



Searcher Plus GT

Leakage Detector

OPERATION MANUAL



TRILITHIC
INNOVATIVE ENGINEERING

Trilithic Company Profile

Trilithic is a privately held manufacturer founded in 1986 as an engineering and assembly company that built and designed customer-directed products for telecommunications, military and industrial customers. From its modest beginnings as a two-man engineering team, Trilithic grew over the years and broadened its offerings of RF and microwave components by adding broadband solutions to its product line. This was accomplished with the acquisition of components manufacturer Cir-Q-Tel and instruments manufacturer Texscan.

Today, Trilithic is an industry leader providing telecommunications solutions for major broadband, RF and microwave markets around the world. As an ISO 9000:2001 certified company with over 40 years of collective expertise in engineering and custom assembly, Trilithic is dedicated to providing quality products, services and communications solutions that exceed customer expectations.

Trilithic is comprised of four major divisions;

- **Broadband Instruments & Systems**
Offers test, analysis and quality management solutions for the major cable television systems worldwide.
- **RF Microwave Components**
Provides components and custom subsystems for companies specializing in cellular, military and other wireless applications.
- **Emergency Alert Systems**
Leading supplier of government-mandated emergency alert systems used by broadcast TV, cable TV, IPTV, DBS, and radio stations.
- **XFTP**
Offers a specialty line of field technical products for cable operators and technicians, as well as a line of products for installing electronics in the home of the future.

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General Information



Helpful Website

The following website contains general information which may be of interest to you:

<http://www.trilithic.com>

Trilithic's website contains product specifications and information, tips, release information, marketing information, Frequently Asked Questions (FAQs), bulletins and other technical information. You can also check this website for product updates.

Where to Get Technical Support

Trilithic technical support is available Monday through Friday from 8:00AM to 5:00PM EST. Callers in North America can dial 1-317-895-3600 or 1-800-344-2412 (toll free). International callers should dial 1-317-895-3600 or fax questions to 1-317-895-3613. You can also email technical support at XFTP@trilithic.com.

For quicker support response when calling or sending email, please provide the following information;

- Your name and your company name.
- The technical point of contact (name, phone number, email).
- The serial number for the Searcher Plus GT leakage detector.
- A detailed description of the problem you are having.

How this Manual is Organized

This manual is divided into the following chapters;

- Chapter 1, “General Information” provides Trilithic contact information and describes how this Operation Manual is structured.
- Chapter 2, “Introduction” introduces the Searcher Plus GT leakage detector and describes what it does. This chapter discusses the practical application, connections, and controls on the Searcher Plus GT.
- Chapter 3, “Using the Optional Mobile Mount” outlines the procedure to install the optional mobile mount in the vehicle, and how to install the Searcher Plus GT in the mobile mount.
- Chapter 4, “Operating the Searcher Plus GT” describes how to operate the Searcher Plus GT.
- Chapter 5, “Operational Tips” provides tips that will enhance the utilization of the Searcher Plus GT.
- Chapter 6, “Calibrating the Searcher Plus GT” details the procedure to calibrate the Searcher Plus GT.
- Chapter 7, “Calibration Calculations” provides equations which are necessary to calibrate the Searcher Plus GT.
- Chapter 8, “Specifications” shows the technical specifications of the Searcher Plus GT.

Conventions Used in this Manual

This manual has several standardized conventions for presenting information.

- User instructions and commands appear in **bold**.
- Section names, web, and email addresses appear in *italics*.



Note: A note is information that will be of assistance to you related to the current step or procedure.



CAUTION: A caution alerts you to any condition that could cause a mechanical failure or potential loss of data.



WARNING: A warning alerts you to any condition that could cause personal injury.

Precautions



WARNING: Use extreme caution when positioning the AFS-2 antenna. Do not contact electrical distribution lines. Contact with electrical lines may cause severe injury or death.



WARNING: Do not use the Searcher Plus GT in any manner not recommended by the manufacturer.



CAUTION: A strong electromagnetic field may affect the accuracy of the Searcher Plus GT's measurements.



CAUTION: Do not allow the Searcher Plus GT to come into close proximity with a magnetic antenna base.



CAUTION: Use only the battery charger supplied with the Searcher Plus GT .

This chapter;

- Describes the Searcher Plus GT's purpose
- Provides an overview of the Searcher Plus GT's features
- Lists the part numbers for the different Searcher Plus GT frequency configurations
- Lists the equipment supplied with the Searcher Plus GT, and optional accessories
- Gives a guided tour of the Searcher Plus GT's features and controls
- Discusses the Searcher Plus GT's battery

What is the Searcher Plus GT?

Trilithic's Searcher Plus GT leakage detector is ideally suited for the new era of digital program services and overbuilt systems. The Searcher Plus GT offers enhanced resistance to "false alarms" from other signal sources - including ignition noise and power line interference - making it the perfect instrument for identifying leaks in noisy areas.

The Searcher Plus GT is the first leakage detector built specifically for cable systems employing digital set top terminals that cannot tolerate "tagged" channels. The Searcher Plus GT employs many of the features found in other Trilithic leakage detectors, without the need for tagged test signals. The Searcher Plus GT displays leak measurements and emits a tone proportional to the leak strength when a leak is encountered.

The Searcher Plus GT may be used with an optional mobile mount for drive out leakage detection or used as a stand-alone device for leakage troubleshooting on foot, with a rubber duck antenna or optional dipole antenna.

The Searcher Plus GT is available in one of four standard frequencies, depending on specific cable system requirements. Contact Trilithic Sales for custom frequency requirements.

Searcher Plus GT Features

CW and FM Carrier Compatibility

Compatibility with an FM leakage transmitter or CW pilot is another key feature of the Searcher Plus GT. By lowering the carrier level slightly, and inserting the leakage transmitter ahead of the test point, locating the source of a leak is simplified.

Source Localization

The Searcher Plus GT emits an audible tone to help the user pinpoint the leakage source. The frequency (pitch) of the tone increases as the strength of the leak increases. As the user moves closer to the leak, the tone frequency will increase.



Note: Common leakage points are around the tap, drop cable, and any connection of the cable to other devices.

Flexible Mounting Options

In the field, the Searcher Plus GT can be used in a hand-held application, or it may be mounted in a vehicle. When used as a hand-held device, the Searcher Plus GT is powered by an internal rechargeable battery. The leakage detector employs a rubber duck antenna for locating leaks, or can be coupled to a 50 ohm (Ω) dipole antenna for observing leakage measurements in microvolts per meter ($\mu\text{V}/\text{m}$).

When the Searcher Plus GT is installed in the optional mobile mount (in the vehicle), it is powered from the vehicle's electrical system. By installing the Searcher Plus GT in the mobile mount, the connection to the vehicle's electrical system is automatically made. When the Searcher Plus GT is removed from the mobile mount, the detector automatically switches to the internal battery and the rubber duck antenna to detect leaks.

Searcher Plus GT Part Numbers

The Searcher Plus GT is available in a number of different base frequencies. Each frequency configuration has a corresponding part number, shown in the table below. Contact Trilithic Sales for custom frequency requirements.

Part Number	Frequency (MHz)
2011233121	121.2625
2011233127	127.2625
2011233133	133.2625
2011233139	139.2500

Equipment Supplied with the Searcher Plus GT

The Searcher Plus GT is shipped with the following components and accessories;

- Searcher Plus GT leakage detector
- Internal rechargeable NiMH battery
- Battery charger
- Rubber duck antenna
- Near-field probe (NFP-1)
- Operation manual

Replacement Parts and Accessories

Parts

The following replacement parts are available for the Searcher Plus GT. These parts are included with the original kit, and the part numbers shown below are direct replacements for lost or damaged parts.

Part Number	Description
0090034000	Searcher Plus GT Battery
2010477000	Near Field Probe (NFP-1)
2060728023	Rubber Duck Antenna
2071895000	Battery Charger

Accessories

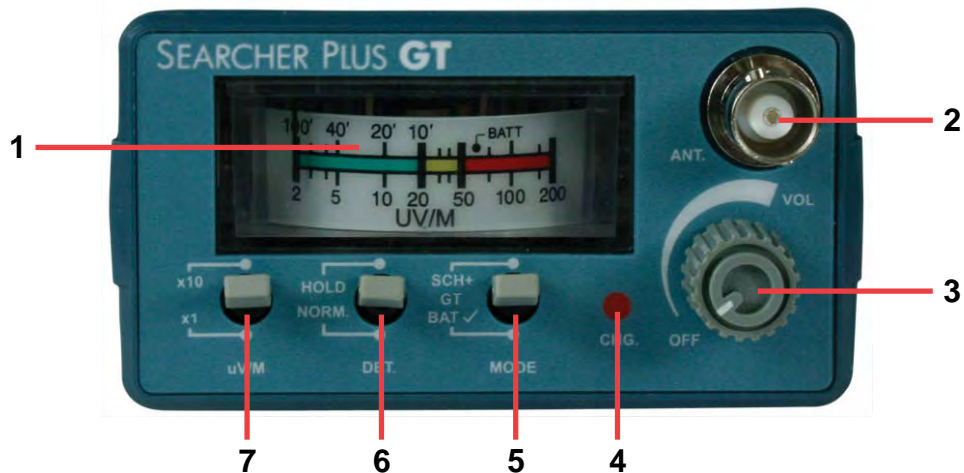
The following aftermarket accessories are available for the Searcher Plus GT. These accessories have been designed by Trilithic to work with the Searcher Plus GT.

Part Number	Description
2010436000	AFS-2 Dipole Antenna
2010649000	APM-2 Permanent Vehicle Mount Antenna
2010650000	APM-3 Permanent Vehicle Mount Antenna
2010380000	AVM-2 Magnetic Mount Vehicle Antenna
2010379000	AVM-3 Magnetic Mount Vehicle Antenna
2011234000	Mobile Mount Kit

To order replacement parts or accessories, call Trilithic at (317) 895-3600 or (800) 344-2412.

A Guided Tour of the Searcher Plus GT

Front View



- 1. Meter Scale** - Depending on the intended use of the Searcher Plus GT, the multifunctional scale functions as follows;
 - **Measuring Leak Strength** - The *lower* meter scale indicates the strength of a leak in $\mu\text{V}/\text{m}$, when using the AFS-2 horizontal dipole antenna.
 - **Indicating Whether a Leak Exceeds FCC Limits** - The *upper* scale is used to determine if a leak exceeds the FCC's maximum limits (no greater than $20 \mu\text{V}/\text{m}$ when measured 10 feet from the leak source).

As the distance from the leak source increases, the maximum leakage allowed (in $\mu\text{V}/\text{m}$) decreases. The *upper* scale indicates the maximum distance from the leak source, as it correlates to the maximum leak strength allowed at that distance (shown in the *lower* scale).
 - **Checking Battery Status** - The scale includes a marker to indicate when the battery is in a low-level condition (when the SCH+ / GT / BAT CHECK switch is depressed).
- 2. External Antenna Input Jack** - The external antenna input is a female BNC connector and is used to connect a rubber duck antenna or calibrated dipole antenna. When the Searcher Plus GT is installed in the optional mobile mount, this antenna jack is internally disconnected.
- 3. ON/OFF Switch / VOLUME Control** - Use this control to turn the Searcher Plus GT on or off, and to control the leakage detector's volume.

4. **Battery Charging Indicator** - When the red battery charging LED is on, the battery is being charged.
5. **SCH+ / GT / BAT CHECK Switch** - This three-position switch has several functions;
 - **BAT CHECK** - With the switch in the BAT CHECK position, the meter indicates the charge status of the battery. Holding the SCH+ / GT / BAT CHECK switch down will enable this feature. Accurate battery level readings are achieved only when the needle falls to the right of the BATT mark during the battery check. If the needle is to the left of the BATT mark, the battery must be charged.

When released, the switch returns to the GT (center) position.
 - **GT** - Set the SCH+ / GT / BAT CHECK switch to the GT position to enable the Searcher Plus GT's "noise discrimination" feature. In the GT position, the meter's resistance to false alarms from overbuilt cable systems is enhanced.
 - **SCH+** - Use SCH+ mode to operate the Searcher Plus GT without the noise discrimination feature.
6. **DETECTOR MODE Switch** - The detector mode switch determines how the meter indication changes as the strength of the leak changes.
 - **NORM** - In the NORM position (down), the needle on the meter moves in real-time over the scale, in proportion to the strength of the leak.
 - **HOLD** - In the HOLD position (up), the meter displays the maximum leak strength encountered within the previous 5 seconds. If the leak strength drops below the peak level, the meter holds the peak reading for 5 seconds.
7. **METER SCALE FACTOR Switch** - The meter scale factor switch is used to determine the value of the leak measured by the Searcher Plus GT.
 - **x1** - In the x1 position (middle), the signal sensitivity range is 2 to 200 $\mu\text{V}/\text{m}$.
 - **x10** - In the x10 position (down), the signal sensitivity range is 20 to 2000 $\mu\text{V}/\text{m}$.

Rear View



- 1. Vehicle Antenna Input** - The Searcher Plus GT is connected to an exterior vehicle antenna through the vehicle antenna input. The Searcher Plus GT is powered through this input - via a DC power inserter - when installed in the mobile mount, and the battery is simultaneously charged. When the Searcher Plus GT is installed in the optional mobile mount, the front antenna input jack is internally disconnected.



CAUTION: Only the external vehicle antenna should be connected to the vehicle antenna input. Any other type of antenna should be attached to the external antenna input jack, located on the front of the Searcher Plus GT.

- 2. x1 - x10 Squelch Control** - The control is used to select the signal strength required for the Searcher Plus GT to break squelch in the x1 to x10 sensitivity range. The Searcher Plus GT is set at the factory to break squelch at 2 $\mu\text{V}/\text{m}$ (to work with the AFS-2 dipole antenna), but can be set by the user to break squelch in the range of 2 to 20 $\mu\text{V}/\text{m}$.



Note: As the squelch level is reduced, the Searcher Plus GT's immunity to false alarms is also reduced.

About the Searcher Plus GT's Battery

Overview

- The Searcher Plus GT uses an 8.4 Volt nickel-metal hydride (NiMH) battery, which has a life of 4 hours (with a 10% audio duty cycle). The battery is charged during manufacture and should be ready to use as long as it has not been stored for a long period of time.



Note: Expended batteries should be disposed of in accordance with local laws and guidelines.

If the Searcher Plus GT Does Not Turn On

- A very low battery may prevent the Searcher Plus GT from turning on. Charge the battery for a few minutes, then re-attempt to turn the Searcher Plus GT on.

Checking the Battery Level

- To check the battery level, turn the Searcher Plus GT **on** and hold the **SCH+ / GT / BAT CHECK** in the **down** position. Accurate battery level readings are obtained only when the needle falls to the right of the BATT mark on the scale. If the needle is to the left of the BATT mark, the battery must be charged. **Release** the **SCH+ / GT / BAT CHECK** switch after checking the battery level.



Note: To fully recharge the Searcher Plus GT's battery from a depleted state, 14-16 hours of charger time is required.

Charging the Battery

- Connect the battery charger to the Searcher Plus GT power inserter input.
- The battery will charge when the Searcher Plus GT is turned on or off.
- When the battery is charging, the battery charging indicator LED on the front of the Searcher Plus GT will be illuminated.
- The battery's charge status is not displayed unless the SCH+ / GT / BAT CHECK switch is held down. The charger must be disconnected when testing the battery's charge.

Using the Optional Mobile Mount

This chapter;

- Provides guidance in selecting an installation location for the mobile mount
- Details the installation procedure for the permanently-mounted exterior antenna
- Gives instructions in connecting the mobile mount to the vehicle's electrical system

Overview

The Searcher Plus GT features a unique mobile mount adapter which connects the vehicle's charging system and the externally-mounted antenna to the leakage detector's rear panel. The mobile mount allows the battery to charge while the Searcher Plus GT is being used to search for leaks from inside the vehicle.

Selecting a Location for the Mobile Mount

The Searcher Plus GT may be installed in any vehicle which uses a +12 VDC *negative ground* electrical system. Choose a location to install the Searcher Plus GT that is within easy reach of the driver, and where the front panel can be easily read.

Suitable installation locations include;

- The underside of the dashboard
- The top of the transmission tunnel
- The engine cowling (for van installations only)



CAUTION: The mobile mount should be installed so that the front panel of the Searcher Plus GT is not exposed to direct sunlight.



WARNING: Do not install the mobile mount overhead, or in any location where the Searcher Plus GT could cause physical injury, should it be dislodged from the mobile mount during a vehicle collision.

Installing the Exterior Antenna

The Searcher Plus GT is designed to work with a AVM magnetic-mount, or APM permanent-mount antenna, installed on the exterior of the vehicle.

1. Choose a location to install the antenna on the roof, away from obstructions or other antennas.
2. Route the coaxial antenna cable into the vehicle and to the location where the mobile mount will be installed. Avoid any sharp bends or kinks in the coaxial cable.



Note: If antennas are in close proximity to each other, the Searcher Plus GT may indicate a false leak when an antenna in close proximity transmits. This condition will not damage the Searcher Plus GT.

Powering the Mobile Mount

The mobile mount for the Searcher Plus GT is equipped with a power inserter. The power inserter is built into the mobile mount, and combines power from the vehicle's electrical system with the signal from the antenna, mounted on the vehicle's exterior.

1. Route the positive (red) and negative (black) power wires for the power inserter to a non-keyed electrical source on the vehicle. The power source should always be *on*, even when the vehicle's ignition is *off*.



Note: Connecting the power inserter to an “always-on” power source will ensure that the Searcher Plus GT's battery continues to charge when the vehicle has been turned off.

2. Connect the positive (red) wire to a positive (+) power source on the vehicle.
3. Connect the negative (black) wire to a negative (-) power source on the vehicle. A suitable chassis ground connection can also be used.
4. Install the mobile mount in the previously selected location (see the section, *Selecting a Location for the Mobile Mount* in this chapter). Use the provided clamp to secure the mobile mount.
5. Route the positive (red) wire, negative (black) wire, and coaxial antenna cable to the installed power inserter. Avoid any sharp bends or kinks in the coaxial cable.



Note: The Searcher Plus GT will not deplete the vehicle's battery, even if left to charge or left on for an extended period of time.



CAUTION: The Searcher Plus GT is not protected against reverse polarity. Ensure that the positive (red) and negative (black) wires to the power inserter are connected correctly before placing the Searcher Plus GT in the mobile mount.

Operating the Searcher Plus GT

This chapter;

- Provides detailed information to consider when monitoring for leakage
- Gives instruction in locating the source of the leak
- Outlines the procedure to measure leaks
- Gives tips in using the Searcher Plus GT for ingress testing

Leakage Monitoring

The Searcher Plus GT is ideally suited for daily leakage monitoring. To monitor leakage, the following equipment is required;

- Searcher Plus GT leakage detector
- AVM-2/AVM-3 (magnetic-mount) or APM-2/APM-3 (permanent-mount) mobile antennas
- Rubber duck antenna
- Horizontal dipole antenna (AFS-2)

The following conditions may affect the accuracy of a leak measurement, and must be considered when patrolling for leaks.

Absolute Leakage Measurements

While it is theoretically possible to calculate the absolute value of a leak, several variables exist which can degrade the accuracy of the leak measurement.

Variable Effects

Vehicle antenna pickup pattern - The AVM-2 and AVM-3 vertical antennas exhibit maximum gain at low angles with respect to the ground plane, which provides good performance at medium to long ranges. The antennas' performance degrades at close range because the sensitivity of the antenna lessens as it comes closer to the leakage source.

Pattern disruption - Placing the roof-mounted antenna near other antennas, booms, ladders, etc., will effect the performance of the antenna.

Polarization angle - Gain characteristics of the antenna versus the polarization angle may disrupt the antennas' sensitivity, and the polarization angle is antenna-dependent.

Field decay - Two forms of emissions are present when making "close-in" measurements;

- Magnetic field (H-field)
- Electronic field (E-field)

These fields can cause voltage induction on the receiving antenna.

The H-field decays in a nonlinear manner and may have some effect on "close-in" measurements (depending on frequency).

The E-field can be the primary source of antenna stimulation at 100 feet. This can result in poor correlation between calculated and actual leak measurements.

Other variables - Other variables which can affect leakage readings include obstructions, multi-leak phasing, standing waves, etc.

Solutions to Variable Effect Problems

The ideal means to eliminate the possibility of external variables affecting the accuracy of a leak measurement is to perform a full evaluation of the Searcher Plus GT's signal pickup characteristics.

The evaluation should be performed using a leak of known amplitude. The known leak should be qualified by a standard measurement test, with a Searcher Plus GT and an AFS-2 dipole antenna located in a horizontal plane, measured 3 meters from the leak.

The vehicle must also be evaluated in both the frontal and broadside orientations, at varying ranges. This measurement can be used as a calibration source for all vehicles in the fleet.

Relative Leakage Measurements

A secondary method exists for calculating relative leakage measurements. The best range at which to obtain a measurement for leakage value is 3 meters. If it is not possible to measure a leak at the ideal range, calculating the relative strength of the leak can prove to be of value. As relative leakage measurements have the greatest potential for error, an understanding of how to correct readings taken from ranges greater than 3 meters is imperative.

- To approximate the value of the leak measurement, estimate the distance to the suspect source, in feet (D).



Note: If the value of the leak measurement is taken from a vehicle, use the estimated distance when a peak value is indicated by the Searcher Plus GT. Always round the estimate up, to the nearest 10 feet.

- Divide the estimated distance (D) by 10 (feet).
- Multiply the result by the meter reading (MR).
- Thus, the *range formula* for computing the approximate value of a leak is:

$$\frac{D}{10 \text{ (ft)}} \times \text{MR} = \text{approximate value of the leak}$$

Example 1

The estimated distance to a leak is 200 feet and the meter reading is 5 $\mu\text{V/m}$.

$$\frac{200 \text{ ft}}{10 \text{ ft}} \times 5 \mu\text{V/m} = 100 \mu\text{V/m}$$

The approximate value of the leak is 100 $\mu\text{V/m}$.

Example 2

While on mobile (vehicle-based) patrol, the Searcher Plus GT breaks squelch, indicating a leak. The meter indicates a value of 2 $\mu\text{V}/\text{m}$ and the distance to the leak is approximately 100 feet. Calculate the approximate value of the leak as follows:

$$\frac{100 \text{ ft}}{10 \text{ ft}} \times 2 \mu\text{V}/\text{m} = 20 \mu\text{V}/\text{m}$$

The approximate value of the leak is 20 $\mu\text{V}/\text{m}$ (20 $\mu\text{V}/\text{m}$ is the FCC limit in the Searcher Plus GT's frequency range).

x1 Sensitivity Range

With the Searcher Plus GT in x1 mode, the leakage detector breaks squelch at 2 $\mu\text{V}/\text{m}$. Using the range formula, the maximum distance at which the Searcher Plus GT can detect a 20 $\mu\text{V}/\text{m}$ leak (while in the x1 setting) is 100 feet.

When patrolling for leaks, use the following guidelines in setting the sensitivity of the leakage detector;

- **Range of 0 - 10 feet** - Use the x10 setting for a maximum signal sensitivity of 20 $\mu\text{V}/\text{m}$ (multiply the readings by 10).
- **Range of 10 - 100 feet** - Use the x1 (standard) setting for a maximum signal sensitivity of 2 $\mu\text{V}/\text{m}$.

x10 Sensitivity Range

The sensitivity of the Searcher Plus GT can be decreased when measuring large leaks by using the sensitivity switch to select the x10 range. Using this feature eliminates low-value leaks when searching for a high-value leak.

When the Searcher Plus GT is in x10 mode, the leakage detector breaks squelch at 20 $\mu\text{V}/\text{m}$.



Note: To read the scale while the Searcher Plus GT is in the x10 setting, multiply the $\mu\text{V}/\text{m}$ reading by 10. For example, in the x10 setting 2 $\mu\text{V}/\text{m}$ becomes 20 $\mu\text{V}/\text{m}$, 5 $\mu\text{V}/\text{m}$ becomes 50 $\mu\text{V}/\text{m}$, and so on.

Localizing the Source of a Leak

The Searcher Plus GT emits an audible tone when a leak is detected. This tone aids in locating the exact source of a leak. To locate a leak, the following equipment is needed;

- Searcher Plus GT leakage detector
- Rubber duck antenna
- Near-field probe (NFP-1)

If the Searcher Plus GT breaks squelch while patrolling in a vehicle, a leak has been detected. After being alerted to the presence of a leak, the location of the leak must be determined.

Park the vehicle and remove the Searcher Plus GT from the mobile mount. The Searcher Plus GT automatically switches the antenna input from the vehicle input source (rear input) to the external input antenna jack (front input). Install the rubber duck antenna on the front of the Searcher Plus GT.



Note: The Searcher Plus GT is not as sensitive when the rubber duck antenna is installed, as compared to when the leakage detector is connected to the antenna installed on the exterior of the vehicle.



Note: When patrolling for leaks on foot, it is easier to pinpoint leaks by listening to the audible tone, rather than reading the meter scale.

As the Searcher Plus GT receives leakage signals, the audio voltage controlled oscillator (VCO) activates. As the Searcher Plus GT moves closer to the source of the leak, the pitch of the audible tone increases. By listening to the increased pitch, the general location of the leak can be determined.

The rubber duck antenna is often not sensitive enough to locate the exact source of the leak. Once the general location has been determined, remove the rubber duck antenna and replace it with the near-field probe to pinpoint the leak within the suspect location. The near-field probe is directionally sensitive. As a result, the probe must be very close to the leak for the Searcher Plus GT to respond. Use the near-field probe to examine individual cable connectors for shield integrity.



Note: Due to the lack of an earth ground in portable test equipment, the cable center conductor of the near-field probe is not well-shielded. When testing with the near-field probe, it is imperative to search with the end of the probe and keep the connecting cable away from the point being tested.

Leakage Measurement

After locating the source of the leak, the strength of the leak must be measured. To measure the strength of a leak, the following equipment is necessary;

- Searcher Plus GT leakage detector
- Horizontal dipole antenna (AFS-2)

To measure the strength of the leak, position the horizontal dipole antenna 3 meters below the suspected leak and 3 meters above the ground. The horizontal dipole antenna includes a telescopic rod which, when fully extended, is 3 meters in length.



WARNING: Use extreme caution when positioning the horizontal dipole antenna. Do not contact electrical distribution lines. Contact with electrical lines may cause severe injury or death.

If there is not enough space below the suspected leak component (the suspected cable connector is less than 3 meters from the ground), move the dipole antenna away from the leak until the measurement envelope is satisfied (3 meters above the ground and 3 meters away from the leak).



Note: Keep any objects which may cause echoes in the leak signal away from the horizontal dipole antenna, such as a vehicle. To obtain the most accurate measurement, any obstruction which may reflect the leak signal should be at least 20 feet away from the dipole antenna.

Once the horizontal dipole antenna is correctly positioned (relative to the source of the leak), rotate the antenna around its vertical axis and record the peak level reading. Use the peak hold feature of the Searcher Plus GT to capture this level (set the detector mode switch to **HOLD**).

For leak measurements in excess of 200 $\mu\text{V}/\text{m}$, set the meter scale factor switch to **x10** to change the meter scale from 2 - 200 to 20 - 2000 $\mu\text{V}/\text{m}$. Listen to the pitch of the audible tone and observe the Searcher Plus GT's meter to determine the peak measurement of the leak.



Note: After repairing a leak, always verify the quality of the repair with the Searcher Plus GT and the near-field probe. After verifying the repair, replace the near-field probe with the rubber duck antenna and check the area for additional leaks. Repair any additional leaks that are found.

Ingress Testing

The Searcher Plus GT can be used to locate ingress points in a cable system. For ingress testing, the following equipment is required;

- Searcher Plus GT leakage detector
- AVM-2/AVM-3 (magnetic-mount) or APM-2/APM-3 (permanent-mount) mobile antennas
- Horizontal dipole antenna (AFS-2)
- Near-field probe (NFP-1)

A cable system component which is a source of leakage can also allow noise to ingress in to the cable system. Ingress noise can originate with a variety of sources; cellular telephones, off-air television, mobile radios, etc. If the strength of the ingress signal is great enough, the ingress can interfere with cable broadcast signals.

Traditional Ingress Testing

Ingress testing is normally measured by testing inside the coaxial cable, and is typically done with a spectrum analyzer. This relative measurement compares the desired signal (usually a video carrier) with an undesired signal which is usually introduced by the antenna effect, through a mechanical failure in the cable. The resulting measurement is used to determine the severity of the ingress within the cable system.

Ingress Testing with the Searcher Plus GT

By testing for leakage with the Searcher Plus GT, leakage points (which may allow ingress at the same location) can be found and repaired. By using the Searcher Plus GT to identify and correct leakage, a majority of ingress points can be corrected without using the more complex traditional testing method.

Ingress Characteristics

The most susceptible points in a cable system for ingress occur are in the sections of the system where the signal is the weakest. This includes drops, low-value taps, and line connectors. As a result, to isolate ingress points, the smallest of leaks must be located and corrected.

As mechanical failures in the coaxial cable are found and corrected, the ingress rejection of the entire system should increase. The rejection characteristics of the cable system should be improved on the forward and return signals.

Ingress Testing Procedure

The most practical method for ingress testing is to first evaluate a section of the cable system which is known to be in good operational condition. Measurements made in this section can be used as a base line measurement and can be compared against other sections which are suspected of allowing ingress.

- Using a spectrum analyzer, check the cable system section for the level of radio frequency ingress.
- Note what is an acceptable level with regard to the nearest tap value. This is an indicator of the line transmission value which is feeding the leakage.
- As the tap value increases, greater measured levels of leakage can be tolerated. When greater leakage tolerance levels are allowed, the system's sensitivity to ingress will be reduced.

Once a base line measurement in a section of the system that is known to be in good operational condition has been made, the Searcher Plus GT, with the vehicle's external antenna, can be used for leakage patrolling. As outlined in Chapter 4: Operating the Searcher Plus GT, sections: Leakage Monitoring, Localizing the Source of a Leak, and Leakage Measurement, use the near-field probe to locate the source of the leak, and use the horizontal dipole antenna to measure the level of the identified leak.

Overview

Beyond the basic features of the Searcher Plus GT, the following tips will help to enhance the utilization of the Searcher Plus GT;

- Operating with CW or FM carriers
- Setting the squelch level

Operating with CW or FM Carriers

The Searcher Plus GT is specifically designed to detect video carrier signals. It can also be used with a CW pilot or narrow band FM leakage transmitter.

If a CW pilot or FM leakage transmitter is used, the level of the carrier must be lowered slightly. To use the Searcher Plus GT with a CW pilot or FM leakage transmitter, set the carrier level 1.5 dB below the appropriate video carrier level for that frequency.



Note: If an FM leakage transmitter is used, disable the level stepping function.

Setting the Squelch Level

The Searcher Plus GT's x1 - x10 squelch level has been set by the factory at 2 μ V/m. The squelch level can be changed by adjusting the SQUELCH potentiometer on the rear panel. To adjust the squelch setting;

1. Find or create a leak equal to the desired squelch level. Use the Searcher Plus GT to locate a leak of the correct level, and with the Searcher Plus GT still in the mobile mount, place the vehicle near the source of the leak.
2. Remove the Searcher Plus GT from the mobile mount. Connect the vehicle's exterior antenna to the Searcher Plus GT's **RF INPUT JACK**, on the front panel.
3. Switch the Searcher Plus GT's mode to **SCH+**.
4. Rotate the **x1 - x10 SQUELCH** control clockwise, until it reaches its stop. Next, rotate the **x1 - x10 SQUELCH** control counterclockwise until the audio signal returns. Stop rotating as soon as the audio tone returns.
5. Confirm the squelch setting by moving toward and away from the source of the leak. The audio signal should alarm as the Searcher Plus GT is moved closer to the leak; the signal should mute as the Searcher Plus GT is moved away from the leak.



Note: The squelch circuit in the Searcher Plus GT turns the scale and the audio off. The scale will not indicate a leak of any strength until the squelch level is exceeded.

Calibrating the Searcher Plus GT

Overview

Trilithic recommends that the Searcher Plus GT's calibration be checked for accuracy on a regular basis. The leakage detector may require occasional re-calibration.

Trilithic further recommends that a 20 $\mu\text{V}/\text{m}$ calibration signal be established for the purpose of performing a monthly verification of the Searcher Plus GT's accuracy (refer to the [Calibration Procedure](#) section in this chapter for detailed instructions). A complete calibration check should be performed at least once per year, or more frequently if calibration variance is indicated by the monthly verification checks.

The performance of the Searcher Plus GT can be verified by using the following procedure, and the signals normally available at a cable television test point.



Note: When calibrating the Searcher Plus GT, first check the test area with the Searcher Plus GT and a rubber duck antenna for leaks. The presence of secondary leaks in the test area can cause significant measurement errors when calibrating the Searcher Plus GT. Correct any leaks found in the test area before proceeding with the calibration procedure.

Required Test Equipment

The following equipment will be necessary to perform the Searcher Plus GT calibration;

- **Signal level meter** - Model Three or 860 DSP
- **75 Ω variable attenuator** - 1 to 64 dB; SA-70
- **75 Ω fixed pad** - 20 dB; FP-75/20 F
- **75 Ω to 50 Ω match network (female F connector to male BNC connector)** - ZM-57 matching pad *or* ZMT-57 matching transformer
- **Adjustable DC power supply** - 7 to 12 VDC @ 50 mA
- **Digital voltmeter**

Test Setup

Refer to the table below to determine the signal level required for the input to the matching pad.

Test Signal Levels for 200 $\mu\text{V/m}$:

Frequency	ZM-57 (5.7 dB loss)	ZMT-57 (0.2 dB loss)
109 MHz	-15.5 dBmV	-21.0 dBmV
115 MHz	-16.0 dBmV	-21.5 dBmV
121 MHz	-16.4 dBmV	-21.9 dBmV
127 MHz	-16.8 dBmV	-22.3 dBmV
133 MHz	-17.2 dBmV	-22.7 dBmV
139 MHz	-17.6 dBmV	-23.1 dBmV
145 MHz	-18.0 dBmV	-23.5 dBmV
151 MHz	-18.4 dBmV	-23.9 dBmV
157 MHz	-18.8 dBmV	-24.3 dBmV



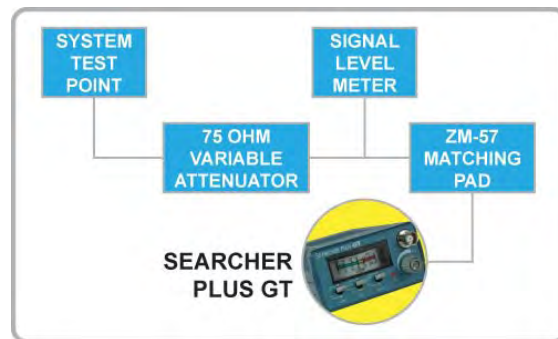
Note: These values include an antenna factor for a standard dipole.
For a derivation of these levels, see [Chapter 7: Calibration Calculations](#).

Connecting the Searcher Plus GT

When checking the calibration of the Searcher Plus GT, the leakage detector should be placed in the horizontal position on the bench. This will eliminate any slight balancing errors near the scale edges which occur with the leakage detector is moved from the horizontal to the vertical position. This should not affect the readings near the center of the scale.

The Searcher Plus GT can be calibrated for measuring leaks while held in the vertical position. Ensure that the technicians using the Searcher Plus GT have been made aware of which orientation the Searcher Plus GT was calibrated to work in.

Connect the Searcher Plus GT to the test equipment as outlined in the figure and the procedure below;



1. Connect the attenuator to the cable system test point.
2. Connect the signal level meter to the attenuator's output.
3. Set the attenuator to display the $200 \mu\text{V}/\text{m}$ reading, as shown in the *Test Setup* section of this chapter.



Note: If the correct level cannot be obtained with the attenuator, it may be necessary to adjust the modulator output level or add a length of coaxial cable to achieve a level as close as possible to the level listed in the table, shown in the *Test Setup* section of this chapter.



Note: Ensure that the correct column (ZM-57 or ZMT-57) for the selected matching pad in the *Test Signal Level* table is being referenced.

4. Once the attenuator is set, note the setting that was required to obtain the $200 \mu\text{V}/\text{m}$ test level.
5. Disconnect the signal level meter and connect the matching pad.

Checking Calibration

Remove the Searcher Plus GT from the mobile mount and check to see that the battery is charged. Turn the leakage detector **on** and depress the **SCH+ / GT / BAT CHECK** switch to verify the battery condition. Next, connect the matching pad to the **RF INPUT JACK**, on the front of the Searcher Plus GT.



Note: All of the values shown below have a tolerance of ± 1.5 dB.

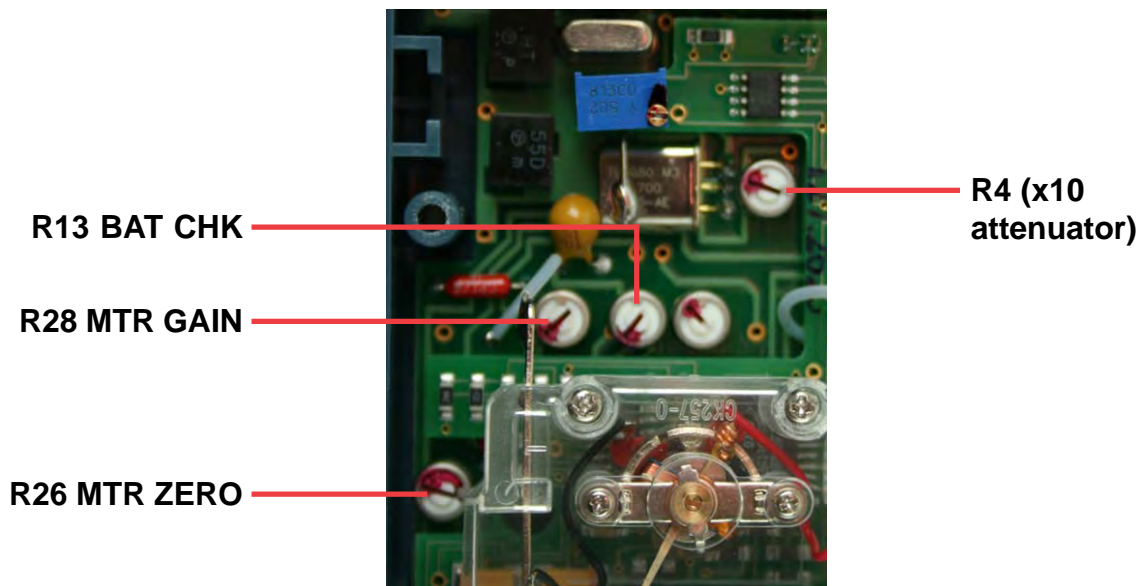
1. Set the Searcher Plus GT to **x1** and **SCH+**. Turn the leakage detector **on** and verify that the scale reads 200 $\mu\text{V}/\text{m}$.
2. Check the 100 $\mu\text{V}/\text{m}$ reading by adding 6 dB to the 200 $\mu\text{V}/\text{m}$ attenuator setting.
3. Check the 50 $\mu\text{V}/\text{m}$ reading by adding 12 dB to the 200 $\mu\text{V}/\text{m}$ attenuator setting.
4. Check the 20 $\mu\text{V}/\text{m}$ reading by adding 20 dB to the 200 $\mu\text{V}/\text{m}$ attenuator setting.
5. Check the 10 $\mu\text{V}/\text{m}$ reading by adding 26 dB to the 200 $\mu\text{V}/\text{m}$ attenuator setting.
6. Check the 5 $\mu\text{V}/\text{m}$ reading by adding 32 dB to the 200 $\mu\text{V}/\text{m}$ attenuator setting.
7. Check the 2 $\mu\text{V}/\text{m}$ reading by adding 40 dB to the 200 $\mu\text{V}/\text{m}$ attenuator setting.

If the Searcher Plus GT reads substantially high on the low end of the scale, the signal may be leaking around the attenuator, or the leakage in the test area may be too great to make an accurate test reading. Locate and repair any leaks, or move the calibration checking procedure to a location free of leaks before attempting to calibrate the Searcher Plus GT.

Calibration Procedure

If the calibration check reveals that the Searcher Plus GT is out of calibration, perform the following calibration procedure;

1. Remove the top cover from the Searcher Plus GT.
2. Establish a 200 $\mu\text{V}/\text{m}$ signal, as described in the section, *Connecting the Searcher Plus GT*, in this chapter.
3. Set the Searcher Plus GT to **x1** range and **SCH+** mode. Turn the **x1 - x10 SQUELCH** control (on the back of the Searcher Plus GT) counterclockwise, until it reaches its stop. Connect the signal to the **RF INPUT JACK** on the front panel.
4. Set the Searcher Plus GT for 200 $\mu\text{V}/\text{m}$ (on the front scale) using the **R28 MTR GAIN** potentiometer.



5. Add 40 dB to the attenuator setting. Set the Searcher Plus GT for 2 $\mu\text{V}/\text{m}$ (on the front scale) using the **R26 MTR ZERO** potentiometer.
6. Check the remaining calibration points, as shown in the *Checking Calibration* section of this chapter.
7. Readjust the **R26** and **R28** settings for the best tracking over the scale.

The Searcher Plus GT is calibrated at the factory to average measurement errors over the entire scale. If desired, the Searcher Plus GT can be calibrated in the field for better accuracy in the center of the scale. This will result in greater error at the scale extremes.

Attenuator x10 Setting

The attenuator x10 can be adjusted, with the following procedure;

1. Add 20 dB to the 200 $\mu\text{V}/\text{m}$ attenuator setting. This will set the test signal to the 20 $\mu\text{V}/\text{m}$ level.
2. Take note of the Searcher Plus GT's reading on the scale.
3. Reset the test signal to the 200 $\mu\text{V}/\text{m}$ value.
4. Set the sensitivity of the Searcher Plus GT to x10 by depressing the **x10** switch on the front.
5. Adjust the **R4** control to display the same reading noted in *Step 2*, with the 20 $\mu\text{V}/\text{m}$ test level.

Setting the Squelch

Adjust the x1 - x10 SQUELCH as described in the following procedure;

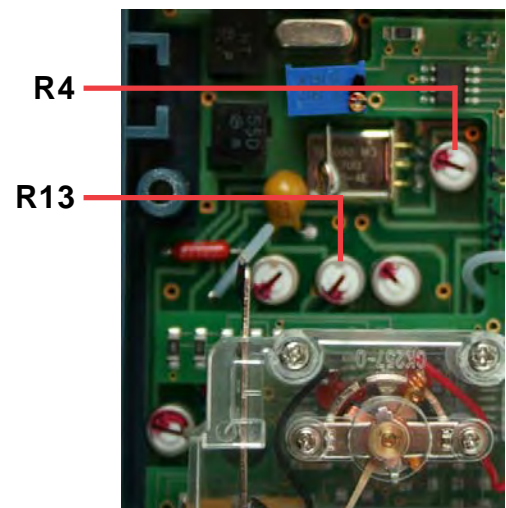
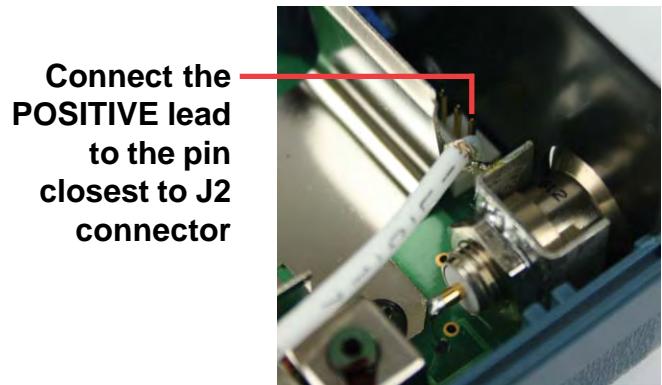
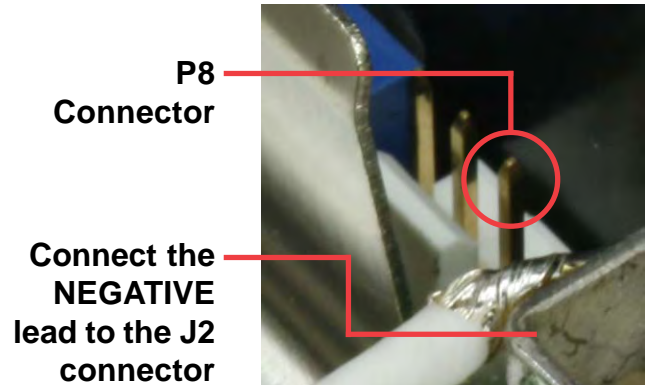
1. Set the test level to 2 $\mu\text{V}/\text{m}$.
2. Set the Searcher Plus GT to the **x1** range and **SCH+** mode.
3. Adjust the **x1 - x10 SQUELCH (R37 potentiometer)** so that the Searcher Plus GT *just* breaks squelch (when an audible tone is emitted).
4. Reduce the test signal by 1 dB and fine-tune the **R37** setting so the Searcher Plus GT is squelched off.
5. Repeat the procedure until the desired squelch settings are achieved.



Calibrating the Battery Indicator Scale

While the Searcher Plus GT is disassembled for calibration, Trilithic suggests that the battery's scale is calibrated against a known voltage. Set the lower limit for the battery scale with the following procedure;

1. Disconnect the battery from the circuit board. It is not necessary to remove the battery from the Searcher Plus GT.
2. Apply 7.55 VDC to the battery circuit.
Connect the NEGATIVE supply lead to the bracket which holds the **J2** connector.
Connect the POSITIVE supply lead to pin on the **P8** connector which is closest to the **J2** connector.
3. Press and hold the **SCH+ / GT / BAT CHECK** switch on the front of the Searcher Plus GT in the **down** position.
4. While holding the **SCH+ / GT / BAT CHECK** switch in the **down** position, adjust the **R13** potentiometer so the needle is aligned over the BATT mark on the scale.
5. Release the **SCH+ / GT / BAT CHECK** switch and disconnect the DC test leads.
6. Reconnect the battery and reinstall the top cover.



Calibration Calculations

The test signal levels for calibrating the Searcher Plus GT are based on the standard equations below;

$$\text{Level (dBmV)} = 20 \log \left(\frac{E (\mu\text{V/m})}{20.5 \times F (\text{MHz})} \right)$$

Where:

E = the desired signal level in $\mu\text{V/m}$

F = the frequency in MHz

Example 1

20 $\mu\text{V/m}$ is the desired signal level

133.2625 (MHz)

$$\begin{aligned} \text{Level (dBmV)} &= 20 \log \frac{20}{20.5 \times 133.2625} \\ &= 20 \log \left(\frac{20}{2731.8813} \right) \\ &= 20 \log (0.007321) \\ &= -42.7086 \sim -42.71 \text{ dBmV} \end{aligned}$$

Example 2

200 $\mu\text{V}/\text{m}$ is the desired signal level

133.2625 (MHz)

$$\begin{aligned}\text{Level (dBmV)} &= 20 \log \frac{200}{20.5 \times 133.2625} \\ &= 20 \log \left(\frac{200}{2731.8813} \right) \\ &= 20 \log (0.0732096) \\ &= -22.7086 \sim -22.71 \text{ dBmV}\end{aligned}$$

Technical Specifications

- **Frequency Range:** Single frequency from 108 to 157.2500 MHz
- **Receiver Bandwidth:** Typical 6 KHz at -3 dB
- **Input Sensitivity:** 2 μ V/m in x1 mode
20 μ V/m in x10 mode
- **Selectivity:** Typical 6 KHz at -3 dB
- **Meas. Accuracy:** +/- 1.5 dB @ 25° C (77° F)
+/- 3.0 dB @ -18° C to 49° C (0° to 120° F)
- **Meter Functions:** 2-2000 μ V/m, normal amplitude tracking.
When detector is set to the HOLD mode, the peak reading is held for 5 seconds before auto-reset.
- **Alarm Indication:** Audio tone with pitch proportional to meter deflection.
- **Power:** Rechargeable NiMH battery; charged from the included AC charger or the optional mobile mount.
- **Weight:** 1 lb. (0.45 kg) without mobile mount.
- **Dimensions:** 1.75" x 3.25" x 6.00" (H x W x D)
(44mm x 83mm x 152mm)

Warranty Information

Trilithic, Inc. warrants that each part of this product will be free from defects in materials and workmanship, under normal use, operating conditions and service for a period of one (1) year from date of delivery. Trilithic, Inc.'s obligation under this Warranty shall be limited, at Trilithic, Inc.'s sole option, to replacing the product, or to replacing or repairing any defective part, F.O.B. Indianapolis, Indiana; provided that the Buyer shall give Trilithic, Inc. written notice.

Batteries are not included or covered by this Warranty.

The remedy set forth herein shall be the only remedy available to the Buyer under this Warranty and in no event shall Trilithic, Inc. be liable for incidental or consequential damages for any alleged breach of this Warranty. This Warranty shall not apply to any part of the product which, without fault of Trilithic, Inc., has been subject to alteration, failure caused by a part not supplied by Trilithic, Inc., accident, fire or other casualty, negligence or misuse, or to any cause whatsoever other than as a result of a defect.

Except for the warranty and exclusions set forth above, and the warranties, if any, available to the Buyer from those who supply Trilithic, Inc., there are no warranties, expressed or implied (including without limitation, any implied warranties of merchantability of fitness), with respect to the condition of the product or its suitability for any use intended for it by the Buyer or by the purchaser from the Buyer.



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