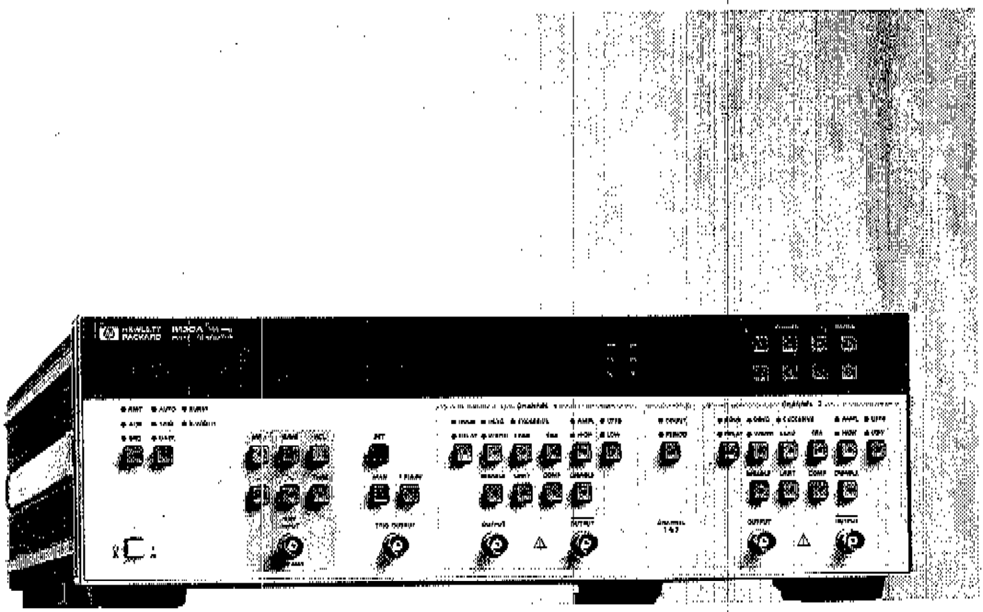
HP 8130A
300 MHZ
PULSE GENERATOR

OPERATING and
PROGRAMMING MANUAL



HEWLETT PACKARD

HP 8130A Programmable Pulse Generator Operating and Programming Manual Including Options 001 and 020

SERIAL NUMBERS

This manual applies to all instruments.

HEWLETT PACKARD

HP Part No. 08130-90011; Microfiche Part Number: 08130-95011
Printed in the Federal Republic of Germany

First Edition
E1089

Printing History

New editions are complete revisions of the manual. Update packages, which are issued between editions contain additional and replacement pages to be merged into the manual by the customer. The date on the title page and back cover of the manual only changes when a new edition is published. When an edition is reprinted, all the prior updates to the edition are incorporated. No information is incorporated into a new edition unless it appears in a prior update.

Control Serial Number: Edition 1 applies directly to all instruments.

Printing History

Edition	Date	Part Number	CODE
Edition 1	3rd October 1989	08130-90011	E0889

Safety Considerations

The Model HP 8130A is a Safety Class 1 instrument (instrument with an exposed metal chassis that is directly connected to earth via the power supply cable). The symbol used to indicate a protective earth terminal in the instrument is ⏚.

Before operation, the instrument and manual, including the red safety page, should be reviewed for safety markings and instructions. These must then be followed to ensure safe operation and to maintain the instrument in safe condition.

Power is supplied to some of the HP 8130A circuits at any time that the instrument is connected to the AC power source.

To disconnect from the line power, disconnect the power cord either at the rear power-inlet or at the AC line-power source (receptacle). One of these must be accessible at all times. If the instrument is installed in a cabinet, it must be disconnected from the line power by means of the system's line-power switch.

- Initial Inspection

  Inspect the shipping container for damage. If the container or cushioning is damaged, it should be kept until the contents of the shipment have been checked for completeness and the instrument has been verified both mechanically and electrically.

  Procedures for checking the operation of the instrument are given in the Performance Tests. If the contents are incomplete, mechanical damage or defect is apparent, or if an instrument does not pass the operator's checks, notify the nearest Hewlett-Packard office. Keep the shipping materials for carrier's inspection. The HP office will arrange for repair or replacement without awaiting settlement.

Warning

To avoid hazardous electrical shock, do not perform electrical tests when there are signs of shipping damage to any portion of the outer enclosure (covers, panels, etc.).

■ Power Requirements

Caution

Before applying AC line power to the HP 8130A, ensure that the voltage selector on rear panel of the HP 8130A is set for the proper line voltage and the correct line fuse is installed in the fuse holder. Procedures for changing the line voltage selector and fuse are contained in the following section "Line Voltage Selection".

The HP 8130A can operate from any single-phase AC power source supplying 100 V, 120 V, 220 V or 240 V in the frequency range from 50 to 60 Hz (see Table 0-1). The maximum power consumption is 250 VA with all options installed.

Table 0-1. Line Voltage Ranges

Selector Voltage	AC Voltage Range
100	90 – 110 V
120	108 – 132 V
220	198 – 242 V
240	216 – 264 V

■ Line Voltage Selection

Caution

BEFORE SWITCHING ON THE INSTRUMENT, make sure that the instrument is set to the local line voltage and the correct line fuse is installed in the fuse holder.

The line voltage selector is set at the factory to correspond to the most commonly used line voltage of the country of destination. The switch is combined with the power line voltage receptacle on the rear panel. Refer to Table 0-1 for the line voltage ranges and Table 0-2 to set the line voltage and select the appropriate fuse.

Table 0-2. Line Voltage and Fuse Selection

Line Voltage	Fuse Type	HP Part Number
100 V / 120 V	T 3A, 250 V	2110-0029
220 V / 240 V	T 1.5A, 250 V	2110-0304

To change the line voltage and fuse:

1. Remove the power cord.
2. Insert a screwdriver into the recess at the side of the assembly.
3. To change the voltage setting, the selector must be removed and then replaced with the new setting value displayed.
4. If necessary, change the fuse in accordance with the new voltage setting.

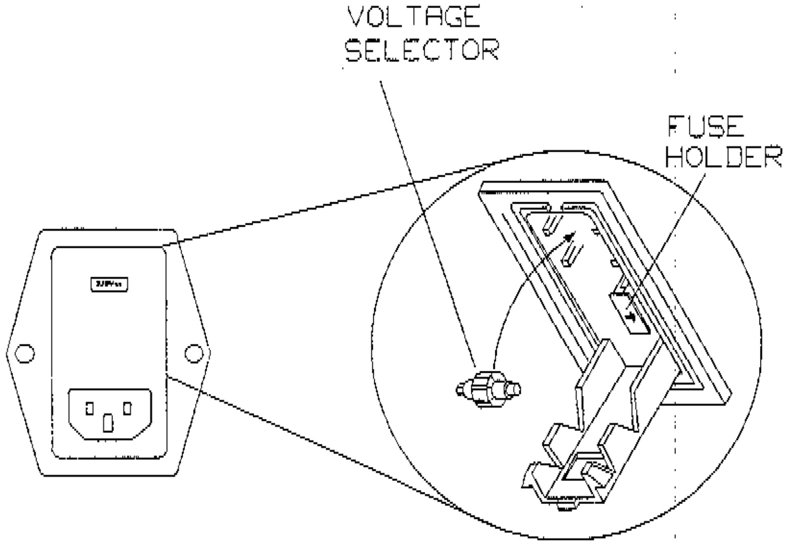


Figure 0-1. Line Voltage Switch Assembly

- Power Cable
  In accordance with international safety standards, this instrument is equipped with a three-wire power cable. When connected to an appropriate AC power receptacle, this cable grounds the instrument cabinet. The type of power cable shipped with each instrument depends on the country of destination. Refer to Figure 0-2 for the part numbers of the power cables available.

Warning **To avoid the possibility of injury or death, the following precautions must be followed before the instrument is switched on.**

- ☐ **If this instrument is to be energized via an autotransformer for voltage reduction, ensure that the Common terminal is connected to the grounded pole of the power source.**

- The power cable plug shall only be inserted into a socket outlet provided with a protective ground contact. The protective action must not be negated by the use of an extension cord without a protective conductor.
- Before switching on the instrument, the protective ground terminal of the instrument must be connected to a protective conductor. This is verified by using the power cord which is supplied with the instrument.
- Intentional interruption of the protective ground connection is prohibited.

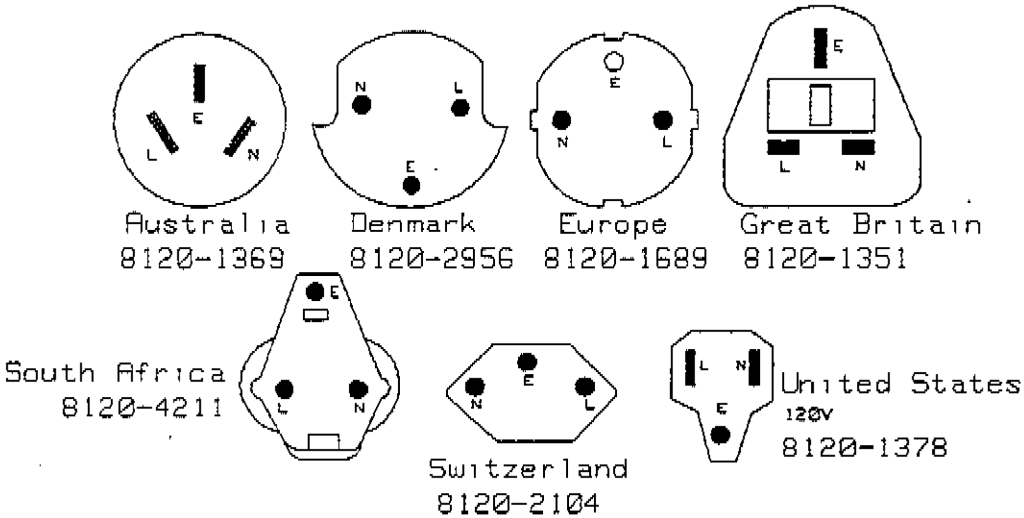


Figure 0-2. Power Cables - Plug Identification

The following work should be carried out by a qualified electrician - all local electrical codes being strictly observed. If the plug on the cable does not fit the power outlet, or the cable is to be attached to a terminal block, cut the cable at the plug end and re-wire it.

The color coding used in the cable will depend on the cable supplied. If a new plug is to be connected, it should meet local safety requirements and include the following features:

- □ Adequate load-carrying capacity (see table of specifications).
- □ Ground connection.
- □ Cable clamp.

- Input/Output Signals

Caution

The maximum external voltages which can be applied to the inputs and outputs of this instrument are as follows:

External Input ±10V

Trigger Output +7V, -2V

Main Output ±5V

- Operating Environment
  The following summarizes the HP 8130A operating environment ranges. In order for the HP 8130A to meet specifications, the operating environment must be within these limits.

Warning

The HP 8130A is not designed for outdoor use. To prevent potential fire or shock hazard, do not expose the HP 8130A to rain or other excessive moisture.

- Temperature
  The HP 8130A may be operated in temperatures from 0°C to 55°C.
- Humidity
  The HP 8130A may be operated in environments with humidity up to 95% (0°C to +40°C). However, the HP 8130A should be protected from temperatures or temperature changes which cause condensation within the instrument.
- Instrument Cooling
  The HP 8130A is equipped with a cooling fan mounted inside the rear panel. The instrument should be mounted so that air can freely circulate through it. When operating the HP 8130A, choose a location that provides at least 75 mm (3 inches) of clearance at the rear, and at least 25 mm (1 inch) of clearance at each side. Failure to provide adequate air clearance will result in excessive internal temperature, reducing instrument reliability.
- Storage and Shipment
  The instrument can be stored or shipped at temperatures between −40°C and +75°C. The instrument should be protected from temperature extremes which may cause condensation within it.

Introduction

This manual is arranged into four categories:

- Instrument Description
  Descriptions of selected operating principles:
  Chapter 1, Chapter 2, Chapter 3, and Chapter 4
- Quick Reference Guide
  Local control and remote control programming information: Chapter 5, Chapter 6 and Chapter 7
- Reference Data
  Supporting information of a non-operational nature: Appendices A to H
- Customer Assistance
  Sales and Service information: Appendix I.

Application programming level knowledge of *IEEE Standards 488.1-1987* and *488.2-1987* is desirable for remote control programming of the HP 8130A.

Appendix G contains cross reference information for earlier instrument languages and the HP8130A language which is based on *IEEE Draft Standard 488.2-1987*

Notices

Subject Matter

The information in this document is subject to change without notice.

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Front Cover Photograph

The instrument photograph on the front cover shows the HP 8130A with OPTION 020 installed.

Limited Warranty

Warranty

This Hewlett-Packard instrument product is warranted against defects in material and workmanship for a period of one year from date of shipment. During the warranty period, HP will, at its option, either repair or replace products which prove to be defective.

For warranty service or repair, this product must be returned to a service facility designated by HP. Buyer shall prepay shipping charges to HP and HP shall pay shipping charges to return the product to Buyer. However , Buyer shall pay all shipping charges, duties, and taxes for products returned to HP from another country.

HP warrants that its software and firmware designated by HP for use with an instrument will execute its programming instructions when properly installed on that instrument. HP does not warrant that the operation of the instrument, software, or firmware will be uninterrupted or error free.

Limitation of Warranty

The foregoing warranty shall not apply to defects resulting from improper or inadequate maintenance by Buyer, Buyer-supplied software or interfacing, unauthorized modification or misuse, operation outside of the environmental specifications for the product, or improper site preparation or maintenance.

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The remedies provided herein are Buyer's sole and exclusive remedies. Hewlett Packard shall not be liable for any direct, indirect, special, incidental, or consequential damages whether based on contract, tort, or any other legal theory.

Assistance

Product maintenance agreements and other customer assistance agreements are available for Hewlett-Packard products. For any assistance contact your nearest Hewlett-Packard Sales and Service Office. Addresses are provided at the back of this manual.

Certification

Hewlett-Packard Company certifies that this product met its published specifications at the time of shipment from the factory.

Hewlett-Packard further certifies that its calibration measurements are traceable to the United States National Institute of Standards and Technology, NIST (formerly the United States National Bureau of Standards, NBS) to the extent allowed by the Institute's calibration facility, and to the calibration facilities of other International Standards Organization members.

Radio Frequency Interference Statement Deutsche Bundespost

(Federal Republic of Germany only)

Hersteller Bescheinigung

Hiermit wird bescheinigt, dass das Geraet, Pulsgenerator-HP8130A, in Uebereinstimmung mit den Bestimmungen von Postverfuegung 1046/1984 funkentstoert ist.

Der Deutschen Bundespost wurde das Inverkehr bringen dieses Geraetes angezeigt und die Berechtigung zur Ueberpruefung der Serie auf Einhaltung der Bestimmungen eingeraeumt.

Zusatzinformation fuer Mess- und Testgeraete:
Werden Mess- und Testgeraete mit ungeschirmten Kabeln und/oder in offenen Messaufbauten verwendet, so ist vom Betreiber sicherzustellen, dass die Funkenstoerbestimmungen unter Betriebsbedingungen an seiner Grundstuecksgrenze eingehalten werden.

Manufacturers Declaration

This is to certify that the HP 8130A Pulse Generator operates in accordance with the radio frequency interference requirements of Deutsche Bundespost (German Post Office) Directive FTZ 1046/1984.

The German Post Office was notified that this equipment was put into circulation. The German Post Office retains the right to check future Hewlett- Packard model HP 8130A instruments for compliance with directive FTZ 1046/1984.

Additional information for test and measurement equipment:
If test and measurement equipment is operated with unshielded cables and/or used for measurements on open set-ups, the user must assure that, under operating

conditions, the radio interference limits are still met at the border of his premises.

Contents

Figures

Tables

1

General

Introduction

The HP 8130A is a 300 MHz pulse generator providing simultaneous normal and complement output signals from 100 mVpp to 5.00Vpp.

The standard instrument contains one channel; a two channel instrument is also available. A second channel cannot be fitted to an existing instrument.

For the specifications of this instrument see Appendix B.

For a list of the options and accessories available see Appendix D.

Instrument Features

Table 1-1.

Input	Signal Output	Trigger Output
External Input	State	
Manual	Polarity	
Single Pulse		
Polarity		
Threshold		

Modes	Memory	Set
Automatic	Save Setting	(calculated setting)
Trigger	Recall Setting	
Gate		
Burst		
External Width		

Pulse	
Period	High Level
Width	Low Level
Duty Cycle	Limit
Delay	Amplitude
Double Pulse	Offset
Leading Edge	Trailing Edge

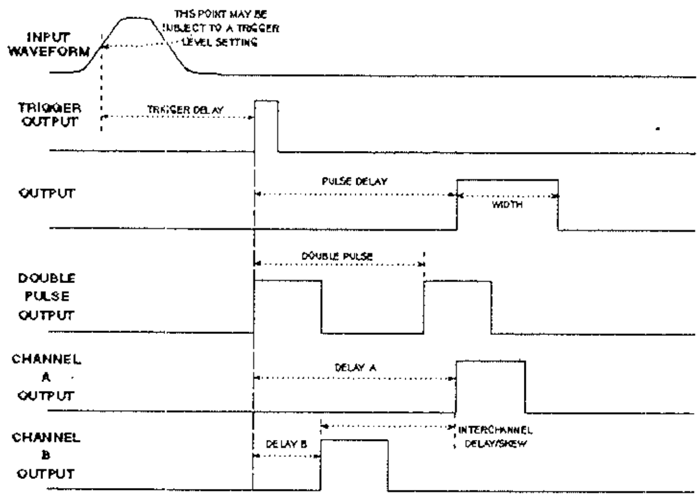
Pulse Generator Definitions

The following are definitions for some of the terms used in connection with this instrument.

Time Reference Point Median (50% amplitude point on pulse edge).

Pulse Period The time interval between the leading edge medians of consecutive trigger output pulses.

Trigger Delay Interval between trigger point of input signal and the trigger output pulse's leading edge median. Applies in trigger, external width, and burst modes.



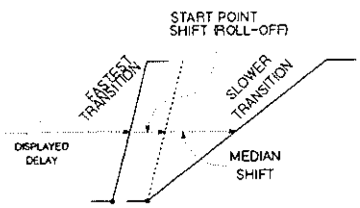
Pulse Delay Interval between leading edge medians of trigger output pulse and output pulse.

Double Pulse Interval between leading edge medians of the double pulse.

Interchannel Delay/Skew

Interval between corresponding leading edge medians.

Delay The specified and displayed value is that obtained with the fastest leading edge. For a slower edge, the actual delay exceeds the displayed delay by the combined shift of start point and median.

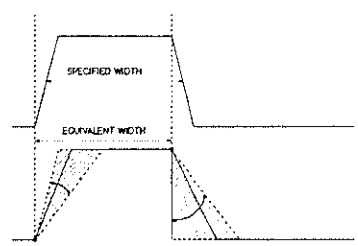


Pulse Width

Interval between corresponding leading- and trailing-edge medians. The specified and displayed value is that obtained with fastest edges; essentially equal to the interval from the start of the leading edge to the start of the trailing edge.

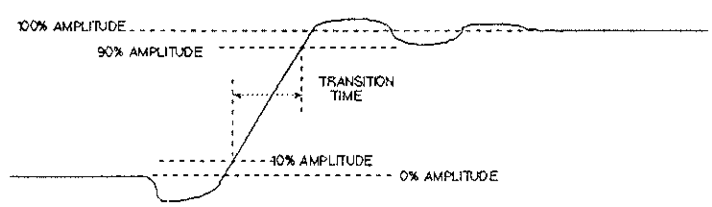
By designing so that the pulse edges turn about their start points, the interval from leading edge start to trailing edge start stays unchanged† when transition times are varied. This is more convenient for programming and the width display is easy to interpret.

†In practice, start points may shift with changes in transition time.

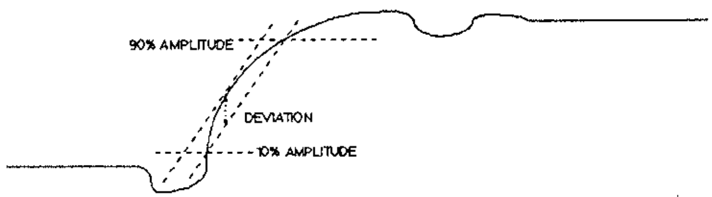


Transition Time

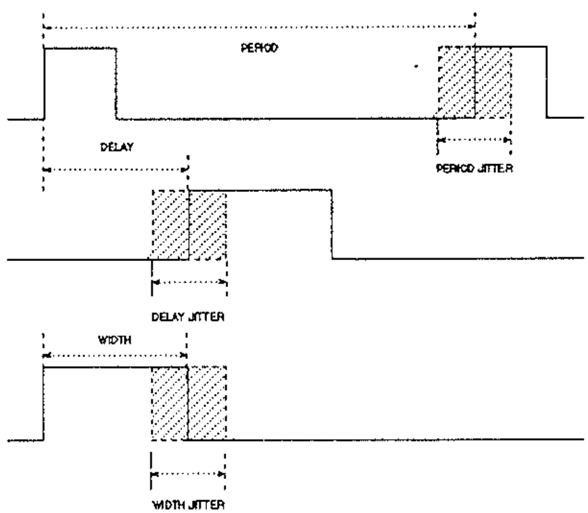
Interval between the 10%- and 90%- amplitude points on the leading/trailing edge.



Linearity Peak deviation of an edge from a straight line through the 10%- and 90%- amplitude points, expressed as percentage of pulse amplitude.



Jitter Short term instability of one event with respect to another. rms jitter is based on 1000 measurements and is identical to the standard deviation

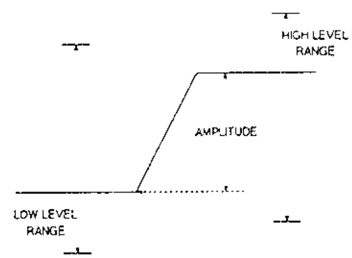


Stability

Long term average instability expressed as percentage of main parameter over a specific time duration, e.g. hour, year. Excludes jitter.

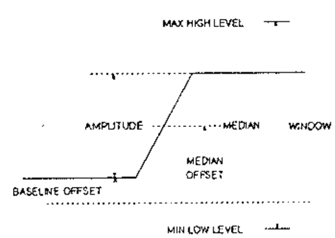
Pulse Level

High level and low level. Any limitation is expressed by an amplitude specification.



Pulse Amplitude

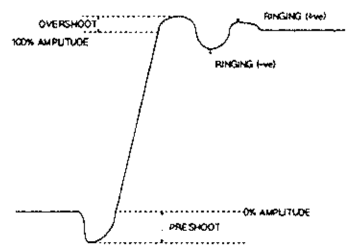
(alternative to level definition)
Pulse amplitude and baseline offset are specified. Any limitation is expressed by a window (max high level, min low level).



Preshoot, Overshoot, Ringing

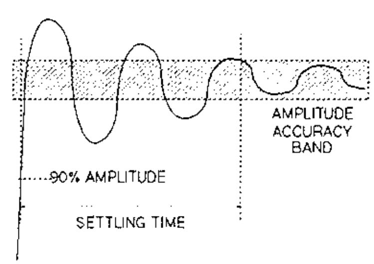
Preshoot and overshoot are peak distortions preceding/following an edge. Ringing is the positive peak and negative peak distortion excluding overshoot, on pulse top or base. A combined specification of e.g. 10% implies:

- Overshoot/undershoot <10%
- Largest pulse-top oscillation <±10% of pulse amplitude.



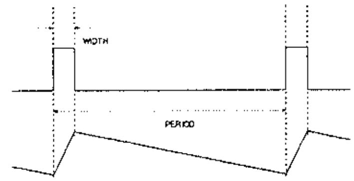
Settling Time

Time taken for pulse levels to settle within level specification, measured from 90% point on leading edge.



Duty Cycle

Percentage ratio of pulse width to period. In pulse/function generators this term is also used to define sine and triangle symmetry.



Output Impedance/Resistance:

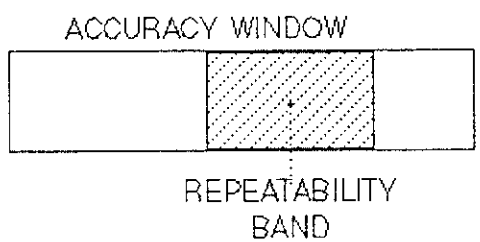
Effective pulse source impedance/dc resistance.

Reflection Coefficient

Reflection at a pulse generator output expressed in percent of incident pulse amplitude. (Test pulse edges correspond to generator's fastest transitions).

Repeatability

When an instrument operates under the same environmental condition, and with the same settings, the value of a parameter will lie within a band inside the accuracy window. Repeatability defines the width of this band.



HP-IB Programming Times

Listen Time The time an instrument occupies the bus to receive and verify a message. The NRFD signal is active during this period.

Settling Time The time taken by the instrument to execute an HP-IB message, and for the output to settle within the accuracy specification.
NRFD inactive.

Execution Time The sum of Listen Time and Settling Time

Talk Time The time an instrument occupies the bus to output a specified string. Output data is typically instrument error status, or current or stored parameters.

2

Operation

Power-On

At power-on, the instrument performs a self-test. After a successful self- test it enters the normal operating state. If the there is a problem an error condition is reported. This is indicated by an error number on the instrument display, or in the status byte if the instrument is being controlled over the HP-IB.

Power-On Self-Test

The instrument performs the following tests during the power-on self-test sequence:

1. Processor board tests
2. Parametric board Tests

During the self-test all of the LEDs light and the display shows 8.8.8.8. If any of the LEDs or display segments do not light during the power-on self-test this indicates a possible problem on the display board.

See Table H-1 for the scope of the power-on self-test.

Normal State

When the instrument enters the normal operating state it is set up as follows:

- The instrument is initialized and enters the idle state.
- The setting is set to one of the following:
  - To the setting stored at power-off, however, the outputs are disabled. The power-off address is restored.

- To the standard setting if the internal memory data is invalid. The instrument's address is set to 11, the default address.

Power-On Error Condition

If an operating-error exists there are two possible causes. These are listed here:

- Processor board test failure: In this case the instrument *can not be operated.* The error condition code is reported at the instrument's display in the format Fnnn. See Table H-1 for a list of the Fnnn type errors.
- Parametric board test failure: In this case the instrument *is operable,* however, *parametric capability is restricted.* The error condition code is reported at the instrument's display in the format Ennn. See Table H-1 for a list of the Ennn type errors.

Power-Off

At power-off, the instrument's setting and interface address are stored in battery supported internal memory.

Instrument Setting

The instrument setting contains the complete operating state of the instrument.

The setting can also be stored in or recalled from internal memory. The internal memory is battery supported and will retain it's contents after the power is switched off. Up to 19 settings can be stored.

Programming of Parameters

Period, width, double, and transition under-programming are allowed. This is to ensure that the specified minimum values can always be obtained. See Chapter 5 and Chapter 7.

Low and high levels can be under-programmed or over-programmed to ensure that the specified minimum and maximum values can always be obtained.

Local Programming

In the local programming mode, the instrument is controlled by using the keys on the front panel.

The front panel controls and functions are described in Chapter 5.

Function Selection and Data Entry

The instrument can be controlled from the front panel. Keys are provided so that any of the operating parameters can be checked or altered. LEDs are used to indicate which parameter is currently selected. The value of the current parameter is displayed.

To select one of the functions on the front panel, press the corresponding key. An LED lights to indicate the selection that has been made. In some cases a key will be used for more than one function, you should press the key repeatedly until the LED for the parameter you want to use is lit.

If the value for the current parameter is to be changed, use the up or down vernier keys or the range keys to make the changes.

Device Errors

Some combinations of parameter values are not possible.. When there is conflict between the values of two parameters the ERROR message lights and the LEDs for each of the conflicting parameters blink. For a description of the relationships between parameters that cause conflicts, see Chapter 5.

The leading and trailing edges of the pulse and the pulse width and period are all programmable. It is possible to program these so that the pulse cannot reach full amplitude, when this occurs EXCESSIVE LED lights to warn you.

If the limiting condition is important in the application, the output should be verified on an oscilloscope. In other cases, the timing should be adjusted until the error display turns off, indicating that the outputs are valid.

Local Programming: A Sample Session

In this short session we will set up a dual channel instrument with a single pulse in one channel and a double pulse in the other. The single pulse is delayed, with respect to the double pulse, by $17.5\mu s$. The pulses have the characteristics given in the following table.

	Pulse 1	Pulse 2
Period	$850\mu s$	$850\mu s$
Delay	$17.5\mu s$	—
2nd Pulse Delay	—	$300\mu s$
Width	$15.5\mu s$	—
Duty Cycle	—	25%
Transition Time:		
Leading Edge	$1.00\mu s$	$40\mu s$
Trailing Edge	$2.75\mu s$	$25\mu s$
High Level	3.00V	—
Low Level	-2.00V	—
Amplitude	—	4.30V
Offset	—	-0.12V

When the instrument is set, we will then save this setup into the internal memory.

To set up the instrument you should use the following procedure.

Note

Some keys have more than one function. An LED lights, above the key, beside the current function. The name given to a key, in the description below, is the current function of that key.

Note

If you have a single channel instrument, you will have to implement the two waveforms separately.

1. Switch the instrument on. Check, during the self-test that all LEDs and display segments are lighting.
2. First we want to restore the default settings of the instrument. To do this you should
   a. Press .
   b. Use the up or down VERNIER arrow keys to select memory 0. Memory zero is selected when 0 is shown on the display.
   c. Press to recall this setup from memory.
3. The LED in the key is lit and the display shows the current period, which is 1.00 ms. Press the left most VERNIER ⇓ twice and the middle VERNIER ⇑ 5 times. These set the value of the left most digit and the middle digit on the display respectively. The display shows the period is now 850 μs.

This completes the setup common to both channels. We will now continue with the setup for channel 1. All of the keys referred to in the next section are for channel 1.

4. Press the key. The LED in the key lights and the display shows the current delay (which is 0ps). Press the left VERNIER ⇑ key once. Press the RANGE ⇑ key 5 times, so that our setting will be in 10.0s of microseconds. Press the middle VERNIER ⇑ key 7 times, and the right VERNIER ⇑ key five times. The variable pulse delay is now set to 17.5μs (as shown on the display).
5. Press the key, and use the VERNIER and RANGE keys to set the width of the pulse to 15.5μs.
6. Press the key and use the VERNIER keys to set the trailing edge transition time to 2.75μs
7. Press the key and use the VERNIER keys to set the high level of the signal to 3.00V.

8. Press the key and use the VERNIER keys to set the low level of the signal to -2.00V.

The delayed single pulse is now setup in the first channel. The following instructions cover the configuration of the second channel.All of the keys referred to in the next section are for channel 2. If you are using a single channel instrument you can use these instructions with keys in channel 1, but these settings will replace any that you have already made.

9. Press the key twice. We can now set the duty cycle of the pulse. Use the VERNIER keys to set the duty cycle to 25%.
10. Press the key twice. We have now enabled the double pulse and can set the delay between the two pulses. Use the VERNIER keys to set the delay to $300\mu s$
11. Press the key. Press the RANGE ⇑ key once so that we are setting the leading edge transition time in 10.0s of microseconds. Use the VERNIER keys to set the leading edge time to $40\mu s$.
12. Press the key. Use the VERNIER keys to set the trailing edge transition time to $25\mu s$.
13. Press the key twice. We can now set the amplitude of the pulse. Use the VERNIER keys to set the amplitude to 4.30V
14. Press the key. Use the VERNIER keys to set the signal offset to -0.12V.

This ends the setting of the parameters for the double pulse signal.

To enable the signals, and to save them to memory use the following procedure.

15. To save the setup to memory
    a. Press .

b. Use the up or down VERNIER arrow keys to select empty memory location. You cannot save to memory location 0.

c. Press to store this setup to memory.

16. To enable the signal from channel 1, press the key above the OUTPUT or the $\overline{\text{OUTPUT}}$.

17. To enable the signal from channel 2, press the key above the OUTPUT or the $\overline{\text{OUTPUT}}$.

Remote Control Programming

The instrument can be programmed from a remote controller by using the Hewlett-Packard Interface Bus (HP-IB). Program messages can be sent to the instrument and the instrument can return test, operating state, parameter, and identification information in response messages.

Program Messages

Information on program messages is to be found in Chapter 4, details on individual commands are to be found in Chapter 6, which covers commands common to all machines using the language specified, and Chapter 7, which covers commands specific to this instrument.

Response Messages

Information on response messages is to be found in Chapter 4, details on individual responses are to be found in Chapter 6, which covers responses to common commands, Chapter 7, which covers the responses to device commands, and Appendix H, which covers the error messages.

Interface

The interface, HP-IB, is a byte-serial, bit-parallel, asynchronous, digital interface.

The interface port is located on the rear panel.

Status Indicators

The following three indicators on the front panel show interface status.

- RMT (remote) indicates when the instrument is in the remote programming mode.
- ADS (address) indicates when the instrument is listen or talk addressed.
- SRQ (service request) indicates when a service request is pending; the interface SRQ control line is asserted.

Address Displaying

The instrument address can be read on the front panel display by pressing the LCL (local) key while in the local programming mode. The result is displayed as A followed by the address, for example A 10 would indicate that the instrument has the address 10.

Address Changing

To change the address (local programming mode only):

- Press the LCL key.
- Change the address in the display by using the vernier keys.
- Press the LCL key again.

The address cannot be changed if the instrument is talk or listen addressed, if a service request is pending or when the instrument is in the remote programming mode.

External Input

External input (marked EXT INPUT on the instrument) is the signal input for use in the trigger, gate, burst, or external width operating modes. The operating modes are described in Chapter 5.

Channel 1/2 Outputs

Each channel has two differential outputs (marked OUTPUT and $\overline{\text{OUTPUT}}$ on the instrument). The standard instrument has one channel. Channel 2 is an optional second channel, specified at the time of ordering the instrument.

Note

It is not possible to fit the second channel to an existing, single-channel instrument.

Trigger Output

Trigger output (marked TRIG OUTPUT on the instrument) is the reference signal for the channel 1 and 2 output waveforms.

3

Firmware Operation

Introduction

This chapter describes various features of the normal operation of the instrument. These include the power-on procedure, the operation of the parser, and structures used for the status data.

Power-On

At power-on, the instrument goes through the following procedure:

1. The instrument initializes itself:
   a. The input queue is cleared.
   b. The output queue is cleared.
   c. The front panel key queue is cleared.
   d. STB, SRE, ESR, and ESE registers, and the error queue are cleared.
   e. The parser is reset.
   f. The execution control is reset.
   g. The response formatter is reset.
2. The instrument then enters the idle state awaiting a command.
3. The setting at power-off is restored as the current setting; however, the outputs are disabled.
4. The power-off address is also restored.

Note

If the RAM data is invalid, the power-off setting cannot be restored. In this case, the standard setting and the default address, 11, are restored.

Parser Operation

The parser is a program which runs on the HP8130A monitoring the HP-IB interface. It is responsible for reading in messages from the interface, converting them into commands, and then performiong those commands on the instrument.

Normally, the instrument removes all incoming data from the interface port and places it in the input queue. When all the data has been received and placed in the queue it is parsed.

When the input queue is full, and there are additional bytes at the interface the parser removes one byte at a time from the input queue and parses it, then a byte is taken from the interface port and added to the input queue. If there are still more bytes at the interface, the process, of parsing one byte and then getting a byte from the port and putting it in the queue, continues until the input port all bytes are input. When all of the bytes have been received the entire input queue is parsed in the normal way.

Synchronization

All commands are executed sequentially, that is one after the other.

If `*OPC` or `*OPC?` is parsed, a delay of two seconds occurs before the OPC bit is set or an ASCII coded '1' is placed in the output queue. See Chapter 6.

If `*WAI` is parsed, a delay of two seconds occurs before executing any other commands. See Chapter 6.

At the end of two seconds, all operations are complete.

Error Types

There are four categories of instrument errors. A full list of errors is to be found in Appendix H

- Power-on self-test errors identify microprocessor and output board failures occurring at power-on. See Table H-1 for the extent of the test.
- Self-test (*TST?) errors identify output board failures. The test is identical to the output board test performed at power-on. See Table H-2
- Command, execution, device dependent, and query error events are reported in the standard event status register (ESR). These errors can be read in response to the :SYST:ERR? query. See Table H-3
- Device dependent error conditions are reported in bit 0 of the status byte register. These errors can be read in response to the :SYST:DERR? query. See Table H-4 and Table H-5

  The device dependent errors are reported on the front panel by blinking LEDs and are referred to as conflicts in the manual.

Local Messages

Power-on error messages are displayed immediately after the failure of one of the power-on self-tests. See Table H-1 for a list of messages.

There are two types:

- Processor board test failure: the instrument *can not be operated.*

  The error condition code is reported at the instrument's display in the format Fnnn.

- Parametric board test failure: the instrument *is operable,* however, parametric capability is restricted.

  The error condition code is reported at the instrument's display in the format Ennn.

Remote Messages

Remote error messages can be read in response to the following queries:

- &*TST? (See Table H-2).
- :ERR? (See Table H-3)
- :DERR? (See Table H-4)

Polling

The instrument's interface is of the type T6 (according to the *IEEE Standard 488*). This means that the serial poll method of requesting service is used.

Polling: STB Bit 0 Behavior

Bit 0 of the status byte register always reflects the actual state of the device. If a conflict is present, Bit 0 will be set. If all conflicts are cleared, Bit 0 will also be reset.

If Bit 0 is set (1) a service request is generated, providing that there is no currently pending service request.

STB Message. The status can be read from bits 7 and 5 to 0 of the status byte register.

Bit 7: not used

Bit 5: ESB (Event Status Bit)

Bit 4: MAV (Message Available)

Bit 3: not used

Bit 2: not used

Bit 1: not used

Bit 0: H (hardware error summary-condition-bit)

The errors causing bit 0 to be set are reported in response to a :DERR? query: See Table H-4 for a listing of the :SYST:DERR? query errors.

Status Information

There are four registers involved in the status information available from the instrument. Two of these are status registers and two are enable registers. These registers conform to the *IEEE Standard 488.2-1987.*

The registers are related as indicated in the following figure.

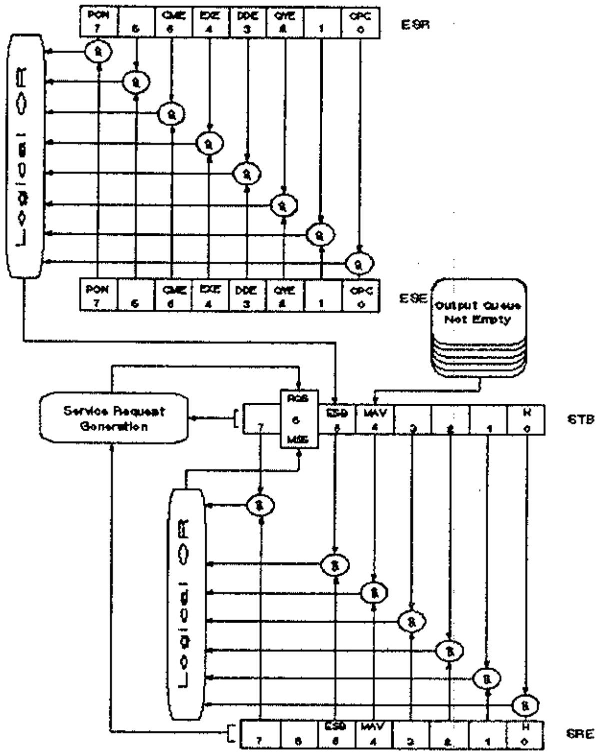


Figure 3-1. Status Report

STB: Status Byte Register

Description

The status byte register (STB) is described in the following figure.

The Master Summary Status (MSS) bit is true when any enabled bit of the STB register is set (excluding Bit 6).

[Bit 7][Bit 6][Bit 5][Bit 4][Bit 3][Bit 2][Bit 1][Bit 0]

Bit 7: Not used, value = 0

Bit 6: RQS / MSS (Request Service / Master Summary Status)

Bit 5: ESB (Event Status Bit)

Bit 4: MAV (Message Available)

Bit 3: Not used, value = 0

Bit 2: Not used, value = 0

Bit 1: Not used, value = 0

Bit 0: H (Hardware error summary-condition-bit)

Figure 3-2. Status Byte Register

Note

MSS is found in bit 6 when the register is read by an *STB query, RQS is found in bit 6 when the register is read by a serial poll.

Reading

There are two ways of reading the status byte register:

- An *STB? query.
- A serial poll.

The status byte including, the master summary bit, MSS, is not directly altered as a result of an `*STB?` query.

Note

MSS can be indirectly altered by the query when MAV is enabled.

The request for service, RQS, bit is cleared, but otherwise the status byte, including the MSS bit, are not altered as a result of a serial poll.

SRE: Service Request Enable Register

Description

The service request enable register (SRE) allows enabling of status byte register (STB) bits. See "*SRE" in Chapter 6 command. A bit must be set in this register to enable the corresponding bit in the STB register to effect the MSS or RQS bits.

Bit six of the status byte register cannot be disabled. Even if an *SRE message tries to disable bit six, it remains operational.

[Bit 7][Bit 6][Bit 5][Bit 4][Bit 3][Bit 2][Bit 1][Bit 0]

Bit 7: Not used, value = 0

Bit 6: Not used, value = 0

Bit 5: ESB (Event Status Byte)

Bit 4: MAV (Message Available)

Bit 3: Not used, value = 0

Bit 2: Not used, value = 0

Bit 1: Not used, value = 0

Bit 0: H (Hardware error summary-condition-bit)

Figure 3-3. Service Request Enable Register

Reading

The service request enable register (SRE) is non-destructively read with the *SRE? query.

ESR: Standard Event Status Register

Description

The standard event status register (ESR) is described in the following figure.

[Bit 7][Bit 6][Bit 5][Bit 4][Bit 3][Bit 2][Bit 1][Bit 0]

Bit 7: PON, Power-on

Bit 6: Not used, value = 0

Bit 5: CME, Command Error

Bit 4: EXE, Execution Error

Bit 3: DDE, Device Dependent Error

Bit 2: QYE, Query Error

Bit 1: Not used, value = 0

Bit 0: OPC, Operation Complete

Figure 3-4. Event Status Register

Reading

The standard events status register is read with the `*ESR?` query.

The register is cleared after being read.

Additional information on CME, EXE, DDE, and QYE status is obtained with the `:SYST:ERR?` query. See Chapter 7 and Table H-3.

ESE: Standard Event Status Enable Register

Description

The standard events status enable register, (ESE), described in the following figure, enables bits of the standard events status register, ESR. A bit must be set in this register to enable the corresponding bit in the events status register.

The register is masked with the *ESE command and cleared with an *ESE 0 message.

[Bit 7][Bit 6][Bit 5][Bit 4][Bit 3][Bit 2][Bit 1][Bit 0]

Bit 7: PON, Power-on

Bit 6: Not used, value = 0

Bit 5: CME, Command Error

Bit 4: EXE, Execution error

Bit 3: DDE, Device Dependent Error

Bit 2: QYE, Query Error

Bit 1: Not used, value = 0

Bit 0: OPC, Operation Complete

Figure 3-5. Event Status Enable Register

Reading

The standard event status enable (ESE) register is non-destructively read with the *ESE? query.

Input Queue

The input queue is:

- FIFO queue (first-in first-out)
- 100 bytes long.

Output Queue

The output queue is:

- FIFO queue (first-in first-out)
- 40 response messages long

The message available, MAV, bit is set in bit four of the status byte when the output queue contains a message.

The output queue and the MAV bit are cleared directly after the program message terminator when a new program message is received.

Error Queue

The error queue is a:

- FIFO queue (first-in first-out)
- 10 errors long

If the queue overflows, message '-350 <too many errors>' overlays the last message in the queue.

Key Queue

The key queue records real key presses, not :SYST:KEY simulated key presses.

The key queue is a:

- FIFO queue (first-in first-out)
- 1 key long

If the queue is empty, message '0' is returned in response to the :SYST:KEY? query.

The key queue is cleared after power-on or *RST.

4

Programming

Introduction

The messages and commands used when programming the HP 8130A from a remote controller are described in this chapter.

HP 8112A/60A/61A Message Cross Reference

The language used by the HP 8130A is based on *IEEE Standard 488.2-1987* and is different from the languages used in the HP 8112A, HP 8160A, and HP 8161A. It is the same as the language used in the HP 8131A.

To assist in converting programs from one language to the other, Appendix E contains cross referenced examples of the HP 8112A/60A/61A and HP 8130A instrument messages.

Interface, Common, and Device Commands

Interface commands are defined in the *IEEE Standard 488.2-1987.* These messages are processed by the interface system directly, they are used to manage the interface. These messages are not described in this manual, though reference is made to them where appropriate.

The remote messages which are described are the messages that are carried by the interface system, but which are not used by it or processed by it. These are described in Chapter 6 and Chapter 7.

Common commands (described in Chapter 6) are a reserved group of commands, which are defined by the *IEEE Standard 488.2-1987*. Common commands can apply to any instrument using this standard.

The device commands which are described in this manual (see Chapter 7) are commands defined specifically for use with this instrument.

Short Form and Long Form

The instrument will accept messages in short or long forms. The short form messages must be all in upper case. Long form messages can be all in upper case or in a mixture of upper and lower case. Where you are using mixed upper and lower case, only the characters not used in the corresponding short form can be in lower case, for example:
the short form message `:INP:TRIG:STAT ON`
can be written as `:INPut:TRIGger:STATe ON`
or as `:INPUT:TRIGGER:STATE ON` in the long form.

In this manual the messages are written in a combination of upper and lower case, the upper case characters are used for the short form parts of the message.

Coupled Messages

The following messages are related, `:PULSe:LEVel:HIGH`, `:PULSe:LEVel:LOW`, `:PULSe:LEVel:AMPLitude`, and `:PULSe:LEVel:OFFSet`. This means that using one of these messages to change a value can affect values set by the other messages.

The relationships of the coupled messages are given in Chapter 5.

Message Types

Two types of messages are used.

1. Program messages which are sent from a remote controller to the HP 8130A.
2. Response messages which are sent from the HP 8130A to the controller.

Program Message Syntax

A program message is of the form <ASCII-string><pmt>.

- <ASCII-string> is one or more program message units. Message units are separated by a semi-colon (;).

  Each path in the syntax diagrams of Chapter 6 and Chapter 7 represents a complete program message unit

- <pmt> is the program message terminator. There are three possible terminators
  - <lf>, the line feed character.
  - <^END>, the EOI line on the HP-IB being asserted.
  - <lf><^END>

Note <lf> is equivalent to newline.

'^' means the END is asserted at the last byte of the program message on the interface bus by asserting the End or Identify (EOI) signal line.

Program Message Example

```
OUTPUT 711;  "*RST;
:PULSe:TIMing:DELay 20 ns;
WIDT 200µs;
:PULSe:LEVel:HIGH 3.5V;
LOW 1"
```

Response Message Syntax

A response messages is of the form <ASCII-string><rmt>.

- <ASCII-string> is one or more response message units.

  The message units are defined in Chapter 6 and Chapter 7.

- <rmt> is the response message terminator. <lf><^END> is the only terminator used by the instrument. <lf>, the line feed character. <^END>, the EOI line on the HP-IB being asserted. '^' means the END is asserted at the last byte of the program message on the interface bus by asserting the End or Identify (EOI) signal line.

Note <lf> is equivalent to newline.

Only values are returned in responses messages; the base units are implied.

See Chapter 6 and Chapter 7 for examples.

Reading Response Messages

If you perform a query, you must read the response before you send the next program message. The response is deleted from the output queue by the instrument while it is processing the next message.

Response Message Example

```
OUTPUT 711; "*RST"
OUTPUT 711;":PULSe:LEVel:HIGH?"
ENTER 711; A$
PRINT A$ -------> 0.50
```

Syntax Diagram Conventions

< ... > The characters between the angled brackets indicate the kind of data that is required. The angled brackets are not typed in the actual message.

wsp is used to indicate white spaces, this group includes ASCII control characters and the space but it excludes the newline character.

value is used to indicate values in integer (12), decimal (85.5), or exponential format (99.9E-9).

unit	is used to indicated one of s/S (seconds), v/V (volts) % (percent) or one of ps/PS, ns/NS, μs/US, ms/MS, uv/UV, mv/MV

[...]	the characters between the square brackets indicates optional information that can be included with the message.
|	is used to indicate an either-or choice of data, for example *a*|*b* indicates either *a* or *b*, but not both at the same time
`MIN`	When used in a program message `MIN` sets up the minimum value allowed for that parameter. When used in a query message `MIN` returns the minimum value allowed for that parameter.
`MAX`	When used in a program message `MAX` sets up the maximum value allowed for that parameter. When used in a query message `MAX` returns the maximum value allowed for that parameter.

All terms not defined above should be input as given. Short and long forms are allowed.

5

Local Functions

Local functions are functions which are available from the front panel keys. They are described here alphabetically using the name given on the front panel. Each key is described and a list of the equivalent and related remote programming commands are given.

Descriptions of the front panel status LEDs are also given.

Multiple Functions

Where a key is used to activate more than one function, the functions are described separately, for example both DCYC and WIDTH are activated by the same key, but they are described separately. When selecting these functions the key should be pressed repeatedly until the LED beside the desired function is lit.

Note

The positive and negative slope keys (located on the front panel above the EXT INPUT) are treated together under the heading *Slope*.

Display

Where a key allows access to one of the parameters, the current value of the parameter is shown on the display. The value can be changed by using the VERNIER keys, see "VERNIER."

The `:SYSTem:KEY` Command

Each of the front panel keys has a related `:SYSTem:KEY` Command. This has not been listed under the *Remote Commands* heading. A full list of the `SYSTem:KEY` Commands is given in Table 7-5

Specifications

All specifications apply after a 30 minute warm-up period with 50Ω load resistance at all outputs and are valid at ambient temperatures in the range 0°C to 55°C.

Conflicts

An error display indicates that a programmed setting exceeds the specification, and that the output may be invalid. If the limiting condition is important in the application, the output should be verified on an oscilloscope. In other cases, the timing should be adjusted until the error display turns off, indicating that all outputs are valid. The table below gives values versus period above which an error will be indicated.

Table 5-1.
Maximum Values of WIDTH, DCYC and DELAY versus PERIOD

PERIOD(ns)	On-Time	DELAY
3.33 … 4.99	0.5×PERIOD	0.5×PERIOD-1ns
5.00 … 19.9	0.7×PERIOD-1ns	0.7×PERIOD-2ns
≥ 20.0	0.9×PERIOD-5ns	0.9×PERIOD-6ns

Note On-Time in this table refers to the value set by DCYC (duty cycle) as well as by WIDTH.

Table 5-2.
Maximum Values of DOUB versus PERIOD

PERIOD(ns)	DOUB
3.33 … 7.19	n/a
7.20 … 9.99	0.5×PERIOD
≥ 10.0	0.9×PERIOD-4ns

Resolution

The resolution of some of the timing parameters depends on the period of the signal. These relationships are outlined in the table below.

Table 5-3. Period, Delay, Double, Width and Transition Time Ranges

Range	Resolution
† - 9.99ns	0.01ns
10.0ns - 99.9ns	0.1ns
100ns - 999ns	1ns
1.00μs - 9.99μs	0.01μs
10.0μs - 99.9μs	0.1μs
‡100μs - 999μs	1μs
‡1.00ms - 9.99ms	0.01ms
‡10.0ms - 99.9ms	0.1ms

†	Period:	3.33ns
	Delay:	0.00ns
	Double:	3.33ns
	Transition	
	Times:	1.00ns
	Width:	1.50ns

‡ does not apply to transition times

Programming of Parameters

Period, width, double, and transitions are under-programmable to ensure that the specified minimum values can always be obtained.

Low and high levels can be under- or over- programmed so that the specified minimum and maximum values can always be obtained.

The minimum and maximum programmable values are displayed in each section with the sign $\leq$. The specified minimum and maximum are given after the *Specified Range* heading.

1 PULSE

Description

One pulse or double-pulse is generated for each press of this key when the instrument is in trigger, gate, or burst operating mode.

Remote Commands

None.

Related Keys

MAN, EXT INPUT, TRIG, GATE, BURST

Interface Commands

None.

ADS

Description

The ADS indicator (lighted LED) indicates when the instrument is listen or talk addressed.

The interface address cannot be changed when the instrument is listen or talk addressed.

Remote Commands

None.

Related Keys

RMT, SRQ, LCL

Interface Commands

`MLA`, `MTA`, `UNL`, `UNT`.