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Introduction

You will find the Modulation Sciences Stereo Reference Decoder easy to install, easy to operate, and trouble-free.

This manual will help you set up and use the SRD-1 to precisely measure the performance of your television stereo generator and to test compliance to FCC OET-60 (Revised) standards.

Chapter One briefly describes the special features that make the SRD-1 a fully rational approach to MTS testing and measurement. Chapter Two contains the specifications for the unit.

Chapters Three and Four explain how to install and operate the SRD-1. Chapters Five and Six cover basic maintenance and field service.

Finally, there are several appendixes that deal with special situations and help you obtain the best possible test measurements.

If you have any questions or comments, please call us on our toll free line: (800) 826-2603 or e-mail us at tech_support@modsci.com. Outside the United States, you may call us at (732) 302-3090.

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CHAPTER 1 ¾ Special Features

1.1 A Rational Approach to MTS[1] Test and Measurement

Modulation Sciences' Stereo Reference Decoder is a precision reference decoder that "closes the loop" on MTS stereo setup, calibration, and off-air monitoring.

Because the SRD-1 works with test equipment your station probably already owns, the unit costs far less than other MTS modulation monitors. Yet it is the most inherently accurate system you can buy.

1.2 Each Unit Individually Calibrated

The SRD-1 is the only MTS stereo decoder available in which each production model is individually calibrated in basic units — voltage, frequency, and phase. Verification of the original calibration requires only an audio oscillator, a frequency counter, and an accurate AC digital voltmeter.

1.3 Verifies Performance to BTSC[2] Standards.

Calibration can be performed by station personnel to verify the performance of the SRD-1 to Appendix D of the "BTSC Recommended Practices." Thus, when an SRD-1 is used to calibrate **any** stereo television generator, it provides a reference to the BTSC standards.

This reference to the original system specifications "closes the loop" of BTSC stereo generation, demodulation, and standards. Contrast this with other approaches where you are asked to accept on faith that the decoder really does comply with the BTSC standard — but no means exist to verify that compliance.

Only the SRD-1 gives you that proof by direct user measurement. Furthermore, only the SRD-1 gives you documentation of verified performance. Modulation Sciences retained a licensed Professional Engineer who prepared a certified report that verifies the SRD-1's performance and explains the measurement procedure in great detail.

[1] Multichannel Television Sound
[2] Broadcast Television Standards Committee

1.4 Four Modes of Operation

Front panel push buttons select any of four output modes:

1. Equivalent Mode, Sum and Difference
2. Equivalent Mode, Left and Right
3. BTSC Mode, Sum and Difference
4. BTSC Mode, Left and Right (normal operation)

This selection of modes allows examination of the transmitted signal in every manner. The BTSC modes provide the signal through a BTSC precision expander. The BTSC Left and Right mode delivers audio as it would be recovered in a viewer's home. The equivalent mode (test mode) demonstrates the performance of the system by replacing the BTSC companding system with 75 μsec pre-emphasis/de-emphasis networks, as specified by the BTSC standards.

In the Sum and Difference modes of equivalent and BTSC, the L+R baseband and the L-R [31.468 kHz (2H)] subchannel may be examined individually.

1.5 Switchable De-emphasis in All Modes for Real World Measurements

Precision 75 μsec de-emphasis may be switched in for any mode. This permits the SRD-1 to be used for either measurements or for accurate listening.

BTSC Standards specify that separation measurements be made at a constant main channel modulation level. This is most easily done with pre-emphasis and de-emphasis removed. However, many operational measurements, such as dynamic separation, as well as off-air listening, require pre-emphasis/de-emphasis to be on, as they are in the "real world."

Switchable de-emphasis provides a way to meet all of these needs.

1.6 Two Sets of Audio Outputs ¾ Precision and Balanced Line

Because the SRD-1 serves a dual role as a measurement instrument and an audio quality monitor, two sets of outputs are provided. Each set is electrically independent of the other. The BNC connectors on the front and rear panel are intended for precision measurements. They are directly driven by very accurate operational amplifiers that employ resistors matched to ± 0.1% in their feedback network. These outputs have an extremely low output impedance, so measurements are accurate regardless of loading.

The screw terminal outputs on the rear are balanced, line-level outputs. They provide a nominal level of 0 dBm. These outputs are coupled to the circuit through high-quality transformers and are intended to drive standard 600Ω studio audio monitoring systems.

1.7 Two Switch-Selected Inputs

The SRD-1 provides two preset switch-selected inputs. This allows rapid selection between two composite stereo sources without the need to reset the input levels.

This is far more than just a simple convenience. Because setting the input level to a BTSC decoder requires the Bessel null procedure, it cannot be done during the normal broadcast day. Thus, to be able to select between two sources of composite stereo, the input level for each must be preset. An example of this is selecting between the output of an aural demodulator and the output of the stereo generator.

This arrangement allows you to determine during normal programming if the exciter is introducing a problem on the air or if the problem is coming from the stereo generator.

1.8 Operates with the msi 320 Demodulator

The SRD-1 needs only a wideband composite aural signal for operation. The most common source of that signal is the “deviation” output of an **msi 320** demodulator. The output of a TV stereo generator can also drive the SRD-1 directly.

1.9 Compliance to BTSC Standard Can Be Measured in the Field

A fundamental and very important part of our unique approach to MTS measurement is that station personnel can verify the SRD-1’s calibration against the BTSC tables.

The BTSC standard for television stereo is not embodied in a circuit card, regardless of who manufactured it. Rather, the standard is a set of equations that can be found in FCC Report OET-60 (R). The equations themselves are very awkward to use. J. J. Gibson of RCA Laboratories used the equations to produce an extensive set of tables that describe the input/output performance in the EIA document “BTSC Recommended Practices”, Appendix D.

1.10 Easy to Calibrate to BTSC Standards

A simple calibration requires only an audio oscillator, a frequency counter, and an accurate AC digital voltmeter. A major recalibration that produces a value for deviation from the ideal decoder requires an accurate phase meter or a dual timebase counter in addition to the test equipment listed above.

1.11 Level Setup Accurate to ±0.03 dB

The accuracy of any BTSC stereo decoder is limited by how precisely its input level can be adjusted. An error in the composite input of ± 0.03 dB will limit the maximum measurable separation to -55 dB at frequencies below 5 kHz and to -51 dB at higher frequencies. A maximum performance of better than -50 dB separation is desirable if the SRD-1 is to accurately measure stereo generator performance greater than -40 dB.

A system accuracy of ± 0.03 dB composite level setting is achieved by using a true RMS detector and a precision window comparator referenced to an Analog Devices high-accuracy 10 volt reference. An LED indicator on the SRD-1 shows when the input level is correct.

1.12 The SRD-1 Can Be Used with any TV Stereo Generator

Because it operates independently of the stereo generator, the SRD-1 can be used to set up and measure any BTSC stereo generator.

The level setup is done at ±25 kHz deviation by using the Bessel null method. Thus, it is not limited to setup with any specific stereo generator.

1.13 Maintains Performance over Temperature

Most manufacturers would prefer that you not ask about BTSC performance over a temperature range. That’s because the BTSC encoder/decoder circuitry is notoriously temperature sensitive.

Modulation Sciences, however, designed the SRD-1 stereo reference decoder to maintain specifications over a range of 10° to 40° Celsius (50° to 104° Fahrenheit). And this impressive performance isn’t just “spec talk.” Others have proven it in environmental chambers.

1.14 Fast, Easy Setup

Full setup requires adjustment of only one control — INPUT LEVEL. No other adjustment is needed. Two front panel LEDs indicate the correct level. When only the green LED is lit, the input level is correct. To improve accuracy, a true RMS detector reduces the effect of random noise on the level setting.

A simple Bessel null procedure sets the modulator to the correct level for alignment.

1.15 Compliance to BTSC Certified by an Independent Engineering Firm

Modulation Sciences commissioned Radio Techniques, an independent firm of licensed Professional Engineers, to test the SRD-1 Stereo Reference Decoder.

Those tests produced the most extensive characterization of any stereo decoder on the market. They also proved the laboratory-grade performance of the SRD-1. A complete copy of the report is available from Modulation Sciences.

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CHAPTER 2 ¾ Specifications

Size

Front Panel: 3.5” H x 19” W (88.9 mm H x 483 mm W)
Chassis: 3.5” H x 17” W x14.37” D (88.9 mm H x 432 mm W x 365 mm D)

Power

95 to 130 VAC, 50 to 60 Hz, 12 W maximum
190 to 260 VAC option available

Temperature Range

10° to 40° Celsius (50° to 104° Fahrenheit)

RF Protection

All inputs and outputs are RF suppressed. Power supply is RF suppressed and shielded from main circuitry.

Input/Output Connections

Composite Input:
- BNC connector on rear panel
- “Floating” input, 10kΩ impedance
- Level range at ±25 kHz deviation: 0.085 to 0.85 VRMS, 0.24 to 2.4 V peak-to-peak

Calibration Input
- BNC connector on rear panel
- When CAL position is selected, it drives the M & D channels.
- Inputs for use with Gibson calibration tables.

Audio Outputs

Test Outputs:

Unbalanced BNC connectors on front and rear panels
Left/Right or Sum/Difference, as selected
Less than 1Ω source impedance
Minimum load impedance = 600Ω
L or R output at ±25 kHz deviation of L+R: 7 dBm
Sum output at ±25 kHz deviation of L+R: 13 dBm
Difference output at ±50 kHz deviation of L-R: 13 dBm

Balanced line outputs:

No. 6 screw terminals on rear panel
Left/Right or Sum/Difference, as selected
Approximately 100Ω source impedance
Minimum load impedance: 600Ω
L or R output at ±25 kHz deviation of L+R: 7 dBm
Difference output at ±50 kHz deviation of L-R: 13 dBm

Indicators

Stereo:

SRD-1 is receiving a stereo signal.

Mono:

SRD-1 is receiving a mono signal.

Ref Level (meaningful only during setup):

Green:

Input signal is within setup window.

Red:

Input signal is above setup window.

Both Off:

Input signal is below setup window.

Separation

75 μsec Equivalent Mode:

Greater than 55 dB from 50 Hz to 15 kHz

BTSC Encoded:

Greater than 45 dB from 50Hz to 14 kHz

Controls

Mode Select:

Selects among the following output modes:

- Equivalent 75 µsec
- Sum and Difference
- Left and Right

BTSC:

- Sum and Difference
- Left and Right (normal operation)

Calibrate:

Places the M & D channel inputs in parallel for calibration to the Gibson tables.

Input:

Selects between preset inputs A or B.

A and B Trimmers:

Adjusts input composite level to fall within the setup window for each of the preset inputs.

75 µsec De-emphasis:

Switches the 75 µsec de-emphasis in or out.

Frequency Response

75 µsec Equivalent Mode (L, R, or L+R):

±0.1 dB from 50 Hz to 14 kHz
Not more than -1.0 dB at 15 kHz.

BTSC Encoded (L+R modulation):

Same as above.

BTSC Encoded (L or R, 10% M Channel Modulation):

±0.1 dB from 50 Hz to 5 kHz
±0.2 dB from 6 kHz to 14 kHz
Not more than –2.0 dB at 15 kHz.

Harmonic Distortion

75 µsec Equivalent Mode (100% M channel modulation):
0.02% maximum

BTSC Mode (70% M channel modulation):
0.15% at 50 Hz, 0.07% at 100 Hz, 0.04% above 200 Hz

Input Setup Window Width

0.03 dB

Signal-to-Noise Ratio

Equivalent Mode with 75 µsec de-emphasis:
- Left channel: -84 dB
- Right channel: -84 dB
- Main channel greater than -84 dB
  - (All below ±25 kHz deviation)
- L-R subchannel greater than -88 dB
  - (Below ±50 kHz deviation)

BTSC Mode with 75 µsec de-emphasis:
- Left channel: -86 dB
- Right channel: -86 dB
- Main channel greater than -89 dB
  - (All below ±25 kHz deviation)
- L-R subchannel greater than -89 dB
  - (Below ±50 kHz deviation)

CHAPTER 3 ¾ Installation

3.1 Preliminary Considerations

3.1.1 Audio Output Connections

The SRD-1 has two sets of audio output connections — one for precision measurements and the other for audio monitoring.

The precision outputs are two pairs of BNC connectors, one mounted on the front and the other mounted on the rear of the unit. They are low impedance (less than 1Ω) and unbalanced. They can drive loads as low as 600Ω. These precision outputs are intended to drive unbalanced test equipment located near the SRD-1. Oscilloscopes, spectrum analyzers, and distortion analyzers are typical.

The audio monitoring outputs are transformer coupled. They appear at screw terminals on the rear of the unit. The signals are balanced and have a source impedance of 100Ω. The minimum load impedance is 600Ω. These outputs are intended to drive standard studio audio monitoring systems. Because of the transformers, they are not as precise as the BNC outputs.

3.1.2 Composite Input Connections

The SRD-1 provides two independently adjustable, switch-selected composite inputs. Independent level controls are needed for each input because the composite input levels should be adjusted when performing a Bessel null alignment, as discussed in Appendix A. Because it is not practical to reset the composite level under program conditions, the SRD-1 provides two independent composite inputs. One input can be adjusted to match the demodulator, the other can match an output of the stereo generator. Thus, it is easy to switch between the stereo generator output and the transmitter output during the broadcast day.

The inputs are rear-mounted BNC connectors. Each input is unbalanced and floating. They float to prevent ground loops and are high-impedance bridging inputs. The bridging inputs can be used with short lengths of coax – less than 10 feet. If the coax is longer than that, connect a “T” adaptor with a 75Ω video termination to the input.

3.1.3 Calibration Input Connections

The calibration input is used to verify the performance of the SRD-1 to basic units in conjunction with Appendix D of “BTSC Recommended Practices”, EIA Bulletin #5. Appendix C of this manual fully explains how to use this input.

3.2 Installation Procedure

3.2.1 Introduction

Installation and location of the SRD-1 are not critical. Only a few criteria need to be considered.

Although the SRD-1 is temperature compensated over a wide range, it is best to install the unit in an area of consistent temperature. The exact temperature is not important, as long as it is not subject to large variations. Generally, any area that is acceptable for the demodulator will be acceptable for the SRD-1.

If the RF demodulator has a 75 Ω or lower output impedance, install the SRD-1 so that it is connected with 25 feet or less of coax.
The **msi 320** composite aural output has a 75Ω impedance.
Other demodulators may have a higher output impedance and need to be moved much closer to the SRD-1 for accurate results. The H-P 8901A/B demodulator is a common example of this situation. It has a 600Ω output impedance and it must be connected to the SRD-1 with a cable that is no longer than 10 feet.

If considerably more than 25 feet of cable must separate the RF demodulator and the SRD-1, contact Modulation Sciences for information about a composite line driver system (the CLD-2500) that will permit up to 2500 feet of cable to be connected between the units.

3.2.2 SRD-1 Setup With a Modulation Sciences STV-784

Before attempting to set up the SRD-1 with a Modulation Sciences STV-784, you must align the STV-784 to the transmitter by using the Bessel null procedure. This procedure is described in detail in the STV-784 Manual, Chapter 3, Section 3.4.

Once the STV-784 and the exciter are aligned, proceed as follows:

1. BYPASS the STV-784 audio processor (A card).
2. Set the STV-784 pre-emphasis to FLAT (A card).
3. BYPASS the STV-784 BTSC encoder (D card).
4. Place the STV-784 in MONO (front panel).
5. Drive the LEFT input of the STV-784 with a 2 kHz tone. Adjust the input level until the STV-784's REF green LED is on and the red LED is off. If the red LED appears to come on at the same point that the green LED does or if either LED flickers, see Chapter 3, "Reference Level Setup" (Section 3.4.8) of the STV-784 manual for suggestions on how to clean up the input signal.

Do not proceed with this setup until a clean indication can be obtained. Any error here will carry through the entire system to reduce the maximum separation.

6. Place the SRD-1 in L/R BTSC mode and adjust the appropriate (A or B) input level control until the SRD-1's green LED is on and the red LED is off. If both the A and B inputs are being used, repeat this setup for each input. If you cannot get a steady, flicker-free indication from either LED, see Appendix D of this manual.

7. Restore the test switches on the STV-784 to the desired mode (all down for normal program operation) and place the STV-784 into STEREO mode.

8. Before proceeding with any additional testing, be certain that the modes of the STV-784 and SRD-1 are in agreement—pre-emphasis/de-emphasis and BTSC/equivalent mode.

9. Use one of the methods described in Appendix C to measure separation.

10. If BTSC mid-band separation is less than -40 dB, "tweak" the L-R gain on the stereo generator. This is a "legal" adjustment. It does not misalign the BTSC encoder reference.

If this does not work, try "tweaking" the composite level. (Adjust the output level of the stereo generator.) If that improves the BTSC separation to better than -40 dB, a setup error exists in either the stereo generator or the SRD-1. This is an "illegal" adjustment because it misaligns the BTSC encoder reference from the standard. The cause of this error must be found and corrected before any measurements made with the SRD-1 may be considered to be accurate.

When this procedure is used, the composite level **must** be restored to its original value by using either of the methods outlined earlier.

3.2.3 SRD-1 Setup With Other Stereo Generators

This procedure is completely independent of the level setting accuracy of the stereo generator. It is a primary level calibration, depending only on the accuracy of measurement of the frequency of the oscillator, the low harmonic content of the oscillator, and your ability to resolve a carrier null. The most convenient source of an accurate, low-distortion 10,396 Hz tone is a Tektronix 1405 Sideband Adaptor. It includes a crystal-controlled tone source with a ten-turn attenuator.

This is the procedure that should be used if any doubts exist about the accuracy of the level setting of **any** BTSC stereo generator. It enables the level setting accuracy of the generator to be checked against the SRD-1's level setting.

1. Disconnect the stereo generator and all other signal sources from the wideband input of the aural exciter.

2. Connect an audio oscillator, frequency counter, and a high-resolution continuous attenuator to the exciter input, as shown in Figure 3-1. **Do not use a step-type attenuator.** This test is easier if the 75Ω termination of the exciter wideband input can be removed. If it cannot be removed, be certain that the oscillator and attenuator can drive a 75Ω load and still maintain low distortion.

3. Adjust the oscillator frequency to exactly 10,396 Hz. Make sure that the frequency does not change during this procedure. **It must remain within ±1 Hertz.**

4. If available, connect a conventional monaural modulation monitor to the RF output of the aural exciter. It will serve as a rough check on this procedure.

5. Using the attenuator, reduce the level of the modulating signal to zero.

6. Set up an RF spectrum analyzer to observe the aural carrier or the aural IF. It helps to avoid confusion if the visual carrier is off. If you do not have a spectrum analyzer available, see Appendix A for an alternative Bessel null procedure.
   Adjust the spectrum analyzer to a narrow enough bandwidth to make it easy to resolve sidebands 10 kHz apart. The vertical resolution should be 10 dB per division. In order to be certain that the spectrum analyzer is really centered on the aural carrier, temporarily increase the aural modulation until several sets of sidebands become visible.
   The resulting sidebands should be symmetrical about the carrier.
   If they are not, the analyzer is not centered on the carrier. Temporarily turn off the aural modulation to be certain that it is the carrier that is centered on the display.

7. Set the aural modulation level fully off. Gradually increase the input level until you see the first null of the aural carrier. The bottom of the null is at exactly ±25 kHz deviation or 100% M channel modulation. The monaural modulation monitor should verify this. If it does not, there is a good chance that you made a mistake counting nulls. Try again from zero modulation.

8. Set the SRD-1 to L/R BTSC mode.

9. Connect an RF sample from the exciter or transmitter to a wideband aural demodulator such as the **msi 320**.

10. Connect the composite aural output of the demodulator to either one of the

inputs of the SRD-1. Do not use a cable longer than 10 feet.

11. Adjust the selected input of the SRD-1 until the REF green LED is lit and the red LED is off. If the green or red LEDs flicker instead of producing a steady indication, noise is getting in somewhere. See Appendix D for help. Resolve this problem before proceeding.

12. Replace the test setup that is driving the exciter with the stereo generator's output. Follow the instructions provided with your stereo generator to align it to the exciter.

13. Before proceeding with any additional testing, be certain that the modes of the stereo generator and SRD-1 are in agreement — pre-emphasis/de-emphasis and BTSC/equivalent mode.

14. Use one of the methods described in Appendix C to measure separation.

15. If BTSC mid-band separation is less than -40 dB, "tweak" the L-R gain on the stereo generator. This is a "legal" adjustment. It does not misalign the BTSC encoder reference.

    If this does not work, try "tweaking" the composite level. (Adjust the output level of the stereo generator.) If that improves the BTSC separation to better than -40 dB, a setup error exists in either the stereo generator or the SRD-1. This is an "illegal" adjustment because it misaligns the BTSC encoder reference from the standard.
    The cause of this error must be found and corrected before any measurements made with the SRD-1 may be considered to be accurate.

    When this procedure is used, the composite level **must** be restored to its original value by using either of the methods outlined earlier.

3.2.4 SRD-1 Setup Without an RF Link

It is often desirable to test a television stereo system without an intervening RF link. This means connecting the composite output of the stereo generator directly to a composite input of the SRD-1.

We provide two procedures for back-to-back testing. The first depends on the accuracy of the stereo generator for setting the reference level of the SRD-1. If the generator is known to be accurate, this is a simpler procedure than the second method. However, if the results with the first procedure are marginal or if operational measurements show poor separation, we suggest the second procedure as a way to verify the level setting accuracy of the stereo generator.

The first procedure is specific to the Modulation Sciences STV-784 TV Stereo

Generator. The second is generator independent. It will work with any stereo generator, including the Modulation Sciences STV-784.

3.2.4.1 Back-To-Back Setup with a Modulation Sciences STV-784

If a Modulation Sciences STV-784 stereo generator is connected to the SRD-1, the procedure is simple:

1. Connect the STV-784 BNC composite output to either the A or B input of the SRD-1. Use less than ten feet of cable. If you are doing these tests in a strong RF field, use foil-shielded coax.

2. If the STV-784 has not been aligned to a transmitter, turn the STV-784 composite output level control to maximum, then back it off about three turns. This is not a critical step. Its purpose is to adjust the composite output to a typical operating level.

3. Follow the instructions in Section 3.2.2, Steps 1-10, for SRD-1 setup with a Modulation Sciences STV-784.

3.2.4.2 Back-To-Back Setup with any Stereo Generator

1. Connect the composite output of your stereo generator to one of the inputs (A or B) of the SRD-1. Use a BNC “T” connector at the SRD-1 to allow easy access to the signal.

2. The stereo generator must be in the monaural mode and any audio AGC must be disabled.

3. Follow your stereo generator’s instructions for setting up ±25 kHz deviation (100% monaural modulation). This is usually done by Bessel null alignment using a 10,396 Hz tone supplied by an external oscillator or an internal calibrator. Sometimes this is done with a different calibration tone. If so, continue this procedure with the tone provided and count the nulls accordingly.

4. Using the BNC “T”, measure the composite input voltage to the SRD-1 with the most accurate digital AC voltmeter available. A 3½digit meter is the minimum acceptable. We suggest a Fluke 8060A. It seems to be the least expensive DVM with sufficient accuracy. At the factory, we use a 5½digit Fluke 8840A.

5. Adjust the oscillator level so that the level measured at the SRD-1 composite input is exactly the same as it was for the stereo generator’s calibration tone. Be certain that the stereo generator remains in the monaural mode for this operation.

6. Adjust the INPUT level of the SRD-1 until the green REF LEVEL LED is on and the red REF LEVEL LED is off.

7. The generator and decoder are now level locked and separation testing may proceed according to the manual. Any further adjustment of either the stereo generator’s composite level or the SRD-1’s input level will uncalibrate the system.

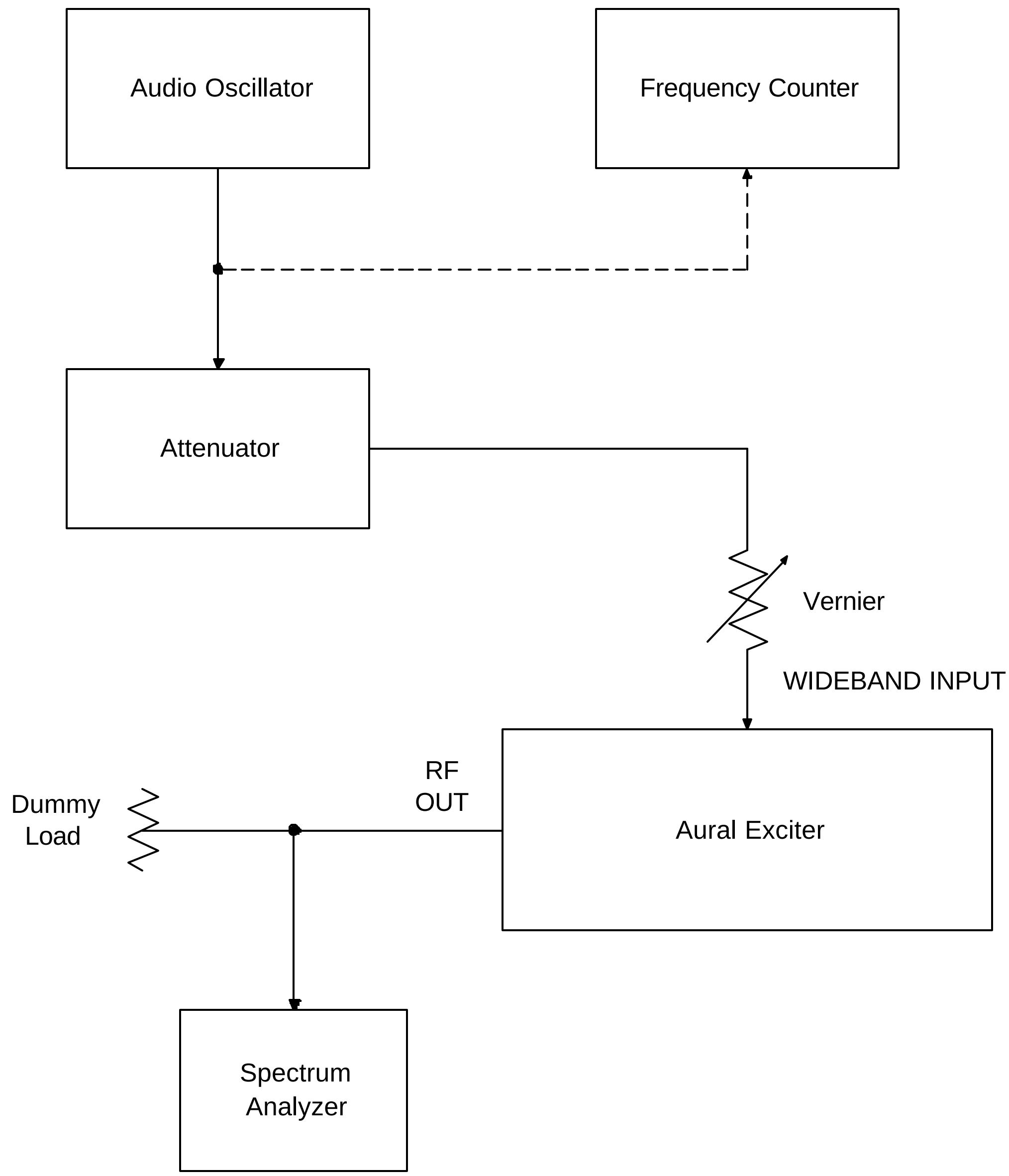

Figure 3-1
SRD-1 Bessel Null Test Setup

CHAPTER 4 ¾ Operation

4.1 Front Panel Controls

The SRD-1 operates in either the BTSC or the equivalent mode. “BTSC mode” means that the BTSC expander is decoding the signal on the L-R (D) channel. The associated time delay compensation circuit is switched into the L+R (M) channel. Consumer television receivers use the BTSC mode.

“Equivalent mode” means that the BTSC expander is removed from the L-R channel and replaced by a precision 75 µsec de-emphasis circuit. In the L+R channel, the BTSC expander time delay compensation circuit is bypassed. This is a linear test mode.

4.2 Main Function Selector

This five-position interlocking set of push buttons selects the basic functions of the SRD-1.

4.2.1 BTSC L/R

The BTSC Left and Right function allows operation in the BTSC mode with the audio outputs producing conventional Left and Right channel audio.

This is the normal on-air operational mode of BTSC stereo.

4.2.2 BTSC S/D

The BTSC Sum and Difference function allows operation in BTSC mode with the audio outputs producing sum and difference signals.

This function allows independent examination of the L+R (M channel) baseband and the demodulated L-R 31.468 kHz (D channel) subcarrier with BTSC decoding.

4.2.3 EQUIV L/R

The Equivalent Left and Right function allows operation in EQUIV mode while the audio outputs produce Left and Right channel audio.

This function allows examination of the recovered Left and Right audio channels without BTSC decoding.

4.2.4 EQUIV S/D

The Equivalent Sum and Difference function allows operation in EQUIV mode while the audio outputs produce sum and difference signals.

This function allows independent examination of the L+R (M channel) baseband and the demodulated L-R 31.468 kHz (D channel) subcarrier without BTSC decoding.

4.2.5 CAL Position

The CAL position is used for primary calibration of the SRD-1 and is not an operational control.

The CAL button disconnects the inputs of the D channel BTSC decoder and the M channel delay compensation. These two inputs are then paralleled and connected to the CAL INPUT connector on the rear of the unit.

The CAL function is only used during bench testing of the SRD-1. It is not for routine setup.

4.3 De-emphasis

This alternate action push button turns the 75 µsec de-emphasis on or off.
It affects all audio outputs, regardless of the function selected. This switch permits measurements in any mode, flat or with de-emphasis.

4.3.1 A/B Switch

The A/B switch selects the preset input that will drive the SRD-1. Each position has an independent input level control. This allows you to set the input level for each of two different composite signal sources. A common application is to drive one input from the off-air demodulator (for instance, an **msi 320**) and to drive the other input from a feed from the stereo generator. Thus, it is possible to select between the input and output of the transmission system during the broadcast day.

This selection function is needed because it is impossible to set the composite input level to a decoder under program conditions.

4.3.4 A and B Trimmers

These two controls set the composite input level to the SRD-1. They are twenty-turn trimmers that are selected by the A/B switch.

4.4 Front Panel Indicators

4.4.1 Stereo

The green STEREO LED indicator comes on when the 15,734 Hz stereo pilot is present on the incoming composite signal and the reference level has been set correctly.

This LED may not come on if the level setting procedure described in Chapter 3, Section 2.0 has not been carried out correctly. Additionally, the pilot frequency must be accurate to ±2 Hertz and have little jitter.

4.4.2 Reference Level LEDs

The operation of these indicators is discussed in Chapter 3, Section 2. During normal operation, these indicators should rarely come on.

4.5 Operation

Figure 4-1 shows a typical test setup providing swept performance data on the stereo system. The frequency range is swept rapidly and the result is displayed on a CRT. This allows you to view the effect of any adjustments of the stereo generator or transmitter as they are made. Such “real time” displays of separation, frequency response and crosstalk may be done with the SRD-1 in either BTSC or equivalent mode.

For more details on this measurement procedure, see Appendix C, “Measuring Separation”.

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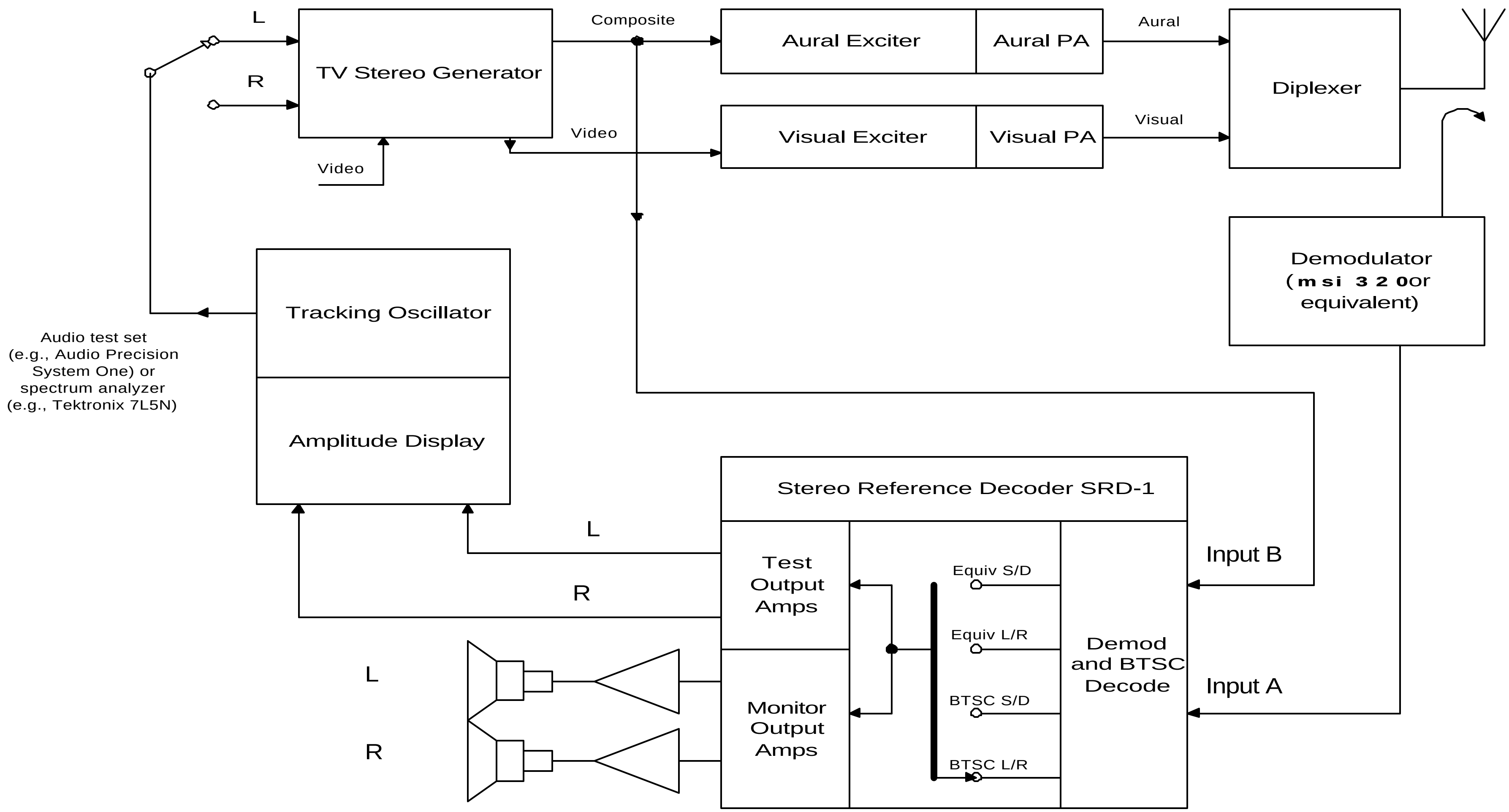

Figure 4-1
Typical MTS Test Setup

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CHAPTER 5 ¾ Routine Maintenance

5.1 Introduction

Routine maintenance of the SRD-1 falls into two categories. The first is the regular maintenance of the system of which the SRD-1 is a part. The second verifies the performance of the SRD-1 itself to ensure the continued accuracy of its readings.

5.2 System Maintenance

The SRD-1 needs no routine maintenance. It is important to ensure that the operating environment remains stable.

5.3 SRD-1 Performance Verification

If you suspect that your SRD-1 is no longer performing properly, you will find the necessary SRD-1 measurement techniques in this section. This is the method outlined in Appendix D of EIA Television Systems Bulletin #5, “Multichannel Television Sound, BTSC System Recommended Practices.”

If your SRD-1 fails this performance verification test, it must be returned to the factory for recalibration. Please contact Modulation Sciences to discuss the shipping procedure.

Using the recommended test equipment, you may verify stereo separation to at least -40 dB. This is good enough for testing broadcast monitoring equipment. In a computer-controlled measurement system, some measurement errors can be removed and even better accuracy is possible. Such a system is used at Modulation Sciences for the production testing of stereo decoders.

5.3.1 Acknowledgement

Appendix D was written by J. J. Gibson of RCA Laboratories. His calculations form the basis for comparing the performance of equipment to the BTSC standard embodied in Bulletin OET-60 Revision A from the FCC’s Office of Engineering and Technology.

5.3.2 Equipment Required

1. A low-distortion sine-wave oscillator. If the distortion is mostly second and third harmonics, 0.1% THD seems acceptable. Generators which synthesize the sine wave, such as function generators or network analyzers, usually contain high levels of high-order harmonics and may produce inaccurate results. If the distortion is mostly high-order harmonics, a value of 0.1% THD may be unacceptable.

2. A frequency counter for measuring the oscillator frequency, if the accuracy of the oscillator is not at least ±0.1%. The most rapid change of expander gain versus frequency occurs between 500 and 2000 Hz. A frequency error of ±0.15% will cause a worst-case gain error of approximately ±0.02 dB.

3. Some means of setting the input level to the SRD-1 with a resolution of at least 0.01 dB. Step attenuators with 0.1 dB resolution are readily available and vernier control may be added to set the level with 0.01 dB resolution. If a step attenuator is not available, use a multiturn potentiometer. Even with the best available multiturn potentiometer, a separate vernier control is usually necessary. If only a single control is used, it is extremely difficult to simultaneously obtain 0.01 dB resolution and a wide level adjustment range.

4. An accurate AC voltmeter. The voltmeter is used to set the input level to the SRD-1 and to measure the gain of the SRD-1. For a given voltmeter, gain measurement accuracy is generally much better than absolute level measurement accuracy, since gain measurement accuracy depends only on the meter's resolution, repeatability, and linearity. Assuming that the same meter is used both to set input level and to measure gain, measurement error is mostly due to level setting error. At low frequencies, the expander's gain error is equal to the input level error. At high frequencies, the gain error approaches twice the input level error. A voltmeter accurate to ±0.2% will cause a worst-case measurement error of ±0.034 dB.

5. A phase meter accurate to ±0.2° or better over the audio frequency range. Since the phase meter is used to measure the phase difference between the L+R channel, which is linear, and the L-R channel, which is expanded, it must maintain this accuracy even with a considerable difference in level between its inputs.

5.3.3 Measurement Procedure

Make copies of the SRD-1 PERFORMANCE VERIFICATION WORKSHEETS, Figures 5-1 to 5-3. Figure 5-4 shows you how to use this worksheet.
Figure 5-5 is a blank worksheet for your use. Connect the test equipment as shown in Figure 5-6.

1. Set the oscillator to 2 kHz. Depress the CAL button on the SRD-1. If you are using a step attenuator, set it to 0 dB attenuation. Using the oscillator output control and the vernier level control, adjust the level at the SRD-1 CAL input until the green REF LEVEL LED is on and the red REF LEVEL LED is off. Measure the voltage applied to the CAL input and record it at the top of the worksheet.

2. Set the oscillator to the frequency to be measured. Its frequency must be within 0.1% of the listed value. Use a frequency counter if your oscillator is not this accurate.

3. Multiply the voltage obtained in Step 1 by the upper figure in the MULT column. Write the result in the CAL LEVEL column. Adjust the level at the CAL input of the SRD-1 to this value. If you are using a step attenuator to set this level, the lower figure in the MULT column (dB ATTEN) is the attenuator setting in dB. Set the level as close as you can by using the attenuator and use the vernier control to make the final level adjustment.

4. Connect the voltmeter to the RIGHT (DIFF) output of the SRD-1. Record the voltage reading in the DIFF VOLTS column.

5. Connect the voltmeter to the LEFT (SUM) output of the SRD-1. Record the voltage reading in the SUM VOLTS column.

6. Calculate the ratio of DIFF to SUM in dB and record the result in the DIFF/SUM dB column.

7. Measure the phase of the RIGHT (DIFF) output of the SRD-1 relative to the LEFT (SUM) output and record the result in the PHASE column.

8. Subtract the IDEAL value from the PHASE value and enter the result under ERROR in the PHASE column.

9. Subtract the IDEAL value from the DIFF/SUM dB value and enter the result under ERROR in the DIFF/SUM dB column.

10. Use the two ERROR values to determine the separation. These are found in

the tables at the end of Appendix D of *BTSC Recommended Practices.* Repeat steps 2 through 10 for each frequency to be measured

			← 2 kHz AT REFERENCE LEVEL				
FREQ	MULT (dB ATTEN)	CAL LEVEL	DIFF VOLTS	SUM VOLTS	DIFF/ SUM dB	PHASE	
25	0.12402						MEAS.
	(18.130)				-1.870	-6.747	IDEAL
	SEPARATION dB ←						ERROR
50	0.10488						MEAS.
	(19.586)				-0.414	-13.439	IDEAL
	SEPARATION dB ←						ERROR
75	0.10060						MEAS.
	(19.948)				-0.052	-20.023	IDEAL
	SEPARATION dB ←						ERROR
100	0.09984						MEAS.
	(20.014)				0.014	-26.453	IDEAL
	SEPARATION dB ←						ERROR
200	0.10606						MEAS.
	(19.489)				-0.511	-49.906	IDEAL
	SEPARATION dB ←						ERROR
300	0.11828						MEAS.
	(18.542)				-1.458	-68.923	IDEAL
	SEPARATION dB ←						ERROR
400	0.13394						MEAS.
	(17.462)				-2.538	-83.581	IDEAL
	SEPARATION dB ←						ERROR
500	0.15198						MEAS.
	(16.364)				-3.636	-94.614	IDEAL
	SEPARATION dB ←						ERROR

Figure 5-1
SRD-1 Performance Verification Worksheet¾ 10% M Channel Modulation¾ Sheet 1

			2 kHz AT REFERENCE LEVEL				
FREQ	MULT (dB ATTEN)	CAL LEVEL	DIFF VOLTS	SUM VOLTS	DIFF/SUM dB	PHASE	
600	0.17169						MEAS.
	(15.305)				-4.695	-102.812	IDEAL
	SEPARATION	dB					ERROR
800	0.21444						MEAS.
	(13.374)				-6.626	-113.018	IDEAL
	SEPARATION	dB					ERROR
1000	0.25939						MEAS.
	(11.721)				-8.279	-117.093	IDEAL
	SEPARATION	dB					ERROR
1500	0.35806						MEAS.
	(8.921)				-11.079	-105.907	IDEAL
	SEPARATION	dB					ERROR
2000	0.38659						MEAS.
	(8.255)				-11.745	-80.919	IDEAL
	SEPARATION	dB					ERROR
2500	0.37068						MEAS.
	(8.620)				-11.380	-63.257	IDEAL
	SEPARATION	dB					ERROR
3000	0.34910						MEAS.
	(9.141)				-10.859	-52.156	IDEAL
	SEPARATION	dB					ERROR
4000	0.31514						MEAS.
	(10.030)				-9.970	-38.014	IDEAL
	SEPARATION	dB					ERROR

Figure 5-2
SRD-1 Performance Verification Worksheet¾ 10% M Channel Modulation¾ Sheet 2

			← 2 kHz AT REFERENCE LEVEL				
FREQ	MULT (dB ATTEN)	CAL LEVEL	DIFF VOLTS	SUM VOLTS	DIFF/SUM dB	PHASE	
5000	0.29326						MEAS.
	(10.655)				-9.345	-28.110	IDEAL
	SEPARATION	dB	←				ERROR
6000	0.28064						MEAS.
	(11.037)				-8.963	-20.417	IDEAL
	SEPARATION	dB	←				ERROR
8000	0.27736						MEAS.
	(11.139)				-8.861	-9.977	IDEAL
	SEPARATION	dB	←				ERROR
10000	0.29188						MEAS.
	(10.696)				-9.304	-3.892	IDEAL
	SEPARATION	dB	←				ERROR
12000	0.31203						MEAS.
	(10.116)				-9.884	0.267	IDEAL
	SEPARATION	dB	←				ERROR
14000	0.33277						MEAS.
	(9.557)				-10.443	3.588	IDEAL
	SEPARATION	dB	←				ERROR
15000	0.34289						MEAS.
	(9.297)				-10.703	5.066	IDEAL
	SEPARATION	dB	←				ERROR

Figure 5-3
SRD-1 Performance Verification Worksheet¾ 10% M Channel Modulation¾ Sheet 3

VALUES YOU MUST CALCULATE OR MEASURE
ARE SHOWN IN *ITALICS.*

1 3 4 5 6 7

		1.285	← 2 kHz AT REFERENCE LEVEL				
FREQ	MULT (dB ATTEN)	CAL LEVEL	DIFF VOLTS	SUM VOLTS	DIFF/SUM dB	PHASE	
300	0.11828 (18.542)	*0.1520*	*0.3247*	*0.3818*	*-1.407*	*-68.12*	MEAS.
					-1.458	-68.923	IDEAL
	SEPARATION *42.4* dB ←				*0.051*	*0.803*	ERROR

2 10 9 8

Figure 5-4
SRD-1 Performance Verification Worksheet Instructions

		← 2 kHz AT REFERENCE LEVEL					
FREQ	MULT (dB ATTEN)	CAL LEVEL	DIFF VOLTS	SUM VOLTS	DIFF/SUM dB	PHASE	
							MEAS.
							IDEAL
	SEPARATION	dB	←				ERROR
							MEAS.
							IDEAL
	SEPARATION	dB	←				ERROR
							MEAS.
							IDEAL
	SEPARATION	dB	←				ERROR
							MEAS.
							IDEAL
	SEPARATION	dB	←				ERROR
							MEAS.
							IDEAL
	SEPARATION	dB	←				ERROR
							MEAS.
							IDEAL
	SEPARATION	dB	←				ERROR
							MEAS.
							IDEAL
	SEPARATION	dB	←				ERROR
							MEAS.
							IDEAL
	SEPARATION	dB	←				ERROR

Figure 5-5
SRD-1 Performance Verification Worksheet

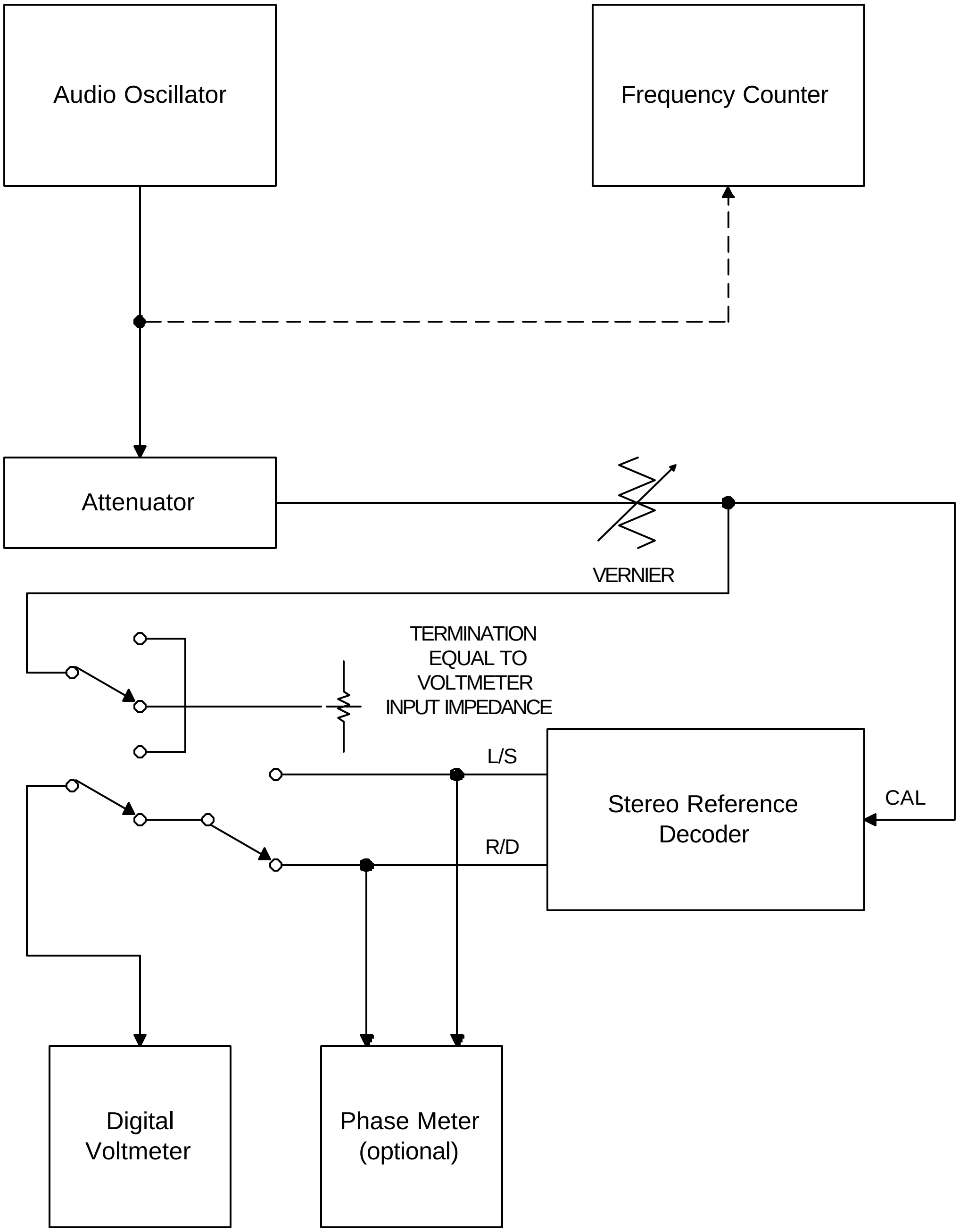

Figure 5-6
SRD-1 Performance Verification Test Setup

CHAPTER 6 ¾ Field Service

6.1 Introduction

There may come a time when even the best-engineered equipment needs servicing. The calibration test described in Chapter 5 will tell you when your SRD-1 needs to be returned to the factory for recalibration. This procedure can **only** be done at the factory.

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6.2 Abbreviations And Symbols Used In Parts Lists

6.2.1 Abbreviations of Manufacturers' Names

3M	3M
Advancedmi	Advanced Micro
Alco	Alco Electronics Products, Inc.
Allenbradl	Allen-Bradley Co.
Amp	Amp Special Industries
Amphenol	Allied Amphenol Products
Analogdevi	Analog Devices
Analogsyst	Analog Systems, Inc.
Aromat	Aromat Corp.
Beauproduc	Beau Products
Belden	Belden Corporation
Berg	Berg Electronics
Bivar	Bivar, Inc.
Bourns	Bourns, Inc. Electronic Components
Bussman	Bussman Mfg. Div., McGraw Edison Co.
Centralab	Centralab, Inc.
Dbx	DBX Inc.
Dennison	Dennison Manufacturing Co.
Dialight	DIALIGHT
Dzus	Dzus Fastener Co., Inc.
Fairritepr	Fair-rite Products Corp.
Generalele	General Electric
Hewlettpac	Hewlett-Packard
Heymanmanu	Heyman Manufacturing Co.
Hhsmith	Herman H. Smith Inc.
Idi	Industrial Devices, Inc.
Ittschadow	ITT Schadow, Inc.
Jwmillr	J. W. Miller
Keystone	Keystone Electronics Corp.
Leecraft	Leecraft Manufacturing Co., Inc.
Littelfuse	Littelfuse, Inc.
Magnetcoil	Magnetic Coils, Inc.
Mallory	Mallory Capacitor Co.
Military	Military
Motorola	Motorola, Inc.
MSI	Modulation Sciences, Inc.
Murataerie	Murata Erie North America, Inc.
Nationalse	National Semiconductor Corp.
Opticalele	Optical Electronics, Inc.

Panduit	Panduit Corp.
Precmonoli	Precision Monolithics, Inc.
RCA	RCA Solid State Devices
Samtec	Samtec
Sgsates	Sgsates
Sfetechnol	San Fernando Electronic Technology
Siliconix	Siliconix
Solidstate	Solid State Scientific, Inc.
Spraguelec	Sprague Electric Company
Switchcraf	Switchcraft, Inc.
Texasinstr	Texas Instruments
Toshiba	Toshiba Semiconductor USA
Tusonix	Tusonix, Inc.
Various	Various
Winchester	Winchester Electronics
Wima	Wima Div., Inter-Technical Group, Inc.
Zierick	Zierick Mfg.

6.2.2 Abbreviations Used in Parts Descriptions

ADJ	adjustable
AE	aluminum electrolytic capacitor
BH	binding head
BL	black
BUSH	bushing
CC	carbon composition resistor
CF	carbon film resistor
CM	cable mount
CONN	connector
DT	dipped tantalum
F (FEM)	female
FH	flat head
INT	internal
LH	left hand
LW	lockwasher
M	male
MC	monolithic ceramic capacitor
MF	metal film resistor
MINI-BAY	mini-bayonet base lamp
MOM	momentary
MT	mount
MY	mylar capacitor
nF	nanofarads
OX	oxide coated
PC	printed circuit
pF	picofarads
PHIL	Phillips head
PS	polystyrene capacitor
PY	polyester/Mylar® capacitor
REG	regulator
RH	round head (or right hand)
RND	round
SB	slow-blow
SEG	segment
SF	stacked film capacitor
SM	silvered mica capacitor
SPAC	space
SPST	single pole-single throw
SS	solder socket
TS	terminal strip
µF	microfarads
WW	wire-wrap

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6.3 Parts Lists

NOTE: Some parts in the following lists are marked with an asterisk (*). When this symbol is used with a reference designator, it means that the part has been tested by Modulation Sciences, Inc. and should not be replaced without consulting the factory.

CHASSIS PARTS

MSI Part Number	Qty	Description	Reference Designator	Manufacturer	Manufacturer's Part Number
V01-SRD-1R					
A04-1005HMBG1	1	.01 uF 50 V 10% MC	C3	CENTRALAB	CW20C103K
A04-3307FTNH1	4	3.3 uF 25 V DT	C1,C2,C4,C5	SPRAGUE	199D335X0025BB1
C01-1B0000006	1	OP AMP	U4	ANALOGDEVI	AD741JN
C02-1NVARM001	1	NEG. VOLT. REG., ADJ. 1.5 A TO-220	U3	TEXASINSTR	LM337KC
C02-1P102L001	1	10 V REF	U1	ANALOGDEVI	AD581JH
C02-1PVARM002	1	POS. VOLT REG., ADJ. 1.5 A TO-220	U2	TEXASINSTR	LM317T
K02-000000002	1	TO-5 MOUNT		BIVAR	501-075
K02-000000003	2	INSULATOR		BERGQUIST	K4-62
K02-3051	2	NO 2 SHOULDER BUSH		KEYSTONE	3051
K06-H3510NT90	1	CABLE TIE, 5.5"		HEYMANMANU	3510NT90
K08-SCARMB	1	MOUNTING BRACKET	MB1	MSI	SCAR-MB
Z01-104	1	1K 1/4W 5% CF	R6	VARIOUS	1/4 W 5 % CF
Z02-2003	1	200 OHM 1/4W 1% MF	R1	VARIOUS	1/4 W 1 % MF
Z02-3323	1	332 OHM 1/4W 1% MF	R2	VARIOUS	1/4 W 1 % MF
Z02-7503	1	750 OHM 1/4W 1% MF	R5	VARIOUS	1/4 W 1 % MF
Z14-1005	2	10.0K 0.1% 1/4W 50 PPM	R3,R4	MILITARY	RN55CF

MSI Part Number	Qty	Description	Reference Designator	Manufacturer	Manufacturer's Part Number
V02-SRD-1H					
A04-1004SCDG1	2	1 nF 10% DISC		CENTRALAB	CE102
A04-1203UCBG1	7	120 pF DISC		SPRAGUE	10TST12
A04-1504XHNI1	2	1.5 nF FEEDTHROUGH		TUSONIX	357-001-X5U0-152M
A04-4705JMCH1	2	0.047 pF 100V MC		CENTRALAB	CZ20A473M
A06-FBEAD0001	6	FERRITE BEAD		FAIRRITEPR	2743002111
A07-L60360302	2	600 OHM OUTPUT XFMR	T1,T2	JENSENTRAN	JE-11-ELCF W/24 AWG LEADS
A08-112202801	1	PWR XFMR, DUAL 28VCT 0.42A		SIGNALTRAN	241-5-28
A09-S3AG01251	1	FUSE, SLOW BLOW, 1/8 A		LITTLEFUSE	313.125
H02-002F00002	5	CONNR, BNC F, UG1094U		AMPHENOL	31-221
H02-002F00003	2	LONG BUSHING BNC CONNR		KINGS	KC79-46
H04-PN0000001	1	FUSE HOLDER		BUSSMAN	HKP
H08-004CFW001	3	4 PIN CM END CONNR W/GOLD		PANDUIT	CE100F24-4-DA
H08-009CFW001	1	9 PIN CM END CONNR W/GOLD		PANDUIT	CE100F24-9-DA
H09-006PR0001	1	6 POS 6/32 SCREW TS		BEAUPRODUC	71706
H11-CRN160401	1	CRIMP LUG, #6, 22-18 AWG		ZIERICKMAN	A3651W/.144"HOLE
J07-P18000001	1	6 FT LINE CORD (1.8 m)		BELDEN	17237B
K04-1450C	4	4/40 x 1/2" HEX SPACER		KEYSTONE	1450C
K06-D08461	5	ADHESIVE WIRE TIE MOUNT		DENNISON	8461
K06-H3510NT90	3	CABLE TIE, 5.5"		HEYMANMANU	3510NT90
K99-000000002	2	NYLON SHOULDER WASHER		HHSMITH	2668
L03-SCA186L3	1	LINE/FUSE LABEL		APEXDESIGN	SCA186L3
L03-SRD-1L1	1	OUTPUT LABEL		APEXDESIGN	SRD-1L1
L03-SRD-1L2	1	I/O LABEL		APEXDESIGN	SRD-1L2
L03-SRD-1LOGO	1	SRD-1 LOGO LABEL		APEXDESIGN	SRD-1LOGO
L03-STVMSIBAR	1	MSI BAR LABEL		APEXDESIGN	STVMSIBAR
Z07-103	2	100 OHM 5% 1/2W CC EB TYPE		VARIOUS	1/4W5%CF

MSI Part Number	Qty	Description	Reference Designator	Manufacturer	Manufacturer's Part Number
V03-SRD-1L					
B04-N3904	1	NPN TRANSISTOR TO-92		VARIOUS	2N3904
E01-S20000001	1	RED LED		DIALIGHT	521-9240
E01-S40000001	1	YELLOW LED		DIALIGHT	521-9176
E01-S50000001	2	GREEN LED		DIALIGHT	521-9270
H08-005CFW001	1	5 PIN END CONNR W/GOLD		PANDUIT	CE100F24-5-DA
K02-000000008	4	LED MOUNT, 0.2"		BIVAR	250
Z01-823	2	820 OHM 1/4W 5% CF		VARIOUS	1/4W5%CF

MSI Part Number	Qty	Description	Reference Designator	Manufacturer	Manufacturer's Part Number
V03-SRD-1T					
A04-2203UCBG1	4	220 pF CER DISC 0.25 LS		SPRAGUE	10TST22
A06-FBEAD0001	4	FERRITE BEAD		FAIRRITEPR	2743002111
G04-STVT1	1	6-POS TS BYPASS CRD		QUALITYCIR	STVT1

MSI Part Number	Qty	Description	Reference Designator	Manufacturer	Manufacturer's Part Number
V03-UPSA					
A04-100AGANH1	2	1000 uF 35V AE 20%		VARIOUS	
A04-4705JMCH1	2	.047 uF 100V MC		VARIOUS	
B01-4003	4	RECTIFIER DIODE		VARIOUS	
Z09-221	2	2.2 OHM,1/2W,5%,CF RESISTOR		VARIOUS	

CIRCUIT BOARD PARTS

V01-SRD-1F

MSI Part Number	Qty	Description	Reference Designators	Manufacturer	Manufacturer's Part Number
A02-M105FS001	1	TRIMPOT, 10K0 20T	RV307	BOURNS	3006P1-103
A02-M503FS001	4	500 OHM 20T TRIMPOT	RV201,RV202,RV301,RV302	BOURNS	3006P1-501
A02-S203FT001	2	200 OHM 1T FLAT TP	RV204,RV304	BOURNS	3386P1-201
A02-S203US001	2	TRIMPOT, 1T 200R UR SIDE	RV206,RV306	BOURNS	3386W1-201
A02-S503FT001	2	500 OHM 1T FLAT TP	RV208,RV308	BOURNS	3386P1-501
A04-1006HMCH1	4	0.1 uF 50 V 20% MC	C239-C242	CENTRALAB	CZ20C104M
A04-1007H-PNF1	2	1 uF 5% 63V PY LS 10MM	C234,C334	WIMA	MKS4RM10 1/6 63V
A04-3903RSND1	2	390 pF 1% SM	C231,C331	VARIOUS	DM15FD391F03
A04-6807FTNH1	6	6.8 uF 25 V DT	C218,C219,C237,C238,C318,C319	MSI	199D685X0025CB1
A04-XXXXXXXXX	4	CAPACITOR	C220*,C230*,C320*,C330*	MSI	
AT4-1004RSND2	2	1 nF SM	C211*,C311*	MSI	A04 (TESTED)
AT4-1004RSND2	2	1 nF SM	C217*,C317*	MSI	A04 (TESTED)
AT4-1004RSND2	2	1 nF SM	C225*,C325*	MSI	A04 (TESTED)
AT4-1004RSND2	8	1 nF SM	C226*-C229*,C326*-C329*	MSI	A04 (TESTED)
AT4-1004RSND2	10	1 nF SM	C212*,C232*,C233*,C235*,C236*, C312*,C332*,C333*,C335*,C336*	MSI	A04 (TESTED)
AT4-5603RSND1	24	560 pF SM	C207-C210,C213-C216,C221-C224, C307-C310,C313-C316, C321-C324	MSI	A04 (TESTED)
C01-2B0000001	7	DUAL OP AMP, PLASTIC	U202*-U208*	TEXASINSTR	NE5532P
C01-2F0000002	1	DUAL OP AMP	U210	NATIONALSE	LF412CN
C01-2F0000006	1	DUAL OP AMP	U209	TEXASINSTR	TL072CP
H05-008000001	9	8 PIN EDGE GRIP SS	US202-US210	AMP	2-640463-2
H08-001PMS001	12	TEST POINTS	TP201-TP205,TP207, TP301-TP305,TP307	OXLEY	040/30P/KP2/L
H08-009CFW001	1	9 PIN CM END CONNR W/GOLD	J201	PANDUIT	CE100F24-9-DA
K04-1450D	4	4/40 x 3/4" HEX SPAC		KEYSTONE	1450D
K06-H3510NT90	1	CABLE TIE, 5.5"		HEYMANMANU	3510NT90
Z01-000	2	0 OHM 1/4W 5% CF	R201,R301	VARIOUS	.4" JUMPER
Z01-104	2	1 K 1/4W 5% CF	R213,R313	VARIOUS	1/4 W 5 % CF
Z01-106	2	100 K 1/4W 5% CF	R208,R308	VARIOUS	1/4 W 5 % CF
Z01-107	2	1 M 1/4W 5% CF	R239,R339	VARIOUS	1/4 W 5 % CF

Z01-226	2	220 K 1/4W 5% CF	R272,R372	VARIOUS	1/4 W 5 % CF
Z02-XXXX	30	RESISTOR 1%	R212*,R216*,R218*,R221*,R222*, R229*,R231*,R234*,R236*,R241*, R243*,R246*,R248*,R257*,R261*, R312*,R316*,R318*,R321*,R322*, R329*,R331*,R334*,R336*,R341*, R343*,R346*,R348*,R357*,R361*	VARIOUS	1/4W 1% MF
Z03-1824	2	1.82 K 1/4W 1% MF RN55 50 PPM	R266,R366	MILITARY	RN55CF
Z03-3014	2	3.01 K 1/4W 1% MF RN55 50 PPM	R238,R338	MILITARY	RN55CF
Z03-3324	2	3.32 K 1/4W 1% MF RN55 50 PPM	R250,R350	MILITARY	RN55CF
Z03-3575	1	35.7 K 1/4W 1% MF RN55 50 PPM	R326	MILITARY	RN55CF
Z03-4025	1	40.2 K 1/4W 1% MF RN55 50 PPM	R226	MILITARY	RN55CF
Z03-4993	2	499 OHM 1/4W 1% MF RN55 50 PPM	R267,R367	MILITARY	RN55CF
Z03-5364	1	5.36 K 1/4W 1% MF RN55 50 PPM	R225	MILITARY	RN55CF
Z14-1245	2	12.4 K 1/4W, 0.1% MF, 25 or 50 PPM	R256*,R356*		
Z14-1655	2	16.5 K RN55 0.1% 1/4W 50 PPM	R227*,R327*	MILITARY	RN55CF
Z14-1545	8	15.4 K 0.1% 1/4W 50 PPM RN55	R228*,R230*,R232*,R233*, R328*,R330*,R332*,R333*	MSI	
Z14-1695	2	16.9 K RN55 0.1% 1/4W 50 PPM	R274*,R374*	VARIOUS	1/4 W 1 % MF
Z14-1005	28	10.0 K RN55 0.1% 1/4W 50 PPM	R224*,R237*,R240*,R242*, R244*,R245*,R249*,R259*, R260*,R262*-R264*,R270*, R275*,R324*,R337*,R340*, R342*,R344*,R345*,R349*, R359*,R360*,R362*-R364*, R370*,R375*	MILITARY	
Z14-1745	8	17.4 K RN55 0.1% 1/4W 50 PPM	R215*,R217*,R219*,R220*, R315*,R317*,R319*,R320*	MILITARY	RN55CF
Z14-2005	2	20.0 K RN55 0.1% 1/4W 50 PPM	R235*,R335*		
Z14-2805	2	28.0 K RN55 0.1% 1/4W 50 PPM	R223*,R323*	MILITARY	RN55CF
Z14-3013	2	301 OHM 0.1% 1/4W 50 PPM RN55	R265*,R365*	MILITARY	RN55CF
Z14-3244	2	3.24 K RN55 0.1% 1/4W 50PPM	R273*,R373*	VARIOUS	1/4 W 1 % MF
Z14-3834	2	3.83 K RN55 0.1% 1/4W 50 PPM	R268*,R368*	VARIOUS	1/4 W 1 % MF
Z14-5364	1	5.36 K PRI/10 0.1% 50 PPM	R325*	MILITARY	RN55CF
Z14-8664	2	8.66 K RN55 0.1% 1/4W 50 PPM	R269*,R369*	VARIOUS	1/4 W 1 % MF
Z14-2215	4	22.1 K RN55 0.1% 1/4W 50 PPM	R254*,R255*,R354*,R355*		
Z14-4994	4	4.99 K RN55 0.1% 25 OR 50 PPM	R271*,R276*,R371*,R376*	VARIOUS	
Z14-8665	2	86.6 K 1/4W 0.1% 50 PPM RN55	R247*,R347*		

MSI Part Number	Qty	Description	Reference Designator	Manufacturer	Manufacturer's Part Number
V01-SRD-1M					
A02-M104FS001	1	TRIMPOT, 20T 1K00 FS SIDE	RV5	BOURNS	3006P1-102
A02-M106UT001	1	TRIMPOT, 20T 100K UR TOP	RV3	SPECTROL	64Y-104
A02-M204FS001	4	2K 20T TRIMPOT	RV1,RV2,RV306,RV309	BOURNS	3006P1-202
A02-M204UT001	1	TRIMPOT, 20T 2K00 UR TOP	RV4	SPECTROL	64Y-202
A02-M504FS001	2	5K 20T TRIMPOT	RV307,RV310	BOURNS	3006P1-502
A02-S104FT001	1	1K 1T FLAT TRIMPOT	RV6	BOURNS	3386P1-102
A02-S203FT001	1	200 OHM 1T FLAT TP	RV302	BOURNS	3386P1-201
A02-S204FT001	2	2K 1T FLAT TRIMPOT	RV301,RV308	BOURNS	3386P1-202
A02-S205FT001	4	TRIMPOT, 1T 20K0 FS TOP	RV304,RV305,RV311,RV312	BOURNS	3386P1-203
A02-S205US001	1	20K UPRIGHT TRIMPOT	RV313	BOURNS	3386W1-203
A02-S503FT001	1	500 OHM 1T FLAT TP	RV7	BOURNS	3386P1-501
A04-1003RSND1	2	100 pF 1% SM 500V	C7,C8	VARIOUS	DM15FD101F03
A04-1005HMBG1	2	0.01 uF 50 V 10% MC	C323,C329	MURATA ERIE	RPE110X7R103K50V
AT4-1005JRNF1	1	0.01 uF 100 V 5% PC	C301*	WIMA	FKC2.01UF 5% 100V PC
A04-1006HMCH1	16	0.1 uF 50 V 20% MC	C14,C23-C26,C33, C304,C305,C310,C312,C321 C325,C332	CENTRALAB	CZ20C104M
A04-1006JPNF1	1	0.1 uF 5% 100V PY	C17	WIMA	MKS4RM7 0.1/100/5 (7.5MM)
A04-1007GTNH1	3	1 uF 35 V DT	C12,C13,C348	SPRAGUE	199D105X0035BB1
A04-1007H-PNF1	2	1 uF 5% 63V PY LS 10MM	C19,C344	WIMA	MKS4RM10 1UF/5/63 (10 MM)
A04-1008FTNH1	5	10 uF 25 V DT	C100,C101,C200,C201,C331	SPRAGUE	199D106X0025CB1
AT4-1008FTNH1	1	CAPACITOR	C330*	SPRAGUE	199D106X0025CB1
A04-1502JMAG1	1	15 pF 100 V 10 % MC	C354	CENTRALAB	CN15A150K
A04-1804RSND1	1	1.8 nF 1% SM	C22	VARIOUS	DM19FD182F03
A04-2202JMAG1	1	22 pF 100 V 10% MC	C343	CENTRALAB	CN15A220K
A04-2202UCCH1	6	22 pF DISC	C103,C107,C203,C207, C306,C315	SPRAGUE	10TSQ22
A04-2204HMAD1	5	2.2 nF 1% 50 V MC	C9,C10,C27,C28,C345	SFETECHNOL	G505BY222F
AT4-2204HMAD1	8	2.2 nF MC	C307*,C318*,C320*, C326,C328*,C333*-C335*	SFETECHNOL	G505BY222F
A04-2207H-PNF1	2	2.2 uF 5% 63 V PY	C5,C6	WIMA	MKS4 2.2/63/5/15MM
A04-3302RSNE1	1	33 pF 2% SM 500V	C21	VARIOUS	DM15FD330G03
A04-3902RCAF1	4	39 pF CER DISC, NPO, 0.25 LS	C102,C106,C202,C206	MALLORY	CMC390J
A04-3903UCBG1	2	390 pF DISC 5%	C308,C317	SPRAGUE	10TST39
A04-4706H-PNF2	2	0.47 uF 5% 63V PY	C11,C18	WIMA	MKS4RM7 0.47/63/5 (7.5MM)
AT4-4706H-PNF2	1	0.47 uF 5% 63V	C327*	WIMA	MKS4RM7 0.47/63/5 (7.5MM)

A04-4708BTNH1	3	47 uF 6 V DT	C303,C309,C311	SPRAGUE	199D476X06R3DB1
A04-5001UCBG1	4	5 pF DISC	C1-C4	CENTRALAB	DD-050
A04-5602HCAF1	1	56 pF 5 % COG DISC	C316	MALLORY	CEC560J
A04-6807FTNH1	7	6.8 uF 25 V DT	C15,C16,C20,C29, C30,C32,C322	SPRAGUE	199D685X0025CB1
A04-XXXXXXXXX	4	CAPACITOR	C31*,C340*,C346*,C353*	MSI	
A06-4306F0001	1	430 uH RF CHOKE	L1	JWMILLER	9220-10
A10-020145641	1	CRYSTAL, 2.014564MHz, HC33	X1	SAVOYELECT	900P 2.014564 SER 20 PPM
AT4-3307FTNH1	1	3.3 uF 25V DT	C324*	MSI	A04 (TESTED)
B01-000000002	1	120 pF 2 VDC VARICAP	D1	MOTOROLA	MV1404
B01-4148	1	GLASS DIODE	D2	VARIOUS	1N4150
B04-N3904	3	NPN TRANSISTOR, TO-92	Q1,Q2,Q4	VARIOUS	2N3904
B04-P3906	1	LOW POWER PNP TRANSISTOR	Q3	VARIOUS	2N3906
C01-1B0000003	4	OP AMP, PLASTIC	U100,U102,U200,U202	SIGNETICS	NE5534P
C01-1F0000001	1	OP AMP	U3	PRECMONOLI	OP-17FJ
C01-1F0000006	2	OP AMP, PLASTIC	U1*,U2*	TEXASINSTR	LM318P
C01-1F0000008	1	OP AMP	U309	TEXASINSTR	TL071CP
C01-2B0000001	8	DUAL OP AMP, PLASTIC	U4*,U6*,U7*,U9*,U19*, U306*,U307*,U310*	TEXASINSTR	NE5532P
C01-2F0000002	4	DUAL OP AMP	U11,U12,U18,U308	NATIONALSE	LF412CN
C01-2F0000007	4	DUAL OP AMP	U8,U305,U311,U312	TEXASINSTR	TL082CP
C07-100000001	2	VCA	U301,U302	DBX	2151
C10-100000002	2	RMS TO DC CONVERTER	U303,U304	DBX	2252
C10-100000003	1	RMS TO DC CONVERTER	U10	ANALOGDEVI	AD536AJD
D01-401750001	1	QUAD `D` FLIP-FLOP	U14	NATIONALSE	CD40175BCN
D01-4040X0001	1	12 BIT RIPPLE COUNTER	U13	SOLIDSTATE	SCL4040BE
D01-4066X0001	1	QUAD ANALOG SWITCH	U16	SGSATES	HCF4066BE
D01-4070X0001	1	QUAD EXCL OR GATE	U15	SOLIDSTATE	SCL4070BE
D06-040100101	1	ANALOG SWTCH	U17	SILICONIX	DG211CJ
D06-040100104	2	HIGH SPEED ANALOG SW.	U5,U20	SILICONIX	DG271CJ
H05-008000001	23	8 PIN EDGE GRIP SS	US1-US2,US4,US6-US9, US11,US12,US18,US19, US100,US102,US200, US202,US305-US312	AMP	2-640463-2
H05-008000003	1	8 PIN MACHINE PIN SS	US3	SAMTEC	ICO-308-SGT
H05-014000002	3	14 PIN FACE GRIP SS	US10,US15,US16	AMP	2-641261-20
H05-016000002	5	16 PIN FACE GRIP SS	US5,US13,US14,US17,US20	AMP	2-641262-20
H08-002PMW002	4	2 PIN WW STRIP	PS301,PS303-PS305	SAMTEC	TSW-102-07-G-S
H08-004PMS002	3	MASCON HEAD, 4-PIN W/GOLD	PS1,PS2,PS5	PANDUIT	MLSS100-4-DA
H08-005PMS001	1	MASCON 5-PIN HEAD W/ GOLD	PS4	PANDUIT	MLSS100-5-DA
H08-009PMS002	2	STRAIGHT MASCON HEAD	PS3,PS6	PANDUIT	MLSS100-9-DA
H14-S00800001	4	8 MACH PIN SIL	US301-US304	SAMTEC	SS-108-G-2
I02-040100201	1	ALT ACT 4P2T PC SWITCH	S6	ITTSCHADOW	1X010003F4UEE
I02-050400201	1	5 STA INTERLOCK SWITCH	S1-S5	ITTSCHADOW	5XFA17.5(NONE)4UGR

I03-010200201	1	DPDT MINI TOGGLE SW	S7	ALCO	TT21NG-RA-1
K01-A02COV001	6	20-T TRIMPOT COVER	RVC1,RVC2,RVC306, RVC307,RVC309,RVC310	BOURNS	H-83-P
K01-I02IND002	3	BLK/GREEN LAMPLESS IND	SC4-SC6	ITTSCHADOW	FA101 BLACK/GREEN
K01-I02IND003	1	LAMPLESS IND, BLK/ORG	SC1	ITTSCHADOW	FA101 BLACK/ORANGE
K01-I02IND004	2	LAMPLESS IND, BLK/YEL	SC2,SC3	ITTSCHADOW	FA101 BLACK/YELLOW
K02-000000001	1	TO-99 TO DIP CONV		BIVAR	808-187
K04-1450D	5	4/40 x 3/4" HEX SPAC		KEYSTONE	1450D
L03-PWBSERLAB	1	PWB SERIAL LABEL (KAPTON)		CRITCHELY	CR3-KG10F
Z01-104	4	1 K 1/4W 5% CF	R68,R334,R348,R361	VARIOUS	1/4 W 5 % CF
Z01-106	1	100 K 1/4W 5% CF	R65	VARIOUS	1/4 W 5 % CF
Z01-107	2	1 M 1/4W 5% CF	R113,R213	VARIOUS	1/4 W 5 % CF
Z01-115	2	11 K 1/4W 5% CF	R105,R205	VARIOUS	1/4 W 5 % CF
Z01-185	1	18 K 1/4W 5% CF	R70	VARIOUS	1/4 W 5 % CF
Z01-224	2	2.2 K 1/4W 5% CF	R41,R42	VARIOUS	1/4 W 5 % CF
Z01-225	1	22 K 1/4W 5% CF	R72	VARIOUS	1/4 W 5 % CF
Z01-226	1	220 K 1/4W 5% CF	R55	VARIOUS	1/4 W 5 % CF
Z01-228	2	22 M 1/4W 5% CF	R351,R359	VARIOUS	1/4 W 5 % CF
Z01-244	2	2.4 K 1/4W 5% CF	R33,R48	VARIOUS	1/4 W 5 % CF
Z01-336	1	330 K 1/4W 5% CF	R391	VARIOUS	1/4 W 5 % CF
Z01-392	1	39 OHM 1/4W 5% CF	R62	VARIOUS	1/4 W 5 % CF
Z01-434	2	4.3 K 1/4W 5% CF	R25,R26	VARIOUS	1/4 W 5 % CF
Z01-475	2	47 K 1/4W 5% CF	R84,R85	VARIOUS	1/4 W 5 % CF
Z01-476	1	470 K 1/4W 5% CF	R11	VARIOUS	1/4 W 5 % CF
Z01-512	2	51 OHM 1/4W 5% CF	R315,R328	VARIOUS	1/4 W 5 % CF
Z01-514	3	5.1 K 1/4W 5% CF	R18,R112,R212	VARIOUS	1/4 W 5 % CF
Z01-515	1	51 K 1/4W 5% CF	R67	VARIOUS	1/4 W 5 % CF
Z01-563	1	560 OHM 1/4W 5% CF	R66	VARIOUS	1/4 W 5 % CF
Z01-XXX	1	RESISTOR 5%	R54*	VARIOUS	1/4 W 5 % CF
Z02-1003	8	100 OHM 1/4W 1% MF	R74,R81,R82,R86, R104,R111,R204,R211	VARIOUS	1/4 W 1 % MF
Z02-1004	1	1.0 K 1/4W 1% MF	R52	VARIOUS	1/4 W 1 % MF
Z02-1005	11	10.0 K 1/4W 1% MF	R53,R56,R58,R59,R61, R69,R71,R73,R92,R94,R389	VARIOUS	1/4 W 1 % MF
Z02-1212	1	12.1 OHM 1/4W 1% MF	R40	VARIOUS	1/4 W 1 % MF
Z02-1214	1	1.21 K 1/4W 1% MF	R337	VARIOUS	1/4 W 1 % MF
Z02-1407	2	1.40 M 1/4W 1% MF	R353,R364	VARIOUS	1/4W 1%MF
Z02-1504	3	1.50 K 1/4W 1% MF	R64,R314,R327		
Z02-1506	3	150 K 1/4W 1% MF	R51,R306,R325	VARIOUS	1/4 W 1 % MF
Z02-1625	1	16.2 K 1/4W 1% MF	R63		
Z02-2212	2	22.1 OHM 1/4W 1% MF	R347,R360	VARIOUS	1/4 W 1 % MF
Z02-2005	1	20.0 K 1/4W 1% MF	R60		
Z02-2875	2	28.7 K 1/4W 1% MF	R395,R396	VARIOUS	1/4 W 1 % MF
Z02-2207	1	2.2 M 1/4W 1% MF	R57		

Z02-3324	2	3.32 K 1/4W 1% MF	R9,R10	VARIOUS	1/4 W 1 % MF
Z02-3403	2	340 OHM 1/4W 1% MF	R75,R78	VARIOUS	1/4 W 1 % MF
Z02-3925	2	39.2 K 1/4W 1% MF	R345,R357	VARIOUS	1/4 W 1 % MF
Z02-4754	2	4.75 K 1/4W 1% MF	R373,R376	VARIOUS	1/4 W 1 % MF
Z02-4755	2	47.5 K 1/4W 1% MF		VARIOUS	1/4 W 1 % MF
Z02-4992	2	49.9 OHM 1/4W 1% MF	R307,R324	VARIOUS	1/4 W 1 % MF
Z02-5496	4	549 K 1/4W 1% MF	R318,R319,R340,R341	VARIOUS	1/4 W 1 % MF
Z02-6815	2	68.1 K 1/4W 1% MF	R346,R358	VARIOUS	1/4 W 1 % MF
Z02-7154	1	7.15 K 1/4W 1% MF	R93	VARIOUS	1/4 W 1 % MF
Z02-XXXX	17	RESISTOR 1%	R354*,R363*,R374*,R375*,R377*-R387*,R392*,R394*	VARIOUS	1/4 W .1 % MF
Z03-1005	9	10.0 K RN55 1/4W 1% 50 PPM	R15,R27,R28, R316,R330,R333,R339	RCD	MF55C
Z03-1104	1	1.10 K RN55 1/4W 1% 50 PPM	R13	MILITARY	RN55CF
Z03-1215	1	12.1 K 1/4W 1% MF RN55 50PPM	R338	MILITARY	RN55CF
Z03-1335	1	13.3 K 1/4W 1% MF RN55 50 PPM	R88	MILITARY	RN55CF
Z03-1505	1	15.0 K 1/4W 1% MF RN55 50 PPM	R308	MILITARY	RN55CF
Z03-2005	2	20.0 K 1/4W 1% MF RN55 50 PPM	R24,R305	MILITARY	RN55CF
Z03-2874	1	2.87 K 1/4W 1% MF RN55 50 PPM	R303	MILITARY	RN55CF
Z03-3245	1	32.4 K 1/4W 1% MF RN55 50 PPM	R336	MILITARY	RN55CF
Z03-3324	1	3.32 K 1/4W 1% MF RN55 50 PPM	R83	MILITARY	RN55CF
Z03-3326	2	332 K 1/4W 1% MF RN55 50 PPM	R352,R362	MILITARY	RN55CF
Z03-6814	3	6.81 K RN55 1/4W 1% 50 PPM	R23,R90,R350	MILITARY	RN55CF
Z03-6984	1	6.98 K 1/4W 1% MF RN55 50 PPM	R349	MILITARY	RN55CF
Z14-1005	31	10.0 K RN55 0.1% 1/4W 50 PPM	R1*-R8*,R16*,R17*,R19*-R22*, R29*-R32*,R43*-R46*,R109*, R110*,R209*,R210*,R309*, R310*,R322*,R323*,R356*	MSI	
Z14-1825	1	18.2 K 1/4W 0.1% MF 25 OR 50 PPM	R366*		
Z14-1826	4	182 K RN55 0.1% 1/4W 50 PPM	R311*,R326*,R331*,R332*		
Z14-2215	4	22.1 K RN55 0.1% 1/4W 50 PPM	R100,R103,R200,R203		
Z14-2376	1	237 K 1/4W 0.1% MF RN55	R355*		
Z14-3405	8	34 K 1/4W 0.1% MF RN55	R37,R38,R76,R77,R79, R80,R302,R390		
Z14-3654	2	3.65 K RN55 0.1% 1/4W 25PPM	R312*,R335*		
Z14-3925	1	39.2 K 1/4W 0.1% MF RN55	R304		
Z14-4325	1	43.2 K 1/4W 0.1% MF RN55	R367*		
Z14-4994	8	4.99 K RN55 0.1% 25 OR 50 PPM	R34,R35,R36,R47,R49, R50,R397,R398		
Z14-4994	1	4.99 K RN55 0.1% 25 OR 50 PPM	R365*		
Z14-5624	1	5.62 K RN55 1/4W 0.1% 50 PPM	R39		
Z14-9094	2	9.09 K RN55 1/4W 0.1% 50 PPM	R321,R344		

CHAPTER 7 ¾ WARRANTY

7.1 MSI Limited Warranty and Disclaimer

We warrant the equipment sold shall be free from defects in materials and workmanship under normal use and service for a period of three (3) years from the date of delivery when properly installed. Our sole obligation under this warranty shall be limited to repair or replacement, at Our option, of any such part or parts of the product which Our examination shall disclose, to Our satisfaction, to be defective.

If you wish to have warranty services performed at Our facilities, You shall obtain from Us, in advance, permission to return the equipment and shall ship it properly packed with transportation and insurance prepaid. Service performed at Our facilities under this warranty shall include parts plus labor. It is expressly agreed that Our obligation to repair and replace defective parts is Your sole and exclusive remedy.

The warranty to repair or replace defective parts is expressly in lieu of and hereby in disclaimer of all other express warranties, and is in lieu of and in disclaimer and exclusion of any implied warranties of merchantability, fitness for a particular purpose, as well as all other implied warranties, in law or in equity, and of all obligations or liability on our part. There are no warranties that extend beyond the description hereof.

Our liability does not include any labor charges for replacement of parts, adjustments, repairs, or any other work done outside our factory unless we authorize such work in writing. Our obligation to repair or replace shall not apply to any equipment which shall have been repaired or altered outside Our factory in any way, subjected to negligence, misuse, unauthorized alteration or abuse, or damaged in transit.

OUR LIABILITY HEREUNDER SHALL NOT INCLUDE LOSSES OF ANTCIPATED PROFITS OR SPECIAL INCIDENTAL OR CONSEQUENTIAL DAMAGES.

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7.2 Summary of Modulation Sciences, Inc. Standard Warranty

Note: This is not the warranty. It is a summary of MSI's standard warranty and a description of how to obtain warranty service. The current, actual warranty is printed in its entirety on Page 59 and supersedes warranty information which may be found elsewhere.

7.2.1 Who receives warranty protection?

Modulation Sciences' standard warranty protects the original end-user purchaser of record, but does not apply to subsequent owners.

7.2.2 What does the warranty cover?

Modulation Sciences agrees to repair or replace, at its expense, any unit which has a defect in materials or workmanship for a period of three (3) years after the date of sale to the original end-user purchaser. This warranty includes all parts, labor, calibration, and packing.

7.2.3 What doesn't the warranty cover?

MSI's warranty does not cover:

1. Freight and insurance charges paid by the purchaser in returning the unit for repair.
2. Defects which result from modifications or repairs to the unit neither made by nor authorized in writing by Modulation Sciences, Inc.
3. Compensation for incidental or consequential damages resulting from any defect.
4. Trivial or cosmetic defects which do not affect the unit's ability to function normally.

7.2.4 How is the warranty period computed?

The warranty period begins on the date of delivery to the original end-user purchaser and is in effect for the next three years. The starting date is deemed to be the date on the invoice from Modulation Sciences, its agent, dealer, or distributor to the first end-user purchaser. Do not lose your invoice. It is your way of establishing that your warranty is still in effect.

7.2.5 What if the unit cannot be repaired?

If Modulation Sciences decides not to repair or replace a given unit, Modulation Sciences agrees to refund to the first end-user purchaser its full purchase price. Payment of that amount will end MSI's responsibilities and Modulation Sciences may keep the unit.

7.2.6 How is warranty service obtained?

To claim your rights under this warranty:

1. Contact the dealer or distributor from whom this product was purchased. Describe the problem and ask if there is an easy solution.

2. If your dealer cannot help, contact Modulation Sciences' service department at (732) 302-3090 or (800) 826-2603 and explain the problem. If that unit requires factory service, you will be given a return authorization number.

3. When you have your return authorization number, you may return the unit. Pack it carefully for shipment, preferably using the original shipping carton and packing materials. **Assume that the box will be dropped several times during shipment. Use UPS or some other private carrier that you know to be reliable. Do not use the Postal Service.** The risk of loss is yours. Modulation Sciences will not be responsible for damage or loss until the package is received by Modulation Sciences. ***Insure the unit for its full replacement value. Ship the unit prepaid to the address specified when you receive your return authorization and be sure to enclose a note giving the following information:***

    - Your company name and shipping address (not a post office box).
    - Your return authorization number.
    - A copy of your original invoice establishing the starting date of your warranty.
    - As full a description as possible of the problem(s).

Appendix A

Alternative Bessel Null Procedures

Alternative procedures exist for doing the critical Bessel null alignment of the SRD-1 to the RF demodulator. These procedures are desirable when an RF spectrum analyzer is not available.

Do not attempt to use a modulation monitor, even one designed for BTSC stereo, to set decoder sensitivity. No modulation monitor is as accurate as the Bessel null procedure.

You will need a stable, low-distortion audio oscillator that can be set to 10,396 Hz and remain exactly on frequency for the duration of the test. The most convenient source of an accurate, low-distortion 10,396 Hz tone is a Tektronix 1405 Sideband Adaptor. It includes a crystal-controlled tone source and a ten-turn attenuator. An accurate counter is necessary to set and verify the frequency.

Using an RF spectrum analyzer to indicate carrier null is a classic case of overkill. We specify it in the setup because of its almost universal availability; however, a narrowband communications receiver can be quicker and more convenient.

The simplest setup is to detect the 4.5 MHz aural IF from a demodulator by using a communications receiver. Most precision video demodulators, such as our **msi 320**, provide a stable 4.5 MHz aural IF. The IF of a pre-MTS monaural aural modulation monitor can also be coupled to a communications receiver. The IF frequencies range from 1 MHz to 10.7 MHz, depending on the make and model of the monitor. Using the CW or SSB bandwidth (300 Hz to 2.5 kHz), center the unmodulated aural carrier in the communications receiver's IF bandpass. The receiver's "S" meter provides an accurate wide-range indication of the first carrier null when ±25 kHz deviation (100% modulation) is reached.

A wide variety of communications receivers is available to do the Bessel null adjustments. The general requirements are that they be well shielded, have a good RF/IF dynamic range, be stable, and have a narrow enough IF bandwidth to accurately resolve sidebands 10 kHz apart. At Modulation Sciences, we use a Collins R390/R391 receiver, vintage 1955. It's big, heavy, and uses lots of vacuum tubes, but it is very stable, well shielded, and costs about one percent of what a modern RF spectrum analyzer costs. Check with local radio amateurs when obtaining such receivers. They often know where bargains exist.

An alternative approach is to use a VHF/UHF receiver made by Yaesu or ICOM. Covering 60 MHz to about 1 GHz directly, they have a minimum IF bandwidth of 2.4 kHz. They appear to be compact, stable, and inexpensive. Although we have not actually checked out these receivers as of this writing, they appear to be an ideal stand-alone solution to Bessel null indication. Their cost is a small percentage of the cost of a spectrum analyzer.

Appendix B

RF Demodulators

Television aural demodulators — devices for converting RF into wideband composite audio suitable for driving the SRD-1 — fall into two categories: precision TV demodulators, such as our **msi 320**, that have a wideband aural output, and laboratory-type wide range demodulators, such as the Hewlett-Packard 8901A/B.

Precision TV Demodulators

The precision TV demodulators, such as the **msi 320**, are the ideal solution to providing an accurate wideband composite signal for the SRD-1. They operate correctly in the presence of visual RF energy — no mean feat when you consider the interference into the aural signal from the color subcarrier energy at 3.58 MHz above the visual carrier.

Most precision demodulators also provide the means to measure ICPM, an important routine measurement if sync buzz is to be kept out of the stereo and SAP signals.

Laboratory Demodulators

Laboratory-type demodulators are impressive instruments. They often cover the range from less than 100 kHz to more than 1 GHz and can demodulate AM, FM, and PM (amplitude, frequency and phase modulation). Many also provide an accurate indication of the signal's parameters. The H-P 8901A/B is a good example of such an instrument. Most are capable of excellent stereo TV performance.

The laboratory demodulators are also very useful for troubleshooting. They can demodulate an FM carrier at any frequency and display an accurate value of deviation. This is especially important when tracing FM noise in a transmitter that does one or more heterodyne conversions to translate the aural signal from its FMO (frequency modulated oscillator) frequency to being "on-channel." Demodulators such as the H-P 8901A/B may often be rented at a rational cost from equipment rental firms for periods as short as ten days.

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Appendix C

Measuring Separation

Many techniques exist for measuring and displaying stereo separation. This appendix deals with methods and equipment common to broadcasting. However, it should not be considered as an exhaustive discussion of the subject.

The simplest method for measuring separation is with an oscillator and an AC voltmeter. This is illustrated in Figure 4-1, page 31 of this manual.

This technique is limited because it displays the separation for only one frequency at a time. The points must be plotted on graph paper in order to view response across a range of frequencies. The resolution is a function of the number of points plotted. If you want to view the impact of an adjustment on overall separation, this can become an exceedingly tedious procedure. For each adjustment, all the points need to be plotted. The complete procedure must be repeated for each adjustment.

The limitations of this method are especially serious when measuring BTSC mode separation. Most of the adjustments — composite gain, L-R level and pilot phase — change the shape of the separation curve as well as its amplitude. Therefore, it is possible to obtain fabulous separation at any single frequency at the expense of performance over the rest of the band. It is difficult to find the best compromise adjustments when separation can be viewed at only one frequency at a time.

The best methods for displaying separation are those that fall into the broad classification of “real time.” “Real time” means making a series of measurements over the entire frequency range rapidly enough that the effect of an adjustment appears at all frequencies nearly immediately. In some cases, it really is a series of discrete tones at 25 or more points distributed logarithmically over the audio spectrum. Other instruments generate a continuous sweep tone over the audio range and track it with a narrow filter.

The Audio Precision System One and Two are examples of the first type of analyzer. These instruments can generate a 270 millisecond burst of multitone audio test signal. Separation (“crosstalk”) measurements are displayed on the CRT screen. Due to the short duration of the test signal, stereo separation may be checked during the regular broadcast day.

The second type of analyzer features a continuous scan with a tracking filter. A Tektronix 7L5 low-frequency spectrum analyzer with tracking generator is a good example of this type of instrument. The H-P 3585A/B is another.

This approach provides a true continuous display of separation, although its actual resolution is limited by the bandwidth of its filters and the speed of the sweep.

The Audio Precision System One and Two also feature an audio measurement system that is a hybrid of both types of analyzers discussed above. The sweep tone consists of a large number of discrete frequencies. There are enough frequency steps so that the sweep appears to be continuous. The sweep is tracked with a filter that is about one-third of an octave wide. This is much wider than the filter in a spectrum analyzer but narrow enough to remove much of the impact of wideband noise and hum from the measurement.

Appendix D

Obtaining Clean Level Indication

This appendix deals with the problem of not getting clean input level indications on the SRD-1. The indications are not clean if both LEDs go on and off together or if either one flashes randomly.

If this problem is encountered in your SRD-1, please refer to Chapter 3 of the Modulation Sciences STV-784 manual or to your stereo generator's manual.

1. To reduce the possibility of hum pickup between the demodulator and the SRD-1, mount the SRD-1 adjacent to the demodulator. Power them from the same AC outlet. This is also a good time to review the setup of the demodulator for lowest noise aural operation. Follow the manufacturer's instructions for correct demodulator setup.

2. Measure the wideband signal-to-noise ratio. Modulate the transmitter with a 400 Hz tone at ±25 kHz deviation. Use the station's existing monaural modulation monitor to establish the ±25 kHz (100%) level. Measure the signal at the wideband output of the demodulator. Remove all modulation from the wideband input of the exciter and measure the noise at the demodulator's wideband output. The noise should be greater than 50 dB below ±25 kHz deviation. If it is not, the nature of the noise should be examined by using an oscilloscope. Typically, the noise will be hum, sync buzz, or wideband noise. If the visual carrier is on, it may be chroma information. Line lock the sync of the oscilloscope. If the signals remain stationary on the CRT, they are power line related. If they move slowly, chances are they are video related. If the scope can be locked to house sync, any video-related components should remain fixed and power line-related noise should drift.

    a) If the noise is hum, look at the wideband input to the exciter, especially if it is a retrofit of an older exciter. Ground loops are common.

    b) Another possibility is mechanical vibration of the exciter's frequency modulated oscillator (FMO). If the transmitter is IF modulated and/or UHF, do not ignore the possibility that the hum or noise may be introduced by the oscillator that heterodynes the aural signal to the carrier frequency.

    c) If the noise floor is sync buzz, the most likely problem is in the demodulator — probably incorrect setup. Turning off the visual transmitter should provide a good deal of information.

d) A wideband noise floor is most likely from a noisy heterodyne oscillator. The most useful piece of test gear for hunting down such a problem is an H-P-8901A/B demodulator, since it can measure absolute FM deviation of a few Hertz on any frequency from 100 kHz to 1 GHz.

3. If the wideband signal-to-noise ratio is okay, reconnect the SRD-1 to the wideband output. Place the SRD-1 in EQUIV L/R mode with de-emphasis on. Apply 400 Hz modulation at ±25 kHz deviation (100% modulation) to the wideband input of the exciter.

4. Measure the level at the left or right output of the SRD-1. Remove the modulation and measure the noise floor. It should be greater than 50 dB below the 400 Hz tone. If not, there is almost certainly a ground loop between the demodulator and the SRD-1. Do not overlook the possibility of RF pickup by the cable between the demodulator and the SRD-1. The use of foil-shielded CATV grade coax (100% coverage) is the best way to avoid any problem.

5. Next, reconnect the oscillator to the wideband input of the exciter and adjust for the first Bessel null with tone modulation at exactly 10,396 Hz as explained in Appendix A. Use a conventional distortion analyzer such as an H-P 334 to null out the modulating frequency. Use the scope output to observe the residual output on a scope.

6 Try to identify the components of the noise floor. If it is line-related hum, there is probably a ground loop between the oscillator and the wideband exciter input. Standard cures for a ground loop include plugging the ocscillator into the same AC outlet as the exciter, floating the AC ground pin of the oscillator, or floating or grounding the low side of the oscillator output. The most effective solution is to balance the output of the oscillator by using a good quality, well-shielded 1:1 audio transformer. A Western Electric 111C repeat coil, found in old style Telco line equalizers, is excellent for this purpose. Using a transformer is especially useful if the exciter wideband input is balanced or quasi-balanced.

7. If the noise is sync buzz or random, look for RF leaking into the test setup.

8. If the noise floor appears to be of some discrete frequency but is not coming from an obvious source, consider that it may be related to the AFC of the aural exciter. Many exciters allow you to shut down the AFC and adjust their frequency manually. Try this (at low power!), using the monitor’s frequency meter to adjust the frequency to within a few kHz of the normal carrier

frequency. If the problem disappears, it is in the AFC and you need to speak to an expert on your exciter.

If none of these efforts seem to help, gather up your notes and call us at (800) 826-2603 or (732) 302-3090. By knowing the details of your situation, we can make some specific suggestions.

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Appendix E

Video Sync Quality and Its Impact on BTSC Stereo

The Problem

BTSC stereo demands nearly perfect sync. If the BTSC stereo generator is being driven by **exactly** the same composite video that is modulating the transmitter, sync rarely causes a problem. If the sync driving the stereo generator is derived from a non-broadcast source or is regenerated before modulating the transmitter, difficulties can arise.

Frequently, non-broadcast sync is encountered during demonstrations and bench testing.

Symptoms

SRD-1 symptoms resulting from nonstandard sync are:

1. Flashing of the green STEREO indicator.

2. Failure of the green STEREO indicator to come on at all, even though stereo is being transmitted.

3. Apparent motion of the stereo image that is unrelated to the program material ("platform motion").

4. Buzz beats audible on intercarrier stereo receivers. The buzz beat is a sync buzz sound that rises and falls in amplitude as the sync and the 1H stereo pilot process about each other. This condition can only be avoided when video sync and the 1H stereo pilot are identical in frequency and have an unvarying phase relationship.

Note that the first two symptoms can also be caused by incorrect composite level setting. Be sure to check the composite level by using the 10,396 Hz Bessel null procedure.

On-Air Operation

The primary rule for avoiding sync problems in on-air operation is:

> Drive the stereo generator with EXACTLY the same composite video that modulates the transmitter.

A frame store or sync regenerating proc amp anywhere between the transmitter video input and the stereo generator will cause problems. This situation can easily be avoided when the stereo generator is located at the transmitter plant.

Composite stereo aural STLs create a special problem. With the stereo generator located at the studio, the best composite video available is the signal modulating the visual portion of the STL. Difficulties arise at the receiver end of the STL. Here, conditions often dictate using a sync regenerating proc amp or a frame store on the video output of the STL. Such sync regeneration virtually guarantees that sooner or later there will be buzz beats on the air.

In some cases, this consideration has prevented the use of a composite STL and has caused the station to choose discrete Left and Right channels for the STL. The potential for buzz beats should always be considered when evaluating a composite STL versus a discrete STL.

Be sure that the sync being broadcast is full NTSC.

This seems to be less of a problem for full-power VHF and UHF stations than for LPTV stations, translators, and cable operations. Modern consumer television receivers are incredibly tolerant of sync that is off frequency, full of jitter, and not even of standard waveform. BTSC stereo is not so tolerant. With BTSC stereo, avoid substandard sync.

Bench Testing and Demos

Many bizarre sync problems are encountered during bench testing and closed circuit demonstrations.

The composite video from 1”, ¾ and ½ machines should never be relied upon to sync lock a BTSC stereo system. The jitter and waveform variations are too great. A professional grade time base corrector (TBC) is needed with almost any videotape machine. The TBC must produce correct H sync ±1 Hertz and it must provide the full NTSC waveform.

Any sync generator must be on frequency and in good repair. It also must be full NTSC. Check the stand-alone frequency of the house sync generator regularly. Because genlock operation is so common, an error of several Hertz in the stand-alone frequency of the house sync generator might go unnoticed.

Summary

To avoid demodulation problems in BTSC stereo operation, the sync for the composite video that locks the stereo generator must be: full NTSC, jitter-free, with the correct color burst frequency. In addition, it must be exactly the same sync as that used to modulate the transmitter.

Appendix F

Gibson Tables and Diagrams

The following pages contain the Gibson tables. Block and schematic diagrams follow the Gibson tables and may be found in the back of the manual.