SECTION 1

INTRODUCTION AND DESCRIPTION

1.1 This procedure describes the calibration of the Acme 123 Waveform Generator. The instrument being calibrated is referred to herein as the TI (Test Instrument).

1.2 This procedure includes tests of essential parameters only. Any malfunction noticed during calibration, whether specifically tested for or not, should be corrected.

Table 1. Calibration Description

TI Characteristics	Performance Specifications	Test Method
Timebase	Frequency: 10 MHz Tolerance: ± 6 ppm	Measured with an electronic counter.
Frequency	Range: 15 MHz Tolerance: ± 6 ppm	Measured with an electronic counter.
Duty Cycle	Range: 20-80% to 5 MHz, 40-60% above 5 MHz Tolerance: ± 10% iv	Measured with an electronic counter.
Amplitude	Range: 100 mV - 20 V p-p open circuit; 50 mV - 10 V into 50 ohms Tolerance: ± 1% iv	Measured with a DMM.
Flatness (compared to 1 kHz)	DC - 100 kHz, ± 1%; 100 kHz - 1 MHz, ± 1.5%; 1-15 MHz: ± 0.3 dB	Measured with a DMM (to 1 MHz) and modulation analyzer (above 1 MHz).
Modulation	AM depth: 90% FM deviation: 150 kHz Tolerance: ± 10% iv	Measured with a modulation analyzer.
Functional tests	As indicated.	Visual check with an oscilloscope.
DC voltage	Range: 10 V dc Tolerance: ± (2% iv + 2 mV)	Measured with a DMM.
Spurious outputs	*Harmonics:* DC - 20 kHz, < -70 dBc; 20-100 kHz, < -60 dBc; 100 kHz - 1 MHz, < -45 dBc 1-15 MHz, < -35 dBc *Non-harmonic spurious:* DC - 1 MHz, < -65 dB; 1-15 MHz,< -(65 dB + 6 dB/octave)	Measured with a spectrum analyzer.

1.3 This procedure does not test sync output, FSK, or single-shot trigger/burst.

SECTION 2

EQUIPMENT REQUIREMENTS

NOTE

Minimum-use specifications are the minimum parameters required for performance of the calibration and are included to assist in the selection of alternate equipment. Satisfactory performance of alternate items shall be verified prior to use. All applicable equipment must bear evidence of current calibration.

Table 2. Calibration Description

Item	Minimum-Use Specifications	Calibration Equipment
2.1 Frequency standard	Value: 10 MHz Uncertainty: < 3.75 x 10-7	Zenith ABC
2.2 Electronic counter	Range: 15 MHz Uncertainty: ± 1.5 ppm	Butterfield 8
2.3 Digital multimeter (DMM)	Uncertainty: ± 0.25% iv Range: 1 MHz	Pelham 123
2.4 Modulation analyzer	Range: 1-15 MHz AM depth range: 90% FM deviation range: 150 kHz	BR 549
2.5 Oscilloscope	No substitute	BYU 1984
2.6 Spectrum analyzer	Range: 0-15 MHz	Gator 8

SECTION 3

PRELIMINARY OPERATIONS

NOTE

Throughout this procedure, TI "hardkeys" are those on the front panel and are printed here in boldface. "Softkeys" are those functions printed in blue or green on the TI front panel and are printed here in italics. Words on the TI display are printed here in regular capital letters.

3.1 Ensure that all power switches are set to off. Set all auxiliary equipment controls as necessary to avoid damage to the equipment and so that dangerous voltages will not be present on output terminals when the power switches are turned on.

3.2 Connect the TI and auxiliary equipment to appropriate power sources.

3.3 Turn all auxiliary equipment on. Press the TI **SHIFT** key and hold it down while pressing the **POWER** key to turn it on. Ensure that the TI displays the word TESTING for several seconds, followed by PASS and UNLOCKED.

3.4 Now allow the TI and auxiliary equipment to finish warm-up (the TI requires 10 minutes warm-up time).

3.5 Press the TI > key three times to display D: SYS MENU. Press the TI keys to display 5: COMMA. Then ensure that the TI displays OFF and press the **ENTER** key. The TI will display EXITING and then return to its last display.

3.6 Press the TI **SHIFT** and *RECALL MENU* keys, followed by the < key four times to display 1: OUT TERM.

3.7 Press the TI **SHIFT** and **ENTER** keys, followed by the < key twice to display F: CAL MENU. Press the < key and ensure that the TI displays 1:SECURED. Then press the TI **ENTER** key.

3.8 Set the DMM (item 2.3) to the following: **ACV, RANGE 10, RES .001, TRIG SGL, LFILTER ON.**

SECTION 4

CALIBRATION PROCESS

NOTE

Unless otherwise specified, verify the results of each test and take corrective action whenever the test requirement is not met before proceeding.

4.1 TIMEBASE TESTS

4.1.1 Connect the frequency standard (item 2.1) 10 MHz OUTPUT to the electronic counter (item 2.2) input. Then connect the electronic counter input to the TI 10 MHZ REF OUT on the rear panel. Set the counter to measure frequency and verify that the counter indicates between 9.99994 and 10.00006 MHz.

4.1.2 Disconnect the frequency standard from the electronic counter. Move the electronic counter input to the TI OUTPUT on the front panel.

4.2 FREQUENCY TESTS

4.2.1 Press the TI **AMPL** button. Then press **ENTER NUMBER**, enter *100*, and press the **SHIFT** and *mV pp* buttons. Press the TI **FREQ** key and enter each of the following frequencies in a similar manner. For each frequency, verify that the electronic counter indicates within the given tolerance limits.

TI Frequency	Counter Tolerance Limits
10 Hz	9.99994 to 10.00006 Hz
100 Hz	99.9994 to 100.0006 Hz
1 kHz	999.994 to 1000.006 Hz
10 kHz	9.99994 to 10.00006 kHz
100 kHz	99.9994 to 100.0006 kHz
1 MHz	0.999994 to 1.000006 MHz
5 MHz	4.99997 to 5.00003 MHz
10 MHz	9.99994 to 10.00006 MHz
15 MHz	14.99994 to 15.00006 MHz

4.3 DUTY CYCLE TESTS

4.3.1 Press the TI squarewave button and set the TI to output a 1 V p-p squarewave at 10 kHz. Set the electronic counter to measure duty cycle.

4.3.2 Set the TI to output each of the following duty cycle percentages and verify that the electronic counter indicates within the given tolerance limits. Press the counter STOP/SINGLE button if necessary to ensure a stable reading.

TI Duty Cycle(%)	Counter Tolerance Limits
20	0.18 to 0.22
30	0.27 to 0.33
40	0.36 to 0.44
50	0.45 to 0.55
60	0.54 to 0.66
70	0.63 to 0.77
80	0.72 to 0.88

4.3.3 Set the TI to output a 15 MHz squarewave. Repeat step 4.3.2 for the following values. Press the counter STOP/SINGLE button if necessary to ensure a stable reading.

TI Duty Cycle(%)	Counter Tolerance Limits
40	0.36 to 0.44
50	0.45 to 0.55
60	0.54 to 0.66

4.3.4 Disconnect the electronic counter from the TI and connect the DMM (item 2.3) in its place.

4.4 AMPLITUDE TESTS

4.4.1 Enter a TI frequency of 10 kHz and each of the following amplitudes in V p-p. For each value, verify that the DMM indicates within the given tolerance limits.

TI Amplitude (V p-p)	DMM Tolerance Limits (V rms)
100 mV	35.00 to 35.71 mV
500 mV	175.03 to 178.54 mV
1	0.350 to 0.357
4	1.400 to 1.428
8	2.800 to 2.857
12	4.200 to 4.285
16	5.600 to 5.713
20	7.001 to 7.142

4.4.2 Set the TI amplitude to 200 mV rms and then to each of the following frequency values. For each TI frequency, record the DMM value in mV rms.

TI Frequency
10 Hz
100 Hz
1 kHz
10 kHz
25 kHz
50 kHz
75 kHz
100 kHz

4.4.3 Verify that all values in step 4.4.2 are within ± 1% of the 1 kHz value in step 4.4.2.

4.4.4 Repeat step 4.4.2 for each of the following TI frequencies.

TI Frequency
100 kHz
250 kHz
500 kHz
750 kHz
1 MHz

4.4.5 Verify that all values in step 4.4.4 are within 1.5% of the 1 kHz value in step 4.4.2.

4.4.6 Disconnect the DMM and connect the modulation analyzer (item 2.4) in its place. Set the modulation analyzer to measure frequency and set the TI to output 1 V rms at 1 MHz.

4.4.7 Set the modulation analyzer for RF LEVEL measurement and press the RATIO DB button. Enter each of the following frequency values and record the modulation analyzer display value for each frequency.

TI Frequency
1 MHz
3 MHz
6 MHz
9 MHz
12 MHz
15 MHz

4.4.8 Verify that all values in step 4.4.7 are between -0.30 and 0.30.

4.5 MODULATION TESTS

4.5.1 AM Tests

4.5.1.1 Set the TI frequency to 1 MHz and the amplitude to 3 V rms. Press the TI **SHIFT** and *AM* keys, followed by **SHIFT** and *RECALL MENU* to display 1: AM SHAPE. Press the TI < key once and then rotate the TI knob if necessary until the display reads SINE. Press **ENTER**.

4.5.1.2 Press the TI **SHIFT** and **FREQ** keys. Adjust the modulating frequency to 100 Hz. Then press **SHIFT** and *LEVEL*.

4.5.1.3 Set the modulation analyzer to measure AM modulation and adjust the TI DEPTH percentage to each of the following values. For each value, verify that the modulation analyzer indicates within the given tolerance limits.

TI DEPTH (V p-p)	Modulation Analyzer Tolerance Limits
30%	27 to 33%
60%	54 to 66%
90%	81 to 99%

4.5.2 FM Tests

4.5.2.1 Press the TI **SHIFT** and *FM* keys, followed by **SHIFT** and *RECALL MENU* to display 3: FM SHAPE. Press the TI > key, ensure that the TI displays SINE, and press **ENTER**.

4.5.2.2 Press the TI **SHIFT** and **FREQ** keys and enter a MOD value of 1 kHz. Press **SHIFT** and *LEVEL*. Set the modulation analyzer to measure FM modulation and then adjust the TI DEVIATION to each of the following values. For each value, verify that the modulation analyzer indicates within the given tolerance limits.

TI DEVIATION (kHz)	Modulation Analyzer Tolerance Limits (kHz)
10	9 to 11
50	45 to 55
100	90 to 110
150	135 to 165

4.5.2.3 Press the TI SHIFT and FM keys to turn the waveform off. Disconnect the modulation analyzer from the TI and connect the oscilloscope (item 2.5) in its place.

4.6 FUNCTIONAL TESTS

4.6.1 Burst Tests

4.6.1.1 Set the TI for a frequency of 1 kHz and an amplitude of 5 V p-p. Press the TI **SHIFT** and *BURST* keys, followed by **SHIFT** and *RECALL MENU* to display 4: BURST CNT.

4.6.1.2 Press the TI < key. Press the > key five times and then use the < key to set the display to 00005 CYC.

4.6.1.3 Press the TI **ENTER** key. Adjust the oscilloscope horizontal scale as necessary to display a stable waveform. Verify that the waveform displays bursts of 5 pulses.

4.6.1.4 Press the TI **SHIFT** and *BURST* keys to turn the waveform off.

4.6.2 Sweep Tests

4.6.2.1 Set the TI for a frequency of 1 kHz and an amplitude of 100 mV p-p. Press the TI **SHIFT** and *SWEEP* keys, followed by **SHIFT** and *RECALL MENU* to display 1: START F. Press the TI < key and set the TI for 1 kHz. Then press **ENTER**.

4.6.2.2 Press **SHIFT**, *RECALL MENU* and > to display 2: STOP F. Press < and set the TI for 100 kHz. Then press **ENTER**.

4.6.2.3 Press **SHIFT**, *RECALL MENU* and > to display 3: SWP TIME. Press < and set the TI for 10 seconds. Then press **ENTER**.

4.6.2.4 Press **SHIFT**, *RECALL MENU* and > to display 4: SWP MODE. Press < and set the TI for LINEAR. Then press **ENTER**.

4.6.2.5 Press the oscilloscope AUTOSET and CLEAR MENU buttons. Verify that the oscilloscope displays a sweep that resets every 10 seconds, as measured by the oscilloscope's on-screen clock.

4.6.2.6 Press the TI **SHIFT** and *SWEEP* keys again to turn the sweep off.

4.6.3 Waveform Tests

4.6.3.1 Set the TI frequency to 100 kHz. Press the TI sawtooth, triangle, and **NOISE** keys one at a time. Verify that the oscilloscope displays each corresponding waveform.

4.6.3.2 For each of the five waveforms available (SINC, NEG RAMP, EXP RISE, EXP FALL, and CARDIAC), press the TI **SHIFT** and *ARB LIST* keys. Rotate the knob until the desired waveform name is displayed and then press **ENTER**. Verify that the oscilloscope displays the corresponding waveforms.

4.6.3.3 Press the TI sinewave button. Disconnect the oscilloscope and reconnect the DMM.

4.7 DC VOLTAGE TESTS

4.7.1 Press and hold down the TI **OFFSET** button until the TI displays DCV momentarily. Release the OFFSET button and enter each of the following DC voltage values (use the TI key to input a negative voltage). Verify that the DMM indicates within the given tolerance limits.

TI Offset (V dc)	DMM Tolerance Limits (V)
0	-0.002 to 0.002
2	1.958 to 2.042
4	3.918 to 4.082
6	5.878 to 6.122
8	7.838 to 8.162
10	9.798 to 10.202
-10	-9.798 to -10.202

4.7.2 Disconnect the DMM from the TI. Then cycle the TI **POWER** on and off.

4.8 SPURIOUS OUTPUTS

4.8.1 Connect the spectrum analyzer (item 2.6) RF input to the TI OUTPUT. Set the TI to output each of the following frequencies at 100 mV p-p. For each frequency, adjust the spectrum analyzer display for a 0 dB reference and a stable display of the TI output

signal. Verify that the spectrum analyzer display of the TI harmonics and non-harmonics are within the given tolerance limits.

TI Frequency	Spectrum Analyzer Harmonics	Spectrum Analyzer Non-harmonics
10 kHz	< -70 dB	< -65 dB
50 kHz	< -60 dB	"
250 kHz	< -45 dB	"
500 kHz	"	"
2 MHz	< -35 dB	< -71 dB
8 MHz	"	< -83 dB
15 MHz	"	< -88 dB

4.8.2 Set the spectrum analyzer to OFF and disconnect it from the TI.

4.8.3 Unless other measurements are to be performed, set the TI POWER switch OFF and disconnect all equipment.