

SENCORE

SLM 1453I

RF Level and Leakage/Ingress Level Meter



OPERATION and APPLICATION MANUAL

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WARNING

PLEASE OBSERVE THESE SAFETY PRECAUTIONS

There is always a danger present when using electronic equipment.

Unexpected high voltages can be present at unusual locations in defective equipment and signal distribution systems. Become familiar with the equipment with which you are working and observe the following safety precautions.

- Every precaution has been taken in the design of your SLM 1453I to insure that it is as safe as possible. However, safe operation depends on you the operator.
- Never exceed the limits of the SLM 1453I as given in the specifications section or other special warnings provided in this manual.
- Always be sure your equipment is in good working order. Ensure that all points of connection are secure to the chassis and that protective covers are in place and secured with fasteners.
- Remove test leads immediately following measurements to reduce the possibility of shock.
- Never work alone when working in hazardous conditions. Always have another person close by in case of an accident.
- Never assume that a cable shield is at earth ground potential. Both static and electrical voltages can be present on a cable's sheath. Do not connect the SLM 1453I to a cable having a hot shield. Doing so may place lethal voltages on the SLM 1453I.
- Always follow standard safety procedures, such as, using your safety belt when working above the ground.

When in doubt be careful.

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SLM 1453I DESCRIPTION

Introduction

Service and Installation Technicians are responsible for the last leg of the CATV System, which connects the subscriber to the system. It is obvious, that for the subscriber to receive the quality signals from your system, that as much care and exacting quality must go into the drop as goes into the rest of the system. The drop must conform to local codes as well as meet the system's design standards. Today's modern broadband system requirements make it almost necessary to test every installation to insure that the proper signal level requirements are provided to the customer.

The basic tools required to perform a quality installation will include a signal level meter. The technician who can verify an installation with his signal level meter can be assured that he has completed a good installation that will continue to provide the subscriber with the quality pictures that subscribers expect today. Likewise, the service technician must rely on his signal level meter to troubleshoot problems in the distribution and drop system. The CATV system is very carefully designed to provide specific signal levels at every point in the system, from the Trunk or Node to the distribution amplifiers and the drop. The Installer and Service technician must be able to insure these levels meet the design criteria for trouble free and long-term subscriber service.

The SLM 1453I will allow you to test any RF connection in the distribution system on any channel as simply as tuning any TV set. The SLM 1453I tunes the entire CATV band of channels from channel 2 through channel 137; a full 878 MHz of tuning capability so that you can use the SLM 1453I on any system and measure the level on any converter channel, Band Edge, Premium or Pay-Per-View channel. Unlike many signal level meters, the SLM 1453I is hand-held and a quality tool that will provide confidence to the user.

Features

The SLM 1453I is the affordable answer to equipping the Installer and Service technician. The SLM 1453I will tune to any CATV channel in the spectrum from 5 to 878 MHz. In addition, frequency tuning allows the user to tune to any frequency to measure pilots, DMX carriers, converter control signals, or other carriers used in today's modern systems. The SLM 1453I also allows you to switch between US Cable, HRC, IRC and VHF/UHF channel plans, including 8-VSB HDTV Off-air channels, Custom, or build your own custom channel plan, right from the keyboard

The LCD display is foolproof to read in the brightest sun and in the coldest weather—no confusing scales to interpret or attenuators to add or subtract from your readings. Attenuator functions are automatic and provide direct signal level reading from -45dBmV to $+65\text{dBmV}$.

In addition to analog signal level measurements the SLM 1453I also provides the convenience of measuring digital power, digital signal quality and flatness without any mental conversions.

The SLM 1453I also provides the technician with an easy-to-use and affordable method of testing for leakage and ingress in the field or after the installation is completed.

Specifications – SLM 1453I

Tuning Range

Channel Plans: FCC (std), HRC, IRC, VHF + UHF, Custom 1, 2, & 3

Channel Step size: 1 CH. (6 MHz)

Freq. Step size: 62.5 kHz

U.S Cable Band:

Channels: 2 thru 137 (Ch 1 in HRC & IRC)

Frequency: 50 thru 878 MHz

VHF + UHF Band:

Channels: 2 thru 69

Frequency: 50 thru 878 MHz

Sub-bands

Channels: T-7 thru T-13

Freq: 5-50 MHz

Resolution:

Channel Mode: 1 Channel

Frequency Mode: 1 kHz

RF Input

Sensitivity: -45 dBmV (analog & digital)

Resolution: dBmV mode: 0.1dBmV, dB μ V mode: 0.1dB μ V

μ V and μ V/m mode: 1 μ V up to 1000 μ V, 10 μ V up to 10,000 μ V

100 μ V up to 100,000 μ V, 1000 μ V above 1V

Maximum Reading: +65 dBmV (analog & digital)

Input Impedance: 75 Ohms

Max. Safe Input: 100V AC/DC, +65 dBmV >1 KHz thru input connector

Measurement Functions

Digital Carrier Functions: Digital Power, BER, Quality, Flatness, C/N

Video Carrier Level Resolution: 1.0 dBmV typical (1.8 dBmV max.)

Format: QAM 64, QAM 256, 8-VSB

Amplitude Accuracy

CATV, UHF, VHF: 1.0 dBmV typical (1.8 dBmV max.)

Audio Carrier Level Accuracy

CATV, UHF, VHF: 1.0 dBmV typical (1.8 dBmV max.)

C/N Ratio

Accuracy: +/- 1.5 dB typical (2.5 dBmV max.)

Input Range: 0 dBmV to measure 50 dB C/N

A/V Ratio

Accuracy: +/- 1.5 dB

Leakage Measurements

Tuning Range: Full Range

Resolution: 1.0 dB μ V/m

Range: 1.4 μ V/m – 5000 μ V/m

Ingress Measurements

Range: 5-47 MHz

Threshold Setting: -50 to +20 dBmV

(Specified to -45 dBmV)

General

Power Requirements: 120 V AC,

Rechargeable Battery Life: 14 Hrs Continuous

Battery Saver Auto Off: 10 min. nominal (defeatable)

Battery Charge Time: 2 Hrs.

Data Logging: 35 Sites

Size: 11" H x 4.25" W x 2.25" D

Weight: 2.0 lb.

Environmental

Operating Temperature: 0°F to +120°F

Storage Temperature: -40°F to +150°F

Humidity: 0 to 90% (non-condensing)

Supplied Accessories

1. **AC Charger** 120 volt AC charger. Plugs into the SLM 1453I to charge the battery or provide AC operation.
2. **Protective Carrying Case** Protective carrying case designed to prevent unit damage while used in the field.
3. **“Rubber Duck” Antenna** - Connects to the 75-Ohm input of the SLM 1453I to perform premises leakage testing.
4. **Serial Data Cable** Used to connect the SLM 1453I to the serial printer or PC.

Options

NOT Supplied with Unit, but available at extra cost

1. **Test Cable** 75-Ohm F-to-F male Test cable. Quality Test Cable with one "Fast F" male cable connector.
2. **F-81 replacement input connector** May be changed from the exterior. (Unscrew and discard the old connector. Screw in the new F-81.)
3. **DC Vehicle Charger** 12 Volt DC adapter. Plugs into the SLM 1453I to charge the battery or provide DC operation.
4. **Dipole Antenna** Adjustable Dipole CLI Antenna. Used to perform Cumulative Leakage Measurements for FCC documentation.
5. **Serial Printer** Portable Serial Printer. Use to print stored data from the SLM 1453I.

CONTROL FUNCTIONS



Figure 1 – Front Panel Controls

Controls

1. **ON/OFF** – Turns power On or Off. After startup, meter will go back to the last function that was used before the meter was turned off. All settings are stored when the meter is turned off.
2. **CUSTOM*** – Switches from a US Cable plan to one of the Custom channel plans. (i.e. Custom 1, Custom 2, or Custom 3) Holding the button down for approximately 3 seconds will set meter into Custom channel planning mode.
3. **UP and DOWN ARROW** – Increments tuning up or down by one channel from the tuned channel in one of the stored channel plans. Also used in the Setup mode to scroll the menu items.
4. **CH/FR** – Switches the meter between Channel tuning and Frequency tuning mode.
5. **MASTER*** – Switches unit to Master channel plan. The Master plan can be set to a US Cable plan: FCC, HRC, IRC, or US Broadcast. Holding the “MASTER” key down for approx. 3 seconds will allow you to switch between these different master channel plans.
6. **LIVE PRINT** – Downloads screen data to Printer or PC through the RS-232 port.
7. **DATA LOGGER** – Sets the meter into automatic data storage operation.
8. **FM RADIO** – Sets the meter into FM tuning operation. Audio can be heard through the unit's built-in speaker.
9. **F1 F2 F3** – Allows the user to move through the meter's various menu selections.
10. **MEAS*** – Measurement mode for analog and digital signals. If button is held down, it will change from “Near” or “Far” for its noise sampling mode in the digital measurement mode. The “Near” should be used if a single digital pilot is being tested. If there are multiple digital pilots, “Far” should be used.
11. **TILT** – Sets the meter to measure the tilt or slope between your selected “Low” and “High” pilot channels or frequencies.
12. **MUX ANALYSIS** – Sets the meter in operation to do Mux Analysis of 8-VSB signals.
13. **VOLUME** – Allows you to select one of the five preset speaker levels in the meter.
14. **LEAKAGE*** – Sets meter into signal leakage operation and automatically calculates leakage level using the $\mu\text{V/m}$ mode. Depressing the button and holding for approximately 3 seconds will allow the Leakage Threshold and Antenna Characteristics to be set.
15. **INGRESS/VOLTMETER** – Sets the SLM 1453I into Ingress sweep mode. Holding the button down for approx. 3 seconds, sets the SLM 1453 to AC/DC Voltmeter operation thru RF input.
16. **BUZZ** – Audio tone that is designed to indicate different signal levels received by the meter through the RF input.
17. **TV SOUND** – Allows the channel audio to be audible through the built-in speaker.
18. **AUTO OFF*** – Allows the user to turn off (or on) the Auto-Off feature of the meter. When the button is held down for approx. 3 seconds, the Unit of Measurement is changed. (dBmV or dB μ V)

Buttons with an * have dual function. Hold button down for approx 3 seconds for 2nd function.

Inputs

19. **RF Input** – Input "F" connector. 75 ohms. Field replaceable with any standard F-81 fitting.
20. **Charger Input** – Charger input charge jack. (18 VAC at 900 mA) Will charge the internal battery or operate the meter from the charger or cigarette lighter adapter.

Output

21. **RS-232 Connector** – RS-232 Output to Serial Printer or Serial Interface to PC.

Operation Example

1. Press **ON** (Turn ON the SLM 1453I).
2. Press **MEAS**.
3. Tune meter to Channel 2. (Use **SELECT Up Arrow** and **Down Arrow**).
4. Meter reads Signal Level, A/V, and C/N automatically.
5. Press **OFF** (Turn OFF the SLM 1453I).

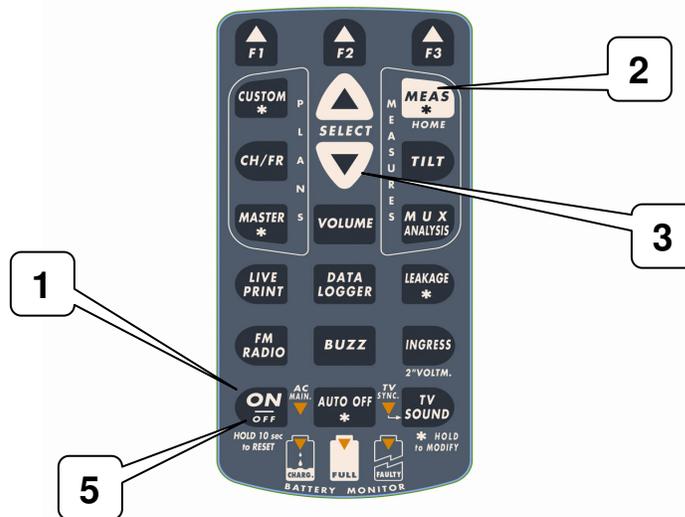


Figure 2 – Control Panel

OPERATION

Introduction

This section of the manual demonstrates all of the user features and capabilities of the SLM 1453I. Most operations are self evident from the front panel nomenclature; however a few Setup functions are less obvious since they are seldom used. All keys with the * symbol have a Second Function to their operation and are effective by holding down for approximately 3 seconds.

Getting Started

Upon receipt, your SLM 1453I will need to be charged overnight before the unit will be ready for a full day's operation. In the meantime, you may operate the SLM 1453I from the charger in order to get more familiar with its operation and keypad controls.

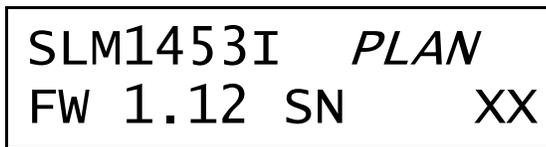


Figure 3 Initial Display

The SLM 1453I has three indicators to explain the condition of the internal battery. The first indicator will show that the battery is in charge mode and a green light will appear on the front panel.



The second indicator will appear when the unit reaches a full charge. Another green light will appear in the "full" display of battery at the bottom of the unit.



The last indicator shows when there is a problem with either the charging of the unit or the internal battery has a problem.



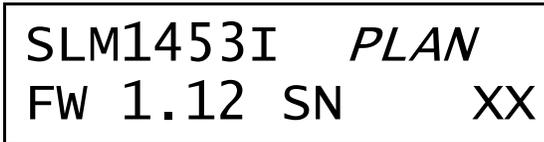
While the SLM 1453I has a continuous 14-hour battery life you should expect this time to vary under some circumstances. Intermittent use, "ON" and "OFF", will extend the total operating battery life. Temperature will also affect the battery life; cold temperatures will reduce the operating time by as much as 40%

Recharging the Battery

When the battery requires charging use only the charger supplied with your SLM 1453I. Applying more than 18 volts will damage your SLM 1453I. Connect the charger to the charge input jack and plug the charger into the AC receptacle. When not charging your SLM 1453I you should remove the charger from the AC receptacle.

Turning ON the SLM 1453I

Pressing the "ON" key turns on the SLM 1453I. When the "ON" key is pressed the display will turn on. The SLM 1453I will then read a level if a signal on that channel is applied to the input.



```
SLM1453I  PLAN
FW 1.12  SN    XX
```

Figure 4 – Initial Display at Power On

Once the SLM 1453I is switched on, the unit will remain on for approximately 10 minutes before it automatically shuts off, if no other keys are pressed. The 10-minute time-out will be reset each time a key is pressed. Any time the SLM 1453I is left on, without any keys being pressed, the unit will turn itself off after 10 minutes to conserve the battery. The operator can defeat the Auto-shut-off feature. The unit may be turned off when you have finished your usage by pressing the "OFF" key.

Setup

Measurement Units

The SLM 1453I allows the user to switch the measurement units that you are using. Different types of applications require the use of a variety of measurements. For example, antenna signal measurements are typically done in dB μ V; this is also the standard of measurement used in Europe. In the U.S, standard CATV measurements are done in dBmV. The SLM 1453I allows you to change your unit of measurement by using the following method.

1. Press the SLM 1453I "ON" key.
2. Press and hold the "AUTO OFF" key until display indicates

UNIT = dbmV
HOME

3. Press the "F1" key when the level-measurement unit is set to dBmV (or dB μ V).

MAKING MEASUREMENTS

To make measurements of the TV channels on your system you will have to properly connect to the system, select a channel plan, either one of the "Master" plans, or one of the three "Custom" channel plans, tune to the desired channel, choose measurement mode and read the displayed level.

The RF Input Connection

The input to the SLM 1453I is the "F" connector located on the top of the instrument. Since this connector will typically see a lot of wear it is field replaceable. Simply unscrew the "F" connector from the meter and replace it with a model 26G322 or similar F-81 barrel.

The input to the SLM 1453I is 75 Ohms unbalanced, just like the other cable system components. You may connect any RG-59 or RG-6 type CATV drop cable directly to the SLM 1453I. Other connections may be made to system components by using the model 39G189 cable supplied or any good quality jumper cable fitted with "F" connectors. Care should always be taken to be sure that a good Test Jumper is used. A good instrument will still give the wrong readings with a defective jumper cable and make troubleshooting impossible.

The input of your SLM 1453I is protected from DC and AC (<1 KHz) voltages up to 100 V peak. Thus the typical power found on system distribution cables will not affect the operation of the SLM 1453I.

Selecting a Channel Plan

Follow these steps to Set your Master Channel Plan

The SLM 1453I provides the user with a variety of options in choosing a channel plan. The meter provides the following standard channel plans under the "MASTER" key:

FCC
HRC
IRC
BROAD (Broadcast – UHF/VHF)

In order to access one of the standard master channel plans, simply hold down the "MASTER" key for approximately 3 seconds or until the display changes. The display will indicate:

MAST.SEL: *PLAN*
HOME

Using the **Up Arrow** or **Down Arrow**, scroll until the desired Master channel plan is indicated. To select that channel plan press **F1**. Begin making RF measurements by pressing the "MEAS" key.

Follow these Steps to Build a Custom Channel Plan

The SLM 1453I also allows you to build up to three "Custom" channel plans to eliminate any unwanted or unused channels. It will also be necessary to build a custom channel plan in order to make digital power measurements. To build a custom channel plan perform the following procedure.

1. Press the "ON" key
2. Press and hold the "CUSTOM" key for approx. 3 seconds, or until display changes. The display will show

EDITING : *PLAN*
HOME NEXT

3. Using the **Up Arrow** or **Down Arrow**, scroll to the desired plan to copy in order to start developing your Custom channel plan.
4. Press the **F2** key for **NEXT** to *customize* this channel plan.
The display will now show:

CH.	2	MODE
HOME	SAVE	MODE

5. Use the **F3** key to select the Channel Measurement Mode.
Choices are Analog, Disable the Channel, QAM64, QAM256, or 8-VSB.
6. Then use the **Up Arrow** to move to the next channel. (Down Arrow to go back.)
7. When Custom Channel Plan is completed, press the **F2** key to **SAVE** this Custom plan.
The display now shows:

CUST . SEL : CUSTOM1
HOME STORE

8. Use the **Up Arrow** and **Down Arrow** key to select which Custom (Custom 1, 2, 3) plan to save as.
9. Press **F2** to **STORE** this Custom plan.

Once you have built a Custom channel plan, it is not necessary to repeat these steps unless you wish to *change* a Custom channel plan. The Custom channel plans are stored in non-volatile memory.

Digital Channel Tagging

Most modern CATV systems have implemented digital signals into their operations. Soon broadcasters will be transmitting HD (8-VSB) signals. The ability of signal level meters to be able to measure digital signals has almost become a must.

In order for the SLM 1453I to properly read the digital average power, digital quality, and emulated BER, of a digital cable channel, the channel must be "tagged" as a digital channel. If the channel isn't tagged as digital mode (QAM64, QAM256, 8-VSB) and the channel level measurement is taken in an analog mode, the level measurement will be as much as 13 dBmV off its proper level. The other digital measurements that the SLM 1453I provides will also not register unless the channel is "tagged" as digital.

Channels can be "tagged" as digital, in a QAM-64, QAM-256, or 8-VSB mode, by building a **Custom** channel plan starting with one of the Master channel plans (FCC, HRC, IRC, US Broadcast) or by modifying a previously defined Custom plan. (Custom 1, 2, 3.)

1. Press the "**ON**" key.
2. Press and hold the "**CUSTOM**" key for approx. 3 seconds or until the display indicates the following:

```

EDITING : PLAN
HOME   NEXT

```

3. Using the **Up / Down Arrow**, scroll to the desired plan to start with to "tag" channels as digital. (Can be a Master plan or a *previous* Custom plan.)
4. Press the **F2** key for **NEXT**. The display will show:

```

CH.    2          MODE
HOME   SAVE     MODE

```

5. Use the **Up / Down Arrow** to move to the channel to "tag."
6. Use the **F3** key to select the Channel Measurement Mode
Choices are Analog, Disable the Channel, QAM64, QAM256, or 8VSB.
7. Repeat steps 5 and 6 to tag all "digital channels."
8. When all digital channels are tagged, press the **F2** key to **SAVE** this Custom plan.
The display now shows:

```

CUST.SEL : CUSTOM1
HOME    STORE

```

9. Use the **Up / Down Arrow** key to select which Custom (Custom 1, 2, 3) plan to save as.
10. Press **F2** to **STORE** this Custom plan.

Tuning the Channels

Once the proper channel plan has been selected you may tune to any of the channels listed for that plan. To tune a particular channel, press either the Up Arrow or Down Arrow on the keyboard until the desired channel is selected. The tuner of the SLM 1453I will stop at the last channel in that particular channel plan.

Frequency Tuning

The SLM 1453I can also be tuned in the frequency mode. Press the **CH/FR**. Key. In the frequency mode the display changes from reading the channel number, to reading frequency only. After pressing the **CH/FR**. key, the frequency for the current channel is displayed. The SLM 1453I tunes in the frequency mode by 62.5 kHz steps.

```

55.250MODE << <
1 << <<

```

Figure 5 – Tuning a Frequency

If the **CH/FR** key is pressed in the frequency mode; the SLM 1453I will tune to the nearest channel and display that channel's assigned number.

Signal Level Measurements

The dBmV mode of the SLM 1453I has a resolution of 0.1dBmV, the dB μ V mode has a resolution of 0.1dB μ V. Both the μ V and μ V/m modes have a resolution of 1 μ V up to 1000, 10 μ V up to 10,000, 100 μ V up to 100,000 and 1000 μ V above 1V. Level measurements may be made from -45 dBmV to +65dBmV within the stated accuracy.

Levels outside the normal -45 to +65 dBmV range will produce an under- or over-range display indicating that too little or too much signal is present on the input. A << symbol indicates that the signal level is less than -45 dBmV, while a >> indicates a level greater than +60dBmV.

dBmV is the typical unit of measure for the signal level of signals carried on the system. 0 dBmV is equal to 1 mV across 75 Ω .

dB μ V is a common unit of measure in the UK and some European locations for the signal level of carriers on the CATV system. 0 dB μ V is equal to 1 μ V across 75 Ω or -60 dBmV. (0 dBmV = 60 dB μ V.)

The μ V/m is a typical unit of measure used to express signal leakage levels, dependant on the frequency of the signal. One μ V/m is a signal level of one microvolt per meter of wavelength. The E_{μ V/m can be determined from the E_{μ V by using the following formula:

$$E_{\mu$$
V/m} = E_{\muV x F x 0.021 \quad (F in MHz)

For example take a 100 μ V signal level at a frequency of 100MHz, then E_{μ V/m} = 210 μ V/m.

The SLM 1453I simplifies this by automatically making the conversions without using these complicated formulas.

Emulated BER

The emulated BER test on the SLM 1453I is based on a C/N measurement. The value is based on an algorithmic calculation. This calculation makes a distinction between adjacent and non-adjacent channels. This measurement is very accurate and reliable but can be degraded if there is interference hidden in the digital multiplex or devices with bad phase noise in the system. This measurement is automatically given by the SLM 1453I when a channel is tagged as digital.

Digital Flatness

The SLM 1453I is designed to give you an indication of digital flatness. If the power distribution in the channel (flatness) is not uniformly scattered, the multiplex analysis will indicate that the signal is degraded. This measurement is also given automatically on a digitally tagged channel.

Digital Quality

The digital quality test of the SLM 1453I is directly related to the C/N measurement. The Multiplex Analysis (MUX ANALYSIS) of a selected digital channel will give you an indication of Pass, Marginal, or Fail.

Mux Analysis

The MUX ANALYSIS is a power measurement analysis for digital channels (multiple program “multiplex”). The test takes samples across the 6 MHz channel checking for not only average flatness, but for distribution (no observed “holes” in the distribution, as well as “randomness”. If the sampled frequencies show even average power, it is reported as **Digital** indicating both evenly distributed frequency components and flat channel response. Less than ideal is reported as **Degraded**, or **Nodigit**. If the channel power is so low that average power samples cannot reliably be made above channel noise, **PwrTooLow** is reported.

When “MUX ANALYSIS” is pressed and a digital channel is selected with the **Up/Down Arrow** from the Home Display, the display will indicate on the top row Channel Number, or Channel Center Frequency. The top row of the display is the Mode (Q 64, Q256, 8VSB), and the RF Level/Power. The second row indicates Channel Plan Number (1, 2, 3) and the test indicator “MuxAn.” followed by the results. The results will read either, Digital, Degraded, Nodigit, or PwrTooLow.

Digital indicates that the power distribution across the digital channel bandwidth is evenly distributed, and reasonable flat.

Degraded indicates a problem with the distribution or flatness of the measured power samples across the channel.

Nodigit indicates that the distribution is so uneven that the channel is considered not to be a digital channel. It may in fact be an analog channel, even though it is tagged as digital.

PwrTooLow indicates that the power level was too low to reliably sample.

If a digital channel is not properly tagged as digital (Mode reads ANA for the channel selected instead of Q 64, Q256, or 8VSB) Mux Analysis will report **Degraded** or lower (Nodigit or possibly PwrTooLow).

Note: Digital Quality (D.QUAL) is reported as Pass, Marginal, or Fail when using the Measurement (MEAS) key IF the channel is tagged as digital (QAM 64, Q256, or 8VSB) in one of the three Custom Channel Plans. Master Plans (Broadcast, FCC, IRC, HRC) cannot have channels tagged as digital. Master Plans can be used for “starter” plans to build a custom plan, but cannot be directly digitally tagged.

APPLICATIONS INFORMATION

Introduction

The application section is intended to give you a "hands on" introduction to using the SLM 1453I. Procedures described here are general in terms and will require adaptation to your specific circumstance. You should also refer to your company procedures. A listing of the FCC minimum requirements and recommended targets for the Subscriber Drop are listed in the table below.

SIGNAL PARAMETER	FCC REQUIRED LEVEL	GOOD PRACTICE
Minimum carrier level	0 dBmV	3 dBmV
Maximum carrier level	< Overload	10 dBmV
Level difference between adjacent channels	3 dB	1 dB
Level difference between all channels	10 dB	7 dB
Minimum A / V ratio	6.5 dB	13 dB
Maximum A / V ratio	17 dB	15 dB
Minimum FM station level	N/A	-20 dBmV
Maximum FM station level	N/A	-10 dBmV
Level difference between adjacent FM stations	N/A	3 dB
C/N (all Channels)	>43dB	46 dB
Tap Isolation	18 dB	20 dB

Figure 6 – FCC Requirements

In the best circumstance an installation should be straightforward and require little troubleshooting or testing, however, assuring the quality of a drop installation

is a simple and quick task with the SLM 1453I. Assuring the quality during the installation will prevent a second truck roll for the subsequent repair and eliminate the dissatisfaction of the subscriber.

The Installation

The first step to a good installation is to be sure that you are starting with a known good signal level. When you climb the pole or open the pedestal to begin the installation take your SLM 1453I with you so that you can first measure the signal level at the TAP. While you probably do not have a system schematic with TAP output levels indicated, you really do not need one. With a little rough math and simple assumptions you can estimate the signal levels that you will need at the TAP to insure a good installation.

Cable Loss

Before you start the installation, the loss of the cable to be used for the drop should be estimated. Remember that the cable loss is dependent on the frequency of the signals it transports. Since the greatest loss occurs at the highest frequency used, we normally talk about a cables loss only at that frequency. For instance, 6dB of cable means the loss at our highest channel is 6dB. Each manufacturer of drop cable specifies the loss of a particular type of cable at some frequency per 100 feet of that cable.

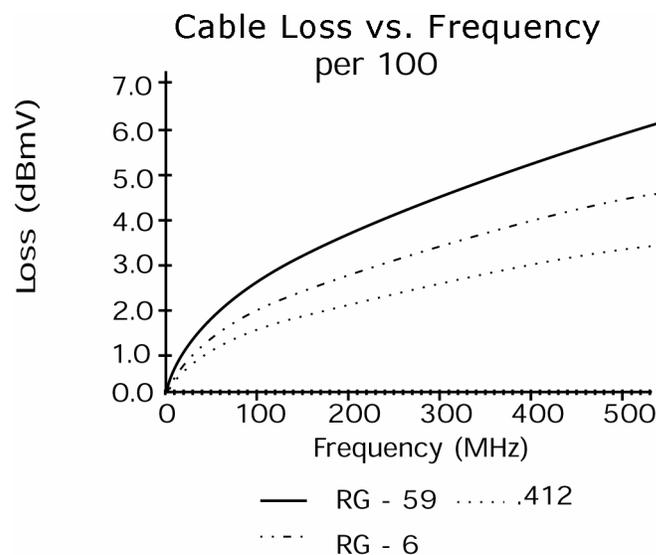


Figure 7 – Cable Loss vs. Frequency

From the manufacturer's specification we can determine the specific loss for our application by the formula:

$$L1 = L2 * \text{Square root of } F1 / \text{Square root of } F2$$

Where,

L1 = Loss at our desired frequency

L2 = Manufacturers stated loss

F1 = Frequency at which we want to determine loss

F2 = Frequency at manufacturers stated loss

Thus, if we were working on a system specified to 800 MHz and using a cable rated at 6dB loss per 100 feet at 550 MHz it would have a loss of:

$$L1 = 6 \text{ dB} * \text{square root } 800\text{MHz} / \text{square root } 550\text{MHz}$$

$$L1 = 7.2 \text{ dB per } 100 \text{ feet @ } 800\text{MHz}$$

Estimate the distance from the TAP to the TV set. The loss will be the distance times the loss per 100 feet divided by 100.

$$L = D * L1 / 100$$

For a distance of 150 feet: $D = 150$

$$L = 150 * 7.2 \text{ dB} / 100$$

$$L = 10.8 \text{ dB}$$

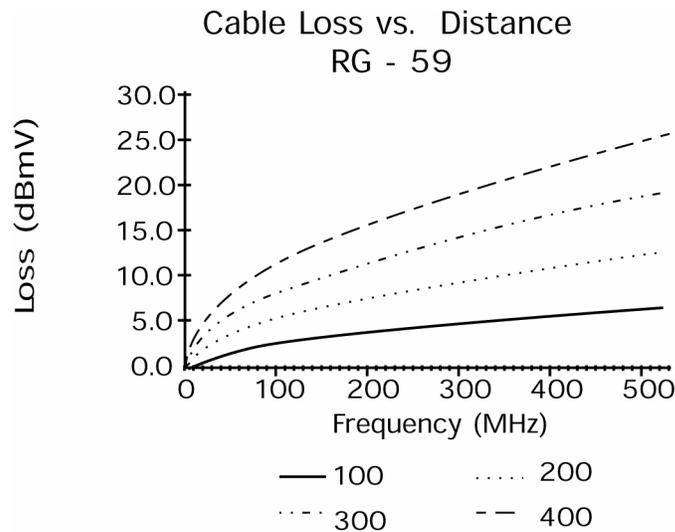


Figure 8 – Cable Loss vs. Distance

Drop Losses

To this loss we also add the other loss in our drop installation. The insertion loss of our Ground Block: ~.5 dB and the loss of any splitters used to provide second outlets ~3.0 dB for a two-way splitter. Thus our total loss will be:

$$L_T = L + L_{GB} + L_S = 10.8 + .5 + 3.0$$

$$L_T = 14.3 \text{ dB}$$

Where,

L_T = Total Loss of the Drop

L = Cable Loss

L_S = Splitter Loss

L_{GB} = Ground Block Loss

With this in mind we know that we need a minimum of 0dBmV at the subscribers set and therefore must have a minimum of 14.3dB + 0dBmV or +14.3 dBmV. To provide a sufficient safety margin a minimum level of +16.0 dBmV should be present at our TAP. While you are connected to the TAP you should also measure the lowest channel, highest channel and a couple of key channels in the spectrum, just to be sure there is no problem with the TAP. Remember from the FCC chart in Figure 6 that we must provide all channels within a 10 dBmV window with adjacent channels within 3 dB. Refer to Figure 6 for the other requirements.

You will only have to make the L1 loss calculation once to determine the loss of your drop cable per 100 feet. You will continue to use that value for L1 unless you change drop cable or extend the bandwidth of your system. Do your calculations on the ground before you climb? Some typical cable losses are listed in the Table:

Cable Characteristics: Nominal Attenuation per 100 feet

CABLE	Ch.2	Ch.6	Ch.7	Ch.13	Ch.30	Ch.40	Ch.50	Ch.60	Ch.70
RG59/U	2.6	3.5	4.9	5.4	8.8	9.2	9.7	10.3	11.0
RG59/U Foam	2.3	2.7	3.8	4.2	6.6	6.8	7.1	7.3	7.7
RG 6 Foam	1.7	1.9	2.8	3.0	5.2	5.6	5.9	6.2	6.5
RG11/U	1.4	1.7	2.2	3.2	5.3	5.5	5.7	6.1	6.2
RG11/U Foam	1.1	1.4	1.6	2.3	4.0	4.1	4.2	4.4	4.6
.412	.74	1.0	1.4	1.5	2.6	2.7	2.9	3.1	3.3
.500	.52	.67	.72	1.1	1.8	2.1	2.4	2.7	3.0

Figure 9 – Cable Characteristics Chart

Drop Signal Levels

If you have a sufficient level at the output of your TAP you are ready to continue your installation. If you do not have sufficient level you can change the TAP to the appropriate value (you may need to get approval from your supervisor or an engineer). Taps are available in most common values. If your level is 3 dB low at the current tap, you need a tap value, which is 3 dB smaller. It is usually best to select the next lower value tap when the exact value falls between those available. Once the drop is installed you should check the levels at the back of the set or the input to the converter. At this test point you should expect a minimum level of 0 dBmV, which we used in our calculation, plus the safety margin and any TAP value variation required from rounding off to the nearest available TAP value. Remember that we must provide the subscriber with a signal between 0 dBmV and +10 dBmV. If the level looks good on our highest channel we should then check the low end of the spectrum and any key channels in between. Remember that our levels will vary with the frequency as the loss increases with the frequency. If you measure all the channels you will see the tilt of the system established at the last Line Extender minus the cable loss from the AMP through the cable to the TAP and through the drop to the Wall Plate. Note that the amount of tilt will change from drop to drop as the distance from the last AMP or Line Extender varies. The FCC requires a minimum of 0 dBmV and a maximum of +10 dBmV, this provides sufficient signal level above the noise floor for a "snow free" picture and prevents "overload" of the TV set and or converter, which would cause 2nd/3rd order or inter-modulation distortions.

If your levels are significantly different than those predicted, there is a fault in the Installation. To locate this fault we will use the SLM 1453I to troubleshoot our installation, starting back through the drop. DIVIDE and CONQUER. Move back to the ground block output to check levels. If they are good the problem is between the ground block and the wall plate. If not, move to the cable at the input of the ground block. Keep dividing the problem area into half until you get down to the one faulty component. Don't forget our assumptions and estimate of loss as you go through the drop components so that you can predict a good signal level reading. If you are using a splitter to provide multiple outlets, be sure that a terminator, TV, or converter terminates each leg. An open leg on a splitter will cause standing waves and erroneous readings on the other leg.

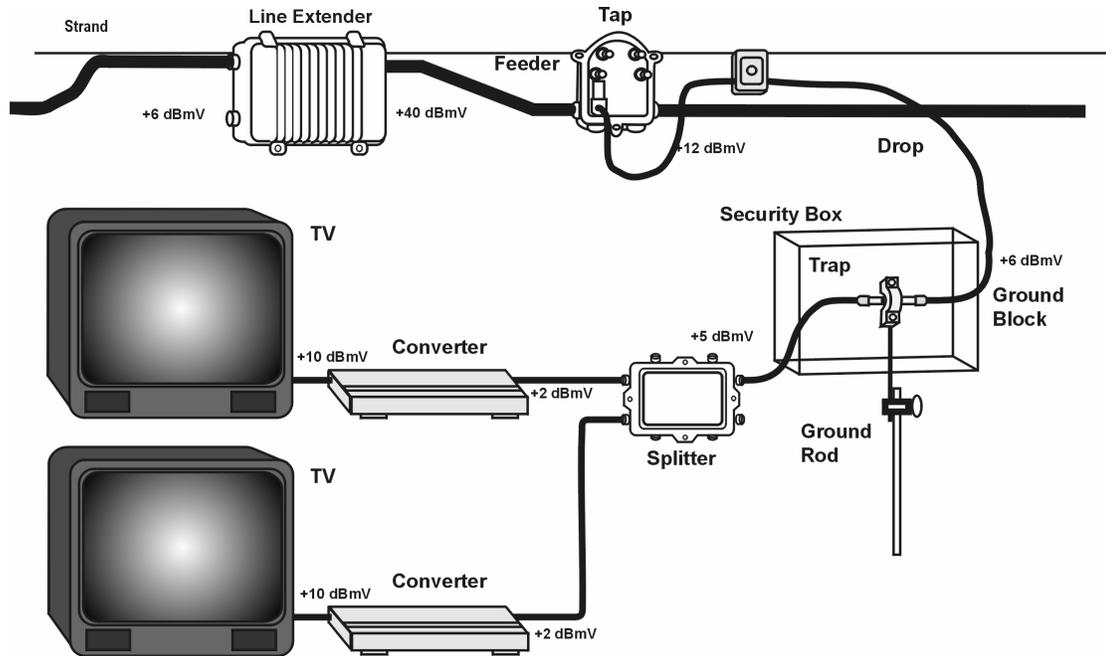


Figure 10 – Typical Installation Levels

If you have had a problem to troubleshoot in an installation be sure to double-check all of your connections for proper tightness, tags and weather boots, etc. It is very easy to forget these items once you have solved the major fault.

dBmV & dB μ V

The common unit of measure in the US and many other countries is the dBmV or decibels above 1 mV across 75 Ω . 0 dBmV equals a signal level of 1 mV across a 75 Ω load. The dB μ V (dB micro volt) is a similar unit of measure, except that it is referenced for 1 μ V across a 75 Ω load. Thus, 0 dBmV = +60 dB μ V. The SLM 1453I may be set up to use either unit of measure. See the SETUP section of this manual for SETUP procedures. See Appendix B for more information on measuring in dBmV and discussion on relative measurements in dB.

In the U.S. we measure the video carrier level in dBmV. Decibels above 1 mV across 75 ohms. In many PAL systems the preferred unit of measure is dB μ V. Decibels above 1 μ V across 75 ohms. It is quite easy to convert a dBmV reading to a dB μ V by adding 60 dB μ V to the reading in dBmV.

$$\Delta = 20 \text{ Log } (1 \text{ mV}/1 \mu\text{V}) = 60$$

For example +10 dBmV becomes +70 dB μ V and -20 dBmV becomes +40 dB μ V. dB μ V is used in a few systems outside the U.S. Systems in the UK and Asia are the main exceptions. Naturally a dB is a dB the world over, 3 dB above 1 mV is

+3 dBmV and 3 dB above 60 dB μ V is 63 dB μ V. Our standard formula:

$dB = 20 \text{ Log } (V1/V2)$, remains true in all systems, only the unit of measure changes.

Finishing the Job

Now that you are sure the signal level to the subscriber is correct, you should double-check the operation of the television set(s), the converter and the traps, if used. Operate the TV on all channels, viewing the picture quality and listening to the audio, especially those channels adjacent to trapped channels. A faulty trap will not only insufficiently block the trapped channel, but may also trap part of the adjacent channel. You can use your SLM 1453I to measure the level of the adjacent video and audio carriers. The FCC requires the audio carriers to be 13 to 17 dBmV down from their respective video carrier. System transmission of the audio carrier should have little effect on this ratio. A problem is usually caused by a faulty trap.

Don't forget to check the remote control for the converter and the power-on and power-off operation. The least little problem will mean a second truck roll and an unhappy subscriber. Be sure. Do it right the first time. The SLM 1453I will help you make more installations and more importantly make them all *good* installations.

Signal Leakage – Measuring and Monitoring

The importance of monitoring and measuring cable signal leakage is much more than an operator trying to improve and maintain their system. The Federal Communications Commission (FCC) in the United States is responsible for regulating the cable industry and enforcing the technical standards regarding cable leakage. The FCC closely monitors the cable industry in order to prevent RF signal leakage from causing potentially hazardous problems.

Egress and Ingress are the two types of RF leakage. Egress is the RF signal that leaks out of the CATV system. Typically, egress is caused by damage to the cable, or improper installations. Ingress leakage refers to the RF noise or interference that gets into the system. Ingress typically occurs due to the environment that can cause interference in the cable. Almost any item with an electrical motor can cause ingress problems that will be intermittent and difficult to isolate and eliminate. Therefore, it is viewed that by testing for leakage, or egress, and repairing the leak you can eliminate ingress problems. The SLM 1453I is designed to test for the egress type of leakage.

The FCC has two basic leakage requirements. One is to monitor your system (75% min.), logging all leakage above 50 μ V/m and calculating the Cumulative Leakage Index so as to maintain an index less than 64 for I (commonly called “I of

infinity”) and less than -7 for I3000. Secondly, leakage must be maintained at levels less than $20 \mu\text{V/m}$ at 10 feet between 54 MHz and 216 MHz, and less than $15 \mu\text{V/m}$ at 100 feet for frequencies less than 54 MHz and greater than 216 MHz.

Leakage requirements may be met by a fly-over or by a drive-out method. Since the fly-over method does not typically utilize a normal signal level meter, we will only make reference to the drive-out procedures.

In today’s modern highly signal-loaded systems, leakage has become one of the hot topics for system operators. One of main reasons for this is that noise or RF noise can cause severe problems for digital signals. Finding the problem in a digital signal can be far more difficult than in an analog signal. The “digital cliff” effect makes it difficult to find the troublesome source when you cannot see the picture in order to help identify the problem.

Proper detection and measurement of signal leakage requires field experience and a good understanding of RF characteristics. There are many different factors that can affect the technician’s ability to detect and find a leak. Some of the factors are temperature and weather conditions. A leak may only appear when all the weather conditions are conducive. A change in temperature and the leak may disappear or increase and mask smaller leaks. A technician’s experience and proper training with the proper equipment can mean the difference between finding and repairing the leak, or it going undetected, and the system faced with probable fines or loss of that frequency.

The art of finding signal leakage is just that—an art. There is no exact science to finding signal leaks. The best method in learning to deal with signal leakage is a combination of several factors; an on-going training program, field experience, and a good set of procedures that are followed by everyone to help maintain system integrity and control RF leakage problems.

Common Leakage Measurements – $\mu\text{V/m}$

$\mu\text{V/m}$ is a common unit of measure in leakage measurements. Most signal level meters require measurement in dBmV and calculation to determine the level in $\mu\text{V/m}$. The SLM 1453I will automatically switch to the $\mu\text{V/m}$ unit of measurement when the “LEAKAGE” key is pressed.

CLI (Cumulative Leakage Index)

Leakage must be monitored through regular patrol procedures, which cover a minimum of 75% of your system annually. Leakage above the $20 \mu\text{V/m}$ at 10 feet (54 to 216 MHz) and $15 \mu\text{V/m}$ at 100 feet ($< 54 \text{ MHz}$ & $> 216 \text{ MHz}$) must be repaired and documented. Leakage above a $50 \mu\text{V/m}$ level must be logged and used in your CLI (Cumulative Leakage Index) calculations.

$$CLI = [10 \log (E_1^2 + E_2^2 + E_3^2 + \dots + E_n^2)] \times 100 / M$$

Where: E_1 to E_n , in $\mu\text{V}/\text{m}$, is all of the recorded leaks $> 50 \mu\text{V}/\text{m}$ and
M is the % of the system monitored for leakage.

The CLI calculation must be less than or equal to 64 to meet the FCC requirements. Note that only leaks greater than or equal to $50 \mu\text{V}/\text{m}$ must be used in the calculation. Other leaks greater than $20 \mu\text{V}/\text{m}$ must be repaired, but not included in the calculation. Typically, systems will use one instrument to monitor system leakage and another to make leakage measurements. Measurements must be made using a calibrated dipole antenna. Since the SLM 1453I is capable of measuring directly in $\mu\text{V}/\text{m}$, it is a convenient tool to use in leakage measurement, since no calculations are required to convert dBmV to $\text{dB}\mu\text{V}$ then μV at a specific frequency to $\mu\text{V}/\text{m}$. These capabilities make the SLM 1453I an ideal meter for the installer or the service tech.

Monopole Antenna

The monopole or “rubber duck” antenna that is supplied with the SLM 1453I is designed to give the operator an indication of signal leakage based on the threshold that is entered into the SLM 1453I. Its receiving pattern is omni-directional, and it can detect leakage on all sides with exception to the top and bottom. Typical CATV RF leakage appears in a spherical pattern, therefore the monopole is best used to find the general location of the leak. Once the general location is determined, the operator should switch to a dipole antenna to locate and measure the leak.

Dipole Antenna

The Dipole antenna is often the most confusing part of any leakage measuring system. This confusion probably stems from the fact that the dipole has “no input,” no electronics or power supply—but pulls signals “right out of the air.” This is not magic; it is in fact quite predicable and quantifiable. We will not go into complex antenna theory here, but ask you to have faith. Simply stated the electromagnetic waves traveling through the air set up a field, which excites the electrons in the dipole antenna when the wavelength of the dipole (or multiple, i.e. $1/4$ or $1/2$) matches the wavelength of the electromagnetic waves. The electron motion in the antenna produces a potential across its output terminals, which we can measure with the SLM 1453I. Quantifying these antenna characteristics is quite simple.

Using the Dipole Antenna

One of the key parameters of the dipole antenna is tuning it to the proper frequency or wavelength. Most manufactures provide a table for tunable dipoles or a fixed dipole for a specific frequency. A standard table is located in Appendix D. If necessary you can easily calculate the proper element length by

the following equation:

$$L = 2808 / F$$

Where L = the length of one side (one element) in inches and
F = the frequency in MHz..

Once tuned, the dipole is ready to use to make measurements. For your convenience refer to Appendix D for the standard element lengths.

To make leakage measurements, the dipole must be held 10 feet above and parallel to the ground, 10 feet from the leakage source and at least 10 feet away from any other conductors. This can be somewhat challenging at times. The FCC statement that the dipole should be 10 feet above the ground is a secondary consideration—consider this a minimum. Ten feet from the leakage source is the primary consideration. In addition the dipole must be rotated to obtain the maximum signal level reading. Note that to insure the proper distance, you must absolutely locate the source of leakage.

When necessary, measurements at greater distance may be used as long as they are corrected to their equivalent measurement at 10 feet. Naturally, you must actually locate the source of the leakage in order to make an appropriate measurement. The following equations may be used for these calculations when the measured signal level is in $\mu\text{V}/\text{m}$:

$$E_{\mu\text{V}/\text{m}}(D1) = E_{\mu\text{V}/\text{m}}(D2) \times D2 / D1$$

Where: $E(D2)$ is in $\mu\text{V}/\text{m}$, $D2$ is the distance of the measurement and
 $D1$ is the desired equivalent distance of 10 feet.

If the measurement is in dBmV the following formula must be used:

$$V_{\text{dBmV}}(D1) = V_{\text{dBmV}}(D2) \times 20 \log (D2 / D1)$$

Where: $V(D2)$ is in dBmV, $D2$ is the distance of the measurement and
 $D1$ is the desired equivalent distance of 10 feet.

Obviously it is much easier to perform the leakage measurements with an instrument that measures the signal strength directly in $\mu\text{V}/\text{m}$.

For reference purposes the following formulae may be used to convert from μV to dBmV and vice versa.

$$E_{\mu\text{V}} = 10^{(V_{\text{dBmV}}/20)} \times 1000$$

$$V_{\text{dBmV}} = 20 \times \text{Log} (E_{\mu\text{V}} / 1000)$$

Remember that $E_{\mu V}$ should not be confused with $E_{\mu V/m}$. Leakage measurements used in calculating CLI must be in $E_{\mu V/m}$, that is, microvolts per meter, where meters represent the wavelength of the signal being measured. The $E_{\mu V/m}$ can be determined from the $E_{\mu V}$ by using the following formula:

$$E_{\mu V/m} = E_{\mu V} \times F \times 0.021$$

Where: $E_{\mu V}$ is the level in microvolts and
F is the frequency of the signal in MHz.

Again you can see the advantage of the SLM 1453I measuring directly in $\mu V/m$.

Ingress Scanning

Ingress is unwanted noise or interference getting into the cable system. Ingress has always been a factor in a closed system and will result in some picture distortion in an analog system. In today's fully loaded, forward and reverse digital systems, ingress can cause serious operating problems, especially if the noise or ingress is present in the return portion of the band. Ingress or noise is perceived as signal to a digital set-top or cable modem. If ingress or noise is delivered to the cable modem or the CMTS, communication between the two devices can be disrupted, causing problems for the customer. Most cable systems use the reverse or sub-band frequencies for communication with their devices in the field.

The SLM 1453I is capable of scanning any tuned frequency between 5-47 MHz. You are also able to set the threshold from -50 to +20 dBmV (specified to -45 dBmV).

To Make Ingress Measurements

You will not be able to make ingress measurements with "live signal" on the cable. The in-home wiring should be disconnected from the outside drop (preferably at the ground block). Once connected to the point where you want to test.

1. Press the "Ingress" button, meter will go into ingress mode
2. The SLM 1453I will automatically begin to scan based on the frequencies that it is tuned to.
3. If you would like to change the settings, press "**MODIFY**" or F1 key. The word "**THRES**" will appear and be flashing. Simply set the threshold level that you want the unit to scan for by using the UP/ DOWN Arrow Keys. Next press the "**START**" key or F2. This will be the start point of the ingress scan. Adjust to the desired frequency by using the UP/DOWN Arrow keys.
4. Next press the "**STOP**" or F3 key. Set the end frequency by using the UP/DOWN Arrow keys. This will be the end of the ingress scan.
5. To return to the Ingress Test simply press "Ingress" button again and the SLM 1453I will begin scanning based on your new settings.

Appendix A

Channel Plans

Cable Channel Frequency Plans on FCC Digital, FCC, HRC, IRC, 50-870 Mhz

Based on Joint EIA/NCTA Engineering Committee approval (EIA IS-6 Interim Standard). Frequencies include Aeronautical FCC designated Offset Frequencies (Designated by an *). HRC carriers are computed with a 6.000300 MHz +/- 1 Hz Comb Generator accuracy. VHF and UHF channels are per the FCC designations.

Sub-Band VHF Cable TV Channels, 5-50 Mhz

Channel #	FCC	HRC	IRC	VHF /UHF
T-7	7.00	---	---	---
T-8	13.00	---	---	---
T-9	19.00	---	---	---
T-10	25.00	---	---	---
T-11	31.00	---	---	---
T-12	37.00	---	---	---
T-13	43.00	---	---	---

Low-High VHF EIA/NCTA TV Channels

Channel #	FCC Digital	FCC	HRC	IRC	VHF /UHF
1	---	---	72.0036	73.2500	---
2	57.00	55.25	54.0027	55.2500	55.25
3	63.00	61.25	60.0030	61.2500	61.25
4	69.00	67.25	66.0033	67.2500	67.25
5	79.00	77.25	78.0039	79.2500	77.25
6	85.00	83.25	84.0042	85.2500	83.25
7	177.00	175.25	174.0080	175.2500	175.25
8	183.00	181.25	180.0090	181.2500	181.25
9	189.00	187.25	186.0093	187.2500	187.25
10	195.00	193.25	192.0096	193.2500	193.25
11	201.00	199.25	198.0099	199.2500	199.25
12	207.00	205.25	204.0102	205.2500	205.25
13	213.00	211.25	210.0105	211.2500	211.25

Channel Plans

Mid-band Cable Channels and UHF Broadcast Channels, 120 to 170 MHz

Channel #	Digital FCC	FCC	HRC	IRC	VHF /UHF
14	123.00	*121.2625	120.0060	*121.2625	471.25
15	129.00	*127.2625	126.0063	*127.2625	477.25
16	135.00	*133.2625	132.0066	*133.2625	483.25
17	141.00	139.2500	138.0069	139.2500	489.25
18	147.00	145.2500	144.0072	145.2500	495.25
19	152.00	151.2500	150.0075	151.2500	501.25
20	159.00	157.2500	156.0078	157.2500	507.25
21	165.00	163.2500	162.0081	163.2500	513.25
22	171.00	169.2500	168.0084	169.2500	519.25

* Aeronautical Offset Freq. Allocation

Super-band Cable TV Channels and UHF Broadcast Channels

Channel #	Digital FCC	FCC	HRC	IRC	VHF /UHF
23	219.00	217.2500	216.0108	217.2500	525.25
24	225.00	223.2500	222.0111	223.2500	531.25
25	231.00	*229.2625	228.0114	*229.2625	537.25
26	237.00	*235.2625	234.0117	*235.2625	543.25
27	243.00	*241.2625	240.0120	*241.2625	549.25
28	249.00	*247.2625	246.0123	*247.2625	555.25
29	255.00	*253.2625	252.0126	*253.2625	561.25
30	261.00	*259.2625	258.0129	*259.2625	567.25
31	267.00	*265.2625	264.0132	*265.2625	573.25
32	273.00	*271.2625	270.0135	*271.2625	579.25
33	279.00	*277.2625	276.0138	*277.2625	585.25
34	285.00	*283.2625	282.0141	*283.2625	591.25
35	291.00	*289.2625	288.0144	*289.2625	597.25
36	297.00	*295.2625	294.0147	*295.2625	603.25

* Aeronautical Offset Freq. Allocation

Hyper-band Cable Channels and UHF Broadcast Channels

Channel #	Digital FCC	FCC	HRC	IRC	VHF /UHF
37	303.00	*301.2625	300.0150	*301.2625	609.25
38	309.00	*307.2625	306.015	*307.2625	615.25
39	315.00	*313.2625	312.0156	*313.2625	621.25
40	321.00	*319.2625	318.0159	*319.2625	627.25
41	327.00	*325.2625	324.0162	*325.2625	633.25
42	333.00	*331.2750 (+25k)	330.0165	*331.2750 (+25K)	639.25
43	339.00	*337.2625	336.0168	*337.2625	645.25
44	345.00	*343.2625	342.0171	*343.2625	651.25
45	351.00	*349.2625	348.0174	*349.2625	657.25
46	357.00	*355.2625	354.0177	*355.2625	663.25
47	363.00	*361.2625	360.0180	*363.2625	669.25
48	369.00	*367.2625	366.0183	*367.2625	675.25
49	375.00	*373.2625	372.0186	*373.2625	681.25
50	381.00	*379.2625	378.0189	*379.2625	687.25
51	387.00	*385.2625	384.0192	*385.2625	693.25
52	393.00	*391.2625	390.0195	*391.2625	699.25
53	399.00	*397.2625	396.0198	*397.2625	705.25
54	405.00	403.25	402.0201	403.2500	711.25
55	411.00	409.25	408.0204	409.2500	717.25
56	417.00	415.25	414.0207	415.2500	723.25
57	423.00	421.25	420.0210	421.2500	729.25
58	429.00	427.25	426.0213	427.2500	735.25
59	435.00	433.25	432.0216	433.2500	741.25
60	441.00	439.25	438.0219	439.2500	747.25
61	447.00	445.25	444.0222	445.2500	753.25
62	453.00	451.25	450.0225	451.2500	759.25
63	459.00	457.25	456.0228	457.2500	765.25
64	465.00	463.25	462.0231	463.2500	771.25
65	471.00	469.25	468.0234	469.2500	777.25
66	477.00	475.25	474.0237	475.2500	783.25
67	483.00	481.25	480.0240	481.2500	789.25
68	489.00	487.25	486.0243	487.2500	795.25
69	495.00	493.25	492.0246	493.2500	801.25
70	501.00	499.25	498.0249	499.2500	---
71	507.00	505.25	504.0252	505.2500	---
72	513.00	511.25	510.0255	511.2500	---
73	519.00	517.25	516.0258	517.2500	---
74	525.00	523.25	522.0261	523.2500	---
75	531.00	529.25	528.0264	529.2500	---
76	537.00	535.25	534.0267	535.2500	---

Channel #	Digital FCC	FCC	HRC	IRC	VHF /UHF
77	543.00	541.25	540.0270	541.2500	---
78	549.00	547.25	546.0273	547.2500	---
79	555.00	553.25	552.0276	553.2500	---
80	561.00	559.25	558.0279	559.2500	---
81	567.00	565.25	564.0282	565.2500	---
82	573.00	571.25	570.0285	571.2500	---
83	579.00	577.25	576.0288	577.2500	---
84	585.00	583.25	582.0291	583.2500	---
85	591.00	589.25	588.0294	589.2500	---
86	597.00	595.25	594.0297	595.2500	---
87	603.00	601.25	600.0300	601.2500	---
88	609.00	607.25	606.0303	607.2500	---
89	615.00	613.25	612.0306	613.2500	---
90	621.00	619.25	618.0309	619.2500	---
91	627.00	625.25	624.0312	625.2500	---
92	633.00	631.25	630.0315	631.2500	---
93	639.00	637.25	636.0318	637.2500	---
94	645.00	643.25	642.0321	643.2500	---

* Aeronautical Offset Freq. Allocation

FM Mid-band Cable Channels

Channel #	Digital FCC	FCC	HRC	IRC	VHF /UHF
95	93.00	91.25	90.0045	91.2500	---
96	99.00	97.25	96.0048	97.2500	---
97	105.00	103.25	102.0051	103.2500	---
98	111.00	*109.2750 (+25K)	108.0054	109.2750	---
99	117.00	*115.2750 (+25K)	114.0057	115.2750	---

* Aeronautical Offset Freq. Allocation

Hyper-band and UHF Broadcast Channels (cont.)

Channel #	Digital FCC	FCC	HRC	IRC	VHF /UHF
100	651.00	649.25	648.0324	649.25	---
101	657.00	655.25	654.0327	655.25	---
102	663.00	661.25	660.0330	661.25	---
103	669.00	667.25	666.0333	667.25	---
104	675.00	673.25	672.0336	673.25	---
105	681.00	679.25	678.0339	679.25	---
106	687.00	685.25	684.0342	685.25	---
107	693.00	691.25	690.0345	691.25	---
108	699.00	697.25	696.0348	697.25	---
109	705.00	703.25	702.0351	703.25	---
110	711.00	709.25	708.0354	709.25	---
111	717.00	715.25	714.0357	715.25	---
112	723.00	721.25	720.0360	721.25	---
113	729.00	727.25	726.0363	727.25	---
114	735.00	733.25	732.0366	733.25	---
115	741.00	739.25	738.0369	739.25	---
116	747.00	745.25	744.0372	745.25	---
117	753.00	751.25	750.0375	751.25	---
118	759.00	757.25	756.0378	757.25	---
119	765.00	763.25	762.0381	763.25	---
120	771.00	769.25	768.0384	769.25	---
121	777.00	775.25	744.0387	775.25	---
122	783.00	781.25	780.0390	781.25	---
123	789.00	787.25	786.0393	787.25	---
124	795.00	793.25	792.0396	793.25	---
125	801.00	799.25	798.0399	799.25	---
126	807.00	805.25	804.0402	805.25	---
127	812.00	811.25	810.0405	811.25	---
128	819.00	817.25	816.0408	817.25	---
129	825.00	823.25	822.0411	823.25	---
130	831.00	829.25	828.0414	829.25	---
131	837.00	835.25	834.0417	835.25	---
132	843.00	841.25	840.0420	841.25	---
133	849.00	847.25	846.0423	847.25	---
134	855.00	853.25	852.0426	853.25	---
135	861.00	859.25	858.0429	859.25	---
136	867.00	865.25	864.0432	865.25	---

Appendix B

What Is A dB?

Many technicians who use Signal Level Meters aren't sure what a dB really is and how it relates to signal strengths. In short, a decibel is a simple way of expressing the ratio of output power to input power as a simple number. Decibels (dBs) were developed to simplify figuring gains and losses of a system. Once the gain of a stage is converted to dB, only simple addition and subtraction is necessary to find the total gain of a system, or portion of the system.

In order to find the total gain of a distribution system without using dBs, it is necessary to multiply the gain of each amplifier stage and then divide the total gain by the total losses.

As a short example, let's assume that we have the portion of the system drawn below:

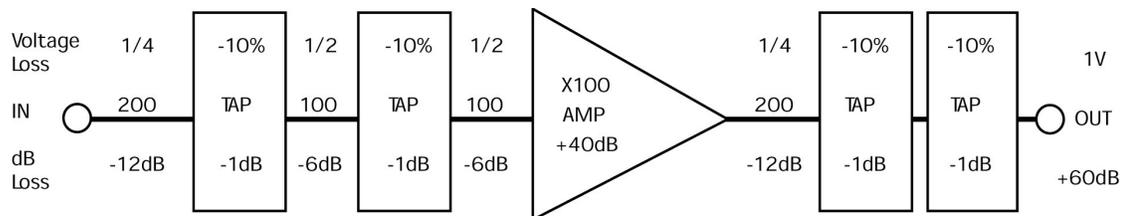


Figure 11 – System Loss and Gain Calculations

In our example the cable loses 1/2 of its applied voltage every 100 ft. (6 dB). The TAPs all have an insertion loss of 10% (1 dB). When 1 V is applied to the input you can calculate the voltage at each component as noted in the figure.

After 200 ft. the voltage will be $1V \times 1/2 \times 1/2 = 1/4 V = 250 \text{ mV}$

At the TAP output a 10% loss is equal to a 90% efficiency, thus the output will be $250 \text{ mV} \times 90\% = 250 \text{ mV} \times 0.90 = 225 \text{ mV}$.

Continuing the calculations will show the output voltage will be 1.01 V.

Voltage Calculation:

$$E = 1V \times 1/4 \times 0.9 \times 1/2 \times 0.9 \times 1/2 \times 100 \times 1/4 \times 0.9 \times 0.9 = 1V$$

You can go through the system multiplying the gains and dividing the losses or using the Decibel (dB) system simply add and subtract the dBs for each component to determine the signal level at any point in the system. A loss of 1/2 the voltage is 6 dB and a 10% loss of voltage is 1 dB (check these with the formulas which follow). Thus we simply add the gains and subtract the losses from our 1 V equivalent of +60 dBmV. The total losses are 40 dB with a gain of 40 dB. Thus, our output will be the same as our input level: 60 dBmV or 1 V.

$$\text{dB Calculation: } E = +60\text{dBmV} - 12 - 1 - 6 - 1 - 6 + 40 - 12 - 1 - 1 = +60\text{dBmV}$$

By having the gains or losses of individual stages represented in dBs, as in Figure 11, you simply add them together to find the total gain. Thus in our example the attenuation of the cable is 6 dB/100 feet and the 1 volt input level is equal to +60dBmV (discussed later). Thus after 100 feet the signal level is 54 dBmV, after 200 feet the level is 48 dBmV and so on.

By definition a dB is 10 times the logarithm of the ratio of output power divided by input power:

$$\text{dB} = 10 \log (P_{\text{out}}/P_{\text{in}})$$

In MATV and CATV work we are most concerned about signal voltages. The input/output ratio of voltages is expressed in dBs by multiplying the logarithm of the ratio of voltages by 20 instead of 10:

$$\text{dB} = 20 \log (V_{\text{out}}/V_{\text{in}})$$

This is proven by substituting E^2/R for P_{in} and P_{out} in the original equation. Thus, our equation becomes:

$$\text{dB} = 10 \log (E_{\text{out}}^2/R / E_{\text{in}}^2/R)$$

To simplify this equation the R in the numerator and denominator cancel each other and the Square can be moved out of the log factor becoming simply 2 x the 10, changing the multiplier to 20.

In these systems, a standard level of signal is required at the input to the television receiver for good picture quality. This standard is 1000 microvolts or 1 mV across 75 ohms, which is properly called 0 dBmV. The term dBmV is not a ratio. It is an absolute voltage level used as a reference point from which you can add and subtract other voltage levels expressed in dBmV. Gain or loss in a system or component is expressed in dBs, as in our earlier example. A specific voltage level is expressed in dBmV; that is: dB above (or below) the 1 mV standard. For example 10 dB may be the gain or loss of a component, but +10 dBmV is a specific voltage level (3.2 mV across 75 Ohms).

Below are tables of equivalent levels and equivalent ratios, which come from these formulas that may be useful:

<i>Levels</i>		<i>Ratios</i>	
Voltage	dBmV	Voltage Change	dB Change
1 μ V	-60 dBmV	0.707	-3.0dB
10 μ V	-40 dBmV	1.0	0.0dB
100 μ V	-20 dBmV	1.414	+3.0dB
1 mV	0 dBmV	2.0	+6.0dB
10 mV	+20 dBmV	3.0	+9.5dB
100 mV	+40 dBmV	5.0	+14.0dB
1 V	+60 dBmV	10.0	+20.0dB

Appendix C

Glossary

Adjacent Channels – Two television channels having video carriers 6 MHz apart, or two FM channels having carriers occupying neighboring channel allocations.

AGC (Automatic Gain Control) – A circuit, which monitors the high pilot and automatically controls amplifier gain and keeps the output level constant with changing input levels. Main control over the High frequencies.

ASC (Automatic Slope Control) – A circuit, which monitors the low pilot and automatically controls the amplifier slope and keeps the output level constant with changing input levels. Main control over the low frequencies.

Amplifier – A device used to increase the power and voltage level of a signal.

Attenuator – A passive device used to reduce signal strength.

Band Separator – A device used to split 2 or more frequency bands into separate leads.

Bridger – An amplifier, which is connected directly to the main trunk amplifier and "splits off" the signal for a distribution system.

Broadband – A device, which is capable of handling one or more channels.

CATV (Community Antenna Television) – An RF distribution system that distributes television broadcast programs, original programs, premium programming and other services using a network of coaxial cable.

Channel – In television, a portion of the RF spectrum 6 MHz wide that carries the audio and video carriers of the television signal.

Chrominance Signal – The portion of the NTSC color television composite video signal containing the color information.

Clipping – Cutting off the peaks of a signal.

Closed Circuit – A system in which television signals are transmitted over cable or telephone lines without being broadcast through the air.

Coaxial Cable – A concentric cable consisting of a center conductor, a dielectric, and a shield. Coax used for most MATV and CATV work has a characteristic impedance of 75 ohms.

Co-Channel – Type of interference caused by receiving the desired signal as well as a weaker signal than is on the same frequency or close to the same frequency as the desired signal.

Composite Video Signal – The complete video signal including the picture (luminance) signal, the blanking and sync pulses, and the color (chrominance).

Contrast – The range of dark and light values in a picture, or the ratio between minimum and maximum brightness.

Converter – A device used in RF distribution systems to convert from one frequency to another. May also control channel access.

dB – A relative ratio of two absolute values.

dBmV – An absolute signal level where 0 dBmV is equal to 1000 uV across 75 ohms.

Diplex Filter – A filter used to separate the low and high frequency bands on a cable into two separate signal paths.

Directional Coupler – A device used in RF distribution systems that has one input and provides two or more isolated outputs. One of the outputs often provides a lower output than the other.

Distortion – Any difference between the wave shape of the original signal and the wave shape after the signal has passed through the distribution system.

Drop – The coaxial cable running between a distribution tap and a subscriber's television receiver; including drop cable, ground block, splitters, traps and wall plates. Sometime to include the terminal device (converter).

Egress – A condition often called "signal leakage" in which signals carried by the distribution system radiate into the air.

Equalizer – A device used on RF distribution systems to compensate for cable or amplifier losses and provide a flat overall frequency response.

Feeder Line – The coaxial cable in a distribution system, which runs between Bridgers, line extenders and taps.

Gain – A measure of amplification of a device, usually expressed in dB and at the highest frequency of operation.

Ghosting – A signal interference condition producing positive or negative pictures displaced in time from the desired picture, caused by multi-path signal reception. Ghost pictures also result from cable ringing.

Ground Block – Connector, which passes the RF signal through with minimum loss while providing a means of attaching a ground wire to the drop cable; typically near the entry to the home. Grounding is accomplished by either a special ground rod or connection to the Water system (see local code for required grounding methods).

Guard Band – A portion of the frequency spectrum, often just below and above a channel, which is kept free of signals to prevent interferences.

Head End – The equipment located at the start of a CATV system. The place where the signals are processed and combined prior to distribution.

Hi-Band – VHF channels 7 to 13.

Hum Modulation – A condition where one or more horizontal bars roll upward through the television picture causing a noticeable change in brightness or contrast.

Impedance – The opposition to the transfer of energy. The impedance of coaxial cable is dependent on physical structure.

Ingress – A condition where unwanted RF signals leak into a distribution system.

Insertion Loss – Also called "feed thru loss". This is the loss that occurs as signals pass through a passive device. Insertion loss occurs in all devices, which do not amplify the signal.

Isolation – The amount of separation or loss between two terminals of a device, or between two components.

Line Amplifier – A broadband amplifier used to compensate for loss in a distribution system.

Line Extender - A type of amplifier used in the feeder system of a distribution system to raise signal levels and create positive tilt prior to TAPs.

Lo-Band – VHF channels 2 to 6.

Loss – Power that is dissipated without doing useful work.

Trunk – The major link of a distribution system between the head end and a major subscriber area.

MATV (Master Antenna Television System) – A distribution system which is usually contained within a single building and receives its signals from an antenna or CATV system.

Matching Transformer – A device, often called a balun, which converts between a 75 ohm impedance and a 300 ohm impedance.

Messenger Strand – A heavy wire or cable that supports the signal-carrying coaxial cable.

Match – The condition, which exists when the maximum power is transferred from one device to another. Maximum power is transferred when the characteristic impedance of both devices are the same.

Mismatch – The condition where maximum power is not transferred from one device to another. The power, which is not transferred, is reflected.

Mixer – A device, which will "mix" the input signals together, producing the two original signals and their sum and difference frequencies.

Noise – Any unwanted signal, which affects a wide or narrow band of frequencies.

Noise Figure – A comparison of the inherent noise of an amplifier to that of an ideal amplifier, which introduces no noise or distortion.

Off-Air – Any channel, which can be received by a conventional antenna system, including VHF and UHF, broadcast stations.

Passive – A circuit or device, which does not produce gain or use tubes, transistors, or integrated circuits. (i.e. TAPs and Splitters)

Preamplifier – An amplifier, which is often mounted on the antenna mast and is used to amplify very weak signals received by an antenna. The system noise figure is established by the preamp.

Processor – A device used in the Headend which receives a channel, reduces it to an IF, and either reproduces the signal on the same channel or converts it to another channel.

Radiation – RF energy, which is emitted, or leaks from a distribution system and travels through space. These signals often cause interference with other communication services.

Receiver – The part of a communications system, which converts electrical waves into visible or audible form.

Return Path – The signal path in a distribution system, which is used to get information back to the head end, usually on the sub-band frequencies of 5 to 50 MHz.

Ringings – A signal interference condition caused by impedance mismatch. Signal reflections produced by the mismatch result in ghost pictures.

Signal-To-Noise Ratio (S/N) – The ratio of desired signal level to the undesired noise level, expressed in dB.

Signal Strength – The intensity of an RF signal measured in volts (V), millivolts (mV), microvolts (μ V), or dBmV.

Snow – A large quantity of random noise in a television picture, which results from a poor C/N (carrier to noise) ratio.

Splitter – A device used to supply a signal to a number of individually isolated outputs.

Tap – A device inserted into a feeder line, which allows a specific amount of signal to be removed from the feeder line and isolates the TAP port from the main through line.

Terminator – A resistive device, which matches a cable, or the unused output of an active or passive system component to its characteristic impedance. Proper termination is required to prevent unused outputs from causing reflections back down the line.

Tilt – A linearized change in the frequency response of the CATV system caused primarily by the frequency dependent cable loss. Tilt is quantified by comparing the difference between the level of the highest channel's video carrier and that of the lowest channel.

Trap – A circuit often called a filter, which is used to attenuate undesired signals while not affecting desired signals. Typically a single channel trap to remove a single premium service, which the subscriber is not signed up for.

Trunk – The main signal path through the CATV system, which transports signals from the headend out to the neighborhood. Built to handle maximum channel capacity, maximize distance capability, minimize noise and distortion and preserve the quality of the headend signals. Drops are NEVER connected directly to the Trunk.

Two-Way System – A distribution system that delivers signals to the subscriber (down stream) and back to the head end (upstream).

UHF (Ultra High Frequency) – Off-air television channels 14 to 83.

VHF (Very High Frequency) – Off-air television channels 2 to 13.

Visual Carrier – The portion of a television signal, which carries the video portion of the picture.

Appendix D

Dipole Antenna Lengths

The length of the dipole antenna element is inversely proportional to the frequency or the desired RF carrier. Note the Frequency or channel you wish to measure and use the corresponding dipole antenna length. The quoted dipole element length is for each side of the dipole in inches. The total end-to-end length would be two times the element length.

Channel	Frequency	Element Length (Inches)	Channel	Frequency	Element Length (Inches)
2	55.25	50.8	26	247.25	11.4
3	61.25	45.8	27	253.25	11.1
4	67.25	41.8	28	259.25	10.8
5	77.25	36.3	29	265.25	10.6
6	83.25	33.7	30	271.25	10.4
			31	277.25	10.1
95	91.25	30.8	32	283.25	9.9
96	97.25	28.9	33	289.25	9.7
97	103.25	27.2	34	295.25	9.5
98	109.25	25.7	35	301.25	9.3
99	115.25	24.4	36	307.25	9.1
			37	313.25	9.0
14	121.25	23.2	38	319.25	8.8
15	127.25	22.1	39	325.25	8.6
16	133.25	21.1	40	331.25	8.5
17	139.25	20.2	41	337.25	8.3
18	145.25	19.3	42	343.25	8.2
19	151.25	18.6	43	349.25	8.0
20	157.25	17.9	44	355.25	7.9
21	163.25	17.2	45	361.25	7.8
22	169.25	16.6	46	367.25	7.6
			47	373.25	7.5
7	175.25	16.0	48	379.25	7.4
8	181.25	15.5	49	385.25	7.3
9	187.25	15.0	50	391.25	7.2
10	193.25	14.5	51	397.25	7.1
11	199.25	14.1	52	403.25	7.0
12	205.25	13.7	53	409.25	6.9
13	211.25	13.3	54	415.25	6.8
14	217.25	12.9	55	421.25	9.7
15	223.25	12.6	56	427.25	6.6
			57	433.25	6.5
23	229.25	12.2	58	439.25	6.4
24	235.25	11.9	59	445.25	6.3
25	241.25	11.6	60	451.25	6.2

Figure 12 – Dipole Antenna Segment Lengths

Channel	Frequency	Element Length (Inches)	Channel	Frequency	Element Length (Inches)
61	457.25	6.1	78	559.25	5.0
62	463.25	6.1	79	565.25	5.0
63	469.25	6.0	80	571.25	4.9
64	475.25	5.9	81	577.25	4.9
65	481.25	5.8	82	583.25	4.8
66	487.25	5.8	83	589.25	4.8
67	493.25	5.7	84	595.25	4.7
68	499.25	5.6	85	601.25	4.7
69	505.25	5.6	86	607.25	4.6
70	511.25	5.5	87	613.25	4.6
71	517.25	5.4	88	619.25	4.5
72	523.25	5.4	89	625.25	4.5
73	529.25	5.3	90	631.25	4.4
74	535.25	5.2	91	637.25	4.4
75	541.25	5.2	92	643.25	4.4
76	547.25	5.1	93	649.25	4.3
77	553.25	5.1	94	655.25	4.3

Figure 13 – Dipole Antenna Segment Lengths (con't)

Warranty Information

Your SLM 1453I has been built to the highest quality standards in the industry. Each SLM 1453I has been tested, aged under power, re-tested and calibrated to ensure that all published specifications are met. Your instrument is fully protected with a one year warranty and Sencore's 100% Made Right Lifetime Guarantee in the unlikely event that a defect was overlooked. Details of this warranty are covered in a separate document shipped with your instrument.

Service

The Sencore Factory Service Department provides all "in and out of warranty" service and complete calibration services for all Sencore instruments. No local service centers are authorized to repair Sencore instruments. Factory service insures you the highest quality work, the latest circuit improvements, factory parts and the fastest turnaround time possible. Most service repairs are completed within 72 hours of their receipt.

Returning an Instrument for Service

Save the original packing materials for reuse should you ever need to ship your SLM 1453I to the Sencore Factory Service Department for repair or re-calibration. If the original packing material is not available, please follow the following procedure steps 1 thru 3.

1. Use a corrugated shipping container that has a tested strength of 50 lbs. and internal dimensions of at least 17"x11"x 9".
2. Pack the unit inside a plastic bag to protect it.
3. Cushion the unit with a minimum of 3 inches of padding on each side of the instrument, more as required to completely fill the shipping carton. Pack the carton tightly enough to prevent the unit from shifting during shipment.
4. Seal all seams in the container with durable shipping tape.
5. Be sure to enclose the following information: Owner's Name, Owner's Address (ship to), Billing Information, Purchase Order (if required), Contact Name and Phone Number, Service Desired or Problem.
Call 1-800-SENCORE (1-800-736-2673) for a Return Authorization Number.
6. Ship the packaged unit to the address listed below. We recommend Federal Express.

Sencore Factory Service
3200 Sencore Drive
Sioux Falls, SD 57107

PARTS

Parts may be ordered from the Service Department. Parts not shown in the parts list may be ordered by description. Sencore reserves the right to inspect defective parts before warranty replacements are issued. If you have a question or a problem that we can help you with, please call or fax :

Toll Free: 1-800-SENCORE (736-2673)

Fax: 605-339-7032

The following information is for your records and may be helpful when calling the service department:

Purchase Date _____ Serial Number _____ Run Number _____

SENCORE

3200 Sencore Drive, Sioux Falls, SD 57107

www.sencore.com

1-800-SENCORE

1-800-736-2673

NOTES
