

Note that only the second line of the display is shown above. The second line of the LCD display contains operator selections. The first line of the display shows the current modulation, frequency, and level settings for the unit.

5.4.3 Implement the Calibration Mode of Operation (AutoCal®) by pressing the "4" key. Software will turn off all modulation, turn off the RF output, and store the current instrument settings. The initial calibration screen will be called up:

CALIBRATION SELECTIONS

1:Freq 2:Level 3:Default +:Exit

Output frequency or output level may be calibrated in the AutoCal® mode. The output frequency calibration routine is described in section 5.4.4; the output level calibration routine is described in section 5.4.6.

The frequency calibration must be performed before the output power level calibration.

When either calibration routine is selected, the entire calibration procedure must be completed. No exit or abort will be allowed after this point.

5.4.4 Before performing a frequency calibration, factory default data must be entered from the initial calibration screen:

CALIBRATION SELECTIONS

1:Freq 2:Level 3:Default +:Exit

## 5.4 AUTOCAL® CALIBRATION

The Wavetek Model 2407 RF Signal Generator uses an almost completely automatic calibration procedure (AutoCal®) to calibrate the circuits that determine output frequency and output power level. The status key is used to implement AutoCal®. The detailed procedure to perform the Model 2407 calibration is described in the following sections.

5.4.1 Turn on the Model 2407 and permit a warm up time of one hour (if necessary).

5.4.2 Press the status key ("Stat") to call up the status key operation select menu:

1:Error 2:Diag 3:Optn 4:Cal 5:Set +:Exit

Press a "3" from this display to load factory default values for frequency and level calibrations into memory. The following message will be displayed:

LEVEL & FREQUENCY CALIBRATION DATA  
RESET TO FACTORY DEFAULT VALUES

This message is displayed for 2-3 seconds while default calibration data is loaded. A generic table of frequency calibration values and a default selection of level flatness calibration frequencies are loaded. The level flatness and linearity calibration factors are reset to 0.0 dB. Then the initial calibration menu is displayed again, ready for another selection.

After entering the default data, press a "1" from the initial calibration menu to call up the menu used to initiate a frequency calibration:

FREQUENCY CAL SELECTIONS  
1:FULL 2:VCO1 3:VCO2 4:Date +:Exit

Three separate frequency calibrations may be selected and a calibration date may be entered. Pressing the "1" key will initiate a complete frequency calibration. Pressing the "2" key will calibrate the lower VCO only. Pressing the "3" key will calibrate the upper VCO only. Pressing the "4" key will initiate the procedure to enter a calibration date (described at the end of this section).

Press the appropriate numeric key ("1-3") from the initial calibration menu to select the desired frequency calibration. Each frequency calibration routine is completely automatic and requires no operator input at any step.

Pressing a "1" or a "2" will initiate calibration of the lower VCO and call up the the VCO 1 display:

FREQUENCY 275 MHZ  
CALIBRATION VCO 1 DELAY 60

Pressing a "3" will initiate calibration

of the upper VCO and call up the VCO 2 display:

FREQUENCY 390 MHZ  
CALIBRATION VCO 2 DELAY 60

The bottom line of either calibration display shows the 60 second countdown delay, with the count decreased by 1 every second, that allows a 60 second warmup time for each VCO to eliminate drift problems. The DELAY message will disappear after reaching "DELAY 1".

During lower VCO calibration, the current frequency being calibrated will be shown. Calibration data will be shown in the right section of the bottom display line, following the characters "DATA". three data values are shown: the coarse tune DAC value, the loop compensation DAC value, and the FM correction value. The A/D error voltage for the associated coarse tune DAC value is shown immediately above the calibration data. A typical display will look like:

FREQUENCY VCO 1 A/D: +0.32 v  
CALIBRATION 275 MHZ DATA: 40 2D 5FD

To calibrate the first calibration point (for each VCO) requires about 10 seconds. Calibration is performed at 2 MHz intervals, taking approximately two seconds for each succeeding calibration point. The loop compensation DAC and coarse tune DAC values are determined every 10 MHz. FM correction is sampled every 5 MHz. These measurements are used to interpolate FM correction values at 1 MHz intervals.

When the lower VCO calibration is complete, the unit will automatically begin calibration of the upper VCO if a complete frequency calibration was requested (the "1" key was the initial key pressed). After the last frequency calibration has been performed the following screen will be displayed for approximately 2 seconds:

FREQUENCY  
CALIBRATION COMPLETED

The initial calibration screen will then be recalled:

CALIBRATION SELECTIONS

1:Freq 2:Level 3:Default +:Exit

Press a "4" from the initial frequency calibration menu to call up the screen for the calibration date:

FREQ CAL Last call: xx-xx-xx  
DATE Enter: MM-DD-YY +:Exit

The last date entry (Last call) is shown on the top line of the display. The date should be updated every time a frequency calibration is performed. Loading default calibration data will reset the date to 00-00-00. The numeric keys are used to modify the date. The cursor is placed under the digit to be changed, and automatically goes to the next digit when an entry is made. Entries are made in the order shown, (month, day, year). There is no internal verification that valid dates are entered. Modifying the frequency calibration date entry does not affect the level calibration date, which is accessed from the level calibration procedure. Date entries are accessible over the GPIB.

5.4.5 Frequency calibration errors typically are due to hardware problems and require some degree of troubleshooting. Wavetek recommends returning the unit to the factory for troubleshooting and repair.

The peak A/D detector is tested before calibration begins because frequency calibration depends upon it functioning properly. If it fails the test, the following screen will be called up:

FREQUENCY 275 MHz FAIL: A/D ERROR  
CALIBRATION PRESS STATUS TO EXIT

The A/D error can occur only at the beginning of the frequency calibration. Press the status key ("Stat") to recall the initial calibration display.

During frequency calibration the coarse tune DAC is adjusted to make the synthesizer error voltage equal 0.0v. Two errors can occur. If the coarse tune DAC can not be reduced as far as it needs to be, the coarse low fail error will occur:

FREQUENCY 275 MHz FAIL: COARSE LOW  
CALIBRATION PRESS STATUS TO EXIT

If the coarse tune DAC can not be increased as much as it needs to be, the coarse high fail error will occur:

FREQUENCY 275 MHz FAIL: COARSE HIGH  
CALIBRATION PRESS STATUS TO EXIT

If either error occurs, press the status key to recall the initial calibration display.

The loop compensation DAC values are derived from the coarse tune values. There are no errors associated with them. The FM correction values are determined by adjusting the FM DAC value until the peak A/D value matches a level corresponding to the desired deviation value. Therefore the FM correction values can have the same errors as the coarse tune DAC. That is, it may not be possible to adjust the DAC value low enough (FM Cal Low error) or high enough (FM Cal High error) to reach the desired voltage level. The associated error messages are:

FREQUENCY 275 MHz FAIL: FM CAL LOW  
CALIBRATION PRESS STATUS TO EXIT

FREQUENCY 275 MHz FAIL: FM CAL HIGH  
CALIBRATION PRESS STATUS TO EXIT

If either error occurs, press the status key to recall the initial calibration display.

5.4.6 The level calibration routine is semiautomatic when performed using front panel controls. A power meter will be

connected to the RF output and the unit tuned from the front panel, according to the power meter readings.

The frequency calibration described in section 5.4.4 should be performed before the output power level calibration to ensure the frequency points used in the level calibration are accurate. If the frequency and level calibrations have been performed, and only an adjustment in either level flatness or linearity is needed, it is not necessary to perform the frequency calibration again.

The LEVEL calibration routine is selected from the initial calibration menu:

#### CALIBRATION SELECTIONS

1:Freq 2:Level 3:Default +:Exit

Press the "2" key to initiate level calibration and call up the initial level calibration screen:

#### LEVEL CAL SELECTIONS

1:Flatness 2:Linearity 3:Date +:Exit

Separate procedures are available to calibrate level flatness and level linearity. Pressing the "3" key will initiate the procedure to enter a calibration date (described at the end of this section).

The level flatness calibration process (section 5.4.6.1) adjusts the level accuracy of the instrument over different frequency settings. This flatness correction is performed at a fixed level output of 0 dBm, and the adjustment corrects for the variations in level across the operating frequencies of the instrument.

The level linearity calibration process (Section 5.4.6.2) adjusts the level accuracy of the instrument over different level settings. Because the level flatness correction is performed at a fixed level output (0 dBm), the linearity adjustment must be performed to correct for the nonlinearities of the

level control circuitry. The linearity calibration is performed at a fixed frequency of 300 MHz, with level settings adjusted from +13 dBm to -7 dBm in 1 dB increments.

If the level calibration data has been reset to the default setting (Section 5.4.4), it doesn't matter whether level flatness or level linearity calibration is performed first. Note that whichever calibration is performed last should have nearly 0.0 dB correction factor at the "crossover" point. The crossover point for the level flatness calibration is the 300 MHz frequency calibration point. The 0.0 dB level calibration point is the crossover point for the level linearity calibration.

5.4.6.1 To begin a level flatness calibration, enter a "1" from the initial level calibration screen to call up the following screen:

#### LEVEL CALIBRATION CONNECT POWER METER

The message to connect a power meter will be displayed for approximately 4 seconds. Connect an RF power meter with range from .01 MHz to 550 MHz to the 2407 RF output connector.

If cable losses are also to be nulled out so that a flat signal is transmitted at the end of a long cable length, connect the power meter to the end of the cable when making the level flatness adjustments.

The level flatness calibration mode screen will appear after the "CONNECT POWER METER" message:

LEVEL CAL UP/DOWN: xx.x dB <- adjust  
FLATNESS LFT/RIT: xxxx MHz +:Exit

The top line of the display indicates the procedure being performed (LEVEL CAL) and shows the UP/DOWN arrow cursor keys control the output RF (xx.x dB). The "<-adjust" identifies the value associated with the UP/DOWN arrow keys

(xx.x dB) as the value to be adjusted. The bottom line indicates the part of the procedure being performed, the "FLATNESS" procedure, and shows the left/right arrow cursor keys advance the level flatness calibration through the frequency points (xxxx MHz) at which calibration occurs. The "+" key will recall the previous display.

During the level flatness calibration, the 2407 output will be tuned so the power meter reads 0 dBm at each frequency calibration point.

The up and down arrow cursor keys increment and decrement the calibration factor (the "xx.x dB" value required to make the power meter reading equal 0 dBm) at each calibration frequency point.

The right and left arrow cursor keys step forward and backward from one frequency calibration point to the next. The right arrow cursor is used to step forward through the level flatness calibration frequencies. Pressing this key at the last calibration point will display the message "DONE" in place of the frequency display, to indicate there are no more calibration points. When this message is displayed, only the left arrow key, the "+" key and the STATUS key are active. The left arrow cursor is used to recall a calibration point for review. The left arrow key has no effect when the first (lowest frequency) calibration point is displayed.

The "+" key and the STATUS key may be used to exit the level flatness calibration mode and recall the initial level calibration menu.

The level flatness calibration factor (in xx.x dB) for the current frequency calibration point is displayed to the left of the UP/DOWN characters. The Up and Down cursor arrow keys will adjust the level flatness calibration factor in 0.1 dB steps. The RF output at each calibration point should be adjusted to

0.0 dBm, using the up/down cursor arrow keys as necessary. The range over which adjustment can occur is from +6 dB to -6 dB. After all calibration points have been adjusted initially, it is usually beneficial to review the calibration points and refine the adjustments.

The calibration factor displayed indicates the amount of adjustment that was necessary at each calibration frequency, but should not to be used as an indicator of how much adjustment to perform.

The following frequencies are points at which level flatness calibration occurs:

10 kHz, 20 kHz, 40 kHz, 60 kHz, 80 kHz, 100 kHz, 200 kHz, 400 kHz, 600 kHz, 800 kHz, 1 MHz, 2 MHz, 4 MHz, 6 MHz, 8 MHz, 10 MHz, 15 MHz, 20 MHz, 40 MHz, 60 MHz, 80 MHz, 100 MHz, 150 MHz, 200 MHz, 250 MHz, 300 MHz, 350 MHz, 400 MHz, 450 MHz, 500 MHz, and 550 MHz

If a point can not be adjusted to 0.0 dBm, a hardware problem is indicated.

When all calibration points have been adjusted to 0.0 dBm, press the "+" key or the STATUS key to exit the level flatness calibration process, and recall the initial level calibration display.

5.4.6.2 To begin a level linearity calibration, enter a "2" from the initial level calibration screen to call up the following screen:

LEVEL CALIBRATION  
CONNECT POWER METER

This message will be displayed for approximately 4 seconds. Connect an RF power meter with range from .01 MHz to 550 MHz to the 2407 RF output connector.

The level linearity calibration mode screen will appear after the "CONNECT POWER METER" message:

LEVEL CAL UP/DOWN: xx.x dB <- adjust  
LINEARITY LFT/RIT: xx.x dBm +:Exit

The top line of the display indicates the procedure being performed (LEVEL CAL) and shows the UP/DOWN arrow cursor keys control the output RF (xx.x dB). The <-adjust" identifies the value associated with the UP/DOWN arrow keys (xx.x dB) as the value to be adjusted. The bottom line indicates the part of the procedure being performed, the "LINEARITY" procedure, and shows the left/right arrow cursor keys advance the level linearity calibration through the power level points (xx.x dBm) at which calibration occurs. The "+" key will recall the previous display.

During the level linearity calibration, the 2407 output will be tuned at each calibration point to make the power meter read the same value as the level value shown on the bottom line of the display.

The up and down arrow cursor keys increment and decrement the calibration factor (the "xx.x dB" value required to make the power meter reading equal to the value shown on the display's bottom line) at each calibration level point.

The right and left arrow cursor keys step forward and backward from one level calibration point to the next. Calibration is from +13 dB to -7 dB. The right arrow cursor is used to step backward through the level linearity calibration power levels. Pressing this key at the last calibration point will display the message "DONE" in place of the level display, to indicate there are no more calibration points. When this message is displayed, only the left arrow key, the "+" key and the STATUS key are active. The left arrow cursor is used to recall a calibration point for review. The left arrow key has no effect when the beginning (+13 dB) calibration point is displayed.

The "+" key and the STATUS key may be used to exit the level flatness calibration mode and recall the initial level calibration menu.

The level linearity calibration factor (in xx.x dB) for the current power level calibration point is displayed to the left of the UP/DOWN characters. The Up and Down cursor arrow keys will adjust the level linearity calibration factor in 0.1 dB steps. The range over which adjustment can occur is from +6 dB to -6 dB. The RF output at each level calibration point should be adjusted using the up/down cursor arrow keys to make the power meter reading equal the level value shown on the bottom line of the display. After all calibration points have been adjusted initially, it is usually beneficial to review the calibration points and refine the adjustments.

The calibration factor displayed indicates the amount of adjustment that was necessary at each calibration level, but should not to be used as an indicator of how much adjustment to perform.

Level linearity calibration occurs from +13 dB to -7 dB, at 1 dB increments.

If a point can not be adjusted so the 2407 level output and the power meter readings are the same, a hardware problem is indicated.

When all calibration points have been adjusted, press the "+" key or the STATUS key to exit the level linearity calibration process, and recall the initial level calibration display.

#### LEVEL CAL SELECTIONS

1:Flatness 2:Linearity 3:Date +:Exit

Press a "3" from the initial level calibration menu to call up the screen for the calibration date:

LEVEL CAL Last call: xx-xx-xx  
DATE Enter: MM-DD-YY +:Exit

The last date entry (Last call) is shown on the top line of the display. The date should be updated every time a level calibration is performed. Loading default calibration data will reset the

date to 00-00-00. The numeric keys are used to modify the date. The cursor is placed under the digit to be changed, and automatically goes to the next digit when an entry is made. Entries are made in the order shown, (month, day, year). There is no internal verification that valid dates are entered. Modifying the level calibration date entry does not affect the frequency calibration date, which is accessed in the frequency calibration mode. Date entries are accessible over the GPIB.