Channel MID” and press Enter. With the cursor at “Freq”, press Enter and select the desired leakage detection channel. Press Enter again and you will see the channel you selected, Pilot Level, and Frequency code.



Once Pilot/QAM mode has been selected it is necessary adjust the Detection Code# and level parameters for detection.

Arcom Pilot/QAM Code

To setup specific pilot frequencies the Navigator Plus presents codes for the operator to select a desired pair of frequencies. Use the Arrows and Enter keys to select “Channel AERO”, “Channel MID” or Channel “LTE” and press Enter. With the cursor at “Freq”, press Enter and select the desired leakage detection channel. Press Enter again and you will see the channel you selected, Pilot Level, and Frequency code.

There are four possible channel codes for every detection channel used by Arcom, intended to provide flexibility in overbuild situations. Table 1 illustrates the frequencies associate with each code. To select the desired code, simply select Code# and use the Up and Down arrows to select the desired frequency code.

Table 1: Code # vs Arcom Pilot Carrier Frequencies

Code #	Pilot 1, MHz	Pilot 2, MHz
1	F1 + 0.005	F2 + 0.005
2	F1 – 0.005	F2 – 0.005
3	F1 + 0.005	F2 – 0.005
4	F1 – 0.005	F2 + 0.005
F1 and F2 = SC-QAM band edge frequencies		

Detecting ComSonics Pilots

A Navigator Plus with firmware version N3.70 and above features additional codes and settings for use with pilots from other manufacturers. For convenience, Arcom has included three codes for ComSonics test pilots. An additional code that is configurable for any two pilot frequencies within a standard 6-MHz channel. Table 2 illustrates codes used for ComSonics carriers.

Table 2: Code # vs ComSonics Pilot Carrier Frequencies

Code #	AERO & MID Pilot 1, (MHz)	AERO & MID Pilot 2, (MHz)	LTE Pilot 2, (MHz)	LTE Pilot 2, (MHz)
5	F-0.001131	F+0.001131	F-0.001283	F+0.001283
6	F-0.001432	F+0.001432	F-0.001511	F+0.001511
7	F-0.001809	F+0.001809	F-0.001663	F+0.001663
F = the Lower SC-QAM band edge frequency				

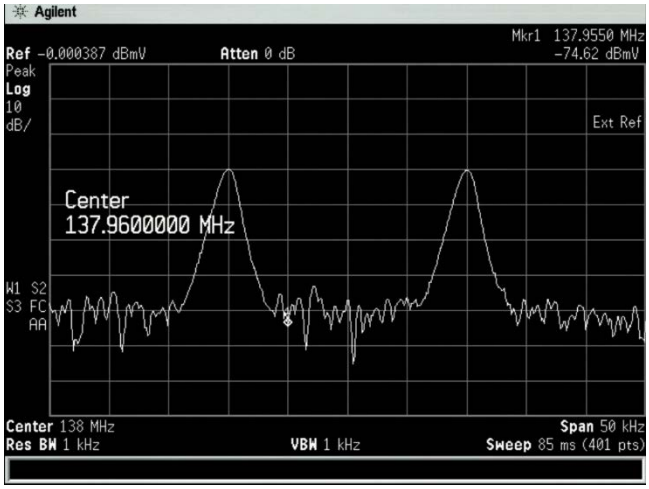
ComSonics typically uses only the channel 17 Lower band edge frequency (138 MHz) and channel 89 lower band edge frequency (612 MHz).

ComSonics specifies the frequency ranges 136.5 – 138.5 MHz and 607 – 615 MHz can be used. Code #8 must be used to detect ComSonics pilots outside of Table 2.

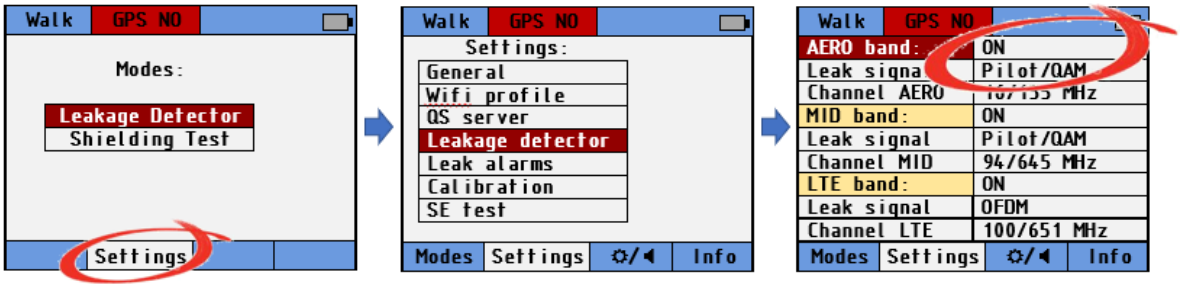
Code #8, Detecting any two pilot carriers within a 6-MHz channel.

The Arcom Digital Navigator Plus Firmware Revision N3.70 and above offer the ability to detect any two carriers CW a minimum of 2KHz apart. However, Arcom is recommending not to use carriers less than 20 KHz apart for leakage detection. frequency accuracy must be within ±5ppm, and frequency separation resolution should be <100Hz. Pilot carriers must be present within a ±3.005 MHz Bandwidth of an NTSC channel center frequency.

The illustration below shows two pilot carriers 20 KHz apart, 137.960 MHz ±10 KHz, at 137.950 MHz & 137.970 MHz, at a level of -30 dBmV. (equivalent to 0 dBmV QAM).

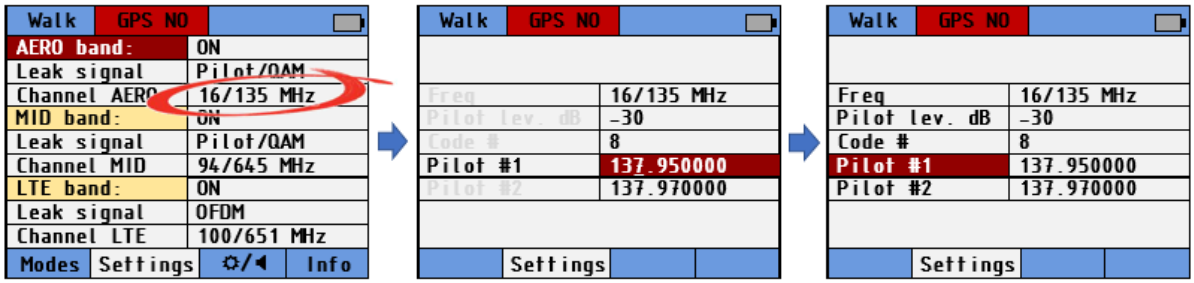


As described above the Pilot/QAM detector utilizes seven codes to set the detector for fixed pilot frequency detection. An eighth code is available for custom setup. To detect carriers like this, use the soft buttons and keypad to select Settings/Leakage detector, then turn the AERO band detection ON and select Pilot/QAM Leak signal.



It is important to select a detection channel where the carriers reside. In our example the pilot carriers are within EIA channel 16.

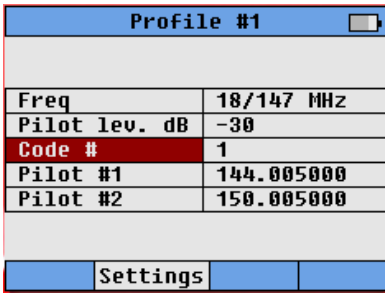
First set Channel AERO to 16/135 MHz. Next select Code# 8. Then use the Arrow keys and Enter button to install the precise frequencies of the carriers to detect. In this case we installed 137.950000 MHz for Pilot #1, and 137.970000 MHz for Pilot #2.



Finally, press the EXIT button to return to the band select screen

Leakage Detector Pilot/QAM mode Level

As illustrated to the right of the table above, you will see the Pilot carriers are set -30 dBc relative to the peak of QAM. Although the carrier levels are typically -30 dBc, the actual levels can be set throughout a range of -20 to -35 dBc The Navigator Plus Pilot/QAM detector setting must match the transmitted level to display accurate detection levels.

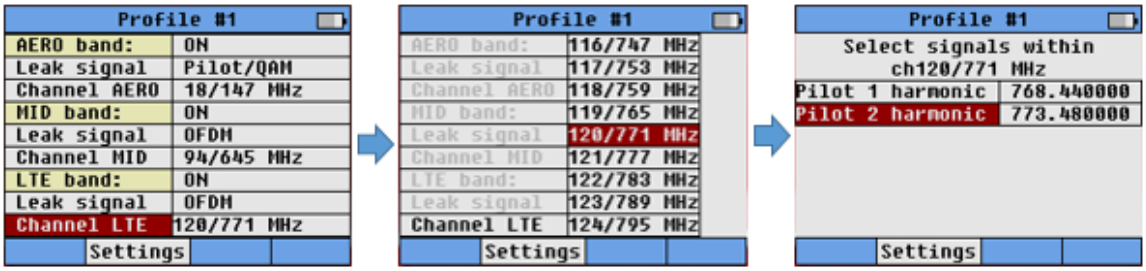


To set this level simply select Pilot level and use the Up and Down arrows to select the desired level relative to the QAM channel.

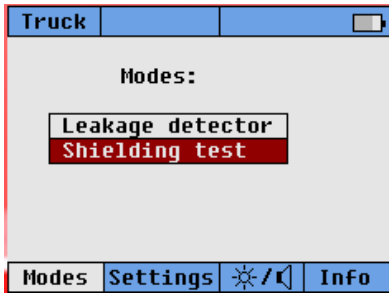
Leakage Detector OFDM mode detector settings

The QAM Snare Navigator detects leakage by detecting two specific pilots within a 6 MHz band of a OFDM spectrum. Because the continuous pilots are at precise frequencies the can be used as test signal tagging to separate legacy singles, overbuilds and to avoid false leak detection. The precise frequencies of the pilots being used for detection must be known prior to Nav Plus setup.

After selecting OFDM in the band of interest, highlight "Channel MID" or "Channel LTE" and press the Enter button. Next select the 6 MHz channel of interest. Next, enter the precise frequencies of Pilot #1 and Pilot #2 in that 6 MHz band.



Shielding Test mode



To quickly and easily troubleshoot difficult ingress problems in the home, the Nav+ is able to operate as a Shielding Efficiency (SE) detector. Operation in this mode requires the use of a QAM Snare Pilot transmitter device.

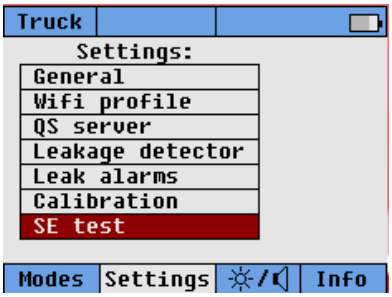
The transmitter is connected at the grounding block in place of the home coax feed (the home is disconnected from the cable network when the transmitter is used) or at the tap. The transmitter places a high level, easy to find signal at the frequency which is programmed into the transmitter when setting up. The process of how to configure the transmitter is described in a later section of this manual. Shielding Test Pilots can be used in either the LOW band, LTE band, or both.

The Pilot Transmitter generates two carriers in each band at frequencies equivalent to the Pilot/QAM detection scheme described above at one selectable channel in each

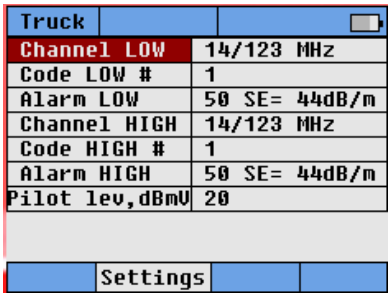
of the LOW and MID bands. Other manufacturers refer to this technique as 'Pressure Testing'.

Shielding Test Channels

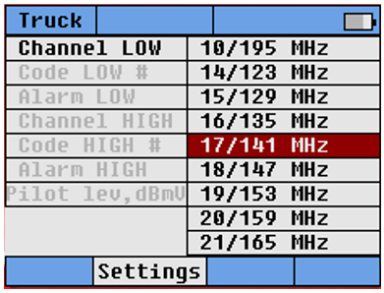
This process configures both the Nav+, and the Pilot TX transmitter. Later we will describe how to configure the Pilot TX using the Navigator Plus.



To configure the Shielding Test, navigate to the setting "SE TEST" option and press enter. Configure the desired Low and High band channels, Shielding Test Code, and Pilot Level.

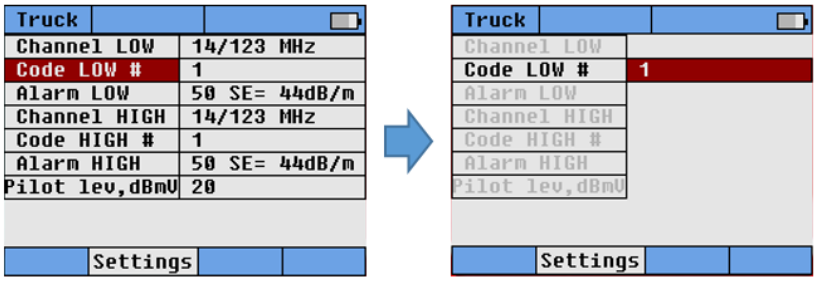


For Low Band, select a single channel between Ch14, 123 MHz, and Ch10, 195 MHz. For High Band, select a single channel between Ch29, 255 MHz, and Ch158, 999 MHz



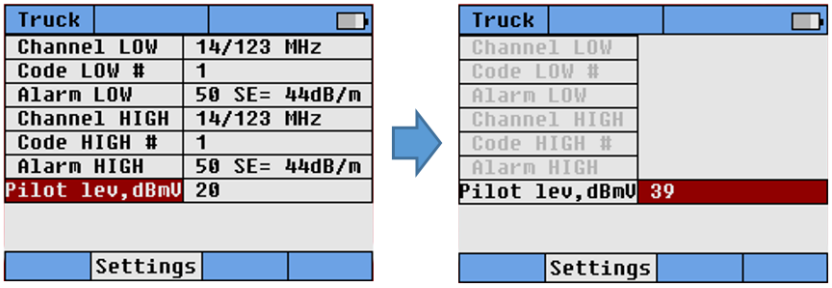
Shielding Test Code

Select the desired Code (as described in Leakage Detector Pilot/QAM mode Code # Table I above).



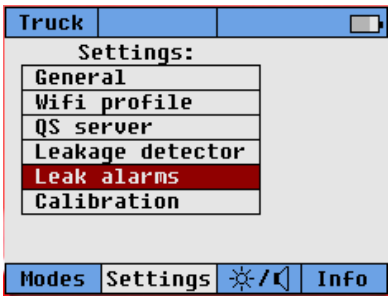
Pilot Level

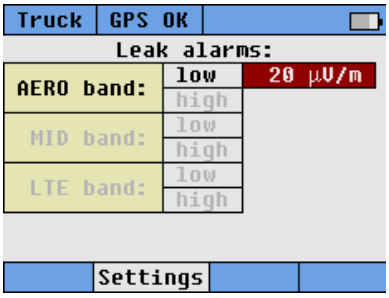
The Transmitter RF output level is +46 dBmV, but there are many scenarios where the test pilot signal level will be lower. For example, if a splitter is connected after the grounding block, the transmitter signal will be attenuated 7 to 8 dB. So, an adjustment to the receiver will be necessary. Assuming the splitter is 3 or 4-way, the Test Pilot RF output of the splitter will be +39 dBmV. In this situation the Nav+ Pilot Level setting should be set to +39 dBmV. (+46 dBmV pilot out – 7.5 dB splitter attenuation).

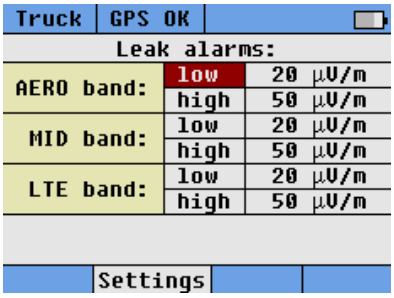


Leak Alarms

The Navigator Plus can be configured to provide low and high-level audio alarms based upon the amplitude of the detected leak, for all three bands of operation. The alarm is based upon the leak level at the detector, until the point in which the server calculates the leak GPS coordinates and scales to the 10-ft. equivalent. After the leak has been located the device alarms based upon the actual leak level. To change the setting, scroll to Leak alarms and press enter. The scroll to the low or high value alarm in the Aero, Mid, or LTE band that you want to change, then press enter and use the up or down arrow key to increment or decrement the selection. Pressing and holding the arrow button will more rapidly increment or decrement the selection. Press enter to confirm selection and return to previous menu item.

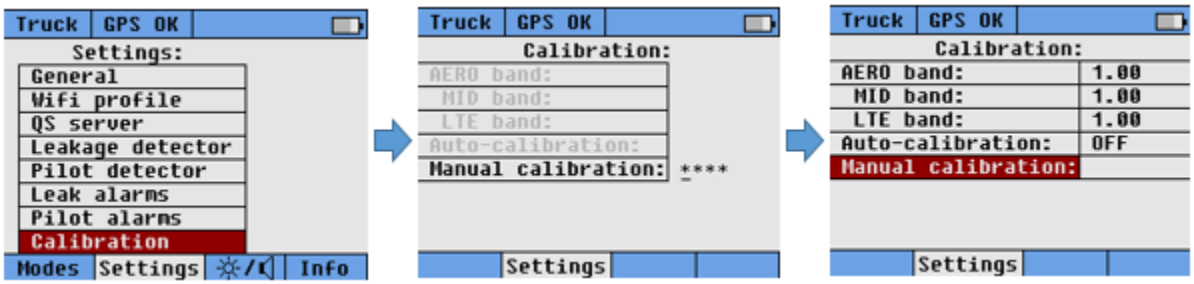






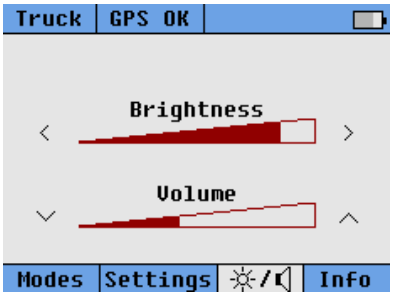
Calibration

The calibration setting is used to normalize the setup to a known leak, and to compensate for antenna variations, antenna placement, and insertion losses from cables, pre-selector filters, and the antenna and GPS combiners. Changes to calibration are password protected, and should only be performed by users familiar with the process



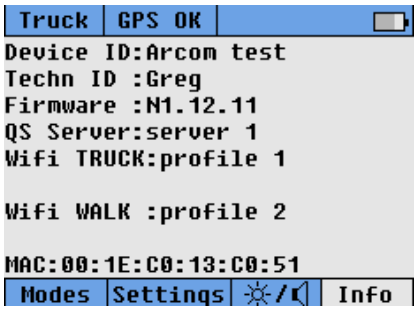
Display brightness and volume adjustment Hot key

This Hot key allows for the display brightness to be adjusted and for the alarm and button click volume to be turned up or down or Off. The left and right arrow keys control the screen brightness, and the up and down arrow keys control the volume. The lowest volume setting is Off, at which time the visual speaker icon on the Hot key will be crossed out.



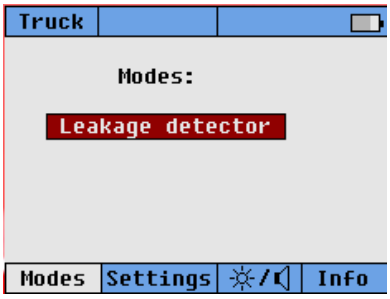
Information Hot Key

The Information selection item provide the user with information on the Device and Technician ID that was assigned to the unit through Q-browser, it provides information on the Firmware revision, the QAM Snare Server name it is configured to connect to, the configured Wi-Fi SSID name for both Walk and Truck mode, and the device MAC address. For security reasons, the Wi-Fi passwords are not displayed.



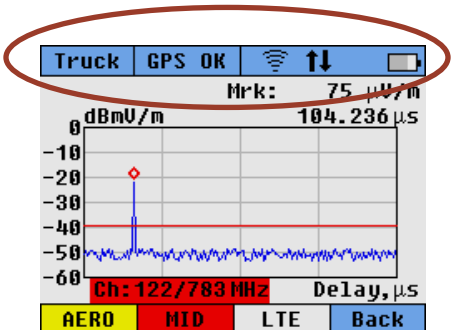
Modes Hot Key

This is the default screen when the device is initially turned on (with Auto-start disabled). Here the user can activate the Leakage detector mode.



Status Indications

On the top banner portion of the screens, information is provided as to status of the device. From the left to right the following indications are provided as described below.



Truck or Walk mode indicator

Truck When the detector is firmly seated in a powered cradle, the device is in Truck mode. When it is pulled from the cradle or power is removed from the cradle it is in Walk mode. Walk

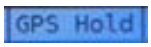
GPS status indicator

There are five possible GPS conditions that can be indicated on the screen:

GPS NO This is the condition the unit is in when it is initially turned on and the unit is waiting for GPS lock. This condition is indicated by a red box to highlight that there is no GPS lock. Leak detection in QAM detector mode is not possible when there is no GPS lock, the device needs to wait until a signal is acquired. It may take a few minutes to get lock, which is typical for modern GPS receivers. The time to get lock may vary each time it connects.

After GPS lock is acquired it will go into GPS Sync mode highlighted in yellow. GPS Sync mode will stay for 60 seconds, which provide sufficient time to ensure a good stable GPS signal so the unit can be used for extended time in walk mode. When GPS Sync is displayed, the unit will operate in truck mode, but if the user attempts to pull from the cradle it will revert to GPS No and will not enter detector mode. The yellow indicator provides feedback to the user to wait before pulling from the cradle.

After the 60 seconds of GPS Sync, the indicator will change to GPS OK. In this condition truck mode is operational and it is also ready to pull from the cradle and enter walk mode.



This indicator is displayed when the unit is pulled from the cradle when entering walk mode. It will stay in this condition while out of the cradle.

GPS is not required when the Navigator is in Walk mode, **and** no QAM channel has been selected in the active Detector Profile. In this case the GPS status indicator will be blank.

Wi-Fi indicator

When the Navigator Plus is connected to a Wi-Fi hotspot, the Wi-Fi indicator is illuminated. The does not indication connection with the server, just the hot spot. Even during times where a wireless signal is not present, the Navigator will still remain actively connected to the hotspot. If Wi-Fi connection is lost the device will continuously attempt to reconnect – let the device do its job in reconnecting before attempting to troubleshoot.

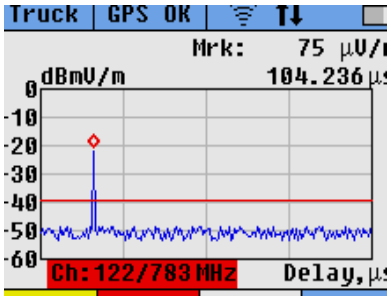
Connection with Server

When the Navigator Plus establishes connection with the QAM Snare server and data is being sent from the server to the device, the Server communication icon will flash every second. A solid icon indicates no communication. If the device loses connection it will continuously attempt to reconnect – let the device do its job in reconnecting before attempting to troubleshoot.

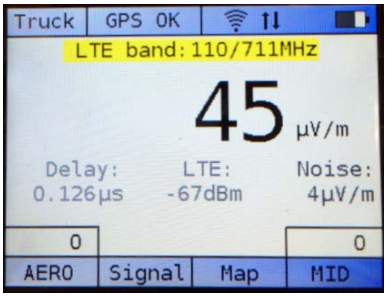
Leakage Detector Mode

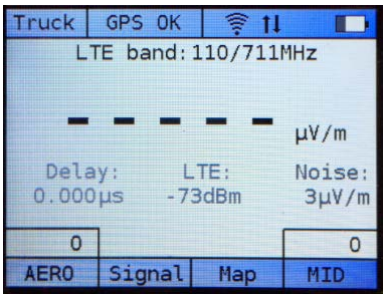
To enter Leakage detector mode, select the “Modes” Hotkey and press the Enter Button. The device will go through its connection sequence and connect to the Wi-Fi network and then connect to the server – and then leakage detection will begin. In the leakage detector mode, the Navigator Plus has the ability to simultaneously detect leaks at three channels, one each within the aeronautic, the mid, and the LTE bands as defined in the QAM Snare Manager program.

While cradled, the detector displays the leak level as measured at the corresponding RF antenna installed on the roof of the vehicle. Every second, data on detected leaks, delay information on detected leaks, GPS coordinates of the vehicle, and measured LTE signal level is transmitted to the QAM Snare Server. If a leak is detected, the Server will calculate the GPS coordinates of the leak using a sophisticated Time Difference of Arrival (TDOA) algorithm and update the leak database with the leak location and the calculated 10 ft. leak level. This same information on the calculated leak level is transmitted back to the field detector – which uses this calculated level information for the audio alarms that provide technician feedback when leaks are detected. Alarming on calculated actual leak level instead of simply detected level is a big-time saver by if automatic fix rules are established in that the user immediately knows when they are driving by large leak. The necessity of driving back to a leak is eliminated. The two alarms thresholds for audio indication are configured through settings.



Leak Level Display Screen



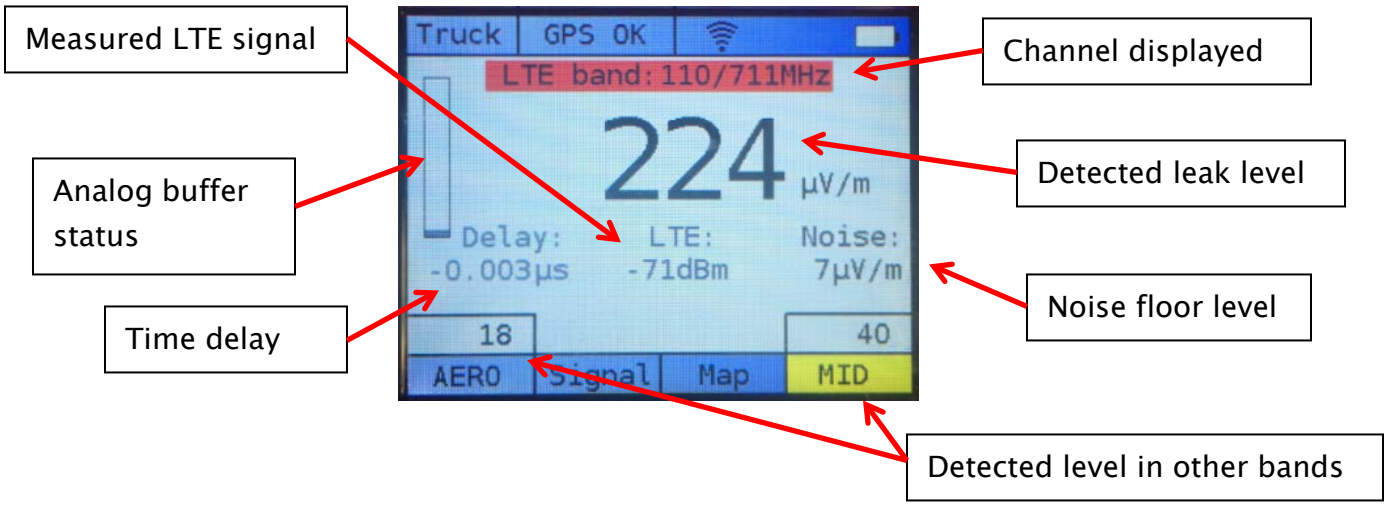


The default leakage detector screen will prominently display the detected level in the selected band. The screens will appear slightly different depending upon if analog aeronautical band detection was selected, and depending upon configured number of channels. When no leakage is detected on a channel, a series of dashes will be displayed, and will blink every second as an indication that data is being received from the server. The channel currently being displayed is written prominently above the leak level indicator. As leaks are detected that are above the alarm thresholds, the color of the band indicator will switch to yellow or red corresponding to low or high-level alarms. Detected leaks in the other two bands (if selected for detection) are also displayed in the bottom right and left portion of the screen. To switch the main display to these bands, simply press the corresponding hot key immediately below the band description.

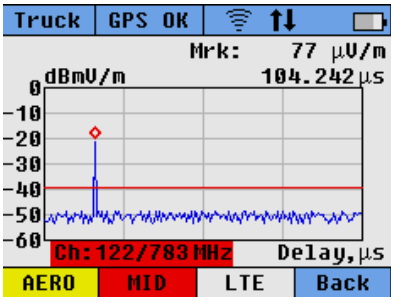
Underneath the main leak level indicator portion of the screen is information on the time delay of the detected leak, information on detected LTE signal level, as well as an indication of the device noise floor.

Information displayed on leak level screen

The leak level screen contains significant information. Most prominently displayed is the detected level in large font. When no leak is currently detected, a series of dashes are indicated. Directly above the leak indication is the channel the display is indicating. This indication will change color to yellow when the detected level reaches the configured low alarm threshold, and will become red when detected level reaches the high alarm threshold. Also indicated are time delay, LTE level, detector noise floor level, detection in other bands if so configured, and analog buffer status which will only be displayed if the device is configured for analog aeronautical band detection.



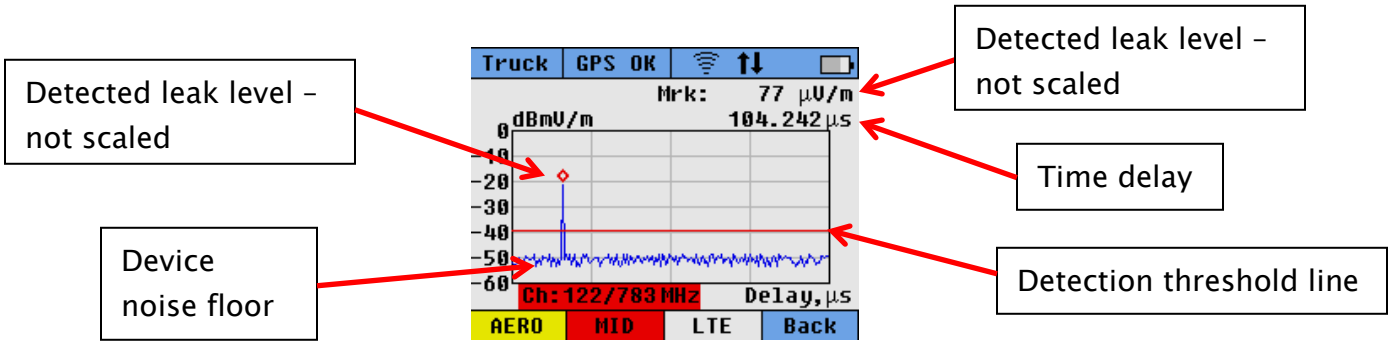
Signal View



The Signal view screen displays the correlation function and shows a graphic representation of a detected QAM signal. To enter the Signal view mode, press the hot key immediately below the Signal box. The red horizontal line is a threshold indicator, and when the correlator response increases above this threshold line, leakage is recorded. In order to exit from this mode, you must press the hot key under the box labeled as Back. To view the Signal of other channels, press the hot key under the corresponding box. Signal view is not available for an analog channel.

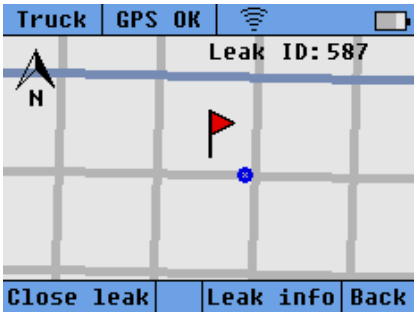
Information displayed on signal view screen

The signal view screen provides quite a bit of information. The screen itself represent the correlation function output – with a peak above the red threshold line indicating leakage being detected. The graphic representation displays time delay on the x axis and detected signal level in dBmV/m on the y axis. The peak level of the correlation function contains a marker – and the equivalent level of the marker displayed in the more familiar µV/m is displayed on the top right portion of the screen. Below the marker signal level indicator is an indication of the time delay for the leak. The bottom portion of the screen provides information on bands in which leakage is being detected. The band displayed in white corresponds to the band currently being displayed – in this chase channel 122 in the LTE band. The colors of the other bands will changed based upon the leakage currently being detected in that band relative to the alarm threshold entered in the device. Yellow is an indication of a low level alarm and red is an indication of a high level alarm



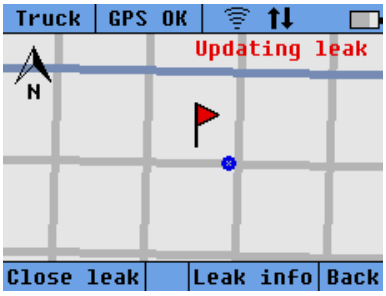
The signal view screen when the device is in walk mode is slightly different. No time delay indication is provided, and the device noise floor is displayed as a flat line that changes with the expected slight fluctuation in average level every second.

Map View



Map view is available by pressing the hot key under the Map box on the main leakage detector screen. Maps are not stored locally on the Navigator Plus, they are stored on the server. When a leak is detected, the server sends the corresponding map to the Navigator Plus, with a flag indicating the GSP coordinates of the leak. The vehicle position on the map is indicated with a blue circle that moves when the vehicle is moving within the map display area. The previous map view will remain on the screen until a new leak is detected, at which point the new map is displayed. Maps are always displayed with the orientation of North at the top of the display. To exit Map view, press the hot key underneath the Back text.

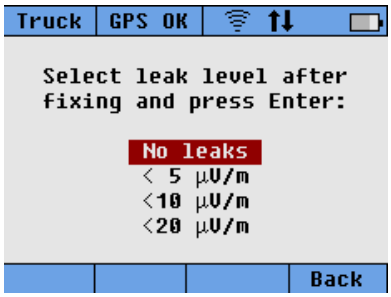
Updating leak



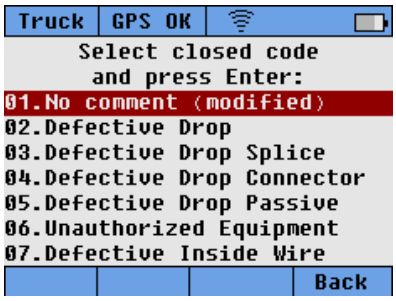
When the vehicle is in proximity to the flagged location, the display will indicate the words ‘Updating leak’. This is because new detection data is being used to further refine the leak location. When the vehicle moves far away from the location, information on the leak ID # will replace the updating leak message.

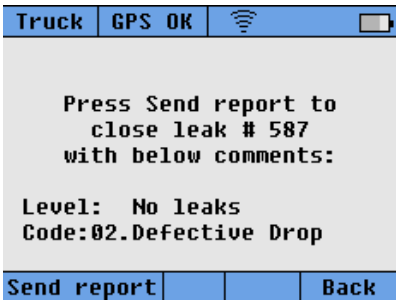
Close leak

Leaks can be closed directly from the Navigator Plus, by pressing the hot key below the Close leak box.



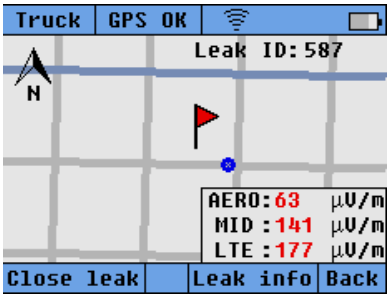
Closing a leak when the Updating leak message is displayed is however not possible, because the leak is still being updated. Options are to either drive away from the leak until the leak ID is displayed, and then closing it – or to pull the unit from the cradle such that you enter Walk mode (which also has the effect of halting the updating leak process). After pressing the Close leak hot button, two screens will appear where you can add information about remaining leak level and information on the problem found for the leak in the form of a close code. Close codes are entered or edited using the QAM Snare Manager program and are transmitted to the device on startup on occasions when the close codes have changed. After entering this information you need to press the Send report hot key in order to send the information to the QAM Snare server.





Leak info

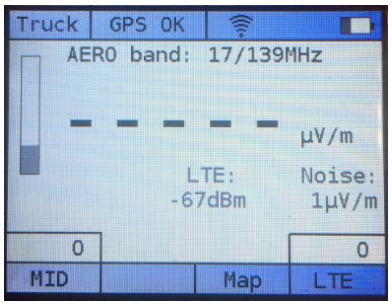
More detailed information about the leak can be found by pressing the hot key under the Leak info text.

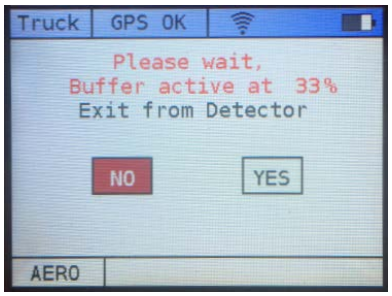


Analog, Pilot/QAM and OFDM Leakage Detector Mode – Buffering

When operating in analog Pilot/QAM, or OFDM mode, continuous communication with the server is not required, and as the vehicle passes through areas with no coverage, the leakage data as well as drive-path coordinates will be buffered. In the background the device will continuously attempt to reconnect to the network, and after it does so the buffer will quickly be dumped to the server. When analog mode is selected, the Leak level display screen for all channels will show a buffer indicator in the form of a vertical rectangle. Normally just the buffer rectangular outline will be displayed, indicating an empty buffer. As the buffer is filled the indicator will rise from the bottom.

In analog detector mode, no time delay information is displayed and the Signal view screen is not available.

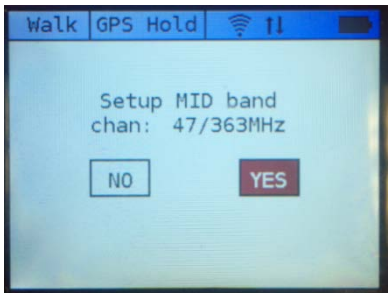




Detector Walk Mode

When the device is removed from the cradle, it will automatically go into walk mode. If the device is configured to utilize a different Wi-Fi network for Walk mode, it will ask the user if it should switch to the Walk mode network – if yes it will switch to that network, and if no it will stay connected to the truck network. If the leak is close to the vehicle, then there is no reason to switch and the truck Wi-Fi can be used.

When in Walk mode, the detector will only detect leaks on the one channel that is shown on the display. In the example to the right, the detected leak is measured on the aeronautical band channel 16, centered at 133 MHz. In Walk Mode the detection process is performed two times per second.



To switch to a different channel, press the hot key corresponding to the new band you would like to select. The device will ask for confirmation that the channel switch is desired – press the enter button to confirm.

When the device is in Walk Mode, no data regarding leak level or GPS coordinates is forwarded to the leakage database.

Walk mode timer

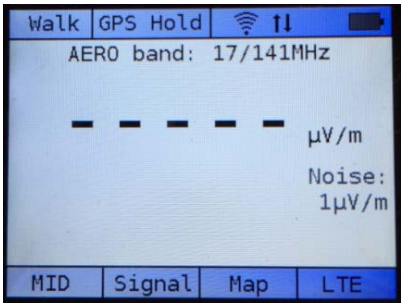
The Navigator Plus contains a 100-minute counter for walk mode. This is a battery saving feature to make sure the unit is not left in the correlator mode for extended time period inadvertently. After 100 minutes the unit will exit detector mode and the GPS indicator will change to GPS No. The unit needs to be re-cradled and get to the GPS OK state before it can be used again in walk mode.

Leakage Display Level Indicator

When in Walk mode, the detector performs a leakage level calculation two times per second. This sampling is too fast to change the display indicator for every calculation, therefore peak hold techniques are utilized.

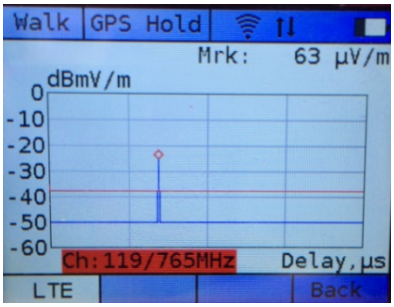
The Navigator Plus leak display shows the peak level detected over the previous two seconds.

When no leakage has been detected within the last two seconds, a dash display is indicated.



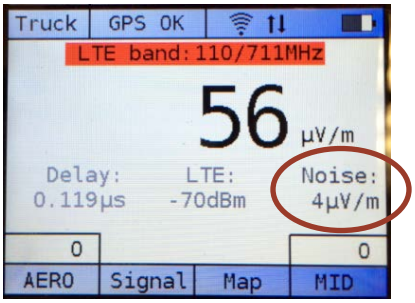
Walk mode signal view

When in walk mode, the Signal view correlator response is available for detected QAM channels. It is not available for analog channels. When in walk mode the time delay indicator is not available and noise floor is shown as a flat line.



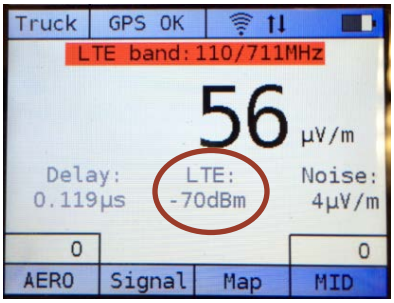
To exit signal view mode, press the Back hot key button.

Noise Floor Level Indication



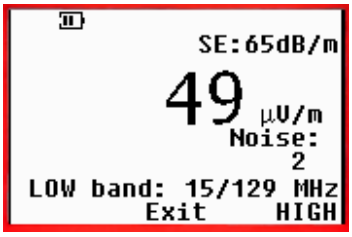
The Navigator Plus contains an indicator that provides feedback as to the device noise floor. The noise floor of the instrument will vary depending upon other off-air signals it is subject to. The lower the noise floor, the lower level leak the Navigator will be able to detect. This number would correspond to a noise floor level of -60dBmV/m using the convention employed in the Navigator.

LTE Level Indication



An important part of QAM Snare which is used to help prioritize repair of detected leaks is the LTE signal level indicator. The QAM Snare correlation detection process is performed in fractions of a second. In the time interval when the device is not correlating, the tuner jumps to the LTE downlink and public safety frequencies, and makes a measurement of peak signal level within this band. This information is then updated to the database each second, and attached to the leak as part of the information used for prioritization. The detected LTE level is displayed in the upper right portion of the screen when the device is cradled. When the device is removed from the cradle, neither the LTE level nor the detected leak level is updated to the database – and LTE level is not displayed on the screen when in walk mode.

Detector Mode – Shielding Test



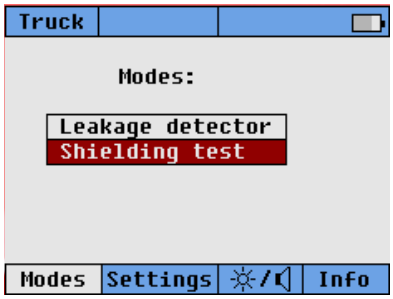
When the detector is put into Shielding Test mode, it detects the signals output by the companion QAM Snare Pilot Transmitter. As described in this manual, the Pilot Transmitter must be programmed by the Nav+ to operate at the frequency for which the Pilit Transmitter is configured. The Nav+ can be configured as a pilot detector to operate at either the aeronautical band and/or the LTE band.

The user must ensure that the proper antenna is used for each band. Make sure you program the Transmitter and Receiver frequencies for the antennas you have available.

The Pilot mode requires neither Wi-Fi connectivity nor GPS connectivity. When the detector is in Pilot mode – for clarity, the words "SE Test" will continuously flash on the upper left corner of the screen.

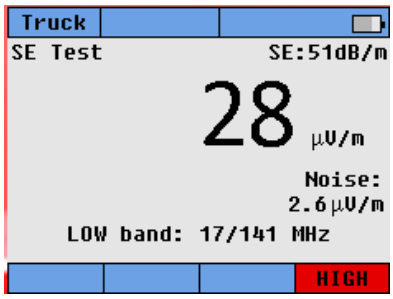
Screen navigation in Shielding Test mode

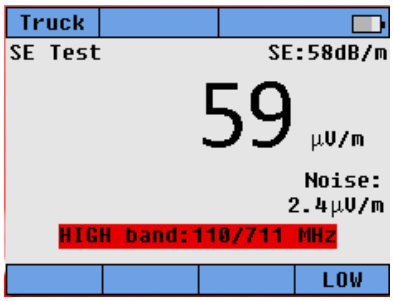
The Nav+ Shielding Test detector is configured for operation in both the LTE and AERO bands. The right arrow button is used to conveniently switch the display between the two frequencies. Remember that when switching, the antenna must also be switched – if a dual band antenna is not being utilized.



The device is capable of simultaneous detection at the two frequencies, and will provide an audio alarm if the detected level exceeds the configured threshold settings at either of the bands. If a leak is detected at the band not being currently displayed in the screen, the second band indication at the lower right portion of the screen will flash, along with the audio alarm.

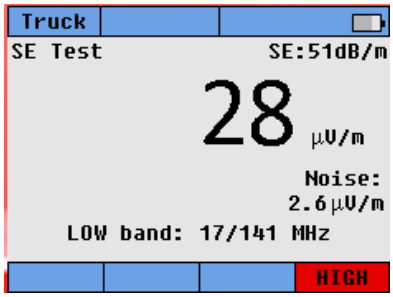
To switch the display to a different band, press Hot-Key underneath the designed band





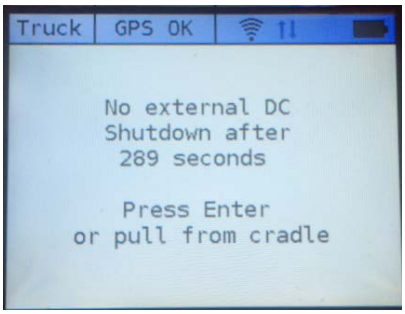
Shielding effectiveness indication

When in Shielding detector mode, along with the detected leak level – the equivalent shielding effectiveness of the leak will be displayed in the upper right corner. This indication may be used by the technician as a sort of home certification metric. The SE and indicated leak level are both normalized to remove the extra signal level from the inserted pilot carrier.



Auto Shutdown Counter

When Auto Start/Stop is enabled – when power is removed from the device while cradled, depending on the shutdown configuration, the unit will begin either a five-minute or 60-minute countdown to shut down the device. No action is required of the user, the message is informational. To stop the countdown and use the device, press enter.

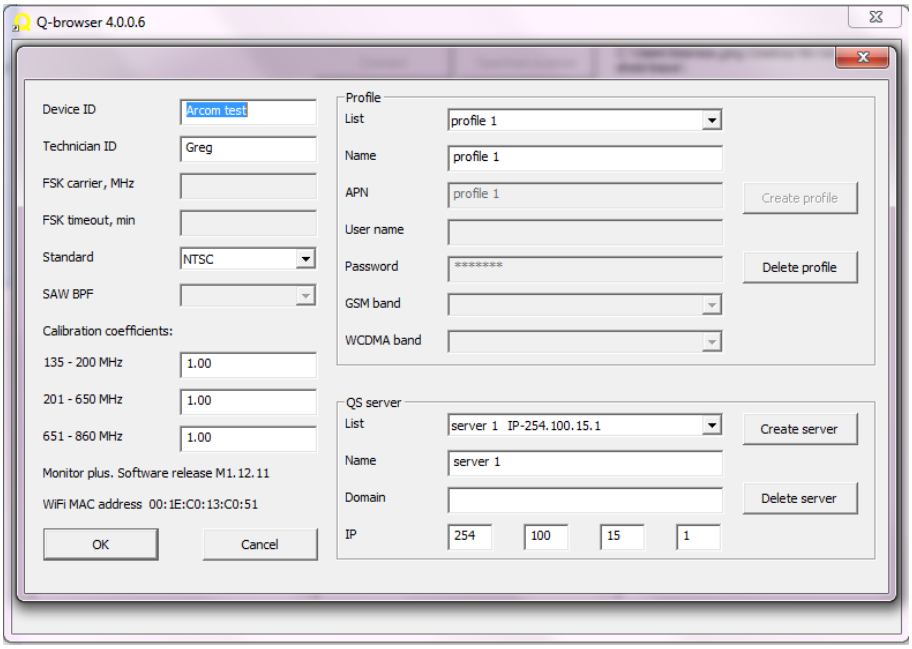


To conserve battery life it is highly recommended that the 5 minute shutdown counter is selected.

Quick, Step by Step Setup Guide

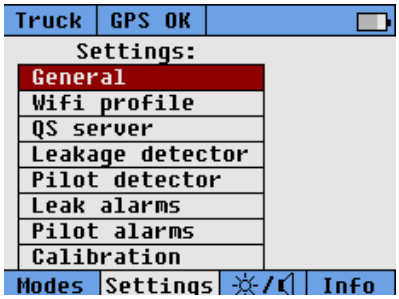
The following procedure should be followed for initial device setup:

1- Configure device using Q-browser



The first step in setup is to place the Navigator plus in its cradle and connect to a PC that has the Q-browser software loaded on it. Connection should be via USB from the cradle USB port to the PC. After connecting, the Wi-Fi SSID(s) and password need to be entered, the Server Dynamic DNS or IP address needs to be entered, and the device and user ID needs to be entered.

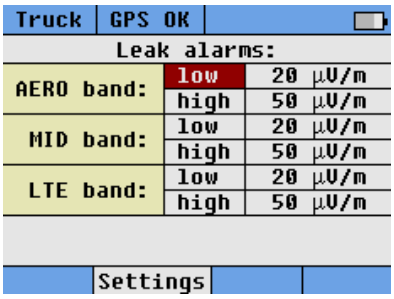
2- Select device settings



Press the Settings hot key, then enter the Wi-Fi Profile and ensure Truck and Walk mode Wi-Fi settings are selected as desired, then enter QS server and make sure the server setting is selected as desired, then enter Leakage detector and select the number of bands desired for detection, and the detection channel and type of modulation within each band. Consult with a manager for guidance as to specifics on what channels should be used for detection. There is a limit of four allowable channels at any one time for a server, and Global channels should be previously configured in the QAM Snare Manager software to ensure the desired channels for detection are always available.

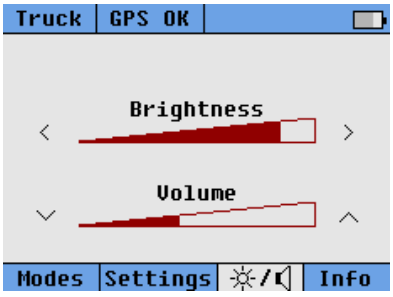
3- Configure Leak alarm thresholds

The Navigator Plus has low and high threshold leakage alarms to provide the user with feedback in the fashion they desire. Enter Leak alarm settings and configure as desired.



4- Adjust volume and brightness

Alarm volume and display brightness are user configurable settings – press the brightness and volume hot key and adjust to preference.



5- Check installation and wiring

Prior to use the user should check that all wiring and installation is correct. The RF antenna and GPS are fed to the bottom of the cradle using a combining network. Ensure the GPS antenna and the RF antennas are connected to the correct combiner port, and ensure all connectors are tight.

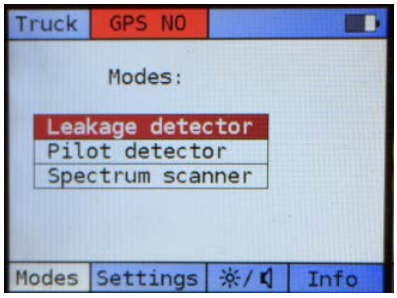
6- Enter detector mode and start detecting leaks

Press Leakage detector mode, confirm that you would like to connect to server, ensure Wi-Fi is turned on, then start detecting leaks. Prior to entering Walk mode, the detector needs to be cradled for at least five minutes to ensure good GPS lock.

Error Messages and Troubleshooting

To assist in troubleshooting any connection or connectivity issues, Navigator Plus will display error messages corresponding to the condition.

No GPS lock

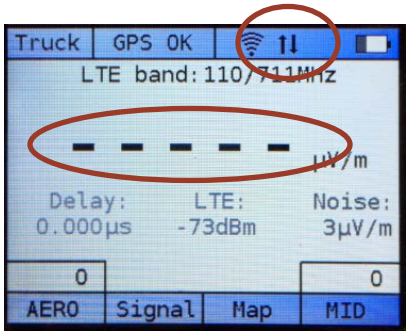


GPS lock is required for proper operation of the device. When the device is turned on with clear visibility to the sky, it may take a few minutes for the GPS lock indication to go from GPS-NO, to GPS-OK – which indicates lock. Before removing the device from the cradle to enter Walk mode, the user should ensure that GPS-OK condition remains for at least five minutes. This time duration is necessary in order to ensure a stable GPS-hold which the device utilizes when it is removed from the cradle in Walk mode. When in Walk mode, no GPS antenna is required.

No Wi-Fi connection

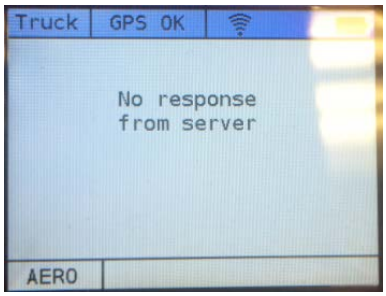
When the device is attempting to connect to a Wi-Fi network, the message to the right is displayed. If the Wi-Fi network with the displayed SSID is not available, the device will continuously attempt to connect to it. If you would like to connect to a different Wi-Fi network, go into the settings menu item and pick the desired network for both walk and truck mode. The time for connection can vary from a few seconds to a few minutes. The reconnection capability of the Navigator Plus is very robust, so when you get this message give the device time to reconnect on its own.

No Data



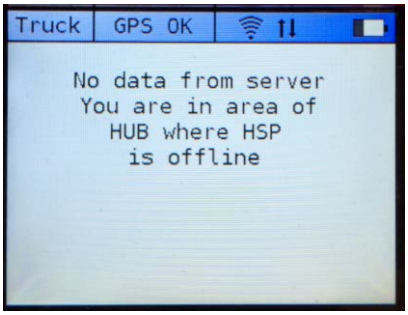
The Navigator Plus screen contains two elements that move to indicate that the device is operating properly and receiving data from the server. The indicators are the circle with up/down arrow display on the top right side of the display, and the five-dash indicator at the location where the leak value is displayed. Both indicators will flash each second data is being received when in QAM detector mode. *When in analog detector mode while viewing the analog screen, the dashes will not blink, but the up/down communication arrow will continue to flash.* When the indicators are solid the device is not communicating with the server and it will attempt to reconnect shortly if new data is not received.

No response from Server



The QAM Snare field device needs to communicate with the server when not in pilot or analog mode. When there is no connection with the server, the following message appears. When this message appears during initial setup, the user should double check the server address that was entered via Q-browser. If this is correct, then the next troubleshooting step would be to power cycle the device and attempt to connect again. The user should check that the server is on-line by connecting to it through either the QAM Snare Manager or Web client. Prior to any troubleshooting the user should allow for the device to reconnect on its own.

Headend Signal Processor offline

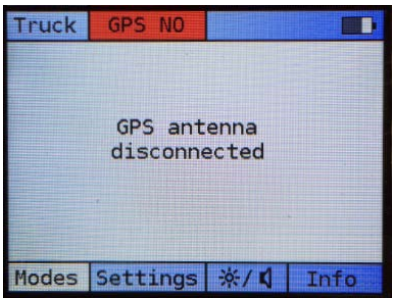


For multiple hub installations, within the QAM Snare server geographic boundaries are defined that correspond to the areas of the plant fed by different Headend Signal Processors. The Headend Signal Processor is what is used to sample the QAM channels and serves a reference signal for the leakage detection process. If a problem exists within the headend signal processor serving the area in

which the field device is currently being used, the following message will appear. There could be several reasons why the HSP is not operating properly that will need troubleshooting. The device could be turned off, the communication port could be disabled blocking data from being forwarded to the server, or the device could have a hardware issue. Consult with an Arcom Digital field engineer if the obvious troubleshooting is not effective after power cycling the unit.

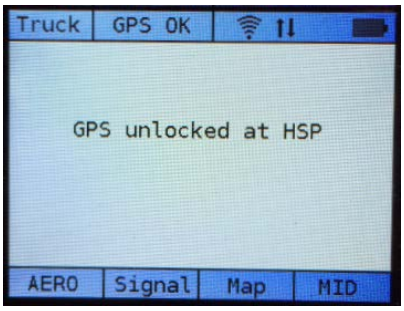
GPS antenna not connected to Navigator Plus

This message indicates a problem with the GPS antenna attached to the Navigator Plus.



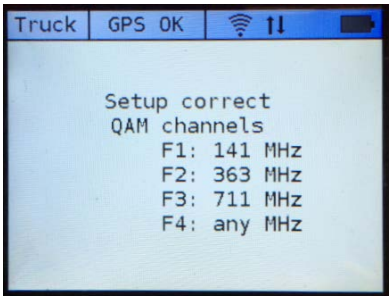
No GPS at Headend Signal Processor

When this error message is displayed, the Headend Signal processor does not have the required GPS lock. The GPS could not be providing signal because it is blocked, disconnected, or possibly even covered with snow depending upon placement and environment – the cause needs to be investigated and rectified.



Setup correct QAM channels

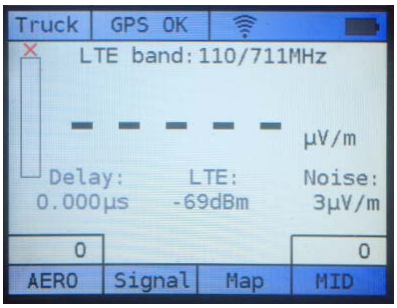
Each QAM Snare server can simultaneously process four channels. It is recommended that one channel is reserved in each band and configured as a global channel, such that they are available for any field device to use. Additionally, one more frequency is available on a first come first served basis. This channel is released when all devices using that frequency are turned off. If when you attempt to connect to the server, the error message to the right appears, it means that



your requested channels are more than the four currently being used. You should change detector settings such that the listed frequencies are used, and then reconnect. If only three channels are currently in use, the 4th frequency will show the word 'any' next to F4. If all four frequencies are currently allocated, the four frequencies will be listed.

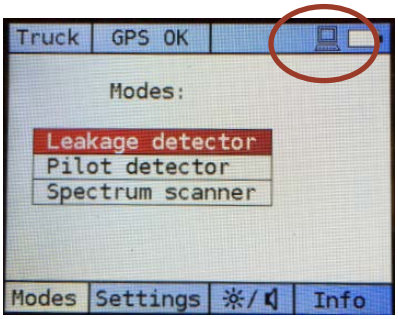
Closed buffer indication

When the device is buffering, and power is removed from the device – a buffer closed indicator will appear briefly in the form of a red X over the buffer box. It is informational only.



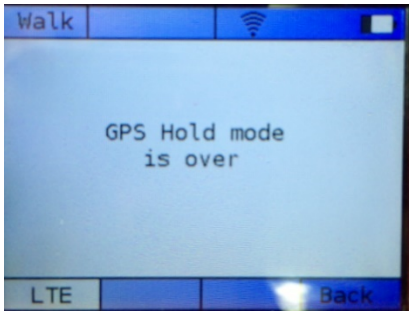
Unable to connect to Q-browser

When connecting to Q-browser, the computer icon must appear on the display. If it does not appear, try pushing down on the detector to ensure it is fully seated into the cradle.



GPS hold mode is over

Upon expiration of the 100-minute walk mode counter, the following message will appear and the device will exit the detector mode. To continue to use in QAM detector mode the unit must be re-cradled. It may be used in Pilot detector mode without re-cradling.



Changes made in Q-browser are not saved in detector

If changes made within Q-browser and the changes are not saved at the detector, the likely cause is that the final step of removing the USB cable from the cradle did not take place, and the user attempted to continue in Settings with the USB cable still in place.

Cradle

Navigator Plus is designed to be seated in its cradle during ride-outs and at all times while not being used. It receives power and battery charging through the cradle. Illumination of the cradle LED indicates the device is being powered. Additionally, while cradled and powered the Navigator Plus should indicate Truck mode.

The cradle is designed to mate with a flexible installation bracket that attaches to the seat bolt of any vehicles. Brackets are available in 60 cm and 80 cm versions.

Antennas

QAM Snare Navigator Plus requires a GPS antenna and multiple RF antennas, the quantity of which varies depending upon the number of channels being monitored. When the device is cradled, the all antennas are fed through the BNC connector at the bottom of the cradle, adjacent to the screw-on power jack input. The RF antennas and GPS signal are combining utilizing combiners that ship with the device, and all connect to the BNC connector. When the Navigator Plus is removed from the cradle, GPS lock is retained and the GPS antenna is no longer required. Additionally, the antenna input automatically switches to the coaxial antenna input on the top of the unit – where a loop dipole antenna, rubber duck, or combination antenna should be connected.

GPS antenna

A GPS or GPS/Glonass antenna is required for correlation time synchronization as well as to establish vehicle GPS coordinates such that the samples from the correct hub are transmitted to the device from the server. These GPS coordinates are also used for the advanced Time Difference of Arrival (TDOA) leak location algorithm.

The GPS antenna can be either magnetic or permanent mount, and it needs to be located at some place on the vehicle with visibility to the sky.

RF roof antenna

One, two, or three RF antennas are utilized depending upon the number of channels being monitored for leakage. Antennas are magnetic or permanent mount, and they require a magnetic ground plane underneath them to operate properly. They should additionally be placed as distant from each other as reasonably possible. They should not touch any roof structures on the vehicle. Equipment is available to tune the antenna to the installed environment, by cutting to the correct length – and this should be part of any installation process. Calibration antennas are also available as necessary to properly calibrate the device.

RF walk mode antenna

For use in Walk mode, while moving around detecting leaks. For low frequency, rubber duck antennas are used. For high frequency, dipole loop antennas are used.

The rubber duck antennas are frequency specific, tuned to the low frequency detection channel. The bandwidth of these antennas is such that if a different frequency is desired to be used, a corresponding different antenna must be used.

The bandwidth of the dipole loop antennas are a few hundred MHz, therefore a 600 MHz antenna can adequately cover from 500 to 700 MHz. The antennas are tuned to a specific central frequency and are available in steps of 50 MHz from 400 MHz to 700 MHz.

The loop antenna ships with a high pass filter attached – the purpose of which is to increase overall sensitivity.

Wi-Fi antenna

Navigator Plus contains an internal Wi-Fi antenna that connects with the external Wi-Fi transmitter utilized for communication between the field device and the server.

Battery Charging

The device battery is charged through the companion cradle, directly through the vehicle battery. An optional DC power pack charger is also available. The detector is designed to be stored and used in the cradle at all times other than when not in use in Walk mode while moving about performing the final leak location. If a battery becomes fully depleted, it will require charging of at least 30 minutes prior to being able to be used in detector mode. Like all Lithium Ion batteries, the temperature in the charging environment needs to be above freezing for the battery to enter the charge cycle.

Specifications

Physical

Dimensions = 3.075in X 1.875in X 7.539in (7.812cm x 4.763cm x 19.149cm)
Weight = 0.895 Lb (0.406 kg)

Environmental

Operating Temperature -15°C to +60C
Operating Humidity 0 to 95 RH

Interfaces

16-circuit, 0.80 mm Receptacle
- DC INPUT for battery charging
- USB

RF "Truck" port = BNC Male (Bottom Panel)
RF "Walk" port SMA-Type Female (Top Panel)

Operating Specifications

Operating current draw: 1.5A Max
DC INPUT for battery charging for 3.7Vdc, 5200 mAh, Li-ion Battery = 12VDC+/- 20%, 2.5 Max
Charge time = 2.5 hrs.
Run time = 4 hrs.
USB = USB 2.0 compliant
GPS = 26 channels GPS L1 C/A, GLONASS L1OF, Input Acquisition Time = 45 sec nominal.
Acquisition / Tracking Sensitivity = -161 dBm/-161 dBm.
Wi-Fi = 802.11 B/G/N, 2.4 GHz band only

RECEIVING BANDS: *(all are center channel except for Analog)*
NTSC:
AERO Analog = 121.2625 - 157.25 MHz
AERO Pilot/QAM = 105 MHz - 189 MHz
AERO QAM = 123 MHz - 195 MHz
MID OFDM, Pilot/QAM, & QAM = 201 MHz - 645 MHz
LTE OFDM, Pilot/QAM, & QAM = 649 MHz - 897 MHz

Pal B/G:
AERO Analog = 119.250 MHz - 161.250 MHz
AERO QAM & Pilot/QAM = 138 MHz - 194 MHz
MID OFDM, Pilot/QAM & QAM = 202 MHz - 642 MHz
LTE OFDM, Pilot/QAM & QAM = 650 MHz - 994 MHz

PAL D/K:
AERO Analog = 119.25 MHz - 167.25 MHz

AERO Pilot/QAM & QAM = 138 MHz – 194 MHz
MID OFDM, Pilot/QAM & QAM = 202 MHz – 642 MHz
LTE OFDM, Pilot/QAM & QAM = 650 MHz – 994 MHz

TRUCK PORT
Type = BNC Male (Bottom)
RF Input Sensitivity = 2.0 uV/m (–54 dBmV/m) min
Input Range = 2.0 uV/m to 1000 uV/m
Input Frequency Range:
    Analog = 121.250 MHz to 649.250 MHz
    QAM, Pilot/QAM, OFDM = 120 MHz to 1002 MHz
GPS Ant:
    Input = 1575.42 MHz (L1), GPS/GLONASS
    Output = 3.5 (+/– 0.4) Vdc

WALK PORT
Type = F–Type Male
RF Input Sensitivity = 2.0 uV/m (–54 dBmV/m) min
Input Range = 2.0 uV/m to 1000 uV/m
Input Frequency Range
    Analog = 121.250 MHz to 649.250 MHz
    QAM, Pilot/QAM, OFDM = 120 MHz to 1002 MHz

Patents

QAM Snare is protected under the following US Patents. Other US and Foreign Patents for QAM Snare are Pending.

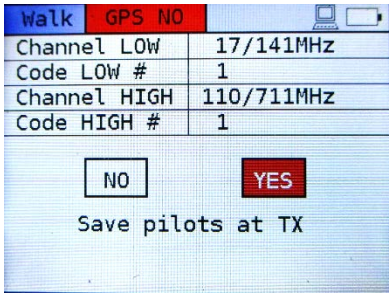
Frequency Setup of QAM Snare Pilot Transmitter

The Navigator Plus can be utilized as a pilot detector, when used with a companion QAM Snare Pilot Transmitter. The Pilot Transmitter can be used in either or both the aeronautical or LTE band, with two CW carriers placed at each utilized frequency band.

Shielding Test signals transmitted from the Pilot Transmitter are like the Pilot/QAM detection described above. The transmitter output is comprised of a pair of high-level CW carriers separated by 6 MHz, at frequencies equivalent to the selected QAM channel upper and lower band edges.

The Pilot Transmitter is configured through a very simple process of connecting a USB cable between the Pilot transmitter and the USB connector of the Nav+ cradle. The Nav+ is required to be in the cradle during this process. The Transmitter Output frequencies are set to the same frequencies as set up in the Shielding Test Settings menu.

While the Nav+ main menu is displayed, once the Pilot transmitter is connected to the Nav+ cradle via USB the message shown at the right will appear on the Nav+ screen. Press the enter button to confirm yes, and the Pilot transmitter will be programmed for those frequencies. Now the USB cable can be disconnected.



This Pilot transmitter setup is a one-time process, and only needs to be repeated if it is desired to change the pilot frequencies.

Turning the Pilot transmitter on

Simply move the lever switch on the top of the transmitter to turn the device on. LED's will illuminate.