with one of the above functional groups. Each time a button is depressed a different menu is displayed. The selected menu is indicated by an LED. Selection of the required parameter within a specific menu is done with the Parameter Select/Edit arrows. Selection and modification of various parameters is discussed in paragraph 3-xxx. The following menus and parameters may be displayed and modified. Table 3-2 lists the limits for each of the these parameters.

3-3-3-1. General Parameters Menus

1. MAIN Menu

FREQ - Frequency of the selected output waveform. Frequency is defined for repetitive signals only. When the function generator is set to operate in triggered mode, the programmed frequency value has no effect on the output. In gated mode, the frequency defines the repetition rate within the gating signal. In continueous mode, the programmed frequency retains its value at both SYNC and the main output connectors. The frequency parameter may be programmed within the range of 10.00mHz to 50.00MHz. Preset value is set to 1.000KHz.

AMPL - Amplitude of the selected waveform at the main output connector. The output signal is driven from a 50Ω source therefore, the value of the amplitude parameter is specified and accurately controlled only when the output is terminated with 50Ω. If the signal from the output connector is connected to an high impedance circuit, the actual amplitude level at the output connector is doubled. Amplitude control has no effect on the amplitude level at the SYNC output connector. The amplitude parameter may be programmed within the range of 10.0mV to 16.0V. Preset value is set to 1.00V.

OFFS - DC offset of the selected waveform at the main output connector. Similarly to the amplitude, the offset parameter is specified and accurately controlled only when the output is terminated with 50Ω. Offset control has no effect on the SYNC output connector. The offset parameter may be programmed within the range of 00.0mV to ±7.95V. Preset value is set to 000mV.

MODULATION - Selects the external control option when the MODUL'N LED is turned on. There are four control options to select from: (0) No modulation, (1) Amplitude modulation, (2) Frequency modulation, and (3) VCO - Voltage Controlled Oscillator.

2. TRIG (Trigger) Menu

TRIG_LEV - The Trigger Level parameter sets the trigger voltage level at the TRIG IN connector. The external signal will trigger the function generator at

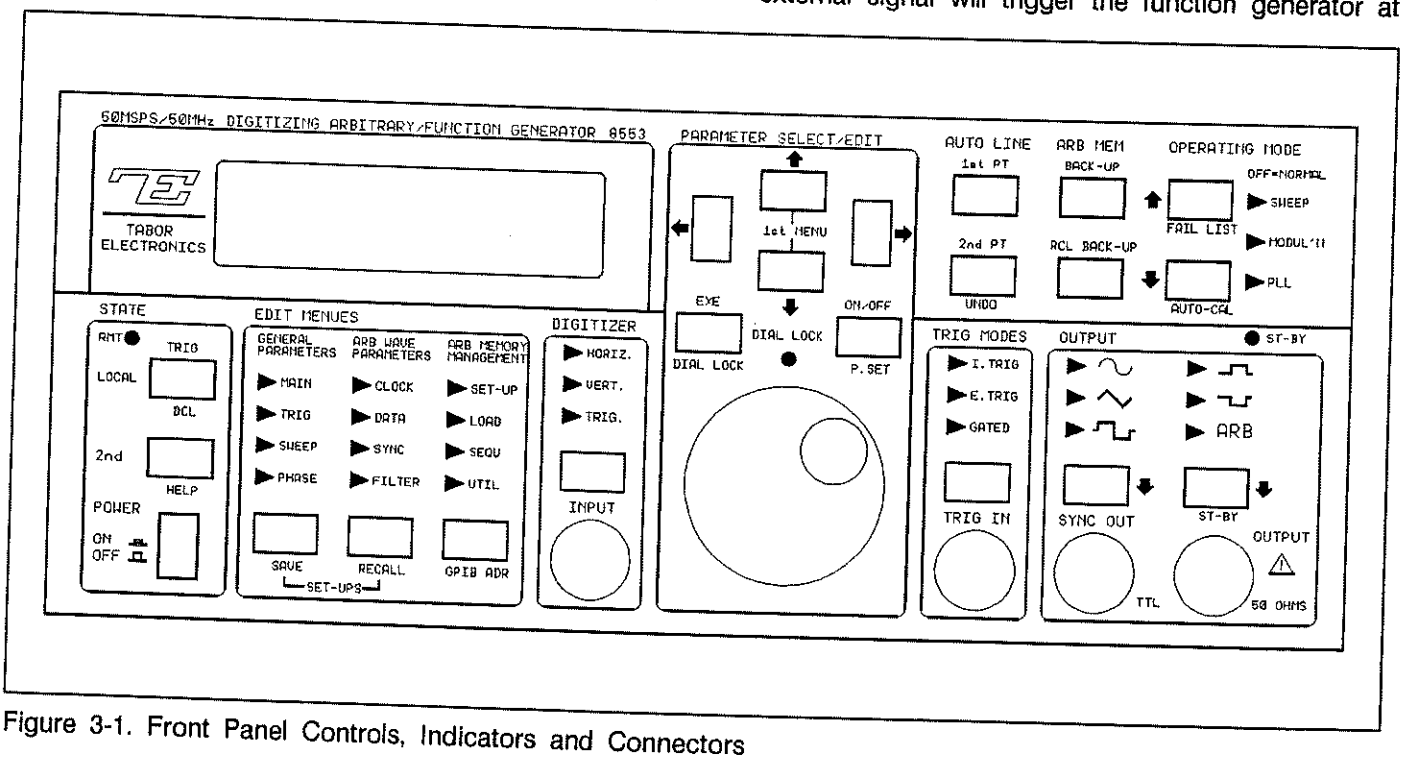


Figure 3-1. Front Panel Controls, Indicators and Connectors

PHAS_OFFS - Model 8553, when placed in PLL operating mode, locks automatically to an external signal. The output of the model 8553 then generates waveforms with the exact frequency and phase of the applied reference signal. A phase offset may then be programmed between the two first rising edges of reference signal and the output waveform. The phase offset is programmed with the PHAS_OFFS parameter. The phase offset parameter may be programmed within the range of ±180°. Preset value is set to 000°.

3-3-3-2. Arbitrary Memory Management Menus

1. SET-UP Menu

MEM_PART - This parameter defines the memory partition table for the arbitrary memory. The maximum available length of memory in this instrument is 32767 words. It is rare that one will want to use the complete range on one segment. Therefore, the memory may be divided to 99 smaller memory segments having memory length from 0 to 32767. Using the memory partition parameter, one can select the number of segments that he wants to use and their relative size in points. If more than one segment is selected, it is also possible to divide the memory to equal segments. The memory partition parameter defaults to 1 on preset and DCL (device clear).

SEG01 ddddd Pts - The length of the memory for each segment is selected with this parameter. This menu also displays the number of point that are still available for use either in the selected segment or in any other segment. DCL (device clear) sets this parameter to 32767.

2. LOAD Menu

SEG01_SOURCE - Following setting up the memory partition, one can proceed with selecting the what will be placed in each of the memory segments. The are a number of sources that can load the memory with waveforms: Built-in digitizer (0), built-in standard waveforms (1), and waveforms which were previously saved in the back-up memory (2). Use the SEG01_SOURCE parameter to select one of the required load source options from the above list. It is also possible of course to download waveforms from a computer or other auxiliary devices. These topics are discussed later in this manual. The LOAD menu has a number of sub-menus to set parameters for each of the selected load source. These sub-menus and the load memory procedures are discussed in paragraph 3-23-3. DCL and preset select the built-in digitizer as load source for SEG01.

3. SEQU (Sequencer) Menu

SEQ_STEP - The total 32K word memory that is made available by the instrument may be divided into smaller memory segments. Each segment is then treated separately by the instrument, and may be replayed individually, repeatedly, or in sequence with other memory segments. The sequencer_steps parameter specifies for the instrument how many steps are sequenced. If the model 8553 is placed in triggered mode, the sequence is repeated once or more; depending on the Trigger_Count parameter. When the instrument is placed in repetitive mode, the steps are repeated continuously. Preset value for the sequencer step is 1.

STEPdd - The maximum value of dd is automatically set to the selected number of steps in the previous menu. This parameter provides information on how many times each segment is repeated in one step. It is not necessary that segments be selected in specific order. One may define the sequence of segments according to his needs. The segment may be repeated from 0 to 65535 times. This means that one can turn segments on and off without the need to access the initial set-up. If only one segment is selected in the memory partition menu, the repeat factors may range from 1 through 65535. Preset value for the repeat multiplier is 1.

4. UTIL'S (Utilities) Menu

SEG01_MODIFY - The modification menu provides global operations on one or two segments. The usage of the utilities in this menu are discussed in paragraph 3-23-5. There are six built-in utilities: copy (0), Clear (1), Fill (2), Offset (3), Delete (4), AM (5), and Combine (6). DCL and preset select the Copy utility.

3-3-3-3. Arbitrary Wave Parameters Menus

1. CLOCK Menu

SAMPLE_RATE - The arbitrary wave is made of digital points which are equally spaced on the horizontal scale. The "spacing" between the points are defined as sampling rate or clock rate and has dimensions of sps (samples per second). The sampling rate, divided by the number of points, determine the repetition rate of the arbitrary waveform. The sampling rate may be programmed within the range of 10.00msps to 50.00Msps. Preset value is set to 10.00Msps.

Table 3-1. Default States After Software Reset (continued).

FUNCTION	DESCRIPTION	DEFAULT STATE
LOAD		
SEG01_SOURCE	Load source to segment 01	From digitizer
SEQU		
SEQ_STEP	Number of sequencer steps	01
UTIL'S		
SEG01_MODIFY	Modification utility	Copy
Digitizer Menus		
HORI		
RATE	Digitizing sampling rate	100.0Ksps
VERT		
FULL_SCALE	Digitizer full scale window	±5V
TRIG		
TRIG_SRC	Trigger source	INT
TRIG_LEV	Trigger level	+0.0V
TRIG_SLOP	Trigger slope	Positive going edge
TRIG_DEL	Trigger delay	None
General Status		
DISPLAY	Main menu parameters	FREQ, AMPL
OPERATING MODE	Operating mode selection	Normal function generator
STATE	GPIB status	Local state
TRIG MODES	VCO stimulant	Internal, Continuous Mode
OUTPUT	Output waveform	Sinewave
ST-BY	Output stand-by mode	Off

WAVE_FREQ - The arbitrary wave frequency parameter is provided for those operators who do not wish to constantly compute this value from the sampling rate and the number of point. The wave frequency depends on many parameters: The sampling rate, the wavelength, and the number of times that the wave is repeated by the sequencer. However, the wave frequency interacts with the sampling rate only. When changing this parameter, the sampling rate and the wave_period parameters are automatically adjusted to the new value of wave frequency. Preset value is set to 305.3Hz (10.00Msps divided by 32767 point).

WAVE_PERIOD - The arbitrary wave period parameter is the reciprocal value of the wave frequency. It is provided for those operators who do not wish to constantly compute this value from the sampling rate and the number of point. The wave period depends on many parameters: The sampling rate, the wavelength, and the of times that the wave is repeated by the sequencer. When changing this parameter, the sampling rate and the wave frequency parameters are automatically adjusted to the new value of wave period. Preset value is set to 3.276ms (10.00Msps multiplied by 32767 point).

Tabel 3-2. Front Panel Parameter Entry Limits

PARAMETER	LOW LIMIT	HIGH LIMIT	REMARKS
FREQ	10.00mHz	50.00MHz	
AMPL	10.0mV	16.0V	Into 50Ω
OFFS	0.0mV	±795mV	Within a ±800mV level window
OFFS	0mV	±7.95V	Within a ±8.00V level window
TRIG_LEV	0.0V	±9.9V	
TRIG_PHAS	0°	±90°	
TRIG_COUN	1	65535	
TRIG_PER	999s	20μs	
START	10.00mHz	50.00MHz	
STOP (log sweep stop)	10.00mHz	50.00MHz	
STOP (lin sweep stop)	10 display counts	5000 display counts	
TIME	10ms	999s	
MARK (log marker freq	10.00mHz	50.00MHz	
MARK (lin marker freq)	10 display counts	9999 display counts	
EXT_REF	/1	65535	
PHAS_OFFS	0°	±180°	
SAMPLE_RATE	10.00msps	50.00Msps	
SYNC_ADD	1	32767	
Z_LEVEL	−0.10V	−5.00V	
ARB_FILTER	50KHz	5MHz	50KHz, 500KHz, and 5MHz
DIGITIZER RATE	10.00msps	300.0Ksps	
DIGITIZER FULL_SCALE	±5V	±10V	
DIGITIZER TRIG_LVL	0.0V	±9.9V	
DIGITIZER PRE_TRIG_DEL	0	32765	
DIGITIZER POST_TRIG_DEL	0	65535	
*SAV (store)	0	9	
*RCL (recall)	0	9	
ADR (GPIB address)	00	31	

digitizer - after the trigger flag has been sensed. Post-trigger limits are from address 0 to address 65531. Preset value is set to 0 (no delay)

3-3-5. Parameter Select/Edit Section

CURSOR/MENU CONTROL - There are four push-buttons that control the position of the cursor within each menu. These buttons are marked with arrows; each arrow points in different direction. The push-buttons which are marked with the up and down arrows are used for scrolling through the various parameters within a specific menu. The push-buttons which are marked with the left and right arrows are used for placing the cursor on the data which has to be modified.

DIAL - The Dial is a mechanical rotary-encoder that simulates a digital potentiometer. It is used for editing the displayed parameter. The dial may rotate clockwise to increment reading or counterclockwise to decrement reading.

EXE - This push-button is used for executing a specific function which requires complete operators' attention. It is normally used in conjunction with front panel settings of the arbitrary parameters that modify front panel settings permanently.

ON/OFF - This push-button is used for terminating front panel operations before the [EXE] push-button has been pressed.

3-3-6. Trigger Modes Section

There is only one push-buttons in the TRIG MODES section. Selection of one of the trigger modes is done by pressing this button. The selected mode is

3-7. POWER-UP PROCEDURE

The basic procedure of powering up the Model 8553 is described below.

1. Connect the female end of the power cord to the AC mains receptacle on the rear panel. Connect the other end of the power cord to a grounded AC outlet.

WARNING

Be sure the power line voltage agrees with the indicated value on the rear panel of the instrument. Failure to heed this warning may result in instrument damage.

The instrument is equipped with a 3-wire power cord designed to be used with grounded outlets. When the proper connections are made, the instrument chassis is connected to the power line ground. **Failure to use a properly grounded outlet may result in personal shock hazard.**

2. Turn on the mains power by pressing and releasing the POWER switch on the front panel.

3. The instrument then begins operation by performing a display and indicator test which takes approximately one second. All front panel indicators illuminate.

4. After all the indicators are tested, the instrument performs ROM and RAM tests. Successful execution of these tests is followed by a one second read-out of the installed software revision, similar to the example below:

Software Rev 1.0
last update 8/92

5. The model 8553 then checks which of its options is installed and displays a message when it recognizes an option. The installed option message will look like the following:

GPIB option
installed

6. If the instrument detects that the GPIB option is installed and displays the above message, the instrument proceeds with displaying its GPIB primary address. The GPIB address is set by front panel programming and is stored in the non-volatile memory. For example, with the generator programmed to address 19, the display shows:

GPIB address
19

7. Following these display messages, the instrument commences its normal operating mode and generates waveforms. Note that the instrument is equipped with a non-volatile memory. This memory automatically monitors front panel traffic and retains its latest set-up for events such as accidental power loss. In case of power loss the instrument resumes operation with its previously programmed front panel set-up.

NOTE

One who does not wish to observe the power-up procedure every time that the generator is turned on, can easily remove the sequence of displayed messages. Depressing [2nd] and then [Parameter Select ⇑] in sequence writes a special code to the non-volatile memory. The next time the generator will be powered-up, the instrument will skip the power-up procedure and will immediately commence with displaying the front panel set-up. Repeating the sequence of [2nd] and [Parameter Select ⇑] restores normal power up procedure. Note that there are no front panel markings that indicate power-up sequence removal. Therefore, unless the instrument is being used by one person only, and to remove confusion, it is recommended that power-up sequence remains unchanged.

3-8. SOFTWARE RESET

An operator who is not yet fully familiar with front panel operation of the function generator, may find himself locked into a "dead-end" situation where nothing operates the way it should. The fastest way of restoring the generator to a known state is by resetting its software. This may be done by pressing the [2nd] push-button and then pressing the [DCL] push-button (second function to the [TRIG] push-button). The instrument then resets to its factory selected defaults. Table 3-1 summarizes these defaults.

3-8-1. Parameter Preset

As discussed in paragraph 3-5, software reset restores all front panel parameters to their factory selected values. It may, however, be required to preset one

the bus, turns the RMT (remote) light on. In this case, all front panel push-buttons except [LOCAL] are disabled. Pressing one of these push-buttons causes the function generator to respond with the following message:

press LOCAL to
remove from RMT!

This message indicates that the instrument expects that the [LOCAL] push-button be first depressed otherwise front panel operations are ignored. After the [LOCAL] button is depressed, the RMT light turns off and the instrument is ready to accept additional front panel programming sequences.

3-11-4. Auto-Calibration Errors

Model 8553 provides an auto-calibration function which may be used, anytime, by the operator. In the event that the calibration routine fails to successfully complete, the generator generates a failure list and starts displaying the calibration failure list.

3-12. SELECTING 2nd FUNCTIONS

A few front panel push-buttons were assigned a secondary function. These functions are marked below the button in yellow color and are accessible through the [2nd] push-button.

There are eleven front panel buttons which were assigned a secondary function. These functions are:

DCL	**HELP**
SAVE	**RECALL**
GPIB ADR	**DIAL LOCK**
P.SET	**UNDO**
AUTO-CAL	**ST-BY**
FAIL LIST	

The operation of these secondary functions is described later in this chapter. Pressing the [2nd] push-button generates the following display read-out:

2nd ?

The cursor under the question mark (?) appears blinking; indicating that the instrument is ready for a consequent press of another push-button which was assigned a secondary function. Depressing [2nd] once more cancels this function. Second functions: DCL, DIAL LOCK, P.SET, UNDO, and ST-BY functions are executed immediately; SAVE, RECALL, GPIB ADR, AUTO-CAL, and FAIL LIST will be executed only after depressing the [EXE] push-button.

3-13. AUTO-CALIBRATION

Model 8553 provides an auto-calibration function that may be operated at any time, either from the front panel or through a GPIB command. Operating the auto-calibration is very simple and can be done by anyone; no special skills are required. Although this function can give the user relative confidence that the instrument is operational and within specification, it is still recommended that the function generator will be checked periodically by certified calibration laboratories. Suggested calibration period by certified calibration laboratories is given in Section 5 of this manual. The auto-calibration takes only few seconds to complete. It therefore could be used often without serious delay to its normal operation. However, the auto-calibration function should be performed when one or more of the following conditions occur:

1. After 30 minutes of warm-up time;
2. After 24 hours of last internal auto-calibration;
3. If ambient temperature changes by more than 5°C, and;
4. After replacing components or sub-assemblies.

To operate the auto-calibration function proceed with the following steps:

1. Depress the POWER switch once to turn power on, and leave the instrument on for at least 30 minutes until the internal circuits reach thermal equilibrium.

2. Depress [2nd] and then the [AUTO-CAL] push-buttons, and observe that the generator displays the following:

Calibrate ?
EXE = yes OFF = no

Depress [OFF] quit the auto-calibration sequence and return to normal operation. Depressing [EXE] initiates the calibration routine. The above display message is replaced by a sequence of messages that indicate the function which undergoes calibration.

Following successful execution of its internal calibration, the instrument displays a message indicating that the calibration process has been successful. Tee message looks like the following:

Calibration ok!
push any key

Depressing a key causes the instrument to resumes normal operation.

If self calibration fails, the generator proceeds with displaying a failure list. Recalling and terminating the

The **Header** describes the function of the parameter, for example, FREQ, AMPL, and SAMPLE_RATE. The header, in most cases is not spelled in-full, but abbreviated in such a way that will make sense to the operator. The headers follow the SCPI (Standard Commands for Programmable Instruments) convention, which specifies the use of such abbreviation. Exactly the same headers are used for GPIB programming; making it easier for the GPIB programmer, who does not need to study reference tables from the manual.

The **Data** is separated from the header by space(s) and may contain integer numbers, floating decimal point, and a leading plus or minus sign. The data represents the value for the displayed header. Each header has different limits for its associated data. These limits are given in Table 3-2.

The **Suffix** associates units and multipliers that modify how the data is interpreted by the device. Some headers, like TRIG_COUN and SWEEP_DIR, do no require the presence of the suffix.

3-15-3. The Cursor and Dial Concept

The cursor, as discussed above, can be move within the menus from line to line and from a data character to a neighboring data character, using the Parameter Select/Edit push-buttons. The dial modifies characters on the cursor location. For instance, With an offset reading of +123mV, if the cursor is placed on 3, this digit will increment or decrement; depending on the direction one rotates the dial. If the cursor is placed on the sign, the dial, when rotated, will modify the sign only. Placing the cursor on a suffix and then rotating the dial, increments or decrements the range.

3-15-4. Modifying a Parameter

There are various parameters, such as frequency, amplitude, offset, sampling rate, and others which control the shape of the waveform at the output connector.

Modification of a specific parameter is simply done by selecting the required parameter as discussed in paragraph 3-15-1, placing the cursor on the required digit for modification, and then rotating the dial until the correct value is displayed. Some modifications cause immediate change at the output connector. Some modification require that [EXE] button be first pressed before output parameters will change. The various parameters which can be displayed and modified are listed in Table 3-2

3-15-4-1. Parameter Limits

In general, parameters were assigned definite boundaries. The instrument was design in such a way that front panel programming, under no circumstances, may lead to an error situation by exceeding the specified limits. GPIB parameter programming errors are discussed in section 4. Front panel programming permits modification of parameters within the limits which are given in Table 3-2.

3-16. SELECTING AN OPERATING MODE

Model 8553 may operate in normal function generator mode, as a sweep generator (linear or logarithmic), The generator may be modulated by an external signal, and may phase lock to a stable reference source. Selecting one of the operating modes is done by depressing one of the OPERATING MODE [⇑ or ⇓] push-buttons until the light next to the desired mode illuminates. When all light are off, the instrument is placed in normal operating mode.

Description of the various modes which can be used in Model 8553 is given in the following.

3-16-1. Normal Function Generator Operating Mode

Function generator operating mode is the normal operating conditions where the output waveform is symmetrical about its horizontal and vertical axis. The generator is placed in its normal operating mode when all light are off. Triggered operation may operate in conjunction with the normal function generator operating mode.

3-16-2. Linear/Logarithmic Sweep Operating Mode

Placing the model 8553 in linear or logarithmic sweep operating mode transforms the instrument into an independent sweep generator. Selecting the sweep operating modes is done by depressing one of the Operating Mode [⇑ or ⇓] push-buttons until the light next to SWEEP illuminates. Sweep steps (linear or logarithmic), sweep direction, and other sweep parameters may be programmed in the Sweep menu. The various sweep modes may operate in conjunction with the external trigger mode.

3-16-3. Modulation Operating Mode

Placing the instrument in this operating mode is done by depressing one of the Operating Mode [⇑ or ⇓] push-buttons until the light next to MODUL'N il-

cy. When external frequency is read, the decimal point blinks at the rate of the internal gate time.

3-17. SELECTING AN OUTPUT WAVEFORM

Selecting one of the available output waveforms is done by depressing one of the two push-buttons in the OUTPUT section until the light next to the required waveform illuminates. Model 8553 makes available six different waveforms through the OUTPUT connector. These waveforms are:

Sine Wave	**Positive Square Wave**
Triangle	**Negative Square Wave**
Squar Wave	**Arbitrary Wave**

3-18. DISABLING THE OUTPUT

The Model 8553 features a stand-by mode which disconnects the signal from the output connectors. The stand-by function is especially useful in automatic test systems where the output is constantly connected to the device under test and where modification of waveform parameters may endanger this device.

To place the instrument in its stand-by mode depress in sequence the [2nd] and the [ST-BY] push-buttons. The ST-BY light illuminates; indicating that the output signal is disconnected from the output connector.

To resume normal operation simply depress one of the push-button in the OUTPUT section. The ST-BY light turns off; indicating that the output signal in now connected to the output connector.

3-19. TRIGGERING THE FUNCTION GENERATOR

Model 8553 when set to one of its trigger modes accepts stimulation from a variety of sources. The Operator has the option of selecting either an external source, an internal source, or a manual source. Each triggering method is used in a different way and for different applications. The triggering options are described in the following.

3-19-1. Triggering The Function Generator With An External Stimulant

When no light in the TRIG MODES section illuminates, the function generator operates in its normal continuous mode. Selecting an external triggering mode is simply a matter of depressing the push-button in the TRIG MODES section until the light next to E.TRIG illuminates.

The Model 8553 triggers either on the leading edge or the trailing edge of the applied external signal. Each transition at the TRIG IN connector generates a single waveform at the OUTPUT connector. The instrument can also generate more than one cycle of its output waveform by changing the counted triggers parameter to the required number of cycles. The various parameters for the trigger mode are available in the TRIG menu. The parameters which can be displayed and modified are: Trigger level, trigger slope, start phase (for sine and triangle only), counted triggers (burst), and the period of the internal trigger generator.

To trigger the generator from an external source proceed as follows:

1. Select the required output waveform and set up the parameters to the required characteristics.

2. Modify TRIG_LEV (trigger level) parameter to the required thrash-hold level.

3. Modify TRIG_SLOP (trigger slope) parameter to the required edge sensitivity.

4. If a different start phase is required (to generate haversines, for instance) modify TRIG_PHAS (trigger phase) parameter to the required angle.

5. Select the required number of output cycles (burst) with the TRIG_COUN (trigger count) parameter.

6. Depress the TRIG MODES push-button until the light next to E.TRIG illuminates.

7. Connect a BNC cable from the external stimulant to the front panel TRIG IN connector. Make sure to observe external signal limits to avoid damage to the input circuit.

8. When done with the triggered operation remove the BNC cable from the input connector and select the normal continuous mode.

3-19-1-1. Gated Mode

When set to operate in gated mode, the first transition at the TRIG INPUT connector enables the generator output. The consecutive transition disables the generator output. First output waveform is synchronized with the first external transition. Last waveform is always completed.

NOTE

The TRIG IN connector is sensitive to dc levels. If this input is left open and the trigger level was set to a negative voltage, the generator may self gate.

3-21. USING FRONT PANEL SET-UPS

Setting-up all parameters in a versatile instrument such as the Model 8553 takes some time. The set-up time is longer when a number of tests are performed and more than one set-up is required. The function generator incorporates a non-volatile memory that preserves stored information for a long time. The size of the non-volatile memory permits storage of up to 10 complete front panel set-ups. Front panel set-ups can be recalled one at a time. The generator also employs a special recall mode that permits automatic scrolling through the stored set-ups for sequential tests. The operator may select to scroll in an ascending or descending order. Description how to save and recall set-ups and how to use the recall mode is given in the following.

3-21-1. Saving Set-ups

First modify front panel parameters as necessary to perform the required test. When all parameters are programmed and verified for accuracy, proceed with storing this set-up as follows:

1. Depress the [2nd] and [SAVE] push-button in sequence and observe that the display is modified to indicate the following:

SAVE_SETUP x
push EXE to save

"x" indicates the number of the present storage cell. Numbers may range from 0 to 9. Depressing any other push-button removes the generator from the memory store mode and leaves front panel settings unchanged.

2. To program individual memory cells for a specific front panel set-up modify "x" using the dial until the desired memory number is displayed. Depressing [EXE] locks in the entire front panel set-up for later usage. The instrument then resumes normal operation.

3. Repeat the above procedure for as many set-ups that are required. Stored front panel set-ups are limited to 9.

3-21-2. Recalling Set-ups

The model 8553 employs a non-volatile memory (RAM). The computer circuit continuously monitors front panel traffic and saves it in a special location within the RAM. This location is separated from the stored front panel set-ups. After turning AC MAINS off or in case of an accidental power failure, the generator updates front panel indicators with the last set-up before power shut-down. To recall a stored front panel set-up proceed as follows:

1. Depress the [2nd] and [RECALL] push-button in sequence and observe that the display is modified to indicate the following:

RECALL_SETUP x
push EXE to rec

"x" indicates the number of the present storage cell. Numbers may range from 0 to 9. Depressing any other push-button removes the generator from the memory recall mode and leaves front panel settings unchanged.

2. Recalling a specific front panel set-up is done rotating the dial until the desired cell number is displayed. Depressing [EXE] updates front panel set-up with the parameters which were stored in the selected memory cell.

3. Repeat the above procedure for as many set-ups that are required. Recalled front panel set-ups are limited to 9.

3-22. CHANGING THE GPIB ADDRESS

GPIB address is modified using front panel programming. The GPIB address is stored in the non-volatile memory. Therefore, conventional address switches are not provided. Detailed instructions how to change the GPIB address are given in Section 4.

3-23. GENERATING ARBITRARY WAVEFORMS

3-23-1. Introduction

In general, whenever the ARB LED, at the OUTPUT section, is lit, the model 8553 generates arbitrary waveforms at the output connector. The arbitrary waveform is stored in a digital form in special memory that has a fixed length of 32K words. When the instrument is programmed to output arbitrary waveforms, there is a special software routine which replays the digital information which is stored in this memory.

The arbitrary waveform is made of digital samples. Each sample has vertical resolution of 12 bits. It is therefore possible to generate arbitrary waveforms that have 32,767 samples; each sample is placed on the vertical axis with precision of 1/4096 (12 bits). Model 8553 provides control over the length of the arbitrary waveform and over its vertical resolution.

The arbitrary waveform is replayed one sample at a time. The speed of which each sample is replayed

This question is more like a warning because changing the memory partition may alter the resident waveform to a distractive and irreversible condition. Pressing EXE changes the memory partition. Pressing OFF leaves the memory intact.

4. Assuming that memory partition table has been changed to two non-equal segments, press the [⇓] push-button in the Parameter Select/Edit section to access the second menu. The following menu is then displayed:

SEG01 32767 Pts
00000 Pts left

This reading indicates that the memory size of segment 01 is 32,767 points long.

5. To change the size to, let's say, 1024 point, use the push-buttons and rotate the dial until the number is displayed correctly. Press [EXE] to let the instrument know that it should accept the new memory size. You'll be asked the following question:

Change SEE Size?
EXE = yes OFF = no

If you press [EXE], the size which you have selected will lock-in permanently and the above reading will change as follows (the same question will be asked if you'll try to leave this menu without finalizing the process):

SEG01 01024 Pts
31743 Pts left

6. Move the cursor under SEG01 and change the segment to 02. Follow the same procedure as above to change the size of the second segment to have 2048 points. The final display reading should look like that:

SEG01 02048 Pts
29695 Pts left

NOTE

You may notice that from the above example there are 29,695 points which were left unattended. This is because it is not necessary to always use the entire length of the arbitrary memory. Model 8553 has a sophisticated sequencing circuit which can use only the required portion out of the complete memory. Therefore, when setting-up the memory partition table, you may leave part of the memory for future use.

3-23-3. Loading Waveforms

Model 8553 does not have many built-in digital waveforms. However, being a digital instrument, Model 8553 makes it possible to load to its memory the required waveform, using one of the methods which will be discussed in the following. The LOAD menu should be displayed in order to select the required source.

1. Press the ARB MEM MANAGEMENT push-button until the light next to LOAD illuminates.

2. Press the [⇑] and [⇓] push-buttons simultaneously to display the 1st MENU. The displayed header and data should look like the following:

SEG01_SOURCE 0
From digitizer

This reading indicates that segment 01 will be loaded with digital data from the built-in digitizer.

3. To select a different load source for this segment, rotate the dial. The other sources to load waveforms from are: from built-in standard waveforms, and from previously saved memory.

3-23-3-1. Loading Waveforms Using the Built-In Digitizer

Model 8553 has a special digitizing input where external signals may be applied to and captured instantaneously. The built-in digitizer provides a powerful tool to capture signals without the need for auxiliary devices and without tedious maneuvers to transfer waveforms from one device to another; thereby, having the risk of loosing data and other characteristics of the signal.

The signal, at the input to the digitizer, is sampled at rates from 10msps for extremely slow signals to 300Ksps for fast signals. The trigger point may be programmed before or after the triggering event, without the risk of loosing data, by utilizing the post and pre trigger facilities. The instrument provides programmable parameters for the vertical capturing window and for the trigger options. To load waveforms using the built-in digitizer proceed with the following instructions:

1. Press the ARB MEM MANAGEMENT push-button until the light next to LOAD illuminates.

2. Press the [⇑] and [⇓] push-buttons simultaneously to display the 1st MENU. The displayed header and data should look like the following:

SEG01_SOURCE 0
From digitizer

segment that was assigned for this purpose. You may unarm the digitizer by pressing [OFF].

If, for some reason or another, you forgot to assign a segment to be loaded from the digitizer input and you pressed [EXE], the instrument will display an error message as follows:

Error! select
memory segment

You must then follow the procedure as given above to assign the digitizer as a load source for one of the memory segments.

When the digitizer completes its digitizing process, the instrument displays the following message:

Digitizing complete
push any key !

With this message, the digitizing process is complete. Pressing any front panel push-button removes this message from the display and the instrument starts displaying normal menus and outputs the waveform at the output connector.

3-23-3-2. Loading Built-In Standard Waveforms

The are a few standard waveforms which are stored in special lookup tables. Use the following procedure to load these waveforms.

1. Press the ARB MEM MANAGEMENT push-button until the light next to LOAD illuminates.

2. Press the [⇑] and [⇓] push-buttons simultaneously to display the 1st MENU. Rotate the dial and select the "From std waves" menu.

3. Go one menu down (use the [⇓] push-button) and observe that the second menu is displayed as follows:

SEG01_LOAD 0
Sine

You may rotate the dial to select from other waveforms like square, triangle and others. Leave sine as your preferred waveform.

4. Go one more menu down and observe that the third menu is displayed as follows:

Load Sine
H_RES 4096 Pts

The first line in this menu indicates the target of this menu. The second line represents the header - Horizontal Resolution, and the data for this header. The data which you program in this menu will tell the instrument how many horizontal points will be used for the sinewave.

5. Change the resolution to 1024, because otherwise it will be too big or too small to fit in the size which you already selected segment 01.

6. Go one more menu down and observe that the forth menu is displayed as follows:

Load Sine
V_RES 4096 Pts

The maximum vertical resolution which can be used is 4096 points (12 bits). If the amplitude in the MAIN menu is set to 1.00V, using resolution of 4096 points will generate the full amplitude span of 1.00V. Using less resolution reduces the amplitude at the output connector proportionally. The ratio between the amplitude setting and the programmed vertical resolution is:

Amplitude (at output) = programmed amplitude x programmed vertical resolution / 4096.

For example, with programmed amplitude of 1.00V and programmed vertical resolution of 2048 points, the actual amplitude at the output connector will be 1.00 x 2048 / 4096 = 0.50V.

7. Go one more menu down and observe that the fifth menu is displayed as follows:

Load Sine
STA_ADD 00000

This menu indicates the address of which the sinewave will start loading. This option permits start address other than 1 so that more than one waves may be loaded in one memory segment. Leave start address as is for this example.

8. Go one more menu down and observe that the sixth menu is displayed as follows:

Load Sine
STA_PHASE 000(DEG)

Use this menu to change the start phase for the sine waveform. The start phase can be programmed in increments of 45 degrees.

9. The last menu executes the loading sequence. Observe the following display:

Load Sine
Push EXE to load

Pressing [EXE] causes the instrument to start loading the sine waveform. If data was previously loaded into segment 01, the instrument will ask you if you want

This reading indicates that the first sequencer step will generate the waveform which is resident in segment number 01 00001 times. Use the Select/Edit push-buttons and the dial to select the segment and the number of times it will be repeated in each step.

3-23-5. Using the Built-In Utilities

There are a number of utilities which perform global operations on the arbitrary memory. The utilities make it possible to copy a waveform from one segment to another, to clear the contents of a segment, to fill a segment with a set of fixed data, and to offset the entire waveform by a known factor. The utilities menu also provide other functions like swap, delete, combine, and modulate.

1. To operate a utility press the ARB MEM MANAGEMENT push-button until the light next to UTIL'S illuminates.
2. Press the [⇑] and [⇓] push-buttons simultaneously to display the 1st MENU. The following will be displayed:

SEG01_MODIFY 0
Copy

The first utility - copy is displayed. Rotate the dial and observe that the utility list. Follow the instructions on the display to perform the required utility function.

3-23-6. Changing the Sampling Rate

When programming function generators the output frequency is programmed in units of Hz and is directly proportional to the result at the output connector. Specifying the frequency of an arbitrary waveform is a little more complex since the waveform is made of digital samples. Depending on the number of samples, the number of segments, the sequence of the various segments, and on the sampling rate, the frequency may become a difficult task to compute.

The sampling rate is a parameter which defines the rate that each sample is clocked and placed at the output connector. The frequency is a derivative of the sampling rate and can be computed by dividing the sampling rate by the total number of samples.

Model 8553 permits independent programming of either the sampling rate, the wave frequency or the wave period. While programming one parameter, the rest of the parameters are adjusted automatically to the correct value. This is extremely convenient since one does not have to compute frequencies and periods from the number of samples. The process of changing the sampling rate is described in the following.

1. Press the ARB WAVE PARAMETERS push-button until the light next to CLOCK illuminates.
2. Press the [⇑] and [⇓] push-buttons simultaneously to display the 1st MENU. The following will be displayed:

SAMPLE_RATE
10.00Msps

This display reading indicates the sampling rate at the output connector.

3. Scroll down to the next menu and observe that the display reading looks like the following:

WAVE_FREQ
305.2 Hz

The display reading indicates the frequency of the arbitrary waveform at the output connector.

4. Scroll down to the next menu and observe that the display reading looks like the following:

WAVE_PER
3.276 ms

The display reading indicates the period of the arbitrary waveform at the output connector.

3-23-7. Editing Waveforms Using the Auto Line

The autoline function is a front panel editing tool for simple modifications of arbitrary waveforms which are resident in a segments. The autoline operation generates a straight line between two end points which are designated as 1st Pt and 2nd Pt. The points in between the two end points are automatically computed and rearranged to form the line. The autoline operation requires an oscilloscope that has "Z" input for intensifying portions of the trace. When operating the autoline function, it is required to connect the Z-axis output to the oscilloscope and to adjust the Z_LEVEL parameter to get the required intensity of the markers. Proceed to operate the autoline function as follows:

NOTE

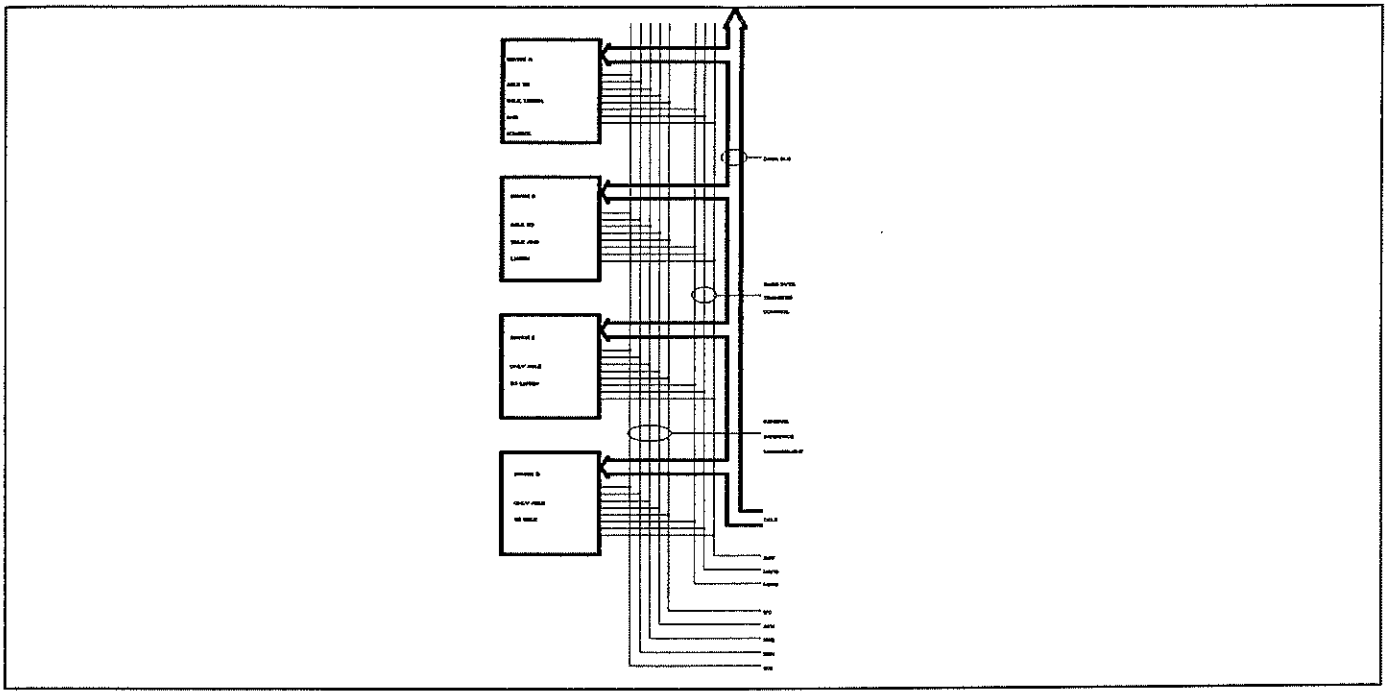
If you try to train yourself with the use of this function, it is suggested that your segment size be in the range of 100 to 1000 horizontal points and the sampling rate in the range of 10KHz to 1MHz. Otherwise, it will be very difficult to exercise the use of this function.

one of the required filter ranges, select the FILTER menu and rotate the dial until the required range is displayed. Place the ARB_FILTER parameter in range "0" (no filter) if you are not certain that you want to use filters, because it may cause undesired distortions in some waveforms.

3-23-10. Using the UNDO Function

The Undo function provides an option to restore the arbitrary waveform in the working memory to its latest condition. The Undo operates only on parameters in the LOAD and the UTIL'S menus which modify the data on the arbitrary waveform. The undo function is also available when you use the Auto Line command. It does not operate on any other function of the instrument. It is also disabled when a waveform is downloaded from a computer through the GPIB interface. The use of the Undo function is very simple. When you feel that you made a programming error and you would like to restore the last waveform, press [2nd] and then the [UNDO] push-button; the last operation will be cancelled, and the instrument will restore the arbitrary waveform to its previous shape.

Figure 4-1. IEEE Bus Configuration



Any given system can have only one controller (control may be passed to an appropriate device through a special command). Any number of talkers or listeners may be present up to the hardware constraints of the bus. The bus is limited to 15 devices, but this number may be reduced if higher than normal data transfer rates are required or if long interconnect cables are used.

Several devices may be commanded to listen at once, but only one device may be a talker at any given time. Otherwise, communications would be scrambled much like an individual is trying to select a single conversation out of a large crowd.

Before a device can talk or listen, it must be appropriately addressed. Devices are selected on the basis of their primary address. The addressed device is sent a talk or listen command derived from its primary address. Normally, each device on the bus has a unique primary address so that each may be addressed individually. The bus also has another addressing mode called secondary addressing, but not all devices use this addressing mode.

Once the device is addressed to talk or listen, appropriate bus transactions may be initiated. For example, if an instrument is addressed to talk, it will usually place its data on the bus one byte at a time. The listening device will then read this information, and the appropriate software is then be used to channel the information to the desired location.

4-3. IEEE-488 BUS LINES

The signal lines on the IEEE-488 bus are grouped into three general categories. The data lines handle bus information, while the handshake and bus management lines assure that proper data transfer and bus operation takes place. Each of the bus lines is "active low" so that approximately zero volts is a logic "one". The following paragraphs describe the purpose of these lines, which are shown in Figure 4-1.

4-3-1. Bus Management Lines

The bus management group is made up of five signal lines that provide orderly transfer of data. These lines are used to send the uniline commands described in paragraph 4-8-1.

1. ATN (Attention) - the ATN line is one of the more important management lines. The state of the ATN line determines whether controller information on the data bus is to be considered data or a multiline command as described in paragraph 4-8-2.

2. IFC (Interface Clear) - Setting the IFC line true (low) causes the bus to go to a known state.

device is ready, and the bus is set to repeat the sequence with the next data byte.

The sequence just described is used to transfer both data and multiline command. The state of the ATN line determines whether the data bus contains data or commands.

4-3-3. Data Lines

The IEEE-488.2 bus uses the eight data lines that allow data to be transmitted and received in a bit-parallel, byte-serial manner. These eight lines use the convention DI01 through DI08 instead of the more common D0 through D7 binary terminology. The data lines are bi-directional and, as with the remaining bus signal lines, low is true.

4-4. INTERFACE FUNCTION CODES

The interface function codes are part of the IEEE-488.2 standards. These codes define an instrument's ability to support various interface functions and should not be confused with programming commands found elsewhere in this manual.

Table 4-1 lists the codes for the Model 8553. The numeric value following each one or two letter code define Model 8553 capability as follows:

SH - (Source Handshake Function) - The ability for the Model 8553 to initiate the transfer of message/data on the data bus provided by the SH function.

AH - (Acceptor Handshake Function) - The ability for the Model 8553 to guarantee proper reception of message/data on the data bus provided by the AH function.

T - (Talker Function) - The ability of the Model 8553 to send device-dependent data over the bus (to another device) is provided by the T function. Model 8553 talker capabilities exist only after the instrument has been addressed to talk.

L - (Listen Function) - The ability of the Model 8553 to receive device-dependent data over the bus (from anther device) is provided by the L function. Listener function capability of the Model 8553 exist only after it has been addressed to listen.

RS - (Service Request Function) - The ability of the Model 8553 to request service from the controller is provided by the RS function.

RL - (Remote-Local Function) - The ability of the Model 8553 to be placed in remote or local modes is provided by the RL function.

Table 4-1. Model 8553 Interface Function Codes

CODE	INTERFACE FUNCTION
SH1	Source Handshake Function
AH1	Acceptor Handshake Capabilities
T6	Talker (basic talker, serial poll, unaddressed to talk on LAG)
L4	Listener (basic listener, unaddressed to listen on TAG)
SR1	Service request capability
RL1	Remote/Local capability
PP2	Parallel Poll capability
DC1	Device Clear capability
DT1	Device Trigger capability
C0	No controller capability
E1	Open collector bus drivers
TE0	No Extended Talker capabilities
LE0	No Extended Listener capabilities

PP - (parallel Poll Function) - The ability of the Model 8553 to respond to a parallel poll request from the controller is provided by the PP function.

DC - (Device Clear Function) - The ability for the Model 8553 to be cleared (initialized) is provided by the DC function.

DT - (Device Trigger Function) - The ability of the Model 8553 to have its output triggered is provided by the DT function.

C - (controller Function) - The Model 8553 does not have a controller function.

TE - (Extended Talker Capabilities) - The Model 8553 does not have extended talker capabilities.

LE - (Extended Listener Function) - The Model 8553 does not have extended listener function.

4-5. SOFTWARE CONSIDERATIONS

The most sophisticated computer in the world would be useless without the necessary software. This basic requirement is also true of the IEEE-488.2 bus, which requires the use of handler routines as described in this paragraph. Before a controller can be used with the IEEE-488.2 interface, the user must make certain that appropriate handler software is present within the controller. With the IBM PC computer, for example, the GPIB interface card must be used with an additional software which contains the necessary handler software.

Other small computers that can be used as controllers have limited IEEE command capability. The capabilities of some computers depends on the particular interface being used. Often, little software "tricks" are required to achieve the desired results.

To check the present address, or to enter a new one, proceed as follows:

1.Depress the [2nd] push-button once then depress the [GPIB ADR] push-button. The display will be modified to display the following:

GPIB_ADDRESS xx

Where xx may be any number from 00 to 30.

2. Rotate the dial for selecting a new GPIB primary address.

3. To store the newly selected primary address depress [EXE]. The instrument then resumes normal operation.

4-8. BUS COMMANDS

While the hardware aspect of the bus is essential, the interface would be essentially worthless without appropriate commands to control the communications between the various instruments on the bus. This paragraph briefly describes the purpose of the bus commands, which are grouped into the following three categories:

1. Uniline commands: Sent by setting the associated bus line low (true).

2. Multiline commands: General bus commands which are sent over the data lines with the ATN line low (true).

3. Device-dependent commands: Special commands that depend on device configuration; sent over the data lines with ATN high (false).

4. Common commands and queries: A special set of commands that all devices must use and does not depend on device configuration; sent over the data lines in the same format as the device dependent commands.

4-8-1. Uniline Commands

Uniline commands are sent by setting the associated bus line to low. The ATN, IFC, and REN commands are asserted only by the system controller. The SRQ command is sent by an external device. The EOI command may be sent by either the controller or an external device depending on the direction of data transfer. The following is descriptions of each command.

REN - (Remote Enable) - The remote enable command is sent to the Model 8553 by the controller to set the instrument up for remote operation. Generally, this should be done before attempting to program the instrument over the bus. The Model 8553 will indicate that it is in the remote mode by illuminating

Table 4-3. IEEE-488 Bus Command Summary

COMMAND TYPE	COMMAND	STATE OF ATN LINE(*)	COMMENTS
Uniline	REN	X	Set up for remote operation
	EOI	X	Sent by setting EOI low
	IFC	X	Clears Interface
	ATN	Low	Defines data bus contents
	SRQ	X	Controlled by external device
Multiline Universal	LLO	Low	Locks out front panel controls
	DCL	Low	Returns device to default conditions
	SPE	Low	Enable serial polling
	SPD	Low	Disables serial polling Addressed
	SDC	Low	Returns unit to default condition
	GTL	Low	Returns to local control
	GET	Low	Triggers device for reading
Unaddress	UNL	Low	Removes all listeners from bus
	UNT	Low	Removes all talkers from bus
Device- Dependent(**)		High	Programs Model 8553 for various modes.

(*) X = Don't Care, (**) See paragraph 4-9 for complete description

Table 4-4. Default Conditions. (Status After SDC, DCL, or *RST)

Mode	Default	Status
Operating Mode	Normal	Normal operating mode
Sweep Direction	SWEEP_DIR 0	Start to stop
Trigger Modes	MODE 0	Normal continuous mode
Arbitrary Filter	ARB_FILTER 0	Filter disabled
Output Waveforms	WAVE 1	Sinewave output
Output Disable/Enable Mode	ST_BY 0	Output enabled
Displayed Menu	MAIN	First menu
Response Message Format	X0	Response header OFF
Response Message Terminator	Z0	New line(LF), ^END(EOI) terminator
Event Status Enable Mask	*ESE0	No mask
SRQ Enable Register Mask	*SRE0	No mask

will respond. Only the addressed device will respond to each of these commands:

SDC (Selective Device Clear) - The SDC command performs essentially the same function as the DCL command except that only the addressed device will respond. This command is useful for clearing only a selected instrument instead of all devices simultaneously. Model 8553 will return to the default conditions listed in Tables 3-1 and 4-4 when responding to an SDC command. To transmit the SDC command, the controller must perform the following steps:

1. Set ATN true.
2. Address the Model 8553 to listen.
3. Place the SDC command on the data bus.

GTL (Go To Local) - The GTL command is used to remove the instrument from the remote mode of operation. Also, front panel control operation will usually be restored if the LLO command was previously sent. To send the GTL command, the controller must perform the following sequence:

1. Set ATN true.
2. Address the Model 8553 to listen.
3. Place the GTL command on the bus.

NOTE

The GTL command does not remove the local lockout state. With the local lockout condition previously set, the GTL command will enable front panel control operation until the next time a listener address command is received. This places the Model 8553 in the local lockout state again.

GET (Group Execute Trigger) - The GET command is used to trigger or arm devices to perform a specific task depends on device configuration. Although GET is considered to be an addressed command, many devices respond to GET without being addressed. Using the GET command is only one of several methods that can be used to initiate a trigger. More detailed information on triggering can be found in Section 3 of this manual. To send GET command over the bus, the controller must perform the following sequence:

1. Set ATN true.
2. Address the Model 8553 to listen.
3. Place the GET command on the data bus.

GET can also be sent without addressing by omitting step 2.

4-8-4. Unaddress Commands

The two unaddress commands are used by the controller to simultaneously remove all talkers and listeners from the bus. ATN is low when these multiline commands are asserted.

UNL (Unlisten) - All listeners are removed from the bus at once when the UNL commands is placed on the bus.

UNT (Untalk) - The controller sends the UNT command to clear the bus of any talkers.

<Command Message Unit> Represents a single command or programming data received by the device.

<Query Message Unit> Represents a single query sent from the controller to the device.

<Program Data> Represents any of the six different program data types.

<Program Message Unit separator> Separates the <Program Message Unit> elements from one another in a <Program Message>.

<Program Data Separator> Separates sequential <Program data> elements that are related to the same header.

<Program Header Separator> Separates the header from any associated <Program Data>.

<Program Message Terminator> Terminates a <Program Message>.

<Command Program Header> Specifies function operation. Used with any associated <Program Data elements>.

<Query Program Header> Similar to <Command Program Header> except a query indicator (?) shows that a response is expected from the device.

<Character Program Data> A data type suitable for sending short mnemonic data, generally where a numeric data type is not suitable.

<Decimal Numeric Program Data> A data type suitable for sending decimal integers or decimal fractions with or without exponents.

<Suffix Program Data> An optional field following <Decimal Numeric Program Data> used to indicate associated multipliers and units.

<NonDecimal Numeric Program Data> A data type suitable for sending integer numeric representation in base 16, 8, or 2. Useful for data that is more easily interpreted when directly expressed in a non-decimal format.

<String Program Data> A data type suitable for sending 7-bit ASCII character strings where the content needs to be "Hidden" (by delimiters)

<Arbitrary Block Program Data> A data type suitable for sending blocks of arbitrary 8-bit information.

<Expression Program data> A data type suitable for sending data that is elevated as one or more non-expression data elements before further parsing.

4-9-2. Separator Functional Element Summary

The various elements within the <Program Message> are separated by ASCII characters that were specially assigned for this purpose. These separators are discussed in the following paragraphs.

4-9-2-1. Program Message Unit Separator

The <Program Message Unit Separator> separates sequential <Program Message Unit> elements from one another within a <Program Message>. The <Program Message Unit Separator> is defined as:

;

It is allowed to use leading <white space> elements before the <Program Message Separator>. <White Space> is defined as a single ASCII-encoded byte in the range of 00-09, 0B-20. This range includes the ASCII control characters and the space, but excludes the new line.

4-9-2-2. Program Data Separator

The <Program Data Separator> separates sequential <Program Data> elements from one another after a <Command Program Header> or <Query Program Header>. It is used when a <Command Program Header> or <Query Program Header> has multiple parameters. The <Program Data Separator> is defined as:

,

Preceding and succeeding <White Space> elements are permitted.

4-9-2-3. Program Header Separator

The <Program Header Separator> separates the <Command Program Header> or <Query Program Header> from the <Program Data> elements. The <Program Header Separator> is defined as white space:

<White Space>

Refer to paragraph 4-9-2-1 for the definition of <White Space> elements.

4-9-3. Program Message Terminator

A <Program Message Terminator> terminates a sequence of one or more definite length <Program Message Unit> elements. There are three possible <Program Message Terminator> elements:

1. NL (new line);
2. NL + ^END (EOI); and
3. ^END

NL is defined as a single ASCII-encoded byte 0A (10 decimal). Leading <White Space> elements are permitted. The instrument interprets any and all of

4-9-6-5. Arbitrary Block Program Data

The <Arbitrary Block Program Data> functional element allows any 8-bit bytes (including extended ASCII codes) to be transmitted in a message. This element is particularly useful for sending large quantities of data. This element represents a general purpose solution to the transmission of 8-bit binary data. Model 8553 uses this element to transmit its waveform data to the controller.

There are two possible methods of using the <Arbitrary Block Program Data> element: as part of a <Program Message>, regardless of the location of this element, or at the end of a <Program Message>, where with the second option, the <Arbitrary Block Program Data> element must terminate the transmission sequence by sending NL + ^END.

The <Arbitrary Block Program Data> element is defined as:

#<non-zero digit>

The value of the <non-zero digit> element equals the number of <digit> elements which follow. The value of the <digit> element taken together as a decimal integer equals the number of <8-bit data byte> elements which follow. If the IEEE-488.1 END message is received before the specified number of bytes has been received, a Command error is reported to the relevant status register.

The <Arbitrary Block Program Data> element is also defined as:

#<0>

This format is especially useful when the length of the transmission is unknown or when transmission speed or other considerations prevent segmentation into definite length blocks. The use of this element requires NL + ^END and forces immediate termination of the <Program Message>.

4-9-6-6. Expression Program Data

The <Expression Program Data> functional element is not implemented in Model 8553. Therefore it shall not be discussed in this manual.

4-10. DEVICE-DEPENDENT COMMAND PROGRAMMING

IEEE-488.2 device-dependent commands are sent to the Model 8553 to control various operating conditions such as display modify, operating mode, output and parameter interrogate. Each command is made up of a program, command or query header followed by program data, program suffix, and terminated by program message terminator. The IEEE bus treats device-dependent commands as data in, providing that ATN is high when the commands are transmitted. For example the output amplitude is programmed by sending the following <Program Message Unit>: AMPL 10.5V.

A number of <Program Message Unit> elements may be grouped together in one <Program Message> provided that each <Program Message Unit> is separated by a <Program Message Unit Separator>. <Program message Unit> elements within a <Program Message> are executed **exactly** in the same order they are received from the controller. The Model 8553 ignores all non-printable ASCII characters (00 HEX through 20 HEX) except the "CR" (carriage return). A command string is terminated by a <Program Message Terminator> which tells the instrument to execute the <Program Message>.

If an illegal <Program Header> or <Program Data> is present within a <Program Message>, the instrument will:

1. Ignore the illegal part or the <Program Message> (but will execute the rest of the <Program Message>).
2. Display an appropriate front panel error message.
3. Set certain bits in its status registers.
4. Generate an SRQ if programmed to do so.

Device-dependent programming aspects are covered in paragraph 4-8-5 and 4-10.

NOTE

Before programming the instrument over the bus, it is recommended that the instrument be set to its default values by sending an SDC or DCL over the bus. See paragraph 4-8-3 for information on using the SDC command.

In order to send a device-dependent or a common command, the controller must perform the following sequence:

1. Set ATN true.
2. Address the Model 8553 to listen.
3. Set ATN false.
4. Send the command string over the data bus one byte at a time.