



# ***RETURN ALIGNMENT SYSTEM***

## **OPERATION MANUAL**



**TRILITHIC**  
INNOVATIVE ENGINEERING



# TRILITHIC

Trilithic, Inc. was founded in 1986 as an engineering and assembly company providing customized communications and routing systems for business and government applications. As business expanded, Trilithic broadened its offerings by acquiring components manufacturer Cir-Q-tel and instruments manufacturer Texscan, adding broadband solutions to the product line.

Today, Trilithic is comprised of three major divisions, Broadband/CATV Instruments & Systems, RF Microwave Components, and Emergency Alert Systems. The Instruments Division offers Test, analysis and quality management solutions for the major cable television systems worldwide. The Division specializes in the design and manufacturing of portable RF test equipment and integrated test systems performing in a wide range of HFC and LAN applications. The Wireless division provides components and custom solutions for companies specializing in cellular, military and other wireless applications. The EAS Division is a leading supplier of government-mandated Emergency Alert Systems used by HFC service providers.

An industry leader providing telecommunications solutions for major broadband and wireless markets around the world, Trilithic is dedicated to providing quality products, services and communications solutions meeting or exceeding our customers' expectations. Today, from our worldwide headquarters in Indianapolis Indiana, we provide over 1500 measurement products and communications components to thousands of customers around the world.



**TRILITHIC**  
9710 Park Davis Drive  
Indianapolis, IN 46235

Phone: (317) 895-3600  
Toll Free in North America: (800)344-2412  
Fax: (317) 895-3613

[www.trilithic.com](http://www.trilithic.com)



# TRILITHIC

## TWO YEAR WARRANTY

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 two (2) years 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 reporting 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.



**TRILITHIC**  
9710 Park Davis Drive  
Indianapolis, IN 46235

Phone: (317) 895-3600  
Toll Free in North America: (800)344-2412  
Fax: (317) 895-3613  
[www.trilithic.com](http://www.trilithic.com)

# INDEX

## General Information

Introduction .....	3
SST Headend Unit .....	4
SSR Field Unit .....	4
Equipment .....	5

## Optimizing the Return Path

Introduction .....	7
Return Path Performance Parameters .....	8
Signal-to-Noise Ratio .....	8
Signal-to-Ingress Ratio .....	8
A Balanced System .....	10

## About Your 9580

9580 System Overview .....	11
Theory of Application .....	12
Balancing the Return Path .....	12
Measuring Ingress and Noise .....	12

## Installing the 9580

Introduction .....	15
SST Headend Unit Installation .....	15
Reverse Test Carriers .....	15
Forward Data Carrier .....	17
Installation Procedure .....	17
Forward Connections .....	17
Reverse Connections .....	18
SST With Single Input Port .....	18
SST With Test Point Manager Option .....	18
SSR Field Unit Preparation .....	19
Test Point Connection .....	19
Injection Level .....	21

## Setting Up the 9580

Introduction .....	23
SST Headend Unit .....	23
Power Up .....	23
Set Up .....	24
RX Freq .....	25
RX Level .....	26
Link Freq .....	28
Link Level .....	29
Fast Mode .....	29
Peak Hold .....	30
Detector .....	31
Adjust Contrast .....	32
Exit Setup Menu .....	33
SSR Field Unit .....	33
Power Up .....	33
Set Up .....	34
TX Freq .....	35

TX Level .....	36
Link Freq .....	37
Unit ID .....	38
Adjust Contrast .....	38
Battery .....	39
Exit Setup Menu .....	40
<b>Basic Operation</b>	
Introduction .....	41
SST Headend Unit .....	41
Sweep Mode .....	41
Gain/Tilt Mode .....	42
Spectrum Mode .....	43
Fast Spectrum Mode .....	44
Zoom Spectrum Mode .....	45
Remote Mode .....	46
SSR Field Unit .....	47
Sweep Mode .....	47
Storing Sweep Data .....	48
Recalling Sweep Data .....	49
Spectrum Mode .....	50
Gain/Tilt Mode .....	51
Source .....	52
<b>Advanced Operations</b>	
Introduction .....	53
Adjusting the Fiber Link .....	54
Adjusting Amplifiers .....	56
Data Logging Feature .....	57
Ingress.....	58
<b>Comm Mgr Operations</b>	
Introduction .....	61
Hardware Installation .....	61
Equipment Required .....	62
Installation Steps .....	62
Testing the CM-8 Installation .....	65
Connecting 9580 SSTs .....	66
Modem-Remote Control .....	67
PC-Direct Control .....	68
Ethernet Control .....	68
Fiber Control .....	69
<b>Feature Notes</b>	
Interoperability .....	71
Version Upgrades .....	72
<b>Specifications</b>	
SST 9580 Specifications .....	73
SSR 9580 Specifications .....	74

# GENERAL INFORMATION



## Introduction

Any CATV operator who maintains a two-way CATV distribution system knows that many factors can affect the performance of that system. Cumulative noise, signal ingress, incorrect gain or bad flatness all conspire to harm the return path which can lead to loss of service and customer complaints.

You have taken an excellent step toward alleviating the problems of your return path with your purchase of this **9580 Return Path Maintenance System**. Trilithic's 9580 is designed to monitor all of the troublesome parameters in a single, simple to use system. The 9580 is part of Trilithic's **Guardian Return Alignment System** which includes the 9580 SST, 9580 SSR, RSVP Installer Return Test Units and Isometer.

It is more than just a return alignment system, however. The system also monitors the total performance of the return path by evaluating ingress and return noise. With the 9580's FAST Mode, you can increase the effective scanning rate of the INGRESS Mode's spectrum analyzer. This enables you to catch the transient events. PEAK HOLD enables the Unit to display the highest ingress points in NORM or FAST Modes. This makes the SST a powerful tool for capturing transient ingress. The AVERAGING feature is an option you can get for the SST. It is used in FAST and ZOOM Modes to reduce the noise floor displayed on the SST when measuring CW or common path.

The basic 9580 system consists of two types of equipment:

- SST Headend Unit
- SSR Field Unit

A system may include more hardware including additional SSR Field Units, RSVP Installer Return Test Units and a variety of headend options.

## SST Headend Unit

The SST Headend Unit is compact; occupying only 3.5" of rack space. It is easy to set up and operate. A single SST Headend Unit can support up to six SSR Field Units at a time with no loss of operating speed.

When it is equipped with Trilithic's optional Test Point Manager (TPM-8), the SST analyzes sweep and ingress signals from up to eight separate test points individually. It sends the appropriate ingress spectrum and flatness data to each SSR Field Unit to which it is connected.

You may also use Trilithic's Test Point Expander (TPX), which is equipped with one or more TPM-8 cards, in conjunction with a single, specially equipped SST unit to monitor up to sixty four nodes for a relatively low cost.

Even when it is not supporting the SSR Field Units, the SST can function as a monitor for return path quality. In attended head-ends, the personnel can observe noise and ingress patterns using the SST's built-in LCD display panel as an aid to troubleshooting.

Unattended locations can be monitored since the SST, when equipped with the Communications Manager option (CM-8 or ACM-8), can send ingress and sweep measurement data via direct connection, phone lines, ethernet or fiber to a PC located in a central office (see *INGRESS MANAGER OPERATION MANUAL* for more information). Monitoring installations are easily expanded since the Communications Manager enables seven additional SST Headend Units (with the Communications Manager option) to be accessed through one phone line. This means that a total of 64 test points may be monitored without having to reconfigure the equipment connections.

## SSR Field Unit

The SSR Field Unit generates test signals and displays the measurement data which is transmitted by the SST Headend Unit. The SSR Field Unit is addressable so that up to six may operate in conjunction with a single SST Headend Unit at any one time.

At the push of a button, the SSR Field Unit's high resolution, backlit LCD panel displays the ingress spectrum, sweep patterns or calculated values for gain and tilt. Operation is designed to be menu-driven and is so simple, you only need to do one keystroke to select any of the analytical displays.

The Unit's data logging feature allows you to store 24 sweep displays which can then be reviewed or uploaded to a PC.

The SSR Field Unit is designed to be handled in the field since it is small, light and inside a water-resistant case. It can operate for up to six full hours using its internal NiCad batteries or it can be operated from AC power while the battery charges.

## Equipment

The 9580 Return Path Maintenance System comes with the following standard items:

- SST Headend Unit (1)
- SSR Field Unit (1)
- Carrying Bag for SSR Field Unit (1)
- SSR NiCad Battery Pack
- Power Cube
- Operation Manual (1)
- Field Operation Guide (1)

In addition to the standard equipment, you can also purchase the following:

- Additional SST Headend Units
- Additional SSR Field Units (Carrying Bags included)
- RSVP Installer Return Test Units
- Communications Manager option (CM-8/ACM-8) - allows 8 SST's to share a communications link (phone via modem, Ethernet, Fiber)
- Test Point Manager option - equips SST so that it can monitor up to 8 individual Headend test points
- Test Point Expander option - used to expand a single SST up to 64 test points (TPX-9580)
- Replacement NiCad battery pack
- Replacement Power Cube





# OPTIMIZING THE RETURN PATH



## Introduction

Before you begin using your 9580 system, let's review the theory behind return path alignment and maintenance. To provide complex interactive services on cable, operators must ensure that they provide a reliable return path or customers won't have access to pay services, which will result in a loss of business. The high power transmissions from CB, ham radio and short-wave operators in the 5 to 30 MHz range, as well as other RF noise generating devices, present a threat to the return path as they can enter the cable system and interfere with upstream traffic. Additionally, the ever present signals from AM broadcast can enter the cable system and increase the power loading on the return laser to problematic levels.

As the return paths converge on their way to the headend or node, they act as interference concentrators. The various sources of ingress tend to add together and these independent sources of noise can merge to form a single strong ingress where the branches converge.

Since return path problems get worse as the branches converge, the best place to measure return path performance is at the headend; just before the upstream data is recovered. Return path performance monitored at the headend needs to be available to the technician in the field for alignment and troubleshooting. The 9580 system simplifies this process as follows:

The SST Headend Unit measures the system ingress as well as the test signals from the SSR Field Unit(s) and then transmits the results as data back to the SSR Field Unit(s), thus enabling the field technician to align the system and trouble shoot ingress problems from anywhere in the system.

## Return Path Performance Parameters

Reliable upstream performance depends upon:

- Proper Gain and Tilt
- Adequate signal-to-ingress ratio

It is important to balance Gain and Tilt in order to get the optimum performance from your system. Refer to Figure 1 on page 10.

### SIGNAL-TO-NOISE RATIO

Gain in a particular branch, if set either high or low, can adversely affect the signal-to-noise ratio in some part or all of the return path.

If set low, signals on this branch could be “swamped” by the noise of other branches.

If set high, noise on this branch might be amplified enough to interfere with signals on other branches.

To minimize noise-induced communications errors, upstream data systems use robust modulation schemes like Quadrature Phase Shift Keying (QPSK) which typically operates at a data rate of 1.544 Mbps.

However, even when using QPSK as the modulation format, your return system must provide a signal-to-noise ratio of at least 10 dB, as measured in a 1 MHz bandwidth around the data carrier center frequency to provide a marginally adequate Bit Error Rate (BER) of  $10E-5$

Incorrect gain settings, in some or all of the return paths, degrade the signal-to-noise ratio and increase the BER of the return path system.

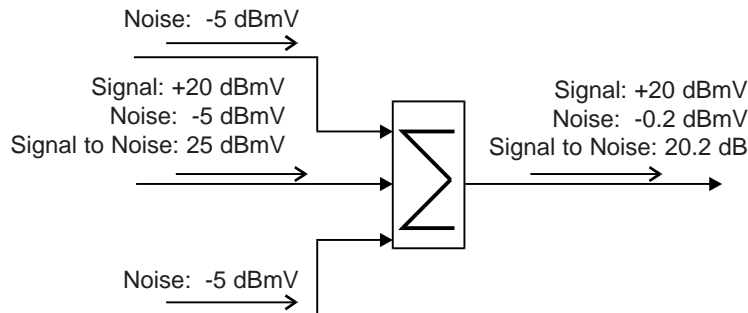
### SIGNAL-TO-INGRESS RATIO

When using QPSK, the sum of all ingressing signals lying within the data signal bandwidth (approximately 1 MHz for the data signal as discussed in *SIGNAL-TO-NOISE RATIO* above) should be at least 20 dB below the level of the data signal.

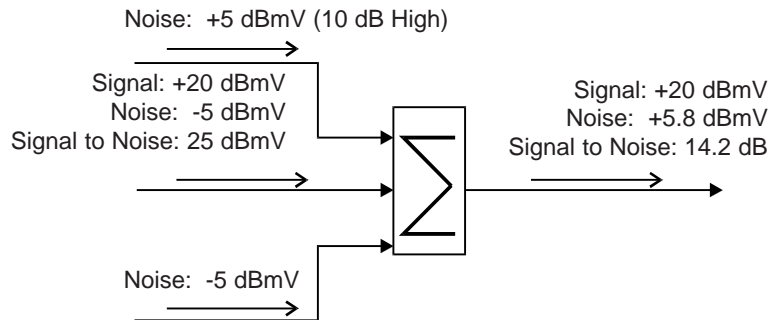
As the sum of ingressing signals exceeds this level, the BER performance of the return path system is degraded. If ingress levels approach  $-10$  dBc, communication may be seriously degraded.

# A Balanced System

When the system is balanced, a signal on one branch is degraded equally by noise on ALL branches to the same node.



If, however, the gain of one path is set HIGHER than the others, its noise could disrupt traffic on ALL other paths.



If the gain of one path is set LOWER than the others, its signals are disrupted by the noise of ALL other paths.

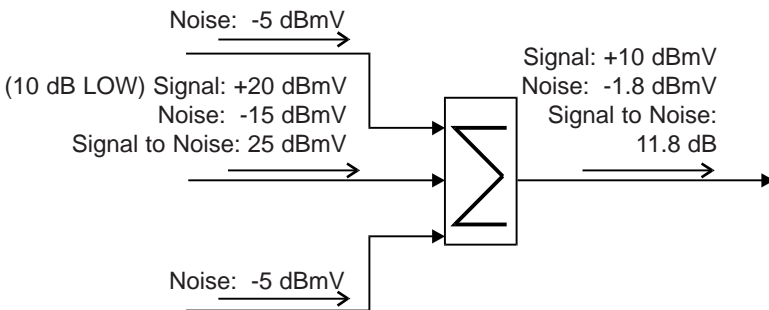


Figure 1. Balance Gain and Tilt.

# ABOUT YOUR 9580



## 9580 System Overview

Your 9580 Return Path Maintenance System is a single test system that enables you to deal with all aspects of return path upkeep; including both ingress control and system balancing. At the core of the system is the SST Unit, a 0.3 to 42 MHz digitizing spectrum analyzer, which is installed at the headend of your cable system.

The SST Headend Unit monitors all signals arriving at the headend, including reverse signal “traffic”, noise, ingress and test carriers from the SSR Field Unit(s).

A single SST Unit can monitor up to eight separate headend test points simultaneously which enables you to analyze the condition of each. The SST analyzes test signals and the return spectra separately. It packages measurement results into a data stream that it transmits to the SSR Field Unit(s).

The SSR's are addressed individually (A - F) which allows six of these units to be in operation at any one time. Each of these SSR Field Units transmits up to eight test carriers at user-settable frequencies. The SST measures these test carriers to compute the gain and tilt of the return path. The SSR's can store up to 24 sweep displays which can be reviewed at a later time or uploaded to a PC.

During system testing, the SST sorts out the test carrier measurements for each SSR and tags the data with the individual addresses (A – F) so that each SSR displays the appropriate information. When the SSR receives its data, it displays the response of the return path as either a line graph or as numeric values for gain and tilt. Ingress and noise data are presented as a spectrum analyzer display.

# Theory of Application

The 9580 test system can be used to:

- Balance the return path
- Measure the return path's ingress and noise

## BALANCING THE RETURN PATH

In the basic test architecture, test signals are injected upstream by the SSR. These signals are measured automatically at the headend by the SST. Then, the measurement data is transmitted back to the SSR for the display.

In order to balance the return path of your system, you need to consider several alignment objectives. You need to set the fiber return path link to the system's design specifications. You must also set each line amplifier so that it will compensate for the gain and tilt of the cable and passives to the next amplifier.

The SSR has two types of displays which will accommodate amplifier adjustment differences:

- Eight-carrier line graph for amplifiers which require screwdriver adjustments.
- Calculated gain and tilt values for amplifiers which use pads and equalizers.

## MEASURING INGRESS AND NOISE

In the basic test architecture, the SST Headend Unit's spectrum analyzer measures the incoming ingress and noise. It then transmits this measurement data to the SSR. The SSR displays the ingress data as a spectrum pattern.

**REMINDER:** If your 9580 is equipped with the Test Point Manager option, you can analyze eight return paths individually.

When you are analyzing the return path, you need to determine if the return frequencies carrying “traffic” have an adequate signal/ingress ratio. To do this, you must first calculate the effective ingress power.

For narrow band ingress, such as CB or shortwave, measure the ingress power directly.

For broadband ingress, such as interference from machinery, treat the ingress as noise and correct for video or data bandwidth. In the formulas below, Measured Power (MP) equals the reading from the 9580 and IP equals the effective Ingress Power.

To compute the effective noise in a 4 MHz video bandwidth, take the reading from the 9580 and add 10.3 dB.

$$IP = MP + 10.3 \text{ dB}$$

To compute the effective noise for data bandwidth, take the reading from the 9580 and add 10 times the log (data BW divided by .375MHz).

$$IP = MP + 10 \times \log (\text{data BW} / .375 \text{ MHz})$$

To maintain good picture quality, video signals require narrow band ingress to be between – 40 to 60 dBc, depending on the offset from the video carrier and broadband ingress to be at least – 40 dBc.

Quadrature Phase Shift Keying (QPSK) should have an effective ingress power of – 20 dBc for either type of ingress for a Bit Error Rate (BER) of approximately  $1 \times 10^{-6}$ .





# INSTALLING THE

## 9580

4

## Introduction

You are now familiar with the theory behind return path alignment and maintenance so you can jump right in, turn on your 9580 system and start optimizing that ole' return path. Actually, before you can even install your 9580, you need to make decisions regarding carrier frequencies, which options you are using...you get the picture. The information in this chapter will assist you in making those pre-installation determinations and will show you how to install your SST Headend Unit and prepare your SSR Field Unit(s) for operation.

## SST Headend Unit Installation

You need to make several decisions concerning the placement and levels of the reverse test carrier and forward data carrier before you install your SST Headend Unit. These vary from one cable system to another depending on the characteristics of the signals already on your system. Several of the following decisions **REQUIRE** information concerning your system's design.

## REVERSE TEST CARRIERS

You may choose up to eight reverse test carrier frequencies. Before making your selection, you should consider the following:

- Return band edges – usually the *highest* and *lowest* frequency test carriers will be near the return band edges (i.e. at 5 - 6 MHz and at 41 - 42 MHz).
- Problem frequencies – a test carrier might be placed at a frequency in the return pass band where problems may occur due to the particular models of passives (taps, power inserters, etc.) which are being used in the system.

For instance, some 750 and 1000 MHz passives have significant rolloff below 10 MHz. In this case, you might want to place test carriers around 5 and 10 MHz so that you can average the compensation for low end rolloff.

- Selected frequencies – you must avoid occupied bands of frequencies such as those carrying data or video. If you are using multiple SSR Field Units, you need to provide the following clear bandwidth ABOVE the frequency of each test signal.

Clear frequency BW = (number of SSR's – 1) x 100 kHz

However, if you plan to use the RSVP Installer Return Tester, you should set up one (or more) of the SST test frequencies close to the active frequency(ies) which will be used by the subscriber's equipment. Since the RSVP acts like a Unit F SSR, place the test carrier frequency which is to be used by the RSVP at least 500 kHz below the band edge of the active return frequency.

- The desired return signal output level is determined by the headend design.

This desired return output level **MUST** be established to set up the SST Headend Unit successfully. Consult the design documentation for your headend or calculate it based on the modem level requirements and the headend architecture to determine the correct figure.

- The actual return signal level arriving at the SST Headend Unit's INPUT port(s) must be equal to, or greater than,  
– 10 dBmV for accurate measurements over the full dynamic range of the SST. Include coupling losses and any in-line pads in your calculation.

**NOTE:** For signal-to-noise considerations, it is necessary that all fiber receivers sharing the same headend data modem have the same output level. For this reason, the SST expects to see the same return level at each return test point.

Levels before adjustment will differ due to the varying length of fiber to the node. One of the objectives for using the 9580 is to balance receivers to the same output level; either through built-in adjustments or by inserting external padding, depending on the receiver's design.

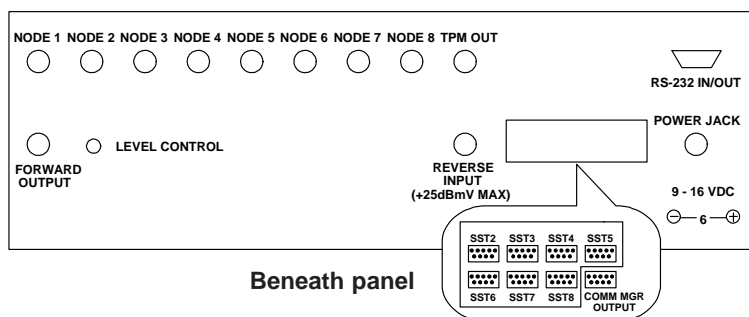
## FORWARD DATA CARRIER

You also need to define the characteristics for the forward data carrier. First, select a forward data carrier frequency.

- The carrier center frequency may be set below Channel 2 (50 – 53.75 MHz) or in the Channel 4 – 5 gap (74 MHz band). The frequency you select must be clear of other “traffic” for 200 kHz above and below the data carrier.

## INSTALLATION PROCEDURE

Now that you have your system levels and frequencies determined, you are ready to install the your SST at the headend. Refer to Figure 2 below for the locations of the connections on the SST's rear panel.

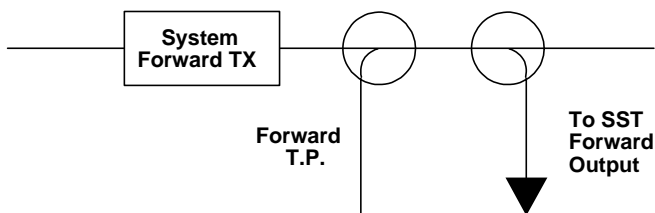


**Figure 2. SST Headend Unit Rear Panel View.**

## Forward Connections

For forward connections, you need to provide a forward signal injection point. If necessary, install a 6 dB to 20 dB coupler before the forward test point.

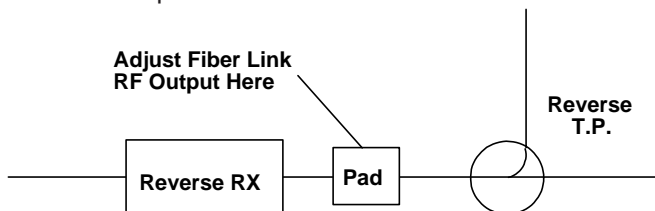
Make sure that it is inserted in the proper direction.



**REMINDER:** The injection point must be BEFORE the Headend's forward output test point.

## Reverse Connections

For reverse connections, you need to install test point couplers, in the range of 6 dB to 20 dB, at the outputs of the reverse path's fiber receiver outputs.



**REMINDER:** Note the coupler loss value. You will need to enter this data in the SST Headend Unit during the set up procedure. See *SET UP* page 24.

## SST WITH SINGLE INPUT PORT

If your SST Headend Unit only has a SINGLE input port, you may connect several test points simultaneously by summing them in an RF combiner. The noise from the combination will increase proportionately to the number of inputs which are combined.

## SST WITH TEST POINT MANAGER OPTION

If your SST Headend Unit contains the Test Point Manager option, you can connect up to eight test points individually to the SST Headend Unit's eight input ports.

**NOTE:** The value of coupling loss in the path between all fiber receiver outputs and inputs to the Test Point Manager **MUST** be the same.

For example, if a 12 dB coupler is used at one test point and a 6 dB coupler is used at another, you must insert an additional 6 dB pad between the coupler's tap port and the SST Headend Unit's input port.

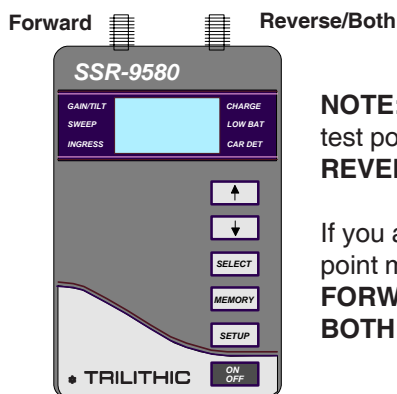
## SSR Field Unit Preparation

Before using your SSR Field Unit, you need to gather data and make several decisions since the way you use your SSR will depend upon your system architecture.

**NOTE:** The following procedures apply to both the fiber nodes and the line amplifiers.

## TEST POINT CONNECTION

You need to determine the proper test point connection for each type of active device in the return system. The SSR Field Unit can accommodate separate forward and reverse test connections (dual test lines). It can also communicate through a single forward/reverse test point if one is available. See Figure 3 below.

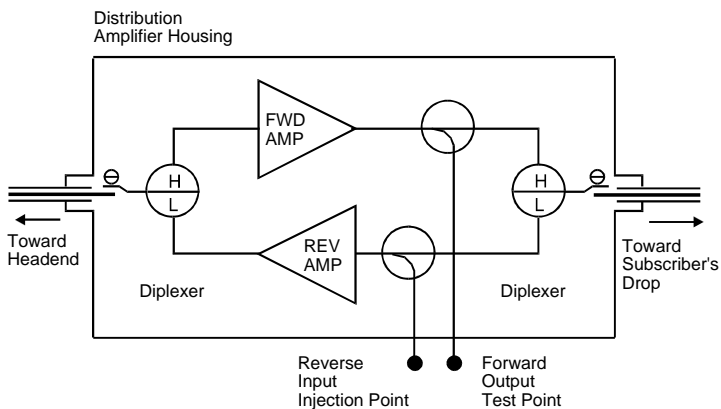


**NOTE:** If you are using the single test point method, use the **REVERSE/BOTH** connector only.

If you are using the dual test point method, use both the **FORWARD** and the **REVERSE/BOTH** connectors.

**Figure 3. SSR Field Unit Front Panel View.**

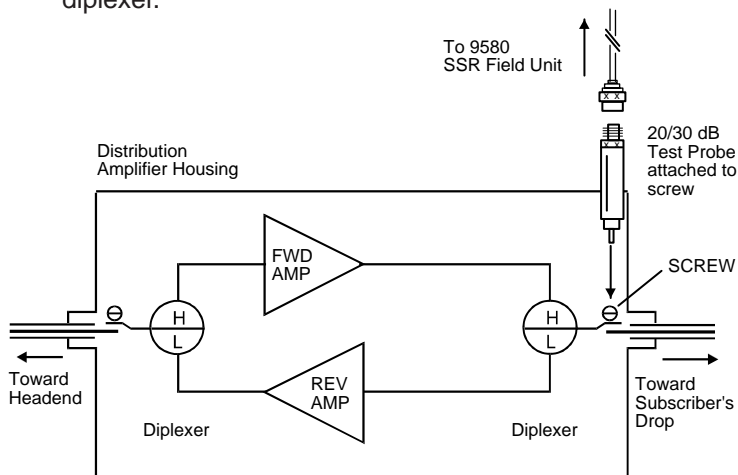
- Dual test lines (See Figure 4 on page 20):  
For the SSR Field Unit's data carrier input, connect it to the forward amplifier output test point, even if it is before the output diplexer.



**Figure 4. Dual Test Lines.**

For the reverse test carrier injection, connect the SSR's **REVERSE/BOTH** connector to the reverse amplifier's input injection point if the injection point is upstream from the forward output diplexer.

- Single test connection (See Figure 5 below):  
To use this method, you need to connect the SSR's **REVERSE/BOTH** connector to the amplifier's (or node's) forward test point which is located after the down stream diplexer.



**Figure 5. Single Test Connection.**

## INJECTION LEVEL

You need to identify the proper injection level for each device in the return path. First, consult the node's or amplifier's data sheet to determine the appropriate input level to the return amplifier for ordinary return path "traffic".

Add the coupler or test probe loss to this input level. Set your SSR Field Unit's test carrier level to the resulting value:

$$\text{Input Level} + \text{Coupler Loss} = \text{SSR's Test Carrier Level}$$





# SETTING UP THE 9580



## Introduction

Okay, you have installed and “prepped” the SST Headend and SSR Field Units of your 9580 system, and you’re all ready to power up and start using everything. Well, almost. Before you can operate the system, you need to perform several basic set up steps for both the SST and SSR Units.

## SST Headend Unit

In this section of the chapter, we will discuss the set up procedures for the SST Headend Unit.

## POWER UP

Now you are ready to power up your SST.

**NOTE:** Make sure that the **FORWARD OUTPUT** of the SST is disconnected.

Connect the AC Power Cube to the **POWER JACK** on the rear panel of the SST. Then plug the power cube into an outlet. See Figure 6 below.

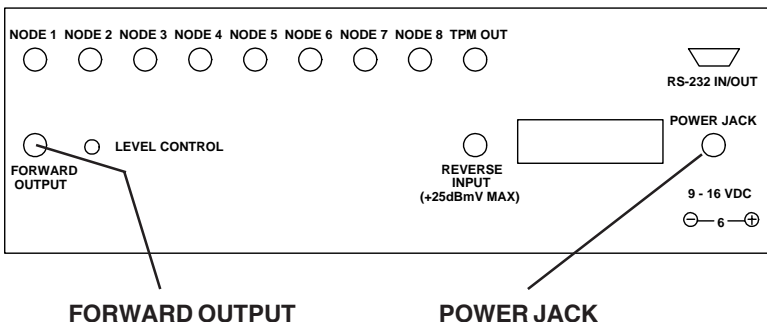


Figure 6. SST Headend Unit Rear Panel View.

Once the SST Headend Unit is connected to the power source, turn it ON via the **ON/OFF** control button on the Unit's front panel. See Figure 7 below.

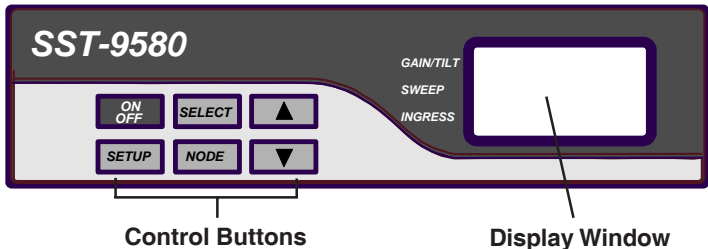
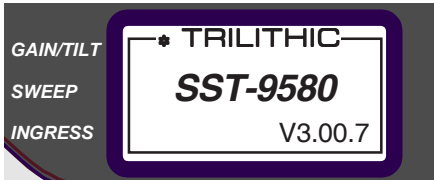


Figure 7. SST Headend Unit Front Panel View.

When you turn the Unit ON, the SST will power up in the INTRO screen and then display the last test mode used.



**NOTE:** In the above figure, you will notice that the version number appears below the model number.

## SET UP

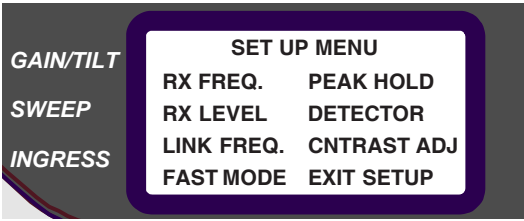
Now that the SST Headend Unit is connected and turned ON, you need to program its nonvolatile memory with several pieces of information:

- Return Sweep Frequencies
- Desired Return Level at the Headend
- Test Point Coupling Value
- Data Link Frequency
- Data Link Level (set on rear panel)

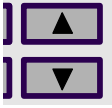
To enter the SETUP Mode, press the **SETUP** button on the front panel.



This will bring up the SET UP MENU in the Unit's display.



Once you are in the SET UP MENU, use the **ARROW** buttons to move from one selection to another.

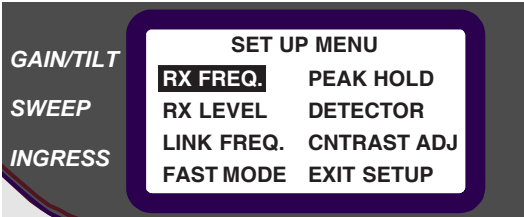


When the desired selection is highlighted, use the **SELECT** button to enter the SET UP SCREEN for that selection.

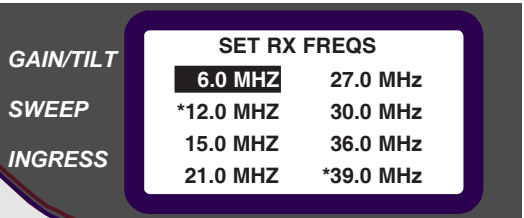
**NOTE:** If you wish to abort the set up selection, turn the Unit OFF.

## RX Freq

Use the **RX FREQ** selection to set the eight frequencies which the SSR will transmit for reverse alignment. Use the **ARROW** buttons to highlight RX FREQ.



Then, press **SELECT** to enter the SET RX FREQS Menu.



The eight test frequencies for SSR Field Unit “A” are displayed and the first frequency will be highlighted. Use the **ARROW** buttons to *increase* or *decrease* the test frequency.

**NOTE:** The test frequencies MUST be ranked in order with the LOWEST frequency at the top of the list and the HIGH-EST frequency at the bottom.

Once you have selected the desired frequency, you may press **SELECT** to highlight the field left of that frequency. Use the arrow keys to *toggle* an “\*” on or off beside that frequency. Only two frequencies can be marked with an “\*”. The SST uses the two marked frequencies to calculate the Gain/Tilt numbers which it displays. You must program the SSR’s Gain/Tilt separately (see page 35). It is a good idea to use the SAME frequencies for Gain/Tilt in both the SST and the SSR. To proceed to the next frequency, press **SELECT** again.

**NOTE:** When you have finished with the “\*” field of frequency eight, pressing **SELECT** returns you to the SETUP Menu.

If you are using more than one SSR Field Unit, the other SSRs (“B” through “F”) space themselves automatically at 90 kHz intervals from the next lower unit. For example, if SSR Field Unit “A” is set for 5.0 MHz, “B” will use 5.09 MHz, “C” will use 5.18 MHz and so on. The frequencies for the SST Headend Unit “A” are transmitted over the data link so that all units have access to the test frequencies.

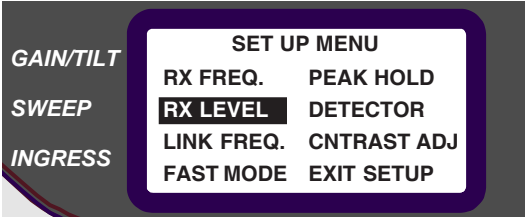
#### **HOT TIP**

***Each SST Headend Unit may have its own set of test frequencies. The SSR Field Units will change automatically to those frequencies when receiving that particular SST’s data signal. This is useful when return paths have different active frequencies which must be avoided when sweeping.***

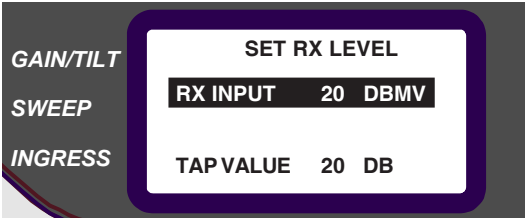
## **RX Level**

The SST Headend Unit must be told what level to expect from a reverse system which is operating properly.

To program the nominal reverse level desired at the headend or at the fiber receiver's output, use the **ARROW** buttons to highlight RX LEVEL in the SETUP Menu.



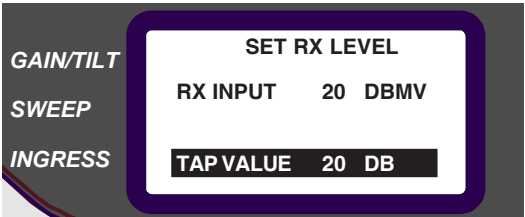
Press **SELECT** to enter the RX LEVEL Menu.



**NOTE:** The actual RF level at the SST input (RX Input – Tap Value) must be LESS than + 25 dBmV and GREATER than – 10 dBmV for proper operation of the SST.

With RX INPUT highlighted, use the **ARROW** buttons to *increase* or *decrease* the RX input value.

When the value is set, press **SELECT** and the highlight will scroll down to the TAP VALUE.



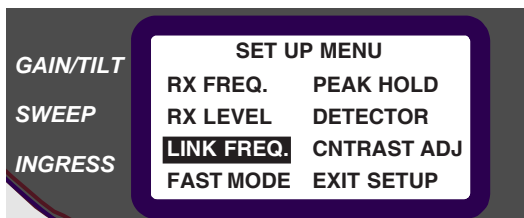
Use the **ARROW** buttons to enter the coupling losses if there are any between the reverse cable or fiber receiver and the SST Headend Unit. For example: if you are using a 20 dB coupler, enter 20 dB.

When you are finished, press **SELECT** to return to the SETUP Menu.

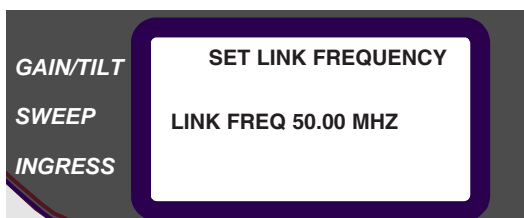
**NOTE:** All displays on the SST and SSR Units will be referenced to the value entered for the RX INPUT.

## Link Freq

Now you need to set the forward data carrier frequency. Use the **ARROW** buttons to highlight LINK FREQ. in the SETUP Menu.



Press **SELECT** to enter the LINK FREQ. Menu.



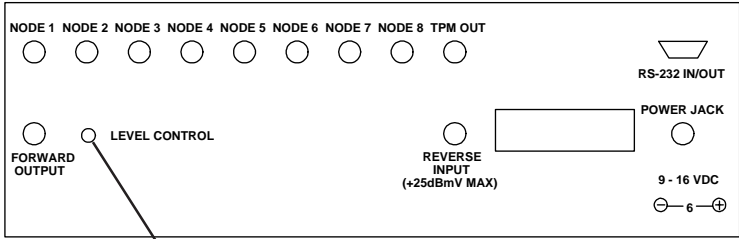
Use the **ARROW** buttons to *increase* or *decrease* the forward data carrier frequency.

When you are finished, press **SELECT** to return to the SETUP Menu.

**NOTE:** All SSR Field Units operating in conjunction with this SST Headend Unit must be set to the same LINK FREQUENCY.

# Link Level

Use the **LEVEL CONTROL** on the SST's rear panel to set the data link level between 0 and 10 dB below system video carrier levels when measured at the **FORWARD OUTPUT** connection on the SST (see Figure 8 below). Connect the SST to the forward path injection point and repeat the adjustment while monitoring the level at the headend output test point.



## LEVEL CONTROL

Figure 8. SST Headend Unit Rear Panel View.

# Fast Mode

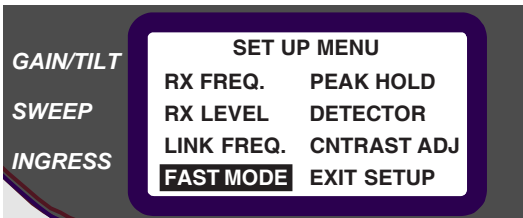
The SST supports two settings in FAST Mode:

- 375 kHz Resolution BW, 20 Hz/node sweep rate
- 525 kHz Resolution BW, 80 Hz/node sweep rate

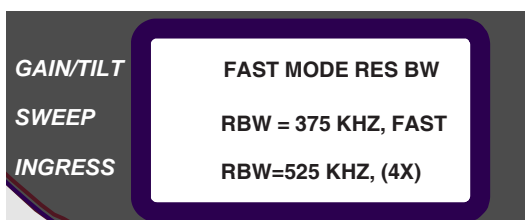
FAST Mode increases the effective sweep rate of the ingress mode spectrum analyzer by enhancing the ability of the SST to capture transient ingress events. These events can be significant sources of ingress even in a well set up system.

**NOTE:** Sweep is NOT supported when the unit is in FAST Mode.

Use the **ARROW** buttons to highlight FAST MODE in the SETUP Menu.



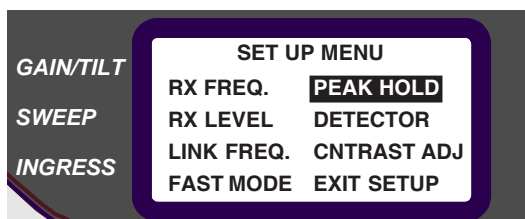




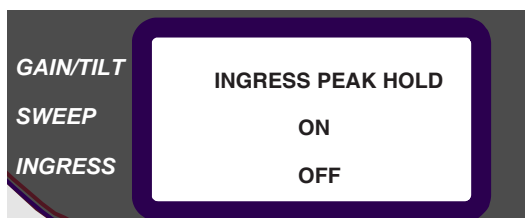
Press **SELECT** to enter the FAST MODE Menu. Use the **ARROW** buttons to highlight the desired Resolution BW setting. Press **SELECT** to return to the SETUP Menu. This mode is memorized so that when the power is cycled, the unit remembers the last setting and returns to it.

## Peak Hold

The SST Headend Unit will peak hold its display in the SPECTRUM Mode. Use the **ARROW** buttons to highlight PEAK HOLD in the SETUP Menu. PEAK HOLD Mode enables the unit to display the highest ingress points until it is reset. When in this mode, the unit works in NORM and FAST Modes. It is useful for long duration tests for ingress on a particular node. This mode always resets to "OFF" when the unit is powered down.



Press **SELECT** to enter the PEAK HOLD Menu.



Use the **ARROW** buttons to highlight the desired peak hold status. Press **SELECT** to return to the SETUP Menu.

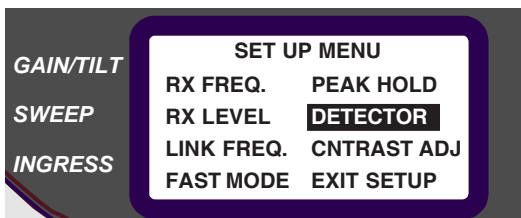
## Detector

The SST Headend Unit supports two ingress detection schemes which are utilized in FAST and ZOOM Modes. The schemes are:

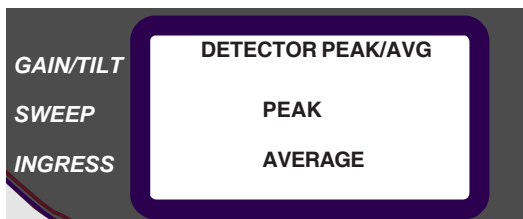
- Peak Detection - standard in all units
- Average Detection - optional

You use the Peak Detection scheme to enable the SST to capture transient ingress events. The Average Detection scheme is used to reduce the noise floor displayed on the SST when measuring CW or common path.

Use the **ARROW** buttons to highlight DETECTOR in the SETUP Menu.



Press **SELECT** to enter the DETECTOR Menu.

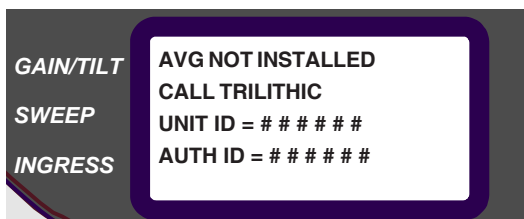


Use the **ARROW** keys to highlight the desired scheme. Once you have highlighted PEAK or AVERAGE, press **SELECT** to return to the SETUP MENU.

**NOTE:** The SST memorizes the selected scheme and will return to it even if the unit has been turned OFF.

When either scheme is selected, the display in FAST and ZOOM Modes will indicate which detector scheme is enabled. For example, the word FAST changes to F-PK or F-AV or the word ZOOM changes to Z-PK or Z-AV (see page 44 for more information for FAST Mode and page 45 for ZOOM SPECTRUM Mode).

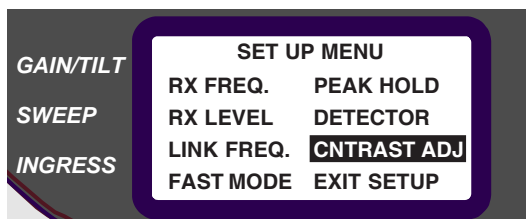
**NOTE:** You must have the Average Detector option installed in order to access the PEAK or AVERAGE detection screen. If this option is not installed, when you select DETECTOR the display will indicate the following:



If you'd like to purchase the Average Detector option for your SST, please contact Trilithic at 1-800-344-2412. (In the above display, the UNIT ID will display the ID number of your particular unit. When you call, the customer service representative will give you a six-digit authorization ID code to activate the option in your unit.)

## Adjust Contrast

The SST Headend Unit's display can be adjusted to your preference with regard to contrast. Use the **ARROW** buttons to highlight CNTRST ADJ in the SETUP Menu.



Press **SELECT** to enter the CNTRST ADJ Menu.



Use the **ARROW** buttons to *increase* or *decrease* the degree of contrast in your display.

When you are finished, press **SELECT** to return to the SETUP Menu.

## Exit Setup Menu

When you have finished programming the SST Headend Unit's nonvolatile memory, highlight the EXIT SETUP option in the SETUP Menu. Press **SELECT** and the Unit will return to whatever mode it was in when SETUP was entered.

## SSR Field Unit

In this section of the chapter, we will discuss the set up procedures for the SSR Field Unit.

### POWER UP

The SSR Field Unit is designed to run from an internal NiCad battery. The Unit also comes with an AC power cube which is used to charge the battery overnight or run the SSR Unit from an AC power source.

Connect the AC power cube to the connection on the left side of the SSR Field Unit and plug the power cube into an outlet.

Once the Unit is connected to a power source, turn it ON via the **ON/OFF** button on the front panel. See Figure 9 below.

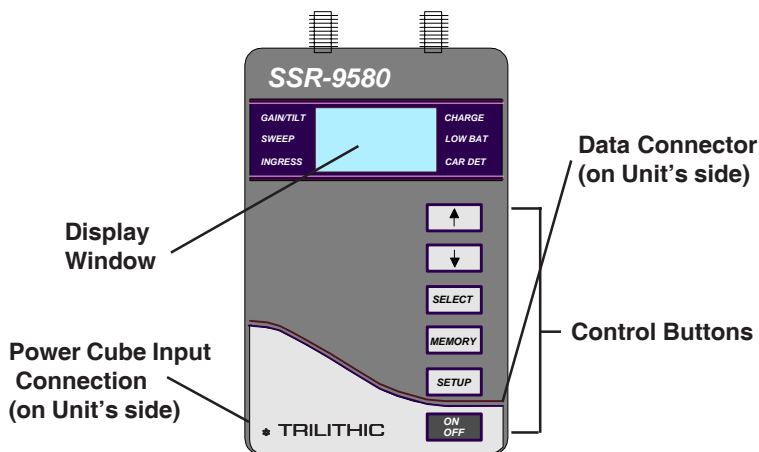


Figure 9. SSR Field Unit Front Panel.

When you turn the Unit ON, the SSR will power up in the INTRO screen and then display the last test mode used.



**NOTE:** In the above figure, you will notice that the version number appears below the model number.

### SET UP

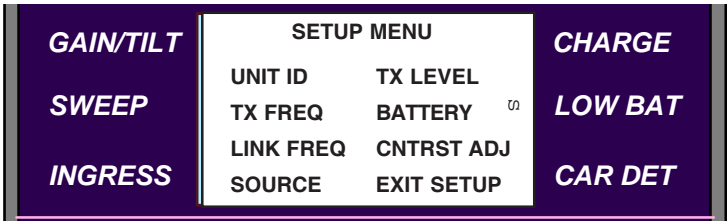
Now that the SSR Field Unit is connected and turned ON, you need to configure its operational parameters via the SETUP Menu.

**NOTE:** You may also use this SETUP Menu to change operational parameters later on.

To enter the SETUP Mode, press the **SETUP** button on the front panel.

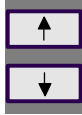


This will bring up the SET UP MENU.



**NOTE:** In the above figure, you will notice that there is an arrow at the LOW BAT indicator. This means that your Unit's NiCad battery needs charging. As battery power runs down, the SSR Field Unit is designed to shut off automatically. For this reason, it is a good idea to use the power cube for your initial set up preparations since the power cube is designed to charge the NiCad battery any time it is plugged into the SSR Field Unit.

Once you are in the SETUP MENU, use the **ARROW** buttons to move from one selection to another.



When the desired selection is highlighted, use the **SELECT** button to enter the SET UP SCREEN for that selection.

**NOTE:** If you wish to abort the set up selection, turn the Unit OFF.

## TX Freq

The TX frequency setup is used to display the test carrier frequencies that the SSR Field Unit is using. It is also used to activate or deactivate any of the eight test carriers.

**NOTE:** Only disable a frequency when absolutely necessary. Usually the SST configuration will select frequencies which avoid interference problems.

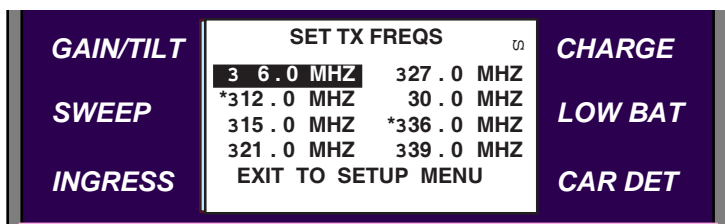
### ***HOT TIP***

***Frequencies are all 0.0 unless the SSR is connected to the system. If connected, the test frequencies shown are the ones downloaded from the SST Headend Unit data link so it is best to have the SSR active on the system before you inspect or modify the TX frequencies.***

When you are ready to select the TX frequencies, use the **ARROW** buttons to highlight TX FREQ.



Then, press **SELECT** to enter the SET TX FREQS Menu. Press the **ARROW** buttons to highlight one of the eight frequencies.



Press **SELECT** to cycle through three options:

- 6 . 0 MHZ Carrier Deactivated
- ✓3 6 . 0 MHZ Carrier Activated
- ✓\*3 6 . 0 MHZ Carrier Activated and used to calculate Gain/Tilt

**NOTE:** You must program the SST's Gain/Tilt separately (see page 26). It is a good idea to use the SAME frequencies for Gain/Tilt in both the SST and the SSR.

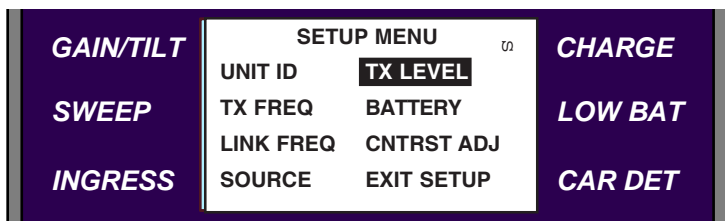
When you press **SELECT** so that you are satisfied with the state of the carrier, use the **ARROW** buttons to move you to a different frequency.

**REMINDER:** Only two frequencies may be marked with the “\*”.

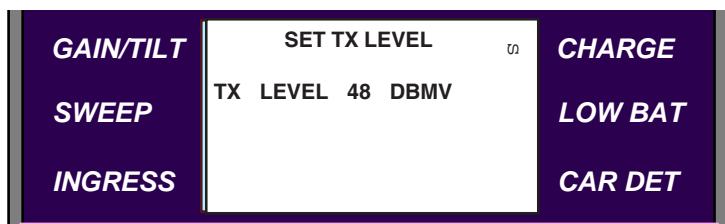
When you have completed activating and deactivating the TX frequencies, highlight EXIT TO SETUP MENU and press **SELECT**. Your Unit will return to the SETUP Menu.

## TX Level

To set the level at which test carriers are transmitted from the SSR, use the **ARROW** buttons to highlight TX LEVEL.



Press **SELECT** to enter the TX LEVEL Menu.

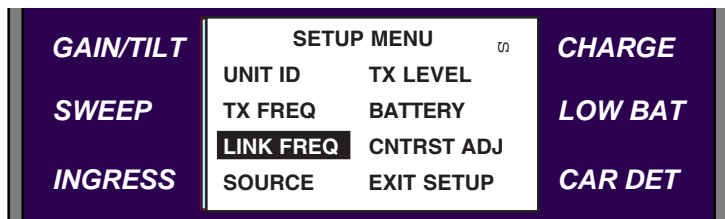


Press the **ARROW** buttons to *increase* or *decrease* the reverse test signal levels in 1 dB steps. When you are finished, press **SELECT** to return to the SETUP Menu. The available range is 24 – 55 dBmV.

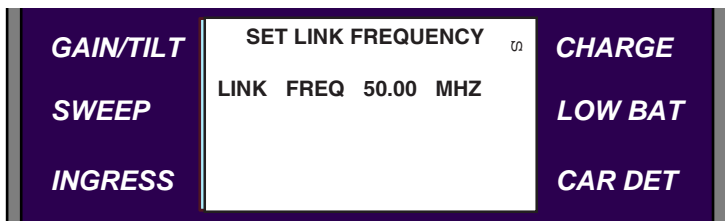
Set your unit to the proper level for injecting signal into your system (as computed on page 21).

## Link Freq

To set the Link Frequency, use the **ARROW** buttons to highlight LINK FREQ.



Press **SELECT** to enter the SET LINK FREQUENCY Menu.



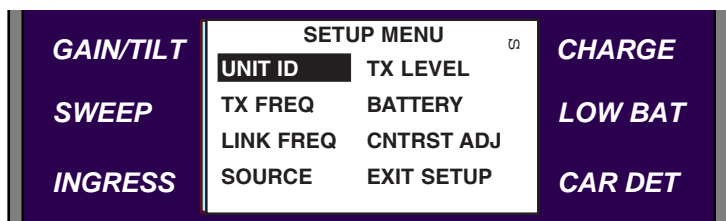
Press the **ARROW** buttons to *increment* or *decrement* the frequency in 50 kHz steps. The Unit will run through the possible 50 MHz frequencies then proceed to the 70 MHz frequencies. When the desired frequency is displayed, press **SELECT** to return to the SETUP Menu.



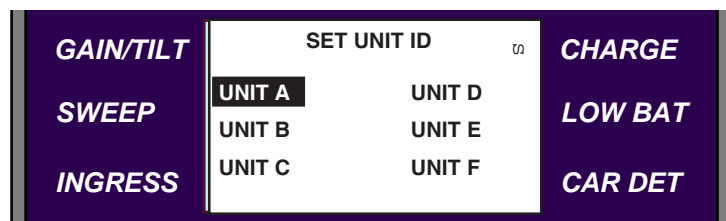
**NOTE:** The frequency selected must match the setting on SST Unit with which the SSR Unit is interfacing.

## Unit ID

To set the Unit Identification, use the **ARROW** buttons to highlight UNIT ID.



Press **SELECT** to enter the SET UNIT ID Menu.



Press the **ARROW** buttons to set the ID from A to F.

When the desired ID is highlighted, press **SELECT** to return to the SETUP Menu.

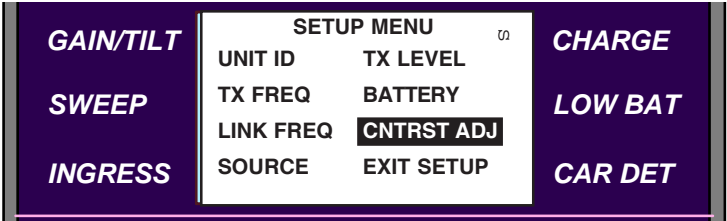
**REMINDER:** Each SSR Field Unit must have a unique ID in order to operate with the same SST Headend Unit. SSR “A” will use the frequencies programmed into the SST while the other units (B - F) space up from that point by 90 kHz.

For example, if SSR Field Unit “A” is set for 5.0 MHz, “B” will use 5.09 MHz, “C” will use 5.18 MHz and so on.

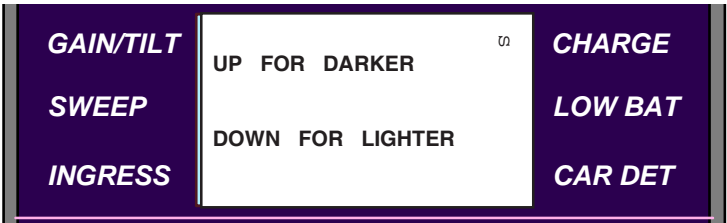
## Adjust Contrast

The SSR Field Unit’s display can be adjusted to your preference with regard to contrast.

Use the **ARROW** buttons to highlight CNTRST ADJ in the SETUP Menu.



Press **SELECT** to enter the CNTRST ADJ Menu.

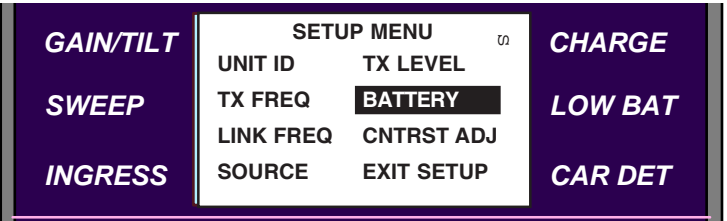


Use the **ARROW** buttons to *increase* or *decrease* the degree of contrast in your display.

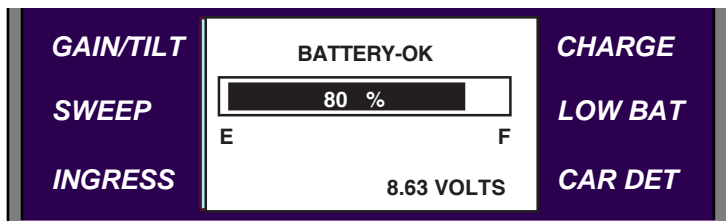
When you are finished, press **SELECT** to return to the SETUP Menu.

## Battery

You can check the battery status in your SSR unit by using the **ARROW** buttons to highlight BATTERY in the SETUP Menu.



Press **SELECT** to enter the BATTERY display.



The display shows the voltage of the SSR's battery and the percentage of battery life remaining.

When you have finished checking the battery, press **SELECT** to return to the SETUP Menu.

## Exit Setup Menu

When you have finished setting the operating parameters for the SSR Field Unit(s), highlight the EXIT SETUP option in the SETUP Menu. Press **SELECT** and the Unit will return to the screen it was in before entering SETUP.

# BASIC OPERATION



## Introduction

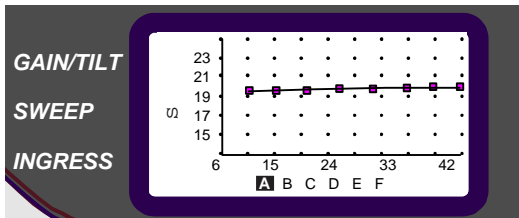
Okay, you have reviewed the theory behind return path alignment and maintenance, installed and “prepped” your SST and SSR Units, and set up the Units according to the procedures in Chapter 5. Now you’re ready to start using your 9580 system. In this chapter, you will learn how to perform basic operations. See Chapter 7 for information on system test and alignment procedures.

## SST Headend Unit

In this section of the chapter, we will discuss the basic operation procedures for the SST Headend Unit.

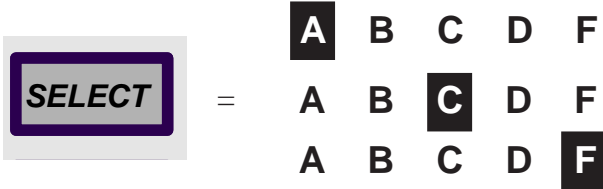
## SWEEP MODE

To select SWEEP Mode, use the arrow keys to select **SWEEP**.

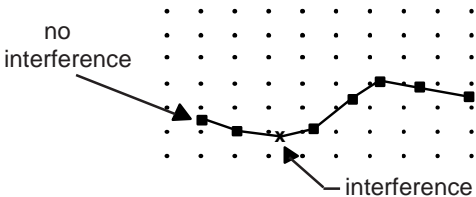


The Unit shows the sweep response for the SSR Field Units, defaulting to the last SSR Unit selected.

To view the response of a different SSR Field Unit, use the **SELECT** button to move from A through F until the desired Unit is highlighted.



**NOTE:** When the SST Headend Unit detects interference at the sweep carrier frequency which is less than 20 dB below the sweep carrier level, it will warn you by placing an “X” at that data point instead of the bar “—” which is normally used.



## GAIN/TILT MODE

To select GAIN/TILT Mode, use the arrow keys to select **GAIN/TILT**.



The gain and tilt are displayed in numeric format along with the two sweep carrier frequencies which are used to compute the gain/tilt data. The display shows the gain and tilt for the Unit last selected in SWEEP Mode.

Gain represents the difference between the desired level which has been programmed into the SST Headend Unit and the actual return level found at the STOP frequency.

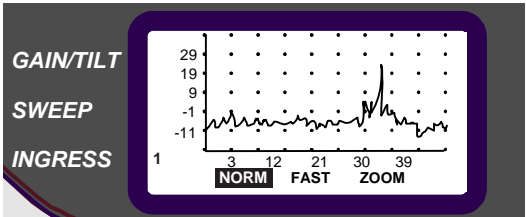
Tilt represents the STOP level minus the START level.

The gain and tilt displayed by the SST Headend Unit represents the SSR Field Unit which is currently selected under the SWEEP Mode.

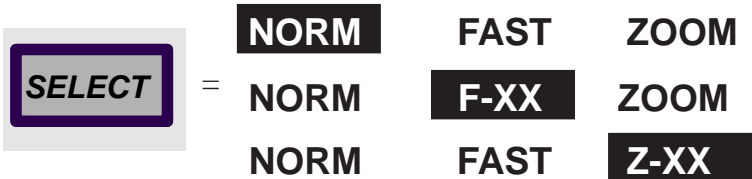
**REMINDER:** The START and STOP frequencies are selected by the “\*” in the SET RX FREQS SETUP Menu.

## SPECTRUM MODE

The SPECTRUM Mode provides a handy way to monitor noise and ingress. To enter SPECTRUM Mode, use the arrow keys to select **INGRESS**.



**NOTE:** The display defaults to NORM. You can use the **SELECT** button to cycle between NORM Mode, FAST Mode and ZOOM Mode.



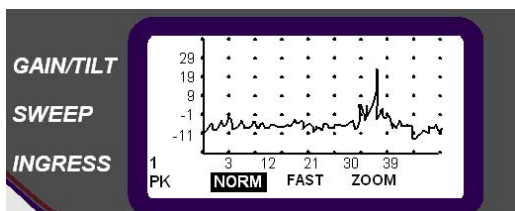
**NOTE:** The “XX” designation is used to denote which detector scheme is enabled, PEAK or AVERAGE (F-PK, F-AV, Z-PK, Z-AV).

If your Unit is equipped with the test point manager, the test point (node) being displayed replaced the cursor next to **INGRESS**. In the above sample display, NODE 1 is displayed so “1” appears next to **INGRESS**.

**NOTE:** If your are using the optional Test Point Manager, press the **NODE** button to cycle through all 8 inputs.

When you wish to look at a specific input channel, press **NODE** until the desired input test point appears next to **INGRESS**.

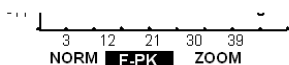
**NOTE:** If you have PEAK HOLD enabled, “PK” appears below the NODE number in the lower left of the display. PEAK HOLD is reset whenever the node is changed or the mode is cycled to FAST.



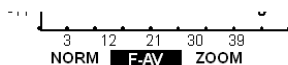
## FAST SPECTRUM MODE

To enter FAST SPECTRUM Mode, press **SELECT** until FAST is highlighted. The unit's display will look similar to the spectrum when it is in NORM Mode; however, the resolution bandwidth and sweep rate will be as indicated in the FAST MODE SETUP Menu.

The word FAST at the bottom of the display changes to reflect the current detector selection.



Peak Detection in  
FAST Mode



Average Detection in  
FAST Mode

**NOTE:** If you are using the optional Test Point Manager, press the **NODE** button to cycle through all 8 inputs.

**NOTE:** You can NOT select the SWEEP or GAIN/TILT Modes while you are in FAST SPECTRUM Mode. To change to other modes, first press **SELECT** to return to the NORM Mode. Then use the **ARROW** buttons to select one of the other modes.

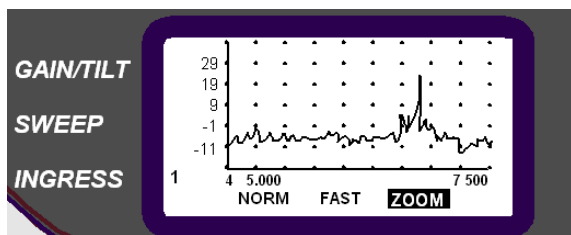
When you wish to look at a specific input channel, press **NODE** until the desired input test point appears next to **INGRESS**.

**NOTE:** If you have PEAK HOLD enabled, “PK” appears below the NODE number in the lower left of the display. PEAK HOLD is reset whenever the node is changed or the mode is cycled to ZOOM.

**REMINDER:** Your SST does not support SWEEP Mode when it is in FAST Mode. SSR Field Units with firmware version 2.00 or greater will be able to display ingress data when the SST is in FAST Mode. However, all sweeping and gain balancing activities will be halted until the SST returns to the NORM Mode. SSR’s with firmware version older than 2.00 will display a *blinking* warning message which indicates that the SST is in ZOOM Mode. These units will not display ingress data when the SST is in FAST Mode. If this causes problems, contact Trilithic to have your SSR upgraded.

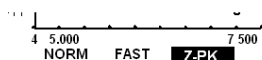
## ZOOM SPECTRUM MODE

To enter ZOOM SPECTRUM Mode, press **SELECT** until ZOOM is highlighted.

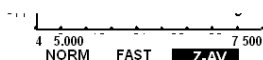


The Unit’s display changes to show a frequency span of approximately 2.5 MHz on the X-axis (bottom row of numerals). The effective resolution bandwidth in ZOOM Mode is 25 kHz.

The word ZOOM at the bottom of the display changes to reflect the current detector selection.



Peak Detection in  
ZOOM Mode



Average Detection in  
ZOOM Mode



Press the **ARROW** buttons to move the center frequency of this range up or down in increments of approximately 1.25 MHz.

**NOTE:** Display updates occur at an approximately 1 Hz rate while the SST Headend Unit is in the ZOOM SPECTRUM Mode as compared to the normal 2 Hz rate.

**NOTE:** You can NOT select the SWEEP or GAIN/TILT Modes while you are in ZOOM SPECTRUM Mode. To change to other modes, first press **SELECT** to return to the NORM Mode. Then use the **ARROW** buttons to select one of the other modes.

**NOTE:** When you are in this mode, you can examine ingress down to 0.3 MHz. This is useful since it enables you to check for AM broadcast ingress which can be a significant source of laser power loading.

**REMINDER:** Your SST Headend Unit is OFF LINE when it is in the ZOOM SPECTRUM Mode so the SSR Field Units are effectively disabled in this mode.

## REMOTE MODE

You may access your SST Headend Unit via a PC by connecting it via its **PC** connector.

**NOTE:** In order to use this feature, you must have the COMM MANAGER (CM-8/ACM-8) option equipped in your 9580. For more information regarding the installation and use of the COMM MANAGER option, see Chapter 8 *COMM MANAGER OPERATIONS*.

When used in the REMOTE Mode, your SST becomes a powerful status monitoring tool when used with **Ingress Manager** software. All of the displays that appear on the unit are also available remotely. Your SST Headend unit continues to operate normally when it is under the control of a remote operator. The effects of entering FAST or ZOOM Mode on SSRs are the same as if a local operator had pushed the buttons on the SST's front panel.

**REMINDER:** The REMOTE Mode is only available when

**REMINDER:** The REMOTE Mode is only available when you have a Communications Manager (CM-8/ACM-8). In this case, you can access data via a serial link to a PC or a communications link (modem, Ethernet or Fiber) and control up to eight SST Headend Units.

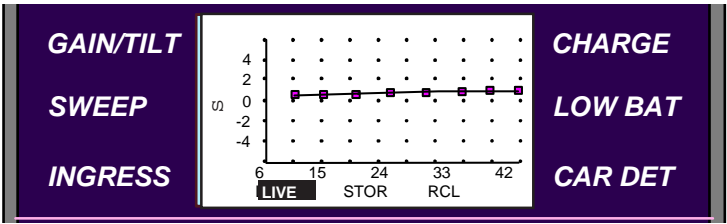
## SSR Field Unit

In this section of the chapter, we will discuss the basic operation procedures for the SSR Field Unit.

**NOTE:** In very dry, high static conditions, electro-static discharge (ESD) near the front panel may result in the SSR switching modes. If this occurs, simply reset to the desired mode.

## SWEEP MODE

To select SWEEP Mode, use the arrow keys to select **SWEEP**.



Use the **SELECT** button to cycle the display through LIVE, STOR and RCL.



## Storing Sweep Data

When you are in LIVE Mode, press **SELECT** to cycle to STOR. Press the **MEMORY** button to put the current sweep display into a buffer. The Unit will switch to the STORE Menu.

When you first enter this menu, SCROLL will be highlighted. The MEMORY pointer will indicate the last used memory along with its user defined 7 digit ID. If the menu is empty or has no ID, dashes will show as in the example below.

<u>STORE MENU</u>	
MEM 02	EDIT
<b>SCROLL</b> _ _ _ _ _	DONE
FILE	ESC

While SCROLL is highlighted, use the arrow keys to cycle through the memories in the unit. For example, if you press the UP arrow key, MEM 02 changes to MEM 03 etc.

**NOTE:** As you use the arrows to cycle, the memory pointer will stop at the maximum or minimum and will not roll over and enable you to cycle continuously. To return to a lower number, you must use the DOWN arrow.

The FILE icon appears when the memory which has been selected has the FILE bit set. This alerts you that this memory has been downloaded to the 9580 from a PC file. When you have scrolled to the desired memory, press **SELECT** to advance to the first digit of the ID.

The first digit will highlight but will remain unchanged. Press **SELECT** to have the Unit accept the current value and advance to the next ID digit. You can also use the arrow keys to cycle through the alphabet and numerals. A blank (underscore) is located between 0 and A. The arrangement of characters is 9,8,7,6,5,4,3,2,1,0,,A,B,C,.....Z with roll over.

When you have selected the desired digit, press **SELECT** to advance the Unit to the next digit of the ID which remains unchanged. You may change it by pressing the arrow keys or press **SELECT** to accept the current value. This process continues for all 7 digits. When you press **SELECT** to accept the last digit of the ID, the DONE icon is highlighted. To accept the entry and store the data, press **SELECT**.

If you wish to escape without accepting the data, use the arrow keys to highlight ESC and press **SELECT**. This will abort the function.

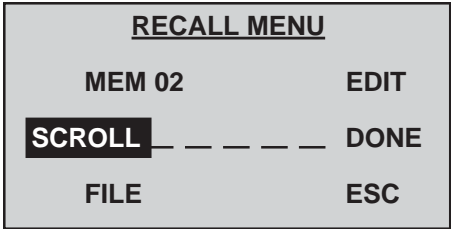
If you wish to return to the first digit of the ID, use the arrow keys to highlight EDIT and press **SELECT**. The Unit will return to SCROLL. This will enable you to scroll through the memories again.

**NOTE:** Storing data in a memory location always resets the FILE flag for that memory.

When you exit the memory selection screen, the Unit returns to the normal sweep mode display with the STOR icon highlighted.

## Recalling Sweep Data

When you are in LIVE Mode, press **SELECT** twice to cycle to RCL to show the sweep display stored in the currently selected memory. To select a different memory, press the **MEMORY** button. The Unit will switch to the RECALL Menu. When you first enter this menu, SCROLL will be highlighted.



Use the arrow keys to scroll through the memories in order to select one to view or edit. Once the desired memory is selected, press **SELECT** which highlights the DONE icon.

**NOTE:** This process differs from the STORE procedure.

With the DONE icon highlighted, press **SELECT** to return to the sweep display and view the memory. You may also use the arrow key to highlight EDIT if modifications to the 7 digit ID are needed or ESC to abort the process. The FILE flag remains unchanged in this menu, even if the ID has been edited.

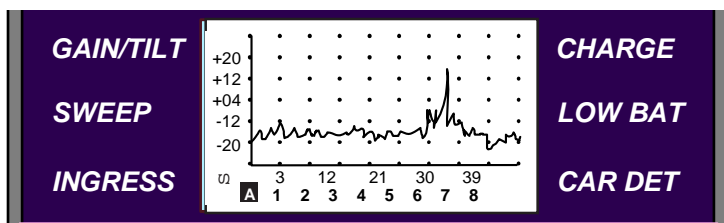
Exiting the RECALL Menu by any means returns the Unit to the sweep display with RCL highlighted and the currently selected memory is displayed. If the memory is empty, no sweep trace is shown.

Your SSR is capable of uploading and downloading the memory data via the RS-232 connection and **SweepSavR** data logging software running on a PC.

**NOTE:** Your Unit monitors the presence of the RS-232 connector plug. If the plug is in, the Unit will communicate via RS-232 and NOT via the RF link. Consequently, the Unit cannot be used in normal mode if the RS-232 plug is in. ALWAYS remove the RS-232 plug unless you are uploading or downloading data from the SSR to the PC.

## SPECTRUM MODE

Your SSR Field Unit is capable of displaying a wide spectrum display for the return path to which it is connected. This can be useful for diagnosing problems in the field; particularly when you need to verify that a source of ingress has been fixed. If the 9580 SST is equipped with the Test Point Manager option, it automatically determines the node on which each SSR Unit is located. To enter SPECTRUM Mode, press the **ARROW** buttons until the cursor is beside **INGRESS**.



The SSR Field Unit automatically displays the spectrum data for the return path to which it is connected, as determined by the SST ("A" is highlighted under the graph).

In certain cases when ingress noise on one or more nodes connected to the SST's Test Point Manager is extremely bad, the SST may mistakenly determine that the SSR is connected to the noisy node. In this instance, you can manually examine the ingress on each of the 8 nodes connected to the SST. To examine the ingress manually, press **SELECT** to advance from "A" to each of the 8 return paths.

**NOTE:** If the SST does not have the Test Point Manager option, the ingress displayed for each of the 8 nodes will be identical to that which is displayed automatically ("A").

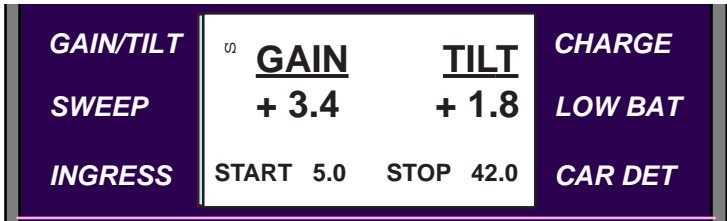
Use the **ARROW** buttons to go to the other modes.

**NOTE:** When the SST is put into FAST Mode, the SSR will operate only in the SPECTRUM Mode since no sweep data is available from the SST. If you push the **ARROW** buttons to move out of the SPECTRUM Mode, the unit will display a warning message.

Since sweep data is used by the SSR to automatically determine on which node to observe ingress data, this feature is disabled when the SST is in the FAST Mode. Consequently, you will not be permitted to cycle the **SELECT** button to the "A" selection.

## GAIN/TILT MODE

The gain and tilt are displayed in numeric format along with the two test frequencies used to acquire the gain/tilt data. Press the **ARROW** buttons to move the cursor to **GAIN/TILT**.



Gain represents the difference between the desired level which has been programmed into the SST Headend Unit and the actual return level at the STOP frequency.

Tilt represents the START minus the STOP level.

**REMINDER:** The START and STOP frequencies are determined by the frequencies marked with an “\*” in the SET TX FREQ SETUP Menu.

## SOURCE

The SSR Field Unit may be used as a calibrated continuous wave (CW) source for troubleshooting. Use the **ARROW** buttons to highlight SOURCE.



Then, press **SELECT** to enter the SET SOURCE FREQUENCY Menu. A CW Carrier at the indicated frequency and level will be present at the **REVERSE/BOTH** connection.



Press **SELECT** to jump from SOURCE LEVEL to SOURCE FREQ.

To *increase* or *decrease* the source level or frequency values, press the **ARROW** buttons.

**NOTE:** The source level and the TX level settings are independent. If the source level is set to a HIGH value for troubleshooting purposes, it does not need to be reset to the same value as the TX level.

The SSR Field Unit puts out the CW signal for as long as it remains in the SOURCE Menu. When you are ready to turn OFF the CW signal, press **SELECT**. The CW signal will go OFF and the Unit will return to the SETUP Menu.

# ADVANCED OPERATIONS



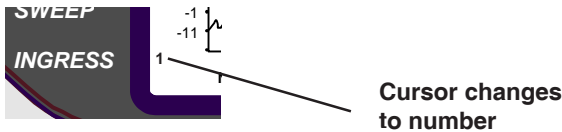
## Introduction

The first step in developing a successful alignment and maintenance strategy for the return path depends on understanding what constitutes a properly operating system. If you have not already done so, review Chapter 5 for the data regarding your system parameters so that you will have the following information handy:

- Proper levels at the headend
- Proper injection points for the node and each type of amplifier in the system
- Proper injection level for each device in the return system including coupling and test probe losses

You may also wish to review Chapters 4 and 6 for the proper installation and basic operation of your 9580 system.

Alignment of the reverse should begin at the headend. Use the SST to monitor the ingress for each return path that you will be aligning (refer to *SPECTRUM MODE* on page 43).



**REMINDER:** When you are reading the ingress, the cursor changes to a number to represent whichever node is being analyzed. In the example above, NODE 1 is being read so a “1” appears next to the word “Ingress” on the front panel. If you have the Test Point Manager option, you can get nodes 2 – 8 as well. If your Unit is not equipped with the Test Point Manager option, there will be no number.



For the 9580 system to achieve sweep accuracies better than  $\pm 1$  dB (and your return data system to function properly), ingress must be at least 20 dB below the expected return levels. If the SST is set properly, this will be 30 dB down from full scale on the ingress display. Carefully inspect the spectrum around each test carrier frequency. If ingress is excessive, take one of the following steps to reduce it:

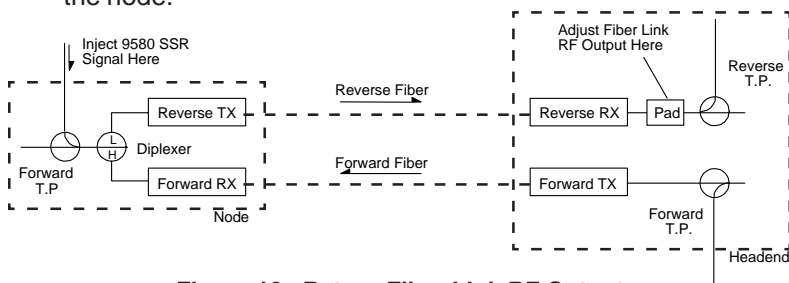
- If you are combining several return paths, try disconnecting some to reduce total ingress.
- If your system has no active carriers, turn down the gain or remove the pads in the reverse amplifiers.
- Temporarily pick a higher operating level for the SST and SSR.
- Find and fix the major ingress problems. Remember, you can use your 9580 system to help you troubleshoot the ingress while in the field. See *INGRESS* on page 58.

If ingress exceeds – 20 dB relative to the desired return level, the 9580 sweep display will show an “X” rather than the usual frequency marker (bar). This is another indication that there is an ingress problem which needs to be tracked down.

## Adjusting the Fiber Link

Adjustment of the fiber link will require two technicians since the fiber receiver output must be adjusted with the SSR connected to the node (see Figure 10 below).

**NOTE:** This could be achieved with one technician but it would involve a lot of back and forth runs to the headend and the node.



**Figure 10. Return Fiber Link RF Output.**

To adjust the fiber path properly, consult the manufacturer's data sheets to determine how to set gain in the fiber receiver. You may also want to measure the optical power at the receiver input to make sure that it meets recommended levels prior to starting alignment. Inject the 9580 test signals at the system design level into the node test point.

If your fiber receiver uses pads to set the gain, use the **GAIN/TILT** display on the SST to determine the correct pad to use in the fiber receiver. The SST will show a maximum gain error of  $\pm 9.9$  dB. If the initial gain is off by more than  $\pm 9.9$  dB, it may be necessary to zero in on the correct pad by changing the pad value until the reading is on scale. Then you can select a pad accordingly to set the gain as close as possible to 0.0 dB. When finished, switch to the **SWEEP** display to observe the sweep response.

If your fiber receiver has a screw driver adjustment, use the **SWEEP** display and adjust the receiver's gain so that the sweep response is positioned on the center graticule of the **SWEEP** display.

#### **HOT TIP**

***Be sure to select the proper Unit ID on the SST SWEEP display. Remember, this also effects which SSR's data is displayed in the GAIN/TILT display.***

**NOTE:** Some fiber nodes have a gain adjustment in the node which must be set first (i.e. Texscan's FLAME-THROWER™). Consult the manufacturer for the proper procedure for making this adjustment prior to setting the fiber receiver's gain.

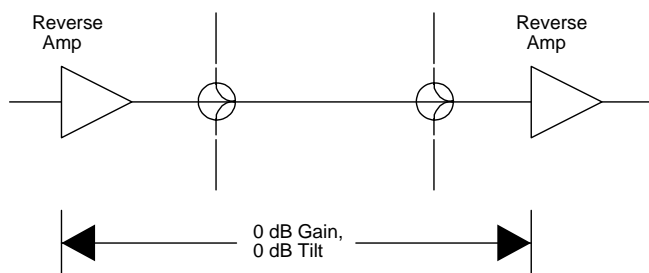
If you cannot get a display, try the following:

- Be sure that the SSR is receiving the data carrier as evidenced by the cursor pointing to **CAR DET** (carrier detect) on the SSR's display.
- Make sure that the injection test point you are using is pointing the correct way (i.e. TOWARD the headend).

- Make sure that the fiber transmitter and receiver are functioning properly and that the proper light level is reaching the headend.
- Increase or decrease the SSR's TX level in 5 dB increments until the response is on screen. Note the difference which is necessary for the output setting and adjust the gain accordingly. Now you can return your SSR to the proper output level and fine tune the gain setting.

## Adjusting Amplifiers

When an amplifier is balanced properly, its gain and tilt will virtually cancel the loss and tilt of everything in the upstream path between the amplifier and the next amplifier upstream (see Figure 11 below).



**Figure 11. Balanced Amplifier.**

With the node adjusted properly, proceed to the first amplifier from the node. Set your SSR's TX level to the proper injection level for the amplifier. Connect it to the amplifier's input test point(s).

**REMINDER:** Don't forget to allow for test point or coupling losses.

For amplifiers with fixed pads and equalizers, use the **GAIN/TILT** display. The 9580 will show a maximum gain error of  $\pm 9.9$  dB. If the initial gain is off by more than  $\pm 9.9$  dB, it may be necessary to zero in on the correct pad by changing the pad value until the reading is on scale. Then you can install the equalizer to compensate for tilt. Once the tilt is corrected, fine tune the pad value to give an overall gain of 0.0 dB. Now, you can switch to the **SWEEP** display to observe the sweep response.

If your amplifier has screw driver gain and tilt adjustments, you need to use the **SWEEP** display and adjust the amplifier's gain controls so that the sweep response is positioned in the display. Adjust the amplifier's tilt for a flat response. Then you can fine tune the gain adjustment to position the sweep response on the center graticule of the display. You can switch to the **GAIN/TILT** display to confirm your settings numerically.

If you do not get a display, try the following:

- Be sure that the SSR is receiving the data carrier as evidenced by the cursor pointing to **CAR DET** (carrier detect) on the SSR's display.
- Make sure that the injection test point you are using is pointing the correct way (i.e. TOWARD the headend).
- Increase or decrease the SSR's TX level in 5 dB increments until the response is on screen. Note the difference which is necessary for the output setting and adjust the gain accordingly. Now you can return your SSR to the proper output level and fine tune the gain setting.

Proceed to the next amplifier and repeat the process until ALL of your amplifiers are aligned. Make sure that you adjust the SSR's TX level if necessary when you are changing amplifier types.

## Data Logging Feature

Your 9580 is equipped with a data logging feature which enables you to save up to 24 sweeps; each containing a 7 digit ID. By using **SweepSaveR** software to upload these sweep files, you can compare past performance to current field conditions via two different methods: Upload from SSR to PC and Download from PC to SSR.

**Upload file from SSR to PC** - this enables you to upload up to 24 sweep files from the SSR to your PC so that you can compare the new files to ones taken at an earlier time.

**Download file from PC to SSR** – this enables you to compare new sweeps to old ones while you are in the field. Before starting your rounds, you can download up to 12 older sweep files from your PC to your SSR. Then, it is a simple matter to call up these records at the actual field location so that you can compare current readings to these older files.

You can identify the older sweep files by the FILE flag which appears in the STORE or RECALL Menus of the SSR's sweep display. You may also over-write these older files with the new data. When you do, the FILE flag is turned OFF.

## Ingress

Ingress along the return path can cause serious disruptions to a subscriber's cable service. This makes regular monitoring of ingress an essential part of a sound return maintenance strategy. The 9580 was designed to provide you with a simple solution to reverse monitoring.

When you are using the 9580 to monitor ingress, there are configuration trade-offs which you need to consider. The most important of these concerns the number of return paths connected to a single input on the SST. Combining your returns may economize on your hardware but it can make it far more difficult to localize on the source of ingress.

If you equip your SST with a Test Point Manager, you will be able to monitor 8 independent return test points. This can reduce the need to combine returns.

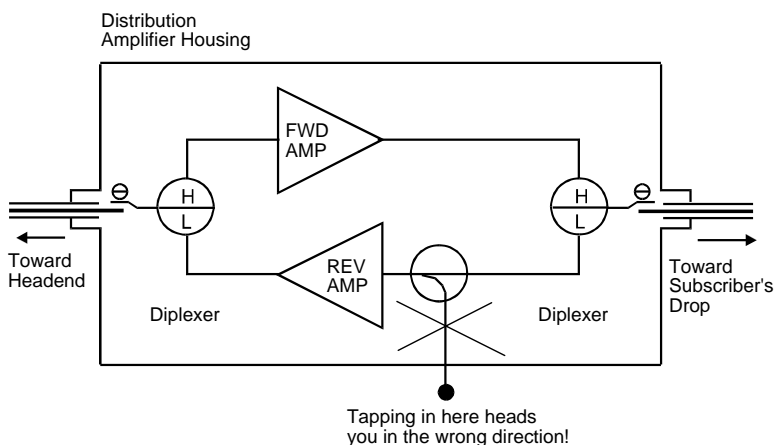
If ingress control is a "must", as it is in the case of telephony or commercial data carrying, consider using more than one SST so that each return can be monitored separately.

You can also automate your ingress monitoring task by using **Ingress ManageR**, the 9580's Remote Monitoring Software, with a PC.

When ingress problems do occur, you can:

- Determine along which return path the ingress is coming. If necessary, disconnect the combined returns one at a time until you locate the “bad” one.
- Read and record ingress levels at several frequencies.
- Go to the node (first amplifier in an all coax system) and read the ingress at the node’s return input using an SLM.

**CAUTION:** Be careful to choose a test point that is looking downstream and NOT toward the headend (see Figure 12 below).



**Figure 12. Incorrect Test Point Selection.**

Compare this ingress to the levels you saw at the headend. If the levels are still about the same, divide the number of amplifiers in each leg in half and test at that point. Continue to divide the amplifier spans in half until you locate the amplifier farthest from the node that still has the ingress problem.

Once you have localized the ingress, you can troubleshoot the hardware and the drops of the target amplifier. When you think that you may have located the difficulty, connect the SSR to the system and verify that the problem is fixed by observing the ingress pattern.

Many ingress problems are transient in nature. For example, ingress from a CB radio will only be present when the radio is keyed on and the vehicle it is in is physically close to a leaky section of cable plant. These transient events will be on the order of 1 or 2 seconds.

Other events in the subscriber's house, such as electrical transients from turning on motors in appliances, can be much shorter in duration. The SST allows you to capture these transient events by combining the use of FAST Mode and PEAK HOLD Mode.

In FAST Mode, the SST analyzes each node at rates up to 80 Hz. This enables you to capture transients in the millisecond range.

When PEAK HOLD Mode is enabled, these transients stay in the screen until you reset the system.

**REMINDER:** The sweeping procedure is not supported when the SST is in FAST Mode.

An effective strategy for you may be to balance a node with the SST in NORMAL Mode. After you have obtained a balance, let the SST analyze the node in FAST Mode for a long duration (i.e. 24 hours) to verify that transient ingress is not a problem.

# COMM MGR OPERATIONS



## Introduction

The Communications Manager (CM-8/ACM-8) option, which is available to the SST Headend Unit, enables you to use remote operation and data collection techniques. In order to utilize this option, you need Trilithic's **Ingress Manager** software and a communications link (modem, Ethernet or Fiber). You may also connect the SST directly to a PC via an RS-232 serial cable and control the SST from the PC.

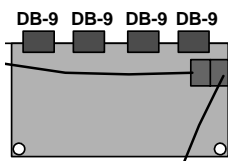
You need only one CM-8 or ACM-8 to remote-access or PC-control from one to eight SST units.

**For example:** If you are using eight SSTs and each is equipped with a Test Point Manager so that you can monitor 64 nodes, you can access all 64 nodes remotely with only ONE telephone modem connection.

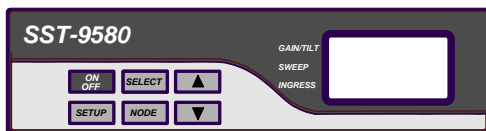
This chapter describes the hardware configuration required for remote operation and data collection. For information regarding the actual performance of these tasks, please refer to the *INGRESS MANAGER* manual.

## Hardware Installation

Before you configure your hardware, you need to install the CM-8 or ACM-8 Communication Manager circuit board into your 9580 SST Headend Unit.



CM-8/ACM-8



9580 SST



## EQUIPMENT REQUIRED

You will need the following for installation:

- Communications Manager Circuit Board  
CM-8 (P/N 20709224000) or ACM-8 (P/N 20709224002)
- Communications Manager SST Cable (5 Conductor)  
(P/N 2070950004)
- 4-40 Jack Screws (16 pieces)
- Philips Screw Driver
- 3/16" Nut Driver (small pliers or needle nose pliers may work)
- Small regular screw driver
- Static Wrist Strap and static free work area

**CAUTION:** Always hold the board by the edges with the hand that is wearing the wrist strap.

## INSTALLATION STEPS

Use the following procedure to install the Communications Board.

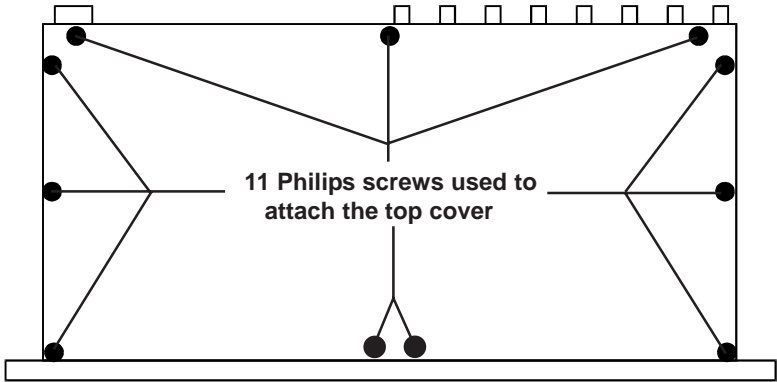
1. Place the 9580 SST Headend Unit (in which the board is to be installed) on your workbench. Disconnect all cables from the back of the SST Unit.

**NOTE:** If this Unit came with the Test Point Manager option, you may leave the RF jumper coax.

**CAUTION:** Make sure that the SST Unit is turned OFF and that the power plug is disconnected.

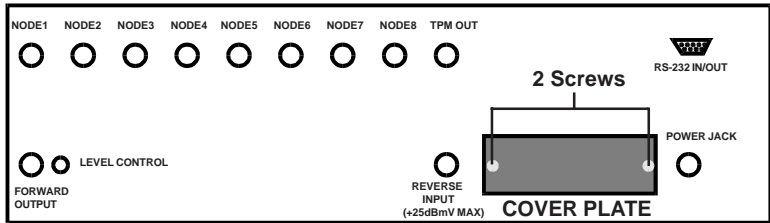
2. Place the static wrist strap on your wrist and attach it to ground.

- Use the Philips screw driver to remove the eleven (11) screws on TOP of the SST Unit. Remove the TOP panel.

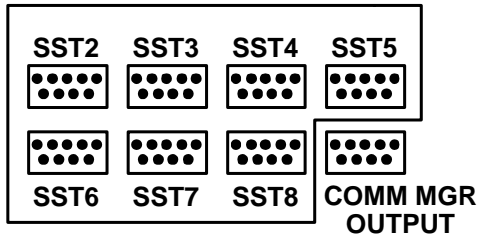


- Use the Philips screw driver to remove the two (2) screws which hold the wide cover plate on the back of the SST Unit.

**CAUTION:** Make sure that you SAVE these screws.



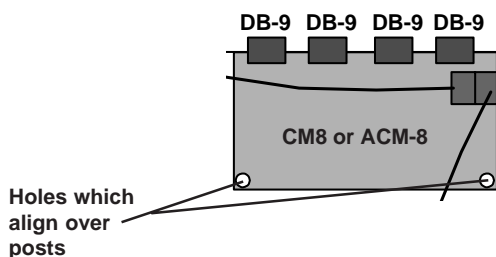
Remove the cover plate. There should be eight (8) slots open labeled **SST2** through **SST8** and **COMM MGR OUTPUT** beneath the panel.



5. You will need to install two posts (included with the kit) into the SST Unit.

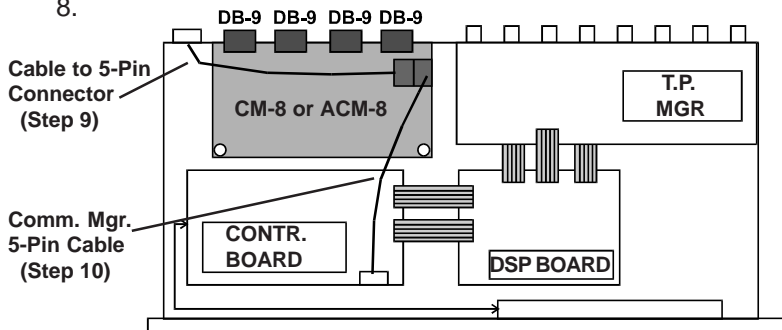
**CAUTION:** Be careful not to over tighten the posts so that you don't twist off the studs.

Slide the CM-8 or ACM-8 board into the 8 slots at an angle. Let the board sit on the two posts which you installed in the SST Unit. The two holes on the front side (side farthest away from the double DB-9 connectors) should line up with the holes in the posts already mounted in the SST Unit. If they do not, check for obstructions and gently align the board.



6. Use the Philips screw driver and the two (2) screws removed in Step 4 to attach the CM-8 or ACM-8 board to the SST Unit. The screws should go through the holes at the front of the board and into the two posts mounted in the SST Unit.
7. Use the 3/16" Nut driver to install the sixteen (16) 4-40 jack screws through the back plate into the holes on the double DB-9s.
8. Remove the 5-pin cable that runs from the RS-232 connector on the back the SST Unit to the main controller board. This board is also attached to the display and keypad.
9. Connect the cable to either one of the five (5) pin connectors on the CM-8 or ACM-8 board.
10. Connect the 5-pin conductor Communications Manager cable to the other 5-pin connector on the CM-8 or ACM-8 board.

Connect the other end of this cable to the main controller board in the place from which you removed the cable in Step 8.

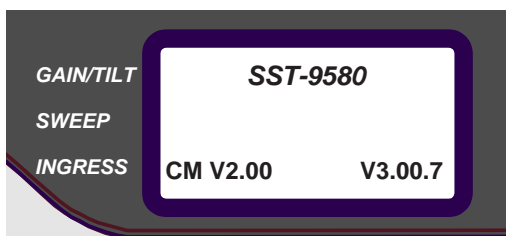


11. Double check all connections and replace the top cover and the eleven (11) screws you removed in Step 3.
12. Insert the power plug into the back of the SST Unit.
13. That's all there is to it! You may also connect up to seven (7) more SST Units to the one containing the Communications Manager board. Connect the additional Units via standard 9-pin to 9-pin serial cables.

## TESTING THE CM-8/ACM-8 INSTALLATION

Use the following procedure to verify that the CM-8 or ACM-8 installation is correct.

1. Turn on the SST. When you turn on the unit, you should see a version number in both the lower left and lower right corners similar to those pictured below:



- Using Windows Terminal or Windows 95 Hyperterminal and Communications Port settings 38400, n, 8, 1, type the following: “~ ~ H I” (do NOT type the quotation marks).

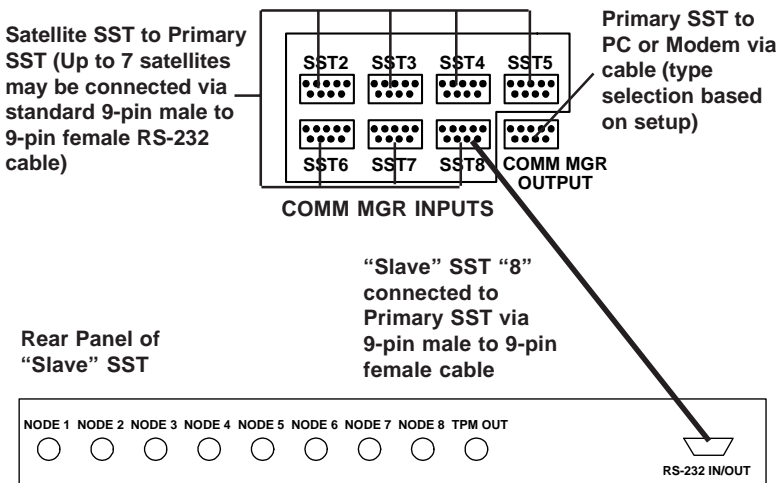
If the CM-8 or ACM-8 is connected via the cable (supplied with Trilithic's INGRESS MANAGER) to the correct COMM PORT, the CM-8 or ACM-8 will respond with the following:

“**CM-8-OK.**” or “**ACM-8-OK**”

## CONNECTING 9580 SSTs

You must connect your primary 9580 SST (the unit equipped with the COMM. MGR. board) directly to a PC or a modem. Depending on the setup, you will need one of several cables. See the *CONNECTING PC AND 9580* and the *CONNECTION TEMPLATES* sections in the **INGRESS MANAGER OPERATION MANUAL** for detailed information regarding the cable type. Once you have selected the proper cable for the desired setup, connect the primary SST to the PC or modem via the **COMM MGR OUTPUT** socket.

You will also need to connect the satellite 9580 SSTs to the primary SST. The satellite units have female D-connectors while the primary unit has male D-connectors. You can use a standard RS-232 cable (9-pin male to 9-pin female) to connect the satellite SSTs to the primary SST.



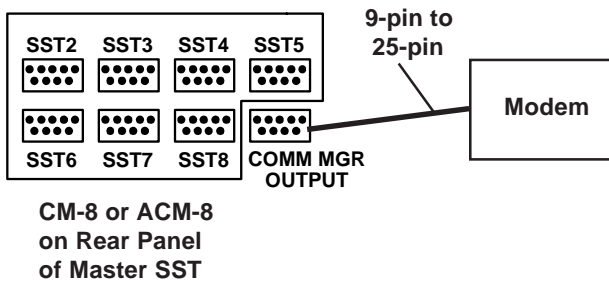
## MODEM-REMOTE CONTROL

If you intend to operate your SST remotely via a modem, you need to purchase a standard 9-pin to 25-pin serial cable (available from Trilithic or any computer store) to connect your SST to the modem.

**NOTE:** The 9-pin to 25-pin cable should be a straight cable, NOT null modem.

For additional information regarding configuring the remote modem, refer to the **Ingress Manager** manual.

When you are ready, connect the 9-pin to 25-pin cable to the **COMM MGR OUTPUT** on the master SST and the other end to the remote modem.

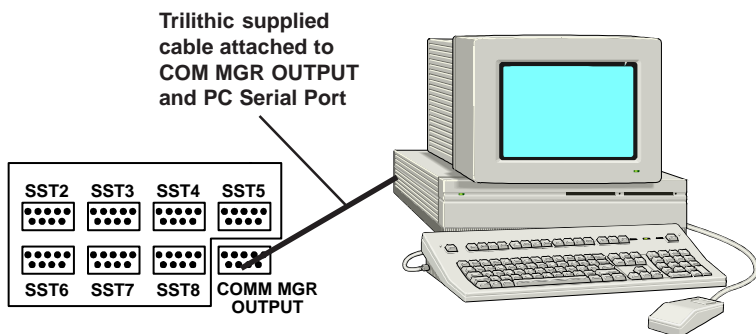


**CAUTION:** Make sure that you log which “slave” SST goes to which serial connector on the CM-8 or ACM-8 since this information can be used with **Ingress Manager** to identify each of the 64 nodes.

You should also log which of your nodes are connected to the Node 1 through 8 inputs on each of the SSTs equipped with the Test Point Manager option.

## PC-DIRECT CONTROL

If you plan to use your PC to directly control the SST, connect the 9-pin to 25-Pin cable which came with your CM-8 or ACM-8 to the connector which is labelled **COMM MGR OUTPUT** and to an available serial port on your PC.

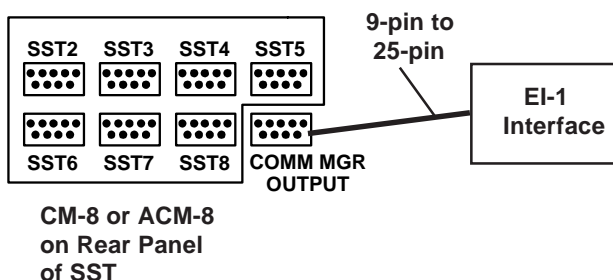


## ETHERNET CONTROL

If you intend to operate your SST via a network, you need a special Trilithic cable (9-Pin to 25-Pin, P/N 2071049001) to connect your SST to the EI-1 Interface.

For additional information regarding installation and configuration of the EI-1 Interface, refer to the **Ingress Manager** manual.

When you are ready, connect the 9-pin to 25-pin cable to the connector which is labelled **COMM MGR OUTPUT** and the other end to the EI-1 Interface.

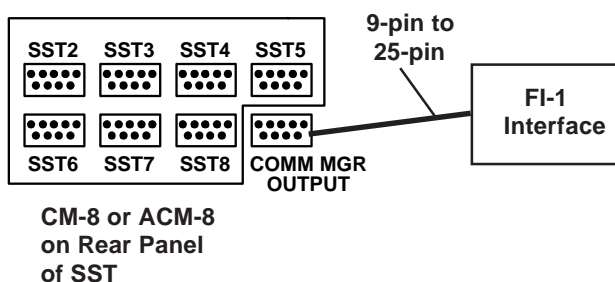


## FIBER CONTROL

If you intend to operate your SST via a “dark fiber”, you need a standard 9-Pin (female) to 25-pin (male) cable to connect your SST to the FI-1 Interface.

For additional information regarding installation of the FI-1 Interface, refer to the **Ingress Manager** manual.

When you are ready, connect the 9-pin to 25-pin cable to the connector which is labelled **COMM MGR OUTPUT** and the other end to the FI-1 Interface.







# FEATURE NOTES

## Interoperability

SSTs, SSRs, CM-8s and ACM-8s which have firmware version 2.00 or higher, are equipped with major new features which were not included in earlier firmware versions. The features include the FAST Mode as well as extra frequency spectrum coverage which includes the AM broadcast band.

While the firmware upgrades have been designed in such a way that the older and newer units will interoperate, there are some operating configurations of which you need to be aware.

### **New SST to Old SSR**

All operations work as designated except:

Fast Mode	Any Mode	No data available message is displayed. New SSRs will display ingress data, but old SSRs will not.
-----------	----------	--

### **New SSR to Old SST**

All operations work as designated except:

Ingress Mode	Normal Mode	No ingress trace on SSR below 5MHz. Normal trace from 5MHz and above.
--------------	-------------	---

### **Old CM-8 to New SST**

All operations work as designated except:

1. Can't put SST into Fast Mode remotely.
2. Ingress Mode    Any Mode    Ingress data below 5MHz not available.

## Version Upgrades

The SST and SSR have been upgraded several times. Below is a chart to help you determine which version you have.

**NOTE:** All upgrades are available. If you have an older version of the SST and would like to upgrade some or all of the features, please contact Trilithic at 800-344-2412 for assistance. All SSR versions are compatible with the SSTs.

FAST	Fast Mode
AVG	Averaging mode
AM	Older models covered 5 to 42 MHz in Normal Ingress Newer models cover .375 to 42 MHz in Normal Ingress

SST Versions	1.xx	No FAST/AVG/AM
	2.xx	FAST/AM but not AVG
	3.xx	FAST/AM; AVG available if it appears in DETECTOR screen

**NOTE:** AVG is not a function of the SSR.

SSR Versions	1.xx	No FAST/AM
--------------	------	------------

**NOTE:** The 1.xx SSR works with newer SSTs however its display only shows 5 to 42 MHz and it will go offline when the SST is in FAST Mode.

	2.xx	FAST/AM
--	------	---------

SST and Ingress ManageR enhancements; Ingress ManageR Versions	1.0 & 1.1	No FAST/AM
	1.2	FAST/AM
	1.3	FAST/AM/AVG upgrades
	1.4	Ping Mode, Ethernet compatibility, Advanced Connectivity, ACM-8 control

CM-8	1.xx	No FAST/AM
	2.xx	FAST/AM

ACM-8	2.04	Advanced Functions
-------	------	--------------------

**NOTE:** No upgrade is required for AVG.

# SPECIFICATIONS

## SST 9580 SPECIFICATIONS

Frequency	0.3 – 42 MHz
Input Level Range (return test carriers)	+ 25 to – 10dBmV for full 50dB dynamic range in Spectrum Mode
Return Inputs	1 standard, 8 with Test Point Manager
Field Units supported	Up to 6 simultaneously
Sweep Mode	5 – 42 MHz with 0.25dB resolution
Sweep Mode Resolution BW	25 kHz effective
Input Level Accuracy	$\pm 0.35\text{dB}$
Spectrum Display	50dB dynamic range from 10dB above to 40dB below nominal return level with 1dB measurement resolution
Spectrum Dispersion	Norm (0.375 – 42) Zoom (0.3 – 42) in 2.5 MHz increments
Resolution BW	375 kHz in Norm; 50 kHz in Zoom; 375 kHz in Fast (1x); 525 kHz in Fast (4x)
Sweep Rate	20 Hz/node in FAST; 80 Hz/node in 4X
Data Carrier TX Frequency	50 to 53.75 and 70.00 to 75.75 MHz Optional 80 - 90 MHz
Data Carrier TX Level	+ 23 to + 55dBmV continuously adjustable
Data Carrier Spurious	– 60dBc
Modulation	FSK with 38.4 kbps data rate

## **SST 9580 SPECIFICATIONS (Continued)**

Data Carrier B.W.	150 kHz at – 20dBc, 475 kHz at –60dBc
Remote Access	Via RS-232 or modem for all displays (with Communications Manager)
Display	64 x 128 pixel graphic LCD w/backlight

## **SSR 9580 SPECIFICATIONS**

Output Frequencies	8 user-selectable from 5 – 42 MHz (in 100 kHz steps)
Output Level	+ 24 to +55dBmV settable in 1dB steps
Output Level Accuracy	± 0.35dB after compensation
Output Spurious	– 25dBc
Data Carrier RX Frequency	50 to 53.75 and 70.00 to 75.75 MHz
Data Carrier Sensitivity	– 15dBmV min., + 30dBmV max.
Display	64 x 128 pixel graphic LCD w/backlight
Display Update Rate	0.7 seconds (in all modes)
Battery Life	6 hours (in normal operating mode)
Data Logging	24 sweep records, uploadable via RS-232
Connectors	Combined TX/RX, or separate TX and RX field replaceable type “F”



**TRILITHIC**  
INNOVATIVE ENGINEERING

9710 Park Davis Drive  
Indianapolis, IN 46236  
(317) 895-3600