Technical Reference Guide for the 2710 Normalizations

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ABSTRACT

The 2710 uses a set of software functions called "normalizations" to insure that the instrument meets various controllable specifications at all operating conditions. This document describes the exact operation of each normalization function as it is implemented. This manual applies to firmware version 09-16-88 and later.

John Turpin | *Document Approval*

Revision History

Nov 27, 1989

Added tracking generator normalizations.

May 18, 1989:

Changed error messages for bandwidth normalization.

April 14, 1989:

Added descriptions, appendix, etc, for bandwidth normalizations. Also changed menu escape terminator displays to new format.

November 8, 1988:

Attached standard header to existing document.

December 14, 1989:

Added Tracking Generator normalizations.

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Technical Reference Guide for the 2710 Normalizations

1. Introduction

This document describes the normalization functions in detail. The purpose of these descriptions is to educate the technical user as to the exact operation of these functions, as an aid to troubleshooting the instrument hardware and as a source of general information about this section of the instrument firmware. This manual applies to firmware version 04-06-89 and later.

This manual includes the following materials:

- A general overview of normalizations.
- Two operation guides, one for general use, one for using the normalizations as a troubleshooting tool.
- Specific descriptions of all normalizations.
- An appendix which lists all normalization values, their location in the menu system and on screen, and their maximum and minimum allowable values.
- An appendix which enumerates and details every debug-style message the normalizations can produce.

2. General Normalization Overview

The instrument contains a variety of adjustments which are designed to fine tune the instrument. This fine tuning allows the instrument to be built with lower cost, readily available components. The instrument is adjusted at the factory, and will "hold" its specifications within a certain degree over a variety of operating conditions.

The normalizations perform a similar function. The adjustment portion of the circuitry can be eliminated entirely in some cases, reducing the total instrument cost. All parameters are adjusted in the environment at which the instrument is used, eliminating drift due to temperature and time.

The term "normalization" comes from the intent of the functions to make a parameter normal with respect to a reference external to the instrument, or with respect to a normalized reference within the instrument.

2.1 Types of Normalizations

There are several kinds of normalizations:

- Reference Normalizations measure the instrument's internal reference sources against user-supplied reference sources. These include the calibrator frequency and amplitude, and a gain reference.
- Amplitude Normalizations measure all parameters related to the vertical screen axis.
- Frequency Normalizations measure all parameters related to the horizontal screen axis.

- Tracking Generator Normalizations measure all parameters related to the tracking generator.

A specific normalization may also be placed into one of two categories.

The first is an Applied Result normalization, where the normalization result is used to set the hardware differently than it would if the instrument was perfectly aligned at all temperatures.

For example:

> When the preamp is turned on, the signals being viewed on screen should not vary in amplitude. Without normalizing, the firmware assumes the preamp gain to be +20 dBm. Since there is no adjustment for the preamp gain, and the preamp gain is not exactly +20 dBm, the VR gain must be set differently to compensate for the deviation. The preamp gain normalization tells the firmware how much to deviate.

The second category is a Measurement Only type of normalization, which only measures a particular parameter for use in future calculations.

For example:

> When a carrier-to-noise measurement is being made, the level of the analyzer's noise floor must be known. The sensitivity normalization produces this figure. Note that no hardware setting must be modified as a result of this normalization.

2.2 How the Normalization Values are Used

The normalization values are used by the regular operating firmware to set various portions of the instrument properly. The exact gain of the VR module, for example, is set to a more accurate gain setting by placing a different number into an adjusting DAC on the VR module.

2.3 Acquiring, Defaulting, and Recalling Values

When the instrument is powered up for the first time, all normalization values are in a defaulted state. These default values are a "best guess" estimate of what the instrument should need. Most of the gain parameters are set to zero, indicating perfect alignment, and the frequency parameters are set to nominal values. Performing the normalizations installs new values into NVRAM, which reflect all gain and frequency errors which the instrument must correct for.

When a normalization passes, the new values are installed in NVRAM. When a normalization fails, the previous value is retained, whether that value was a default value or a previously passed normalization value.

The normalization values may be defaulted by accessing the appropriate service menu. All values for a specific normalization are defaulted at once,and may be recalled by the use of the same menu. This menu also allows execution of a specific normalization.

2.4 Summary Messages

When any normalization is executed, defaulted, or recalled, the firmware makes a determination as to the condition of the normalized values. This information is summarized in a few lines in the normalization menus. These messages are displayed in the normalization menu (**[UTIL] [3]**).

Two pieces of information are displayed for each of the three types of normalization:

- Pass/Fail/Not_Tested -- This part of the message indicates whether or not the normalizations have been executed successfully.
- Default -- This indicator appears when any of the normalizations in the category contain default values.

The following diagram shows the format of the messages:

```
!                                     !
!FRQ PPPPPPPP, DDDDDD VALUES USED!
!REF PPPPPPPP, DDDDDD VALUES USED!
!AMP PPPPPPPP, DDDDDD VALUES USED!
!TG  PPPPPPPP, DDDDDD VALUES USED!
!                                     !

"PPPPPPPP" = Either "PASS", "FAIL", or "NOT DONE".
     "DDDDDD"   = Either "DEFLT" or "NRMLZD".
```

The precedence of the pass/fail/not_tested message is as follows:

- If any normalizations in the category have failed, use "FAILED", even if some are not tested.
- If none have failed, but some are not tested, use "NOT TESTED".
- If all have been tested and all pass, use "PASS".

2.5 Measurement Devices

There are two major measurement devices in the 2710 which are used by the normalizations. These devices are used to acquire information about the hardware, such as the current beat note frequency or the amplitude of a signal. These major devices are the internal frequency counter and the digital storage accumulator.

Several minor devices are used in conjunction with the major devices. These are all parts of the instrument which have previously been measured, and are used as references for other measurements. For example, the gain steps are used to measure the VR filter levels, and the calibrator frequency is used as a time base for all frequency counting.

2.5.1 Internal Frequency Counter

The internal frequency counter is used by the processor system to monitor several internal frequencies. This counter has three inputs, one of which is used during the normalizations. This input is used to count the beat frequency or the VCO frequency (B020319 and up) while normalizing all of the frequency-related parameters.

2.5.2 Display Storage Accumulator

The display storage accumulator is used exclusively for amplitude- related measurements. This device operates in one of two modes:

- The accumulator may be read directly if a fast measurement is required. This requires that the signal of interest is in the same position horizontally on screen as the sweep position. Usually the signal is identified and centered through other means, then the instrument is placed in zero span.

- The accumulator may also be read by simply sweeping the screen and reading the result from the proper location in display storage memory. This requires searching through memory for the highest (or other) point on a signal, but does not require that the signal be as stable as the direct accumulator reading method.

2.5.3 Normalization Values

Many of the normalization values are used to aid in normalizing other parameters. The reference normalization values are always used, except when they themselves are normalized. **If the normalizations are executed out of order, the resultant values cannot be guaranteed.** The detailed descriptions define which normalization values are dependent on which others.

3. General Operations

In most cases, the normalization values being used by the 2710 will be correct for all measurements. The instrument must be re-normalized under the following conditions:

- After the instrument is built.
- After NVRAM is corrupted or erased.
- When the operating conditions (primarily temperature) change significantly.
- After an extended period of time since the last normalization.

In general, whenever the instrument's optimum accuracy is required, the appropriate normalization must be performed. For example, if highly accurate amplitude measurements are required, the amplitude normalizations should be performed prior to making measurements.

3.1 User Accessed Normalization Operation

The normalizations are invoked by pressing **[UTIL] [3] [#]**, where **[#]** may be **0** (for ALL NORMALIZATIONS), **1** (for FREQUENCY ONLY), **2** (for AMPLITUDE ONLY), or **3** (for TRACKING GENERATOR ONLY). The normalizations may also be invoked individually through **[UTIL] [5] [5] [#]**, where **[#]** is a sequence of keystrokes for selecting the specific normalization.

3.2 Service Normalizations

There are three normalizations which normalize the internal references with respect to externally applied reference signals. These normalizations are accessed by **[UTIL] [5] [5] [#]**, where **[#]** represents the selection for the reference normalization in question.

3.2.1 Gain Step Normalization

A 100 MHz signal and an external attenuator are used for this normalization. The required level for the signal is stated in the on-screen instructions. If the signal is near the limit of the stated range, the normalization may still fail to operate. In this case, adjust the level of the signal source to bring it farther inside the required tolerances.

3.2.2 Reference Frequency Normalization

A Frequency reference which is easily countable by the instrument is used for this normalization. A signal of any countable frequency and level is connected to the RF input and brought to center screen in a reasonable span and resolution setting.

It should be verified that the instrument can count the signal before proceeding. The exact frequency of the external reference used must be entered (This is NOT the frequency which the instrument has just counted, as that frequency is based on an unnormalized reference). The reference frequency normalization is then invoked, which measures the signal and applies a normalization value for the internal frequency reference.

3.2.3 Reference Amplitude Normalization

A monotonic, 100 MHz signal source is connected to the RF input for this test. The signal must be within 1 MHz of 100 MHz, and the level of the signal must be -30 dBm +/- .1 dB. When the signal is connected, the normalization is invoked and the firmware measures the internal reference amplitude based on the externally-applied reference.

3.3 Order of Normalizations

Since most normalizations are dependent on others, the normalizations must be executed in a specific order. The order of normalization follows for various instrument types and conditions:

- Standard (without NVRAM) instruments:
  - For instruments from B010001 to B010318:

    lll. 1. **[UTIL] [5] [5] [1] [0]** *(Gain step reference) 2. **[UTIL] [5] [5] [1] [1]** *(Reference Frequency) 3. **[UTIL] [5] [5] [1] [2]** *(Reference Amplitude) 4. **[UTIL] [3] [0]**(All Normalizations) 5. **[UTIL] [3] [3]**(Tracking Generator Normalizations)

    * - For full EIS compliance, the steps marked as such must be followed after EACH instrument powerup.

  - For B020319 and up:

    lll. 1. **[UTIL] [3] [1]**(Frequency Normalizations) 2. **[UTIL] [5] [5] [1] [0]** *(Gain step reference) 3. **[UTIL] [5] [5] [1] [1]** *(Reference Frequency) 4. **[UTIL] [5] [5] [1] [2]** *(Reference Amplitude) 5. **[UTIL] [3] [0]**(All Normalizations) 6. **[UTIL] [3] [3]**(Tracking Generator Normalizations)

    * - For full EIS compliance, the steps marked as such must be followed after EACH instrument powerup.

- First time after NVRAM corrupted or with a new display storage board, option 11 installed:
  - For instruments from B010001 to B010318:

    lll. 1. **[UTIL] [5] [5] [1] [0]**(Gain step reference) 2. **[UTIL] [5] [5] [1] [1]**(Reference Frequency) 3. **[UTIL] [5] [5] [1] [2]**(Reference Amplitude) 4. **[UTIL] [3] [0]**(All Normalizations) 5. **[UTIL] [3] [3]**(Tracking Generator Normalizations)

  - For B020319 and up:

    lll. 1. **[UTIL] [3] [1]** (Frequency Normalizations) 2. **[UTIL] [5] [5] [1] [0]**(Gain step reference) 3. **[UTIL] [5] [5] [1] [1]**(Reference Frequency)

4. **[UTIL]** [5] [5] [1] [2](Reference Amplitude) 5. **[UTIL] [3] [0]** (All Normalizations) 6. **[UTIL] [3] [3]**(Tracking Generator Normalizations)

- All other times :

  - For instruments from B010001 to B010318:

    lll. 1. **[UTIL] [3] [0]**(All Normalizations) or **[UTIL] [3] [1]**(Frequency Normalizations) or **[UTIL] [3] [2]**(Amplitude Normalizations) or **[UTIL] [3] [3]**(Tracking Generator Normalizations)

  - For B020319 and up:

    lll. 1. **[UTIL] [3] [0]**(All Normalizations) or **[UTIL] [3] [1]**(Frequency Normalizations) or **[UTIL] [3] [2]**(Amplitude Normalizations) or **[UTIL] [3] [3]**(Tracking Generator Normalizations)

4. Advanced Operations on Normalizations

There are several advanced operations which can be performed on with normalizations. These operations are typically used only for troubleshooting the instrument itself, and are not a normal part of the 2710's operation. The normalizations can be individually set to default values, and conversely set back (recalled) to the most recent normalized values. Each normalization can also be executed by itself to help locate a specific failure in the instrument.

4.1 Defaulting, Recalling, And Executing

To perform an advanced operation on a normalization or group of normalizations, select **[UTIL] [5] [5]** [#] , where [#] is a sequence of keystrokes which selects the appropriate normalization to default, recall, or execute.

> NOTE: The default and recall functions for the service normalizations (**[UTIL] [5] [5] [1] [0]**, **[UTIL] [5] [5] [1] [1]**, and **[UTIL] [5]** [5] [1] [2]) **are accessed by selecting "CONNECTED, MEASURE" and then either [B] or [C].**

When defaulting normalization values, it is important to remember that other normalizations are dependent on the defaulted values, and any new normalization may be somewhat invalid by the defaulting action. For Example:

> Step 1: Normalize everything (no defaulted values)
> Step 2: Default GAIN AND ATTENUATION normalization values.
> Step 3: Execute VR FILTER AMPLITUDE normalization
> After step 3, the vr filters will have normalized values, but those values may be incorrect to some degree, since the vr gain steps are used to measure the vr filter amplitudes.

When executing normalizations individually, full accuracy can only be achieved by performing the individual normalizations in the specified order. This order is described later in this document.

4.2 Extracting Debug Information

As the normalizations execute, several types of debug (troubleshooting) information can be extracted. Each message which can be printed by the normalizations is detailed in appendix 2. This information can be used to get a better insight as to why a particular normalization fails at a given time.

4.2.1 CAL DEBUG messages

To enable the cal debug messages, use **[UTIL] [5] [3] [6], then [8]** as many times as necessary to select the device where the messages will be sent. If the debug display is selected, the messages can be viewed only after normalizations have completed. The printer and/or RS232 ports can only be selected when an option 09 (digital options) board is installed.

5. Detailed Normalization Descriptions.

The following descriptions contain the exact procedure the firmware follows when executing a particular normalization. Some general notes about the descriptions:

- The **DEPENDENCIES** section details which normalization(s) must be executed first to insure maximum accuracy. In some cases, failure to execute the dependent normalizations will cause the normalization in question to fail.
- The **OPERATION** section details the steps which the firmware follows when executing that particular normalization. Some of the steps cannot be followed by any manipulation from the front panel. These procedures are included for the person who is troubleshooting a normalization-related problem, and must know what operations the firmware uses.
- Any setting change made by the normalizations is the same as a direct entry from the front panel, except where noted.
- Some subroutines are called at various points in the normalizations, and are described under the section "Normalization Subroutines". These are refered to in the decription in all capital letters, surrounded by an underscore, as in "_VERT_ADJ_".

5.1 MAIN DAC OFFSET

MAIN DAC OFFSET finds the value to place into the main DAC to get zero MHz Center Frequency. This value is used in conjunction with the *MAIN DAC SENS* to get the main DAC value for any center frequency:

center; rl. DACVAL = OFFSET + CF/SENS where DACVAL = Main DAC value OFFSET = MAIN DAC OFFSET CF = Desired Center Frequency SENS = MAIN DAC SENS

VALUES UPDATED

The single value Main DAC Offset is updated

DEPENDENCIES

Dependent upon:

- *INTERNAL REF FREQ*
- *UPPER VCO SENS*

OPERATION

INITIAL SETTINGS

5 MHz Resolution
0 MHz Center Frequency
100 MHz Span/div
+20 dBm Reference Level
Single Sweep ON
50 dB RF Attenuation

PROCEDURE

- Beginning with span set to 125 MHz/div, then 5 and 1 MHz/div, center the signal by changing the main DAC and sweeping the signal. Degauss the YIG at each new DAC setting, and set resolution to 500 KHz when the span is less than 5 MHz/div. This leaves the start spur set to near center screen in 1 MHz/div. If the signal cannot be centered with the Main DAC after 5 tries, message **E01** is generated.
- Set the instrument to zero span by setting the span DAC to 0.
- Decide on a beat frequency to look for when the start spur is centered. For B020319 and up, this is 5 MHz when the strobe frequency is 2105 MHz. For instruments from B010001 to B010318, this is always 10 MHz.
- Count the beat frequency to get an initial count. If the signal cannot be counted, generate message **E02.**
- Set the main DAC such that the desired beat frequency is counted. If the Main DAC cannot be set low enough, generate message **E03.** If the frequency cannot be counted, generate message **E04.**
- Main DAC Offset is equal to the last main DAC value used. If this value is outside of allowable limits, generate message **E05.**

5.2 MAIN DAC SENS (instruments from B010001 to B010318)

MAIN DAC SENS measures the sensitivity of the main DAC, in Hz/step. This value is used in conjunction with the *MAIN DAC OFFSET* to get the main DAC value for any center frequency.

VALUES UPDATED

The values Main DAC Sensitivity, Main DAC Offset, and a value representing the ratio of the FM DAC to the main DAC are updated

DEPENDENCIES

Dependent upon:

- *INTERNAL REF FREQ*
- *MAIN DAC OFFSET*

OPERATION

INITIAL SETTINGS

Single Sweep ON
Zero Span

PROCEDURE

- Set the FM DAC to 2047 (Center Range)
- Degauss The YIG
- Set the Main DAC to Main DAC Offset (Approx 0 MHz center frequency).
- Count the beat frequency. If an error occurs during counting, generate message **E01.**
- Using only the main DAC, attempt to set the CF to the following frequencies: 5, 100, 200, 400, 600, 800, 1000, 1200, 1400, 1600, and 1800 MHz.
- For each of the above frequencies, count the beat frequency, calculate the center frequency change, and then calculate a better estimation of the main DAC sensitivity. If an error occurs during counting the beat frequency at any center frequency, generate message **E02.** If the main DAC cannot be set high enough (required value is > 4095), generate message **E03.** If the main DAC cannot be set low enough (required value is < 1), generate message **E04.**
- The latest calculated sensitivity is the overall main DAC sensitivity. If this result is outside allowable limits, genrate message **E05.**
- Set the center frequency to 900 MHz. Since the YIG is not always linear, the main DAC offset value should be updated to help lower the maximum frequency error.
- Degauss the YIG

- Count the beat frequency. If this cannot be done, generate message **E06.**
- The difference between the beat frequency and 10 MHz is the error in centrer frequency at 900 MHz center frequency. Split this difference and adjust the main DAC offset to compensate for it.
- Since the main DAC sensitivity figure may have changed, calculate the ratio of the FM DAC to the main DAC.

5.3 MAIN DAC SENS (B020319 and up)

MAIN DAC SENS measures the sensitivity of the main DAC, in Hz/step. This value is used in conjunction with the *MAIN DAC OFFSET* to get the main DAC value for any center frequency.

VALUES UPDATED

The values Main DAC Sensitivity, Main DAC Offset, and a value representing the ratio of the FM DAC to the main DAC are updated

DEPENDENCIES

Dependent upon:

- *INTERNAL REF FREQ*
- *UPPER VCO SENS*
- *MAIN DAC OFFSET*

OPERATION

INITIAL SETTINGS

Single Sweep ON
Zero Span

PROCEDURE

- Set the FM DAC to 2047 (Center Range).
- Set the main DAC to Main DAC Offset (0 MHz center frequency)
- Measure the YIG frequency (see _MSR_YIG_FREQ_). If this cannot be done, generate message **E01.**
- Set the main DAC to 80% of its range.
- Measure the YIG frequency (see _MSR_YIG_FREQ_). If this cannot be done, generate message **E02.**
- Calculate what DAC value will be required for a center frequency of 1800 MHz. If this value is greater than 4095, generate message **E03.**
- Set the main DAC to produce what should be 1800 MHz center frequency.
- Measure the YIG frequency (see _MSR_YIG_FREQ_). If this cannot be done, generate message **E04.**
- Calculate the main DAC sensitivity. If this value is outside allowable limits, generate message **E05.**
- Set the center frequency to 900 MHz. Since the YIG is not always linear, the main DAC offset value should be updated to help lower the maximum frequency error.
- Degauss the YIG
- Count the yig frequency (see _MSR_YIG_FREQ_). If this cannot be done, generate message **E06.**

- The difference between the YIG frequency and 3010 MHz is the error in center frequency at 900 MHz center frequency. Split this difference and adjust the main DAC offset to compensate for it.
- Since the main DAC sensitivity figure may have changed, calculate the ratio of the FM DAC to the main DAC.

5.4 FM DAC SENS

FM DAC SENS measures the sensitivity of the FM DAC, in Hz/step. This value is used to determine a new FM DAC value when the YIG's FM coil is being moved in small steps.

VALUES UPDATED

The value FM DAC Sensitivity is updated, as well as a value representing the ratio of the FM DAC to the main DAC.

DEPENDENCIES

Dependent upon:

- *INTERNAL REF FREQ*
- *UPPER VCO SENS* (B020319 and up)
- *MAIN DAC OFFSET*
- *MAIN DAC SENS*

OPERATION

INITIAL SETTINGS

100 MHz Center Frequency
Single Sweep ON
5 MHz Resolution Bandwidth
Zero Span (By setting the span DAC to Zero)

PROCEDURE

- For B020319 and up, set the strobe frequency such that the beat frequency is 5 MHz (2205 MHz strobe). If this cannot be done, generate message **E01.** This 5 MHz will be the target beat frequency. The upper and lower limit frequencies are 7 and 3 MHz, resp.
- For instruments from B010001 to B010318, the target frequency is 15 MHz, with the upper and lower limits being 8 and 25 MHz, resp.
- Set the main DAC such that the beat frequency is within the two limit frequencies. If the count cannot be completed properly, generate message **E02.** If the frequency cannot be set within 15 attempts, generate message **E03.**
- Set the FM DAC to minimum (1) and count the beat frequency. If the count cannot be made, generate message **E04.**
- Set the FM DAC to maximum (4095) and count the beat frequency. If the count cannot be made, generate message **E05.**
- Calculate the FM DAC Sensitivity. If the result is outside allowable limits, generate message **E06.**
- Since the FM DAC sensitivity figure may have changed, calculate the ratio of the FM DAC to the main DAC.

5.5 FREQUENCY DRIFT

FREQUENCY DRIFT measures the medium-term YIG drift parameter, and is used to determine how accurately the YIG's frequency can be predicted over a frequency counting period. **This parameter is only measured on instruments from B010001 to B010318**

VALUES UPDATED

The single value Frequency Drift is updated

DEPENDENCIES

Dependent upon:

- *INTERNAL REF FREQ*
- *MAIN DAC OFFSET*
- *MAIN DAC SENS*

OPERATION

INITIAL SETTINGS

5 MHz Resolution
100 MHz Center Frequency
Single Sweep ON
Zero Span (by loading 0 into the span DAC)

PROCEDURE

- For B020319 and up, set the strobe frequency such that the beat frequency is 5 MHz (2205 MHz strobe). This 5 MHz will be the target beat frequency. The upper and lower limit frequencies are 7 and 3 MHz, resp.
- For instruments from B010001 to B010318, the target frequency is 15 MHz, with the upper and lower limits being 8 and 25 MHz, resp.
- Set the main DAC such that the beat frequency is within the two limit frequencies. If the count cannot be completed properly, generate message **E01.** If the frequency cannot be set within 5 attempts, generate message **E02.**
- Wait 5 seconds to eliminate all post-tune drift.
- Count the beat frequency. This is the base frequency against which all subsequent frequencies are checked. If this count cannot be performed, generate message **E03.**
- Count the beat frequency 10 More times, at intervals of 200 msec. If any one of these counts cannot be performed, generate message **E04.**
- Note the maximum positive and negative differences between the base frequency and the 10 subsequent frequency counts. The difference between these two numbers is the frequency drift value. If this value is outside allowable limits, generate message **E05.**

5.6 UPPER VCO SENS

UPPER VCO SENS is the sensitivity of the VCO's Upper-order DAC. This parameter takes the form of a table of coefficients. These coefficients are plugged into a polynomial equation, into which is sent the desired VCO frequency, and out of which is extracted the Upper VCO DAC value. **This parameter is only measured on B020319 and up.**

VALUES UPDATED

An array of coefficients for a sixth-order polynomial is updated, as well as the highest and lowest VCO frequencies and a value representing the sensitivity of the VCO when the VCO is at 13 MHz.

DEPENDENCIES

Dependent upon:

- *INTERNAL REF FREQ*

OPERATION

INITIAL SETTINGS

Zero span (Set the span DAC to 0)
Single Sweep ON

PROCEDURE

- Center the lower VCO DAC.
- Set the Upper VCO DAC to 20 different settings, approximately 215 steps apart. This covers the entire range of the DAC.
- For each of the above steps, count the VCO. If any of these counts cannot be performed, generate message **E01.**
- Check the highest and lowest VCO frequencies measured against allowable limits. If either value is out of range, generate message **E02.**
- Using the 20 sample frequencies and their corresponding DAC values, calculate the coefficients for a sixth-order polynomial which best describes the sample points. If the polynomial cannot be calculated, generate message **E03.**
- Save the highest and lowest VCO frequencies for future reference.
- Use the new coefficients to calculate the sensitivity of the upper VCO DAC when the VCO is at 13 MHz.

5.7 LOWER VCO SENS

LOWER VCO SENS measures the sensitivity of the lower VCO DAC, in terms of the number of steps on the lower DAC which equals one step on the upper DAC. Since the frequency change per step of the lower DAC will change depending on what the upper DAC's setting is, the polynomial which calculates the upper VCO DAC setting is used in conjunction with this value to determine the sensitivity of the lower DAC at the upper DAC setting.

VALUES UPDATED

The value Lower VCO Sensitivity is updated.

DEPENDENCIES

Dependent upon:

- *INTERNAL REF FREQ*
- *UPPER VCO SENS*

OPERATION

INITIAL SETTINGS

Zero span (Set span DAC to 0)
Single Sweep ON

PROCEDURE

- Set the Lower VCO DAC to center (2047).
- Calculate where the upper VCO DAC should be set for a VCO frequency of 13.4 MHz, then set it to that value.
- Count the VCO 8 times, then average the result. If any count cannot be performed, generate message **E01.**
- Calculate the sensitivity of the Upper VCO DAC at the measured average frequency. This value is the sensitivity of the Upper VCO DAC at the measured frequency, in Hz/step.
- Set the Lower VCO DAC to its upper limit (4095).
- Average 8 frequency counts of the the VCO. If any of the counts cannot be performed, generate message **E02.**
- Calculate the number of lower VCO DAC steps which equals one upper VCO DAC step. If this value is outside allowable limits, generate message **E03.**

5.8 SPAN/DIV

SPAN/DIV measures the sensitivity of the span DAC in terms of Hz/bit/div. These values allow the instrument firmware to calculate the proper DAC value for a desired span/div. The instrument uses more than one set of hardware to get all desired spans, such as Main Coil sweep, FM coil sweep, and various decade dividers. The normalizations must therefore provide a sensitivity value for each type of hardware setup.

The general method for measuring a span DAC range is to count a signal (YIG, beat, or VCO) at four points:

- When the beam is at center screen and the DAC is at some minumum value cent_min).
- When the beam is at center screen and the DAC is at maximum (cent_max).
- When the beam is at the rightmost graticule line and the DAC is at some minimum value (right_min).
- When the beam is at the rightmost graticule line and the DAC is at maximum (right_max).

The span sensitivity for the range is then calculated as:

This parameter is only measured on B020319 and up.

On version 11-18-88 and later, only cent_max and right_max are measured, changing the span calulation to:

VALUES UPDATED

A table of span sensitivities is updated, one for each range that the span operates in.

DEPENDENCIES

Dependent upon:

- *INTERNAL REF FREQ*
- *MAIN DAC OFFSET*
- *MAIN DAC SENS*

OPERATION

INITIAL SETTINGS

100 MHz Center Frequency
100 MHz Span/div
Single Sweep ON

PROCEDURE

- Select what to count for each range:

  - For the Main Coil Span ranges using the divide-by-1 and divide-by-10 attenuators, and the FM Coil Span using the divide-by-1 attenuator, count the YIG (see _MSR_YIG_FREQ_). when measuring spans (span ranges 0-2).
  - For the FM Coil Span ranges using any other divide-by attenuators, count the beat frequency when measuring spans (span ranges 3-6).
  - For any VCO Span ranges, count the VCO when determining spans (spans 7-8).

- If counting the YIG (ranges 0-2), degauss before measuring.
- If counting the beat frequency (ranges 3-6), first set the beat frequency to 10 MHz.
- If counting the VCO (ranges 7-8), first set the VCO to 13 MHz.
- Set the beam to center screen.
- Set the Span DAC to 100.
- Count the signal (cent_min). If the signal cannot be counted, generate message **E01.**
- Set the Span DAC to the maximum expected value (3600).
- Count the signal (cent_max). If the signal cannot be counted, generate message **E02.**
- Set the bean to the right-hand park position (right-most graticule line).
- Set the Span DAC to 100.
- Count the signal (cent_min). If the signal cannot be counted, generate message **E03.**
- Set the Span DAC to the maximum expected value (3600).
- Count the signal (cent_max). If the signal cannot be counted, generate message **E04.**
- Calculate the sensitivity for this span range. If this value is outside of allowable limits, generate message **E05.**

5.9 FREQUENCY ACCURACY

FREQUENCY ACCURACY measures the frequency accuracy of the instrument with corrections off, and with normalization values applied. The value generated by this normalization is used by the frequency correction routine to determine how close the center frequency can be predicted after tuning. **This parameter is only measured on instruments from B010001 to B010318**

VALUES UPDATED

The single value Frequency Accuracy is updated.

DEPENDENCIES

Dependent upon:

- *INTERNAL REF FREQ*
- *MAIN DAC OFFSET*
- *MAIN DAC SENS*

OPERATION

INITIAL SETTINGS

5 MHz Resolution
Single Sweep ON
Zero Span (Set the span DAC to 0)

PROCEDURE

- Set the instrument to center frequencies 100 MHz apart, beginning with 0 MHz.
- For B020319 and up, count the YIG frequency (see _MSR_YIG_FREQ_) at each of the above frequencies. Calculate the deviation from the expected yig frequency at each frequency. If any of the counts cannot be performed, generate message **E01.**
- For instruments from B010001 to B010318, count the beat frequency at each of the above frequency. Calculate the deviation from 10 MHz at each frequency. If any of the counts cannot be performed, generate message **E02.**
- Determine which center frequency has the greatest error from the expected value. This error is the Center Frequency Accuracy figure.
- If the Center Frequency Accuracy is outside of allowable limits, generate message **E03.**

5.10 GAIN AND ATTEN

GAIN AND ATTEN measures the exact gain of each VR gain step and RF attenuator. These gains are used to determine which gain step to invoke for a desired reference level, and how much VR FINE GAIN to use.

VALUES UPDATED

Two arrays are updated, one for the actual VR step gains, the other for the actual RF attenuator gains.

DEPENDENCIES

Dependent upon:

- *INTERNAL REF AMPLTD*
- *GAIN STEP REFERENCE*
- *UPPER VCO SENS* (B020319 and up)
- *MAIN DAC OFFSET* (B020319 and up)
- *MAIN DAC SENS* (B020319 and up)

OPERATION

INITIAL SETTINGS

100 MHz Center Frequency
5 MHz Resolution
5 MHz Span/div
-30 dBm Reference Level
Calibrator ON
LIN Vertical Display Mode
Single Sweep ON

PROCEDURE

- Span down gradually to zero span, keeping the calibrator signal centered. If the signal is lost, or cannot be centered properly before going to zero span, generate message **E01.**
- Wait for 1 second and repeat the above step, as a precaution against signal drift. If an error occurs while spanning down, generate message **E02.**
- Turn on the 300 Hz Video Filter
- Set VR gain to 0, RF attenuation to 0, and VR fine gain to center (127 on the PIN DAC). This simulates an uncorrected -30 dBm reference level.
- Calculate the LIN mode sensitivity, using the PIN DAC only to place the signal at full screen (see _CALC_LIN_SENS_). If the signal was lost or the sensitivity values are outside of allowable limits, generate message **E03.**
- Beginning with -10 dB VR gain (all gain steps off) and 2 dB RF attenuation, measure all VR gain and RF atteunation steps, using the following method:

  - Measure the signal level.
  - If the signal is less than 1.5 dB below full screen, go to the next attenuator step and remeasure the signal. Use the difference in signal level to calculate the actual gain of the attenuator step. If the value is outside of allowable limits, generate message **E04.**
  - If the signal level is more than 1.5 dB below full screen, go to the next gain step and remeasure the signal. Use the difference in signal level to calculate the actual gain of the gain step. If the value is outside of allowable limits, generate message **E05.**

- A normalization exists for the extra 10dB step in the VR gain (-20dB to -11dB). This normalization is run only if the requisite hardware is present.

  - Perform the initializations and sensitizations specified above. **E06** and **E07** will be generated if there is signal drift or and inability to calculate the LIN mode sensitivity.
  - Turn off the extra 10dB VR gain step, placing the step at the bottom of its range.
  - Step up through the 1dB steps, one step at a time, comparing the actual signal level with the expected.
  - At each step, make sure the actual signal level does not exceed the limits of the display, and that the calculated error does not exceed the error limits. If the display limit is exceeded, add in RF Attenuation. If the value is outside of allowable limits, generate message **E08.**

5.11 BW FLTR AMPLTD (LIN)

BW FLTR AMPLTD (LIN) measures the amplitude of each VR filter, using the 5 MHz filter as a reference. This allows gain correction when switching between 2 resolution bandwidth settings. The filters are all normalized in LIN vertical display mode.

VALUES UPDATED

A table of corrections is updated, one correction for each VR filter installed.

DEPENDENCIES

Dependent upon:

- *INTERNAL REF AMPLTD*
- *GAIN STEP REFERENCE*
- *GAIN AND ATTEN*
- *GAIN CORRECTION DAC*
- *UPPER VCO SENS* (B020319 and up)
- *MAIN DAC OFFSET* (B020319 and up)
- *MAIN DAC SENS* (B020319 and up)

OPERATION

INITIAL SETTINGS

100 MHz Center Frequency
-30 dBm Reference Level
Calibrator ON
5 MHz Resolution
5 MHz Span/div
Single Sweep ON
LIN Vertical Display Mode
Video Filter ON, AUTO

PROCEDURE

- Turn Frequency Corrections ON.
- Set VR gain to 0, RF attenuation to 0, and VR fine gain to center (127 on the PIN DAC). This simulates an uncorrected -30 dBm reference level.
- Calculate the LIN mode sensitivity, using the PIN DAC and gain and attenuation steps to place the signal at full screen (see _CALC_LIN_SENS_). If the signal was lost or the sensitivity values are outside of allowable limits, generate message **E01.**
- For each filter in the instrument, from narrowest to widest:
  - Set the instrument to the resolution of interest.
  - Set the span/div to be the same as the width of the filter of interest (approx. 1 division wide signal).

- If this is the first (narrowest) filter, run frequency corrections twice to get signal on screen.
- Sweeping the screen to get the signal peak, attenuate the signal until it is below full screen (if necessary). If this is not possible, generate message **E02.**
- Keeping in mind any attenuation which was used, calculate the amplitude of the filter with respect to the 5 MHz filter. If this value is outside allowable limits, generate message **E03.**

5.12 BW FLTR AMPLTD (LOG)

BW FLTR AMPLTD (LOG) measures the amplitude of each VR filter with a bandwidth equal to or greater than 300 KHz. The filters are normalized in LOG vertical display mode. The narrower bandwidth filters are extrapolated using the LIN filter measurements. filter.

VALUES UPDATED

A table of corrections is updated, one correction for each VR filter installed.

DEPENDENCIES

Dependent upon:

- *INTERNAL REF AMPLTD*
- *GAIN STEP REFERENCE*
- *GAIN AND ATTEN*
- *GAIN CORRECTION DAC*
- *BW FLTR AMPLTD (LIN)*
- *UPPER VCO SENS* (B020319 and up)
- *MAIN DAC OFFSET* (B020319 and up)
- *MAIN DAC SENS* (B020319 and up)

OPERATION

INITIAL SETTINGS

100 MHz Center Frequency
-30 dBm Reference Level
Calibrator ON
5 MHz Resolution
5 MHz Span/div
Single Sweep ON
LOG Vertical Display Mode
1 dB/div Vertical Scale
Video Filter ON, AUTO

PROCEDURE

- Set VR gain to 0, RF attenuation to 0, and VR fine gain to center (127 on the PIN DAC). This simulates an uncorrected -30 dBm reference level.
- Set the 5 MHz filter to full screen, using the gain and attenuator steps and the VR PIN DAC. If the 5 MHz filter cannot be set to full screen, generate message **E01.**
- For each filter in the instrument with a bandwidth equal to greater than 300 KHz (scanned from widest to narrowest):
  - Set the resolution to the bandwidth of interest.

  - Set the span/div to the same value as the bandwidth filter of interest.
  - Set the signal to full screen, using VR gain steps, RF attenuators, and the VR PIN DAC (see _VERT_ADJ_). If the signal cannot be set to full screen, generate message **E02.**
  - Calculate the exact amount of gain (or attenuation) which was necessary to set the signal to full screen. This is the gain correction factor for the filter of interest.

- For all other filters:

  - Calculate the correction for the filter of interest by noting the difference between the next highest filter and the filter of interest in the LIN mode VR filter correction table, and extrapolating the correction for the filter of interest.

- If this value is outside allowable limits, generate message **E03.**

5.13 PREAMP GAIN

PREAMP GAIN measures the actual gain of the preamp at 100 MHz center frequency. This allows reference level corrections to occur when the preamp is being used.

VALUES UPDATED

The single value Preamp Gain is updated.

DEPENDENCIES

Dependent upon:

- *INTERNAL REF AMPLTD*
- *GAIN STEP REFERENCE*
- *GAIN AND ATTEN*
- *UPPER VCO SENS* (B020319 and up)
- *MAIN DAC OFFSET* (B020319 and up)
- *MAIN DAC SENS* (B020319 and up) *INTERNAL REF FREQ*

OPERATION

INITIAL SETTINGS

100 MHz Center Frequency
5 MHz Resolution
5 MHz Span/div
LIN Vertical Display Mode
Calibrator ON
-30 dBm Reference Level
Single Sweep ON

PROCEDURE

- Sweep screen and center the calibrator signal.
- Turn on the video filter in AUTO mode.
- Span down gradually to zero span, keeping the calibrator signal centered. If the signal is lost, or cannot be centered properly before going to zero span, generate message **E01.**
- Set VR gain to 0, RF attenuation to 0, and VR fine gain to center (127 on the PIN DAC). This simulates an uncorrected -30 dBm reference level.
- Calculate the LIN mode sensitivity, using the PIN DAC only to place the signal at full screen (see _CALC_LIN_SENS_). If the signal was lost or the sensitivity values are outside of allowable limits, generate message **E02.**
- Turn on the preamp.
- Attenuate the signal back below full screen. If the signal cannot be brought back on screen, generate message **E03.**

- Measure the new signal level.
- Calculate the gain of the preamp from the two measured levels and the amount of attenuation used to bring the signal on screen. If this value is outside allowable limits, generate message **E04.**

5.14 DETECTOR GAIN

DETECTOR GAIN measures the actual detector gain at 100 MHz center frequency. This allows reference level corrections to occur when EMC mode is being used.

VALUES UPDATED

Four Detector Gain values are updated. Two 20dB steps in Lin mode, and two 20dB steps in Log mode.

DEPENDENCIES

Dependent upon:

- *INTERNAL REF AMPLTD*
- *GAIN STEP REFERENCE*
- *GAIN AND ATTEN*
- *UPPER VCO SENS* (B020319 and up)
- *MAIN DAC OFFSET* (B020319 and up)
- *MAIN DAC SENS* (B020319 and up) *INTERNAL REF FREQ*

OPERATION

INITIAL SETTINGS

100 MHz Center Frequency
5 MHz Resolution
5 MHz Span/div
LIN Vertical Display Mode for first part
LOG Vertical Display Mode for second part
Calibrator ON
-30 dBm Reference Level
Single Sweep ON

PROCEDURE

- Sweep screen and center the calibrator signal.
- Turn on the video filter in AUTO mode.
- Span down gradually to zero span, keeping the calibrator signal centered. If the signal is lost, or cannot be centered properly before going to zero span, generate message **E01.**
- Set VR gain to 0, RF attenuation to 0, and VR fine gain to center (127 on the PIN DAC). This simulates an uncorrected -30 dBm reference level.
- Calculate the LIN mode sensitivity, using the PIN DAC, VR Gain, and RF Attenuation to place the signal at full screen (see _CALC_LIN_SENS_). If the signal was lost or the sensitivity values are outside of allowable limits, generate message **E02.**
- Measure the initial signal level.

- Turn on the first 20dB Detector Gain step.
- Attenuate the signal back below full screen. If the signal cannot be brought back on screen, generate message **E03.**
- Measure the new signal level.
- Calculate the Detector Gain from the two measured levels and the amount of attenuation used to bring the signal on screen. If this value is outside allowable limits, generate message **E04.**
- The second 20dB Detector Gain step in Lin mode is found in similar fashion. At the outset though, 20dB of VR Gain 'reduction' is employed to offset the 20dB of the first Detector Gain step. This first 20dB must be active during the second 20dB's normalization because of the hardware configuration. The error messages **E05** and **E06** will be displayed under the same conditions as **E03** and **E04,** respectively.
- In the Log Mode normalizations, **E07** or **E08** will be displayed if the signal cannot be attenuated back down to 1 division below top of screen in the first 20dB step. **E10,** or **E11** will be displayed if the signal cannot be attenuated back down to 1 division below top of screen in the second 20dB step.

  E09 or **E12** will be display if either 20dB step result is outside the allowable limits.

5.15 GAIN CORRECTION DAC

GAIN CORRECTION DAC measures the exact gain of the VR PIN attenuator for each step on the VR PIN DAC. This table of gains is then used to produce a cross reference table from which the firmware selects a DAC value for a desired gain. For example, if +1.0 dB of gain is required:

Nominal gain/DAC step is 0.04 dB.
The "center" of the DAC is step 127.
Nominal DAC value desired:
  127 + (1.0 dB / 0.04 dB/step) = step 153
Number 153 in the normalization-generated table
  may be 135 (for this example).
Therefore, the value 135 is placed into the
  VR PIN DAC.

VALUES UPDATED

The fine gain cross-reference array is updated, along with values representing the highest and lowest gains attainable by the VR PIN DAC.

DEPENDENCIES

Dependent upon:

- *INTERNAL REF AMPLTD*
- *GAIN STEP REFERENCE*
- *GAIN AND ATTEN*
- *UPPER VCO SENS* (B020319 and up)
- *MAIN DAC OFFSET* (B020319 and up)
- *MAIN DAC SENS* (B020319 and up)

OPERATION

INITIAL SETTINGS

100 MHz Center Frequency
-30 dBm Reference Level
Calibrator ON
5 MHz Resolution
5 MHz Span/div
Video Filter ON, AUTO
LIN Vertical Display Mode
Single Sweep ON

PROCEDURE

- Span down gradually to zero span, keeping the calibrator signal centered. If the signal is lost, or cannot be centered properly before going to zero span, generate message **E01.**

- Set VR gain to 0, RF attenuation to 0, and VR fine gain to center (127 on the PIN DAC). This simulates an uncorrected -30 dBm reference level.
- Calculate the LIN mode sensitivity, using the VR gain and RF attenuation to place the signal near full screen (see _CALC_LIN_SENS_). If the signal was lost or the sensitivity values are outside of allowable limits, generate message **E02.**
- Beginning with step 127 on the PIN DAC, reduce the DAC value by 4 until the DAC value equals 0:
    - measure the new signal level, and calculate the gain at the current PIN DAC setting.
    - Interpolate between the previous measurement and the current one to find the gain of the steps which were not measured.
    - If the signal gets too low, add a gain step, noting the effect of the extra gain.
- Beginning with 127 on the PIN DAC, increase the DAC value by 4 until 255 is reached:
    - measure the new signal level, and calculate the gain at the current PIN DAC setting.
    - Interpolate between the previous measurement and the current one to find the gain of the steps which were not measured.
    - If the signal gets too low, add a gain step, noting the effect of the extra gain.
- If the highest gain measured and the lowest gain measured are not within allowable limits, generate message **E03.**

5.16 LOG AMPLIFIER

LOG AMPLIFIER measures the logging error in all three log modes (1, 5, and 10 dB/div). This normalization produces a table of error values which are used to determine the level at a particular point below full screen.

VALUES UPDATED

Three tables are updated, one for each LOG vertical display scale.

DEPENDENCIES

Dependent upon:

- *INTERNAL REF AMPLTD*
- *GAIN STEP REFERENCE*
- *GAIN AND ATTEN*
- *GAIN CORRECTION DAC*
- *UPPER VCO SENS* (B020319 and up)
- *MAIN DAC OFFSET* (B020319 and up)
- *MAIN DAC SENS* (B020319 and up)

OPERATION

INITIAL SETTINGS

100 MHz Center Frequenmcy
5 MHz Resolution
5 MHz Span/div
-30 dBm Reference Level
Calibrator ON
LIN vertical Display Mode
Single Sweep ON

PROCEDURE

- Span down gradually to zero span, 500 KHz resolution bandwidth, keeping the calibrator signal centered. If the signal is lost, or cannot be centered properly before going to zero span, generate message **E01.**
- Set Vertical Display Mode to LOG, Scale to 1dB/div.
- Set VR gain to 0, RF attenuation to 0, and VR fine gain to center (127 on the PIN DAC). This simulates an uncorrected -30 dBm reference level.
- Set the Calibrator signal to full screen, using gain steps, attenuators, and the VR PIN DAC (see _VERT_ADJ_). If this cannot be done, generate message **E02.**
- Turn on 300 Hz Video Filter
- For each Vertical LOG scale (1, 5, 10 dB/div):

- Set the Calibrator signal to full screen, using gain steps, attenuators, and the VR PIN DAC. If this cannot be done, generate message **E03.**
- Place the signal at every 1/3 of a division from full screen (24 points), using the gain steps, RF attenuators, and VR PIN DAC (see _VERT_ADJ_).
- For each point in the previous step, calculate the amount of attenuation necessary to place the signal at that point. The difference between that value and the expected value is the correction factor for that position.
- If any result is outside allowable limits, generate message **E04.**
- If the signal could not be attenuated far enough (not enough attenuators, too much noise, etc), copy the last known good result through to the end of the table.

5.17 FULL SCREEN OFFSETS

FULL SCREEN OFFSETS measures the amount of gain which must be added to (or subtracted from) the current instrument gain to set the 5 MHz resolution bandwidth filter to full screen when the RF attenuators, VR gain steps, and VR fine gain are all set to a nominal zero value. This zero value is the same as an unnormalized -30 dBm reference level. This normalization is performed for each 1, 5, and 10 dB/div in LOG display mode, and also for LIN display mode.

VALUES UPDATED

One value is updated for each LOG mode vertical scale and one for LIN mode.

DEPENDENCIES

Dependent upon:

- *INTERNAL REF AMPLTD*
- *GAIN STEP REFERENCE*
- *GAIN AND ATTEN*
- *GAIN CORRECTION DAC*
- *UPPER VCO SENS* (B020319 and up)
- *MAIN DAC OFFSET* (B020319 and up)
- *MAIN DAC SENS* (B020319 and up)

OPERATION

INITIAL SETTINGS

100 MHz Center Frequency
5 MHz Resolution
5 MHz Span/div
-30 dBm Reference Level
Calibrator ON
LIN Vertical Display Mode
Single Sweep ON
Video Filter ON

PROCEDURE

- Span down gradually to 1 MHz span/div, 5 MHz resolution bandwidth, keeping the calibrator signal centered. If the signal is lost, or cannot be centered properly, generate message **E01.**
- For each Vertical Scale Factor (including LIN):
  - Set the instrument to the Scale factor of interest.
  - Set the signal to full screen using VR gain steps, RF attenuators, and the VR PIN DAC (see _VERT_ADJ_). If this cannot be performed, generate message **E02**

- Calculate the offset necessary to place the signal to full screen, in dB. This value is the correction factor for this scale factor. If this value is outside allowable limits, generate message **E03**

5.18 VR FILTER BW & CEN

VR FILTER BW & CEN measures the 6dB, noise, and impulse bandwidths of each VR filter.

VALUES UPDATED

Three tables of corrections are updated, one for each type of bandwidth, one correction for each VR filter installed.

DEPENDENCIES

Dependent upon:

- *INTERNAL REF AMPLTD*
- *GAIN STEP REFERENCE*
- *GAIN AND ATTEN*
- *GAIN CORRECTION DAC*
- *LOG AMPLIFIER*
- *FULL SCREEN OFFSETS*
- *UPPER VCO SENS* (B020319 and up)
- *MAIN DAC OFFSET* (B020319 and up)
- *MAIN DAC SENS* (B020319 and up)

OPERATION

INITIAL SETTINGS

100 MHz Center Frequency
-30 dBm Reference Level
Calibrator ON
5 MHz Resolution
5 MHz Span/div
Single Sweep ON
5 dB/div LOG Vertical Display Mode
Video Filter OFF

PROCEDURE

- Create a table to convert between log dB and lin volts. If this table cannot be created, generate message **E01.**
- Turn Frequency Corrections ON.
- Set VR gain to 0, RF attenuation to 0, and VR fine gain to center (127 on the PIN DAC). This simulates an uncorrected -30 dBm reference level.
- For each filter in the instrument, from narrowest to widest:
    - Set the instrument to the resolution of interest.

- Set the span/div to be the same as one half the width of the filter of interest (approx. 2 division wide signal).
- If this is the first (narrowest) filter, run frequency corrections twice to get signal on screen.
- At this point, if the signal is less than 1 division tall (35 dB too low), generate message **E02.**
- Sweeping the screen to get the signal peak, add attenuation or gain to the signal until it is betwee 2 and 5 dB from full screen (if necessary). If this is not possible, generate message **E03.** Remember this attenuation and gain as ATTN and GAIN.
- Measure the 6dB bandwidth of this filter in the following way:
  - Find the a and y position of the signal peak. If this peak is less than half screen, generate message **E04.**
  - Find the x and y position of the point 6dB down to the right of the signal peak (right_x and right_y). If this point cannot be found, generate message **E05.**
  - Find the x and y position of the point 6dB down to the left of the signal peak (left_x and left_y). If this point cannot be found, generate message **E06.**
  - Calculate the 6dB bandwidth as follows:

6dB_bw = ((right_x - left_x) / span_per_div) * points_per_div

  - If this result is outside reasonable limits, generate the message **E07.**
- Measure the impulse and noise bandwidths of this filter in the following way:
  - Find the a and y position of the signal peak. If this peak is less than half screen, generate message **E08.**
  - Add up all of the points in the signal which are more than one division above the bottom of the screen (signal area).
  - Add up the squares of all the points in the signal which are more than one division above the bottom of the screen (signal area squared).
  - Calculate the impulse bandwidth as:

((sig_area / peak_volts) * span) / points_per_div

  - If this result is outside reasonable limits, generate the message **E09.**
  - Calculate the noise bandwidth as:

$$((sig\_area^2 / peak\_volts^2) * span) / points\_per\_div$$

  - If this result is outside reasonable limits, generate the message **E10.**

5.19 SENSITIVITY

SENSITIVITY measures the level of the noise floor for each resolution bandwidth filter at intervals of 100 MHz center frequency, starting at 90 MHz center frequency. The peak of the noise is also measured once for each filter at 100 MHz center frequency only. The first portion of this normalization is repeated with the preamp turned on.

VALUES UPDATED

Three Tables are updated: An average sensitivity figure is found for each resolution bandwidth filter installed with the Preamp OFF, at each 100 MHz.; An average sensitivity is found for each resolution with the preamp ON, at each 100 MHz; A peak-minus-average sensitivity figure is found for each resolution at 100 MHz.

DEPENDENCIES

Dependent upon:

- *INTERNAL REF AMPLTD*
- *GAIN STEP REFERENCE*
- *GAIN AND ATTEN*
- *GAIN CORRECTION DAC*
- *BW FLTR AMPLTD (LOG)*
- *LOG AMPLIFIER*
- *FULL SCREEN OFFSETS*
- *UPPER VCO SENS* (B020319 and up)
- *MAIN DAC OFFSET* (B020319 and up)
- *MAIN DAC SENS* (B020319 and up)

OPERATION

INITIAL SETTINGS

Zero Span
-65 dBm Reference Level
Calibrator ON
LOG Vertical Scale Mode
3 Hz Video Filter
Single Sweep ON
50 dB RF Attenuation *
* - Set by directly writing to the RF Deck Driver.

PROCEDURE

- With the Preamp OFF, Using the 5 MHz resolution filter, Set the instrument to every 100 MHz, beginning with 90 MHz (90, 190, 290, etc).
- Measure the noise level by reading the storage accumulator 12 times, then throwing out the highest and lowest measurement and averaging the rest. This is the sensitivity at this frequency in 5 MHz filter.

- Returning to 100 MHz CF, Measure the average sensitivity at 100 MHz in all filters. By cross-mapping the frequency-by-frequency results (collected in the previous step) with the filter-by-filter results, a sensitivity figure is be calculated for all filters at each frequency.
- If the preamp is off, the peak sensitivity is also calculated in the previous step for all resolution filters. This is done by turning off the video filter, measuring the noise with the accumulator, and subtracting the average sensitivity figure.
- If any value calculated for the peak-minus-average table is outside of allowable limits, generate message **E01.**
- If any value calculated for the filter-frequency table is outside of allowable limits with the preamp ON, generate message **E02.**
- If any value calculated for the filter-frequency table is outside of allowable limits with the preamp OFF, generate message **E03.**

5.20 INTERNAL REF FREQ

INTERNAL REF FREQ measures the frequency of the internal calibration signal.

VALUES UPDATED

The single value Reference Frequency is updated.

DEPENDENCIES

Dependent upon:

- *UPPER VCO SENS* (B020319 and up)
- *MAIN DAC OFFSET* (B020319 and up)
- *MAIN DAC SENS* (B020319 and up)

OPERATION

INITIAL SETTINGS

None.

NOTE: Much of the setup for this test depends upon the operator. The external reference signal must be near or at center screen, and must be at a countable level before this normalization is executable. The operator is also responsible for entering the EXACT frequency of their reference signal.

PROCEDURE

- Count the externally-applied signal with the center-measure function. If the signal cannot be counted, generate message **E01.**
- The internal reference frequency is used as a time base for the previous signal count. If this signal count is different from what the operator entered for the external reference frequency, the percentage error will be the same percentage that the internal reference frequency is in error. The internal reference frequency is calculated from this figure. If this value is outside allowable limits, generate message **E02.**

5.21 INTERNAL REF AMPLTD

INTERNAL REF AMPLTD measures the frequency of the internal calibration signal.

VALUES UPDATED

The single value Reference Amplitude is updated.

DEPENDENCIES

Dependent upon:

- *GAIN STEP REFERENCE*
- *UPPER VCO SENS* (B020319 and up)
- *MAIN DAC OFFSET* (B020319 and up)
- *MAIN DAC SENS* (B020319 and up)

OPERATION

INITIAL SETTINGS

NOTE: Before this normalization is invoked the user must connect an external amplitude reference signal into the analyzer.

-30 dBm Reference Level
100 MHz Center Frequency
5 MHz Resolution
5 MHz Span/div
Calibrator OFF
Single Sweep ON

PROCEDURE

- Center the user-applied signal.
- Span down gradually to Zero Span, 5 MHz resolution bandwidth, keeping the calibrator signal centered. If the signal is lost, or cannot be centered properly, generate message **E01.**
- Beginning with 10 dB gain in the VR and 10 dB RF attenuation (effectively -30 dBm reference level with 10 dB RF attenuation), set the signal to one division below full screen using the gain steps, attenuator steps, and the VR PIN DAC (see _VERT_ADJ_). If the signal cannot be set to this point, generate message **E02.**
- Measure the signal level, then turn off the reference gain step, then remeasure the signal.
- If the two measurements are the same, the signal has probably been lost. Generate message **E03.**
- Calculate the lin mode sensitivity from the two measurements and the known gain of the reference gain step. If this value is outside allowable limits (see _CALC_LIN_SENS_), generate message **E04.**

- Replace the reference gain step.
- Ask the operator to remove the externally-applied signal. When the signal drops by 1/2 screen, continue.
- The position of the external signal is known by this step. Now reset the instrument to measure the internal signal. Set the instrument to:

  100 MHz Center Frequency
  5 MHz Resolution
  5 MHz Span/div
  Calibrator ON
  Single Sweep ON

- Center the calibrator signal.
- Span down gradually to Zero Span, 5 MHz resolution bandwidth, keeping the calibrator signal centered. If the signal is lost, or cannot be centered properly, generate message **E05.**
- Reset the instrument to the gain, attenuation, and PIN DAC value used when measuring the external signal.
- Measure the internal signal.
- Calculate the amplitude of the internal calibrator signal, using the difference between the internal and external signals. If this value is outside allowable limits, generate message **E06.**

5.22 GAIN STEP REFERENCE (part 1)

GAIN STEP REFERENCE (part 1) is the first part of normalizing the reference gain step. This entails setting the user-supplied signal to full screen.

VALUES UPDATED

None.

DEPENDENCIES

Dependent upon:

- *UPPER VCO SENS* (B020319 and up)
- *MAIN DAC OFFSET* (B020319 and up)
- *MAIN DAC SENS* (B020319 and up)

OPERATION

INITIAL SETTINGS

The operator connects a 100 MHz signal to the RF input. The level of this signal is between -20 and +20 dBm.

+20 dBm Reference Level
100 MHz Center Frequency
5 MHz Resolution
5 MHz Span/div
Calibrator OFF
10 dB RF Attenuation
Single Sweep ON
LIN Vertical Display Mode

PROCEDURE

- The Target Level for this test is 3/4 divisions below full screen.
- Set RF attenuation to 50 dB.
- Set VR gain to 0.
- Set the VR PIN DAC to center (127).
- Turn off the reference gain step.
- Decrease RF attenuation in 10 dB steps until the signal is over the Target Level.
- Increase RF attenuation in 2 dB steps until the signal is below the Target Level.
- If the RF attenuation is at or beyond limits, generate message **E01.**
- Use only the VR PIN DAC to set the signal right at the target level (see _VERT_ADJ_). If this cannot be done, generate message **E02.**
- Measure the signal level (should be the same as the target level).

5.23 GAIN STEP REFERENCE (part 2)

HI GAIN STEP REFERENCE (part 2) is the second part of normalizing the reference gain step. This entails measuring the new (reduced) level of the user- supplied signal, then using that difference to measure the internal gain step.

VALUES UPDATED

The single value Reference Gain Step is updated.

DEPENDENCIES

Dependent upon:

- *GAIN STEP REFERENCE (part 1)*
- *UPPER VCO SENS* (B020319 and up)
- *MAIN DAC OFFSET* (B020319 and up)
- *MAIN DAC SENS* (B020319 and up)

OPERATION

INITIAL SETTINGS

The operator reduces the external signal by approximately 10 dB. The exact amount by which the signal is reduced is entered by the operator. All instrument settings remain as they were during the first part of the reference gain step normalization.

PROCEDURE

- The signal level is measured.
- If the level did not decrease by 70 vertical display locations, generate message **E03.**
- From the level measured at the end of the first part of the reference gain step normalization and the previous signal level, calculate the LIN mode sensitivity. If this value is outside allowable limits, generate message **E04.**
- Turn the reference gain step back on.
- The amount the external signal changed between the first and second parts of this normalization, added to the difference between the last step of the first part and the first step of this part, is the actual gain of the reference gain step. If this value is outside allowable limits, generate message **E05.**

5.24 TG FREQ OFFSET POS

FREQ OFFSET POS finds the correct tracking generator VCO frequency to use for a peaked tracking generator display.

VALUES UPDATED

The single value Frequency Cal Position is updated.

DEPENDENCIES

Dependent upon:

- *INTERNAL REF FREQ*
- *UPPER VCO SENS* (B020319 and up)
- *MAIN DAC OFFSET* (B020319 and up)
- *MAIN DAC SENS* (B020319 and up)

OPERATION

INITIAL SETTINGS

100 MHz Center Frequency
Zero Span
-10 dBm Reference Level
Calibrator OFF
Single Sweep ON
3 KHz Resolution
5 dB/div Vertical Display Mode
TG Output Enabled
0 dB TG Attenuation

PROCEDURE

- Scan the TG frequency DAC in coarse (20 bit) steps, looking for a maximum response greater than -20 dBm which rises to a peak and then drops at least 5 dB. This scan travels from 1 to 4095 on the TG frequency DAC. If a signal of sufficient size is not located throughout the range of the frequency DAC, generate message **E01.**
- Scan the TG frequency DAC in fine (1 bit) steps, looking for a maximum response greater than -20 dBm. This scan travels from 20 steps before the previous peak to 20 steps after the previous peak. If a signal of sufficient size is not located throughout the range of the frequency DAC, generate message **E02.**
- When a maximum is found, count the VCO a this DAC value and record this frequency as the Cal position. If the VCO cannot be counted, generate error message **E03.**
- Set the frequency DAC to its min and max values. If the VCO cannot be counted at the lowest position, generate error message **E04.** If the VCO cannot be counted at the highest position, generate error message **E05.**

- Compare the cal frequency against the highest and lowest VCO frequencies. If the cal position is too close to the lower frequency, generate error message **E06**
- Compare the cal frequency against the highest and lowest VCO frequencies. If the cal position is too close to the upper frequency, generate error message **E07**

5.25 TG FREQ DAC

TG FREQ DAC Measures the TG VCO at several points in order to characterize the relationship between the frequency DAC and the VCO frequency.

VALUES UPDATED

A table of DAC value versus frequency is generated.

DEPENDENCIES

Dependent upon:

- *INTERNAL REF FREQ*

OPERATION

INITIAL SETTINGS

Zero Span
Single Sweep ON

PROCEDURE

- Enable the TG, setting the attenuators to 48 dB (nominal).
- Connect the TG divider output to the frequency counter.
- For 20 evenly-spaced DAC positions:
    - Set the frequency DAC to the desired position.
    - Measure the frequency from the divider output. If this frequency cannot be counted, generate error message **E01.**
- The allowable range for the TG VCO is +/- (20 KHz / 20) above and below the cal position. If the VCO cannote be set low enough, generate error message **E02.** If the VCO cannot be set high enough, generate error message **E03.**

5.26 TG ATTENUATORS

TG ATTENUATORS are normalized by measuring the actual level produced by the tracking generator when each of the attenuator steps is switch in. The resulting values include the step-to-step variations as well as any overall offset.

VALUES UPDATED

A table of levels is produced, one for each attenuator step.

DEPENDENCIES

Dependent upon:

- *UPPER VCO SENS* (B020319 and up)
- *MAIN DAC OFFSET* (B020319 and up)
- *MAIN DAC SENS* (B020319 and up)
- *GAIN AND ATTEN*
- *GAIN CORRECTION DAC*
- *FULL SCREEN OFFSETS*
- *BW FLTR AMPLTD(LOG)*
- *LOG AMPLIFIER*

OPERATION

INITIAL SETTINGS

100 MHz Center Frequency
Zero Span
+10 dBm Reference Level
Calibrator OFF
1 dB/div Vertical Scale
Single Sweep ON
300 Hz Video Filter
3 KHz resolution bandwidth
TG ON
Amplitude DAC to 1600

PROCEDURE

- For each attenuator step in the TG:
  - Set the TG attenuator for the step to be normalized.
  - Adjust the reference level to bring within 2 divisions of full screen. If the signal cannot be set correctly, generate error message **E01.**
  - Use the display storage accumulator and the marker system to measure the signal level. If the measured attenuation is outside allowable limits, generate error message **E02.**

5.27 TG AMPL DAC

TG AMPL DAC
normalization measures the gain characteristics of the fine gain adjustment in the tracking generator. This fine gain adjustment allows the level to be set to levels which cannot be reached by the attenuators. It also allows correction for the attenuator inaccuracies.

VALUES UPDATED

A cross-reference table is produced, which allows a quick lookup of DAC value versus desired gain (attenuation).

DEPENDENCIES

Dependent upon:

- *UPPER VCO SENS* (B020319 and up)
- *MAIN DAC OFFSET* (B020319 and up)
- *MAIN DAC SENS* (B020319 and up)
- *GAIN AND ATTEN*
- *GAIN CORRECTION DAC*
- *FULL SCREEN OFFSETS*
- *BW FLTR AMPLTD(LOG)*
- *LOG AMPLIFIER*

OPERATION

INITIAL SETTINGS

100 MHz center frequency
Zero Span
+10 dBm reference level
Calibrator OFF
1 dB/div Vertical Scale
Single Sweep ON
300 Hz Video Filter
3 KHz Resolution Bandwidth
TG ON
TG Attenuators to Zero.

PROCEDURE

- Set the DAC from zero to 4095 in 256 equal steps. For each step:

  Set the referenc level such that the signal is within 2 divisions of full screen. If the signal cannot be set properly, generate error message **E01.**

  - Use the display storage accumulator and marker system to measure the signal level.

- Find the signal level which corresponds to the center of the amplitude DAC. Subtract this amount from each of the 256 measurements. The "center" of the amplitude DAC is 1600.
- If the gain did not change an appropriate amount from center DAC, generate error message **E02** (not low enough), or **E03** (not high enough).
- Using the collected gain values, calculate the DAC values necessary for 128 equal steps above and below a center DAC value. The first entry in the resulting table will be the DAC value necessary for -4 dBm from center DAC, the last table entry for +4 dBm from center DAC.

6. Detailed Normalization Subroutine Descriptions

This section contains descriptions of the commonly used normalization subroutines. These subroutines are referred to in section V as _VERT_ADJ_, _CALC_LIN_SENS_, and _MSR_YIG_FREQ_

These subroutines do not produce error messages themselves, but may cause a normalization to produce a message.

6.1 Vertical Adjustment

This routine is used to set a signal to full screen. The routine may use The gain and attenuator steps only, the VR fine gain DAC only, or both mechanisms to accomplish this task. The measurement method is selectable between direct-read and memory-read operation (see section II.E.2, "Display Storage Accumulator").

PROCEDURE

- Calculate a reasonable accuracy of adjustment. If the instrument is in LIN or 1dB/div LOG vertical display mode, adjust the signal within 2 steps of the desired vertical position. Adjust within 1 step for all other modes.
- If the VR fine gain DAC is to be adjusted, preset it to step 75.
- Measure the initial position of the signal.
- If the gain and attenuation are to be adjusted, increase gain or attenuation until the signal crosses the desired position. If gain was used (as opposed to attenuation), reduce the gain by 1 step, placing the signal just below the desired level. If the instrument ran out of attenuation or gain, return an error to the calling function.
- If the VR fine gain is to be adjusted, adjust it repeatedly until the signal is at the desired position, +/- the desired accuracy. If the DAC runs out or range, return an error to the calling function. If the signal "crossed over" the desired position more than 12 times, return an error message to the calling function indicating a "jumpy" signal.
- After all adjustments, if the signal is below a reasonable level, return an error to the calling function.

6.2 LIN Mode Sensitivity Calculations

This subroutine is used to calculate the sensitivity of lin mode in V/step on screen. By using the values calculated in this subroutine, other routines can determine the number of dB from full screen for a specific vertical position.

PROCEDURE

- Set the signal to the desired level, using the vertical adjustment subroutine. The reference gain step is guaranteed to be ON after this adjustment.
- Measure the signal with the gain step ON.
- Turn the reference gain step OFF.
- Measure the signal with the gain step OFF.
- Calculate where 0 volts would be on screen.
- Since the following calculations require a division by the difference in the previously measured levels, an error is returned to the calling function if the signal level did not change (potential division by zero). This is classed as a "no signal" condition.
- Calculate the "range" of lin mode by subtracting the 0 volt position from the position used as a reference (the "desired position" in the vertical adjustment).
- Calculate the lin mode sensitivity by dividing the voltage at the reference position by the lin mode range.
- If either the zero position or the lin range are outside allowable limits (see chart, below) return an error to the calling function. If these two parameters are within limits, the sensitivity will be within limits.

  1. Name : Zero Position
     Upper Limit: 40
     Lower Limit: -40

  2. Name : Lin Range
     Upper Limit: 350
     Lower Limit: 125

6.3 YIG Frequency Counting

In B020319 and up, the YIG oscillator frequency is determined by setting the LF VCO to various frequencies, measuring the resultant beat frequency, and analyzing all frequencies together. This method allows calculation of the YIG frequency without prior knowledge of the approximate frequency.

If the VCO is set to 2 different frequencies, a pair of beat frequencies will be produced which are related to the VCO frequencies by a factor of the strobe frequency N-number.

For many settings of the VCO and YIG, the beat frequency pairs will not correspond to a valid or correct YIG frequency. To validate the calculated frequency, a second pair is measured in an attempt to match to the first frequency calculation.

PROCEDURE

- Set the VCO to several different frequencies.
- For each frequency, measure the resultant beat frequency.
- For each frequency, calculate the base strobe frequency. This is equal to the VCO frequency divided by four, added to 100 MHz, and divided by four again.
- For each pair of VCO frequencies and beat frequencies, calculate the apparent N-number by dividing the beat frequency difference by the base strobe frequency difference.
- Using the apparent N-number and strobe frequency, calculate the apparent YIG frequency.
- When two consecutive YIG frequencies have the same N-number and the same frequency (within limits), return that frequency as the actual YIG frequency. The Yig frequencies must be within 100 KHz of each other, and the N-numbers must be within 0.3 N-numbers.
- If two YIG frequency calculations do not match within 15 VCO-beat-frequency samples, an error is returned to the calling function.

Appendix 1 -- Normalization Values

Most normalization values can be viewed on the 2710 CRT by selecting **[UTIL] [5] [5] [4]** (Normalization Values). The following diagrams show where each normalization value can be found.

RF ATTEN ~~AND~~ PREAMP GAIN, [UTIL] [5] [5] [4] [0]

This menu contains the actual attenuations of the RF attenuators and the actual gain of the preamp. The attenuator figures are organized from lowest (0 dB) to highest (50 dB) attenuation, in 2 dB steps, read from left to right and top to bottom. If the appropriate hardware is installed, the detector gain steps will also be displayed.

```
+--------------------------------+
|RF ATTEN AND PREAMP GAIN        |
| RF ATTENUATION                 |
|  0.0   2.0   4.0   6.0   8.0   |
| 10.0  12.0  14.0  16.0  18.0   |
| 20.0  22.0  24.0  26.0  28.0   |
| 30.0  32.0  34.0  36.0  38.0   |
| 40.0  42.0  44.0  46.0  48.0   |
| 50.0                           |
| PREAMP GAIN              20.0  |
| LIN DETECTOR GAIN   20.0  20.0 |
| LOG DETECTOR GAIN   20.0  20.0 |
|                                |
|                                |
|                                |
|      "<-" = PREVIOUS MENU      |
|  MENU KEY = RETURN TO DISPLAY  |
+--------------------------------+
```

VR GAIN STEPS, [UTIL] [5] [5] [4] [1]

This menu contains the actual gain of each VR gain step. The values are organized from lowest (-20dB) to highest (+40 dB), in 1 dB steps, read from left to right, top to bottom. If the appropriate hardware is not installed, the first two lines, -20dB through -11dB will not be displayed.

```
+--------------------------------+
|VR GAIN STEPS                   |
| -20.0 -19.0 -18.0 -17.0 -16.0  |
| -15.0 -14.0 -13.0 -12.0 -11.0  |
| -10.0  -9.0  -8.0  -7.0  -6.0  |
|  -5.0  -4.0  -3.0  -2.0  -1.0  |
|  0.0  1.0  2.0  3.0  4.0  5.0  |
|  6.0  7.0  8.0  9.0 10.0 11.0  |
| 12.0 13.0 14.0 15.0 16.0 17.0  |
| 18.0 19.0 20.0 21.0 22.0 23.0  |
| 24.0 25.0 26.0 27.0 28.0 29.0  |
| 30.0 31.0 32.0 33.0 34.0 35.0  |
| 36.0 37.0 38.0 39.0 40.0       |
|                                |
|                                |
|      "<-" = PREVIOUS MENU      |
|  MENU KEY = RETURN TO DISPLAY  |
+--------------------------------+
```

VR FINE GAIN, [UTIL] [5] [5] [4] [2]

This menu contains a section of the cross reference table which is used to select what step value to place into the VR fine gain DAC, as well as the lowest and highest acheivable gain (attenuation). For the cross reference table, the star marks the step value which corresponds to zero dB (no correction). All other steps are the 40 DAC positions immediately surrounding the zero dB point.

```
+--------------------------------+
|VR FINE GAIN                    |
|  0   0   0   0   0   0   0   0 |
|  0   0   0   0   0   0   0   0 |
|  0   0   0   0   0   0   0   0 |
|  0   0   0   0   0   0   0   0 |
|  0   0   0   0   0   0   0   0*|
|  0   0   0   0   0   0   0   0 |
|  0   0   0   0   0   0   0   0 |
|  0   0   0   0   0   0   0   0 |
|  0   0   0   0   0   0   0   0 |
|  0   0   0   0   0   0   0   0 |
|  LOW -11.3DB    HIGH  3.2DB    |
|                                |
|                                |
|      "<-" = PREVIOUS MENU      |
|  MENU KEY = RETURN TO DISPLAY  |
+--------------------------------+
```

FILTER AMPLITUDES, [UTIL] [5] [5] [4] [3]

This menu displays the filter amplitude corrections for both LOG and LIN vertical scale modes. For each mode, the correction values shown relate to the relative amplitude of each filter with respect to the 5 MHz filter. The order of the results (read from left to right and top to bottom) is as follows: 300 Hz, 1 KHz, 3 KHz, 9 KHz, 30 KHz, 100 KHz, 500 KHz (300 KHz), 1 MHz, and 5 MHz.

```
+--------------------------------+
| FILTER AMPLITUDES              |
|  LIN FILTER AMPLITUDES         |
|    0.0  0.0  0.0  0.0  0.0     |
|    0.0  0.0  0.0  0.0          |
|                                |
|  LOG FILTER AMPLITUDES         |
|    0.0  0.0  0.0  0.0  0.0     |
|    0.0  0.0  0.0  0.0          |
|                                |
|                                |
|                                |
|                                |
|                                |
|                                |
|      "<-" = PREVIOUS MENU      |
|  MENU KEY = RETURN TO DISPLAY  |
+--------------------------------+
```

FILTER SENSITIVITY, [UTIL] [5] [5] [4] [4]

This menu displays some of the sensitivity measurements. For preamp on and preamp off, the sensitivity for each VR filter is displayed at 100 MHz and at the top of the usable range of the instrument (1.8 GHz for preamp off, 500 MHz for preamp on). The order of the results (read from left to right and top to bottom) is as follows: 300 Hz, 1 KHz, 3 KHz, 9 KHz, 30 KHz, 100 KHz, 500 KHz (300 KHz), 1 MHz, and 5 MHz.

```
+--------------------------------+
|FILTER SENSITIVITY              |
| SENSITIVITY @100MHZ (ALL NEG)  |
|   PREAMP ON     0   0   0   0  |
|             0   0   0   0   0  |
|   PREAMP OFF    0   0   0   0  |
|             0   0   0   0   0  |
| SENSITIVITY @500MHZ (ALL NEG)  |
|   PREAMP ON     0   0   0   0  |
|             0   0   0   0   0  |
| SENSITIVITY @1800MHZ (ALL NEG) |
|   PREAMP OFF    0   0   0   0  |
|             0   0   0   0   0  |
|                                |
|                                |
|      "<-" = PREVIOUS MENU      |
|  MENU KEY = RETURN TO DISPLAY  |
+--------------------------------+
```

LOG NORMALIZATIONS, [UTIL] [5] [5] [4] [5]

This menu is the access to the logging error normalization values, and also displays the normalization values for the full screen (vertical) offsets.

```
+--------------------------------+
|LOG NORMALIZATIONS              |
|                                |
| 0 1 DB                         |
| 1 5 DB                         |
| 2 10 DB                        |
|                                |
|                                |
|     VERTICAL SCALE OFFSET      |
|   1DB -    0.0    5DB -   0.0  |
|  10DB -    0.0    LIN -   0.0  |
|                                |
|                                |
|                                |
|                                |
|      "<-" = PREVIOUS MENU      |
|  MENU KEY = RETURN TO DISPLAY  |
+--------------------------------+
```

LOG NORMALIZATIONS, [UTIL] [5] [5] [4] [5] [0]

This menu displays the logging error when in 1 dB/div vertical display scale. The values are organized such that the first value is for top of screen, the next for 1/3 div from top, the next for 2/3 from top, etc., as read from left to right and top to bottom.

```
+---------------------------------+
!LOG NORMALIZATIONS   -  1 DB     !
!                                 !
!   0.0   0.0   0.0   0.0   0.0   !
!   0.0   0.0   0.0   0.0   0.0   !
!   0.0   0.0   0.0   0.0   0.0   !
!   0.0   0.0   0.0   0.0   0.0   !
!   0.0   0.0   0.0   0.0   0.0   !
!                                 !
!                                 !
!                                 !
!                                 !
!                                 !
!                                 !
!                                 !
!      "<-"  = PREVIOUS MENU      !
!  MENU KEY = RETURN TO DISPLAY   !
+---------------------------------+
```

LOG NORMALIZATIONS, [UTIL] [5] [5] [4] [5] [1]

This menu displays the logging error when in 5 dB/div vertical display scale. The values are organized such that the first value is for top of screen, the next for 1/3 div from top, the next for 2/3 from top, etc., as read from left to right and top to bottom.

```
+---------------------------------+
!LOG NORMALIZATIONS   -  5 DB     !
!                                 !
!   0.0   0.0   0.0   0.0   0.0   !
!   0.0   0.0   0.0   0.0   0.0   !
!   0.0   0.0   0.0   0.0   0.0   !
!   0.0   0.0   0.0   0.0   0.0   !
!   0.0   0.0   0.0   0.0   0.0   !
!                                 !
!                                 !
!                                 !
!                                 !
!                                 !
!                                 !
!                                 !
!      "<-"  = PREVIOUS MENU      !
!  MENU KEY = RETURN TO DISPLAY   !
+---------------------------------+
```

LOG NORMALIZATIONS, [UTIL] [5] [5] [4] [5] [2]

This menu displays the logging error when in 10 dB/div vertical display scale. The values are organized such that the first value is for top of screen, the next for 1/3 div from top, the next for 2/3 from top, etc., as read from left to right and top to bottom.

```
+--------------------------------+
|LOG NORMALIZATIONS  -  10 DB    |
|                                |
|   0.0   0.0   0.0   0.0   0.0  |
|   0.0   0.0   0.0   0.0   0.0  |
|   0.0   0.0   0.0   0.0   0.0  |
|   0.0   0.0   0.0   0.0   0.0  |
|   0.0   0.0   0.0   0.0   0.0  |
|                                |
|                                |
|                                |
|                                |
|                                |
|                                |
|                                |
|       "<-" = PREVIOUS MENU     |
|  MENU KEY = RETURN TO DISPLAY  |
+--------------------------------+
```

REFERENCES, [UTIL] [5] [5] [4] [6]

This menu displays the normalization values for all references. The "CALIBRATOR FREQ" value is the normalized value for the internal calibrator frequency, while the "CF REFERENCE" is the frequency of the reference as read from the reference oscillator. The other two parameters are the internal calibrator amplitude and the VR gain step reference.

```
+--------------------------------+
|REFERENCES                      |
|                                |
| CALIBRATOR FREQ  100.109700MHZ |
| CF REFERENCE     100.109700MHZ |
| CALIBRATOR AMPLTD       -30.00 |
| GAIN STEP REFERENCE      10.40 |
|                                |
|                                |
|                                |
|                                |
|                                |
|                                |
|                                |
|                                |
|       "<-" = PREVIOUS MENU     |
|  MENU KEY = RETURN TO DISPLAY  |
+--------------------------------+
```

CF NORMALIZATIONS, [UTIL] [5] [5] [4] [7]

This menu displays many of the center frequency-related parameters. The span DAC sensitivities are displayed in the following order (as read from left to right, top to bottom):

- Main coil spans using the divide-by-one decade attenuator.
- Main coil spans using the divide-by-ten decade attenuator.
- FM coil spans using the divide-by-one decade attenuator.
- FM coil spans using the divide-by-one-hundred decade attenuator.
- FM coil spans using the divide-by-one-hundred decade attenuator.
- FM coil spans using the divide-by-one-hundred decade attenuator.

```
+--------------------------------+
!CF NORMALIZATIONS               !
!                                !
! MAIN DAC SENS        461.50KHZ !
! MAIN DAC OFFSET            100 !
! FM DAC SENS           488.00HZ !
!                                !
!                                !
! SPAN DAC SENSITIVITY           !
!  50.00KHZ   5.00KHZ   1.38KHZ  !
!  138.90HZ   13.89HZ    1.38HZ  !
!                                !
!                                !
!                                !
!                                !
!      "<-" = PREVIOUS MENU      !
!  MENU KEY = RETURN TO DISPLAY  !
+--------------------------------+
```

VCO NORMALIZATIONS, [UTIL] [5] [5] [4] [8]

This menu displays all of the VCO-related normalization values. The VCO min and max values describe the range of the LF VCO. The 13 MHz sensitivity value is an internal-use parameter. The VCO span values are for the divide-by-one and divide-by-ten decade attenuator, respectively.

```
+---------------------------------+
|VCO NORMALIZATIONS               |
|                                 |
| VCO MAX FREQUENCY     17.59MHZ  |
| VCO MIN FREQUENCY     10.79MHZ  |
| VCO SENS @ 13 MHZ    0.0005301  |
|                                 |
| VCO SPAN SENSITIVITY            |
|     2.722HZ   0.273HZ          |
|                                 |
|                                 |
|                                 |
|                                 |
|                                 |
|                                 |
|       "<-" = PREVIOUS MENU      |
|  MENU KEY = RETURN TO DISPLAY   |
+---------------------------------+
```

MISCELLANEOUS, [UTIL] [5] [5] [4] [9]

This menu displays the difference between the peak and average of the noise floor, and provides access to the bandwidth and centering results. The order of the results (read from left to right and top to bottom) is as follows: 300 Hz, 1 KHz, 3 KHz, 9 KHz, 30 KHz, 100 KHz, 500 KHz (300 KHz), 1 MHz, and 5 MHz.

```
+---------------------------------+
| MISCELLANEOUS - NORM VALUES     |
|                                 |
| 0 VR 6DB BANDWIDTHS             |
| 1 VR NOISE BANDWIDTHS           |
| 2 VR IMPULSE BANDWIDTHS         |
| 3 VR FILTER CENTERING           |
| 4 TRACKING GENERATOR PARAMETERS|
|                                 |
| PEAK-AVERAGE DIFFERENCE         |
|    0.0  0.0  0.0  0.0  0.0      |
|    0.0  0.0  0.0  0.0           |
|                                 |
|                                 |
|                                 |
|       "<-" = PREVIOUS MENU      |
|  MENU KEY = RETURN TO DISPLAY   |
+---------------------------------+
```

VR 6DB BANDWIDTHS, [UTIL] [5] [5] [4] [9] [0]

This menu displays the 6 dB-down VR filter bandwidths. The order of the results (read from left to right and top to bottom) is as follows: 300 Hz, 1 KHz, 3 KHz, 9 KHz, 30 KHz, 100 KHz, 500 KHz (300 KHz), 1 MHz, and 5 MHz.

```
+--------------------------------+
| VR 6DB BANDWIDTHS              |
|                                |
|  300.00HZ    1.00KHZ   3.00KHZ |
|  10.00KHZ  30.00KHZ 100.00KHZ  |
| 300.00KHZ    1.00MHZ   5.00MHZ |
|                                |
|                                |
|                                |
|                                |
|                                |
|                                |
|                                |
|                                |
|                                |
|       "<-" = PREVIOUS MENU     |
|  MENU KEY = RETURN TO DISPLAY  |
+--------------------------------+
```

VR NOISE BANDWIDTHS, [UTIL] [5] [5] [4] [9] [1]

This menu displays the VR filter noise bandwidths. The order of the results (read from left to right and top to bottom) is as follows: 300 Hz, 1 KHz, 3 KHz, 9 KHz, 30 KHz, 100 KHz, 500 KHz (300 KHz), 1 MHz, and 5 MHz.

```
+--------------------------------+
| VR NOISE BANDWIDTHS            |
|                                |
|  240.00HZ  800.00HZ   2.40KHZ  |
|   8.00KHZ  24.00KHZ  80.00KHZ  |
| 240.00KHZ 800.00MHZ   4.00MHZ  |
|                                |
|                                |
|                                |
|                                |
|                                |
|                                |
|                                |
|                                |
|                                |
|       "<-" = PREVIOUS MENU     |
|  MENU KEY = RETURN TO DISPLAY  |
+--------------------------------+
```

VR IMPULSE BANDWIDTHS, [UTIL] [5] [5] [4] [9] [2]

This menu displays the VR filter impulse bandwidths. The order of the results (read from left to right and top to bottom) is as follows: 300 Hz, 1 KHz, 3 KHz, 9 KHz, 30 KHz, 100 KHz, 500 KHz (300 KHz), 1 MHz, and 5 MHz.

```
+--------------------------------+
! VR IMPULSE BANDWIDTHS          !
!                                !
!                                !
!  300.00HZ    1.00KHZ   3.00KHZ !
!  10.00KHZ  30.00KHZ 100.00KHZ  !
! 300.00KHZ    1.00MHZ   5.00MHZ !
!                                !
!                                !
!                                !
!                                !
!                                !
!                                !
!                                !
!                                !
!       "<-" = PREVIOUS MENU      !
!  MENU KEY = RETURN TO DISPLAY  !
+--------------------------------+
```

TRACKING GENERATOR NORM VALUES, [UTIL] [5] [5] [4] [9] [4]

This menu displays the tracking generator attenuator and VCO normalization results. The attenuator values read from 0 to 48 dB in 4 dB steps, read from left to right, top to bottom.

```
+--------------------------------+
! TRACKING GENERATOR NORM VALUES !
!                                !
! 0 OUTPUT AMPLITUDE DAC         !
!                                !
! ATTENUATORS:                   !
!   0.0  -4.0  -8.0 -12.0 -16.0  !
! -20.0 -24.0 -28.0 -32.0 -36.0  !
! -40.0 -44.0 -48.0              !
!                                !
! VCO MAX FREQ       105500800HZ !
! VCO MAX FREQ       105499200HZ !
! VCO MAX FREQ       105500000HZ !
!                                !
!                                !
!       "<-" = PREVIOUS MENU      !
!  MENU KEY = RETURN TO DISPLAY  !
+--------------------------------+
```

TRACKING GEN AMPLITUDE DAC, [UTIL] [5] [5] [4] [9] [4] [0]

This menu displays the center 80 tracking generator amplitude DAC cross-reference table entries. The asterisk represents the value used for the reference (0.0 dB) position.

```
+--------------------------------+
! TRACKING GEN AMPLITUDE DAC     !
! 88   89   90   91   92   93   94   95  !
! 96   97   98   99  100  101  102  103  !
!104  105  106  107  108  109  110  111  !
!112  113  114  115  116  117  118  119  !
!120  121  122  123  124  125  126  127*!
!128  129  130  131  132  133  134  135  !
!136  137  138  139  140  141  142  143  !
!144  145  146  147  148  149  150  151  !
!152  153  154  155  156  157  158  159  !
!160  161  162  163  164  165  166  167  !
!  LOW   -4.0DB     HIGH    4.0DB   !
!                                !
!                                !
!       "<-" = PREVIOUS MENU     !
!  MENU KEY = RETURN TO DISPLAY  !
+--------------------------------+
```

The following is a list of all normalization values. Some values are listed for reference only (as noted), since they are not visible to the user through any menu. These values are listed in an order similar to their positions in the normalization value display (UTIL/5/5/7).

```
1.  Name        : RF Attenuation
    Desc        : The actual gain of each 2 dB attenuation step, from
                  0 to -52 dB.
    Default     : 0.0 to -52.0 dB, in 2.0 dB steps
    Upper Limit: +3.0 dB from the default values.
    Lower Limit: -3.0 dB from the default values.

2.  Name        : Preamp Gain
    Desc        : The actual gain of the Preamp.
    Default     : 20 dB
    Upper Limit: 30 dB
    Lower Limit: 10 dB

2a. Name        : Detector Gain
    Desc        : The actual gain utilized in EMC mode.
    Default     : 20 dB
    Upper Limit: +3.0 dB from the default values.
    Lower Limit: -3.0 dB from the default values.

3.  Name        : VR Gain Steps
    Desc        : The actual gain of each 1 dB gain step, from -10 (-20)
              to +40 dB.
    Default     : -10.0 (-20.0) to +40.0 dB, in 1.0 dB steps
    Upper Limit: +3.0 dB from the default values.
    Lower Limit: -3.0 dB from the default values.

4.  Name        : VR Fine Gain
    Desc        : The actual gain of the VR PIN attenuator at each
                  setting of the control DAC. The Upper and lower
                  limits apply to the max and min DAC points, resp.
    Default     : From -5.1 dB to +5.1 dB, in .04dB/DACstep.
    Upper Limit: The highest DAC step must give at least 2.0 dB
                  gain.
    Lower Limit: The lowest DAC step must give more than 2.0 dB
                  attenuation.

5.  Name        : VR Filter Amplitude (LIN)
    Desc        : The amplitude difference between each VR filter and
                  the 5 MHz filter.
    Default     :  0.0 dB
    Upper Limit:  5.0 dB
    Lower Limit: -5.0 dB

6.  Name        : VR Filter Amplitude (LOG)
    Desc        : The amplitude difference between each VR filter and
                  the 5 MHz filter.
    Default     :  0.0 dB
    Upper Limit:  5.0 dB
    Lower Limit: -5.0 dB
    Notes       : Not on all firmware versions.
```

7. Name : 6dB VR Filter Bandwidths
Desc : The bandwidth of each VR filter at the 6 dB-down points.
Default : Same as the nominal filter bandwidth.
Upper Limit: Nominal bandwidth + 80%
Lower Limit: Nominal bandwidth - 80%
Notes : Not on all firmware versions.

8. Name : VR Filter Noise Bandwidths
Desc : The noise bandwidth of each VR filter.
Default : 80% of the nominal filter bandwidth.
Upper Limit: (80% of the nominal bandwidth) + 80%
Lower Limit: (80% of the nominal bandwidth) - 80%
Notes : Not on all firmware versions.

9. Name : VR Filter Impulse Bandwidth
Desc : The impulse bandwidth of each VR filter.
Default : Same as the nominal filter bandwidth.
Upper Limit: Nominal bandwidth + 80%
Lower Limit: Nominal bandwidth - 80%
Notes : Not on all firmware versions.

10. Name : Filter Sensitivity
Desc : The level of the average noise, measured in 100 MHz increments beginning at 90 MHz, measured for each filter and with/without the preamp. These figures are used in carrier to noise calculations.
Default :

filter	Preamp	100 MHz	1800 MHz
5 MHz	Off	-85	-77
* 1.5 MHz	Off	-90	-82
500 kHz	Off	-95	-87
* 120 kHz	Off	-101	-93
30 kHz	Off	-107	-99
* 9 kHz	Off	-112	-104
3 kHz	Off	-117	-109
* 1 kHz	Off	-122	-114
** 300 Hz	Off	-127	-119
* 200 Hz	Off	-127	-119
5 MHz	On	-97	
* 1.5 MHz	On	-102	
500 kHz	On	-107	
* 120 kHz	On	-113	
30 kHz	On	-119	
* 9 kHz	On	-124	
3 kHz	On	-129	
* 1 kHz	On	-134	
** 300 Hz	On	-139	
* 200 Hz	On	-139	

* - RF options only.
** - Option 01 (Phase lock) only

Upper Limit: filter ¦ Preamp ¦ limit ¦

	5 MHz	Off	-68
*	1.5 MHz	Off	-73
	500 kHz	Off	-78
*	120 kHz	Off	-84
	30 kHz	Off	-90
*	9 kHz	Off	-95
	3 kHz	Off	-100
*	1 kHz	Off	-105
**	300 Hz	Off	-110
*	200 Hz	Off	-110
	5 MHz	On	-88
*	1.5 MHz	On	-93
	500 kHz	On	-98
*	120 kHz	On	-104
	30 kHz	On	-110
*	9 kHz	On	-115
	3 kHz	On	-120
*	1 kHz	On	-125
**	300 Hz	On	-130
*	200 Hz	On	-130

* - RF options only.
** - Option 01 (Phase lock) only

Lower Limit: No Limit

11. Name : Logging Error
    Desc : The logging error in each log scale factor, measured at every 10 vertical storage locations.

	1dB/	5dB/	10dB/	
Default :	0.0	0.0	0.0	
Upper Limit:	3.0	5.0	5.0	(max dB error)
Lower Limit:	-3.0	-5.0	-5.0	(max dB error)

12. Name : Vertical Offset
    Desc : The amount of gain to be added to bring the 5 MHz filter to full screen at -30 dBm reference level. There is one value for each scale factor (1dB, 5dB, 10dB, LIN).
    Default : 0.0 dB
    Upper Limit: 5.0 dB
    Lower Limit: -5.0 dB

13. Name : Reference Frequency
    Desc : The measured frequency of the internal calibrator.
    Default : 100.000 MHz
    Upper Limit: 100.010 MHz
    Lower Limit: 99.990 MHz

14. Name : Reference Amplitude
    Desc : The measured amplitude of the internal calibrator.
    Default : -30.0 dBm

Upper Limit: -28.0 dBm
Lower Limit: -32.0 dBm

15. Name : 10 dB Reference Gain Step
Desc : The gain of the internal 10 dB reference gain step.
Default : 10.4 dB
Upper Limit: 11.9 dB
Lower Limit: 8.9 dB

16. Name : Main DAC Sensitivity
Desc : The CF change for each Main CF DAC step.
Default : 461.5 kHz/step
Upper Limit: 600.0 kHz/step
Lower Limit: 200.0 kHz/step

17. Name : Main DAC Offset
Desc : The Main CF DAC value necessary to place the instrument at 0 MHz center frequency.
Default : 100
Upper Limit: 450
Lower Limit: 40

18. Name : FM DAC Sensitivity
Desc : The CF change for each FM CF DAC step.
Default : 488 Hz/step
Upper Limit: 650 Hz/step
Lower Limit: 200 Hz/step

19. Name : FM DAC to Main DAC ratio
Desc : The number of FM CF DAC steps which is equal to one Main CF DAC step. This value is used internally to reduce calculation time, and is not seen by any user.
Default : 946
Upper Limit: 3000
Lower Limit: 307
Note : Not on all firmware versions.

20. Name : Span DAC values
Desc : The non-phaselocked span DAC sensitivities. These are stored in terms of Hz/DAC_step/div. If range 3 was used to get a 100 kHz/div span, using default values from the table below, the span DAC would be set to 1000/138.9, or 719.
Default :

range	coil swept	divide by	default value (Hz/step/div)
0	Main	1	50000
1	Main	10	5000
2	FM	1	1389
3	FM	10	138.9
4	FM	100	13.89
5*	FM	100	13.89
6*	FM	100	13.89

```
                         --------------------------------
                           * - Duplicate ranges, used to simplify firmware.
     Upper Limit: 13% Over the default values.
     Lower Limit: 13% Under the default values.
     Note       : Not normalized on instruments from B010001 to B010318.

21.  Name       : VCO Polynomial Coefficients
     Desc       : These are the coefficients used to set the LF
                  VCO upper DAC. The coefficients belong to the
                  following equation:

                            0       1          n
                    DAC = X0*f  + X1*f ... + Xn*f

                       where f is the desired frequency

                  These coefficients are not seen by any user.
     Default    : x0 (constant) : 40323.5904
                  x1            :-22427.1026
                  x2            :  4560.4199
                  x3            :  -467.7120
                  x4            :    26.4079
                  x5            :    -0.7858
                  x6            :     0.0097
     Upper Limit: { Upper and lower limits are taken care of in }
     Lower Limit: { the VCO Upper and VCO Lower normalization   }
                  { values.                                      }
     Note       : Not normalized on instruments from B010001 to B010318.

22.  Name       : VCO Lower to Upper Ratio
     Desc       : The ratio between the Upper and lower LF VCO DACs.
                  This value is used internally by the frequency
                  setting software, and is not seen by the user.
     Default    : 1024
     Upper Limit: 2000
     Lower Limit:  400
     Note       : Not normalized on instruments from B010001 to B010318.

23.  Name       : VCO Lower Limit
     Desc       : The lowest frequency that the LF VCO can be set
                  to.
     Default    : 10.637 MHz
     Upper Limit: 12.7 MHz
     Lower Limit:  9.0 MHz
     Note       : Not normalized on instruments from B010001 to B010318.

24.  Name       : VCO Upper Limit
     Desc       : The highest frequency that the LF VCO can be set
                  to.
     Default    : 17.508 MHz
     Upper Limit: 18.5 MHz
     Lower Limit: 16.0 MHz
     Note       : Not normalized on instruments from B010001 to B010318.
```

25. Name : 13 MHz VCO Sensitivity
    Desc : The Sensitivity of the VCO when the VCO is at 13 MHz. This is in terms of LSB's of the Upper LF VCO DAC / MHz change in the LF VCO.
    Default : .000526 LSB/MHz
    Upper Limit: .002000 LSB/MHz
    Lower Limit: .000400 LSB/MHz
    Note : Not normalized on instruments from B010001 to B010318.

26. Name : VCO Span values
    Desc : The phaselocked span DAC sensitivities. These values are interpreted in terms of the LF VCO's frequency change as the sweep position changes. The actual span DAC value is calculated from these values, along with the VCO 13 MHz Sensitivity (Below), the strobe harmonic number, and the currently calculated VCO sensitivity.
    Default :

range	divide by	default value (Hz/step/div)
0	1	2.710
1	10	.271

    Upper Limit: 13% Over the default values.
    Lower Limit: 13% Under the default values.
    Note : Not normalized on instruments from B010001 to B010318.

27. Name : Peak to Average Sensitivity
    Desc : The difference between the peak of the unfiltered noise floor and the average of the filtered noise. This is measured for each filter, and for Preamp on/off conditions, at 90 MHz Center Frequency.
    Default : 12 dB
    Upper Limit: 32 dB
    Lower Limit: 1 dB

28. Name : YIG Drift
    Desc : The largest center frequency change when measred 10 times over 2 seconds.
    Default : 5 kHz
    Upper Limit: 50 kHz
    Lower Limit: 0 Hz
    Note : Not normalized on B020319 and up.

29. Name : Frequency Accuracy
    Desc : The largest center frequency error when measured at every 100 MHz from 100 MHz to 1800 MHz. This value is a magnitude only.
    Default : 2 MHz
    Upper Limit: 6 MHz
    Lower Limit: 0 Hz
    Note : Not normalized on B020319 and up.

```
30. Name        : TG Frequency DAC
    Desc        : Pairs of values which describe the relationship
                  between DAC value and VCO frequency.
    Default     : DAC values spaced evenly from 1 to 4095.
                  Frequency values which match a sample TG VCO.
    Upper Limit: Must reach at least 250 Hz above the cal
                  position (see TG Frequency Cal Position).
    Lower Limit: Must reach at least 3 KHz below the cal
                  position (see TG Frequency Cal Position).
    Note        : Tracking Generator Only.

31. Name        : TG Frequency Cal Position
    Desc        : The TG VCO frequency which gives the highest
                  signal response.
    Default     : 105.5 MHz
    Upper Limit: 250 Hz from the highest possible VCO frequency.
    Lower Limit: 3 KHz from the lowest possible VCO frequency.
    Note        : Tracking Generator Only.

32. Name        : TG Attenuators
    Desc        : The attenuation of each TG attenuator plus any
                  "full scale" offset seen at 0 dB attenuation.
    Default     : Same as the nominal attenuator value.
    Upper Limit: 3 dB higher than the nominal attenuator value
    Lower Limit: 3 dB lower than the nominal attenuator value
    Note        : Tracking Generator Only.

33. Name        : TG Fine Gain DAC
    Desc        : 256 DAC values which correspond to 256 evenly-
                  spaced gains from -4.0 to + 4.0 dB.
    Default     : Evenly spaced DAC values.
    Upper Limit: Must reach at least 4 dB above center DAC (1600).
    Lower Limit: Must reach at least 4 dB below center DAC (1600).
    Note        : Tracking Generator Only.
```

Appendix 2 -- Normalization Error Messages

The following is a list of all possible message which the normalizations can produce when the "CAL_DEBUG" debug flag is turned on. The term "reasonable limits" refers to the limits specified in Appendix 1.

Errors in MAIN DAC OFFSET

MESSAGE: "MAIN DAC OFFSET: **E01** : Cannot center start spur"
MEANING: Beginning at 10 MHz/div span, the start spur was located and centered, then span was reduced. In 1 MHz/div span, the signal could not be centered within 30 horizontal storage bits.

MESSAGE: "MAIN DAC OFFSET: **E02** : Cannot count beat frequency"
MEANING: The beat frequency was connected to the counter, but an attempt at counting was unsuccessful. This attempt occurred when the start spur was near center screen, producing a beat frequency of around 5 to 10 MHz.

MESSAGE: "MAIN DAC OFFSET: **E03** : Cannot set main DAC low enough"
MEANING: To actually center the start spur, a DAC value < 1 was requested.

MESSAGE: "MAIN DAC OFFSET: **E04** : Cannot count beat frequency"
MEANING: The beat frequency was connected to the counter, but an attempt at counting was unsuccessful. This attempt occurred when the start spur was being set to center screen.

MESSAGE: "MAIN DAC OFFSET: **E05** : Result out of range. Meas: XXX Upper: YYY Lower: ZZZ"
MEANING: The calculated result for this test was outside of reasonable limits.
XXX is the measured result, YYY and ZZZ are the upper and lower limits for this step.

Errors in MAIN DAC SENS (instruments from B010001 to B010318)

MESSAGE: "MAIN DAC SENS: **E01** : Cannot count beat frequency"
MEANING: The beat frequency should have been around 10 MHz, but was not countable. This count was done at 0 MHz CF.

MESSAGE: "MAIN DAC SENS: **E02** : Cannot count beat frequency"
MEANING: The beat frequency should have been around 10 MHz, but was not countable. This count was done on the way up from 0 to 1800 MHz.

MESSAGE: "MAIN DAC SENS: **E03** : Main DAC overrange"
MEANING: The next 100 MHz step going up to 1800 MHz would have

set the main DAC over 4095.

MESSAGE: "MAIN DAC SENS: **E04** : Main DAC underrange"
MEANING: The next 100 MHz step going up to 1800 MHz would have set the main DAC under 1.

MESSAGE: "MAIN DAC SENS: **E05** : Result out of range.
Meas: XXX Upper: YYY Lower: ZZZ"
MEANING: The calculated result for this test was outside of reasonable limits.
XXX is the measured result, YYY and ZZZ are the upper and lower limits for this step.

MESSAGE: "MAIN DAC SENS: **E06** : Cannot count beat frequency."
MEANING: The beat frequency should have been around 10 MHz, but was not countable. This count was done at 900 MHz CF.

Errors in MAIN DAC SENS (B020319 and up)

MESSAGE: "MAIN DAC SENS: **E01** : YIG cannot be counted at 0 MHz"
MEANING: The YIG frequency could not be determined after a series of LF VCO and beat frequency counts. This was tried at approximately 0 MHz (2110 MHz YIG frequency).

MESSAGE: "MAIN DAC SENS: **E02** : YIG cannot be counted at 80% of CF range"
MEANING: The YIG frequency could not be determined after a series of LF VCO and beat frequency counts. This was tried at approximately 1440 MHz (3550 MHz YIG frequency).

MESSAGE: "MAIN DAC SENS: **E03** : Result out of range Meas: XXX"
MEANING: The intermediate result predicted a main DAC value > 4095 at 1800 MHz. XXX is the measured result.

MESSAGE: "MAIN DAC SENS: **E04** : YIG cannot be counted at 100% of CF range"
MEANING: The YIG frequency could not be determined after a series of LF VCO and beat frequency counts. This was tried at approximately 1800 MHz (3910 MHz YIG frequency).

MESSAGE: "MAIN DAC SENS: **E05** : Result out of range.
Meas: XXX Upper: YYY Lower: ZZZ"
MEANING: The final value calculated is outside reasonable limits.
XXX is the measured result, YYY and ZZZ are the upper and lower limits for this step.

MESSAGE: "MAIN DAC SENS: **E06** : YIG cannot be counted at 50% of CF range"
MEANING: The YIG frequency could not be determined at 900 MHz CF.

Errors in FM DAC SENS

MESSAGE: "FM DAC SENS: **E01** : Cannot set strobe to required frequency"
MEANING: The strobe frequency could not be set to a known frequency.
NOTE : B020319 and up.

MESSAGE: "FM DAC SENS: **E02** : Cannot count beat frequency"
MEANING: Failed to count the beat frequency while trying to set the YIG to a specific position (5 MHz for B020319 and up, 15 MHz for instruments from B010001 to B010318.)

MESSAGE: "FM DAC SENS: **E03** : Cannot set beat frequency with main DAC"
MEANING: 5 attempts have failed to set the beat frequency to the proper location.

MESSAGE: "FM DAC SENS: **E04** : Cannot count beat frequency"
MEANING: The beat frequency could not be counted when the FM DAC was set to 1.

MESSAGE: "FM DAC SENS: **E05** : Cannot count beat frequency"
MEANING: The beat frequency could not be counted when the FM DAC was set to 4095.

MESSAGE: "FM DAC SENS: **E06** : Result out of range. Meas: XXX Upper: YYY Lower: ZZZ"
MEANING: The calculated result for this test was outside of reasonable limits.
XXX is the measured result, YYY and ZZZ are the upper and lower limits for this step.

Errors in FREQUENCY DRIFT

MESSAGE: "FREQUENCY DRIFT: **E01** : Cannot count beat frequency"
MEANING: The beat frequency could not be counted while finding a good starting frequency.
NOTE : Instruments from B010001 to B010318

MESSAGE: "FREQUENCY DRIFT: **E02** : Cannot find a good starting frequency"
MEANING: 5 attempts have failed to set the beat frequency to the proper location.
NOTE : Instruments from B010001 to B010318

MESSAGE: "FREQUENCY DRIFT: **E03** : Cannot count beat frequency"
MEANING: Could not count beat frequency after letting YIG settle.
NOTE : Instruments from B010001 to B010318

MESSAGE: "FREQUENCY DRIFT: **E04** : Cannot count beat frequency"
MEANING: Could not count beat frequency during actual drift test.

NOTE : Instruments from B010001 to B010318

MESSAGE: "FREQUENCY DRIFT: **E05** : Result out of range.
Meas: XXX Upper: YYY Lower: ZZZ"
MEANING: The calculated result for this test was outside of reasonable limits.
XXX is the measured result, YYY and ZZZ are the upper and lower limits for this step.
NOTE : Instruments from B010001 to B010318

Errors in UPPER VCO SENS

MESSAGE: "UPPER VCO SENS: **E01** : Cannot count phase lock VCO"
MEANING: The LF VCO could not be counted at some point on the Upper VCO DAC.

MESSAGE: "UPPER VCO SENS: **E02** : Result out of range.
Meas: XXX Upper: YYY Lower: ZZZ"
MEANING: The calculated result for this test was outside of reasonable limits.
XXX is the measured result, YYY and ZZZ are the upper and lower limits for this step.

MESSAGE: "UPPER VCO SENS: **E03** : Cannot calculate polynomial"
MEANING: The coefficients for the curve-fitting algorithm could not be calculated. One or more of the 20 sample points taken along the VCO curve were probably in error, due to a frequency counter malfunction.

Errors in LOWER VCO SENS

MESSAGE: "LOWER VCO SENS: **E01** : Cannot count phase lock VCO"
MEANING: The LF VCO could not be counted when the upper VCO DAC was set for a VCO frequency of approximately 13.4 MHz and the lower VCO DAC was at center (2047).

MESSAGE: "LOWER VCO SENS: **E02** : Cannot count phase lock VCO"
MEANING: The LF VCO could not be counted when the upper VCO DAC was set for a VCO frequency of approximately 13.4 MHz and the lower VCO DAC was at its upper limit (4095).

MESSAGE: "LOWER VCO SENS: **E03** : Result out of range.
Meas: XXX Upper: YYY Lower: ZZZ"
MEANING: The calculated result for this test was outside of reasonable limits.
XXX is the measured result, YYY and ZZZ are the upper and lower limits for this step.

Errors in SPAN/DIV

MESSAGE: "SPAN/DIV: **E01** : Cannot count at center screen, DAC low. rng: RRR"
MEANING: For this span range, the effective screen frequency could not be determined when the span DAC was set to 30 and the sweep was parked at center screen. RRR is the span range number.

MESSAGE: "SPAN/DIV: **E02** : Cannot count at center screen, DAC high. rng: RRR"
MEANING: For this span range, the effective screen frequency could not be determined when the span DAC was set to 4095 and the sweep was parked at center screen. RRR is the span range number.

MESSAGE: "SPAN/DIV: **E03** : Cannot count at right screen, DAC low. rng: RRR"
MEANING: For this span range, the effective screen frequency could not be determined when the span DAC was set to 30 and the sweep was parked at right screen. RRR is the span range number.

MESSAGE: "SPAN/DIV: **E04** : Cannot count at right screen, DAC high. rng: RRR"
MEANING: For this span range, the effective screen frequency could not be determined when the span DAC was set to 4095 and the sweep was parked at right screen. RRR is the span range number.

MESSAGE: "SPAN/DIV: **E05** : Span out of range. Meas: XXX Upper: YYY Lower: ZZZ. rng: RRR"
MEANING: The calculated result for this test was outside of reasonable limits.
XXX is the measured result, YYY and ZZZ are the upper and lower limits for this step, and RRR is the span range number.

Errors in FREQUENCY ACCURACY

MESSAGE: "FREQUENCY ACCURACY: **E01** : Cannot count YIG, frq: FFF"
MEANING: The YIG frequency could not be determined.
FFF is the center frequency where the count was attempted.
NOTE : B020319 and up

MESSAGE: "FREQUENCY ACCURACY: **E02** : Cannot count beat frequency, frq: FFF"
MEANING: The beat frequency could not be counted.
FFF is the center frequency where the count was attempted.
NOTE : Instruments from B010001 to B010318

MESSAGE: "FREQUENCY ACCURACY: **E03** : Out of range, Meas: XXX Upper: YYY Lower: ZZZ"
MEANING: The result was outside of acceptable limits.

XXX is the measured result, YYY and ZZZ are the upper and lower limits for this step.

Errors in GAIN AND ATTEN

-10dB THROUGH 40dB STEPS

MESSAGE: "GAIN AND ATTEN: **E01** : Cannot span down on calibrator"
MEANING: On The first attempt, the calibrator could not be centered sufficiently to go to zero span without losing the signal.

MESSAGE: "GAIN AND ATTEN: **E02** : Cannot span down on calibrator"
MEANING: On The second attempt, the calibrator could not be centered sufficiently to go to zero span without losing the signal.

MESSAGE: "GAIN AND ATTEN: **E03** : Cannot calculate lin mode sensitivity"
MEANING: Lin mode sensitivity figures were outside of reasonable limits.

MESSAGE: "GAIN AND ATTEN: **E04** : Attenuation result out of range. Meas: XXX Upper: YYY Lower: ZZZ step: AAA"
MEANING: One of the attenuator steps measured outside of reasonable limits.
XXX is the measured result, YYY and ZZZ are the upper and lower limits for this step, and AAA is the attenuator step being measured. Attenuator steps are 0 to 52 dB, in 2 dB steps, numbered from 0 to 26.

MESSAGE: "GAIN AND ATTEN: **E05** : Gain step result out of range. Meas: XXX Upper: YYY Lower: ZZZ step: GGG"
MEANING: One of the gain steps measured outside of reasonable limits.
XXX is the measured result, YYY and ZZZ are the upper and lower limits for this step, and GGG is the gain step being measured. Gain steps are -10 to +40 dB, numbered 0 to 50.

-20dB THROUGH -11dB STEPS

MESSAGE: "GAIN AND ATTEN: **E06** : Cannot span down on calibrator"
MEANING: On The second attempt, the calibrator could not be centered sufficiently to go to zero span without losing the signal.

MESSAGE: "GAIN AND ATTEN: **E07** : Cannot calculate lin mode sensitivity"
MEANING: Lin mode sensitivity figures were outside of reasonable limits.

MESSAGE: "GAIN AND ATTEN: **E08** : Gain step result out of range.

Meas: XXX Upper: YYY Lower: ZZZ step: GGG"
MEANING: One of the gain steps measured outside of reasonable limits. XXX is the measured result, YYY and ZZZ are the upper and lower limits for this step, and GGG is the gain step being measured. Gain steps are -20 to -11 dB, numbered 0 to 9.

Errors in BW FLTR AMPLTD (LIN)

MESSAGE: "BW FLTR AMPLTD (LIN): **E01** : Cannot measure lin mode" sensitivity"
MEANING: Lin mode sensitivity figures were outside of reasonable limits.

MESSAGE: "BW FLTR AMPLTD (LIN): **E02** : Cannot set filter to full" screen"
MEANING: The RF attenuators could not reduce the signal below full screen.

MESSAGE: "BW FLTR AMPLTD (LIN): **E03** : Result out of range. Meas: XXX Upper: YYY Lower: ZZZ fltr: FFF"
MEANING: The calculated result for this test was outside of reasonable limits.
XXX is the measured result, YYY and ZZZ are the upper and lower limits for this step, FFF is the filter bandwidth.

Errors in BW FLTR AMPLTD (LOG)

MESSAGE: "BW FLTR AMPLTD (LOG): **E01** : Cannot set 5MHz filter to full screen"
MEANING: The 5 MHz filter shape could not be set to full screen with the gain and attenuator steps and the VR fine gain DAC.

MESSAGE: "BW FLTR AMPLTD (LOG): **E02** : Cannot set filter to full screen"
MEANING: The RF attenuation, VR gain, and VR fine gain together could not set the filter being tested to full screen.

MESSAGE: "BW FLTR AMPLTD (LOG): **E03** : Result out of range. Meas: XXX Upper: YYY Lower: ZZZ fltr: FFF"
MEANING: The calculated result for this test was outside of reasonable limits.
XXX is the measured result, YYY and ZZZ are the upper and lower limits for this step, FFF is the filter bandwidth.

Errors in PREAMP GAIN

MESSAGE: "PREAMP GAIN: **E01** : Cannot span down on calibrator"
MEANING: On The second attempt, the calibrator could not be centered sufficiently to go to zero span without losing the signal.

MESSAGE: "PREAMP GAIN: **E02** : Cannot calculate lin mode

sensitivity"
MEANING: Lin mode sensitivity figures were outside of reasonable limits.

MESSAGE: "PREAMP GAIN: **E03** : Cannot bring signal on screen with attenuators"
MEANING: Once the preamp was turned on, the signal could not be brought down below full screen with the RF attenuators.

MESSAGE: "PREAMP GAIN: **E04** : Result out of range. Meas: XXX Upper: YYY Lower: ZZZ"
MEANING: The calculated result for this test was outside of reasonable limits.
XXX is the measured result, YYY and ZZZ are the upper and lower limits for this step.

Errors in DETECTOR GAIN

LIN MODE - FIRST 20DB DETECTOR GAIN STEP

MESSAGE: "DETECTOR GAIN: **E01** : Cannot span down on calibrator"
MEANING: On The second attempt, the calibrator could not be centered sufficiently to go to zero span without losing the signal.

MESSAGE: "DETECTOR GAIN: **E02** : Cannot calculate lin mode sensitivity"
MEANING: Lin mode sensitivity figures were outside of reasonable limits.

MESSAGE: "DETECTOR GAIN: **E03** : Cannot bring signal on screen with attenuators"
MEANING: Once the preamp was turned on, the signal could not be brought down below full screen with the RF attenuators.

MESSAGE: "DETECTOR GAIN: **E04** : Result out of range. Meas: XXX Upper: YYY Lower: ZZZ"
MEANING: The calculated result for this test was outside of reasonable limits.
XXX is the measured result, YYY and ZZZ are the upper and lower limits for this step.

LIN MODE - SECOND 20DB DETECTOR GAIN STEP

MESSAGE: "DETECTOR GAIN: **E05** : Cannot bring signal on screen with attenuators"

MEANING: Once the preamp was turned on, the signal could not be brought down below full screen with the RF attenuators.

MESSAGE: "DETECTOR GAIN: **E06** : Result out of range. Meas: XXX Upper: YYY Lower: ZZZ"
MEANING: The calculated result for this test was outside of reasonable limits.
XXX is the measured result, YYY and ZZZ are the upper and lower limits for this step.

LOG MODE - FIRST 20DB DETECTOR GAIN STEP

MESSAGE: "DETECTOR GAIN: **E07** : Cannot set signal to 1 div down"
MEANING: Initially, the calibrator signal could not be set to 1 division below full screen with the RF attenuators, VR gain steps, or VR fine gain DAC.

MESSAGE: "DETECTOR GAIN: **E08** : Cannot set signal to 1 div down"
MEANING: The calibrator signal could not be set to 1 division below full screen after the first 20dB step was turned on. This is necessary to be able to measure the gain step.

MESSAGE: "DETECTOR GAIN: **E09** : Result out of range. Meas: XXX Upper: YYY Lower: ZZZ"
MEANING: The calculated result for this test was outside of reasonable limits.
XXX is the measured result, YYY and ZZZ are the upper and lower limits for this step.

LOG MODE - SECOND 20DB DETECTOR GAIN STEP

MESSAGE: "DETECTOR GAIN: **E07** : Cannot set signal to 1 div down"
MEANING: Initially, the calibrator signal could not be set to 1 division below full screen with the RF attenuators, VR gain steps, or VR fine gain DAC.

MESSAGE: "DETECTOR GAIN: **E08** : Cannot set signal to 1 div down"
MEANING: The calibrator signal could not be set to 1 division below full screen after the first 20dB step was turned on. This is necessary to be able to measure the gain step.

MESSAGE: "DETECTOR GAIN: **E09** : Result out of range. Meas: XXX Upper: YYY Lower: ZZZ"
MEANING: The calculated result for this test was outside of reasonable limits.
XXX is the measured result, YYY and ZZZ are the upper and lower limits for this step.

Errors in GAIN CORRECTION DAC

MESSAGE: "GAIN CORRECTION DAC: **E01** : Cannot span down on calibrator"
MEANING: On The second attempt, the calibrator could not be centered sufficiently to go to zero span without losing the signal.

MESSAGE: "GAIN CORRECTION DAC: **E02** : Cannot calculate lin mode sensitivity"
MEANING: Lin mode sensitivity figures were outside of reasonable limits.

MESSAGE: "GAIN CORRECTION DAC: **E03** : Result out of range. Meas: XXX Upper: YYY Lower: ZZZ"
MEANING: The calculated result for this test was outside of reasonable limits.
XXX is the measured result, YYY and ZZZ are the upper and lower limits for this step.

Errors in LOG AMPLIFIER

MESSAGE: "LOG AMPLIFIER: **E01** : Lost signal while spanning down"
MEANING: On The second attempt, the calibrator could not be centered sufficiently to go to zero span without losing the signal.

MESSAGE: "LOG AMPLIFIER: **E02** : Cannot set signal to full screen"
MEANING: Initially, the calibrator signal could not be set to full screen with the RF attenuators, VR gain steps, or VR fine gain DAC.

MESSAGE: "LOG AMPLIFIER: **E03** : Cannot set signal to full screen, scale: SSS"
MEANING: The calibrator could not be set to full screen for one of the three log mode scale factors. SSS is the scale factor being measured.

MESSAGE: "LOG AMPLIFIER: **E04** : Result out of range. Meas: XXX Upper: YYY Lower: ZZZ scale: SSS"
MEANING: The calculated result for this test was outside of reasonable limits.
XXX is the measured result, YYY and ZZZ are the upper and lower limits for this step, SSS is the scale factor which failed.

Errors in FULL SCREEN OFFSETS

MESSAGE: "FULL SCREEN OFFSETS: **E01** : Cannot span down on calibrator"
MEANING: Could not keep calibrator signal on screen when spanning down to 1 MHz span, 5 MHz filter.

MESSAGE: "FULL SCREEN OFFSETS: **E02** : Cannot set calibrator to

full screen, scale SSS"
MEANING: The signal could not be set to full screen with the RF attenuators, VR gain steps, and VR fine gain in the specified scale factor. SSS is one of:
1dB/div
5dB/div
10dB/div
LIN

MESSAGE: "FULL SCREEN OFFSETS: **E03** : Out of range, Meas: XXX Upper: YYY Lower: ZZZ scale: SSS"
MEANING: The calculated result for this test was outside of reasonable limits.
XXX is the measured result, YYY and ZZZ are the upper and lower limits for this step, SSS is one of:
1dB/div
5dB/div
10dB/div
LIN

Errors in SENSITIVITY

MESSAGE: "SENSITIVITY: **E01** : Result out of range. Meas: XXX Upper: YYY Lower: ZZZ rbw: RRR"
MEANING: The peak of the unfiltered noise floor minus the peak of the filtered noise floor was outside of reasonable limits.
XXX is the measured result, YYY and ZZZ are the upper and lower limits for this step, RRR is the resolution bandwidth setting.

MESSAGE: "SENSITIVITY: **E02** : Result out of range. Meas: XXX Upper: YYY Lower: ZZZ rbw: RRR frq: FFF"
MEANING: The average sensitivity with preamp on was outside of reasonable limits.
XXX is the measured result, YYY and ZZZ are the upper and lower limits for this step, RRR is the resolution bandwidth setting, FFF is the center frequency.

MESSAGE: "SENSITIVITY: **E03** : Result out of range. Meas: XXX Upper: YYY Lower: ZZZ rbw: RRR frq: FFF"
MEANING: The average sensitivity with preamp off was outside of reasonable limits.
XXX is the measured result, YYY and ZZZ are the upper and lower limits for this step, RRR is the resolution bandwidth setting, FFF is the center frequency.

Errors in VR FILTER BW & CEN

MESSAGE: "VR FILTER BW & CEN: **E01** : Ran out of memory"
MEANING: The instrument could not acquire enough memory to create the log-to-lin correction table.

MESSAGE: "VR FILTER BW & CEN: **E02** : Cannot find signal,

fltr: RRR"
MEANING: The signal was at least 35 dB lower than expected. There is not enough signal to do the test.

MESSAGE: "VR FILTER BW & CEN: **E03** : Cannot set RRR filter to full screen"
MEANING: The signal could not be set near enough to full screen to do the test. RRR is the resolution bandwidth setting.

MESSAGE: "VR FILTER BW & CEN: **E04** : Signal peak too small, RRR"
MEANING: The signal was below 1/2 screen when the 6 dB-down measurement was taking place. RRR is the resolution bandwidth setting.

MESSAGE: "VR FILTER BW & CEN: **E05** : No Right-hand 6dB down point, fltr: RRR"
MEANING: The firmware could not find a point to the right of the signal peak which was 6 dB down from the peak.
RRR is the resolution bandwidth setting.

MESSAGE: "VR FILTER BW & CEN: **E06** : No Left-hand 6dB down point, fltr: RRR"
MEANING: The firmware could not find a point to the left of the signal peak which was 6 dB down from the peak.
RRR is the resolution bandwidth setting.

MESSAGE: "VR FILTER BW & CEN: **E07** : 6dB BW Result out of range. Meas: XXX Upper: YYY Lower: ZZZ rbw: RRR"
MEANING: The 6 dB down bandwidth measurement was outside of reasonable limits.
XXX is the measured result, YYY and ZZZ are the upper and lower limits for this filter, RRR is the resolution bandwidth setting.

MESSAGE: "VR FILTER BW & CEN: **E08** : Signal peak too small, RRR"
MEANING: The signal was below 1/2 screen when the noise and impulse bandwidth measurement was taking place.
RRR is the resolution bandwidth setting.

MESSAGE: "VR FILTER BW & CEN: **E09** : Impulse BW Result out of range. Meas: XXX Upper: YYY Lower: ZZZ rbw: RRR"
MEANING: The impulse bandwidth measurement was outside of reasonable limits.
XXX is the measured result, YYY and ZZZ are the upper and lower limits for this filter, RRR is the resolution bandwidth setting.

MESSAGE: "VR FILTER BW & CEN: **E10** : Noise BW Result out of range. Meas: XXX Upper: YYY Lower: ZZZ rbw: RRR"
MEANING: The noise bandwidth measurement was outside of reasonable limits.
XXX is the measured result, YYY and ZZZ are the upper

and lower limits for this filter, RRR is the resolution
bandwidth setting.

Errors in INTERNAL REF FREQ

MESSAGE: "INTERNAL REF FREQ: **E01** : Cannot count reference signal"
MEANING: The user-applied reference signal could not be counted
using the center-measure function.

MESSAGE: "INTERNAL REF FREQ: **E02** : Result out of range.
Meas: XXX Upper: YYY Lower: ZZZ"
MEANING: The calculated result for this test was outside of
reasonable limits.
XXX is the measured result, YYY and ZZZ are the upper
and lower limits for this step.

Errors in INTERNAL REF AMPLTD

MESSAGE: "INTERNAL REF AMPLTD: **E01** : Cannot span down on
external signal"
MEANING: The externally-applied signal could not be set to
zero span, 5 MHz filter. Probably due to frequency
instability in the signal or the 2710.

MESSAGE: "INTERNAL REF AMPLTD: **E02** : Cannot set calibrator to full
screen"
MEANING: The user-applied reference signal could not be set 0.5 divs
from full screen using VR gain steps, RF attenuators,
and the VR fine gain DAC.

MESSAGE: "INTERNAL REF AMPLTD: **E03** : No amplitude change when 10 dB
step changes"
MEANING: The 10 dB reference step was removed to calculate
the lin mode sensitivity, The amplitude did not change.

MESSAGE: "INTERNAL REF AMPLTD: **E04** : Lin mode sensitivity out of
range"
MEANING: The calculations for lin mode sensitivity were
outside of reasonable limits.

MESSAGE: "INTERNAL REF AMPLTD: **E05** : Cannot span down on calibrator"
MEANING: The internal calibrator signal could not be set to
zero span, 5 MHz filter. Probably due to frequency
instability in the signal or the 2710.

MESSAGE: "INTERNAL REF AMPLTD: **E06** : Result out of range.
Meas: XXX Upper: YYY Lower: ZZZ"
MEANING: The calculated result for this test was outside of
reasonable limits.
XXX is the measured result, YYY and ZZZ are the upper
and lower limits for this step.

Errors in GAIN STEP REFERENCE

MESSAGE: "GAIN STEP REFERENCE: **E01** : Cannot set external signal near full screen"
MEANING: The signal could not be placed at or above full screen by reducing RF attenuation.

MESSAGE: "GAIN STEP REFERENCE: **E02** : Cannot set signal to 0.75 divs from full screen"
MEANING: The signal could not be placed exactly 0.75 div's below full screen by using only the VR fine gain DAC.

MESSAGE: "GAIN STEP REFERENCE: **E03** : External signal at incorrect level Meas: XXX Exp: < YYY"
MEANING: The signal did not drop at least 70 storage locations when the operator reduced the signal by 10 dB (lin mode).
XXX is the measured vertical position of the signal,
YYY is the position which the signal must be below.

MESSAGE: "GAIN STEP REFERENCE: **E04** : Cannot measure lin mode sensitivity"
MEANING: The calculations for lin mode sensitivity were outside of reasonable limits.

MESSAGE: "GAIN STEP REFERENCE: **E05** : Result out of range. Meas: XXX Upper: YYY Lower: ZZZ"
MEANING: The calculated result for this test was outside of reasonable limits.
XXX is the measured result, YYY and ZZZ are the upper and lower limits for this step.

SH 1 Errors in TG FREQ OFFSET POS

MESSAGE: "TG FREQ OFFSET POS: **E01** : Could not find a peak (coarse tune)."
MEANING: A signal peak could not be found when using coarse VCO tuning steps.

MESSAGE: "TG FREQ OFFSET POS: **E02** : E02 : Could not find a peak (fine tune)."
MEANING: After a coarse peak was found, the fine peak did not resolve, usually because the signal was not high enough.

MESSAGE: "TG FREQ OFFSET POS: **E03** : Could not count VCO at peak position"
MEANING: After the peak response was found, the VCO could not be counted.

MESSAGE: "TG FREQ OFFSET POS: **E04** : Could not count VCO at 0 DAC value"
MEANING: The VCO could not be counted when the VCO DAC was set to zero.

MESSAGE: "TG FREQ OFFSET POS: **E05** : Could not count VCO at highest DAC value"
MEANING: The VCO could not be counted when the VCO DAC was set

to 4095.

MESSAGE: "TG FREQ OFFSET POS: **E06** : Cannot set VCO low enough. Meas: XXX, Limit: YYY"
MEANING: The lowest possible VCO frequency was higher than acceptable limits. XXX is the measured result, YYY is the acceptable limit.

MESSAGE: "TG FREQ OFFSET POS: **E07** : Cannot set VCO high enough. Meas: XXX, Limit: YYY"
MEANING: The highest possible VCO frequency was lower than acceptable limits. XXX is the measured result, YYY is the acceptable limit.

SH 1 Errors in TG FREQ DAC

MESSAGE: "TG FREQ DAC: **E01** : Cannot count TG VCO (XXX)"
MEANING: The VCO could not be counted at the DAC value XXX.

MESSAGE: "TG FREQ DAC: **E02** : Cannot set VCO low enough. Meas: XXX, Limit: YYY"
MEANING: The lowest possible VCO frequency was higher than acceptable limits. XXX is the measured result, YYY is the acceptable limit.

MESSAGE: "TG FREQ DAC: **E03** : Cannot set VCO high enough. Meas: XXX, Limit: YYY"
MEANING: The highest possible VCO frequency was lower than acceptable limits. XXX is the measured result, YYY is the acceptable limit.

SH 1 Errors in TG ATTENUATORS

MESSAGE: "TG ATTENUATORS: **E01** : Could not set signal to full screen"
MEANING: The signal could not be placed near enough to full screen.

MESSAGE: "TG ATTENUATORS: **E02** : Result out of range. Meas: XXX Upper: YYY Lower: ZZZ"
MEANING: The calculated result for this test was outside of reasonable limits.
XXX is the measured result, YYY and ZZZ are the upper and lower limits for this step.

SH 1 Errors in TG AMPL DAC

MESSAGE: "TG AMPL DAC: **E01** : Could not set signal to full screen"
MEANING: The signal could not be placed near enough to full screen.

MESSAGE: "TG AMPL DAC: **E02** : DAC cannot be adjusted low enough. Meas: XXX, Limit: YYY"
MEANING: The lowest gain acheivable with the amplitude DAC was not low enough. XXX is the measured result, YYY

is the acceptable limit.

MESSAGE: "TG AMPL DAC: **E03** : DAC cannot be adjusted high enough. Meas: XXX, Limit: YYY"
MEANING: The highest gain acheivable with the amplitude DAC was not high enough. XXX is the measured result, YYY is the acceptable limit.