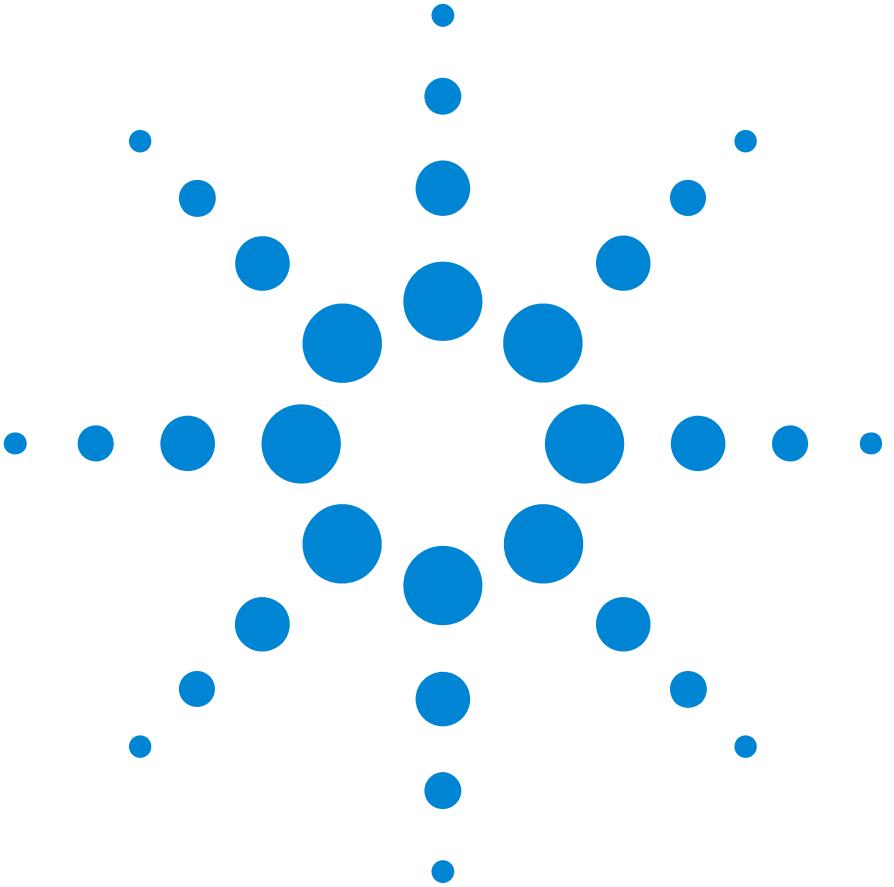

Agilent 81101A 50 MHz Pulse Generator

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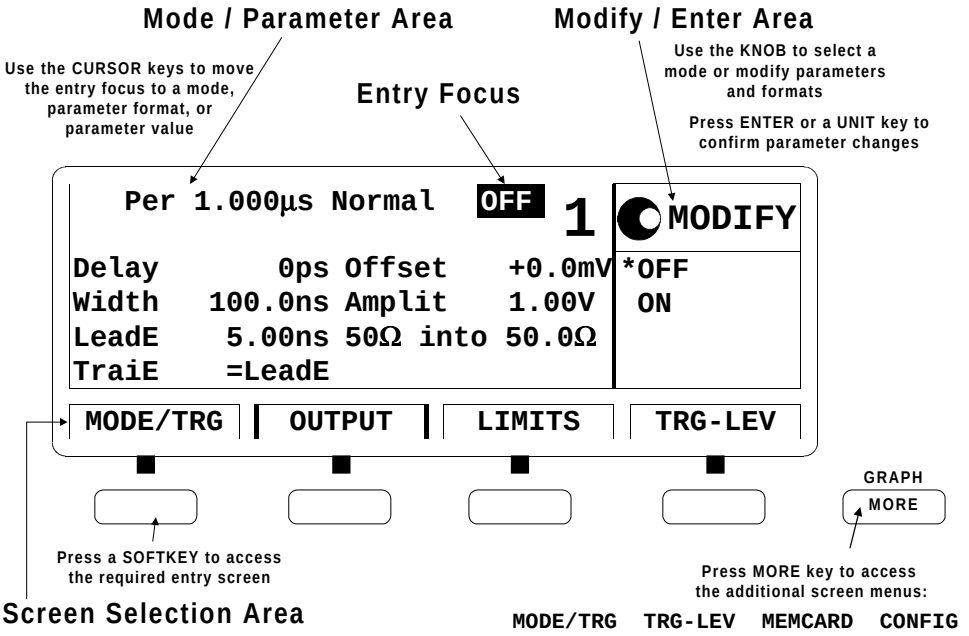
Front Panel Display and Softkeys



Reference Guide

Agilent 81101A 50 MHz Pulse Generator

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Any adjustment, maintenance, or repair of this product must be performed by qualified personnel. Contact your customer engineer through your local Agilent Technologies Service Center. You can find a list of local service representatives on the Web at:

`http://www.agilent.com/Service/English/index.html`

Safety Summary

The following general safety precautions must be observed during all phases of operation of this instrument. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of design, manufacture, and intended use of the instrument. Agilent Technologies Inc. assumes no liability for the customer's failure to comply with these requirements.

General

This product is a Safety Class 1 instrument (provided with a protective earth terminal). The protective features of this product may be impaired if it is used in a manner not specified in the operation instructions.

All Light Emitting Diodes (LEDs) used in this product are Class 1 LEDs as per IEC 60825-1.

Environmental Conditions

This instrument is intended for indoor use in an installation category II, pollution degree 2 environment. It is designed to operate at a maximum relative humidity of 95% and at altitudes of up to 2000 meters. Refer to the specifications tables for the ac mains voltage requirements and ambient operating temperature range.

Before Applying Power

Verify that the product is set to match the available line voltage, the correct fuse is installed, and all safety precautions are taken. Note the instrument's external markings described under *"Safety Symbols" on page 8*.

Ground the Instrument

To minimize shock hazard, the instrument chassis and cover must be connected to an electrical protective earth ground. The instrument must be connected to the ac power mains through a grounded power cable, with the ground wire firmly connected to an electrical ground (safety ground) at the power outlet. Any interruption of the protective (grounding) conductor or disconnection of the protective earth terminal will cause a potential shock hazard that could result in personal injury.

Fuses

Only fuses with the required rated current, voltage, and specified type (normal blow, time delay, etc.) should be used. Do not use repaired fuses or short-circuited fuse holders. To do so could cause a shock or fire hazard.

Do Not Operate in an Explosive Atmosphere

Do not operate the instrument in the presence of flammable gases or fumes.

Do Not Remove the Instrument Cover

Operating personnel must not remove instrument covers. Component replacement and internal adjustments must be made only by qualified service personnel.

Instruments that appear damaged or defective should be made inoperative and secured against unintended operation until they can be repaired by qualified service personnel.

Safety Symbols

Caution (refer to accompanying documents)

Protective earth (ground) terminal

In the manuals:

WARNING **The WARNING sign denotes a hazard. It calls attention to a procedure, practice, or the like, which, if not correctly performed or adhered to, could result in personal injury. Do not proceed beyond a WARNING sign until the indicated conditions are fully understood and met.**

CAUTION The CAUTION sign denotes a hazard. It calls attention to an operating procedure, or the like, which, if not correctly performed or adhered to, could result in damage to or destruction of part or all of the product. Do not proceed beyond a CAUTION sign until the indicated conditions are fully understood and met.

About this Book

This guide provides reference information primarily for programming the Agilent 81101A via remote control.

Chapter 1 "General Programming Aspects" on page 13 gives general hints for programming instruments like the Agilent 81101A using SCPI commands.

Chapter 2 "Programming Reference" on page 25 provides detailed information on the SCPI commands supported by the instrument.

Chapter 3 "Specifications" on page 89 lists the instrument's technical specifications and provides exact definitions for the instrument's parameters.

For an introduction and information on the Agilent 81101A's user interface, please refer to the *Quick Start Guide*, p/n 81101-91020.

Conventions Used in this Book

This book uses certain conventions to indicate elements of the Agilent 81101A's user interface. The following table shows some examples:

Softkeys	Press the MODE/TRG softkey to access the Mode/ Trigger screen.
Hardkeys	Press the MORE key to switch to the alternative softkey layout.
Alternate Keys	Press SHIFT + 0 (ON/OFF) to switch on the output. The alternate key label—which is selected by pressing the SHIFT key—is given in parentheses.
Screen Quotes	Move the entry focus down to PULSE-PERIOD and turn the knob to select INTERNAL PLL.
Entry Focus	The highlight field, that can be moved with the cursor keys, to change modes, parameters, or parameter formats.
`:VOLTage:HIGH 3V`	Full command for programming a 3 V high level. The upper case letters represent the short form of the command, which results in faster programming times.
`*RST`	Common IEE 488 command, to reset instrument to default status.

Contents

Contents

1 General Programming Aspects

This chapter provides general information on writing GP-IB/SCPI programs for instruments like the Agilent 81101A.

Detailed information on programming the Agilent 81101A can be found in *Chapter 2 "Programming Reference" on page 25*.

The GP-IB Interface Bus

The General Purpose Interface Bus is the interface used for communication between a controller and an external device, such as the Agilent 81130A. The GPIB conforms to IEEE standard 488-1987, ANSI standard MC 1.1, and IEC recommendation 625-1.

If you are not familiar with the GPIB, please refer to the following books:

- The Institute of Electrical and Electronic Engineers: IEEE Standard 488.1-1987, IEEE Standard Digital Interface for Programmable Instrumentation.
- The Institute of Electrical and Electronic Engineers: IEEE Standard 488.2-1987, IEEE Standard Codes, Formats, and Common Commands for Use with IEEE Standard 488.1-1987.

In addition, the commands not from the IEEE 488.2 standard are defined according to the Standard Commands for Programmable Instruments (SCPI). For an introduction to SCPI and SCPI programming techniques, refer to the following document:

- The SCPI Consortium: Standard Commands for Programmable Instruments, published periodically by various publishers. To obtain a copy of this manual, contact the SCPI Consortium:

  SCPI Consortium Office
  Bode Enterprise
  2515 Camino del Rio South,
  Suite 340
  San Diego, CA, 92108
  USA

Agilent 81101A Remote Control

GP-IB Address

You can only set the GP-IB address from the front panel of the instrument (refer to the *Quick Start Guide*).

The default GP-IB address is 10.

Modes of Operation

The Agilent 81101A has two modes of operation:

- Local
  The instrument is operated using the front panel keys.
- Remote
  After receiving the first command or query via the GP-IB, the instrument is put into remote state. The front panel is locked.
  To return to local operating mode, press SHIFT (LOCAL).

Programming Recommendations

Here are some recommendations for programming the instrument:

- Start programming from the default setting. The common command for setting the default setting is:

  ```
  *RST
  ```

- Switch off the automatic update of the display to increase the programming speed. The device command for switching off the display is:

  ```
  :DISPlay  OFF
  ```

- The SCPI standard defines a long and a short form of the commands. For fast programming speed it is recommended to use the short forms. The short forms of the commands are represented by upper case letters. For example the short form of the command to set 100 ns double pulse delay is:

  ```
  :PULS:DOUB:DEL  100NS
  ```

- To improve programming speed it is also allowed to skip optional subsystem command parts. Optional subsystem command parts are depicted in square brackets, e.g.: enable double pulse mode by `[SOURce]:PULSe:DOUBle[1][:STATe] ON|OFF`. Sufficient to use:

  ```
  :PULS:DOUB  ON
  ```

- For the commands to set the timing and level parameters, except of period/frequency, you can explicitly specify output 1 (for compatibility reasons). If there is no output specified, the commands will set the default output 1.

  So, for setting a high level of 3 Volts for output 1 the commands are:

  ```
  :VOLT:HIGH  3V     # sets high level of 3 V at out 1
  :VOLT1:HIGH  3V    # sets high level of 3 V at out 1
  ```

- It is recommended to test a new setting that will be programmed on the instrument by setting it up manually.

  Enable the outputs so that the instrument's error check system is on and possible parameter conflicts are immediately displayed.

When you have found the correct setting, then use this to create the program. In the program it is recommended to send the command for enabling outputs (for example, :OUTPut ON) as the last command. With this procedure it is possible to switch off the error check system (:SYSTem:CHECk OFF) to increase programming speed.

The error check is enabled again by sending *RST.

```
*RST                # set default settings
:DISP  OFF          # switch off display update
:SYST:CHEC  OFF     # switch off error check
...                 # other commands to set modes
...                 # and parameters
:OUTP  ON           # enable the output
```

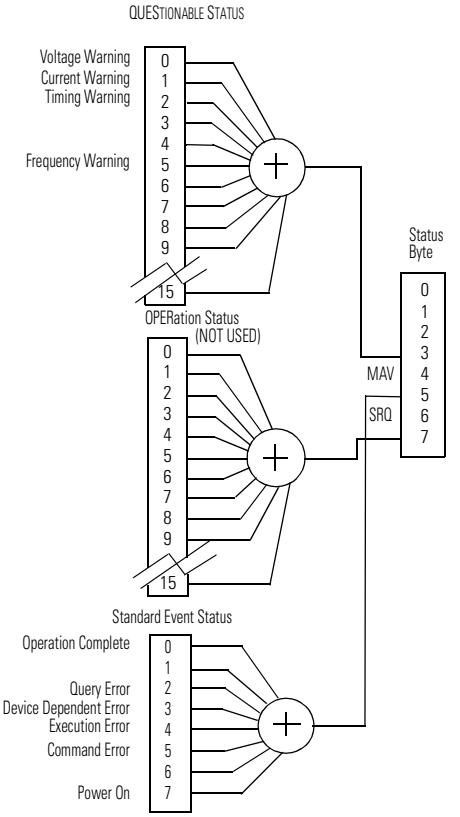
- Selftest of the instrument can be invoked by the common command
  *TST
- If it is important to know whether the last command is completed, then send the common command
  *OPC?

Common Command Summary

This table summarizes the IEEE 488.2 common commands supported by the Agilent 81101A:

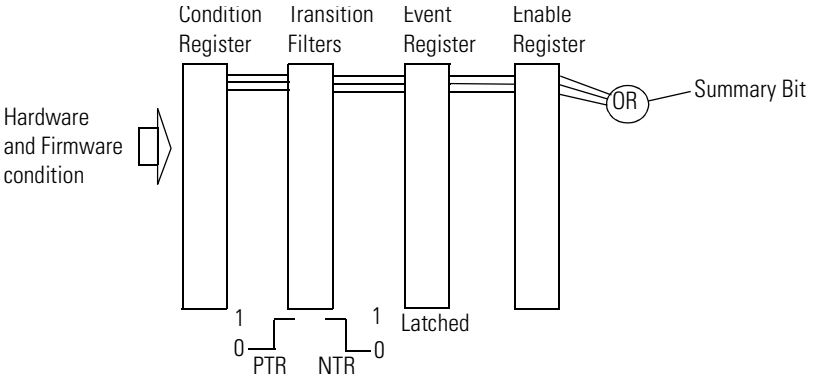
Command	Parameter	Description
*CLS	–	Clear the status structure
*ESE	<0–255>	Set the Standard Event Status register mask
*ESE?	–	Read the state of the Standard Event Status enable register
*ESR?	–	Read the state of the Standard Event Status event register
*IDN?	–	Read the Instrument's Identification string
*LRN?	–	Read the complete Instrument Setting
*OPC	–	Set the Operation Complete bit when all pending actions are complete
*OPC?	–	Read the status of the Operation Complete bit
*OPT?	–	Read the installed options
*RCL	<0–9>	Recall a complete Instrument Setting from memory
*RST	–	Reset the instrument to standard settings
*SAV	<1–9>	Save the complete Instrument Setting to memory
*SRE	<0–255>	Set the Service Request Enable Mask
*SRE?	–	Read the Service Request Enable Mask
*STB?	–	Read the Status Byte
*TRG	–	Trigger
*TST?	–	Execute instrument’s selftest
*WAI	–	Wait until all pending actions are complete

Status Model



The instrument has a status reporting system conforming to IEEE 488.2 and SCPI. The above figure shows the status groups available in the instrument.

Each status group is made up of component registers, as shown in the following figure.



Condition Register

A condition register contains the current status of the hardware and firmware. It is continuously updated and is not latched or buffered. You can only read condition registers. If there is no command to read the condition register of a particular status group, then it is simply invisible to you.

Transition Filters

Transition filters are used to detect changes of state in the condition register and set the corresponding bit in the event register. You can set transition filter bits to detect positive transitions (PTR), negative transitions (NTR) or both. Transition filters are therefore read/write registers. They are unaffected by *CLS.

Event Register

An event register latches transition events from the condition register as specified by the transition filters or records status events. Querying (reading) the event register clears it, as does the *CLS command. There is no buffering, so while a bit is set, subsequent transition events are not recorded. Event registers are read only.

Enable Register

The enable register defines which bits in an event register are included in the logical OR into the summary bit. The enable register is logically ANDed with the event register and the resulting bits ORed into the summary bit. Enable registers are read/write, and are not affected by ***CLS** or querying.

Although all status groups have all of these registers, not all status groups actually use all of the registers. The following table summarizes the registers used in the instrument status groups.

	Registers in Group				
Status Group	**CONDition**	**NTR**	**PTR**	**EVENt**	**ENABLe**
QUEStionable	√	√	√	√	√
OPERation[1]	**x**	**x**	**x**	**x**	**x**
Standard Event Status	**x**	**x**	**x**	√[2]	√[3]
Status Byte	**x**	**x**	**x**	√[4]	√[5]

1 Present, but not used. COND and EVEN always 0.
2 Use *ESR? to query.
3 Use *ESE to set, *ESE? to query
4 Use *STB? to query
5 Use *SRE to set, *SRE? to query

Status Byte

The status byte summarizes the information from all other status groups. The summary bit for the status byte actually appears in bit 6 (RQS) of the status byte. When RQS is set it generates an SRQ interrupt to the controller indicating that at least one instrument on the bus requires attention. You can read the status byte using a serial poll or *STB?

Bit	Description
0	Unused, always 0
1	Unused, always 0
2	Unused, always 0
3	QUESTionable Status Summary Bit
4	MAV—Message AVailable in output buffer
5	Standard Event Status summary bit
6	RQS; ReQuest Service
7	OPERation Status summary Bit, unused

Standard Event Status Group

Bit	Description
0	Operation Complete, set by *OPC
1	Unused, always 0
2	Query Error
3	Device Dependent Error
4	Execution Error
5	Command Error
6	Unused, always 0
7	Power On

OPERation Status Group

This Status Group is not used in the instrument.

Bit	Description
0	Unused, always 0
1	Unused, always 0
2	Unused, always 0
3	Unused, always 0
4	Unused, always 0
5	Unused, always 0
6	Unused, always 0
7	Unused, always 0
8	Unused, always 0
9	Unused, always 0
10	Unused, always 0
11	Unused, always 0
12	Unused, always 0
13	Unused, always 0
14	Unused, always 0
15	Always 0

QUEStionable Status Group

Bit	QUEStionable
0	Voltage warning
1	Current warning
2	Time warning
3	Unused, always 0
4	Unused, always 0
5	Frequency warning
6	Unused, always 0
7	Unused, always 0
8	Unused, always 0
9	Unused, always 0
10	Unused, always 0
11	Unused, always 0
12	Unused, always
13	Unused, always 0
14	Unused, always 0
15	Always 0

The QUEStionable Status group is used to report warning conditions amongst the voltage, current, pulse timing and frequency parameters. Warnings occur when a parameter, although not outside its maximum limits, could be causing an invalid signal at the output because of the actual settings and uncertainties of related parameters.

2 Programming Reference

This chapter provides reference information on the following topics:

For general programming information, please refer to *Chapter 1 "General Programming Aspects" on page 13*.

Agilent 81101A SCPI Command Summary

Command	Parameter	Description	see page
:ARM		(Trigger mode and source)	
[:SEQuence[1] | :STARt]			
[:LAYer[1]]			
:EWIDTh			
[:STATe]	ON|OFF|1|0	Set/read External Width mode	39
:FREQuency	<value>	Set/read trigger frequency, when PLL(INT2) used as source	39
:IMPedance	<value>	Set/read impedance at EXT INPUT	40
:LEVel	<value>	Set/read threshold level at EXT INPUT	40
:PERiod	<value>	Set/read trigger period, when PLL(INT2) used as source	41
:SENSe	EDGE|LEVel	Set/read trigger on edge or gate on level	42
:SLOPe	POS|NEG|EITH	Set/read trigger slope at EXT INPUT	42
:SOURce	IMM|INT2|EXT|MAN	Set/read trigger source (VCO|PLL|EXT INPUT|MAN key)	43
:DISPlay			
[:WINDow]			
[:STATe]	ON|OFF|1|0	Set/read front panel display state	43
:MMEMory			
:CATalog?	[A:]	Read directory of memory card	44
:CDIRectory	[<name>]	Change directory on memory card	44
:COPY	<source>[,A:],<dest>[,A:]	Copy a file on memory card	45
:DELete	<name>[,A:]	Delete a file from memory card	45
:INITialize	[A:[DOS]]	Initialize memory card to DOS format	45
:LOAD			
:STATe	<n>,<name>	Load file from memory card to memory n	46
:STORe			
:STATe	<n>,<name>	Store memory n to memory card	46

Command	Parameter	Description	see page
:OUTPut[1]			
[:NORMal]			
[:STATe]	OFF|ON|1|0	Set/read normal output state	
:IMPedance			47
[:INTernal]	<value>	Set/read internal source impedance of output	
:EXTernal	<value>	Set/read expected external load impedance at output	47
:POLarity	NORM|INV	Set/read output polarity	48
[:SOURce]			
:CURRent[1]			
[:LEVel]			
[:IMMediate]			
[:AMPLitude]	<value>	Set/read channel amplitude current	48
:OFFSet	<value>	Set/read channel offset current	49
:HIGH	<value>	Set/read channel high level current	50
:LOW	<value>	Set/read channel low level current	51
:LIMit			
[:HIGH]		Set/read maximum current limits	52
:LOW		Set/read minimum current limits	53
:STATe	ON|OFF|1|0	Enable/Disable the current limits	53
:FREQency			
[:CW | :FIXed]	<value>	Set/read frequency of pulses	54
:AUTO	ONCE	Measure frequency at CLK-IN	55
:HOLD[1]	VOLT|CURR	Switch between VOLtage and CURRent command subtrees	55
:PHASe[1]			
[:ADJust]	<value>	Set/read channel phase	56
:PULSe			
:DCYCLe[1]	<value>	Set/read channel duty cycle	57
:DELay[1]	<value>	Set/read channel delay (to leading edge)	57
:HOLD	TIME|PRATio	Hold absolute delay|phase delay fixed with varying frequency	58
:UNIT	S|SEC|PCT|DEG|RAD	Set/read delay units	59

Command	Parameter	Description	see page
:DOUBle[1]			
[:STATe]	OFF|ON	Enable/disable double pulses per pulse period	59
:DELay	<value>	Set/read delay between double pulses	60
:HOLD	TIME|PRATio	Hold absolute delay|phase delay fixed with varying frequency	61
:UNIT	S|SEC|PCT	Set/read delay units	61
:HOLD[1]	WIDTh|DCYCle|TDELay	Hold Width|Duty cycle|Trailing edge delay fixed with varying frequency	62
:PERiod	<value>	Set/read pulse period	62
:AUTO	ONCE	Measure pulse period at CLK-IN	63
:TDELay[1]	<value>	Set/read trailing edge delay	63
:TRANsition[1]			
:HOLD	TIME|WRATio	Hold absolute transitions|transitions as width ratio fixed with varying width per period	64
:UNIT	S|SEC|PCT	Set/read transition time units	65
[:LEADing]	<value>	Set/read leading edge transition	65
:TRAiling	<value>	Set/read trailing edge transition	66
:AUTO	OFF|ON|ONCE	Couple trailing edge to leading edge	67
:TRIGger[1]			
:VOLTage	TTL|ECL	Set/read TRIGGER|STROBE OUTput levels	67
:WIDTh[1]	<value>	Set/read channel pulse width	68
[:SOURce]			
:ROSCillator			
:SOURce	INTernal|EXTernal	Set/read PLL reference source	68
:EXTernal			
:FREQuency	<value>	Set/read frequency of external PLL reference	69
:VOLTage[1]			
[:LEVel]			
[:IMMediate]			
[:AMPlitude]	<value>	Set/read channel amplitude voltage	70

Command	Parameter	Description	see page
:OFFset	<value>	Set/read channel offset voltage	*71*
:HIGH	<value>	Set/read channel high level voltage	*72*
:LOW	<value>	Set/read channel low level voltage	*73*
:LIMit			
[:HIGH]		Set/read maximum voltage limit	*74*
:LOW		Set/read minimum voltage limit	*74*
:STATe	ON|OFF|1|0	Enable|Disable the voltage limits	*75*
:STATus			
:OPERation			
[:EVENt]?		Read Operation event register	*75*
:CONDition	Numeric	Read Operation condition register	
:ENABle	Numeric	Set/Read Operation enable register	
:NTRansition	Numeric	Set/Read Operation negative transition register	
:PTRansition	Numeric	Set/Read positive transition register	
:PREset		Clear and preset status groups	*76*
:QUEStionable			
[:EVENt]?		Read Questionable event register	*76*
:CONDition?		Read Questionable condition register	
:ENABLe	Numeric	Set/Read Questionable enable register	
:NTRansition	Numeric	Set/Read Questionable negative transition register	
:PTRansition	Numeric	Set/Read Questionable positive transition register	
:SYSTem			
:CHECk			
[:ALL]			
[:STATe]	OFF	Switch error checking off	*78*
:ERRor?		Read error queue	*78*
:KEY	Numeric	Simulate key press or read last key pressed	*79*
:PRESet		no function	*81*
:SECurity			

Command	Parameter	Description	see page
[:STATe]	ON|OFF	Switch security on and off	82
:SET	Block data	Set/read complete instrument setting	83
:VERSion?		Read SCPI compliance setting	83
:WARNing			
[:COUNt]?		Read number of active warnings	83
:STRing?		Read active warnings as concatenated string	84
:BUFFer?		Read maximum possible length of concatenated string	84
:TRIGger			
[:SEQuence [1] | :STARt]		(Pulse mode and period source)	
:COUNt	<value>	Set/read number of triggered periods to be generated per ARM event	84
:IMPedance	<value>	Set/read impedance at CLK-IN	85
:LEVel	<value>	Set/read threshold level at CLK-IN	86
:SLOPe	POS|NEG	Set/read trigger slope at CLK-IN	86
:SOURce	IMM | INT[1] | INT2 |EXT	Set/read trigger source (IMM | VFO | PLL | CLK-IN)	86

Default Values, Standard Settings

Parameter			*RST, Default Values
:ARM :	EWIDth:STATe		OFF
	:FREQuency		100kHz
	:IMPedance		50Ω
	:LEVel		+1.00V
	:PERiod		10.00µs
	:SENSe		EDGE
	:SLOPe		POS
	:SOURce		IMMediate
:DISPlay	[:WINDow]	[:STATe]	ON
:MMEMory	:CATalog?		not applicable
	:CDIRectory		not applicable
	:COPY		not applicable
	:DELete		not applicable
	:INITialize		not applicable
	:LOAD :STATe		not applicable
	:STORe:STATe		not applicable
:OUTPut[1][:NORMal][:STATe]			OFF
	:IMPedance[:INTernal]		50Ω
	:EXTernal		50.0Ω
	:POLarity		NORMal
[:SOURce]:CURRent[1][:LEVel][:IMM][:AMPL]			20.0mA (from 50Ω into 50Ω)
	:OFFset		0.0mA (from 50Ω into 50Ω)
	:HIGH		+10.0mA (from 50Ω into 50Ω)
	:LOW		–10.0mA (from 50Ω into 50Ω)
	:LIMit[:HIGH]		+10.0mA

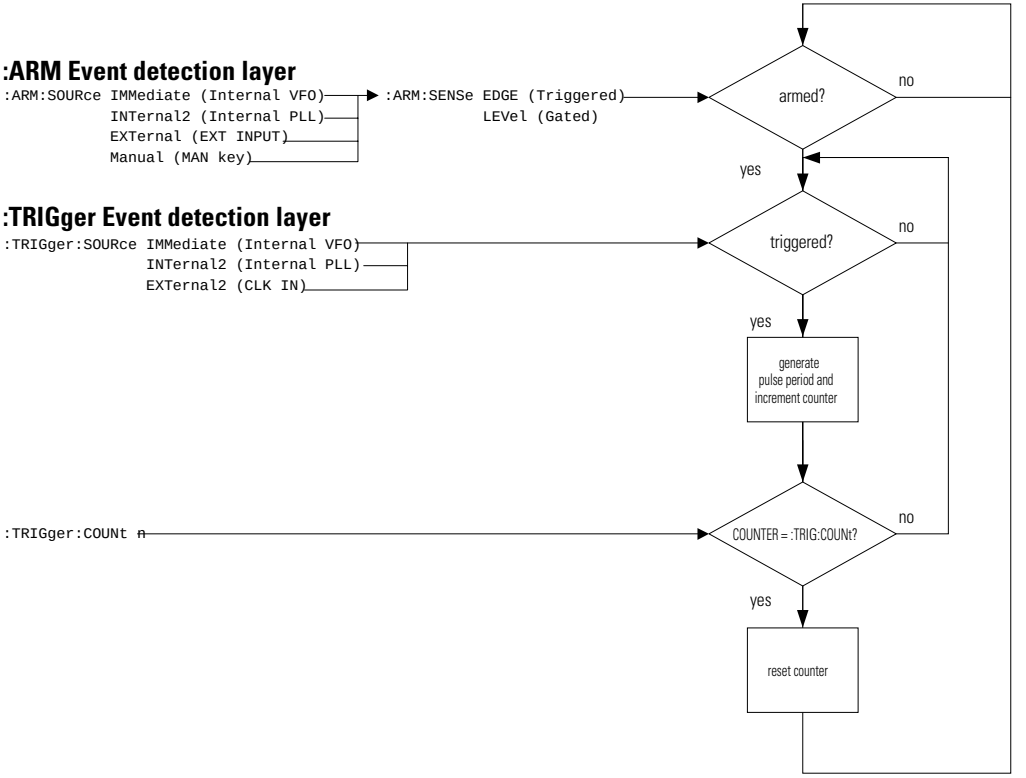
Parameter	*RST, Default Values
:LOW	–10.0mA
:STATe	OFF
:FREQ [:CW|:FIXed]	1.00MHz
:AUTO	not applicable
:HOLD	VOLT
:PHASe[1][:ADJust]	0.0
:PULSe:	
:DCYCle[1]	10.0% (derived from Width and Period)
:DELay[1]	0.0
:HOLD	TIME
:UNIT	S
:DOUBle[1][:STATe]	OFF
:DELay	250 ns
:HOLD	TIME
:UNIT	S
:HOLD[1]	WIDTh
[:SOURce]:PULSe:PERiod	1µs
:AUTO	not applicable
:TDELay[1]	100ns
:TRANsition[1|2]:HOLD	TIME
:UNIT	S
[:LEADing]	5.0 ns
:TRAiling	5.0 ns
:AUTO	ON
:TRIGger[1]:VOLTage	TTL
:WIDTh[1]	100ns
:ROSCillator:SOURce	INTernal
:EXTernal:FREQ	5MHz

Parameter		*RST, Default Values
[:SOURce]:VOLTage[1]		
	:LEVel]	
	[IMMediate]	
	[:AMPLitude]	1.0V
	:OFFSet	0.0V
	:HIGH	500mV
	:LOW	–500mV
	:LIMIt[:High]	+500V
	:LOW	–500V
	:STATe	OFF
:STATus:	:OPERation	not applicable
	:PRESet	not applicable
	:QUEStionable[:EVENt]?	not applicable
	:CONDition?	not applicable
	:ENABle	not applicable
	:NTRansition	not applicable
	:PTRansition	not applicable
:SYSTem	:CHECk [:ALL][:STATe]	ON
	:ERRor?	not applicable
	:KEY	+255
	:PRESet	not applicable
	:SECurity[:STATe]	OFF
	:SET	not applicable
	:VERSion	"1992.0
	:WARNing[:COUNt]?	not applicable
	:STRing?	not applicable
	:BUFFer?	not applicable
:TRIGger	:COUNt	1
	:IMPedance	50Ω

Parameter	*RST, Default Values
:LEVel	1.0V
:SLOPe	POSitive
:SOURce	IMMediate

Programming the Instrument Trigger Modes

The following figure shows the instrument's arming/triggering model:



You program the comprehensive triggering capabilities of the instrument using the SCPI :ARM and :TRIGger subsystems. Using these two command subsystems you can program the operating modes of the instrument, which are set up using the MODE/TRIGGER SCREEN on the front panel.

Use the :ARM subsystem to select the overall triggering mode of the instrument (CONTINUOUS, TRIGGERED, GATED, EXT WIDTH), and the :TRIGger subsystem to select the pulse period source, triggering and number of pulse periods per :ARM event (BURST or PATTERN length).

Continuous

Set Continuous mode by arming the instrument from its internal oscillator:

```
:ARM:SOURce IMMediate   Arm from internal oscillator.
```

Triggered

Set Triggered mode by arming the instrument on edges from the EXT INPUT:

```
:ARM:SOURce EXTernal1  Arm from EXT INPUT
:ARM:SENSe EDGE        Arm on edge
:ARM:SLOPe POSitive    Arm on positive edge
:ARM:LEVel 1V          Set EXT INPUT threshold
```

You can also arm the instrument from the PLL and set the frequency (or period) of the PLL to the required triggering rate:

```
:ARM:SOURce INTernal2  Arm from PLL
:ARM:SENSe  EDGE       Arm on edge
:ARM:SLOPe  POSitive   Arm on positive edge
:ARM:FREQuency <value> Set PLL frequency
```

NOTE The PLL (INTernal2) *cannot* be used as :ARM:SOURce (triggering rate) if it is already being used as :TRIGger:SOURce (pulse period source).

Gated

Set Gated mode by arming the instrument on levels from the EXT INPUT:

```
:ARM:SOURce EXTernal1  Arm from EXT INPUT
:ARM:SENSe LEVel       Arm on signal level
:ARM:SLOPe POSitive    Arm on positive level
```

External Width

Set External Width mode using the `:EWIDth[:STATe]` command:

```
:ARM:EWIDth ON              Switch on EXT WIDTH mode
```

This command disables the arm-trigger system. The arm-trigger system is reenabled by switching `OFF EWIDth` mode.

Pulses

Set Pulses mode by setting the `:TRIGger:COUNt` to 1 so that a single triggered pulse period is generated for every arm event. The trigger source sets the pulse period:

```
:TRIGger:COUNt 1            Single pulse period per arm event
:TRIGger:SOURce INTernal1 Pulse period from internal osc.
:DIGital:PATTern OFF        Disable pattern data.
```

Pulse period Source	:TRIGger SOURce
internal OSC.	`INTernal[1]`
internal PLL	`INTernal2`
CLK-IN	`EXTernal2`

NOTE The internal PLL (INTernal2) *cannot* be used as `:TRIGger:SOURce` (pulse period source) if it is already being used as `ARM:SOURce` (triggering rate).

Note that in triggered pulses mode the pulse period source is not relevant because a single pulse is generated for each ARM event.

Burst

Set Burst mode by setting the `:TRIGger:COUNt` to the burst length required. The trigger source sets the pulse period for the pulses within the burst.

```
:TRIGger:COUNt 16           Burst of 16 pulse periods
:TRIGger:SOURce INTernal1 Pulse period from internal osc.
:DIGital:PATTern OFF        Disable pattern data
```

SCPI Instrument Command List

The following reference sections list the instrument commands in alphabetical order. In addition to a command description, the attributes of each command are described under the following headings. Not all of these attributes are applicable to all commands. The commands are conform to the IEEE 488.2 SCPI standard.

Command Shows the short form of the command.

Long Shows the long form of the command.

Form Most commands can be used in different forms:

Set	The command can be used to program the instrument
Query	The command can be used to interrogate the instrument. Add a ? to the command if necessary.
Event	The command performs a one-off action.

Parameter The type of parameter, if any, accepted by the command. The minimum and maximum value of numeric parameters can be accessed by the option MINimum or MAXimum.

Parameter Suffix The suffixes that may follow the parameter.

Functional Coupling Any other commands that are implicitly executed by the command.

Value Coupling Any other parameter that is also changed by the command.

Range Coupling Any other parameters whose valid ranges may be changed by the command.

***RST value** The value/state following a *RST command.

Specified Limits The specified limits of a parameter.

Absolute Limits Some parameters can be programmed beyond their specified limits.

Example Example programming statements.

Command	**:ARM:EWID**
Long	`:ARM[:SEQuence[1]|STARt][:LAYer]:EWIDth[:STATe]`
Form	Set & Query
Parameter	`ON | OFF | 1 | 0`
***RST value**	`OFF`
Description	Use this command to enable the EXT WIDTH trigger mode available on the MODE/TRIGGER SCREEN. When EXT WIDTH mode is switched on, the rest of the `:ARM` and `:TRIG` system is disabled. In EXT WIDTH mode a signal applied to the EXT INPUT determines the width and period of the output signal(s) from the instrument. You can still control the edge transition times and levels of the output signal(s).

Command	**:ARM:FREQ**
Long	`:ARM[:SEQuence[1]|STARt][:LAYer]:FREQuency[:CW][:FIXed]`
Form	Set & Query
Parameter	Numeric
Parameter Suffix	`HZ` with engineering prefixes, e.g.: `MHZ` is Megahertz.
***RST value**	`100 kHz`
Specified Limits	1 mHz to 50 MHz
Description	Use this command to program the frequency of the PLL (INTernal2) when it is used as the `:ARM:SOURce` for internal triggering of pulses, bursts or patterns. If you are using the PLL as `:TRIGger:SOURce` to set the pulse frequency, use the `[:SOURce]:FREQuency[:CW|:FIXed]` command.
Example	To set up bursts of four 20 MHz pulses occurring at a burst rate of 2 MHz:

```
:TRIG:SOUR INT          Select internal osc. as pulse period source
:FREQ 20 MHZ            Set pulse frequency to 20 MHz
:ARM:SOUR INT2          Select PLL as triggering source
:ARM:SENS EDGE          Sense edge of PLL signal
:ARM:FREQ 2 MHZ         Set triggering frequency to 2 MHz
:TRIG:COUNT 4           Set burst length to 4
```

Command	**:ARM:IMP**
Long	`:ARM[:SEQuence[1]|STARt][:LAYer]:IMPedance`
Form	Set & Query
Parameter	Numeric
Parameter Suffix	`OHM` with engineering prefixes, e.g.: `MOHM` is Megaohms.
***RST value**	50 Ω
Specified Limits	50 Ω or 10 kΩ
Description	Use this command to program the input impedance of the EXT INPUT connector. Note that only two settings are available. If you try to program any other value, it will be rounded to one of the specified values.
Example	To set up the input impedance and the triggering threshold of the EXT INPUT connector:

```
:ARM:IMP 50OHM          Set EXT INPUT impedance to 50 Ω
:ARM:LEV 2.5V           Set EXT INPUT threshold to 2.5 V
```

Command	**:ARM:LEV**
Long	`:ARM[:SEQuence[1]|STARt][:LAYer]:LEVel`
Form	Set & Query
Parameter	Numeric
Parameter Suffix	`V` with engineering prefixes.
***RST value**	+1.0 V
Specified Limits	–10 V to +10 V
Description	Use this command to program the triggering threshold of the EXT INPUT connector.
Example	To set up the input impedance and the triggering threshold of the EXT INPUT connector:

```
:ARM:IMP 50OHM          Set EXT INPUT impedance to 50 Ω
:ARM:LEV 2.5V           Set EXT INPUT threshold to 2.5 V
```

Command	**:ARM:PER**
Long	`:ARM[:SEQuence[1]|STARt][:LAYer]:PERiod`
Form	Set & Query
Parameter	Numeric
Parameter Suffix	S or SEC with engineering prefixes.
***RST value**	10.00 µs
Specified Limits	20 ns to 999.5 s
Description	Use this command to program the period of the PLL (INTernal2) when it is used as the `:ARM:SOURce` for internal triggering of pulses, bursts or patterns. If you are using the PLL as `:TRIGger:SOURce` use the `[:SOURce]:PULSe:PERiod` command to set the pulse period.
Example	To set up bursts of four 50 ns pulses occurring every 500 ns:

```
:TRIG:SOUR INT          Select internal osc.as pulse period source
:PER 50 NS              Set pulse period to 50 ns
:ARM:SOUR INT2          Select PLL as triggering source
:ARM:SENS EDGE          Sense edge of PLL signal
:ARM:PER 500ns          Set triggering period to 500 ns
:ARM:TRIG:COUNT 4       Set burst length to 4
```

Command	**:ARM:SENS**
Long	`:ARM[:SEQuence[1]|STARt][:LAYer]:SENSe`
Form	Set & Query
Parameter	`EDGE | LEVel`
***RST value**	`EDGE`
Description	Use this command to select Triggered or Gated mode by choosing whether the instrument arms on the edge(s) or level of the arming signal. When sensing edges, the instrument triggers when the arming signal crosses the selected threshold level (`:ARM:LEV`) in the selected direction (`:ARM:SLOP`). This corresponds to the Triggered mode selected on the Mode/Trigger screen when using the front panel. When sensing levels, the instrument triggers as long as the arming signal is above (`:ARM:SLOP POS`), or below (`:ARM:SLOP NEG`) the selected threshold level (`:ARM:LEV`). This corresponds to the Gated mode selected on the MODE/TRIGGER SCREEN when using the front panel.

Command	**:ARM:SLOP**
Long	`:ARM[:SEQuence[1]|STAR7t][:LAYer]:SLOPe`
Form	Set & Query
Parameter	`POSitive | NEGative | EITHer`
***RST value**	`POS`
Description	Use this command to select the trigger slope for the arming signal when triggering on edges. Use `EITHer` to trigger on both the positive and negative edges of the arming signal. This allows you to trigger at twice the frequency of the arming signal. If you are arming on levels, use this command to select whether the instrument triggers during the positive or negative cycle of the arming signal.

Command **:ARM:SOUR**

Long `:ARM[:SEQuence[1]|STARt][:LAYer]:SOURce`

Form Set & Query

Parameter `IMMediate|INTernal[1]|INTernal2|EXTernal[1]|MANual`

***RST value** `IMM`

Description Use this command to select the triggering mode of the instrument by selecting the source of the arming signal:

Triggering Source	:ARM:SOURce	Mode
Internal Osc.	`IMMediate|INTernal[1]`	Continuous
PLL	`INTernal2`	Triggered | Gated by PLL
EXT INPUT	`EXTernal1`	Triggered | Gated by EXT IN
MAN key	`MANual`	Triggered | Gated by MANKey

Use `:ARM:SENSe EDGE | LEVel` to choose between Triggered and Gated.

Command **:DISP**

Long `:DISPlay[:WINDow][:STATe]`

Form Set & Query

Parameter `ON | OFF | 1 | 0`

***RST value** `ON`

Description Use this command to turn the front panel display on and off. Switching off the display improves the programming speed of the instrument.

*RST switches the display back on. Use `:SYSTem:PRESet` to perform an *RST without switching the display back on.

Example To switch off the front panel display:

```
DISP OFF
```

Command **:MMEM:CAT?**

Long `:MMEMory:CATalog?`

Form Query

Parameter `["A:"]`

***RST value** Not applicable

Description Use this command to get a listing of the contents of the currently selected directory on the memory card. As there is only one memory card slot, the parameter A: is optional. The information returned is:
<bytes_used>,<bytes_free>[,<file_entry>]

<bytes_used>	The total number of bytes used on the memory card.
<bytes_free>	The total number of bytes still available on the memory card.
<file_entry>	String containing the name, type and size of one file: "<file_name>,<file_type>,<file_size>"

The <file_type> is always blank. A directory name has <file_size> = 0.

Command **:MMEM:CDIR**

Long `:MMEMory:CDIRectory`

Form Event

Parameter `["directory_name"]`

***RST value** Not applicable

Description Use this command to change the current directory on the memory card. If you don't specify a directory name parameter, the root directory is selected.

Note that you cannot use DOS pathnames as directory names, you can only select a directory name within the current directory.

Use the directory name ".." to move back to the parent directory of the current directory, unless you are already in the root directory "\".

Examples To change to different directories on the memory card:

`:MMEM:CDIR`	Select root directory
`:MMEM:CDIR "PERFORM"`	Select directory "PERFORM"
`:MMEM:CDIR ".."`	Select parent directory

Command **:MMEM:COPY**

Long `:MMEMory:COPY`

Form Event

Parameter `"filename"[,"A:"],"copyname"[,"A:"]`

***RST** Not applicable

Description Use this command to copy an existing file *filename* in the current directory to a new file *copyname*. If *copyname* is the name of a sub-directory in the current directory, a copy of the file *filename* is made in the sub-directory. Use ".." as *copyname* to copy a file into the parent directory of the current directory.

Examples To copy files on the memory card:

```
:MMEM:COPY "test1","test2"          Copy test1 to test2
:MMEM:COPY "test1",".."             Copy test1 into parent directory
```

Command **:MMEM:DEL**

Long `:MMEMory:DELete`

Form Event

Parameter `"filename"`

***RST** Not applicable

Description Use this command to delete file *filename* from the currently selected directory.

Command **:MMEM:INIT**

Long `:MMEMory:INITialize`

Form Event

Parameter `["A:"[,"DOS"]]`

***RST** Not applicable

Description Use this command to initialize a memory card to DOS format.

CAUTION Initializing a memory card destroys any existing data on the card.

Command	**:MMEM:LOAD:STAT**
Long	`:MMEMory:LOAD:STATe`
Form	Event
Parameter	`<n>,"filename"[,"A:"]`
***RST**	Not applicable
Specified Limits	<n> = 0 to 9 (integer)
Description	Use this command to load a complete instrument setting from file *filename* in the current directory into memory <n> in the instrument. Memories 1 to 9 are the internal customer memories. Memory 0 holds the default setting.
Examples	See next command.

Command	**:MMEM:STOR:STAT**
Long	`:MMEMory:STORe:STATe`
Form	Event
Parameter	`<n>,"filename"[,"A:"]`
***RST**	Not applicable
Specified Limits	<n> = 0 to 9 (integer)
Description	Use this command to store a complete instrument setting from memory <n> to file *filename* in the current directory on the memory card. Memories 1 to 9 are the internal memories. Use memory 0 to store the current instrument setting to a file.
Examples	To load/save instrument settings from/to the memory card:

```
:MMEM:LOAD:STAT 1,"FREQPERF"    Load FREQPERF into memory 1
:MMEM:LOAD:STAT 0,"AMPTEST"     Load AMPTEST as current setting
:*SAV 2                         Save current setting in memory 2
:*RCL 3"                        Recall memory 3 as current setting
```

Command	**:OUTP[1]**
Long	`:OUTPut[1][:NORMal][:STATe]`
Form	Set & Query
Parameter	`ON | OFF | 1 | 0`
***RST value**	`OFF`
Description	Use this command to switch the normal OUTPUT on or off.
Example	To switch on the output: `:OUTP ON`

Command	**:OUTP[1]:IMP**
Long	`:OUTPut[1]:IMPedance[:INTernal]`
Form	Set & Query
Parameter	Numeric
Parameter Suffix	`OHM` with engineering prefixes, e.g.: `MOHM` is Megaohms.
***RST value**	50 Ω
Specified Limits	50 Ω or 1 kΩ
Description	Use this command to program the source impedance of the OUTPUT connector. Note that only two settings are available. If you try to program any other value, it will be rounded to one of the specified values.
Example	To program the source impedance: `:OUTP:IMP 50OHM` Set OUTPUT impedance to 50 Ω

Command	**:OUTP[1]:IMP:EXT**
Long	`:OUTPut[1]:IMPedance:EXTernal`
Form	Set & Query
Parameter	Numeric
Parameter Suffix	`OHM` with engineering prefixes, e.g.: `MOHM` is Megaohms.
***RST value**	50.0 Ω

Specified Limits 0.1 Ω to 1 MΩ

Description Use this command to set the expected load impedance of the device under test at the OUTPUT connectors. If you have a non-50 Ω load, the output levels at the device under test will not be the levels you program or set via the front panel *unless* you set the expected load using this command.

Example To set the expected load impedance:

```
:OUTP:IMP:EXT 47.6OHM          Set load impedance at OUTPUT to 47.6 Ω
```

Command **:OUTP[1]:POL**

Long `:OUTPut[1]:POLarity`

Form Set & Query

Parameter `NORMal | INVerted`

***RST value** `NORM`

Description Use this command to invert the signal at the OUTPUT.

Example To invert and re-invert the signal:

```
:OUTP:POL INV                  Inverted signal at OUTPUT
:OUTP:POL NORM                 Normal signal at OUTPUT
```

Command **:CURR[1]**

Long `[:SOURce]:CURRent[1][:LEVel][:IMMediate][:AMPLitude]`

Form Set & Query

Parameter Numeric

Parameter suffix A with engineering prefixes.

***RST value** 20 mA (50 Ω into 50 Ω)

Specified Limits 10 V Outputs (from high Z into short): max. 400 mA typical

3.8V Outputs (50 Ω into short): max. 152 mA typical

Value coupling

$$Amplitude = High - Low$$

$$Offset = \frac{High - Low}{2}$$

Range coupling Offset

Description Use this command to program the amplitude current of the OUTPUT signal. Note that to set the OUTPUT levels in terms of current, you first have to execute the `[:SOURce]:HOLD CURRent` command to enable the [:SOURCE]:CURRENT subsystem.

The available current range is limited by the combination of:

- Specified Voltage limits
- Actual OUTPUT Impedance setting `:OUTPut:IMPedance`
- Actual Expected Load impedance setting: `:OUTPut:IMPedance:EXTernal`

Example To program the amplitude current of the output signal:

```
:HOLD CURR                    Enable CURRENT subsystem
:CURR 75MA                    Set OUTPUT amplitude to 75 mA
```

Command **:CURR[1]:OFFSet**

Long `[:SOURce]:CURRent[1][:LEVel][:IMMediate]:OFFSet`

Form Set & Query

Parameter Numeric

Parameter suffix A with engineering prefixes.

***RST value** 0.0 µA (50 Ω into 50 Ω)

Value coupling

$$Amplitude = High - Low$$

$$Offset = \frac{High - Low}{2}$$

Range coupling Amplitude

Description Use this command to program the offset current of the OUTPUT signal. Note that to set the OUTPUT levels in terms of current, you first have to execute the `[:SOURce]:HOLD CURRent` command to enable the `:SOURce]:CURRent` subsystem.

The available current range is limited by the combination of:

- Specified Voltage limits
- Actual OUTPUT Impedance setting `:OUTPut:IMPedance`
- Actual Expected Load impedance setting

Example To program the offset current of the output signal:

```
:HOLD CURR                    Enable CURRENT subsystem
:CURR:OFF 50MA                Set OUTPUT offset to 50 mA
```

Command **:CURR[1]:HIGH**

Long `[:SOURce]:CURRent[1][:LEVel][:IMMediate]:HIGH`

Form Set & Query

Parameter Numeric

Parameter suffix A with engineering prefixes.

Value coupling

$$Amplitude = High - Low$$

$$Offset = \frac{High - Low}{2}$$

Range coupling Low level

***RST value** +10 mA (50 Ω into 50 Ω)

Specified Limits 10 V Output (from high Z into short): –396 mA to 400 mA typical

3.8 V (from 50 Ω into short): –82 mA to 152 mA typical

Description Use this command to program the high level current of the OUTPUT signal. Note that to set the OUTPUT levels in terms of current, you first

have to execute `[:SOURCE]:HOLD CURRent` command to enable the `[:SOURCE]:CURRent` subsystem.

The available current range is limited by the combination of:

- Specified Voltage limits
- Actual OUTPUT Impedance setting `:OUTPut:IMPedance`
- Actual Expected Load impedance setting: `:OUTPut:IMPedance:EXTernal`

Example To program the high level current of the output signal:

```
:HOLD CURR                    Enable CURRENT subsystem
:CURR:HIGH 150MA              Set OUTPUT high level to 150 mA
```

Command **:CURR[1]:LOW**

Long `[:SOURce]:CURRent[1][:LEVel][:IMMediate]:LOW`

Form Set & Query

Parameter Numeric

Parameter suffix A with engineering prefixes.

Value coupling

$$Amplitude = High - Low$$

$$Offset = \frac{High - Low}{2}$$

Range coupling High level

***RST value** –10 mA (50 Ω into 50 Ω)

Specified Limits 10 V Outputs (from high Z into short): –400 mA to 396 mA typical

3.8 V Outputs (from 50 Ω into short): –84 mA to 150 mA typical

Description Use this command to program the low level current of the OUTPUT signal. Note that to set the OUTPUT levels in terms of current, you first have to execute the `[:SOURce]:HOLD CURRent` command to enable the `[:SOURce]:CURRent` subsystem.

The available current range is limited by the combination of:

- Specified Voltage limits
- Actual OUTPUT Impedance setting `:OUTPut:IMPedance`
- Actual Expected Load impedance setting: `:OUTPUT:IMPedance:EXTernal`

Example To program the low level current of the output signal:

```
:HOLD CURR                    Enable CURRENT subsystem
:CURR:LOW 50 MA               Set OUTPUT low level to 50 mA
```

Command **:CURR[1]:LIM**

Long `[:SOURce]:CURRent[1]:LIMit[:HIGH]`

Form Set & Query

Parameter Numeric

Parameter suffix A with engineering prefixes.

***RST value** +10.0 mA

Description Use this command to set/read the high level current limit. If you switch on current limiting, the high level current cannot be set above the programmed limit.

The current is *not* limited by the OUTPUT hardware, this is a software limit.

Example To set the high level current limit for the output signal:

```
:HOLD CURR                    Enable CURRENT subsystem
:CURR:LIM 50 MA               Set OUTPUT high level current limit to 50 mA
:CURR:LIM:STAT ON             Switch on OUTPUT limits
```

Command **:CURR[1]:LIM:LOW**

Long `[:SOURce]:CURRent[1]:LIMit:LOW`

Form Set & Query

Parameter Numeric

Parameter suffix A with engineering prefixes.

***RST value** –10.0 mA

Description Use this command to set/read the low level current limit. If you switch on current limiting, the low level current cannot be set below the programmed limit.

The current is *not* limited by the OUTPUT hardware, this is a software limit.

Example To set the low level current limit for the output:

```
:HOLD CURR                  Enable CURRENT subsystem
:CURR:LIM:LOW –50MA         Set OUTPUT low level current limit to –50 mA
:CURR:LIM:STAT ON           Switch on OUTPUT limits
```

Command **:CURR[1]:LIM:STAT**

Long `[:SOURce]:CURRent[1]:LIMit:STATe`

Form Set & Query

Parameter `ON | OFF | 1 | 0`

***RST value** `OFF`

Description Use this command to switch the output limits on or off. When you switch on the output limits, you cannot program the output levels beyond the programmed limits, until you switch off the output limits. The limits apply whether you program high/low levels or amplitude/offset levels.

NOTE You can switch the limits on and off in both the `[:SOURce]:CURRent` and the `[:SOURce]:VOLTage` subsystems *but the current and voltage limits are not enabled/disabled independently.* The voltage and current limits are always enabled/disabled together.

Example To set and activate the current limits for the output:

```
:HOLD CURR                  Enable CURRENT subsystem
:CURR:LIM 50MA              Set OUTPUT high level current limit to 50 m
:CURR:LIM:LOW –50MA         Set OUTPUT low level current limit to –50m
:CURR:LIM:STAT ON           Switch on OUTPUT limits
```

Command **:FREQ**

Long `[:SOURce]:FREQuency[:CW|:FIXed]`

Form Set & Query

Parameter Numeric

Parameter Suffix `HZ` with engineering prefixes, or `MHZ` for Megahertz.

Value coupling

$$Period = \frac{1}{Frequency}$$

***RST value** 1.00 MHz

Specified limits 1 mHz to 50 MHz

Description Use this command to set/read the pulse frequency. Select the frequency source for the pulse frequency using `:TRIGger:SOURce`. The currently selected source is programmed by this command. Note that the specified limits and available resolution depend on the selected source.

You cannot set the pulse frequency if you have selected the CLK-IN connector as the frequency source (`:TRIG:SOUR EXT`).

Example To set the pulse frequency to 40 MHz:

```
:TRIG:SOUR INT              Select internal osc. as pulse trigger
:FREQ 40MHz                 Set pulse frequency to 40 MHz
```

Command **:FREQ:AUTO**

Long `[:SOURce]:FREQuency[:CW|:FIXed]:AUTO`

Form Event

Parameter `ONCE`

***RST value** Not applicable

Description Use this command to measure the frequency at the CLK-IN connector. If the CLK-IN connector is the selected pulse frequency source, you can then read the measured value with `:FREQ?`

Example To measure and read the frequency at the CLK-IN connector:

```
:TRIG:SOUR EXT          Select ext CLK-IN as pulse trigger
:FREQ:AUTO ONCE         Measure frequency at CLK-IN
:FREQ?                  Query pulse frequency
```

Command **:HOLD**

Long `[:SOURce]:HOLD`

Form Set & Query

Parameter `VOLTage | CURRent`

***RST value** `VOLT`

Description Use this command to enable either of the `[:SOURce]:VOLTage` or `[:SOURce]:CURRent` subsystems.

You can control the signal levels of the instrument's OUTPUT in terms of voltage or current.

Command **:PHAS[1]**

Long `[:SOURce]:PHASe[1][:ADJust]`

Form Set & Query

Parameter Numeric

Parameter suffix DEG or RAD. A parameter without a suffix is interpreted as RAD.

Functional coupling Programming the pulse phase also executes `[:SOURce]:PULSe:HOLD PHASe` so that the pulse phase is held constant when the signal frequency is changed.

Value coupling

$$Delay = \frac{Phase}{360} \times Period$$

***RST value** 0.0

Specified limits 0 to 360° constrained by delay and period limits.

Description Use this command to set/read the relative phase delay of the output signal. This is equivalent to setting an absolute or percentage pulse delay with `[:SOURce]:PULSe:DELay`.

If you want the phase delay to remain constant when the pulse period is varied (rather than the absolute pulse delay) use `[:SOURce]:PULSe:DELay[1]:HOLD PRATio`.

Example To set and hold the phase delay:

```
:PHAS 180 DEG                Set OUTPUT phase to 180°
:PULS:DEL:HOLD PRAT          Hold OUTPUT phase constant with varying
                             period
```

Command **:PULS:DCYC[1]**

Long `[:SOURce]:PULSe:DCYCle[1]`

Form Set & Query

Parameter Numeric

Value coupling

$$Width = \frac{Duty\ Cycle}{100} \times Period$$

***RST value** 10.0% (derived from width and period)

Specified limits 0.001% to 99.9%, depends on width, transition & period.

Description Use this command to program the duty cycle of the pulse signal. If you want to set an absolute pulse width use `[:SOURce]:PULSe:WIDTh[1]`.

If you want the pulse duty cycle to remain constant when the pulse period is varied (rather than the absolute pulse width use) `:SOURce]:PULSe:HOLD[1] DCYCle`

Example To set and hold the duty cycle:

```
:PULS:DCYC 25PCT        Set OUTPUT duty cycle to 25%
:PULS:HOLD DCYC         Hold duty cycle constant with varying period
```

Command **:PULS:DEL[1]**

Long `[:SOURce]:PULSe:DELay[1]`

Form Set & Query

Parameter Numeric

Parameter suffix S with engineering prefixes. You can change the default unit using `[:SOURce]:PULSe:DELay[1]:UNIT.`

Value coupling

$$Phase = \frac{Delay}{Period} \times 360$$

$$Delay\% = \frac{Delay}{Period} \times 100$$

***RST value** 0.0

Specified limits 0.00 ns to 999 s (limited by period – 20 ns)

Description Use this command to set/read the pulse delay. Delay is the time between the start of the pulse period and the start of the leading edge of the pulse.

If you want the pulse delay to remain constant when the pulse period is varied (rather than the phase delay) use `[:SOURce]:PULSe:DELay[1]:HOLD TIME.`

Example To set and hold the pulse delay:

```
:PULS:DEL 500NS                Set OUTPUT delay to 500 ns
:PULS:DEL:HOLD TIME            Hold OUTPUT delay constant with varying
                               period
```

Command **:PULS:DEL[1]:HOLD**

Long `[:SOURce]:PULSe:DELay[1]:HOLD`

Form Set & Query

Parameter `TIME | PRATio`

***RST value** `TIME`

Description Use this command to set/read the coupling between the pulse period and the pulse delay:

TIME	The absolute pulse delay is held fixed when the pulse period is varied (pulse phase varies).
PRATio	The pulse phase delay (delay as ratio of period) is held fixed when the pulse period is varied (pulse delay varies).

Example To set and hold the pulse delay:

```
:PULS:DEL 500ns                Set OUTPUT delay to 500ns
:PULS:DEL:HOLD TIME            Hold OUTPUT delay constant with varying
                               period
```

Command	**:PULS:DEL[1]:UNIT**
Long	`[:SOURce]:PULSe:DELay[1]:UNIT`
Form	Set & Query
Parameter	`S | SEC | PCT | DEG | RAD`
***RST value**	`S`
Description	Use this command to set/read the default units for the pulse delay parameter. The default unit of a parameter is the unit used when the parameter is programmed to a value without a unit suffix.
Example	To set the pulse delay to 50% of period:

```
:PULS:DEL:UNIT PCT          Set OUTPUT delay unit to %
:PULS:DEL 50                Set OUTPUT delay to 50% of period
```

Command	**:PULS:DOUB[1]**
Long	`[:SOURce]:PULSe:DOUBle[1][:STATe]`
Form	Set & Query
Parameter	`OFF | ON`
***RST value**	`OFF`
Description	Use this command to switch double-pulse mode on or off. In double-pulse mode two pulses are generated per pulse period. The delay between the leading edges of the first and second pulse can be adjusted.

Command **:PULS:DOUB[1]:DEL**

Long `[:SOURce]:PULSe:DOUBle[1]:DELay`

Form Set & Query

Parameter Numeric

Parameter suffix S with engineering prefixes. You can change the default unit using `[:SOURce]:PULSe:DOUBle:DELay[1]:UNIT.`

Value coupling

$$DblDel\% = \frac{DblDel}{Period} \times 100$$

***RST value** 0.0

Specified limits 10 ns to 999.5 s (width +10 ns) to (period – width – 10 ns)
min. period: 20 ns

Description Use this command to set/read the delay between the leading edges of the two pulses in double-pulse mode. The first pulse always starts at the start of the pulse period.

If you want the double delay to remain constant when the pulse period is varied (rather than the double delay as percentage of period) use `[:SOURce]:PULSe:DOUBle[1]:DELay:HOLD TIME.`

Example To set and hold the double-pulse delay:

```
:PULS:DOUB ON                Switch on Double pulses on OUTPUT
:PULS:DOUB:DEL 500NS         Set interpulse delay to 500 ns
:PULS:DOUB:DEL:HOLD TIME     Hold interpulse delay fixed with varying
                             pulse period
```

Command **:PULS:DOUB[1]:DEL:HOLD**

Long `[:SOURce]:PULSe:DOUBle[1]:DELay:HOLD`

Form Set & Query

Parameter `TIME|PRATio`

***RST value** `TIME`

Description Use this command to set/read the coupling between the pulse period and the double-pulse delay:

TIME	The absolute double-pulse delay is held fixed when the pulse period is varied.
PRATio	The double-pulse delay as percentage of period is held fixed when the pulse period is varied.

Example To set and hold the double-pulse delay:

`:PULS:DOUB ON`	Switch on double-pulses on OUTPUT
`:PULS:DOUB:DEL 50 PCT`	Set interpulse delay to 50% of pulse period
`:PULS:DOUB:DEL:HOLD PRAT`	Hold interpulse delay as fixed percentage of pulse period

Command **:PULS:DOUB[1]:DEL:UNIT**

Long `[:SOURce]:PULSe:DOUBle[1]:DELay:UNIT`

Form Set & Query

Parameter `S | SEC | PCT`

***RST value** `S`

Description Use this command to set/read the default units for the double delay parameter. The default unit of a parameter is the unit used when the parameter is programmed to a value without a unit suffix.

Example To set the double-pulse delay to 50%:

`:PULS:DOUB:DEL:UNIT PCT`	Set OUTPUT double delay unit to %
`:PULS:DOUB:DEL 50`	Set OUTPUT double-pulse delay to 50% of period

Command **:PULS:HOLD[1]**

Long `[:SOURce]:PULSe:HOLD[1]`

Form Set & Query

Parameter `WIDTh | DCYCle | TDELay`

***RST value** `WIDTh`

Description Use this command to set whether the pulse width, the pulse duty cycle or the pulse trailing edge delay is held constant when the pulse period is changed.

Example To set and hold the delay and the duty cycle:

`:PULS:DEL:HOLD TIME`	Hold OUTPUT delay fixed when frequency varies
`:PULS:DEL 20NS`	Set OUTPUT delay to 20ns
`:PULS:HOLD DCYC`	Hold OUTPUT duty cycle fixed when frequency varies
`:PULS:DCYC 25PCT`	Set OUTPUT duty cycle to 25%

Command **:PULS:PER**

Long `[:SOURce]:PULSe:PERiod`

Form Set & Query

Parameter Numeric

Parameter Suffix S with engineering prefixes.

Value coupling

$$Frequency = \frac{1}{Period}$$

***RST value** 1 µs

Specified limits 2 ns to 999.5 s

Description Use this command to set/read the pulse period. Select the pulse period source using `:TRIGger:SOURce.` The currently selected source is programmed by this command. Note that the specified limits and available resolution depend on the selected source.

You cannot set the pulse period if you have selected the CLK-IN connector as the frequency source (`:TRIG:SOUR EXT`).

Example To set the pulse period using the internal oscillator:

```
:TRIG:SOUR INT          Select internal osc. as pulse trigger
:PULS:PER 25NS          Set pulse frequency to 25 ns
```

Command **:PULS:PER:AUTO**

Long `[:SOURce]:PULSe:PERiod:AUTO`

Form Event

Parameter ONCE

***RST value** Not applicable

Description Use this command to measure the period at the CLK-IN connector. If the CLK-IN connector is the selected pulse period source, you can then read the measured value with `:PULS:PER?`

Example To measure the period at the CLK-IN connector:

```
:TRIG:SOUR EXT          Select ext. CLK-IN as pulse trigger
:PULS:PER:AUTO ONCE     Measure period at CLK-IN
:PULS:PER?              Query pulse period
```

Command **:PULS:TDEL[1]**

Long `[:SOURce]:PULSe:TDELay[1]`

Form Set & Query

Parameter Numeric

Parameter Suffix S with engineering prefixes.

***RST value** 100 ns

Specified Limits 10 ns to 999.5 s (max. period –10 ns)

Description Use this command to program the delay of the trailing edge of the pulse relative to the start of the pulse period. This is an alternative method of programming the pulse width.

Example To program the pulse width by means of the delay parameters:

```
:PULS:DEL 500NS              Set OUTPUT delay to 500 ns
:PULS:DEL:HOLD TIME          Hold OUTPUT delay constant with
                             varying period
:PULS:TDEL 750NS             Set OUTPUT trailing delay to 750 ns
```

Command **:PULS:TRAN[1]:HOLD**

Long `[:SOURce]:PULSe:TRANsition[1]:HOLD`

Form Set & Query

Parameter `TIME | WRATio`

***RST value** `TIME`

Description Use this command to set the coupling between transition times and the pulse width:

`TIME`	The absolute transition times are held when the pulse width is varied.
`WRATio`	The ratio of transition time to pulse width is held when the pulse width is varied.

Example To set the coupling between transition times and the pulse width:

```
:PULS:TRAN:HOLD TIME         Hold OUTPUT transitions fixed when
                             pulse width varies
:PULS:TRAN:HOLD WRAT         Hold OUTPUT transition width ratio
                             when pulse width varies
```

Command	**:PULS:TRAN[1]:UNIT**
Long	`[:SOURce]:PULSe:TRANsition[1]:UNIT`
Form	Set & Query
Parameter	`S | SEC | PCT`
***RST value**	`S`
Description	Use this command to set the default units for the pulse transition times. The default unit is used when the parameter is programmed to a value without a unit suffix.

Command	**:PULS:TRAN[1]**
Long	`[:SOURce]:PULSe:TRANsition[1][:LEADing]`
Form	Set & Query
Parameter	Numeric
Parameter suffix	`S` with engineering prefixes, or `PCT`
***RST value**	5 ns
Specified limits	5 ns to 200 ms
Parameter coupling	By default: Trailing edge = Leading edge with `:PULS:TRAN:TRA:AUTO ON`. Use `:PULS:TRAN:TRA:AUTO OFF` to enable independent programming of the trailing edge within a 1:20 ratio for the ranges.
Description	Use this command to set/read the transition time of the pulse leading edge. Note that the leading and trailing edges of the pulse have to fit within the defined pulse width.
Example	To set leading and trailing edges independently:

`:PULS:TRAN1 6NS`	Set OUTPUT leading edge to 6 ns
`:PULS:TRAN:TRA:AUTO OFF`	Enable independent setting of trailing edge
`:PULS:TRAN:TRA 15 NS`	Set OUTPUT trailing edge to 15 ns

Command	**:PULS:TRAN[1]:TRA**
Long	`[:SOURce]:PULSe:TRANsition[1]:TRAiling`
Form	Set & Query
Parameter	Numeric
Parameter suffix	S with engineering prefixes, or PCT
***RST value**	5 ns
Specified limits	5 ns to 200 ms
Parameter coupling	By default: Trailing edge = Leading edge with `:PULS:TRAN:TRA:AUTO ON`. Use `:PULS:TRAN:TRA:AUTO OFF` to enable independent programming of the trailing edge within a 1:20 ratio for the ranges.
Description	Use this command to set/read the transition time of the pulse trailing-edge. Note that the leading and trailing edges of the pulse have to fit within the defined pulse width.
Example	To set the leading and trailing edges independently:

`:PULS:TRAN 6NS`	Set OUTPUT leading edge to 6ns
`:PULS:TRAN:TRA:AUTO OFF`	Enable independent setting of trailing edge
`:PULS:TRAN:TRA: 15NS`	Set OUTPUT trailing edge to 15 ns

Command **:PULS:TRAN[1]:TRA:AUTO**

Long `:[SOURce]:PULSe:TRANsition[1]:TRAiling:AUTO`

Form Set & Query

Parameter ON | OFF | ONCE

***RST value** ON

Description Use this command to set/read the automatic coupling of the pulse trailing edge transition time to the leading edge transition time.

ON	The trailing edge transition time is automatically set to the same value as the leading edge, and is updated automatically each time the leading edge transition time changes.
OFF	The trailing edge transition time is independently programmable.
ONCE	The trailing edge transition time is set ONCE to the same value as the leading edge.

Example To set leading and trailing edges independently:

`:PULS:TRAN 6NS`	Set OUTPUT leading edge to 6 ns
`:PULS:TRAN:TRA:AUTO OFF`	Enable independent setting of trailing edge
`:PULS:TRAN:TRA 15NS`	Set OUTPUT trailing edge to 15 ns

Command **:PULS:TRIG[1]:VOLT**

Long `[:SOURce]:PULSe:TRIGger[1]:VOLTage[:LEVel][:IMMediate][:AMPlitude]`

Form Set & Query

Parameter `TTL | ECL`

***RST value** TTL

Description Use this command to set/read the output levels at the TRIGGER OUT connector.

Command **:PULS:WIDT[1]**

Long `[:SOURce]:PULSe:WIDTh[1]`

Form Set & Query

Parameter Numeric

Parameter suffix S with engineering prefixes

***RST value** 100 ns

Specified limits 10 ns to 999.5 s (max. period –10 ns)

Description Use this command to program the width of the pulse signal. If you want to set width as duty cycle use `[:SOURce]:PULSe:DCYCle[1]`.

If you want the pulse width to remain constant when the pulse period is varied (rather than the duty cycle) use `[:SOURce]:PULSe:HOLD[1] WIDTh`.

Example To set and hold the pulse width:

```
:PULS:WIDT 50NS          Set OUTPUT pulse width to 50 ns
:PULS:HOLD WIDTH         Hold pulse width constant with varying period
```

Command **:ROSC:SOUR**

Long `[:SOURce]:ROSCillator:SOURce`

Form Set & Query

Parameter `INTernal | EXTernal`

***RST value** `INT`

Description Use this command to set/read the reference source for the PLL. If you select the external reference (CLK-IN connector), you can choose to use a 5 MHz or 10 MHz reference signal using `:ROSC:EXT:FREQ`.

`INTernal`	Lock the PLL to its internal reference
`EXTernal`	Lock the PLL to a reference signal at the CLK-IN connector. The external reference signal can be 5 or 10 MHz.

Example To set up the external PLL reference:

```
:ROSC:SOUR EXT                  Set external PLL reference (CLK-IN)
:ROSC:EXT:FREQ 10 MHZ           Set expected PLL reference frequency to
                                10 MHz
```

Command **:ROSC:EXT:FREQ**

Long `[:SOURce]:ROSCillator:EXTernal:FREQuency`

Form Set & Query

Parameter Numeric

***RST value** 5 MHz

Specified limits 5 MHz or 10 MHz

Description Use this command to set/read the expected reference frequency for the PLL at the CLK-IN connector. The external reference can be a 5 or 10 MHz signal. Note that if you program any value other than the two specified values, the value will be set to the nearest of the two specified values.

Example To set up the external PLL reference:

```
:ROSC:SOUR EXT                  Set external PLL reference (CLK-IN)
:ROSC:EXT:FREQ 10MHZ            Set expected PLL reference frequency to
                                10 MHz
```

Command **:VOLT[1]**

Long `[:SOURce]:VOLTage[1][:LEVel][:IMMediate][:AMPLitude]`

Form Set & Query

Parameter Numeric

Parameter suffix V with engineering prefixes.

Value coupling

$$High = Offset + \frac{Amplitude}{2}$$

$$Low = Offset - \frac{Amplitude}{2}$$

Range coupling With Offset, see *page 71*

***RST value** 1.00 V

Specified limits 100 mVpp to 10.0 Vpp (values are valid from 50 Ω into 50 Ω)

Description Use this command to program the amplitude voltage of the output signal. Note that to set the output levels in terms of voltage, you first have to execute the `[:SOURce]:HOLD VOLTage` command to enable the `[:SOURce]:VOLTage` subsystem.

The available voltage range is limited by the combination of:

- Specified current limits
- Actual output impedance setting `:OUTPut:IMPedance`
- Actual expected load impedance setting: `:OUTput:IMPedance:EXTernal`

Example To set the amplitude voltage:

```
:HOLD VOLT                    Enable VOLTAGE subsystem
:VOLT 5V                      Set OUTPUT amplitude to 5 V
```

Command **:VOLT[1]:OFFSet**

Long `[:SOURce]:VOLTage[1][:LEVel][:IMMediate]:OFFSet`

Form Set & Query

Parameter Numeric

Parameter suffix V with engineering prefixes.

Value coupling

$$High = Offset + \frac{Amplitude}{2}$$

$$Low = Offset - \frac{Amplitude}{2}$$

Range coupling With Amplitude, see *page 70*

***RST value** 0.0 mV

Specified Limits –10 V to +10 V

Description Use this command to program the offset voltage of the OUTPUT signal. Note that to set the OUTPUT levels in terms of voltage, you first have to execute the `[:SOURce]:HOLD VOLTage` command to enable the `[:SOURce]:VOLtage` subsystem.

The available voltage range is limited by the combination of:

- Specified current limits
- Actual OUTPUT impedance setting `:OUTPut:IMPedance`
- Actual expected load impedance setting `:OUTput:IMPedance:EXTernal`

Example To set the offset voltage:

```
:HOLD VOLT                    Enable VOLTAGE subsystem
:VOLT:OFF –800MV              Set OUTPUT offset to –800mV
```

Command **:VOLT[1]:HIGH**

Long `[:SOURce]:VOLTage[1][:LEVel][:IMMediate]:HIGH`

Form Set & Query

Parameter Numeric

Parameter suffix V with engineering prefixes.

Value coupling

$$Amplitude = High - Low$$

$$Offset = \frac{High - Low}{2}$$

Range coupling With low level, see *page 73*

***RST value** 500 mV

Specified limits –9.9 V to 10.0 V (50 Ω into 50 Ω)

Description Use this command to program the high level voltage of the OUTPUT signal. Note that to set the OUTPUT levels in terms of voltage, you first have to execute the `[:SOURce]:HOLD VOLTage` command to enable the `[:SOURce]:VOLTage` subsystem.

The available voltage range is limited by the combination of:

- Specified current limits
- Actual OUTPUT impedance setting `:OUTPut:IMPedance`
- Actual expected load impedance setting `:OUTPut:IMPedance:EXTernal`

Example To set the high level voltage:

```
:HOLD VOLT                  Enable VOLTAGE subsystem
:VOLT:HIGH 4.8V             Set OUTPUT high level voltage to 4.8 V
```

Command **:VOLT[1]:LOW**

Long `[:SOURce]:VOLTage[1][:LEVel][:IMMediate]:LOW`

Form Set & Query

Parameter Numeric

Parameter suffix V with engineering prefixes.

Value coupling

$$Amplitude = High - Low$$

$$Offset = \frac{High - Low}{2}$$

Range coupling With high level, see *page 72*

***RST value** –500 mV

Specified limits –10.0 V to 9.9 V (50 Ω into 50 Ω)

Description Use this command to program the low level voltage of the OUTPUT signal. Note that to set the OUTPUT levels in terms of voltage, you first have to execute the `[:SOURce]:HOLD VOLTage` command to enable the `[:SOURce]:VOLTage` subsystem.

The available voltage range is limited by the combination of:

- Specified current limits
- Actual OUTPUT impedance setting `:OUTPut:IMPedance`
- Actual expected load impedance setting `:OUTPut:IMPedance:EXTernal`

Example To set the low level voltage:

```
:HOLD VOLT                    Enable VOLTAGE subsystem
:VOLT:LOW 500MV               Set OUTPUT low level to 500mV
```

Command **:VOLT[1]:LIM**

Long `[:SOURce]:VOLTage[1]:LIMit[:HIGH]`

Form Set & Query

Parameter Numeric

Parameter suffix V with engineering prefixes.

***RST value** +500 mV

Description Use this command to set/read the high level voltage limit. If you switch on voltage limiting, the high level voltage cannot be set above the programmed limit. Note that the voltage is *not* limited by the OUTPUT hardware, this is a software limit.

Example To set and activate the high level voltage limit:

```
:HOLD VOLT                  Enable VOLTAGE subsystem
:VOLT:LIM 3V                Set OUTPUT high level limit to 3 V
:VOLT:LIM:STAT ON           Switch on OUTPUT limits
```

Command **:VOLT[1]:LIM:LOW**

Long `[:SOURce]:VOLTage[1]:LIMit:LOW`

Form Set & Query

Parameter Numeric

Parameter suffix V with engineering prefixes.

***RST value** –500 mV

Description Use this command to set/read the low level voltage limit. If you switch on voltage limiting, the low level voltage cannot be set below the programmed limit. Note that the voltage is *not* limited by the OUTPUT hardware, this is a software limit.

Example To set and activate the low level limit:

```
:HOLD VOLT                  Enable VOLTAGE subsystem
:VOLT:LIM:LOW 0V            Set OUTPUT low level voltage
:VOLT:LIM:STAT ON           Switch on OUTPUT limits
```

Command **:VOLT[1]:LIM:STAT**

Long `[:SOURce]:VOLTage[1]:LIMit:STATe`

Form Set & Query

Parameter `ON | OFF | 1 | 0`

***RST value** `OFF`

Description Use this command to switch the output limits on or off. When you switch on the output limits, you cannot program the output levels beyond the programmed limits, until you switch off the voltage limits. The limits apply whether you program high/low levels or amplitude/offset levels.

NOTE You can switch the limits on and off in both the `[:SOURce]:CURRent` and the `[:SOURce]:VOLTage` subsystems *but the current and voltage limits are not enabled/disabled independently.* The voltage and current limits are always enabled/disabled together.

Example To set and activate the high and low voltage limits:

`:HOLD VOLT`	Enable VOLTAGE subsystem
`:VOLT:LIM 3V`	Set OUTPUT high level voltage limit to 3 V
`:VOLT:LIM:LOW 0V`	Set OUTPUT low level voltage limit to 0 V
`:VOLT:LIM:STAT ON`	Switch on OUTPUT limits

Command **:STATus:OPERation**

This command tree accesses the `OPERation` status group. *The* `OPERation` *status group is not used by the instrument. Therefore, this command tree is redundant.*

- `:STATus:OPERation[:EVENt]?`
- `:STATus:OPERation:CONDition?`
- `:STATus:OPERation:ENABle`
- `:STATus:OPERation:NTRansition`
- `:STATus:OPERation:PTRansition`

Command **:STATus:PRESet**

Long `:STATus:PRESet`

Form Event

***RST value** Not Applicable

Description This command

- Clears all status group event registers
- Clears the error queue
- Presets the status group enable-, PTR-, and NTR-registers as follows:

Status Group	Register	Preset value
OPERation	ENABle	`0000000000000000`
	PTR	`0111111111111111`
	NTR	`0000000000000000`
QUEStionable	ENABle	`0000000000000000`
	PTR	`0111111111111111`
	NTR	`0000000000000000`

Command **:STATus:QUEStionable**

This command tree accesses the QUEStionable status group. The QUEStionable status group contains warning bits for voltage, current, time and frequency parameters. A warning occurs when the output signal *could* be out of specification due to the combined specification uncertainties of many parameters, although all parameters are set within their individually specified limits. If a parameter is set outside its specified limits an error is generated.

The following commands are used to access the registers within the status group:

1. **:STATus:QUEStionable[:EVENt]?**

Form	Query
*RST value	Not Applicable
Description	This command reads the event register in the QUEStionable status group.

2. **:STATus:QUEStionable:CONDition?**

Form	Query
*RST value	Not Applicable
Description	This command reads the condition register in the QUEStionable status group.

3. **:STATus:QUEStionable:ENABle**

Form	Set & Query
Parameter	Numeric
*RST value	Not affected by *RST''
Specified limits	0 – 32767
Description	This command sets or queries the enable register in the QUEStionable status group.

4. **:STATus:QUEStionable:NTRansition**

Form	Set & Query
Parameter	Numeric
*RST value	Not applicable'
Specified limits	0 – 32767
Description	This command sets or queries the negative transition register in the QUEStionable status group.

5. **:STATus:QUEStionable:PTRansition**

Form	Set & Query
Parameter	Numeric
*RST value	Not applicable'
Specified limits	0 – 32767
Description	This command sets or queries the positive transition register in the QUEStionable status group.

Command **:SYST:CHEC**

Long `:SYSTem:CHECk[:ALL][:STATe]`

Form Set & Query

Parameter `OFF | ON`

***RST value** `ON`

Description Use this command to switch the instrument's error checking on or off. Switch off the error checking if you want to improve the programming speed of the instrument, but remember that no invalid parameter or mode settings will be detected and reported. Error checking is switched off by the *RST command, or when default setting is invoked.

CAUTION Error checking cannot be switched on from the front panel. Error checking is *not* automatically re-enabled if you switch the instrument off and on again. Therefore your test programs should send either *RST or set default setting before ending.

Command **:SYST:ERR?**

Long `:SYSTem:ERRor?`

Form Query

***RST value** Not Applicable

Description Use this command to read the instrument error queue. The instrument error queue can store up to 30 error codes on a first-in-first-out basis. When you read the error queue, the error number and associated message are put into the instrument's output buffer.

If the queue is empty, the value 0 is returned, meaning NO ERROR. If the queue overflows at any time, the last error code is discarded and replaced with –350 meaning QUEUE OVERFLOW.

Example To read the error queue:

```
:SYS:ERR?                                   Query for errors
```

Example Error String

```
–222 "Data out of range" overlap at output 1: Width>Double Delay
```

The above message is an example of a customized description. Generic descriptions are available in the SCPI 1995 Command Reference, items 21.8.4 to 21.8.11.

For more detailed information in the 81110A error.

Send `":SYST:WARN:STR?"`. Alternatively, the HELP key shows the current errors and warnings and their description on the instruments display.

Command **:SYST:KEY**

Long `:SYSTem:KEY`

Form Set & Query

Parameter Numeric

Parameter suffix No suffix allowed

***RST value** –1

Specified limit

No.	Key Description
–1	No key pressed (Query only)
0	DATA ENTRY 0
1	DATA ENTRY 1
2	DATA ENTRY 2
3	DATA ENTRY 3
4	DATA ENTRY 4
5	DATA ENTRY 5
6	DATA ENTRY 6
7	DATA ENTRY 7
8	DATA ENTRY 8
9	DATA ENTRY 9
10	DATA ENTRY .

No.	Key Description
11	DATA ENTRY +/–
12	Cursor Up
13	Cursor Down
14	Cursor Left
15	Cursor Right
16	MAN
17	STORE
18	HELP
19	SHIFT
20	MORE
21	Softkey 1
22	Softkey 2
23	Softkey 3
24	Softkey 4
25	NANO
26	MICRO/MEGA
27	MILLI/KILO
28	ENTER
29	Modify Knob Left (counter-clockwise)
30	Modify Knob Right (clockwise)

Description

In query form, this command reads the last key pressed. The buffer is emptied by *RST and returns the value –1 when empty.

In set form, the command simulates pressing a key on the front panel. Simulated key press are also recorded as the last key pressed.

`:SYST:KEY 19` sets the instrument to LOCAL mode.

- In remote mode *only* the softkeys below the display and the SHIFT (LOCAL) key are active. Because the instrument normally switches to remote mode when any command is received, including `:SYSTem:KEY`, simulating one of the other disabled keys has no effect.
- If you want to simulate full front panel operation, you must prevent the instrument from entering remote mode by using the REN line of the GP-IB to maintain local mode (LOCAL 7 in BASIC).

If you do this, the `:SYSTem:KEY` command is the only command that works. Any other commands will be buffered in the instrument blocking any further `:SYSTem:KEY` commands, until remote mode is enable.

Command **:SYST:PRES**

Long `:SYSTem:PRESet`

Form No function.

Command	**:SYST:SEC**
Long	`:SYSTem:SECurity[:STATe]`
Form	Set & Query
Parameter	`ON|OFF`
***RST value**	`OFF`
Description	

CAUTION Do not switch on system security unless you are willing to erase the instrument settings stored in the instrument. All instrument memories, including the current setting, will be overwritten with the default settings if you

- switch off system security
- switch the instrument off and on again

If you accidentally switch on system security, and want to rescue the settings stored in the instrument, store the settings on a memory card.

You can then recall them from the memory card later.

Use this command to switch on system security mode. Switch on system security if you need to make sure that all instrument settings stored in the instrument are erased automatically when the instrument is switched off, or when security mode is switched off.

The instrument settings are erased by overwriting them with the default settings.

System security mode is not available via the front panel. If you want to erase all settings by hand:

1 SHIFT + STORE (RECALL) + 0 to recall the default settings from memory location 0.

2 STORE + 1, STORE + 2, ... STORE + 9, to store the defaults in memory locations 1 to 9.

Command	**:SYST:SET**
Long	`:SYSTem:SET`
Form	Set & Query
Parameter	Block data
***RST value**	Not applicable
Description	In query form, the command reads a block of data containing the instrument's complete setup. The set-up information includes all parameter and mode settings, but does not include the contents of the instrument setting memories, the status group registers or the `:DISPlay[:WINDow][:STATe]` The data is in a binary format, not ASCII, and cannot be edited. In set form, the block data must be a complete instrument setup read using the query form of the command.

Command	**:SYST:VERS?**
Long	`:SYSTem:VERSion?`
Form	Query
***RST value**	"1992.0"
Description	Use this command to read the SCPI revision to which the instrument complies.

Command	**:SYST:WARN?**
Long	`:SYSTem:WARNing[:COUNt]?`
Form	Query
***RST value**	Not applicable
Description	Use this command to read the number of warnings which are currently active. Note that the warning status of voltage, current, time and frequency are also summarized by bits in the QUESTionable Status register.

Command **:SYST:WARN:STR?**

Long `:SYSTem:WARNing:STRing?`

Form Query

***RST value** Not applicable

Description Use this command to read all the currently active warning messages. The warning messages are concatenated to form a single string with a ";" as separator between the messages.

Command **:SYST:WARN:BUFF?**

Long `:SYSTem:WARNing:BUFFer?`

Form Query

***RST value** Not applicable

Description Use this command to read the maximum possible number of characters that could be returned by `:SYST:WARN:STR?` if all warnings were active.

Command **:TRIG:COUNt**

Long `:TRIGger[:SEQuence[1]]:COUNt`

Form Set & Query

Parameter Numeric

***RST value** 1

Specified limits 1 to 65 536

Description Use this command to set/read the number of trigger events (pulse periods) to be generated for each arming event. This corresponds to selecting the event mode on the MODE/TRIGGER SCREEN:

`PULSES`	Set a **trigger count to 1** so that a single pulse period is generated for each arming event. The instrument is in pulse (stream) mode.
`BURST of`	Set a **trigger count of 2 to 65536** so that a burst of 2 to 65536 pulse periods is generated for each arming event.

Examples

To set up a triggered burst of 16 Single Pulses at Out1, each burst triggered by a positive edge at the EXT INPUT:

```
:ARM:SOUR EXT1          Set arming from EXT INPUT
:ARM:SENS EDGE          Set arming on edges
:ARM:SLOP POS           Set arming on positive edges
:TRIG:COUN 16           Burst length 16
:TRIG:SOUR INT1         Pulse period trigger from internal osc.
:DIG:PATT OFF           Disable pattern operating mode
:PULS:DOUB OFF          Ensure single pulses at OUTPUT
```

To set up gated pulses (Single Pulses at Out1), gated by a positive level at the EXT INPUT:

```
:ARM:SOUR EXT1          Set arming from EXT INPUT
:ARM:SENS LEV           Set arming on levels
:ARM:SLOP POS           Set arming on positive level 1 pulse period
:TRIG:COUN 1            Single pulse output mode
:TRIG:SOUR INT1         Pulse period trigger from internal osc.
:DIG:PATT OFF           Disable pattern data
:PULS:DOUB OFF          Ensure single pulses at OUTPUT
```

Command **:TRIG:IMP**

Long `:TRIGger:IMPedance`

Form Set & Query

Parameter Numeric

Parameter Suffix `OHM` with engineering prefixes, e.g.: `MOHM` is Megaohms.

***RST value** 50 Ω

Specified Limits 50 Ω or 10 kΩ

Description Use this command to program the input impedance of the CLK-IN connector. Note that only two settings are available. If you try to program any other value, it will be rounded to one of the specified values.

Example To set the input impedance and the threshold of the CLK-IN connector:

```
:TRIG:IMP 50OHM         Set CLK-IN impedance to 50 Ω
:TRIG:LEV 2.5V          Set CLK-IN threshold to 2.5V
:TRIG:SOUR EXT2         Pulse period trigger from CLK-IN
```

Command	**:TRIG:LEV**
Long	`:TRIGger:LEVel`
Form	Set & Query
Parameter	Numeric
Parameter Suffix	V with engineering prefixes.
***RST value**	1.0 V
Specified Limits	–10 V to +10 V
Description	Use this command to program the triggering threshold of the CLK-IN connector.
Example	To set the input impedance and the threshold of the CLK-IN connector:

```
:TRIG:IMP 50OHM          Set CLK-IN impedance to 50 Ω
:TRIG:LEV 2.5V           Set CLK-IN threshold to 2.5V
:TRIG:SOUR EXT2          Pulse period trigger from CLK-IN
```

Command	**:TRIG:SLOP**
Long	`:TRIGger:SLOPe`
Form	Set & Query
Parameter	`POSitive | NEGative`
***RST value**	`POS`
Description	Use this command to select the trigger slope for the pulse period triggering signal applied to the CLK-IN connector.

Command	**:TRIG:SOUR**
Long	:TRIGger:SOURce
Form	Set & Query
Parameter	`IMMediate | INTernal[1] | INTernal2 | EXTernal2`
***RST value**	`IMM`
Description	Use this command to select the pulse period source of the Agilent 81101A by selecting the source of the pulse period trigger signal:

Pulse period sources set by `:TRIG:SOUR`

Pulse period source	`:TRIG:SOURce`
internal osc	`IMMediate  INTernal[1]`
internal PLL	`INTernal2`
CLK-IN	`EXTernal2`

3 Specifications

In this chapter you will find the specifications of the Agilent 81101A Pulse Generator.

At the end of this chapter, *"Pulse Parameter Definitions" on page 105* provides detailed information on the definition of the pulse parameters used by the instrument.

NOTE

Warranted Performance

Specifications describe the instrument's warranted performance. Non-warranted values are described as typical. All specifications apply after a 30 minute warm-up phase with 50 Ohm source, a 50 Ohm load resistance and separate channels. They are valid from 0 °C to 55 °C ambient temperature.

Declaration of Conformity

Manufacturer

Agilent Technologies Deutschland GmbH
Boeblingen Verification Solutions
Herrenberger Str. 130

71034 Böblingen/Germany

We declare that the system:

AGILENT 81100	Family of Pulse-/Data Generators
AGILENT 81110 A	330/165 MHz Pulse/Pattern Generator
AGILENT 81104 A	80 MHz Pulse Pattern Generator
AGILENT 81101 A	50 MHz Pulse Pattern Generator
AGILENT 81112 A	330 MHz , 3.5V Output Module-
AGILENT 81130 A *	400/660 MHz Puls-/Pattern Generator
AGILENT 81131 A *	400 MHz , 3.5V Output Module
AGILENT 81132 A *	660 MHz , 2.5V Output Module
AGILENT E 8305 A *	VXI Plugin 250 MHz Pulse Generator
AGILENT E 8306 A *	VXI Plugin 100 MHz Clock Generator

Conforms to the following standards:

Safety

IEC 1010-1:1990 +A1:1992 +A2 :1995 ... EN61010-1:1993 +A2:1995

EMC

EN 55011:1991 / CISPR 11	Group 1, Class B*
EN 55011:1991 / CISPR 11	Group 1, Class A
EN 61000-4-2:1995	ESD: 4kVcd; 8 kVad;4kV c.p.
EN 61000-4-3:1995	Radiated Immunity: 3V/m 80%AM
ENV 50204: 1995	Radiated Immunity: 3V/m;50%Dty
EN 61000-4-4:1995	Fast Transients/Bursts: 0.5kV, 1kV
EN 61000-4-5:1995	Surges: 1kVdiff; 2kV com.mode
EN 61000-4-6:1995	Conducted Immunity
EN 61000-4-8:1993	Power freq. magn. field 3A/m;50Hz
IEC1000-4-11:1994	Voltage Dips and Interruptions

Supplementary Information

The product herewith complies with the requirements of the

- Low Voltage Directive (73/23/EEC)
- EMC Directive (89/336/EEC).

During the measurements against EN55011, the I/O ports were terminated with their nominal impendance, the GP-IB connection was terminated with the cable AGILENT 10833B.

When the Product is connected to other devices, the user must ensure that the connecting cables and the other devices are adequately shielded to prevent radiation.

Böblingen, June 09th 1998
Update, Oct. 13th 1998

Wolfgang Fenske
Regulations Consultant

Agilent 81101A Specifications

General

Environmental Conditions

Operating temperature:	**0 °C to +55 °C**
Storage temperature:	–40 °C to +70 °C
Humidity:	95% r.h. up to 40 °C ambient temperature
Altitude:	up to 2000 m
Installation:	Category II
Pollution:	Degree 2
EMC:	conforms to EN50082-1, EN55011, Class B
Battery:	Lithium, type CR2477-N (Agilent part number 1420-0557)

Safety

IEC1010, CSA1010

Power requirements

100–240 Vac, ±10%, 50–60 Hz;

100–120 Vac, ±10%, 400 Hz

Power consumption: 300 VA max.

Maximum Dimensions (H x W x D)

89 mm x 426 mm x 521 mm

Weight

Net

8.5 kg Single Channel
9.2 kg Dual Channel

Shipping

13.8 kg Dual Channel

Recalibration period

1 year recommended

Warranty

3 years standard

Acoustic Noise Emission

For ambient temperature up to 30°C,
under normal operation and at the typical operator position:

LpA = 52 dB (5.9 bel) typical {47 dB (5.3 bel) at 23°C) typical}

Measured in accordance with ISO 7779/EN 27779.

Timing Specifications

Period

Period can also be entered as frequency.

Period	Agilent 81101A
Range:	20 ns to 999.5 s
Resolution:	3.5 digits, 5 ps best case for VFO 4 digits, 1 ps best case for PLL
Accuracy:	PLL: ±0.01% VFO: ±5%
Repeatability:	typically 4 times better than accuracy
RMS-jitter:	PLL: 0.001% + 15 ps VFO: 0.01% + 15 ps
Frequency range:	1.00 mHz to 50 MHz

There are 2 period generation sources available:

- startable oscillator (variable frequency oscillator VFO)
- high-accuracy frequency generator (PLL)

Glitch-free timing changes

You can sweep your timing values without danger of spurious pulses or drop outs that could cause measurement errors. This applies to continuous mode with timing values < 100 ms (frequency: < 10 Hz), and consecutive values between one-half and twice the previous value.

Width

Can be entered as absolute width, duty cycle or trailing edge delay.

Width	Agilent 81101A
Range:	10 ns to 999.5 s (max value: period –10 ns)
Accuracy:	±5 % ±250 ps
Duty cycle:	0.1% to 95% (depends on period and width; overprogrammable to 99%)

Duty cycle values from 0.1% to 95% can be entered directly. For values >95 % press SHIFT and use the Modify knob. Note that pulses may be deteriorated or skipped due to the inaccuracy of period and width. Hence for large values, it is better to select complement and enter 100 minus the required duty cycle value.

Delay

Measured between trigger output and main output. Can be entered as absolute delay, phase ° or % of period.

Delay	Agilent 81101A
Fixed delay from TRIGGER OUT:	17.0 ns typical
Additional variable range:	0.00 ns to 999.5 s (max value: period –20 ns)
Accuracy:	±5 % ±1 ns

Double Pulse Delay

Double pulse delay and delay are mutually exclusive. Double Pulse delay is the delay between the two pulses in Double Pulse mode.

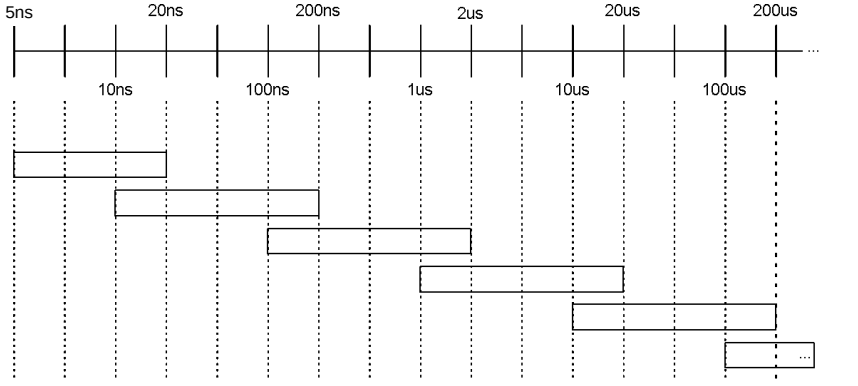
Double Pulse Delay	Agilent 81101A
Double Pulse Delay range:	20 ns to 999.5 s (width + 10 ns) to (period – width – 10 ns)
Accuracy:	±5 % ±500 ps
Min. period:	40 ns (25 MHz)

Transition Times

Measured between 10% and 90% of amplitude. Can be entered as leading/ trailing edge or % of width.

Transition Times	Agilent 81101A
Range:	5.00 ns to 200 ms
Min. transition:	5.0 ns
	7.5 ns typical for 1 kΩ source impedance
Accuracy:	±10% ±200 ps
Linearity:	3% typical for transitions >100 ns

Leading and trailing edges can be programmed independently within the following ranges (Maximum ratio 1:20):



Level Specifications

Level Parameters	Agilent 81101A
Source impedance:	selectable 50 Ω ± 1% typical or 1 kΩ
Maximum external voltage:	±24 V
Short circuit current:	±400 mA
Normal/complement:	selectable
ON/OFF:	relay connect/disconnect output (HiZ).
Limits:	high and low levels can be limited to protect the DUT

External Load compensation

For loads ≠ 50Ω, the actual load impedance can be entered to correct the output values.

Level Parameters

Level parameters can be entered as high/low level in terms of voltage or current or offset/amplitude.

Level Specifications	(50Ω into 50Ω)	(1kΩ into 50Ω)
Amplitude:	100 mVpp to 10.0 Vpp	200 mVpp to 20.0 Vpp
Level Window	–10.0 V to +10.0 V	–20.0 V to + 20.0 V
Level Accuracy (in ± 19 V level window):	±(3% Amplitude + 75 mV)	±(3% Amplitude + 150 mV)
Resolution:	10 mV	20 mV

Pulse Performance

Pulse Performance	Agilent 81101A
Overshoot, Preshoot, Ringing:	±5% of amplitude ±20 mV
Settling time:	30 ns typical
Baseline noise:	8 mV RMS typical
Dynamic Crosstalk	< 0.1% typical

Clock Sources

It is possible to select between three clock sources, the startable oscillator (VFO), the internal PLL, or the External Clock. In Triggered Mode the PLL can be used as the trigger source for the VFO, without the need of an additional source.

Clock / PLL Reference Input

Input Specifications	Agilent 81101A
Input impedance:	50Ω or 10kΩ selectable
Threshold:	–10 V to +10 V
Maximum input voltage:	±15 V
Input transitions:	<100 ns
Input Frequency:	dc to max 50 MHz
Minimum pulse width:	10 ns
Input sensitivity:	≤ 300 mVpp typical
Delay from Clock Input to TRIGGER OUT/ STROBE OUT:	12 ns typical

Rear panel BNC connector used as:

- External system clock input: pulse frequency = input frequency. The input frequency can be measured.
- 5 MHz or 10 MHz frequency reference input for internal PLL.

Phase Locked Loop (PLL)

- Locks either to an external frequency reference at the PLL Ref Input Clk In (5 MHz or 10 MHz selectable) or to its internal reference.
- High accuracy period (frequency) source.
  When locked to the internal reference, period accuracy, resolution, and jitter are improved.
  When locked to an external frequency reference, the external frequency affects these accuracies.
- Internal triggering of bursts: the internal PLL can replace an external trigger source, while the output period is determined by the startable oscillator.

External Clock

- The output period is determined by the signal at clock input. Frequency accuracy can be increased by using a precise external clock.
- Trigger synchronously to external clock: the output period is synchronous to the signal at clock input. The signal at the External Input is used for arming.

Output Modes

Pulses Mode

The output signal consists of single or double pulses, controlled by the Trigger mode.

Burst Mode

The output signal consists of bursts of single or double pulses, controlled by the Trigger mode.

Burst Parameters	**Agilent 81101A**
Burst count:	2 to 65536
Format:	single or double pulses

Trigger Modes

Continuous

Generate continuous pulses, double pulses, or bursts.

Externally Triggered

Each active input transition (rising, falling or both) triggers a single pulse, a double pulse, or a burst.

The trigger source can be selected from:

- External Input
- MAN Trigger key
- internal PLL.

Externally Gated

The active input level (high or low) enables pulses, double pulses, or bursts. The last pulse, double pulse, or burst is always completed. The gate source can be selected from:

- External Input
- MAN Trigger key

External Width

To recover a pulse shape of an external signal, applied to the External Input, the period and width are maintained, levels and transitions can be set.

Trigger and Strobe Specifications

Trigger Output

Trigger Output Specifications	Agilent 81101A
Level:	TTL or ECL selectable
Output impedance:	50 Ω typical
Trigger pulse width:	typically 50% of period Triggered mode: 9 ns typically External Width mode: recovered pulse shape of external signal
Maximum external voltage:	–2 V ... +7 V
Output Voltage	TTL or ECL into GND selectable

Strobe Output

Strobe Output Specifications	Agilent 81101A
Level:	TTL or ECL selectable
Output impedance:	50 Ω typical
Maximum external voltage:	–2 V/+7 V
Transition times:	1 ns typical for TTL, 600 ps typical for ECL
Output Voltage	TTL or ECL into GND selectable

Typical Delays

Mode	from	to	typ. value
External Width	Ext Input	Strobe/Trigger Out OUTPUT	8.5 ns 22.5 ns
Trigger Gated	Ext Input	Strobe/Trigger Out OUTPUT	12.0 ns 29.0 ns
Continuous	Strobe/ Trigger Out	OUTPUT	17.0 ns
Ext. clock signal as pulse period	CLK-IN	Strobe/Trigger Out OUTPUT	12.0 ns 29.0 ns

Human Interface

Overprogramming

Parameter values can be entered exceeding the specified range.

Warnings and Errors

Warning messages indicate potentially conflicting parameters due to accuracy tolerances.

Error messages indicate conflicting parameters.

Help Key

Displays a context-sensitive message about the selected parameter. Concept help for getting started is also available. If warnings or errors occur, the HELP key displays the warning/error list accordingly.

Memory

Non-Volatile Memory

Actual setting is saved on power down. 9 user and 1 default setting are also stored in instrument.

Memory Card

99 settings can be stored per 1 MB (MS-DOS, PCMCIA) memory card. Also used for convenient firmware updates.

Remote Control

Operates according to IEEE standard 488.2, 1987 and SCPI 1992.0.

Function Code

SH1, AH1, T6, L4, SR1, RL1, PP0, DC1, DT1,C0.

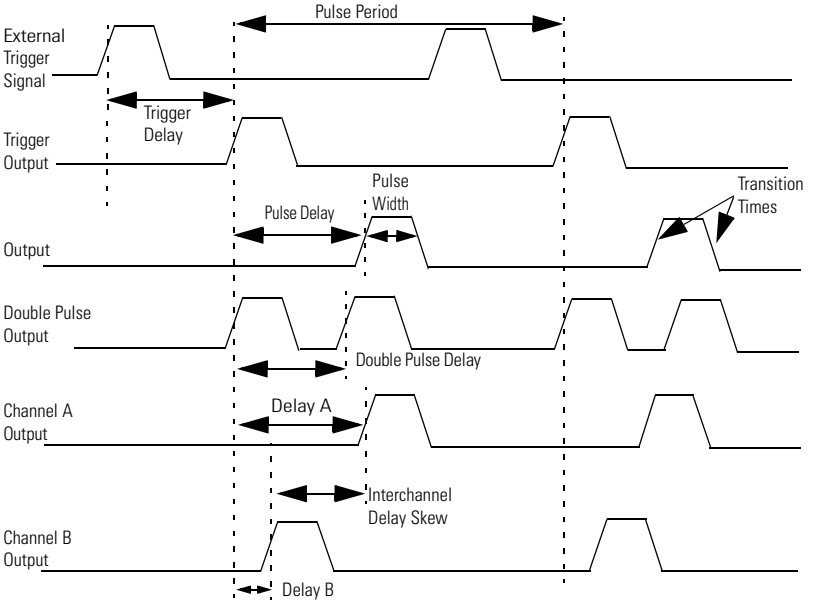
Programming Times

(all checks and display off).

Command	Typical execution time
One parameter or mode	30 ms typ.
Recall Setting	250 ms typ

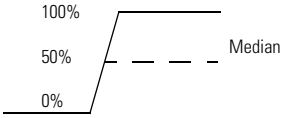
Pulse Parameter Definitions

Here you find the pulse parameter definitions of terms used in the instrument specifications. In the following figure a graphical overview of the pulse parameters is provided:



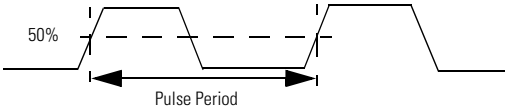
Time Reference Point

The time reference point is at the median of the amplitude (50% amplitude point on pulse edge):



Pulse Period

The time interval between the leading edge medians of consecutive output pulses:

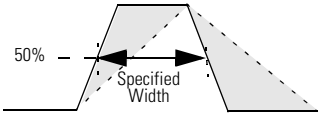


Trigger Delay

Interval between trigger point of the external trigger input signal and the trigger output pulse's leading edge median.

Pulse Width

Interval between leading and trailing edge medians:

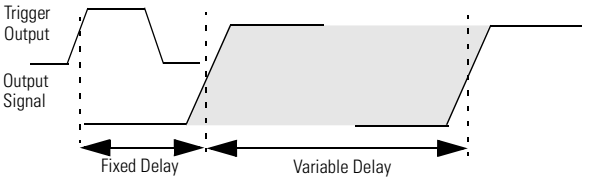


The specified and displayed value is that obtained with fastest edges, essentially equal to the interval from the start of the leading edge to the start of the trailing edge. By designing so that the pulse edges turn about their start points, the interval from leading edge start stays unchanged (in

practice, start points may shift with changes in transition time) when transition times are varied. This is more convenient for programming and the width display is easy to interpret.

Pulse Delay

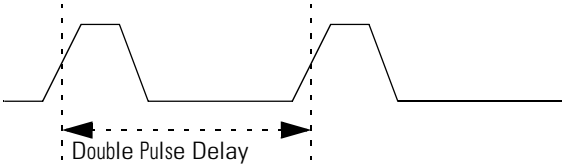
Interval between leading edge medians of trigger output pulse and output pulse:



The specified and displayed value is that obtained with the fastest leading edge. Pulse delay has two components, a fixed delay from trigger output to output signal and a variable delay with respect to the trigger output.

Double Pulse Delay

Interval between leading edge medians of the double pulses.

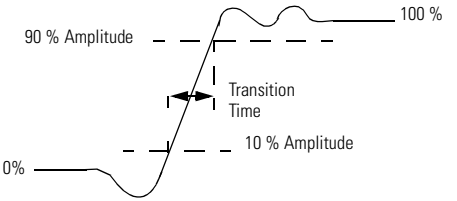


Interchannel Delay (Skew)

Interval between corresponding leading edge medians of the output signals.

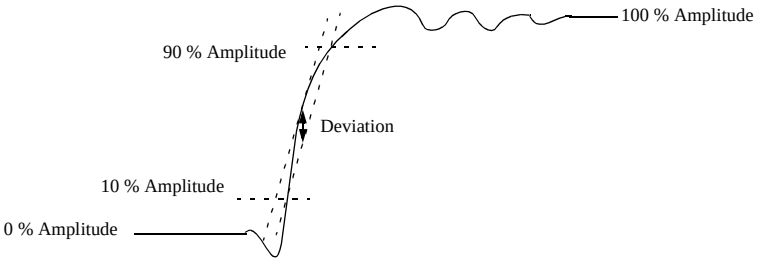
Transition Time

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 edge relative to a reference edge. Usually specified as rms value, which is one standard deviation or “sigma”. If distribution is assumed Gaussian, six sigma represents 99.74% of the peak-peak jitter.

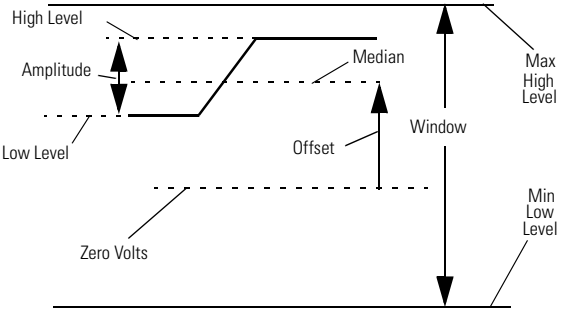
The reference edge for period jitter is the previous leading edge. That for delay jitter is the leading edge of the trigger output. Width jitter is the stability of the trailing edge with regard to the leading edge.

Stability

Long-term average instability over a specific time, for example, hour, year. Jitter is excluded.

Pulse Levels

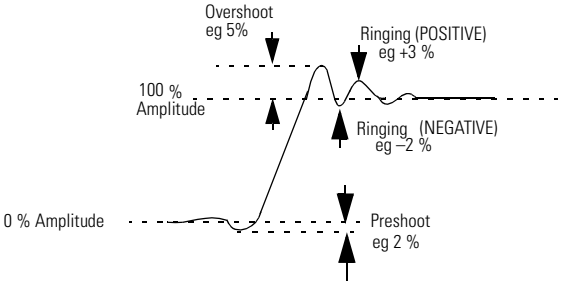
Pulse output is specified as pulse top and pulse base (usually referred to as high level and low level), or as peak to peak amplitude and median offset. A “window” specification shows the limits within which the pulse can be positioned.



Preshoot, Overshoot, Ringing

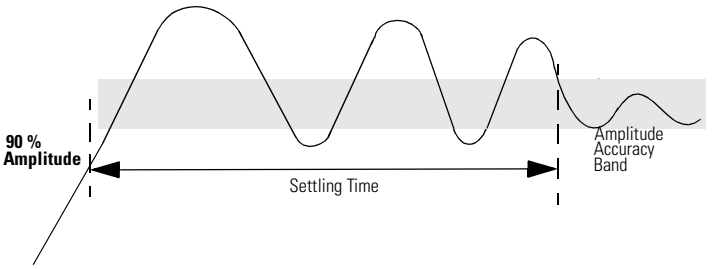
Preshoot and overshoot are peak distortions preceding/following an edge. Ringing is the positive-peak and negative-peak distortion, excluding overshoot, on pulse top or base. For example, a combined preshoot, overshoot, and ringing specification of 5% implies:

- Overshoot/undershoot < 5%
- Largest pulse-top oscillation <± 5%, of pulse amplitude.



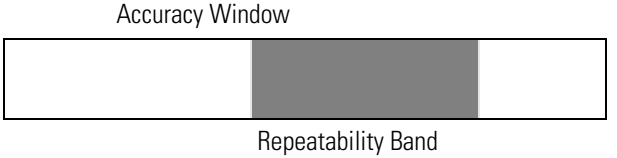
Settling Time

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



Repeatability

When an instrument operates under the same environmental conditions 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.



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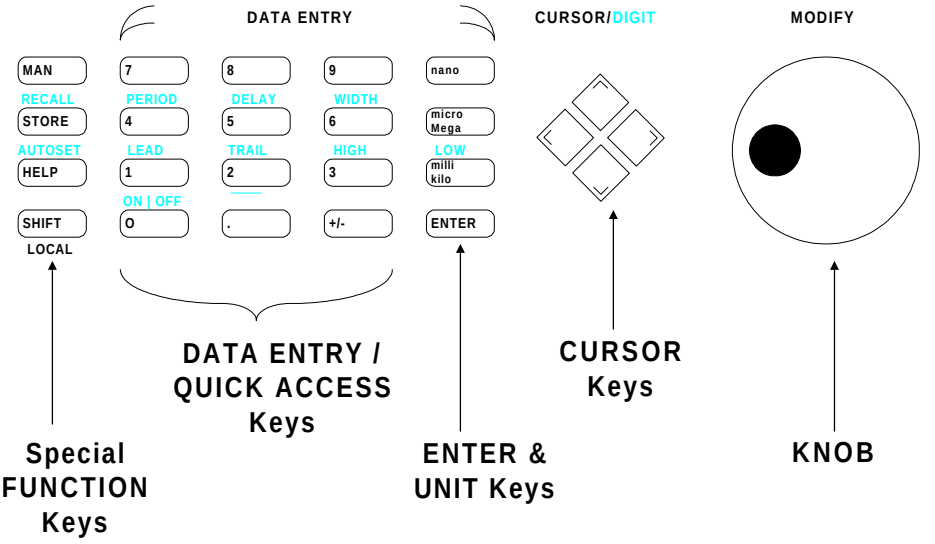
Front Panel Controls



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