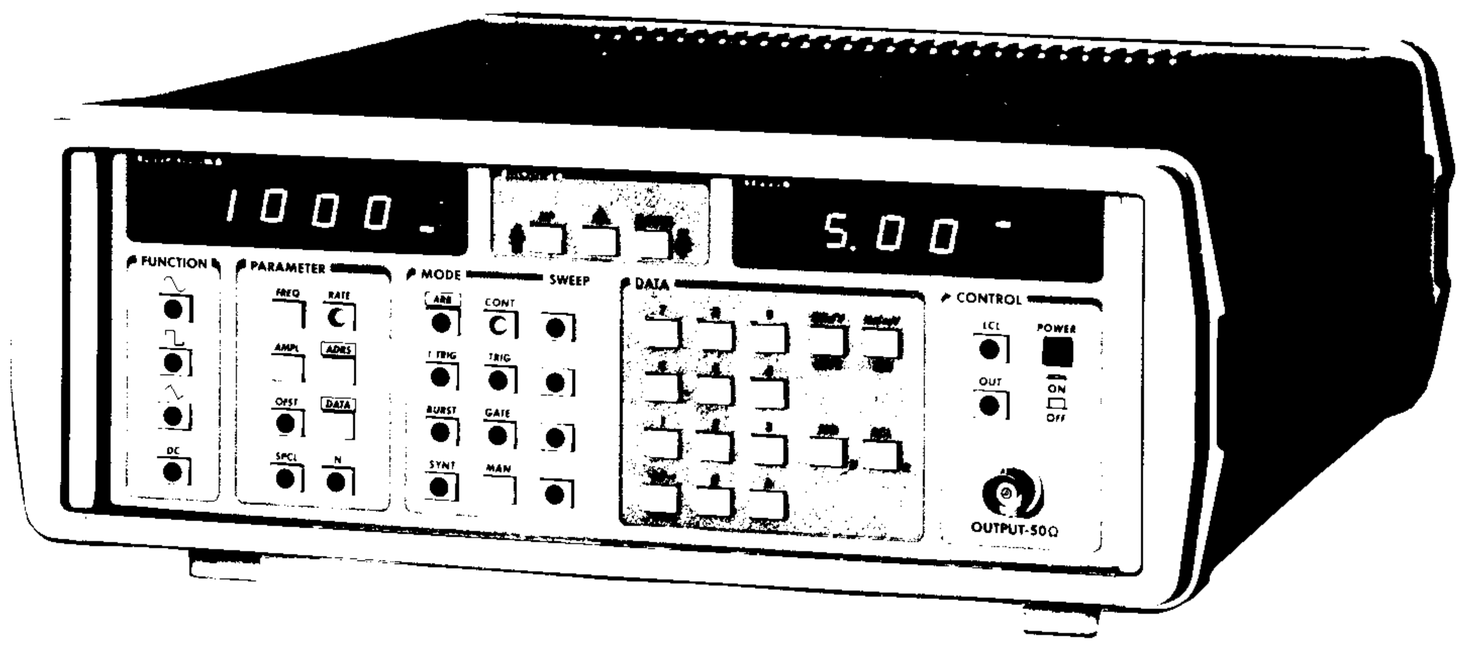
OR-X

PROGRAMMABLE FUNCTION GENERATOR

MODEL 402A



OPERATING AND SERVICE MANUAL

MODEL 402A

PROGRAMMABLE FUNCTION GENERATOR

OPERATING AND SERVICE MANUAL

OR-X P.O.Box 2116 - REHOVOT 76121 - ISRAEL.

0402-503-00

MAY 1989

WARRANTY

This OR-X instrument is warranted against defects in material and workmanship for a period of one year from date of shipment (except that in case of certain components listed in this manual, the warranty shall be for the specified period).

During the warranty period, OR-X will, at its option, either repair or replace any assembly or component found to be defective.

For warranty service or repair, this instrument must be returned to the factory or to an authorized service center designed by OR-X. Shipping charges to the factory or service center are to be prepaid by buyer and SHOULD NOT BE MADE WITHOUT PRIOR AUTHORIZATION BE OR-X. However, buyer shall pay all shipping charges, duties and taxes for products returned to OR-X from another country.

The foregoing warranty shall not apply to defects resulting from improper or inadequate maintenance by buyer, unauthorized modification or misuse, operation outside of specifications for the product, buyer supplied interfacing, or improper repair.

OR-X SHALL NOT BE LIABLE FOR ANY DIRECT, INDIRECT, SPECIAL INCIDENTAL OR CONSEQUENTIAL DAMAGES, WHETHER BASED ON CONTRACT OR ANY OTHER LEGAL THEORY.

OR-X DOES NOT WARRANT that the operation of the instrument, software, or firmware will be uninterrupted or error free.

No other warranty is expressed or implied, and no representative or person is authorized to assume for OR-X any liability in connection with the sale of our products other than set forth herein.

TABLE OF CONTENTS

SAFETY SUMMARY

GENERAL - The general safety information in this part is for both operating and servicing personnel.

TERMS - In this manual CAUTION statements identify conditions or practices that could result in damage to the equipment or other property. WARNING statements identify conditions or practices that could result in personal injury or loss of life. Do not proceed beyond a CAUTION or WARNING sign until the indicated conditions are fully understood and met.

OPERATION - Before applying power comply with the installation and operating instructions.

GROUNDING - This product is grounded through the grounding conductor of the power cord. Do not alter this connection. Upon loss of the protective - ground connection, all accessible conductive parts (including knobs and controls) can render an electric shock.

ADDITIONALLY -

- Any adjustment , maintenance and repair should be done only by qualified personnel.
- To avoid personal injury, do not operate this product without covers or panels installed.
- Use only fuses of the specified type in the parts list. Avoid the use of repaired fuses and the short - circuiting of fuseholders.
- Do not perform any unauthorized modification to the instrument.
- Do not operate the instrument in the presence of flammable gases or in explosive atmospheres.
- Disconnect power cord before removing protective panels, soldering or replacing components.
- Do not attempt internal service or adjustment unless another person, capable of rendering first aid and resuscitation is present.

SECTION 1

GENERAL INFORMATION

1.1 INTRODUCTION

This manual contains information required to operate, programme and test the OR-X MODEL 402A ARBITRARY FUNCTION GENERATOR. This section covers instrument general description, specifications and characteristics.

1.2 DESCRIPTION

The OR-X MODEL 402A is a versatile high performance programmable function generator. The MODEL 402A produces sine, triangle and square wave outputs from 0.004Hz to 9.99MHz and amplitude from 10mV to 9.99V peak-to-peak,with variable symmetry from 20% to 80%.

ARBITRARY waveforms can be generated with a 12 bit resolution by 8K points memory. Editing is flexible, including auto increment - decrement, and waveform can be continuous, triggered, gated or burst. Besides, lin-log SWEEP or any USER DEFINED sweep pattern or mode can be generated. A dynamic marker can be displayed on any X-Y oscilloscope and can be shifted over all the response plot.

TRIGGERED and GATED modes with MANUAL or EXTERNAL trigger, TTL SYNC output, VCO input and fully protected inputs and outputs make the OR-X MODEL 402A the perfect choice for a large spectrum of applications, including front panel or remote IEEE-488 operation.

1.3 SAFETY REMARKS

The OR-X MODEL 402A function generator is a SAFETY CLASS 1 instrument. Before operation, review the SAFETY SUMMARY [page 1].

SPECIFICATIONS

WAVEFORMS

Programmable sine, square, triangle, positive ramp, negative ramp, pulse, ARB-waveform and DC.

OPERATING MODES

CONTINUOUS : Output continuous at programmed frequency.

TRIGGERED : Output quiescent until triggered by an internal signal, external signal, GPIB trigger or manual trigger then then generates one cycle at programmed frequency.

GATED : As triggered mode except output on for the duration of the gate signal. The last cycle started is completed.

BURST : As triggered mode for programmed number of cycles from 2 to 9999.

MODIFY : Frequency, amplitude and offset can be manually incremented-decremented with a predetermined number of counts. Step rate is 500 mS for each first 10 steps and 100 mS for successive steps at one continuous keystroke.

SWEEP : Internal, programmable start, stop, rate and marker frequency. Linear, logarithmic and user defined sweep shapes can be continuous, trigger, gated or burst selected.

SYMMETRY : Variable from 20% to 80% in 1% steps up to 399.9KHz.

MODULATION : Generator can be frequency and amplitude modulated.

FREQUENCY CHARACTERISTICS

RANGE : 0.004 MHz to 9.99 MHz.

RESOLUTION : Up to 3 3/4 digits (3999 counts).

ACCURACY : ±0.2% of reading 40Hz to 9.99 MHz in continuous mode.
±5% of reading on other frequencies and modes.

JITTER : <0.2%

STABILITY : ±0.2% in continuous mode.
±0.2% for 10 minutes, ±0.5% for 24 hours in other modes.

REPEATABILITY : ±1% for 24 hours in other than continuous mode.

OUTPUT CHARACTERISTICS

AMPLITUDE RANGE : 10 mV to 9.99 peak-to-peak into 50 OHM, (20mV to 19.98V peak-to-peak into open circuit).

AMPLITUDE RESOLUTION : 3 digits. 1mV from 10mV to 999mV and 10mV from 1.0V to 9.999V.

AMPLITUDE ACCURACY : ±2% of programmed value and ±20mV for output 1.0V-10V and ±3% and ±5mV for output 10mV-999mV, specified for a sinewave output at 1KHz.

REPEATABILITY : ±1% for 24 hours.

AMPLITUDE FLATNESS : 0.5dB to 400 KHz, 3dB to 9.99 MHz for 1V-10V output.

OFFSET RANGE : From - 4.99V to + 4.99 into 50 OHM (-10V to +10V into open circuit). Absolute peak amplitude plus offset limited to 5V into 50 OHM (10V into open circuit).

OFFSET RESOLUTION : 3 digits. 1mV when peak-to-peak amplitude less than 999 mV, 10mV when peak-to-peak amplitude more than 1V.

OFFSET ACCURACY : ±0.5% ±20mV in DC function.

REPEATABILITY : ±1% ±20mV for 24 hours.

OUTPUT IMPEDANCE : 50 OHM ±2%.

OUTPUT PROTECTION : The instrument is non-destructively protected against short circuit or accidental AC-DC voltage of up to 100V applied to the main output.

WAVEFORM CHARACTERISTICS

SINE DISTORTION : < 0.6% THD, 40Hz to 39.99KHz.
< 1% THD, 10Hz to 100KHz.

TRIANGLE LINEARITY : 98% to 100KHz.

TIME SYMMETRY : ±1% 40Hz to 399KHz, in 50% duty cycle mode.

SQUARE TRANSITION TIME : < 18 nS.

SQUARE OVER/UNDERSHOOT : < 5% of peak-to-peak amplitude ±20mV.

INTERNAL TRIGGER

RANGE : 0.001 mS to 999.9 S.

RESOLUTION : 4 digit

ACCURACY : 0.01%

ARBITRARY CHARACTERISTICS

FUNCTIONS : User defined, or internal preprogrammed sine, square, triangle, ramp up and ramp down with 0.01% frequency accuracy. From 0.004 mHz to 1 KHz.

HORIZONTAL RESOLUTION : 8K points.
VERTICAL RESOLUTION : 12 bits.
POINT DURATION : 0.001mS to 999.9 Sec with 4 digit resolution, 0.01% accuracy.

SWEEP

SWEEP TIME	: 0.001mS to 999.9 Sec per point, 4 digit resolution with 0.01% accuracy, 1 sweep equals 1000 points.
SWEEP WIDTH	: 4000 : 1 maximun, start and stop must be in the same range.
SWEEP RANGES	: 0.004 Hz - 3.999Hz, 0.01Hz - 39.99Hz and so on until 1 KHz - 3999KHz and 2.5KHz - 9990 KHz.

INPUTS AND OUTPUTS

VCO INPUT	: 0 - 5V for up to 1000 : 1 frequency change. Input impedance : 10 KOHM.
TRIGGER IN	: Level 2V factory selected, internally adjustable ±10V. Impedance : 10 KOHM. Maximum rate : 10MHz. Minimum width : 50nS.
PROTECTION	: Inputs protected against up to ±50V accidental input.
SYNC OUTPUT	: TTL level square wave at programmed frequency. Impedance 50 OHM, protected against short circuit and up to ± 15V accidental input.
SWEEP OUTPUT	: Source impedance 600 OHM, same waveshape as sweep selected.
ARB. SYNC. OUT	: TTL level, 50 OHM impedance.
AM INPUT	: Impedance 10 KOHM, 5V peak-to-peak for 100% modulation, bandwidth DC to 20 KHz minimum.
MARKER OUT	: TTL level signal, time coincident with marker programmed.

GPIB PROGRAMMING

IEEE 488 - Compatible, non isolated.

ADDRESS : 0-30 internal switch selectable.

SUBSETS : SH1, AH1, T5, TE0, L3, LE0, SR1, PP0, DC1, C0, E2.

INTERFACE TIMING : PARAMETERS : 10mS.

FUNCTION and MODES: 5mS.

OTHERS : 10mS.

GENERAL

MEMORY : Non-volatile, stores up to 45 complete instrument settings.

POWER REQUIREMENTS : 90-126V, 180-256V switch selectable, 48-66Hz single phase, 50 VA max.

DIMENSIONS (mm) : 115 high, 290 wide, 340 deep.

WEIGHT : 4.5 Kg net.

SYNTHESIZER (OPTION 02)

RANGE : 4Hz to 9.99 MHz.

RESOLUTION : Up to 4 digits (3999 counts).

ACCURACY : 0.005% of reading.

STABILITY : 10 PPM/DEG.C

NOTES

Specifications apply for instrument operating at 25±5 DEG.-C ambient temperature, at 0V offset, and after 30 minutes warm up. Specifications measured into 50 OHM load and verified by completing the performance checks in the technical manual.
Specifications not verified in the technical manual are either explanatory notes or general performance characteristics only.
Due to ongoing product development, specifications are subject to change without notice.

SECTION 2

INSTALLATION

2.1 INTRODUCTION

This section contains installation information, power requirements, initial inspection and signal connections for the OR-X MODEL 402A.

2.2 MECHANICAL INSPECTION

This instrument was carefully inspected before shipment. Upon receipt inspect the instrument for damage that might have occurred in transit. If there is damage due to shipping, file a claim with the carrier who transported the unit. The shipping and packing material should be saved if reshipment is required. If the original container is not to be used, then use a heavy carton box. Wrap the unit with plastic and place cardboard strips across the face for protection. Use packing material around all sides of the container and seal it with tape bands. Mark the box "FRAGILE".

2.3 INITIAL INSPECTION

After the mechanical inspection, verify the contents of the shipment (accessories and installed options). If the contents are incomplete, or if the instrument does not pass the acceptance checks, notify the local OR-X service center. Procedures for acceptance checks are given in section 5.

2.4 INSTRUMENT MOUNTING

The OR-X MODEL 402A PROGRAMMABLE FUNCTION GENERATOR is intended for bench use. The instrument includes a front feet tilt mechanism for optimum panel viewing angle. The instrument does not require special cooling when operated within conventional temperature limits. A 5 cm minimum clearance must be provided at the rear of the unit for proper convection cooling of the heatsink.

The unit can be installed in a closed reck or test station if proper air flow is assured for removing about 30 W of power dissipation.

2.5 POWER REQUIREMENTS

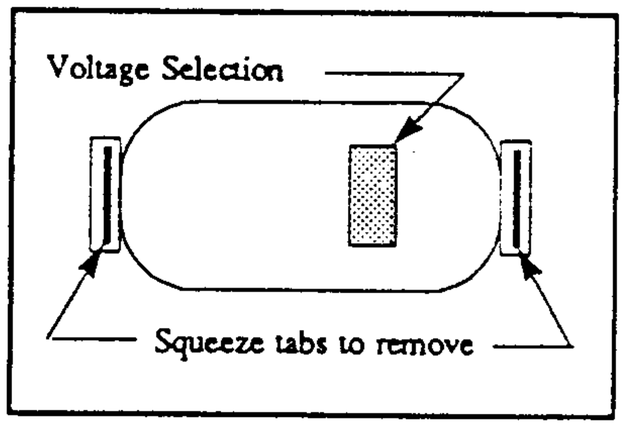
The OR-X MODEL 402A can be operated from any source of 90V to 128V, or 180V to 256V AC, frequency from 48Hz to 66Hz. The maximum power consumption is 50 VA. Use slow blow fuse only of magnitude indicated on the rear panel.

WARNING

THE LINE POWER VOLTAGE OF THE INSTRUMENT IS NOTED ON THE AC INPUT PLUG. TO PREVENT DAMAGE TO THE INSTRUMENT,CHECK FOR PROPER MATCH OF LINE VOLTAGE AND PROPER FUSE TYPE AND RATING.

2.6 The instrument power fuse is located in the AC input plug. To access the fuse, first disconnect the power cord and then remove the fuse cartridge.

2.7 To change the line voltage, turn the indicator to show the desired line voltage (110V or 220V) on the window.



2.8 GROUNDING REQUIREMENTS

For the safety of operating personnel, the instrument must be grounded. The central pin on the AC plug grounds the instrument when properly connected to the ground wire and plugged into proper receptacle.

WARNING

TO AVOID PERSONAL INJURY DUE TO SHOCK, THE THIRD WIRE EARTH GROUND MUST BE CONTINUOUS TO THE POWER OUTLET. BEFORE CONNENTION TO THE POWER OUTLET, EXAMINE ALL CABLES AND CONNECTIONS BETWEEN THE UNIT AND THE FACILITY POWER FOR A CONTINUOUS EARTH GROUND PATH.

The instrument is supplied with a three-wire power cable. To change the power plug, the work should be carried out by a qualified electrician and meet local safety requirements and codes.

2.9 SIGNAL CONNECTIONS

Use RG58U 50 OHM or equivalent coaxial cables for all input and output signals to and from the instrument.
The BNC connectors are:

OUTPUT - Up to 10V peak-to-peak into 50 OHM impedance (20V p-p into open circuit). Protected from short circuit to any voltage between ± 100V AC or DC.

TRIG IN - 10 KOHM impedance, positive slope with internal adjusted level of ± 10V (factory selected at +2V). Input protected to ±50V.

SYNC OUT - A symmetric square signal in phase with the main output. TTL levels with a 50 OHM source impedance, protected from short circuit to any voltage between ± 15 V DC.

VCO IN - Voltage control of generator frequency. AC or DC input 0V to 5V for a 1000:1 frequency change. Protected to ± 50V.

SWP OUT - Sweep output with 600 OHM source impedance and same waveshape as sweep selected, protected against short circuit.

ARB.SYNC OUT- A TTL output clock with 50 OHM impedance at the arbitrary waveform rate.

MKR OUT - Marker output with TTL levels, at a rate and duration identical with programmed "moving" marker.

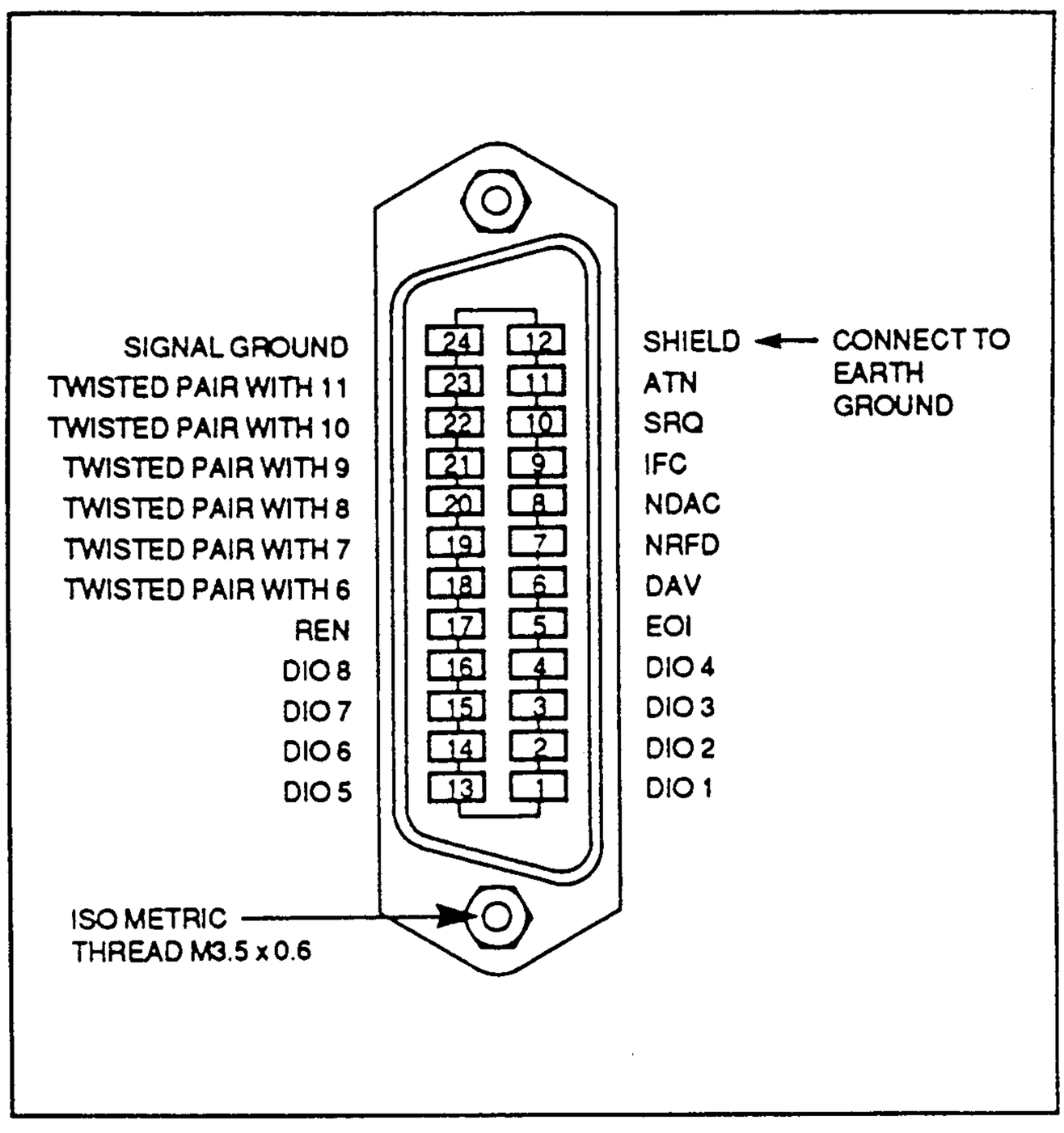
AM INPUT - 5V peak-to-peak for a 100% modulation. The input impedance is 10 KOHM, protected against up to ±50V accidental input and with a bandwidth of DC to 20 KHz minimum.

2.10 GPIB CONNECTIONS

The rear panel GPIB connector is a AMPHENOL 57-10240 or equivalent, and connects to a standard IEEE-488 bus cable connector. The GPIB line screens are not isolated from chassis and signal ground.

2.11 GPIB ADDRESS

The instrument is shipped with the address set to decimal 7. The address can be changed by an internal switch after removing instrument covers. See section 3 - "ADDRESS ASSIGNMENT" for detailed procedure.



24-Pin Micro-Ribbon (Series 57) Connector

SECTION 3

OPERATING INSTRUCTIONS

3.1 PANEL CONTROLS

Panel controls are shown in front picture of the MODEL 402A PROGRAMMABLE FUNCTION GENERATOR, figure 3-1. Each operating control, pushbutton and indicator is identified by an associated number and described in the following paragraphs, with the corresponding number.

1 - POWER ON-OFF - Aapplies or removes AC power to the instrument.

2 - MAIN OUTPUT - A 50 OHM output BNC connector.

3 - LOCAL PUSHBUTTON - Returns the instrument to local manual operation. The internal LED indicates that the unit is under computer control.

4 - OUTPUT ON-OFF - This pushbutton disables the function generator main output. Enable state indicated by illuminated internal LED.

5 - NUMERIC KEYBOARD - These non-illuminated pushbuttons are used to enter the numerical value of the selected parameter. The function of the keys should be self - explanatory.

6 - ENTER KEYS - The KHz/V and Hz/mV buttons enter a valid parameter into the operating setup and determine the parameter unit. Every numeric entry must be "ENTERED" using these buttons.

7 - STORE - Stores the last instrument setup, in the desired memory location.

8 - RECALL - Recalls and activates the entire setup stored in the selected memory location.

9 - FREQUENCY DISPLAY- 4 digit display, used to indicate the numerical value and associated unit of the currently displayed parameter.

10 - LEVEL DISPLAY - 3 digit display, used to indicate the numerical value and associated unit of the currently displayed parameter, including polarity of the offset voltage.

11 - PARAMETER - Selects the enter mode of the following parameters: frequency, amplitude, offset, special, trigger rate, arbitrary point data address and number of burst cycles.
The offset internal LED illuminates when the main output selected offset voltage is not zero.

- SPCL pushbutton is used to select special operating modes.

12 - FUNCTION - Select waveform shape. The selected waveform is identified by an illuminated LED on the pushbutton. These functions are mutually exclusive.

13 - MODE - Selects continuous, triggered, gated, synthesized, burst and arbitrary operating mode.

14 - MODIFY - Selects the step size (DELTA) and direction of variation (UP and DOWN) of the selected parameter.

15 - SWEEP - Allows the entry of sweep start and stop frequencies, marker frequency and sweep RUN mode (LINEAR, LOG or USER DEFINED).
The value of the selected parameter is displayed on the frequency window.

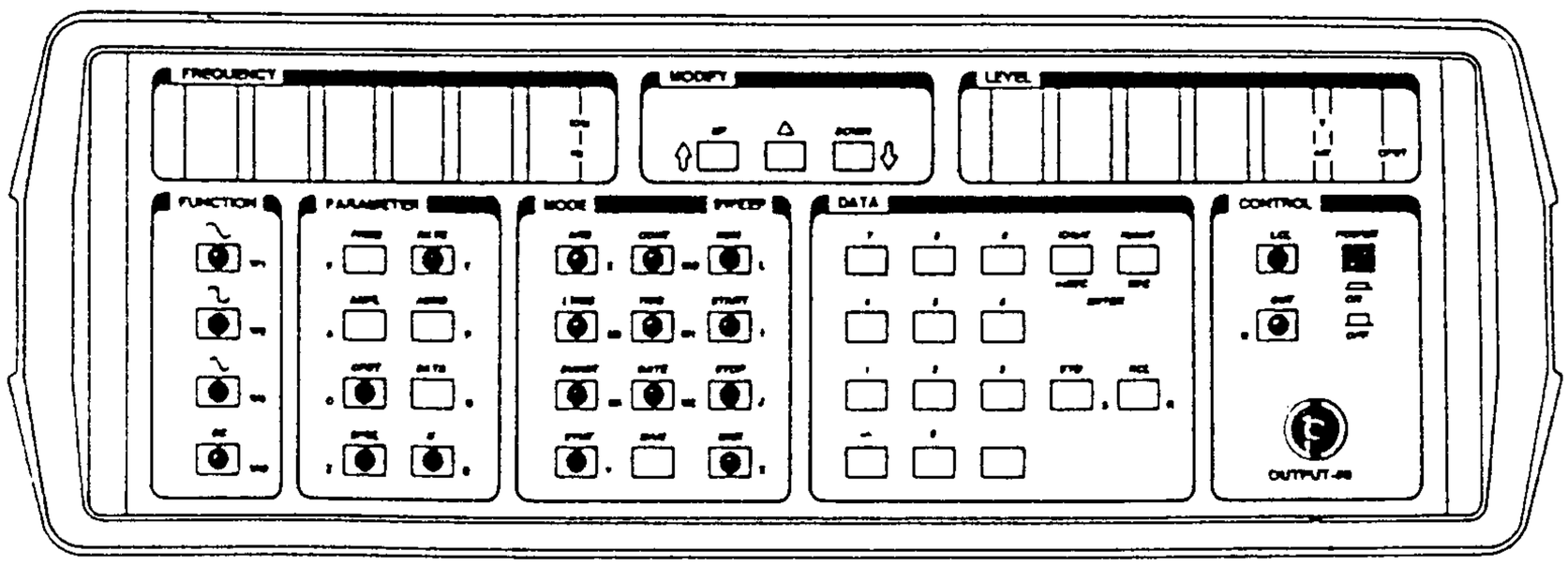
3.2 INSTRUMENT INPUTS AND OUTPUTS

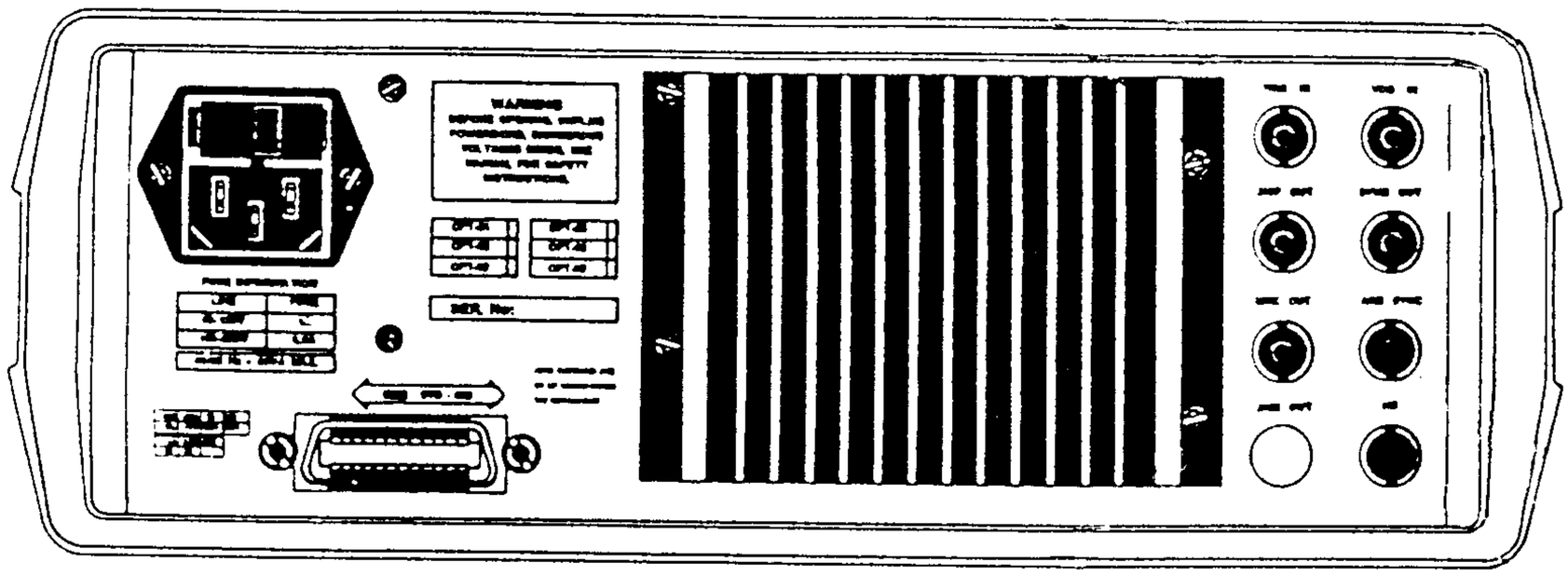
The OR-X MODEL 402A main output is located on the front panel. The output impedance of main output is 50 OHM and can deliver up to 10V peak-to-peak into this load. Proper signal loading and connection is necessary for the generator main output to meet its specifications. RG-58 shielded cable equipped with BNC connector and 50 OHM feedthru termination is recommended.

The main output is internal non destructive protected for short circuit to any voltage between ± 100 V AC or DC. If the external voltage applied to the main output exceed ± 15 volts, the output is disconnected from the instrument and an error message (ERROR 5-1) is displayed on the instrument front panel.

3.3 An optional rear panel main output can be available with the OR-X MODEL 402A PROGRAMMABLE FUNCTION GENERATOR. This rear output is parallel wired to the front panel BNC.

3.4 The TRIGGER input, VCO input, SWEEP out, MARKER out, AM input, ARB SYNC and SYNC output are located on the instrument rear panel.





3.5 TRIG INPUT

A BNC connector for coupling the external trigger or gate signal to the generator. The trigger level is internal adjustable between + 10V and - 10V and is factory selected at + 2V. This input is protected to ± 50V.

3.6 VCO INPUT

A BNC connector for external FM modulation and sweeping of the generator. A voltage source applied to this input causes the frequency of the output waveform to change and be voltage controlled. A positive going voltage from 0V to +5V will increase the frequency of the output to a ratio of minimum 1000:1, depending on the selected start frequency. The input is protected to ± 50V.

3.7 SYNC OUTPUT

A symmetric square signal at the main output frequency is available at this output. TTL levels with a 50 OHM source impedance, protected from short circuit to any voltage between ± 15 V DC, and can drive a minimum of 20 TTL loads.

3.8 Leads connected to the SYNC OUT should be as short as possible to prevent rounding of the TTL pulse. Reflection from a load (connected to this output) not matched to the interconnecting cable will not be absorbed by the source, resulting in ringing.
Over and undershoot is less then 10% into 50 OHM feedthru termination.

3.9 AM INPUT

A BNC connector for external AM modulation of the generator. A voltage of 5V peak-to-peak applied to this input causes 100% modulation.
The input impedance is 10 KOHM and is protected against up to ± 50V accidental input.

3.10 SWEEP OUTPUT

The internal sweep voltage is available at this output. The source impedance is 600 OHM and is protected from short circuit. The sweep output magnitude is determined by the sweep start and stop frequency up to a maximum of about 5V.

3.11 MARKET OUTPUT

A TTL output signal at the sweep rate, located between sweep start and stop positions. Can be used for SYNC of external instruments or as a PEN LIFT signal for X-Y recorders.

3.12 ARB OUT

A TTL output signal with the arbitrary waveform repetition rate, available at the end of each arbitrary block. Can be used for external devices synchronization.

3.13 OPERATING INSTRUCTIONS

Operating modes and parameters can be set on the front panel or programmed using the IEEE-488 interface. The remote mode is indicated by an illuminated LED in the LCL switch. All parameters, mode of operation and functions selected are indicated on the SEVEN SEGMENT LED display (frequency and level windows) or an illuminated pushbutton LED.

Connect the function generator output to the input of an oscilloscope (use proper coaxial cable and 50 OHM termination).

3.14 At POWER ON, The OR-X MODEL 402A PROGRAMMABLE FUNCTION GENERATOR performs a self-test, indicated by illuminating all front panel LED's for a 2 seconds period.

NOTE: Allow a few seconds between power-off and power-on. If after power-on the instrument does not illuminate all LEDS, turn it off and repeat procedure.

3.15 The instrument enters the following start-up mode:

FREQUENCY	1KHz
AMPLITUDE	5V
OFFSET	0V
MODE	CONTINUOUS
FUNCTION	SINE
OUTPUT	OFF
SYMMETRY	50%

At start-up, the output is disabled to protect externally connected load or device.

3.16 DATA ENTRY

To set parameter value and sign, select increment size, access memory and selecting special modes, a numerical keyboard is used. The data required is entered and executed after pressing one of the unit pushbuttons (KHz/V and Hz/mV) which act as ENTER function key. The clear data mode is accomplished by pressing the same parameter again and entering the new data.

If the parameter value entered is beyond specified limits, a error message is displayed on the front panel (error 1-1)

When entering data, do not be concerned with range selection. The instrument will take a free format data entry (fixed or floating) and automatically select the optimal operating range for the value entered.

NOTE:

The parameter value entry must be completed within 10 seconds. If not, error message "ERROR 0-1" will appear and the data entered will be ignored.

3.17 PARAMETER SETTING

The parameter group includes:

FREQ - The frequency pushbutton allows, via the keyboard or modify group, to set or change the frequency of the selected output waveform.

AMPL - The amplitude pushbutton allows, via the data keyboard or modify group, to set or observe the amplitude of the output waveform.

OFST - The offset pushbutton allows, via the data keyboard or modify group, to set or observe the offset voltage of the output waveform. If the offset voltage is not zero, the internal LED will be ON.

SPCL - The special pushbutton allows the operator to select various modes of operation (such as sweep and range locking) and perform tests, calibration procedures and data interrogation. The special pushbutton allows the future incorporation of new functions and modes, and the upgrading of the instrument according to development progress.
The internal LED illuminates when a special function is selected.

RATE - The rate pushbutton allows via the data keyboard to set or observe the internal trigger rate, the arbitrary point duration and the sweep rate. The internal LED will be ON if the rate data is displayed on the frequency window.

ADRS - Displays the ARB memory address point. The range is from 0000 to 8191 points and active in the arbitrary programming mode only.

DATA - Allows to enter the required data value for each displayed address point. The range is from 0000 to 3999; value 0 correspond to the negative peak amplitude, value 2000 correspond to zero baseline and value 3999 to the positive peak amplitude.

N - Displays the burst count and enables count change. N count can be from 2 (default count) to 9999, corresponding to the number of output cycles generated each time it is triggered in the burst mode. The internal LED illuminates when the count number is displayed on the frequency window.

3.18 FREQUENCY SELECTION

To enter a frequency, press the frequency key followed by a data entry and the unit (KHz, Hz,) key.
EXAMPLE : To set a frequency of 400 Hz press:

```
[ FREQ  ]   [4]   [0]   [0]      [Hz/mV ]
Parameter   |--- data ----|       |-unit-|
```

The function generator will accept frequency inputs of 0.004 Hz to 9900 KHz in a 3 3/4 digit format. There are no range selections when entering data, and the instrument will take a floating notation (explicit decimal point in any position). The frequency selected will be automatically allocated in the best performance range, with proper units displayed in the frequency window. In the 4000KHz to 9990KHz frequency range, enter the required frequency in KHz, in a four digits format, last digit being always 0"

3.19 AMPLITUDE CONTROL

To enter amplitude, press the amplitude parameter key followed by a numerical entry and unit key.
EXAMPLE: To select an amplitude of 2.10V press:

```
[ AMPL  ]   [2]   [.]   [1]   [0]    [KHz /V]
Parameter   |------data------|        |-unit-|
```

The amplitude programmed must be from 10 mV to 9.99V peak-to-peak with a resolution of 3 digits. The function generator assumes that it is 50 OHM loaded or terminated. As with frequency, amplitude programming is in a floating format and the instrument will select the best performance range.

3.20 OFFSET CONTROL

To enter offset, press the offset parameter key followed by a numerical entry and unit key.
EXAMPLE: To select an offset of -1V press:

```
[ OFST  ]   [-]   [1]   [KHz /V]
Parameter   |-data-|   |-unit-|
```

The offset programmed must be from -4.99V to +4.99V (into 50 OHM). The absolute peak amplitude plus offset may not exceed 5V into 50 OHM. The resolution is 3 digits, 10mV when absolute peak to peak amplitude >1.0V or 1mV when peak to peak amplitude <1.0V.

NOTE: The sum or the absolute peak amplitude plus the absolute offset has the following limits:

AMPL (Vp-p)	MAX Vpeak +OFS
1.00V-9.99V	4.99V
100mV-999mV	499mV
10mV-99mV	49mV

Attempting to exceed these prodefined limits results in "ERROR 1-2" display.

3.21 RATE CONTROL

The RATE pushbutton selects the internal trigger and the point duration for ARB and SWEEP modes. To change the rate, press the rate key followed by a numerical entery and unit key.
EXAMPLE: To enter a rate of 10 mS press:

```
[ RATE  ]   [  10  ]   [ mSEC ]
Parameter   |-data-|   |-unit-|
```

The programmed rate must be from 0.001 mS to 999.9 second and up to 4 digits resolution.

3.22 ADDRESS AND DATA SELECTION

The ADRS pushbutton is used to select the arbitrary waveform address for the entering of the arbitrary data.

The ADRS key is active only in the arbitrary programming mode selected by SPCL 701. To enter the desired address, press ADRS key followed by address number (from 0000 to 8191) and any unit key (acting as ENTER). The address selected is displayed in the frequency window.

The data value of displayed address is indicated in the amplitude window and can be changed by pressing the DATA key followed by the new value and any unit key. The data value range is from 0 to 3999. Value 2000 correspond to zero baseline, 3999 to the positive peak amplitude and 0 to the negative peak amplitude.

3.23 BURST COUNT SELECTION

The N pushbutton selects the number of waveform cycles that are generated when the instrument is triggered in the BURST mode. The burst count can be set from 2 to 9999 cycles. To change the N count, press the key followed by a numerical entry and a unit key.
EXAMPLE : To enter a count of 17 press:

```
[  N  ]      [  17  ]    [ KHz  ]
Parameter    |-data-|    |-unit-|
```

The internal LED illuminates when the count number is displayed on the frequency window.
The default N count is 2.

3.24 FUNCTION SELECTION

The pushbuttons in this group are illuminated when the associated function is active and allow the selection of sine, square, triangle or DC at the output of the instrument. These functions are mutually exclusive.

3.25 MODE CONTROL

The pushbuttons in this group are illuminated when the associated mode is active. The CONT, TRIG, GATE and BURST modes are mutually exclusive.

CONT - The waveform selected is continuously generated at the programmed frequency.

TRIG - One complete cycle of the selected waveform will be generated for each trigger signal at the TRIG-IN connector, GPIB trigger or each time the MAN button is pressed.

GATE - The waveform selected is continuously generated for the duration of the gating signal at the TRIG-IN connector or for as long as the MAN button is pressed. The last cycle started is completed.

BURST - N cycles of the selected waveform will be generated for each trigger signal, GPIB trigger or each time the MAN button is pressed.

I.TRIG - Internal trigger mode generates trigger signals at the RATE entered time for TRIGGER, GATE and BURST modes of operation. Internal trigger is not allowed in the ARB and SWEEP modes.

3.26 The trigger of input circuit is a positive slope signal with a threshold level of +2V (factory selected). The threshold level can be changed from -10V to +10V by adjusting a potentiometer inside the instrument.

3.27 SYNTHESIZER OPERATION (OPTION 02)

The MODEL 402A PROGRAMMABLE FUNCTION GENERATOR can be ordered with a SYNTHESIZER OPTION. This option enables to obtain stable output waveform with frequency locked to an internal quartz crystal.

To operate the synthesizer, simply press the SYNT pushbutton. The internal LED illuminates when the synthesizer is locked, and blinks when it is not.

3.28 If the SYNTHESIZER OPTION is not installed in your instrument, a message "ERROR 4-1" is displayed.

3.29 The synthesizer can be operated in continuous mode only and in the frequency range of 4Hz to 9990KHz.

3.30 MODIFY GROUP OPERATION

The MODIFY group pushbuttons (UP, DOWN and DELTA) act on the frequency, amplitude, offset, arbitrary address and marker keys.

EXAMPLE: **[FREQ] [UP] - to increase frequency**
[AMP] [DOWN] - to decrease amplitude.

3.31 When the button UP (or DOWN) is pressed and released, the parameter will be stepped one unit of the defined increment size (selected with the delta function). When it is pressed and held, the parameter will be stepped in unit of the defined increment size, but after 10 steps will accelerate to a rapid rate until the button is released, or the parameter limit is reached. The slow rate is 0.5 seconds and the fast rate is 100 mS.

3.32 To define the increment size, select the required parameter, press DELTA pushbutton and enter the data followed by unit ENTER.
EXAMPLE : To set frequency increment to 50 press:

```
[ FREQ  ]  [DELTA]   [ 5 ]   [ 0 ]   [ Hz /mV ]
Parameter            |--d a t a--|   |--unit--|
```

The increment entered is unitless and the resolution is that of the last digit of the frequency displayed. When the parameter is modified the instrument can go over a number of operating ranges. Each time a range is changed, the size of the increment is multiplied (or divided) by a factor of ten, in order to maintain the original step size selected.

3.33 Different increment sizes can be selected for each frequency, amplitude, offset and marker parameters.

The default increment size is one unit. The last increment entered is stored and used on each modify operation (of the same parameter) until power-up or reset.

To display the increment size of each parameter press:

-SPCL 101 for frequency delta.
-SPCL 102 for amplitude delta.
-SPCL 103 for offset delta.
-SPCL 104 for marker delta.

3.34 READOUT DISPLAY

The MODEL 402A PROGRAMMABLE FUNCTION GENERATOR employs seven-segment LED's to display the numerical value of the selected parameters and error messages. The generator frequency is displayed in the left window, on 4 digit with Hz or KHz units illuminated.

The output level and offset are displayed on the right window on 3 digit with V or mV units illuminated.

In the offset mode, the "OFST" indication is illuminated. A negative offset voltage is indicated by a minus sign before the 3 digit display.

The generator left window is also used to display the following parameters:

- RATE
- ADDRESS
- N COUNT
- SWEEP START, STOP AND MARKER.

The display mode is indicated by the internal illuminated LED of the selected parameter.

3.35 OUTPUT CONTROL

The OUT pushbutton enables generated signals to the output BNC connector. A "ON" condition is indicated by the illuminated LED in the "OUT" pushbutton. On power-on, output is disabled. If an overload condition is applied to the output of the instrument, the unit is disconnected and a blinking message "ERROR 5-1" is displayed.

3.36 SETUPS

The "STR" and "RCL" keys permit the access to 45 available memory locations.

The STR key followed by two digits (01-45) stores the last valid setup (except increment size) in the desired memory location (01-45).
To delete a stored setting, simply enter a new setup on the same location.

The RCL key followed by two digits (01-45) recalls and activates the entire setup stored in the selected memory location.
An attempt to recall an empty memory location will cause the display of "ERROR 1-6".

3.37 At power off, all memory settings are stored even if the power is interrupted for a long time period (depending on the lithium battery condition installed in the instrument).

3.38 The last entered arbitrary waveform is stored in the non-volatile memory after power off.

3.39 LOCAL KEY

The "LCL" key removes the unit from the IEEE 488 bus control and places it under front panel control. This function can be locked out by the IEEE 488 controller with a "LLD" (local lockout).

When illuminated the internal LED indicates that the unit is in the remote mode.

3.40 ERROR CODES

When an attempt is made to enter an invalid key sequence, out of range data or operation beyond limits, an error message will be displayed. All further instructions will be ignored until the error is cleared (after 2 seconds display or by depressing a parameter key).

3.41 Errors caused by front panel entries do not generate a service request (SRQ). The error codes consist of two numbers, one indicating the error group number and the other indicating the specific error.

3.42 ERROR CODES TABLE

C O D E	E R R O R
0-1	Syntax error.
1-1	Data out of range.
1-2	Output amplitude and offset out of limit (>5V on 50 OHM).
1-3	Data error (illegal entry).
1-4	Increment range over.
1-5	Decrement range over.
1-6	Empty memory recall.
1-7	Address not available to store setup.
2-0	Special function selected does not exist.
2-5	Sweep operation error.

3-0 System mode error.

4-1 Synthesizer option not installed.
4-2 Synthesizer lock error.

5-1 Output protection condition.
5-2 Low battery indication.

6-1 N count out of range.
6-2 Rate out of range.
6-3 Arbitrary mode error.
6-4 Sweep mode error.
6-5 Marker out of range.
6-6 Marker delta error.

3.43 SPECIAL FUNCTION

A special function is selected by depressing the SPCL key and the 3 digit number which defines the operation required. The following table describes the special functions available on MODEL 402A PROGRAMMABLE FUNCTION GENERATOR:

S P C L D E S C R I P T I O N

888 LED display test.
488 The IEEE 488 address is displayed.
601-699 Calibration procedure for maintenance personnel only.
101 Displays the frequency increment magnitude.
102 Displays the amplitude increment magnitude.
103 Displays the offset increment magnitude.
104 Displays the marker increment magnitude.
200 Disable and enable frequency locking circuit.
901-999 Internal sweep operation.
701-714 Arbitrary programming modes.
520-580 Wariable symmetry control.

The special mode operation is indicated by an illuminated internal LED.

3.44 FM MODULATION

The MODEL 402A PROGRAMMABLE FUNCTION GENERATOR can be frequency modulated with a voltage applied to the input connector SWEEP IN, located on the rear panel.

3.45 VOLTAGE CONTROLLED OUTPUT (VCO)

The frequency output of the unit can be sweept by connecting a voltage source to the SWEEP IN (on rear panel). A positive going voltage increases the frequency, while a negative going voltage decreases the frequency.

3.46 A voltage of 0V to 5V can sweep the instrument over a 1000:1 range. It should be noted that the generator can only be sweept to the top of its normal frequency ranges, giving a range of only 10:1 (from 400 to 3999 in each range). To obtain the maximum available sweep range use the following procedures:

Select the sweep stop frequency (press FREQ, DATA, UNIT) depress the special pushbutton SPCL and enter 998. This sequence locks the frequency range within which the selected stop frequency falls. A second, or start, frequency can be selected after range locking. Since the start frequency can be selected from one unit of the range, to the stop frequency, total external control of 1000:1 is possible (and more, up to 3999:1) with a positive 5 volt input signal.

3.47 To exit from range-lock operation mode, depress special SPCL and enter 999.

3.48 INTERNAL MODE SWEEPING

The internal sweeping of the unit freqency can be obtained by various special entries. Select the stop frequency and depress SPCL 998 (range locking of frequency). After this, select the start frequency from one unit of the range to the stop frequency.

The sweep mode is determined by depressing SPCL pushbutton and:

997 - CONTINUOUS SWEEP UP (from start to stop frequency selected).
996 - CONTINUOUS SWEEP DOWN (from stop to start frequency).
995 - ONE SINGLE SWEEP UP.
994 - ONE SINGLE SWEEP DOWN.

3.49 The step frequency on sweep mode is the last frequency increment entered.

The sweep rate is 10 msec/step in default mode. To change the rate, depress SPCL and enter a data from 901 (for 10 msec/step) to 990 (for 900 msec/step). The step time in msec is obtained by multiplying the last two digits of SPCL data with 10 msec.

3.50 AM MODULATION

The MODEL 402 programmable function generator can be amplitude modulated with a external AC voltage applied to the AM input connector located on the rear panel.

A 5V peak to peak signal is required to obtain 100% modulation. The AM input bandwidth is DC to 20 KHz.

3.51 SWEEP OPERATION

Before operating the sweep mode, the sweep parameters (start, stop, rate and marker) must be entered. To enter the start, stop and marker frequencies, press the desired key followed by a data entry and a unit key (KHz or Hz). The sweep duration is 1000 times the selected RATE, example: A sweep repetition rate of 10 mSEC is obtained by a point rate entering of 0.01 mSEC.

SWEEP EXAMPLE: To obtain a sweep from 1000Hz to 3999 Hz with a repetition rate of 100mSEC press:

```
[ START ]  [1][0][0][0]  [ Hz/mV ]
Parameter  |---data---|  |-unit--]

[  STOP ]  [3][9][9][9]  [ Hz/mV ]
Parameter  |---data---|  |-unit--]

[  RATE ]  [0] [.]  [1]  [ mSEC  ]
Parameter  |---data---|  |-unit--]
```

MARKER: default is OFF; To enter a marker frequency of 2000Hz press:

```
[  MKR  ]  [2][0][0][0]  [ Hz/mV ]
Parameter  |---data---]  |-unit--]
```

SWEEP RUN is selected by pressing:

```
[ RUN ]  [ M ]
```

M = 1 for linear sweep.
M = 2 for log. sweep.
M = 3 for arbitrary sweep.
M = 0 for sweep off.

3.52 The maximum sweep range is 4000:1 (the sweep start to stop ratio). The sweep can be up or down depending of start and stop frequencies selected. The marker entered must be between start and stop frequencies and can be dynamically shifted up and down by pressing:

[MRK] [UP] or **[MRK] [DOWN]**

The marker instantaneous frequency is displayed on the frequency window. The shifting is slowly for the first 10 step and fast afterwards, for each continuous key stroke. The marker default step size is 1 and can be changed by:

[MRK] [DELTA] [VALUE] [ENTER]

The marker frequency or step size can be entered only in the RUN off mode (by entering RUN 0).
To cancel the marker press (in RUN off only):

[MRK] [0] [ENTER]

3.53 A SWEEP OUT signal with the same waveshape as sweep selected is available at the rear panel for external devices synchronization. The SWEEP OUT magnitude depends on the selected start and stop frequencies. If the unit main output is connected to the oscilloscope Y input and the sweep out to the X input, with the proper selection of X-Y mode and gains, a response plot can be displayed. The entered marker is intensified and can be moved to points of interest over all the response plot.

3.54 A MARKER OUT signal with TTL levels and time coincident with marker programmed is available at the rear panel.
This signal can be used for various synchronization of external devices or as a pen lift signal for XY recorders.

3.55 SWEEP MODES

The sweep selected can be:

CONT - Continuous sweep between start and stop limits.

TRIG - One single sweep is generated for each trigger signal at the TRIG IN connector, GPIB trigger or each time the MAN pushbutton is pressed.

GATE - Continuous sweep between start and stop for the duration of the gating signal at the TRIG IN connector or for as long as the MAN pushbutton is pressed.

BURST - N sweep cycles will be generated for each trigger signal, GPIB trigger or each time the MAN pushbutton is pressed.

3.56 SWEEP SHAPES

The shapes available for sweeping the unit frequency are:

LINEAR - A linear ramp of 1000 steps from start to stop frequency. Each step is quartz synthesized and with a selectable rate of 0.001 mSEC to 999.9 SEC, therefore a total sweep duration of 1mSEC to 1,000,000 SEC can be obtained. The linear sweep is selected by "RUN 1".

LOG - A logarithmic waveform of 1000 steps from start to stop frequency with same time characteristics as the linear sweep. The log sweep is selected by "RUN 2".

ARBITRARY - Any USER DEFINED sweep pattern or mode can be generated using the arbitrary programming mode. The programmed arbitrary waveform is used to sweep the unit output frequency. The ARB sweep is selected by "RUN 3".

To exit the sweep mode (sweep off) select:

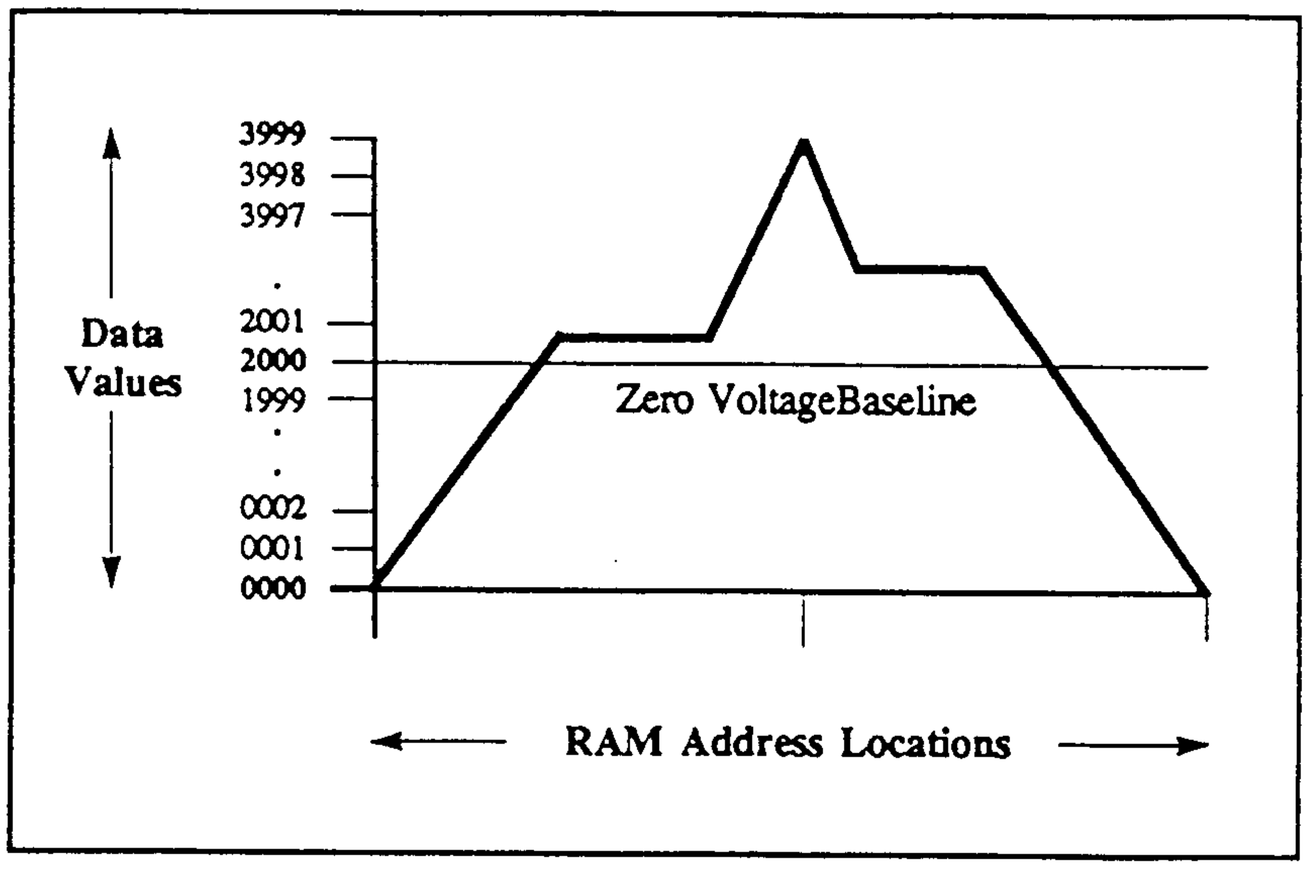
[RUN] [0]

3.57 ARBITRARY OPERATION

The arbitrary waveform is stored as data values in a random-access memory (RAM). The RAM address corresponds to the waveform position on the X axis of a graph, the RAM data at this address corresponds to the Y axis value. The horizontal axis provides 8191 address point with a data assigned level for each point (up to 3999 vertical resolution). Scanning this memory with the rate duration for each point, creates the arbitrary output waveform.

3.58 The DATA 2000 is defined as zero baseline, 0 DATA correspond to the negative peak amplitude and 3999 to the positive peak amplitude. Each vertical resolution step is 2.5mV output if the instrument amplitude is set to 9.99V (into 50 OHM). It is proportionally attenuated for lower output amplitude (each point will be 1.25mV if the output amplitude is set to 5V).

To shift the arbitrary waveform around baseline use the output offset capabilities of the generator. To enable the arbitrary mode press the ARB pushbutton (the internal LED will be ON). To disable this mode press ARB pushbutton again.



3.59 ARBITRARY MODES

The arbitrary waveform can be :

CONT - Continuously generated.

TRIG - One single waveform is generated for each trigger signal at the TRIG IN connector, GPIB trigger or each time the MAN pushbutton is pressed.

GATE - Continuously generated waveforms for the duration of the gating signal at the TRIG IN connector or for as long as the MAN pushbutton is pressed.

BURST - N waveform cycles will be generated for each trigger signal, GPIB trigger or each time the MAN pushbutton is pressed.

3.60 ARBITRARY WAVEFORM ENTERING

The arbitrary waveform entering can be performed in the arbitrary programming mode only. To select or cancel this mode press SPCL 701. The point address is displayed on the frequency window and the point data on the amplitude window. There are two methods of entering waveform data into the arbitrary memory:

- Using one data point at a time entry.
- Using the AUTO LINE for straight line segments.

3.61 Points are defined by recalling an address and entering the corresponding data.

```
|‾[ADRS]   [VALUE]   [ENTER]‾|
|                            | -     first point
|_[DATA]   [VALUE]   [ENTER]_|
|‾[ADRS]   [VALUE]   [ENTER]‾|
|                            | -     second point
|_[DATA]   [VALUE]   [ENTER]_|
  .          .         .     .
  .          .         .     .
  [POINT   NUMBER - N      ]   -     Maximum 1999 points.
```

For easy editing of consecutive points, automatic address increment - decrement is provided and selected by:

SPCL 704 Automatic increment.
SPCL 705 Automatic decrement.

For exiting the automatic increment - decrement mode press the same SPCL number again.

3.62 For fast examination of points of interest, the ADRS up or down can be performed with the MODIFY group keys. When the UP or DOWN key is pressed and held, the address will be stepped continuously and after 10 steps will accelerate to a rapid rate until the button is released.

3.63 The AUTO LINE feature is obtained by pressing **SPCL 700**. A straight line segment is entered between the two last selected point addressed.

3.64 To CLEAR all the arbitrary memory (all 1999 points) press **SPCL 706**.

3.65 ARBITRARY START - STOP

When only a partial waveform is required the arbitrary START and STOP address must be programmed.

By pressing **SPCL 702** the last displayed address is automatically defined as the waveform START point. If an address other then the one displayed is required, recall the required address and then press **SPCL 702**.

Similarly, to define a STOP point, recall the required address and press **SPCL 703**.

3.66 PREDEFINED WAVEFORMS

Six predefined waveforms are implemented in the MODEL 402A PROGRAMMABLE FUNCTION GENERATOR. To load the arbitrary memory with a predefined waveform press:

SPCL 710 - for SINE
SPCL 711 - for SQUARE
SPCL 712 - for TRIANGLE
SPCL 713 - for RAMP UP
SPCL 714 - for RAMP DOWN

Each predefined waveform is composed of 360 points with a repetition of 360 times the selected RATE. High accuracy (0.01 %) low frequency waveforms (from 0.004 mHz) can be continuous, triggered, gated or burst generated. Please note that selecting a predefined waveform, the arbitrary memory is loaded with this function and the previous arbitrary data is lost.

3.67 ARBITRARY SYNC OUT

An ARB SYNC OUT signal with TTL levels is available at the rear panel for external devices synchronization. The signal is at logic "0" and goes HIGH for the RATE point duration at the end of each arbitrary waveform.

3.68 PROGRAMMING AN ARBITRARY WAVEFORM

The arbitrary waveform is programmed by recalling addresses (0000-8191) and assigning each address a data value (0000-3999).

There are two front panel methods of entering waveform data into the arbitrary memory.

1. **INDIVIDUAL ENTRY**- for entering individual data points, one data point at a time. This method, in turn, provides three different modes of data entry:

   1) Manual
   2) Auto-increment addresses
   3) Auto-decerment addresses

2. **LINE DRAW**- for entering straight line segments.

Each of these editing modes can be entered or exited by pressing SPCL and the proper 3 digit code. The general edit mode, SPCL 701, must be entered before any addresses or data points can be altered. While in the edit mode, each of the special editing functions can be activated or deactivated by keying in SPCL and the code.

ARBITRARY EDITING CODES

SPCL 701 - Enter/Exit editing
SPCL 702 - Start Address
SPCL 703 - Stop Address
SPCL 704 - Auto-increment address
SPCL 705 - Auto-decrement address
SPCL 706 - Line draw

INDIVIDUAL ADDRESSES

This method is typically used when editing a previously programmed arbitrary waveform.

Each address is selected by pressing the ADRS button, entering the memory location, and then pressing either of the ENTER buttons.

1. Enter SPCL 701.

2. Press ADRS.

3. Enter the address location.

4. Press either ENTER button.

5. Press DATA.

6. Enter the data value.

7. Press either ENTER button.

Repeat the above procedure for each address as required.

8. Enter SPCL 701 to exit the edit mode.

AUTO-INCREMENT ADDRESSES

This method is used when programming consecutive address locations. The operator selects the first address, and the generator automatically increments to the next address after each data value has been assigned.

1. Enter SPCL 701.

2. Enter SPCL 704.

3. Press ADRS.

4. Enter the first address.

5. Press either ENTER button.

6. Press DATA.

7. Enter the data value.

8. Press either ENTER button.

The generator increments to the next memory address automatically. Repeat steps 9,10, and 11 for the remaining memory addresses that are to be assigned data values.

9. Press DATA.

10. Enter the data value.

11. Press either ENTER button.

AUTO-INCREMENT OFF:

1. Press SPCL.

2. Enter 704.

Enter SPCL 701 to exit the edit mode.

AUTO-DECREMENT ADDRESSES

This method is used when programming consecutive address locations. The operator selects the first address, and the generator automatically decrements to the previous address after each data value has been assigned.

1. Enter SPCL 701.

2. Press SPCL 705.

3. Press ADRS.

4. Enter the first address.

5. Press either ENTER button.

6. Press DATA.

7. Enter the data value.

8. Press either ENTER button.

The generator decrements to the previous memory address automatically. Repeat steps 9,10, and 11 for the remaining memory addresses that are to be assigned data values.

9. Press DATA.

10. Enter the data value.

11. Press either ENTER button.

Auto-Increment Off:

1. Press SPCL.

2. Enter 705.

Enter SPCL 701 to exit the edit mode.

LINE DRAW

On the Model 402A, the LINE DRAW mode enters a straight line segment between the last two addresses entered.

1. Enter SPCL 701.

2. Press ADRS.

3. Enter the first address.

4. Press either ENTER button.

5. Press DATA.

6. Enter the start data value.

7. Press either ENTER button.

8. Press ADRS.

9. Enter the stop address.

10. Press either ENTER button.

11. Press DATA.

12. Enter the data value.

13. Press either ENTER button.

14. Enter SPCL 707.

A straight line segment connects the data values in the last two addresses.

15. Repeat steps 8-14 for the next line segment.

Enter SPCL 701 to exit the edit mode.

NOTE: Do not use SPCL 707 to connect two adjacent addresses. This is not needed.

EXAMINING THE ADDRESSES

Address data values can be examined quickly by pressing the UP or DOWN buttons and viewing the windows on the Model 402A.

1. Enter SPCL 701.

2. Press ADRS.

3. Press UP or DOWN.

The first ten addresses and corresponding data values are displayed at a slow rate when either button is held in, and then at a faster rate for the remainder.

Enter SPCL 701 to exit the edit mode.

ERASING AN ARBITRARY WAVEFORM

CAUTION: The following sequence will clear all 8192 arbitrary waveform memory addresses.

1. Enter SPCL 701.

2. Enter SPCL 706.

3. Enter SPCL 701 to exit the edit mode.

To replace old data values in memory with new data values, simply reprogram the memory addresses with the new information. The old values will be immediately replaced with the new ones.

SELECTING THE ARBITRARY WAVEFORM AMPLITUDE.

The data values assigned to each address are only relative to each other. The actual amplitude voltage levels are selected via the AMPL and mumerical buttons.

Each vertical data level increment is a 2.5mV output if the instrument's amplitude is set to 9.99V (into 50 ohms). It is proprotionally attenuated for lower output amplitudes (each point will be 1.25 mV if the output amplitude is set to 5V).

To shift the baseline (2000 level) voltage value, use the output offset capabilities of the Model 402A.

The output amplitude is selected in the same manner as in the non-arbitrary mode.

1. Press AMPL.

2. Enter the amplitude value.

3. Press either the KHz/V or Hz/mV buttons as required.

NOTE: The amplitude setting is voltage peak-to-peak as in the nonarbitary mode. Regardless of the actual entered data values, the specified amplitude applies to the full data value range of 0-3999.
Arbitrary waveforms which do not span the total possible range of data values will not reach the amplitude which was entered. It is important to remember, however, that the allowable amplitude/offset combinations depend on the programmed amplitude, not on the actual voltages measured at the output.

SELECTING THE ARBITRARY WAVEFORM FREQUENCY

NOTE: The FREQ button is not used for arbitrary waveforms.
Rather, the RATE button is used to select the point rate (0.01mS to 999.9 seconds).

The default Point Rate is 0.01 mS.

1. Press RATE.

2. Enter the point rate value.

3. Press either the mSEC or SEC button as required.

CALCULATING THE ARBITRARY WAVEFROM PERIOD

The arbitrary waveform's period can be calculated by using :

P = N X RATE

Where
N = Number of addresses comprising the arbitrary waveform.

RATE = Selected point rate.

SELECTING THE ARBITRARY WAVEFORM MODE

The arbitrary waveform can be output continuously, triggered, gated, or burst by pressing the appropriate button.

CONT - Continuous outputs are generated.

TRIG - One single waveform is generated for each trigger signal at the rear panel TRIG IN, GPIB interface, or each time the front panel MAN button is pressed.

GATE - Continuously generated waveforms for the duration of the gating signal at the rear panel TRIG IN BNC, or for as long as the MAN button is pressed.

BURST - N waveform cycles are generated for each trugger signal input to the rear panel TRIG IN, GPIB interface, or each time the MAN button is pressed.

To select the number of cycles:

1. Press BURST.

2. Press N.

3. Enter the number of cycles.

4. Press either ENTER button.

SELECTING PARTIAL ARBIRTARY WAVEFORMS

The operator can select to output a portion of the arbitrary waveform This will require the selection of start and stop addresses.

Selecting the START address:

1. Enter SPCL 701.

2. Press ADRS.

3. Enter the desired START address.

4. Press SPCL 702.

Selecting the STOP Address:

5. Press ADRS.

6. Enter the desired STOP address.

7. Press SPCL 703.

Enter SPCL 701 to exit the edit mode.

SELECTING PREPROGRAMMED ARBITRARY WAVEFORMS

Five resident waveforms are programmed into the Model 402A. These waveforms can be used as is, or modified as required. Each preprogrammed arbitrary waveform will occupy the first 360 addresses if recalled into memory.

NOTE: The ARB button must be turned off to make these selections.

IMPORTANT: The following procedure destroys any arbitrary waveform previously stored by the user in the first 360 arbitrary memory addresses.

1. Press SPCL.

2. Enter the appropriate number for the desired waveform.

   710 - Sine
   711 - Square
   712 - Triangle
   713 - Ramp up
   714 - Ramp down

3. Press ARB to output the selected waveform.

Since point by point modification of existing waveforms is quite easy, the various preprogrammed arbitrary waveforms can be used as foundations for creating new, unique arbitrary waveforms.

3.69 ARBITRARY SWEEPS PROGRAMMING

Any chosen frequency sweep pattern can be achieved using the MODEL 402A arbitrary sweep mode. Like linear or logarithmic sweeps, the change in output frequency can be thought of as being controlled by a "waveform" of a given shape.

As the "waveform" magnitude increases, the output frequency also increases. For the simple cases of RUN 1 and RUN 2, the "waveform" shape is a linear or logarithmic ramp.

Entering an arbitrary waveform for arbitrary sweep is done in precisely the same way as entering an arbitrary waveform for direct output as the actual signal shape.

With any arbitrary waveform, it is necessary to chose the correct data levels and specify the proper starting and stopping addresses. If the arbitrary sweep waveform can be output and viewd on an oscilloscope, then it is also ready to be used to generate an arbitrary sweep.

Generating an arbitrary sweep with a chosen starting point and carefully selected frequency transitions requires some planning. The starting frequency determines the possible sweep range and fineness of the frequency steps. The data values in the arbitrary waveform determine the actual output frequencies and the ultimate stopping frequency.

PLANNING AN ARBITRARY SWEEP

1. Set the start frequency by pressing START and entering the chosen frequency.

2. Based on the displayed numerical value of the start frequency, calculate the necessary data levels needed to produce the required output frequencies. Doing this calculation prevents the problem of choosing starting frequencies incompatible with your overall sweep plan.

For example:

* Select a start frequency of 10.00 KHz.

* Arbitrary data values range from 0 to 3999. Therefore, the maximum possible output frequency is:

  10.00 KHz + 3999 = 49.99 KHz

  To reaffirm the above equation, the answer is truly 49.99 KHz, <u>not</u> 13.999 KHz. The least significant digit and the decimal place location remain fixed by the starting frequency.
  If the maximum achievable frequency is acceptable, construct an arbitrary waveform capable of giving the desired sweep.

* Choose a RATE setting which will cause the arbitrary sweep to be output at a speed consistant with the chosen output frequencies.

* Initiate the sweep with the command RUN 3.

3.70 VARIABLE SYMMETRY

The variable symmetry range is 20% to 80% from 40Hz to 399.9 KHz.
The power-up default symmetry is 50%. To change the waveform symmetry press SPCL pushbutton followed by 5XX, where XX is the required symmetry in % (from 20 to 80).
EXAMPLE: SPCL 530 for a 30% symmetry.
To return to 50% normal symmetry mode enter SPCL 550 or SPCL 500.
For displaying the instrument symmetry enter SPCL 501; the duty cycle will be displayed on the frequency window (EXAMPLE: 30-70 for a 30% symmetry).

SECTION 4

PROGRAMMING

4.1 INTRODUCTION

This section provides the information required for programming the MODEL 402A ARBITRARY FUNCTION GENERATOR via the IEEE-488 bus.The IEEE-488 bus is specified and described in the IEEE-488 - 1978 standard digital interface for programmable instrumentation. The information in this section assumes that the reader is knowledgeable in GPIB bus communication and has some experience in programming the system.

IEEE-728 STANDARD (the IEEE recommended practice for code and format conventions for use with IEEE-488) is used in programming the OR-X MODEL 402 ARBITRARY FANCTION GENERATOR.

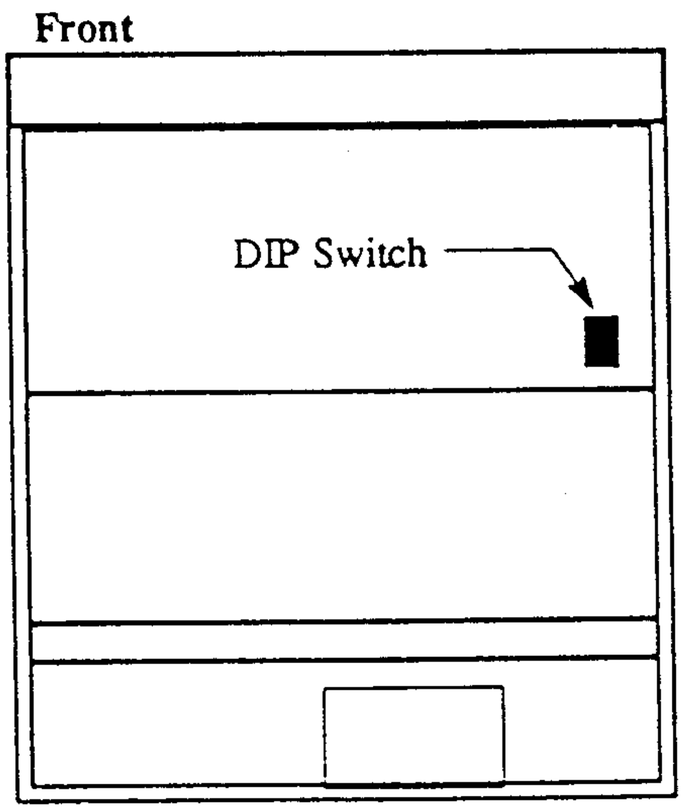
4.2 The MODEL 402A operates on the GPIB bus as listener and talker. The unit listens to messages from the GPIB system controller and all modes and parameters are programmable. The talk function provides error messages and reports operating modes to controller.

4.3 ADDRESS ASSIGNMENT

The instrument GPIB address is determined by an internal register. This register is initialized upon power turn-on by reading the address bits A1-A5 from GPIB address switch located on the digital board inside the unit. This switch is factory preset to decimal 7. TO CHANGE THE ADDRESS, power off the unit, remove the bottom covers, change the bit settings on the switch (see attached figure).

4.4 The current GPIB address can be checked by pressing SPCL 488. The address is then displayed in decimal form on the unit display.

4.5 The IEEE-488 interface function subsets of MODEL 402 are: SH1, AH1, T6, L4, LE0, TE0, SR1, RL1, PP0, DC1, DT1, C0, E2.



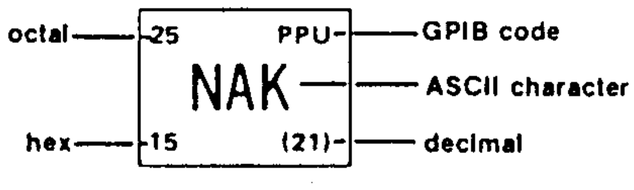
Bottom View

DIP SWITCH					GPIB ADDRESS		LISTEN ADDRESS		TALK ADDRESS	
Sw1	Sw2	Sw3	Sw4	Sw5	Decimal	Octal	Decimal	ASCII	Decimal	ASCII
ON	ON	ON	ON	ON	0	0	32	space	64	@
OFF	ON	ON	ON	ON	1	1	33	!	65	A
ON	OFF	ON	ON	ON	2	2	34	"	66	B
OFF	OFF	ON	ON	ON	3	3	35	#	67	C
ON	ON	OFF	ON	ON	4	4	36	$	68	D
OFF	ON	OFF	ON	ON	5	5	37	%	69	E
ON	OFF	OFF	ON	ON	6	6	38	&	70	F
OFF	OFF	OFF	ON	ON	7	7	39	'	71	G
ON	ON	ON	OFF	ON	8	10	40	(	72	H
OFF	ON	ON	OFF	ON	9	11	41	)	73	I
ON	OFF	ON	OFF	ON	10	12	42	*	74	J
OFF	OFF	ON	OFF	ON	11	13	43	+	75	K
ON	ON	OFF	OFF	ON	12	14	44	,	76	L
OFF	ON	OFF	OFF	ON	13	15	45	-	77	M
ON	OFF	OFF	OFF	ON	14	16	46	.	78	M
OFF	OFF	OFF	OFF	ON	15	17	47	/	79	O
ON	ON	ON	ON	OFF	16	20	48	0	80	P
OFF	ON	ON	ON	OFF	17	21	49	1	81	Q
ON	OFF	ON	ON	OFF	18	22	50	2	82	R
OFF	OFF	ON	ON	OFF	19	23	51	3	83	S
ON	ON	OFF	ON	OFF	20	24	52	4	84	T
OFF	ON	OFF	ON	OFF	21	25	53	5	85	U
ON	OFF	OFF	ON	OFF	22	26	54	6	86	V
OFF	OFF	OFF	ON	OFF	23	27	55	7	87	W
ON	ON	ON	OFF	OFF	24	30	56	8	88	X
OFF	ON	ON	OFF	OFF	25	31	57	9	89	Y
ON	OFF	ON	OFF	OFF	26	32	58	:	90	Z
OFF	OFF	ON	OFF	OFF	27	33	59	;	91	[
ON	ON	OFF	OFF	OFF	28	34	60	<	92	\
OFF	ON	OFF	OFF	OFF	29	35	61	=	93	]
ON	OFF	OFF	OFF	OFF	30	36	62	>	94	^
OFF	OFF	OFF	OFF	OFF	DO NOT USE		DO NOT USE		DO NOT USE	
Unlisten/Untalk							63	?	95	_

ASCII & IEEE 488 (GPIB) CODE CHART

BITS B7 B6 B5 / B4 B3 B2 B1	Ø Ø Ø	Ø Ø 1	Ø 1 Ø	Ø 1 1	1 Ø Ø	1 Ø 1	1 1 Ø	1 1 1
	CONTROL		NUMBERS SYMBOLS		UPPER CASE		LOWER	
Ø Ø Ø Ø	0 NUL 0 (0)	20 DLE 10 (16)	40 SP 20 (32)	60 0 30 (48)	100 @ 40 (64)	120 P 50 (80)	140 ` 60 (96)	160 p 70 (112)
Ø Ø Ø 1	1 GTL SOH 1 (1)	21 LLO DC1 11 (17)	41 ! 21 (33)	61 1 31 (49)	101 A 41 (65)	121 Q 51 (81)	141 a 61 (97)	161 q 71 (113)
Ø Ø 1 Ø	2 STX 2 (2)	22 DC2 12 (18)	42 " 22 (34)	62 2 32 (50)	102 B 42 (66)	122 R 52 (82)	142 b 62 (98)	162 r 72 (114)
Ø Ø 1 1	3 ETX 3 (3)	23 DC3 13 (19)	43 # 23 (35)	63 3 33 (51)	103 C 43 (67)	123 S 53 (83)	143 c 63 (99)	163 s 73 (115)
Ø 1 Ø Ø	4 SDC EOT 4 (4)	24 DCL DC4 14 (20)	44 $ 24 (36)	64 4 34 (52)	104 D 44 (68)	124 T 54 (84)	144 d 64 (100)	164 t 74 (116)
Ø 1 Ø 1	5 PPC ENQ 5 (5)	25 PPU NAK 15 (21)	45 % 25 (37)	65 5 35 (53)	105 E 45 (69)	125 U 55 (85)	145 e 65 (101)	165 u 75 (117)
Ø 1 1 Ø	6 ACK 6 (6)	26 SYN 16 (22)	46 & 26 (38)	66 6 36 (54)	106 F 46 (70)	126 V 56 (86)	146 f 66 (102)	166 v 76 (118)
Ø 1 1 1	7 BEL 7 (7)	27 ETB 17 (23)	47 ' 27 (39)	67 7 37 (55)	107 G 47 (71)	127 W 57 (87)	147 g 67 (103)	167 w 77 (119)
1 Ø Ø Ø	10 GET BS 8 (8)	30 SPE CAN 18 (24)	50 (28 (40)	70 8 38 (56)	110 H 48 (72)	130 X 58 (88)	150 h 68 (104)	170 x 78 (120)
1 Ø Ø 1	11 TCT HT 9 (9)	31 SPD EM 19 (25)	51) 29 (41)	71 9 39 (57)	111 I 49 (73)	131 Y 59 (89)	151 i 69 (105)	171 y 79 (121)
1 Ø 1 Ø	12 LF A (10)	32 SUB 1A (26)	52 * 2A (42)	72 : 3A (58)	112 J 4A (74)	132 Z 5A (90)	152 j 6A (106)	172 z 7A (122)
1 Ø 1 1	13 VT B (11)	33 ESC 1B (27)	53 + 2B (43)	73 ; 3B (59)	113 K 4B (75)	133 [5B (91)	153 k 6B (107)	173 { 7B (123)
1 1 Ø Ø	14 FF C (12)	34 FS 1C (28)	54 , 2C (44)	74 < 3C (60)	114 L 4C (76)	134 \ 5C (92)	154 l 6C (108)	174 | 7C (124)
1 1 Ø 1	15 CR D (13)	35 GS 1D (29)	55 - 2D (45)	75 = 3D (61)	115 M 4D (77)	135] 5D (93)	155 m 6D (109)	175 } 7D (125)
1 1 1 Ø	16 SO E (14)	36 RS 1E (30)	56 . 2E (46)	76 > 3E (62)	116 N 4E (78)	136 ^ 5E (94)	156 n 6E (110)	176 ~ 7E (126)
1 1 1 1	17 SI F (15)	37 US 1F (31)	57 / 2F (47)	77 ? UNL 3F (63)	117 O 4F (79)	137 UNT _ 5F (95)	157 o 6F (111)	177 RUBOUT (DEL) 7F (127)
	ADDRESSED COMMANDS	UNIVERSAL COMMANDS	LISTEN ADDRESSES		TALK ADDRESSES		SECONDARY ADDRESSES OR COMMANDS	

KEY TO CHART



ASCII and IEEE 488 (GPIB) Code Chart.

4.6 MNEMONICS

Each command message comprises a number of ASCII data bytes transmitted serially over the data lines of GPIB. The ASCII code mnemonics are indicated on the unit front panel.

C O N T R O L	MNEMONICS	N O T E S
FREQUENCY	F	units : Hz or KHz
AMPLITUDE	A	units : V or MV
OFFSET	O	units : V or MV
SPECIAL	Z	
SINE	W1	
SQUARE	W2	
TRIANGLE	W3	
DC	W0	
SYNTHESIZER OFF	Y0	
SYNTHESIZER ON	Y1	
CONTINUOUS	M0	
TRIGGERED	M1	
GATED	M2	
INCREMENT FREQUENCY	F@	
INCREMENT AMPLITUDE	A@	
INCREMENT OFFSET	O@	
DATA 0,1,2...9	0,1,2,..9,-,.	
KILOHERTZ	KHz	
HERTZ	Hz	
VOLTS	V	
MILLIVOLTS	MV	
STORE	S	
RECALL	R	
OUTPUT ON	N1	
OUTPUT OFF	N0	
INTERNAL TRIGGER SELECT	M3	
BURST MODE SELECT	M4	
BURST NUMBER	B	
SWEEP START	I	
SWEEP STOP	J	
MARKER FREQUENCY	K	
RATE	T	Units: SEC or mSEC.
SWEEP RUN	L	Followed by desired mode number 1,2 or 3.
ARBITRARY ON	X1	
ARBITRARY OFF	X0	
ARBITRARY POINT ADDRESS	P	In arbitrary programming mode only.
ARBITRARY POINT DATA	Q	
INTERROGATION	?	Must be followed by the required mnemonics.
ARBITRARY INTERROGATION	?!	
INSTRUMENT INTERROGATION	?*	

PARAMETER

F - FREQUENCY

Syntax : F[value] [units]
Example: F3999HZ

This command sets the output frequency to the value specified by the argument.
The choice units are HZ, KHZ.
Frequency can be specified to 3999 counts.

The query ?F returns the current frequency setting.

A - AMPLITUDE

Syntax : A[value in p-p] [units]
Example: A2V

The A command sets the peak-to-peak amplitude output voltage into 50 OHMS to the value specified by the argument. The units are MV or V.
The resolution is 3 digits with 10mV from 1V to 9.99V and 1mV from 10mV to 999 mV.

The query ?A returns the current amplitude setting.

O - OFFSET

Syntax : O[value] [units]
Example: O1V
O-1V

This command sets the offset voltage of the output signal to the value specified by the argument. The argument is specified in V or MV.

The absolute peak amplitude plus offset is limited to a maximum that is dependent on the signal amplitude range and following formula:

$$\frac{\text{AMPLITUDE}}{2} + \text{OFFSET} < 4.99\ \text{AMPLITUDE RANGE}$$

The resolution is 10mV if the amplitude is 1V-9.99V and 1mV if the amplitude is 10mV-999mV.

AMPL RANGE	PEAK AMPL+OFST	RESOLUTION
1.0V-9.99V	4.99V	10mV
0.1V-999mV	0.499V	1mV
0.01V-99mV	49 mV	1mV

The query ?O returns the current offset setting.

Z - SPECIAL

Syntax : Z[value]
Example: Z200

The Z command selects the special function.
The value specified by the argument is a 3 digits number as following:

888 - LED display test
488 - The IEEE 488 address is displayed.
101 - Displays the frequency increment magnitude.
102 - Displays the amplitude increment magnitude.
103 - Displays the offset increment magnitude.
200 - Disable and enable the frequency locking circuit.
520-580 - Variable symmetry control, last 2 digits indicating the symmetry.
(20 for 20%, 50 for 50% etc).
901-999 - Sweep operation (internal).

FUNCTION

W1 - SINE
W2 - SQUARE
W3 - TRIANGLE
W0 - DC

The commands W1,W2,W3,W0 select the type of waveform for instrument output.

MODE

M0 - CONTINUOUS
M1 - TRIGGERED
M2 - GATED

This command sets the trigger mode to the mode specified by the argument (0,1,2). See mode description on the operating section of this manual.

SYNTHESIZER

Y0 - SYNTHESIZER OFF
Y1 - SYNTHESIZER ON

This command is available only on an instrument with OPTION 02 installed and sets the instrument to the synthesizer mode. If this mode is selected and the instrument does not have the option installed, an execution error is reported.

INCREMENT

F@ - FREQUENCY INCREMENT
A@ - AMPLITUDE INCREMENT
O@ - OFFSET INCREMENT

Syntax : F@[value] [unit]
Example: f@10Hz

This command sets the increment of selected parameter to the value specified by the argument. The value is unitless and the unit push button serves as an ENTER key.

OUTPUT

N1 - OUTPUT ON
N0 - OUTPUT OFF

This command controls the instrument output signal to the MAIN OUT connector.
N1 connects the signal to the output and N0 disconnects the signal.
At power - on the output is off.

STORE

S - STORE

Syntax : S[value]
Example: S34

The current settings of the instrument are saved in the setting buffer specified by the argument value.
99 setting buffers are available, from 01 to 99.

RECALL

R - RECALL

Syntax : R[value]
Example: R35

This command changes the instrument settings to those stored in the setting buffer specified in the argument.
An atempt to recall an empty memory location will cause the display of "ERROR 1-6".

INTERROGATION

?* - INSTRUMENT INTERROGATION

This command returns the status of all instrument setting.

SWEEP

I - SWEEP START

J - SWEEP STOP

The commands set the frequency at wich a sweep will begin and stop. The resolution and the units are the same as for the frequency parameter (up to 3 3/4 digits).

L - SWEEP RUN

SYNTAX: L [VALUE]
EXAMPLE : L1

This command sets the sweep to the shape specified by the argument:

1 - Sets the sweep shape to a linear sweep.
2 - Sets the sweep shape to a logarithmic sweep.
3 - Sets the sweep shape to the arbitrary waveform currently selected in the arbitrary memory.
0 - To exit the sweep operation mode.

K - MARKER FREQUENCY

SYNTAX: K[VALUE] [UNIT]
EXAMPLE: K1000 Hz

This command sets the marker frequency. The marker appears as an intensified point on the waveshape. When the marker frequency is encountered during a sweep, the marker output is enabled while that frequency is output. Resolution is 3 3/4 digits. When the marker entered frequency is not between sweep start and stop frequencies, an "ERROR 6-5" message is displayed.

I - RATE

SYNTAX: I[VALUE] [UNITS]
EXAMPLE: I100 MS

This command sets the internal rate for trigger interval, the sweep rate and the arbitrary waveform output rate. The resolution is 4 digits, from 0.0001mS to 999.9S. The units are MS for miliseconds and S for seconds.

ARBITRARY

X1 - ARBITRARY ON
X0 - ARBITRARY OFF

The commands set the instrument to the arbitrary operating mode and outputs the programmed arbitrary waveform.

The programming of the arbitrary waveform is identical as in the manual mode. Use P for programming the ARBITRATY POINT ADDRESS and Q for the ARBITRARY POINT DATA.

4.7 MESSAGE SYNTAX

Commands sent to the instrument must have the proper syntax to be understood and executed. The instrument accepts ASCII encoded messages in upper case characters. The message consist of a mnemonics command followed by data and a message terminator. Multiple commands message are accepted but must be separated by a delimiter(, or ;) between commands.

TERMINATING MESSAGES

Messages may be terminated with CR and LF, LF only or by EOI. A syntax error is generated for two terminators in a single message (LF and EOI). Data accepted by the instrument is in accordance with IEEE-728, NR-2 floating point notation.

4.8 MESSAGE PROTOCOL

Message received is stored in the instrument input buffer, then processed and executed.

Processing a message consists of decoding commands, detecting delimiters and checking syntax. Executing a message consists of performing the actions specified by its commands. If an error is detected during processing or execution, the instrument asserts SRQ and ignores the remainder of the message.

The input buffer has a capacity of 40 characters. It is recommended after each transmit to spool the output buffer; messages can be lost by not being read.

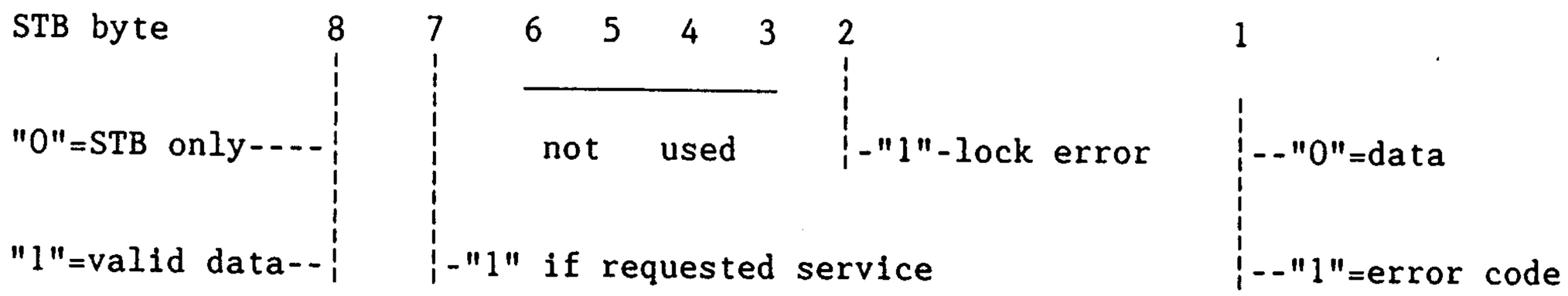
4.9 INSTRUMENT INTERROGATION

The instrument interrogate function is possible by the "?" prefix to the required mnemonics. Recall function interrogation must be followed by the memory number loction. The "?*" message sends the current instrument setting to system controller. Arbitrary interrogation is perform by the "?!".

4.10 ERROR REPORTING

The instrument may alert the controller that it requires service. This service request is also used to indicate an error.

The controller performs a serial poll and the instrument returns a status byte STB which indicates whether it was requesting service or not. The format of the information encoded in the STB is:



The error codes are listed in para 3.35. For GPIB two new error codes can be received:

9-0 non available IEEE-488 communication.

9-1 communication syntax error.

4.11 UNIVERSAL COMMANDS

Universal GPIB commands and the effects of those messages on the instrument functions are defined in IEEE-488 standard. The OR-X 402 programmable function generator will respond to the following universal commands which are sent in the command modes:

MNEMONIC	COMMAND	NOTES
DCL	Device clear	effect similar to power-on
SDC	Selected device clear	
GET	Group execute trigger	acts like a MANUAL trigger pushbutton
GTL	Go to local	
LLO	Local lockout	
REN	Remote enable	
STB	Status byte	
UNL	Unlisten	
UNT	Untalk	
MLA	My listen address	
MTA	My talk address	
SPE	Serial poll enable	
SPD	Serial poll disable.	

4.12 LOCAL AND REMOTE OPERATION

In LOCAL mode, instrument settings are controlled by the operator via front panel pushbuttons.

In **REMOTE** mode the instrument front panel controls are disabled, except the line switch and local key. The **REMOTE** mode indication is the illuminated LED inside LCL pushbutton. The MODEL 401A front panel digital display shows the value of the last programmed parameter.

The instrument switches to remote upon receipt of the remote enable **REN** and **MLA** or MTA; all control settings remain unchanged with the local-to-remote transition. The instrument returns to LOCAL mode by pressing the front panel LCL key (assuming that LOCAL LOCKOUT is not in effect). The output signal and all settings remain unchanged with the remote-to-local transition.

LOCAL LOCKOUT

A LOCAL LOCKOUT command disables the LCL key. LOCAL LOCKOUT remains in effect until the instrument is returned to the local state by either turning the line switch off-on or by programming the local message.

4.13 SAMPLE PROGRAMS

Because controller programming commands are not standardizes, it is impossible to provide actual operations in this manual. The following example programs are provided for a general demonstation of instrument operation under GPIB command. The examples wer written for IBM PC provided with "CEC" GPIB controller card.

```
10 ' S-401  WITH GPIB DEMO PROGRAM
20 '
30 ' **** ASSUME DEVICE ADDRESS IS - 7 !!! ****
40 '
50 DEF SEB=&HE000                          ' define GP-IB card segment address
60 '
70 INITIALIZE = 0 : SEND = 9               ' entry point to GPIB rom routin
80 TRANSMIT = 3 : RECEIVE = 6 : SPOLL = 12 : ENTER = 21
90 SYSTEM.CONTROLLER%=0 : MY.ADDRESS%=21 ' GP-IB controller parameter
100 ADDR% = 7                              ' set device address
110 '
120 CALL INITIALIZE (MY. ADDRESS%, SYSTEM.CONTROLLER%)
130 ST$="IFC REN " : CALL TRANSMIT(ST$,STATUS%) ' check if unit is active
140 '
150 ' set unit to : FREQ. = 3KHz , AMPLE. = 2V , sqware wave
160 ' and store in memory no.23
170 ' then read default set up and check the set up
180 ;
190 C$ = "F3KHZ;A2V;W2;S23" + CHR$(10)
200 CALL SEND (ADDR%, C$, STATUS%)
210 '
220 C$ = "R00" + CHR$(13) + CHR$(10)     ' read memory no. 0
230 CALL SEND (ADDR%, C$, STATUS%)
240 '
250 C$ = "?*" + CHR$(13) + CHR$(10)      ' get all data command
260 CALL SEND (ADDR%, C$, STATUS%)
270 FOR I = 1 TO 500 : NEXT I            ' wait for command decode
280 CALL SPOLL (ADDR%, POLL%, STATUS%)   ' check STB for data received
290 IF POLL% <> 192 THEN ERROR
300 '
310 R$=SPACE$(80)
320 CALL ENTER (R$, LENGTH%, ADDR%, STATUS%) ' get current set up
330
```

```
10 ' GP-IB interactive test routine
20 '
30 ' **** ASSUME DEVICE ADDRESS IS  -  7 !!! ****
40 '
50 ' ******************************************
60 ' initialize variables and GPIB card
70 ' ******************************************
80 '
90 CLS : KEY OFF                          ' clear screen
100 ON ERROR GOTO 630                ' system error handling
110 DEF SEG=&HE000                              ' define GPIB card segment address
120 '
130 S$=SPACE$(80)                               ' used to erase an input line
140 INITIALIZE = 0 : SEND = 9                   ' entry point to gpib rom rutin
150 TRANSMIT = 3 : RECEIVE = 6 : SPOLL = 12 : ENTER =21
160 SYSTEM.CONTROLLER%=0 : MY.ADDRESS%=21 ' GP-IB controller parameter
170 ADDR% = 7                                   ' set device address
180 '
190 '*** initialize gpib card to work as controller ***
200 '
210 CALL INITIALIZE (MY.ADDRESS%, SYSTEM.CONTROLLER%)
220 LOCATE 1,3 :PRINT "*** USE UPPERCASE ***"
230 '
240 ST$="IFC REN " : CALL TRANSMIT(ST$,STATUS%) ' check if unit active
250 '
260 command entry point
270 '
280 LOCATE 3,1 : PRINT R$ : LOCATE 3,1
290 INPUT "ENTER DEVICE COMMAND > ",C$
300 C$ + CHR$(13) + CHR$(10)
310 CALL SEND (ADDR%, C$, STATUS%)
320 IF STATUS% <> 0 THEN GOSUB 550 : GOTO 280 ' check comm.
330 '
340 ' poll STB from gpib device
350 '
360 FOR I = 1 TO 500 : NEXT I                   ' wait for command decode
370 CALL SPOLL (ADDR%, POLL%, STATUS%)
380 IF STATUS% <> 0 THEN GOSUB 550 : GOTO  280  ' check comm.
390 '
400 IF POLL% < 192 THEN GOTO 280                    ' get another command
410 '                                               ' if no data pending
420 ' receive data from device
430 '
440 R$=SPACE$(80)
450 CALL ENTER (R$, LENGTH%, STATUS%)
460 IF STATUS% <> 0 THEN GOSUB 550 : GOTO 280 ' check comm.
470 '
480 LOCATE 5,1 : PRINT S$ : LOCATE 5,1
490 IF POLL% = 192 THEN  PRINT "DATA = ":       ' data recived
500 IF POLL% = 193 THEN  PRINT "ERROR = ":      ' error message recived
510 PRINT R$
520 GOTO 280     ' return to command entry
530 '
540 '*** status error handler ***
550 '
560 LOCATE 5,1: PRINT S$ : LOCATE 5,1
570 IF STATUS% = 8 THEN PRINT "  TIMEOUT ERROR "
580 IF STATUS% = 2 THEN PRINT " BAD COMM. TALK/LISTEN"
590 RETURN
600 '
610 '*** system error handler ***
620 '
630 PRINT "ERROR NO. ";ERR;"  IN LINE  ";ERL : STOP
```