



QAM Snare Navigator Plus User Manual

QS-NAVPLUS-v1.4

5/27/15



This document details the functions and operation of the QAM Snare Navigator Plus leakage detector

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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 an analog detector mode with buffering that can be used as an alternative to digital detection in the aeronautical band. This mode can be used simultaneous to digital leakage detection at the LTE and middle frequency bands.

The Navigator Plus additionally contains a pilot detector mode intended to be used in conjunction with the QAM Snare Pilot Transmitter, in order to quickly troubleshoot locations in the home and MDU's where poor shielding effectiveness results in forward ingress issues related to close proximity LTE transmitters.

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.

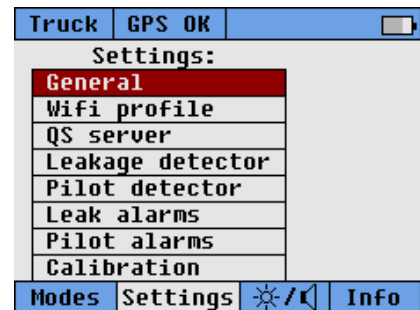


Settings

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.

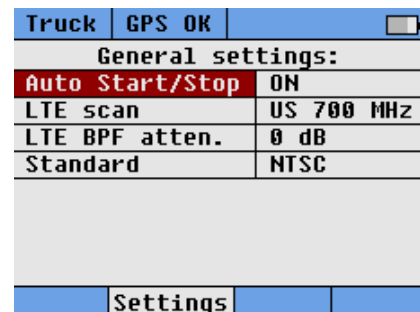
General

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



Auto Start/Stop

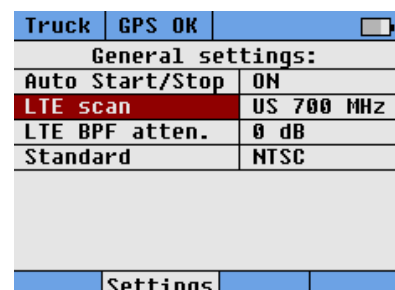
The Autostart on setting allows for the unit to enter Detector mode automatically when the unit is manually turned on. It will connect according to the last configured settings. This setting also controls the automatic turn off counter feature.



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.


Truck	GPS OK	
General settings:		
Auto Start/Stop	ON	
LTE scan	US 700 MHz	
LTE BPF atten.	0 dB	
Standard	NTSC	

Truck	GPS OK	<input type="checkbox"/>
General settings:		
Auto Start/Stop		
LTE scan		
LTE BPF atten.	24 dB	
Standard		
Settings		

Standard

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

Truck	GPS OK	<div></div>
General settings:		
Auto Start/Stop	ON	
LTE scan	US 700 MHz	
LTE BPF atten.	0 dB	
Standard	NTSC	
	Settings	

Truck	GPS OK	
General settings:		
Auto Start/Stop		
LTE scan		
LTE BPF atten.		
Standard	NTSC	
	PAL B/G	
	PAL D/K	
Settings		

Wi-Fi Profile

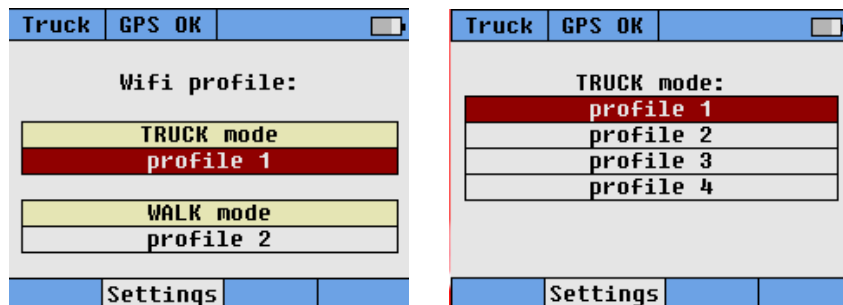
The Navigator Plus is a Wi-Fi enabled device that requires connectivity to operate in the QAM Leakage Detector Mode. Profiles that were previously entered into the device through the Q-browser are selected through

Truck	GPS OK	<input type="checkbox"/>
Settings:		
General		
Wifi profile		
QS server		
Leakage detector		
Pilot detector		
Leak alarms		
Pilot alarms		
Calibration		
Modes	Settings	<input type="checkbox"/> <input type="checkbox"/> Info

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 they will both default to the one entered profile.** After entering a new Wi-Fi profile, power cycle the unit prior to use.

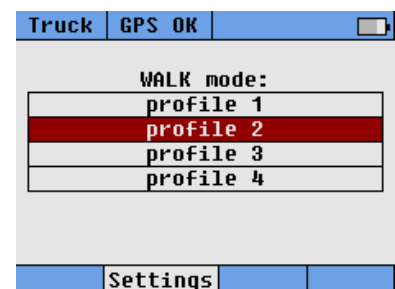
Truck mode

The Truck mode (cradled) Wi-Fi profile needs to be selected from the list of entered profiles. It can be either the same or different from the Walk mode profile. 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.



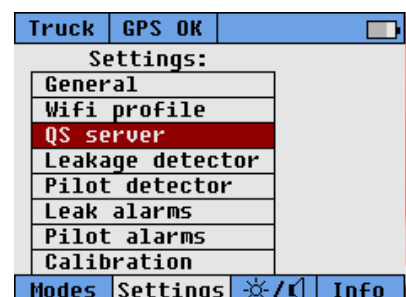
Walk mode

The Walk mode Wi-Fi profile needs to be selected from the list of entered profiles. It can be either the same or different from the Truck mode profile. 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.



QS Server

The QAM Share 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 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.

Truck	GPS OK	<input type="checkbox"/>
QS server: <div>server 1</div> <div>server 2</div>		
Settings		

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 is fixed to channels between 133MHz and 195MHz. 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, there is the addition of Analog detection as a selectable option. OFDM is shown as a signal type option for each of the three channel bands, but this option is not yet active and will require a software update prior to use.

In order to navigate menu items, simply scroll down to the line item you wish to change, press enter, and again scroll to select the

Truck	GPS OK	<input type="checkbox"/>
Settings:		
General		
Wifi profile		
QS server		
Leakage detector		
Pilot detector		
Leak alarms		
Pilot alarms		
Calibration		
Modes	Settings	Info

Truck	GPS OK	<input type="checkbox"/>
AERO band:	ON	
Leak signal	QAM	
Channel AERO	17/141 MHz	
MID band:	ON	
Leak signal	QAM	
Channel MID	60/441 MHz	
LTE band:	ON	
Leak signal	QAM	
Channel LTE	122/783 MHz	
Settings		

Truck	GPS OK	<input type="checkbox"/>
AERO band:		
Leak signal		
Channel AERO		
MID band:		
Leak signal		
Channel MID		
LTE band:		
Leak signal	QAM	
Channel LTE	OFDM	
Settings		

Truck	GPS OK	<input type="checkbox"/>
AERO band:	OFF	
Leak signal	ON	
Channel AERO		
MID band:		
Leak signal		
Channel MID		
LTE band:		
Leak signal		
Channel LTE		
Settings		

desired menu item, then press enter and the selection will be made.

Leakage Detector – selecting channel

When selecting a QAM channel, the desired channel can be selected from a pull-down list. When selecting an analog

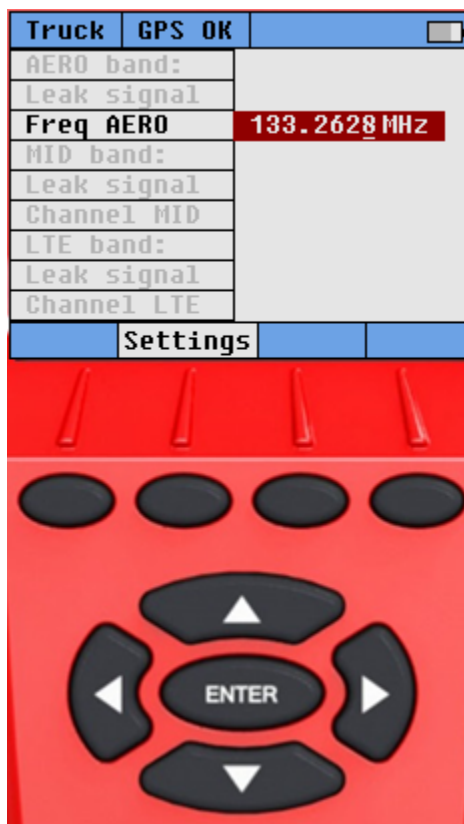
channel the process is a little different. Since the receiver is highly accurate, the process is to measure the actual analog carrier frequency using one click built in

tools of the QAM Snare Manager program – and then entering that measured carrier frequency into the detector. After acquiring the actual frequency it needs to be entered into the Navigator Plus. Select Freq Aero and then press enter, and the screen to the

right will appear. Use the left and right arrow button to move the cursor, and use the up and down arrow button to increment and decrement the selected frequency.

Truck	GPS OK	
AERO band:	91/627 MHz	
Leak signal	92/633 MHz	
Freq AERO	93/639 MHz	
MID band:	94/645 MHz	
Leak signal	100/651 MHz	
Channel MID	101/657 MHz	
LTE band:	102/663 MHz	
Leak signal	103/669 MHz	
Channel LTE	104/675 MHz	
Settings		

Truck	GPS OK	
AERO band:	ON	
Leak signal	Analog	
Freq AERO	133.0000 MHz	
MID band:	ON	
Leak signal	QAM	
Channel MID	11/201 MHz	
LTE band:	ON	
Leak signal	QAM	
Channel LTE	100/651 MHz	
Settings		



Pilot detector

In order to quickly and easily troubleshoot difficult ingress problems in the home, Navigator Plus is able to operate in a Pilot mode. Operation in this mode requires the use of a QAM Snare Pilot transmitter. 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). The transmitter places a high level, easy to find signal at the frequency

Truck	GPS OK	
Settings:		
General		
Wifi profile		
QS server		
Leakage detector		
Pilot detector		
Leak alarms		
Pilot alarms		
Calibration		
Modes	Settings	Info

Truck	GPS OK	
Pilot detector:		
AERO band:	ON	
F1	138 MHz	
F2	144 MHz	
LTE band:	ON	
F1	706 MHz	
F2	777 MHz	
Settings		

which is programmed into the transmitter when setting up. To configure the transmitter, set the Navigator Plus to the desired pilot frequency – and connect to the transmitter via a USB cable. This setup is one time only, and needs to be repeated only if it is desired to change the pilot frequencies. Pilots can be used in either the aeronautical band or in the LTE band, or both. Two pilot carriers are utilized in both the aeronautical and LTE bands in order to minimize multipath effects and to make the product easier to use. For the aeronautical band, a recommendation on the pilot separation is 6 MHz, and for the LTE band the recommended separation is 70 – 80MHz – for example 707MHz and 777MHz.

To change the pilot settings, scroll to Pilot detector and press enter. You can then turn both bands to On, or just keep one band on. Scroll to the desired band, press enter, then scroll to the desired setting. To change the frequency, scroll down to the desired F1 or F2 line item, press enter – then use the up or down arrow to increment. You can either press the button once to increment to decrement by 1MHz steps, or if you press and hold the button it will quickly increment up or down. Press enter again to confirm selection and return to the previous menu item.

If you are only interested in LTE detection, then it is recommended to turn the aeronautical pilot off.

Truck	GPS OK	
Pilot detector:		
AERO band:	OFF	
F1	ON	
F2		
LTE band:		
F1		
F2		
Settings		

Truck	GPS OK	
Pilot detector:		
AERO band:		
F1		
F2		
LTE band:		
F1		
F2	777 MHz	
Settings		

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

Truck	GPS OK	
Settings:		
General		
Wifi profile		
QS server		
Leakage detector		
Pilot detector		
Leak alarms		
Pilot alarms		
Calibration		
Modes	Settings	Info

Truck	GPS OK	
Leak alarms:		
AERO band:	low	20 μ V/m
	high	
MID band:	low	
	high	
LTE band:	low	
	high	
Settings		



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.

Truck	GPS OK	
Leak alarms:		
AERO band:	low	20 $\mu\text{V}/\text{m}$
	high	50 $\mu\text{V}/\text{m}$
MID band:	low	20 $\mu\text{V}/\text{m}$
	high	50 $\mu\text{V}/\text{m}$
LTE band:	low	20 $\mu\text{V}/\text{m}$
	high	50 $\mu\text{V}/\text{m}$
Settings		

Pilot alarms

The pilot alarms also display a shielding effectiveness indicator, which equates the detected signal to shielding effectiveness. From the setting, one can see that it is possible to locate very small leaks which could be the source of forward ingress from close proximity transmitters such as LTE devices.

To change the value, navigate to the alarm level indicator and use the arrows to increase or decrease the alarm setting. $.01\mu\text{V}/\text{m}$ is the minimum setting for both the aero and LTE bands.

Truck	GPS OK	
Settings:		
General		
Wifi profile		
QS server		
Leakage detector		
Pilot detector		
Leak alarms		
Pilot alarms		
Calibration		
Modes	Settings	Info

Truck	GPS OK	
Leak alarms:		
AERO band:	0.40 $\mu\text{V}/\text{m}$	
	SE= 65 dB/m	
LTE band:	0.40 $\mu\text{V}/\text{m}$	
	SE= 80 dB/m	
Settings		

Truck	GPS OK	
Leak alarms:		
AERO band:		
LTE band:		
0.40 $\mu\text{V}/\text{m}$		
SE= 80 dB/m		
Settings		

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

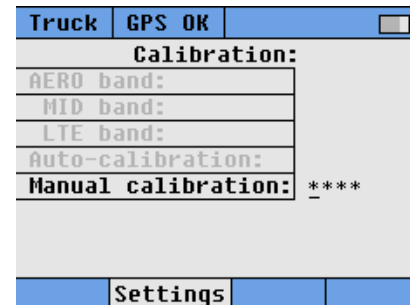
Truck	GPS OK	
Settings:		
General		
Wifi profile		
QS server		
Leakage detector		
Pilot detector		
Leak alarms		
Pilot alarms		
Calibration		
Modes	Settings	Info

Truck	GPS OK	
Calibration:		
AERO band:		
1.00		
MID band:		
1.00		
LTE band:		
1.00		
Auto-calibration:		
OFF		
Manual calibration:		
Settings		

ARCOM
DIGITAL

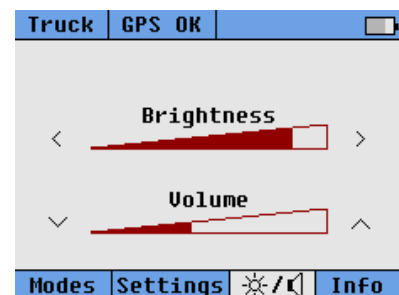


protected, and should only be performed by users familiar with the process.



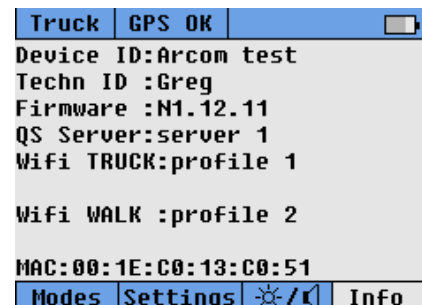
Display brightness and volume adjustment Hot key

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.



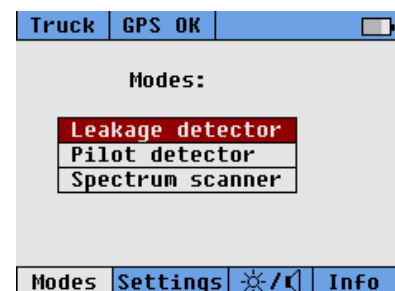
Information Hot Key

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 WiFi 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

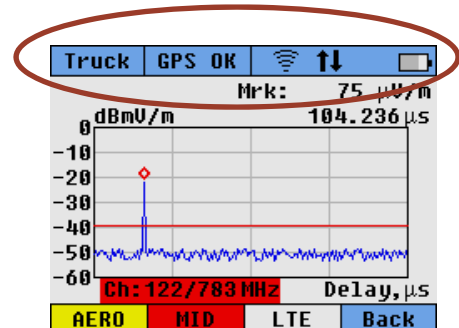




select Leakage detector mode, Pilot detector mode, or Spectrum scanner.

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 four 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.

GPS Sync 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.




GPS OK 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.


GPS Hold 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.

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.

Wi-Fi indicator

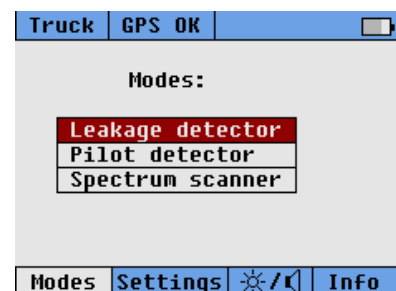
 When the Navigator Plus is connected to a Wi-Fi hotspot, the Wi-Fi indicator is illuminated. The does not indication connection with the server, just the hot spot. Even during times where a wireless signal is not present, the Navigator will still remain actively connected to the hotspot. If WiFi connection 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, highlight Leakage detector and press enter. The device will go through its



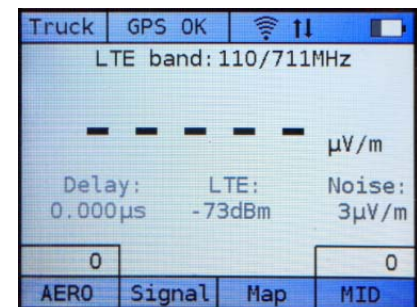
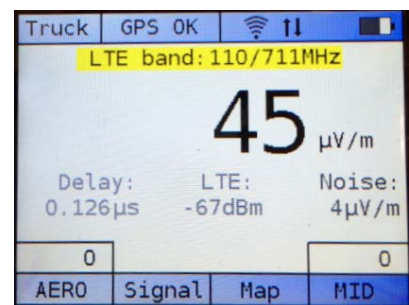


connection sequence and connect to the Wi-Fi network and then connect to the server – and then leakage detection will begin. In the leakage detector mode, the Navigator Plus has the ability to simultaneously detect leaks at three channels, one each within the aeronautic, the mid, and the LTE bands as 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 QAM channels. When no leakage is detected on a QAM 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

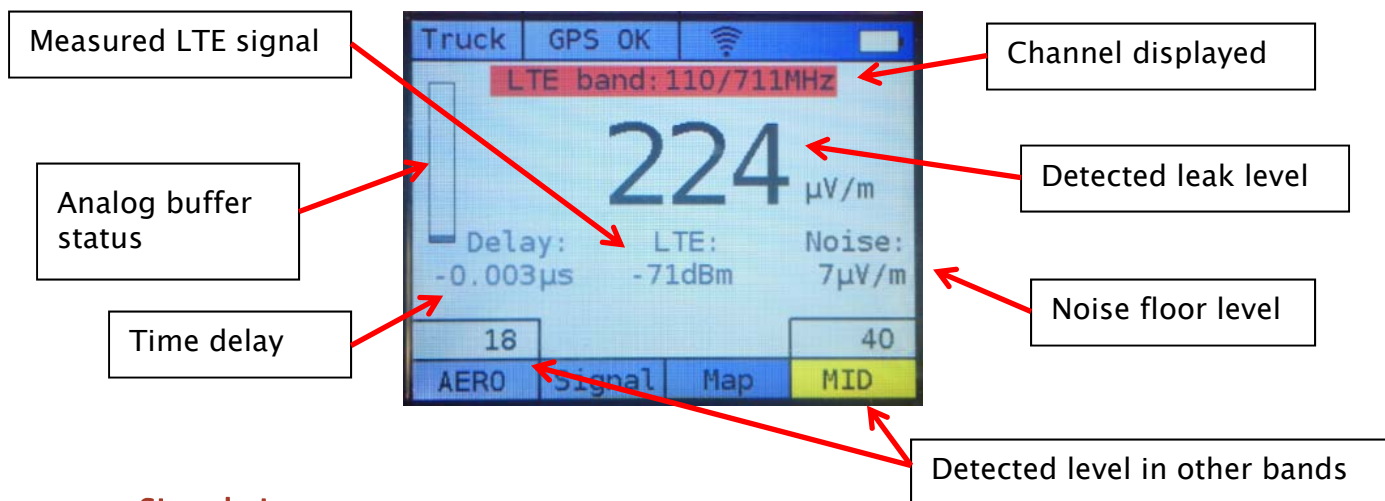


bottom right and left portion of the screen. To switch the main display to these bands, simply press the corresponding hot key immediately below the band description.

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.

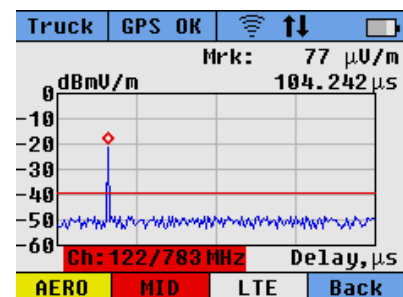
Information displayed on leak level screen

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

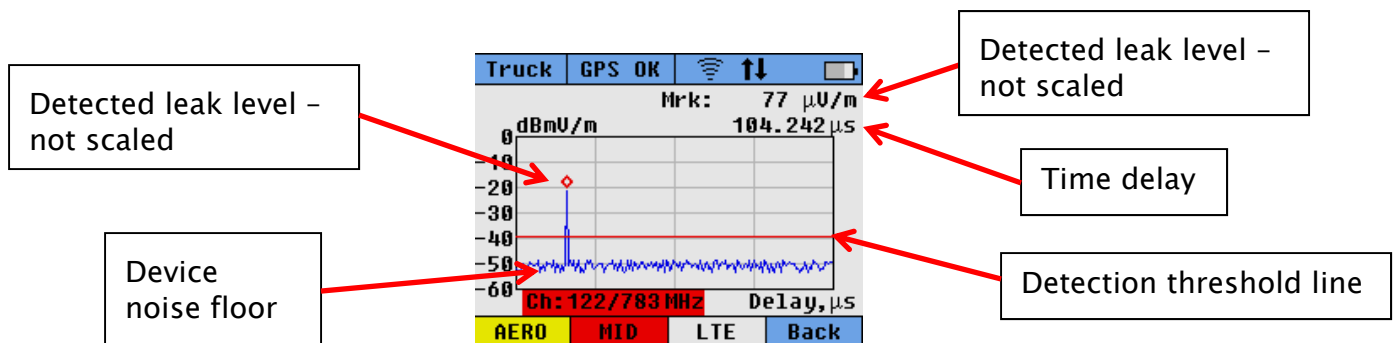
The Signal view screen displays the correlation function and shows a graphic representation of the detected signal. To enter the Signal view mode, press the hot key immediately below the Signal box. The red horizontal line is a threshold indicator, and when the



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

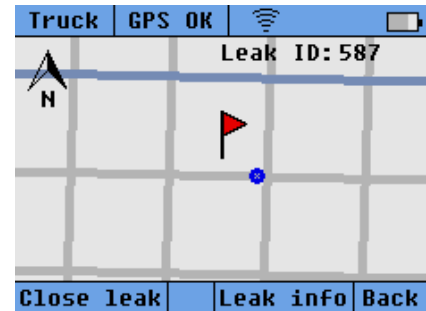
The signal view screen provides quite a bit of information. The screen itself represent the correlation function output – with a peak above the red threshold line indicating leakage being detected. The graphic representation displays time delay on the x axis and detected signal level in dBmV/m on the y axis. The peak level of the correlation function contains a marker – and the equivalent level of the marker displayed in the more familiar $\mu\text{V}/\text{m}$ 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.

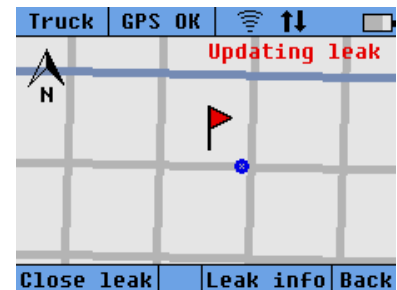
Map view

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.



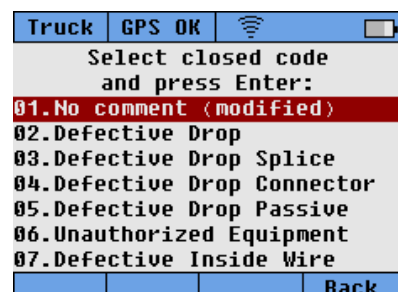
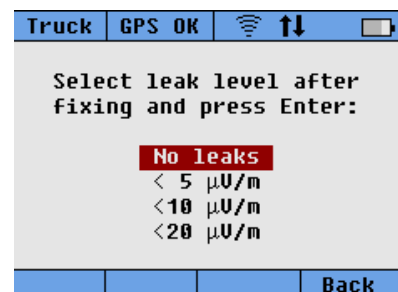
Updating leak

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.



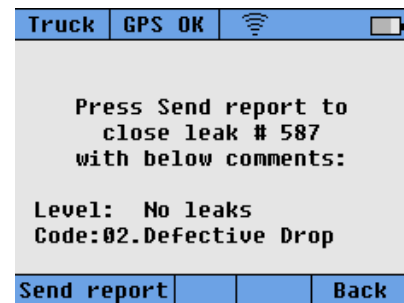
Close leak

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



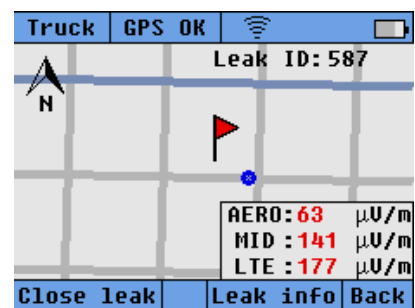


problem found for the leak in the form of a close code. Close codes are entered or edited using the QAM Snare Manager program and are transmitted to the device on startup on occasions when the close codes have changed. After entering this information you need to press the Send report hot key in order to send the information to the QAM Snare server.



Leak info

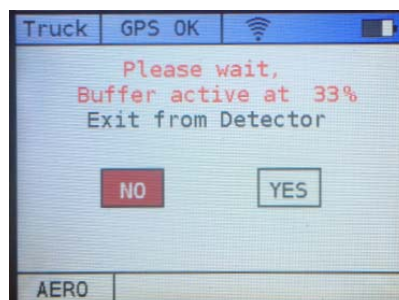
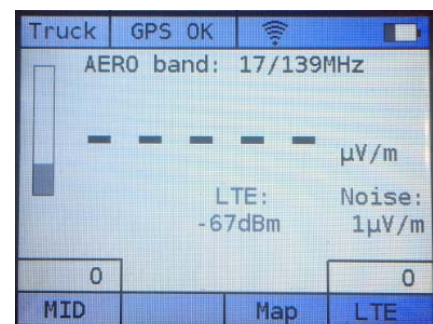
More detailed information about the leak can be found by pressing the hot key under the Leak info text.



Analog leakage detector mode – buffering

When operating in analog 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 drivepath 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 headend leakage database.

Walk mode timer

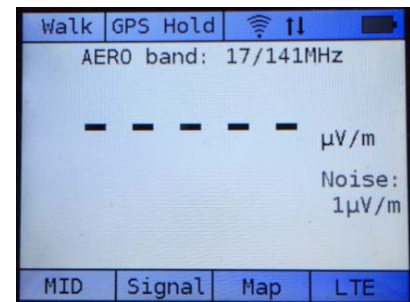
The Navigator Plus contains a 100 minute counter for walk mode. This is a battery saving feature to make sure the unit is not left in the correlator mode for extended time period inadvertently. After 100 minutes the unit will exit detector mode and the GPS indicator will change to GPS No. The unit needs 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.

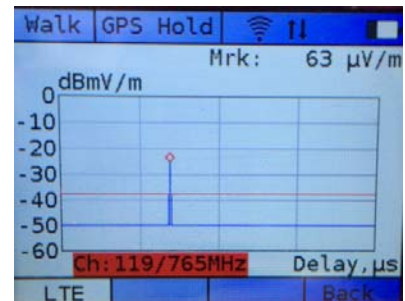
When no leakage has been detected within the last two seconds, a dash display is indicated.



Walk mode signal view

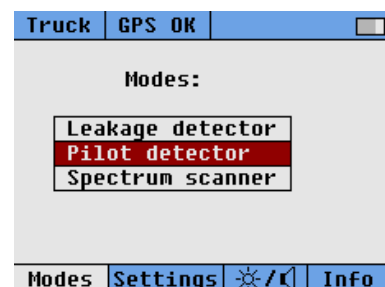
When in walk mode, the Signal view correlator response is available for detected QAM channels. It is not available for analog channels. When in walk mode the time delay indicator is not available and noise floor is shown as a flat line.

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



Pilot detector mode

To enter Pilot detector mode, highlight Pilot detector and press enter. The device will immediately enter that mode. No GPS or Wi-fi connectivity is necessary for this mode. In Pilot 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 Navigator Plus to operate at the frequency for



which the Navigator Plus is configured. The Navigator Plus 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. The antennas will only be the same if a combination antenna is employed. When the detector is in Pilot mode – for clarity, the word Pilot will continuously flash on the upper left corner of the screen.

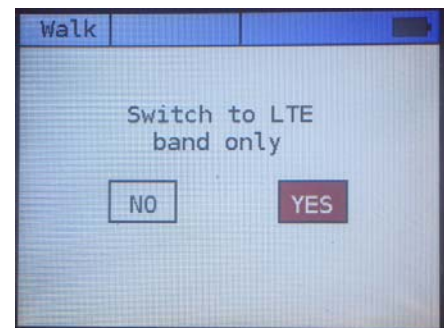
Screen navigation in pilot mode – single band detection

Typically a user will be looking for leakage at only one frequency band configured for the device, likely the LTE band. When configured as such, after entering Pilot detector mode, the device will display and alarm for the selected band. Press exit to exit this mode.



Screen navigation in pilot mode – dual band detection

If the device is configured for operation in both the LTE and aero band, the left and right hot key buttons are 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. The band being currently detected is displayed on the top screen to the right – here the aeronautical band.



To switch the display to a different band press the right hot key button that corresponds to the highlighted second band – in this case the LTE band.

To fix detection such that only one band is



displayed and alarmed – press the left hot key corresponding to the Fix button.

After pressing the Fix button, a confirmation screen will appear, press Enter to confirm the switch.

If it is desired to switch back to simultaneous two channel detection, press the left arrow button again to add the second band.

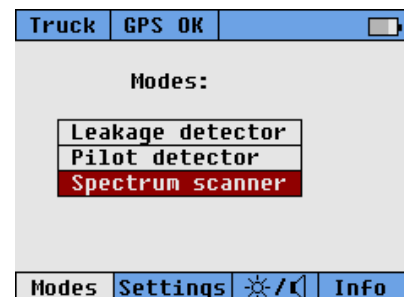
Pilot mode shielding effectiveness indication

When in Pilot detector mode, along with the detected leak level – the equivalent shielding effectiveness of the leak will be displayed. 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.



Spectrum Scanner Mode

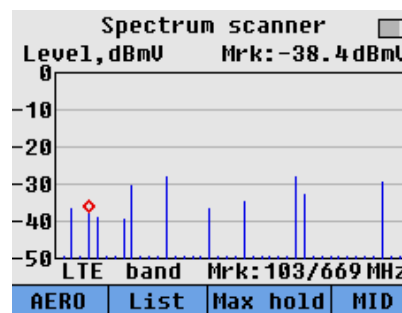
Spectrum scanner is a tool that can be used to provide visibility as to the terrestrial signals present in the local environment. A requirement for QAM Snare is that the channel utilized for detection must be relatively free from interfering signals. Spectrum scanner lets you see what signals are present off-air that could possibly interfere with optimum operation. The information from Spectrum scanner indicates potential co-channel interference, this however is not the entire story as strong adjacent channels could also overload the receiver and result in an elevated noise floor, even in situation when the tuned channel itself is relatively free from interference. In such situations, an external pre-selector filter can be used to mitigate the interfering signal– please consult with your Arcom Digital contact for more information on this subject. **The final test on suitability of a particular channel is the correlator noise floor itself. No conclusions should be made as to the suitability of a channel without looking at the noise floor of the desired channel.**



To use Spectrum scanner, highlight the menu item from the Modes menu and press enter. The scanner is split into three bands corresponding to the Aero, Mid, and LTE detection bands. Use the hot key buttons to select the desired band and to toggle to different band. The scanner will continuously cycle through channels in the band and the levels will continuously change based upon momentary differences in level. The Spectrum scanner is not intended to be a precision instrument, and is intended only to provide relative signal level indications. Indicated level results are scaled based upon calibration coefficients for each device, so variances between unit to unit are expected. The antenna used with spectrum scanner should be similar to that antenna used in the corresponding detection band.

Channel and Marker

The displayed channel is indicated by the red diamond shaped marker. The corresponding marker channel is displayed below the graph, and the marker signal level is displayed above. To move the marker left and right in order to highlight different channels, simply press the left and right arrow direction buttons.



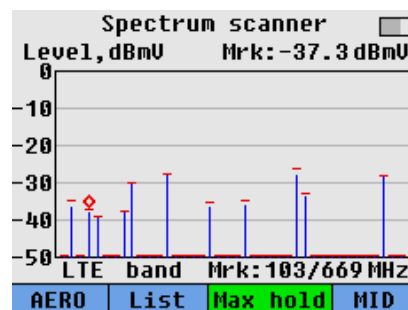
List view

An alternative way to view the same data is through the List feature. Press the List hot key and the same information will be presented in a tabular format. The Up/Down Hot key can be used to scroll up and down, alternatively the up and down arrow buttons can be used. Those channels whose level is indicated with red letters are not to be used, green can be considered candidates, but the correlator noise floor itself needs to be tested to determine if a pre-selector filter is required.

Spectrum scanner	
Channel	Level
100/651 MHz	-50.0 dBmV
101/657 MHz	-35.8 dBmV
102/663 MHz	-50.0 dBmV
103/669 MHz	-38.1 dBmV
104/675 MHz	-39.4 dBmV
105/681 MHz	-50.0 dBmV
106/687 MHz	-50.0 dBmV
107/693 MHz	-39.2 dBmV
Up Down Back	

Max Hold

Max Hold can help in identifying those signal levels that change dynamically. The best conditions are when the selected channel has no interferences on itself and

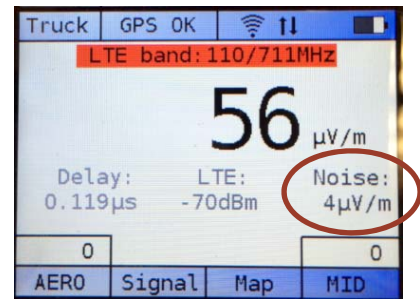




there is nothing disturbing on the adjacent channels. The max indication is represented as a small red horizontal line above the active scan indicator which will continue to move up and down.

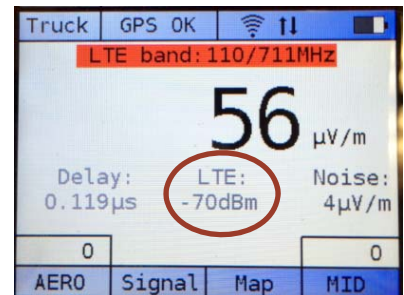
Noise Floor Level Indication

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.



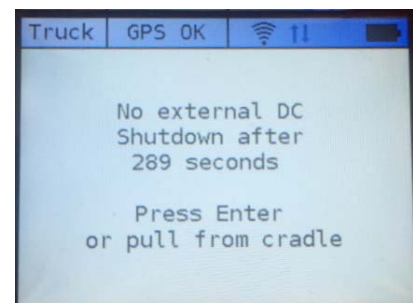
LTE Level Indication

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.



Auto shutdown counter

When Auto Start/Stop is enabled – when power is removed from the device while cradled, the unit will begin





a five 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.

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.

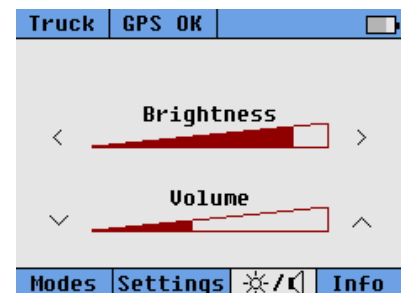
3- Configure Leak alarm thresholds

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.

Truck	GPS OK	
Leak alarms:		
AERO band:	low	20 $\mu\text{V}/\text{m}$
	high	50 $\mu\text{V}/\text{m}$
MID band:	low	20 $\mu\text{V}/\text{m}$
	high	50 $\mu\text{V}/\text{m}$
LTE band:	low	20 $\mu\text{V}/\text{m}$
	high	50 $\mu\text{V}/\text{m}$
Settings		

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

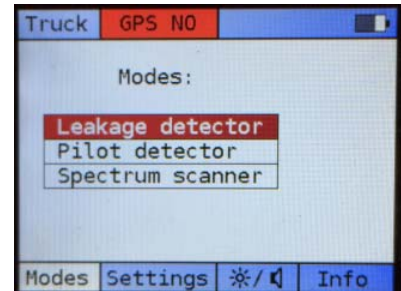
Press Leakage detector mode, confirm that you would like to connect to server, ensure Wi-Fi is turned on, then start detecting leaks. Prior to entering Walk mode, the detector needs to be cradled for at least five minutes to ensure good GPS lock.

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.



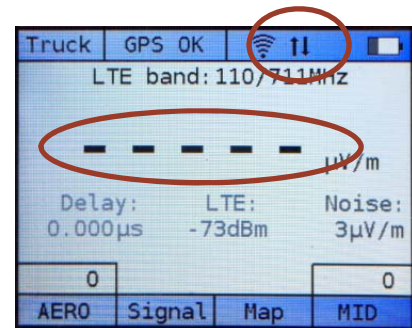
No Wi-Fi connection

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

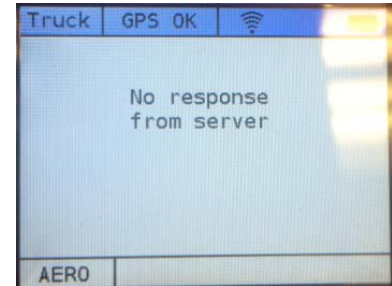




where the leak value is displayed. Both of these indicators will flash each second data is being received when in QAM detector mode. *When in analog detector mode while viewing the analog screen, the dashes will not blink, but the up/down communication arrow will continue to flash.* When the indicators are solid the device is not communicating with the server and it will attempt to reconnect shortly if new data is not received.

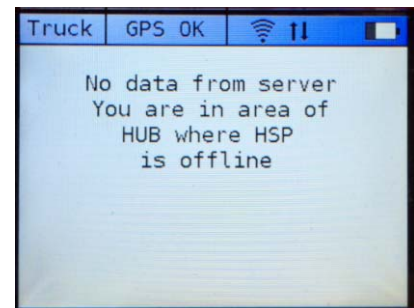
No response from Server

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.



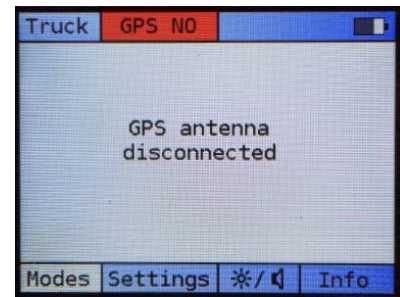
Headend Signal Processor offline

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.



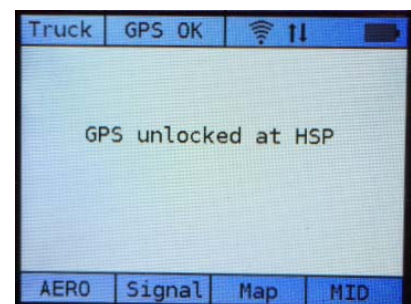
GPS antenna not connected to Navigator Plus

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



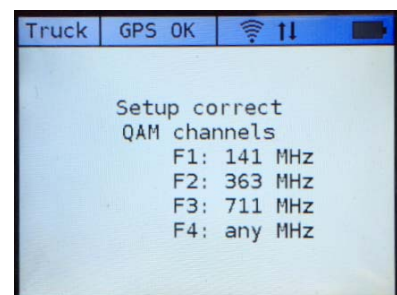
No GPS at Headend Signal Processor

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.



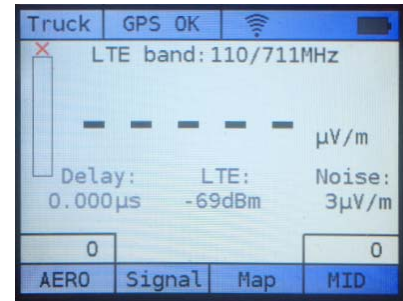
Setup correct QAM channels

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 in excess of 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.



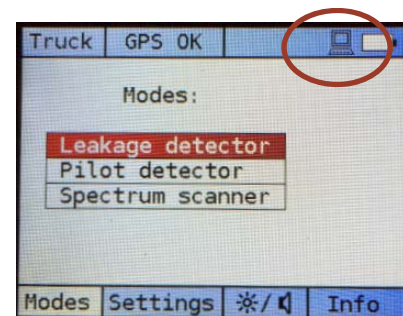
Closed buffer indication

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.



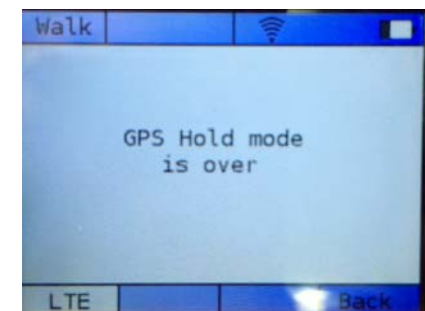
Unable to connect to Q-browser

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 highpass filter attached – the purpose of which is to increase overall sensitivity.

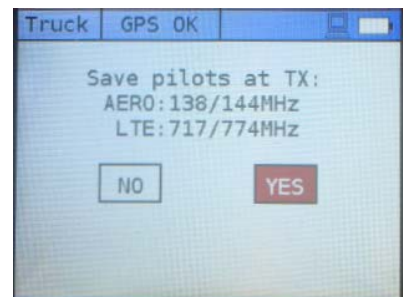
Wi-Fi antenna

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.

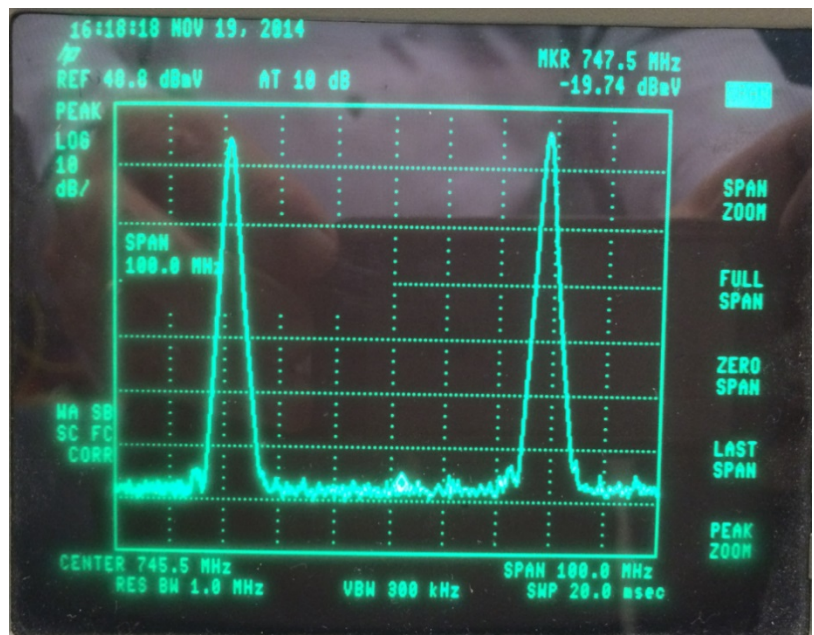
Frequency Setup of QAM Snare Pilot transmitter



The Navigator Plus can be utilized as a pilot detector, when used with a companion QAM Snare Pilot Transmitter device. The Pilot transmitter can be used in either or both the aeronautical of LTE band, with two CW carriers placed at each utilized frequency band. The frequency of 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 Navigator Plus cradle. The Navigator Plus is required to be in the cradle during this process, and the Pilot transmitter must be turned on. In settings, under the Pilot mode, the pilot frequencies need to be configured. Once the Pilot transmitter is connected to the Navigator Plus cradle via USB, the following message will appear on the Navigator Plus screen. The computer icon on the Navigator Plus display will illuminate indicating a good USB connection. Press the enter button to confirm yes, and the Pilot transmitter will be programmed for those frequencies, and 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.



The image below is illustrative of how the Pilot transmitter CW carriers appear.





Switching from Pilot mode back to QAM detector mode

When the Navigator Plus is in Pilot detector mode, GPS is not utilized and GPS lock is not retained. As such, when going back to QAM detector mode after operating in Pilot mode, it is necessary to place the device back in the cradle, operating in detector mode for at least five minutes prior to removal to again use as a QAM detector in walk mode.

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.

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 in order for the battery to enter the charge cycle.

Patents

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

