Test Bench Automation

WiFi Programmable Low Distortion Function Generator

V1.0 February 2024

Key Features

- Seven flexible waveforms
- Two independent or linked channels, with adjustable phase
- 11.5V p-p maximum output level
- Sine frequency range: 0.01Hz to 70kHz.
- Response: +/- 0.1dB 1Hz – 50kHz
- Distortion: < 0.003% up to 5kHz and < 0.007% to 20kHz
- Signal to noise ratio > 80dB
- Square, triangle and pulse: 0.01 Hz to 20kHz
- Intermodulation (IMD) , white noise and step functions
- Comprehensive sweeps and tone bursts
- 3.5” LCD touch screen, web browser or WiFI SCPI control
- TouchController definitions for test automation
- Optional stand

Repository: https://github.com/palmerr23/DDS_FuncGen

Contents

Safety

Once commissioned, always use an isolated USB connection to the instrument.

When the USB interface is connected, differing ground potentials may cause damage unless a USB isolator is employed where an earth differential is present between the computer, this device and any equipment being tested.

The computer, function generator and/or device under test may be damaged.

Input Protection

The device is optimised for use in controlling and testing equipment that has an analogue signal input voltage range of +/- 5.5V, and 3.3V or 5V logic.

Moderate protection is provided against voltages outside these ranges.

The device is isolated when run from a plug-pack and takes its ground potential from the device under test (DUT).

Overview

This function generator offers seven waveforms, with burst and sweep modes available for the regular waveforms (sine, square, triangle and pulse).

External trigger pulses are output for most waveforms and operating modes (table x). Most modes can also be externally triggered (table X).

For most functions Channel B can be configured independently; as a mirror of Channel A; or with a phase-delayed / inverted Channel A waveform.

The IMD and white noise waveforms, as well as the sweep and burst functions are only available on Channel A.

The unit may be operated via its touch screen, a web interface or in command-line mode on port 5023, or using a SCPI-based test bench automation program such as TestController. If the USB serial control interface is used, it is strongly recommended that a USB isolator be employed to avoid ground loops.

There are a broad range of settings, some of which may not be set simultaneously. Specifically, some A-B channel coupling modes are not implemented across all waveforms. Likewise, with the B-alt-A burst mode.

There are no parameter combinations that will damage the unit, however some combinations, such as the one above, will cause the unit to clip or otherwise distort waveforms. For sine and IMD waveforms, settings that will cause clipping are identified and the sine Amplitude or IMD Amp-2 value is automatically reduced to prevent clipping. Similarly, if V Low > V High for square waves, overshoot correction works in reverse, procuring a significantly.

While extensive testing has been undertaken there may be some incompatible settings that cause the unit to output a distorted or clipped signal. Validating any unusual combinations before connecting to the DUT is highly recommended.

Features and Functions

Parameter	Range and Limits	Features
Waveforms		
Sine	0.01 – 70,000 Hz 11.5V p-p +/- 5.75V	Variable amplitude and DC offset Channel B = A coupling with variable phase. Tone burst (B channel alternating option). Frequency or amplitude (voltage) sweep.
Square and Triangle	0.01 Hz – 20 kHz 0 – 100% duty cycle +/- 5.75V	Variable high and low voltages Variable duty cycle Channel B = A coupling with variable phase (0 .. 359.99 deg). Tone burst (B channel alternating option). Frequency, voltage or duty cycle sweep
Pulse	0.01 – 99,999 mS low/rise/high/fall +/- 5.75V 40uS min cycle time	Variable high, low, rise and fall times Variable high and low voltage B=A coupling (in-phase and inverted only)
Step	0.1 – 99,999 mS / cycle 1 – 10,000 steps +/- 5.75V	Variable times for up and down slopes Variable steps up and down (0 .. 10,000) Variable high and low voltage B=A coupling (in-phase and inverted only)
IMD	Same as sine waveform frequency and amplitude ranges	Two frequencies and amplitudes (0 .. 11.5V p-p) independently set. Disables Channel B sine wave generation.
White noise	Sine amplitude and DC offset ranges	Setting is VRMS.
Output Coupling		
Type	DC	All functions are DC coupled.
B=A	T/F	All waveforms. T: B signal takes its mode and values from Channel A. (White noise is independently generated for Channel B) F: B signal has independent parameters. Burst mode: B=A is ignored when BaltA is set.
Control Menu: B Phase	B=A and B Phase (0-355.99 degrees)	Sine, Square and Triangle for Normal and Sweep Modes: B signal lags A by set number of degrees. Pulse and Step waveforms. Synchronised (phase < 0.01), Inverted (phase >= 0.01) B Phase is ignored for IMD and White noise waveforms.
Burst Menu: B alt A	T/F	B signal is active when A signal is idle. Ignores B=A setting.
External Triggers (Control Menu)		

Trigger Out	Always enabled	**Sine, Square, Triangle** Trigger output alternates, in phase, at the crossover point of the signal. (DC offset for Sine, (A1+A2)/2 for Triangle. The signal is active at the start of the waveform. **Sweep** A short active pulse is output at the beginning of the sweep, equal to the duration of the first step. **Burst** The trigger pulse follows the burst pattern – active when the burst is active, idle when it is idle. *Note that there is a variable delay of between three and five buffer times (8-13mS) between the pulse and the start of the waveform or sequence.*
Trigger output polarity: (T Out Pol)	+/-	Polarity of the Trigger output +: High level at the start of the waveform or sequence. -: Low level at the start of the waveform or sequence.
Trigger input enable: (Ext Trig)	T/F	Enable external triggering for Burst Sweep
Trigger input polarity: (T In Pol)	+/-	+: Initiate function on rising edge -: Initiate function on falling edge Re-triggering is disabled until the trigger output resets.
Sweep Mode		
Sweep	0 – 99,999 mS duration 1 – 10,000 steps Waveform limits as for underlying waveform.	Single or repeated sweeps. Logarithmic or linear variable increments. Externally triggerable. Non-swept parameters taken from base mode. Sine: Amplitude (voltage) and frequency Square, Triangle: Amplitude, frequency and duty cycle Pulse: Amplitude Step, IMD, White Noise: Sweep not available.
Burst Mode		
Burst	0 – 10,000 cycles on/off	All waveforms. Single or repeated bursts. Externally triggerable. Sine, Square, Triangle and Pulse: On/off duration in cycles. IMD and White Noise: On/off duration in mS

Table 1: Features and functions

Waveforms

The unit supports seven different *waveforms* with a voltage range of +-/5.75V (11.5V p-p). All waveforms are DC coupled.

While it is possible to set some parameter combinations that will produce signals outside this range, erroneous parameter combinations are generally flagged on-screen and blocked.

While care has been taken to ensure settings do not produce unexpected waveforms, unusual combinations of parameters should be checked before being applied to the device under test.

Sine

The sine output has a wide frequency range at low distortion, making it suitable for testing most audio equipment including subwoofers.

When the sum of the Amplitude and DC Offset exceeds the allowable values, the Amplitude is automatically reduced to stay within range.

Intermodulation (IMD)

The intermodulation waveform is made up of two separate frequencies with different amplitudes. The default values are the SMPTE standard 60 Hz and 7KHz at a 4:1 ratio.

IMD is available on Channel A only, as it employs the sine generators of both channels.

When the sum of Amp1 and Amp 2 is outside the allowable range, Amp2 is automatically reduced to compensate.

White Noise

The white noise generator provides a random signal with equal intensity at all frequencies across its bandwidth. White noise generation is CPU intensive and only offered on channel A.

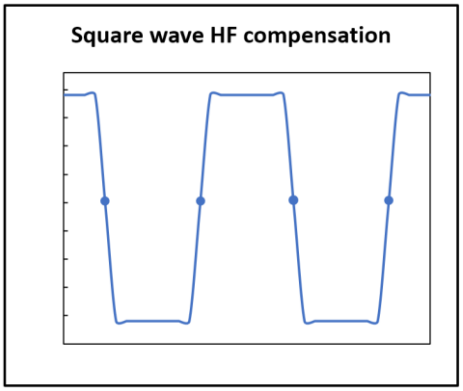
When the sum of the Amplitude and DC Offset exceeds the allowable values, the Amplitude is automatically reduced to stay within range.

Square

The square waveform is a special case of Pulse, with rise and fall times set to ‘zero,’ and frequency and duty cycle parameters instead of high- and low-level dwell times.

To reduce overshoots and ringing, the last sample in the high or low state is set to half way to the alternate state.

The minimum rise or fall time for square waves is 10uS, regardless of frequency or amplitude.



Triangle

The triangle waveform is another special case of Pulse, with high and low dwell times set to zero, and frequency and it has duty cycle parameters instead of rise and fall times.

The slight rounding visible at higher frequencies is due to the DAC’s internal filtering and interpolation.

Pulse

The pulse waveform varies between two voltage levels, with variable high, low, rise and fall times.

The audio DAC has a (Nyquist) frequency limit at half the sampling rate, and also interpolates several values between samples. A digital filter also modifies the waveform in an attempt to minimise in-band noise. As the frequency

increases the impact of the interpolation and digital filter becomes more apparent, with visible overshoot and pre-shoot occurring.

The minimum individual rise/high/fall/low periods are 0.00 mS, however it is recommended that the total (high + fall + low + rise) pulse time is greater than 0.02 mS.

The minimum rise or fall time for square waves is 10uS, regardless of frequency or amplitude.

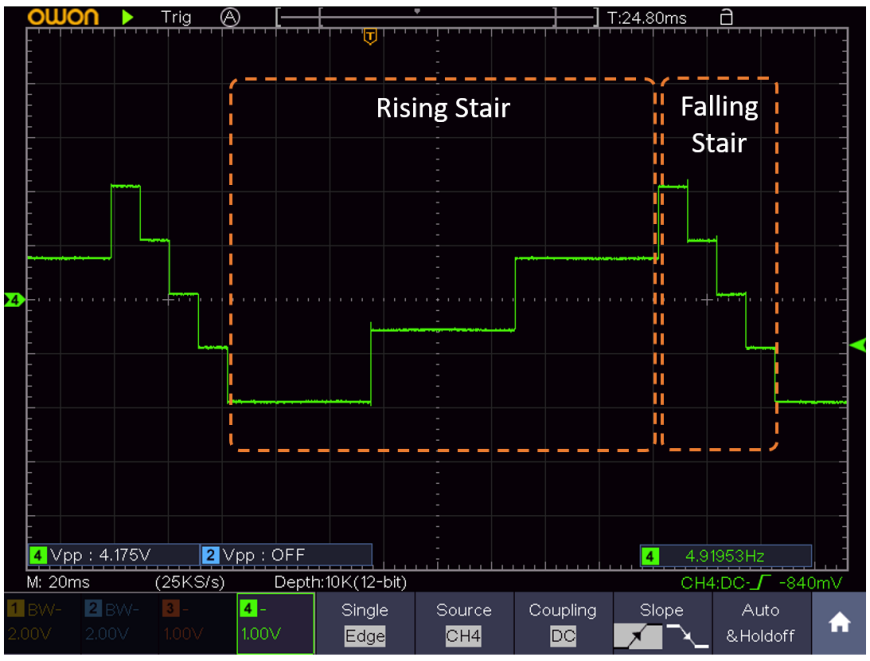
Where both the rise and fall times are zero, the square waveform has better high frequency compensation.

A 10kHz square wave as output by the DAC (green) and after filtering (orange). The (stepped) rise time at 4V p-p is close to 10uS.

Step

The step waveform is a special case of Pulse, generating staircase waveforms with a variable number of rising and falling steps, as well as independent durations for the overall rising and falling periods.

The dwell time on the top rising step is dependent on the ‘Down’ parameters, and similarly, the dwell time on the bottom falling step is dependent on the ‘Up’ parameters.



A 3-step up, 4- step down waveform.

Sweep and Burst Modes

- Sweep and burst *modes* are available on channel A.
- Channel B can generate an independent signal, or be coupled to channel A (see below).

Normal (not Sweep or Burst)

Channels A and B operate independently unless explicitly coupled in the Control menu.

The phase of channel B relative to channel A, can be set for sine, square and triangle waveforms (see table above).

For pulse and step waveforms, channel B can mirror channel A or output an inverted waveform.

Sweep

Three sweep *types* are provided: frequency, voltage and duty cycle. See Table 1 for the applicable types for each waveform.

Each combination of waveform and sweep type has independent settings, which are saved between sessions.

For sine, the voltage type alters the amplitude, with the DC offset remaining fixed. For square and triangle waveforms, the V Low voltage remains stable, with V High varying.

Reverse log and linear sweeps can be generated by setting the start value lower than the end value.

Logarithmic sweeps are available for frequency and duty cycle sweeps only, due to undefined values for logarithm calculations for zero or negative voltage values. For duty cycle sweeps, if the start or end value is not greater than zero, 0.01 is used to avoid divide by zero errors in calculation.

When coupled, channel B takes its parameters from Channel A. When the channels are coupled for frequency sweeps, both channels restart at each step to retain the correct phase relationship.

If the mode is changed from coupled to un-coupled (B=A : T → F), channel B's output is automatically stopped.

Table 2: Sweep types

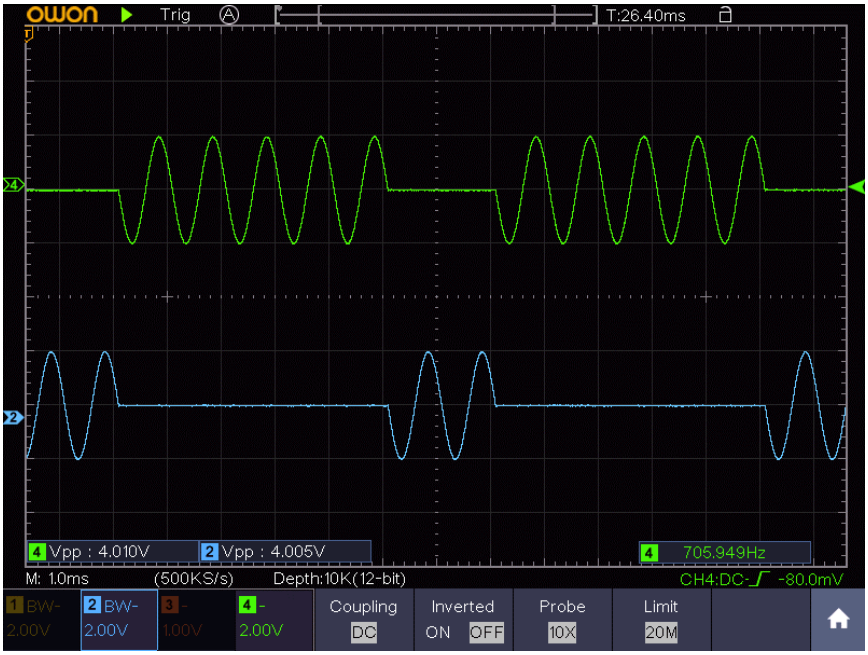
Function	**Sweep types**
Sine	Amplitude (V), Frequency (F)
Square	Amplitude (V), Frequency (F), Duty Cycle (D)
Triangle	Amplitude (V), Frequency (F), Duty Cycle (D)
Pulse	Amplitude
IMD, White Noise, Step	None

Burst

Tone bursts are supported for all waveforms. The burst on and off values are complete waveform (step sequence) cycles for all waveforms except IMD and White Noise, where the on and off values are in mS.

The B channel may be set to alternate bursts with the A channel, using the *B alt A* setting. All settings on the B channel are mirrored from the A channel when *B alt A* is enabled. Any Coupling menu settings are ignored if *B alt A* is enabled.

Single or continuous burst cycles can be generated.



A 1kHz sine wave with a 5-on, 2-off burst signal and B alt A enabled.

A 150/1500 Hz IMD signal with a 15mS on / 5mS off burst.

Table 3: Burst parameters

Function	Burst units	Idle value
Sine	Cycles	DC offset
IMD	milliSeconds	0V
White Noise	milliSeconds	DC offset
Square, Triangle, Pulse, Step	Cycles	V Low

Control Menu

Coupling

The A and B channel signals may be independent, or B can follow A, for some waveforms.

When coupled, channel B settings are ignored.

- For sine, square and triangle waveforms, B channel can be set to lag by 0-359.99 degrees.
- For step and pulse waveforms, when the phase setting is greater or equal to 0.01, channel B inverts.
- For White noise, channel B mirrors channel A.
- Coupling is ignored for IMD.

If in *Burst* mode and *B alt A* is set, the coupling settings are ignored.

Table 4: Channel B coupling

Waveform	**B Channel (when B=A)**
Sine, Square and Triangle	B delayed by phase setting value.
Step and Pulse	Phase = 0: in phase Phase >= 0.01 (settings > 0 are ignored)
Other waveforms	Coupling setting is ignored.

External Triggering

The unit may be externally triggered, by a positive or negative rising edge. Retriggering is disabled until the trigger output is cleared (see below).

Triggering may be initiated on a high or low signal, depending on the Ext Trig Polarity setting.

As the waveform outputs are buffered, the effect of trigger input will be delayed by up to the buffer delay (see Specifications table). The resulting delay and jitter are negligible for low frequency signals. It is recommended that externally triggered waveforms are viewed on oscilloscopes in single shot mode.

Triggering activity is dependent on both *function* and *mode*, according to the following table.

Table 5: External triggering actions

Mode	**Function**	**Triggering action**
Normal	Step only	Step sequence begins
Sweep	Sine, Square, Triangle, Pulse, Step	Sweep begins
Burst	Any	A burst is triggered

Trigger Output

As for trigger inputs, the trigger output signal leads the resulting signal change by up to the buffer delay.

The trigger output function is most useful for waveforms with a repetition rate of < 10Hz. To minimise visible signal jitter, it is recommended that, when the trigger out pulse is used as a trigger input to an oscilloscope, waveforms are triggered in single shot mode.

The unit outputs a trigger pulse or level under the conditions noted in the following table.

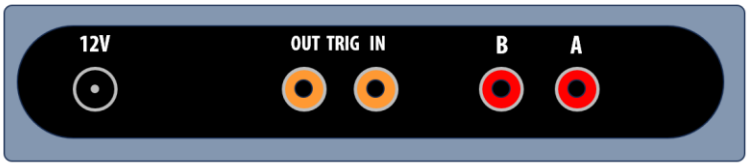
The (0 to 3.3V) pulse polarity may be set to positive or negative in the *Control* menu. Negative (–) polarity will result in a Low voltage level when the trigger output is *Set*.

The trigger LED is lit while the trigger output is in the *Set* condition.

Table 6: Trigger outputs

Mode	Function	Trigger output
Normal	Sine, Square, Triangle	Set: rising edge, Clear: Falling edge
	Step	Set: Rising sequence begins, Clear: Falling sequence begins
Sweep	Any	Set: Sweep begins, Clear: Second step
Burst	Any	Set: Burst begins, Clear: Burst ends

Inputs and Outputs



Waveform Outputs

The sine output has a wide frequency range at very low distortion, making it suitable for testing audio equipment including subwoofers.

The outputs are DC coupled. The output op-amps are specified to drive 600 ohm loads to the maximum amplitude. Driving lower impedances should be at a lower amplitude so that the maximum current of 30mA is not exceeded.

Trigger Output

Logic transition points are < 0.33V and > 2.6V, and should correctly drive most types of 5V logic.

The output impedance is 1k Ohm.

The output has a LED indicator.

The inputs and outputs use 3.3V GPIO pins with series resistances to limit current if they are misconnected.

Trigger Input

For positive trigger polarity the trigger input is weakly pulled down (approximately 80k) within the Pico. For negative trigger polarity the input is pulled up.

Logic transition points are 0.8V and 2.0V and should correctly trigger with most types of 3.3V and 5V logic.

The inputs have diode protection, which also provides 5V logic level tolerance.

The current draw is 0.3mA maximum for 3.3V and 5V logic. A 4.7K / 100pF input filter and capacitor, along with Schmitt trigger GPIO inputs provide some protection against mis-triggering.

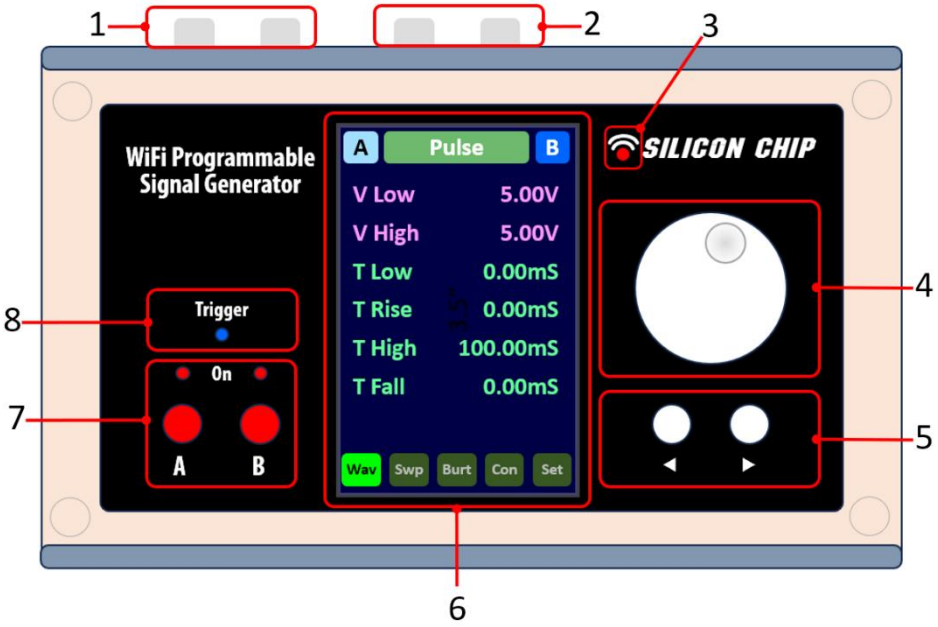
The input has a LED indicator driven by a separate GPIO pin to avoid loading the input.

Power Supply

The unit requires 250mA at 12V when driving both channels at full voltage into 600 Ohms, and 200mA at idle.

There is no reverse voltage or other protection on the power supply input.

Console Operation



1. Channel A & B RCA output sockets
2. Trigger In and Out RCA sockets
3. WiFi and EEPROM save indicator LED.
4. Scrubber knob (rotary encoder) and push-button.
5. Digit buttons
6. LCD Touch Screen
7. Channel A & B control buttons and LEDs
8. Trigger output LED.

Buttons and Indicators

The buttons to the left of the LCD screen [7] turn the Channel A & B outputs On and Off. The associated red LEDs indicate the current state of the outputs, which may also be controlled remotely.

The Scrubber knob [5] and the associated ‘digit buttons’ [5] change numeric settings on the screen after the setting has been selected by touching it.

The red LED [3] blinks when WiFi is active and trying to connect. It on once WiFi has connected. The LED changes state for 2 seconds every time settings are saved to EEPROM.

Changing Values

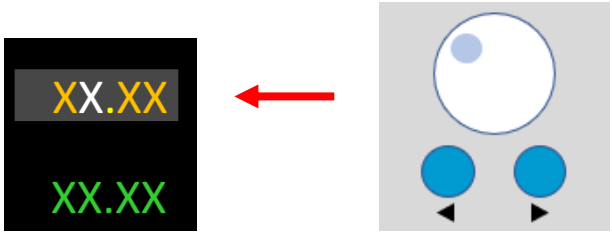
Menu items are selected by touching the value or an associated button on the touch screen [6]. When a setting or button is selected, the item or its background changes to a brighter colour. The value may then be changed using the scrubber knob [4] and digit buttons [5].

The channel settings selection buttons are across the top of the main screen. Touching A or B will display the current waveform and settings. Touching the waveform button allows a different waveform to be chosen.

Sub-menu buttons Swp (Sweep), Bur (Burst), Con (Control) and Set (Settings) are arranged across the bottom of the screen.

Numeric values

Select the item with its associated on-screen button, and use the numeric setting controls (rotary encoder and buttons) to alter settings. When a setting is selected its background is highlighted as is one of the digits. The rotary encoder will change the value by 1 unit of the highlighted digit per click. Clockwise rotation increases the value, anti-clockwise decreases it.



The selected setting is highlighted and the 'tens' digit is being edited.

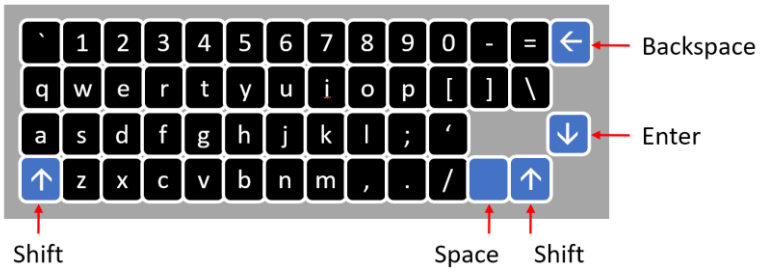
The highlighted digit is changed with the buttons under the encoder (*digit buttons*). The left button will move the highlight to a more significant digit, and the right button to a less significant digit.

On/off settings

Touching a selection button for on/off controls will change the value, as will rotating the encoder knob or pressing the numeric setting buttons (right button or clockwise rotation = On, left button or anti-clockwise rotation = Off).

Changing text values

An on-screen keyboard is displayed when alphanumeric settings are changed. As the individual characters are small, a stylus is recommended.



To provide the largest possible character buttons, the keyboard is rotated on the LCD screen.

The cursor is always at the end of the string.

When a character is touched, it is appended to the end of the string. Backspace deletes the last character typed.

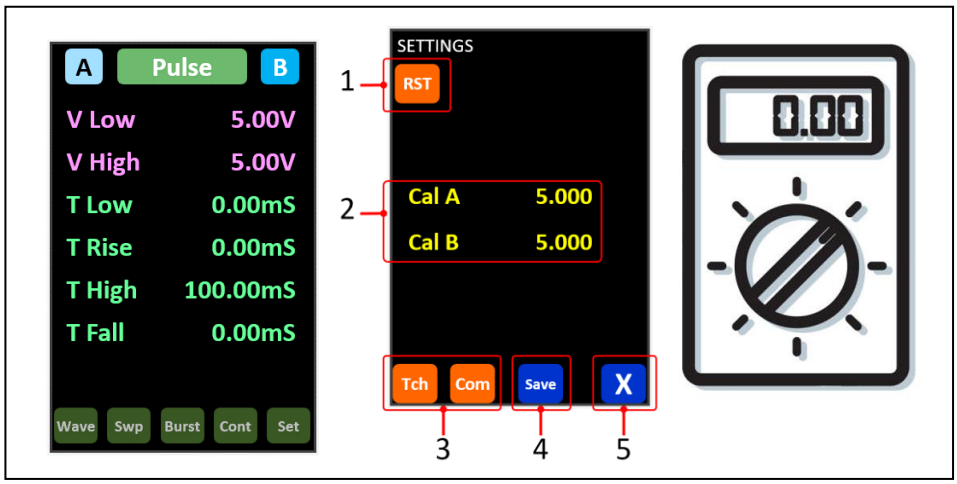
Shift buttons at the lower right and left change the case off alphabetic characters and which symbols or numbers are displayed.

The *Enter* button saves the value and returns to the menu screen.

Processing of the underpinning menu screen is suspended while the on-screen keyboard is active.

Settings Menu

Voltage Calibration

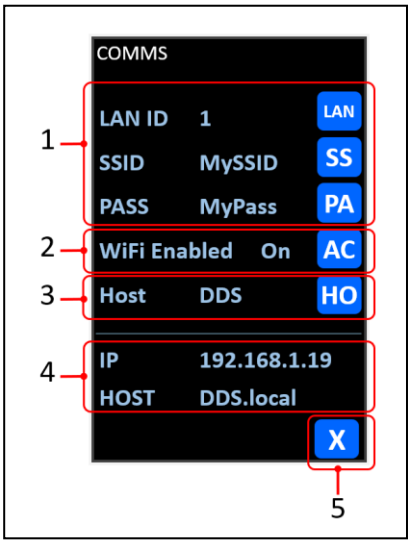


1. Set both channels to the Pulse function.
2. Adjust the settings as shown in the diagram:
   - V Low = 5.00V
   - V High = 5.00V
   - T High = 100mS or greater
   - T Low, T Rise and T Fall= 0.00mS (minimum value)
3. Connect a DC voltmeter to the A output.
4. Start both channels.
5. Go to the Set menu on the touch screen.
6. Enter the voltmeter reading in the Cal A entry [2].
7. Repeat for the B channel and Cal B
8. Click Save. (Clicking X will exit without saving any changes.)
9. The voltmeter reading should now be 5.00V on both channels
10. Rinse and repeat if required.

It is not possible to set the Cal A or Cal B settings outside the range 4.5V to 5.5V.

The new calibration values are saved permanently 30 seconds after Save is clicked.

Communications Menu



The unit can store credentials for up to five WiFi networks, which can be entered on the Settings > Comms menu. When WiFi is enabled, the unit will connect to the strongest signal from the stored networks.

If none of the stored local networks are found, the unit will enter Access Point (AP) mode with the credentials listed in the Specifications table, allowing other devices to connect to it.

The unit can store up to five separate WiFi LAN configurations. WiFi credentials may be changed by:

- Entering the LCD Set>Com menu
  - Selecting the desired LAN ID to change.
  - Editing the SSID and password parameters.
- Using the SCPI :SYSTEM:SSID, :SYSTEM:PASS commands from either a serial terminal or via the UDP port.
  - The SSID command should be sent before the PASS command.
    When an SSID is received, the LAN ID list is searched.
    If the SSID is not already stored, then a vacant LAN ID slot will be sought. If one isn't available, the first slot will be changed.
  - If an existing SSID was the last received, then its PASSphrase will be changed.
    If not the SSID for the first LAN ID will be changed.

- LAN ID slots can be cleared by entering an empty SSID in the LCD menu.
- The hostname may be changed in the LCD Set > Com menu.

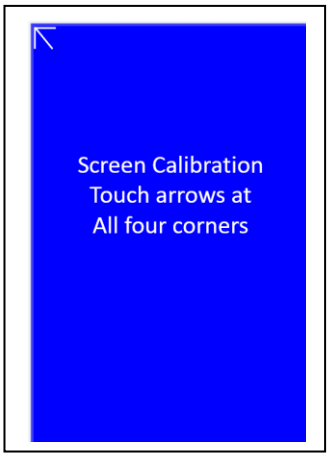
New or changed parameters will not be enabled until the AC button in the Com menu or the power is cycled.

It is not possible to change WiFi parameters from the browser interface.

To satisfy the requirements of IEEE 802.11, the SSID and PASSphrase values are case-sensitive.

- SSIDs may be up to 32 characters in length. While any valid 8-bit value (e.g. special characters) is permitted, non-alphabetic and non-numeric values should be used with care.
- Passphrases must be between 8 and 32 characters long. All 8-bit values are acceptable.

Touch Screen Calibration



For most purposes the default touchscreen calibration should be adequate. However, the on-screen keyboard may benefit from more accurate calibration of touch to position.

1. Enter the Set>Tch item [3] on the LCD screen.
2. Touch on the four arrows in sequence. A stylus is preferred to using a finger, for the obvious reason.
3. Click Save to retain the settings.
4. Wait for the next EEPROM save cycle for the new settings to become permanent.

Factory Reset

Clicking the RST button [1] on the Settings menu will reset all settings to their factory defaults:

- Voltage and touchscreen calibrations
- Waveform, sweep, burst and control settings.
- WiFi parameters are cleared, and WiFi (Set>Com AC) turned off.

The unit will reset to complete the process.

Web Interface

A comprehensive web interface is provided for the device, however communications and calibration functions are only available on the touch screen.

It is accessible from the web address indicated on the serial monitor after start-up, (on the standard Port 80) or via the hostname http://DDS.local. Communication is not encrypted.

It is recommended that the hostname address format is used, as DHCP sourced IP addresses may change from time to time. On some WiFi LANs connecting using the hostname may not work due to router or operating system configurations. In this case use the IP address shown on the Set > Com menu

Notes:

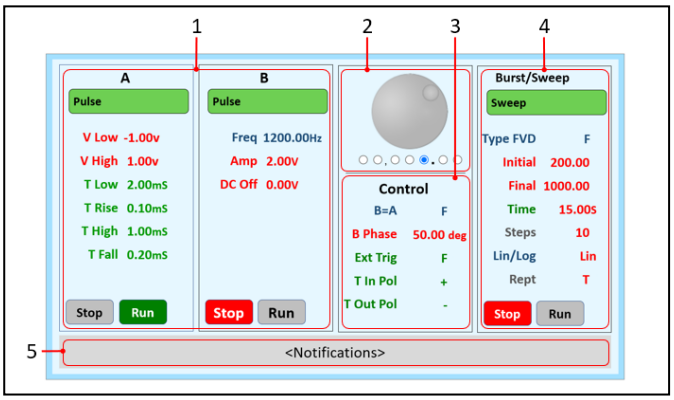
> Some devices (particularly Android) do not resolve http://xxx.local DNS addresses correctly. For these devices the IP address must be used.
>
> Firefox appears to resolve webpages and run JavaScript better than Chrome or the embedded browser on mobile devices and tablets.

It is recommended that only one web interface is used at a time, as any changed values will only update to the first web screen that requests them.

Layout

The browser screen layout has the

1. Input settings for both channels in the left two panels
2. A ‘scrubber’ knob and range radio buttons
3. Control settings
4. Settings for Burst and Sweep modes
5. Below the settings area is a bar for information and error messages.



To set a numeric value, click on the setting to be changed (e.g. -1.00V) and wind the knob.

The radio buttons under the knob determine the size of the increment, from 0.01 to 10,000 units per click.

A message window (5) indicates when the web interface is disconnected from the unit, and warnings about incorrect settings and setting combinations.

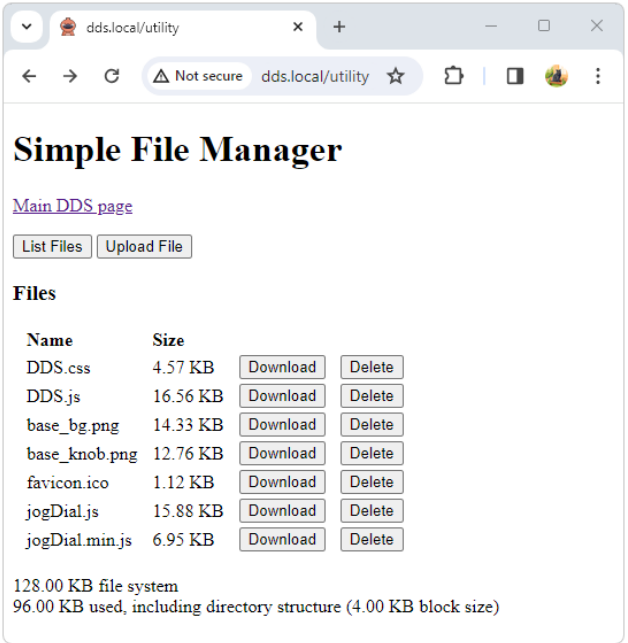
Web Utilities

A simple file manager utility is provided and can be accessed at http://DDS.local/utility.

It provides for uploading, downloading and deleting files from the Pico’s LittleFS file system.

The file system contains files required for the Web interface to function properly.

Some files on your unit may have ‘.gz’ suffixes, denoting compressed files, which are smaller and faster to transfer.



TestController

There is no TestController device pop-up control screen for this unit, as a full control interface is provided on the web interface.

All SCPI commands are available for direct entry, or as scripting functions.

Calibration and communications settings are not supported on the TestController interface.

It is best to avoid changing settings on the web interface while using TestController, as settings are not always updated in TestController if they are changed elsewhere.

Extensive TestController documentation is available at
https://lygte-info.dk/project/TestControllerIntro%20UK.html

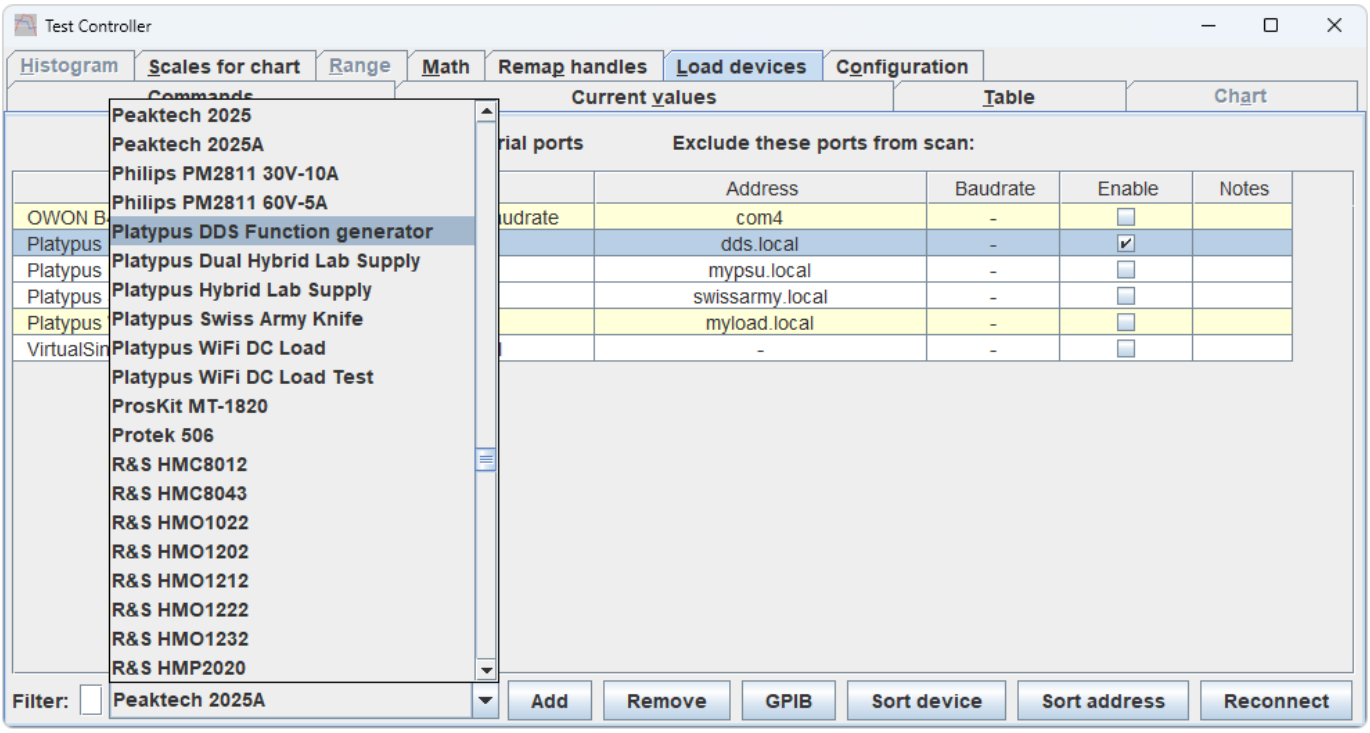
The TestController forum is at
https://www.eevblog.com/forum/testgear/program-that-can-log-from-many-multimeters/

Configuration

- Copy the PlatyDDS.txt device definition file downloaded from the repository into the Devices folder at the location you installed the TestController program. This may require Administrator privileges.
- Copy the PlatyDDS Help.txt file into your Documents > TestController > Settings folder. Once loaded, as you start to type commands, the Help window, below the command line, will display the remaining command options.

The device will be available next time TestController is started.

- Add the device on the Load Device tab. If DHCP is being used, the DNS name of the device (DDS.local) as a better way to identify its Address, as a device's DHCP assigned IP address may change over time.

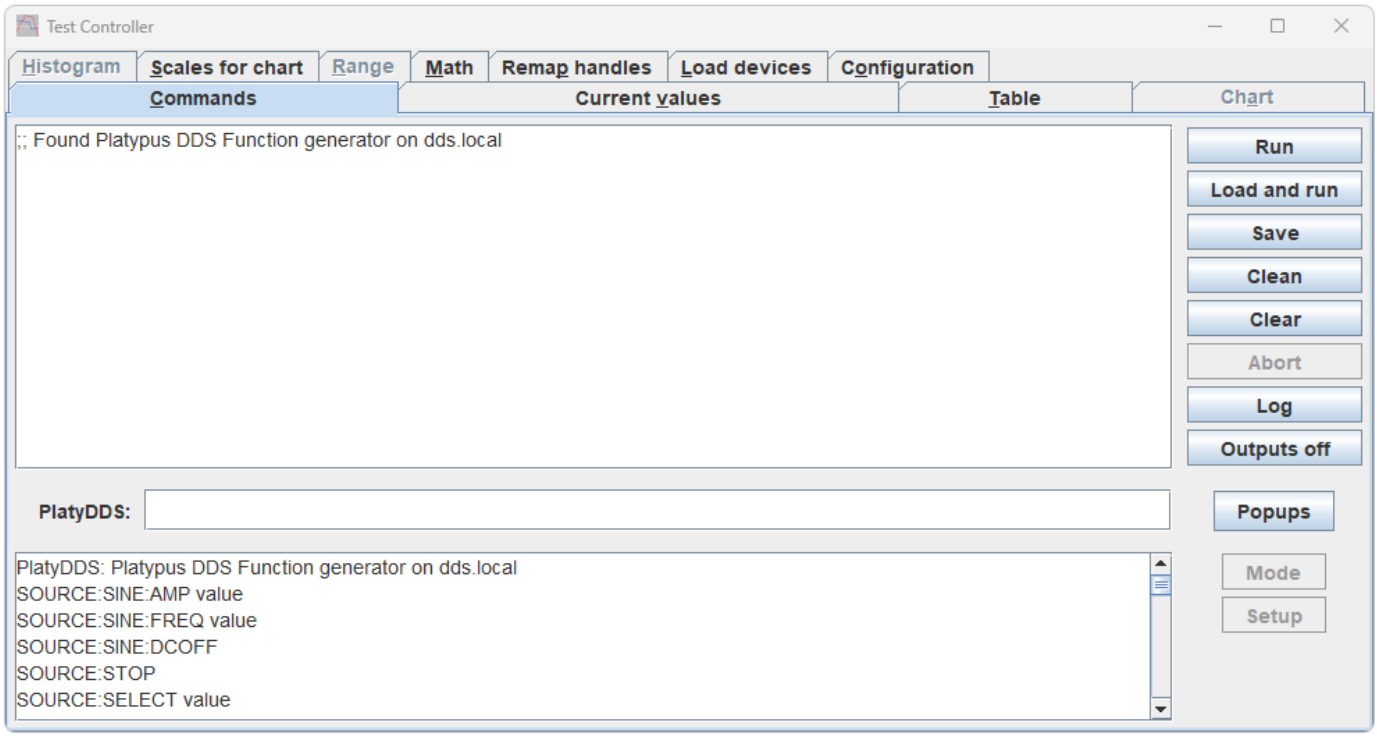


The Load Devices tab with several devices added. The DNS name for the device (DDS.local) or its IP address can be used.

Operation

SCPI commands can be entered directly into the command line, or into the log window to be run as a script.

See https://lygte-info.dk/project/TestControllerIntro%20UK.html#Commands for information on the screen layout.



The main TestController window with the PlatyDDS device selected. The Help window is displaying the command options.

Scripting in TestController

There are two ways to set a value in the controlled instrument:

1 Use the DeviceName followed by a colon (:) and the SCPI command, which begins with an additional colon.
PlatyDDS::SOURCE:WAVE SINE
PlatyDDS::SINE:AMP 2.5

2 Use the command function with the Device name and value
=setWave("PlatyDDS", "SINE")
=setSineAmp ("PlatyDDS", 2.5)
The Device name should be in quotes,
non-numeric arguments should be inside quotes.

The example creates an exponential sine wave amplitude sweep, beginning at 100mV and finishing when the voltage exceeds 5V.

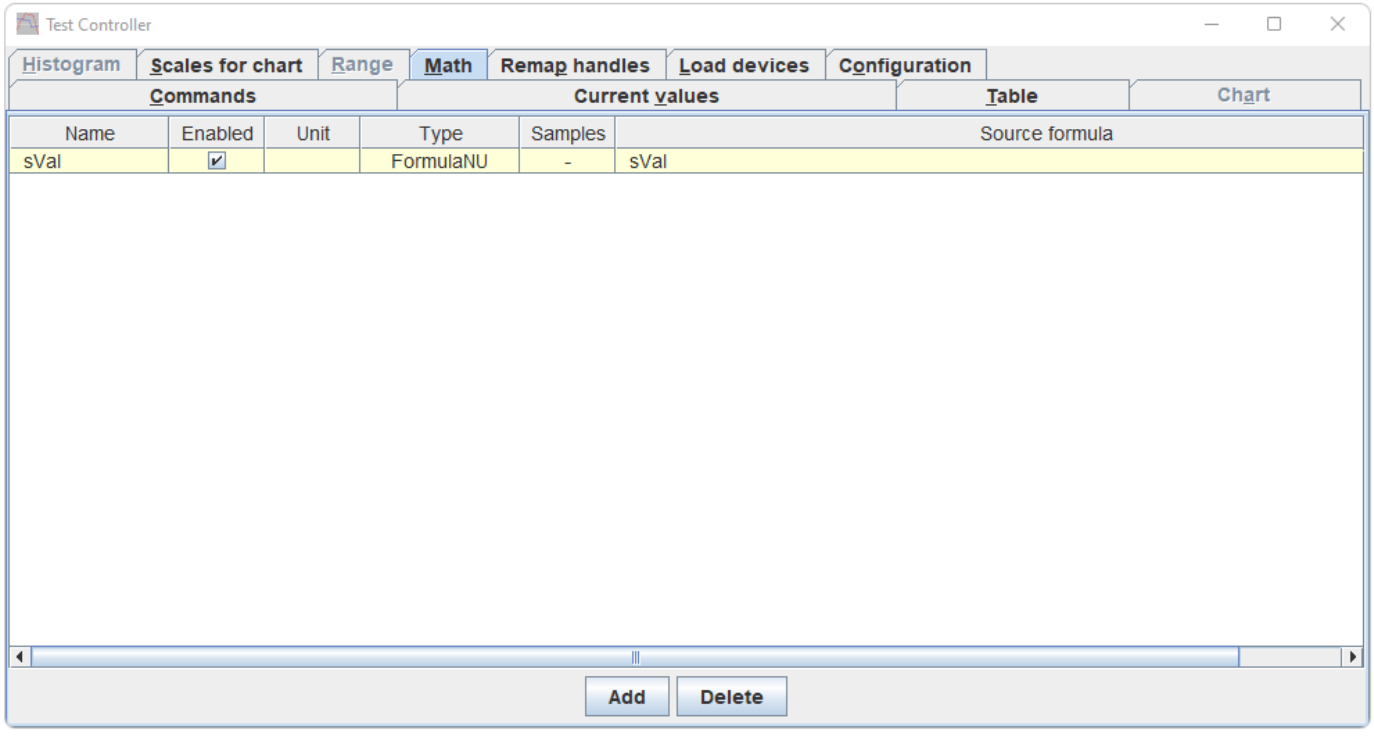
Each cycle waits for 3 seconds for the readings to stabilise and then log the entry, before updating to the next value.

To capture the control variable, sVal, in the log and charts, it must be declared and set, at the top of the code, as a globalvar.

In the Math tab the variable is added, Enabled and given the Type FormulaNU.

https://lygte-info.dk/project/TestControllerMath%20UK.html

```
; Sine log sweep voltage test
; create a control variable that can be logged and set the initial value
=globalvar sVal=0.0
PlatyDDS::SOURCE:SELECT A
PlatyDDS::SOURCE:WAVE SINE
; other values have been set on the Web or LCD screens
PlatyDDS::SINE:AMP (sVal)
PlatyDDS::SOURCE:START
; don't log commands. Log values every 3 seconds
#logcmds 0
#log 3
#haslogged
;wait until value has settled and logged
; for each iteration: update output voltage and wait for logging
#while (sVal<5.0)
  :SINE:AMP (sVal)
  #hasLogged
  =sVal=(sVal*1.2)
#endwhile
#hasLogged ; log final value
#log 0
```



The scripted sVal global variable will not be available for logging or charting unless it has been added and Enabled in the Math tab.

SCPI Communication

Standard Commands for Programmable Instruments (SCPI) was developed in the early 1990's to provide a common syntax and command structure for programmable instruments from power supplies to oscilloscopes and beyond. It was designed as a master-slave protocol, with the controlling software always being master. While it was originally implemented on the GPIB bus (IEEE 488) other protocols, such as serial (including USB serial) and Telnet, are now commonly used.

The IVI Foundation, which is the successor to the non-profit SCPI Consortium, has a website with exhaustive documentation on SCPI and more recently developed, and more flexible instrument communication protocols such as VISA and VXI. https://www.ivifoundation.org/specifications/default.aspx

SCPI commands can be processed from several sources:

- A TELNET connection on Port 5025, for instance from TestController.
- The Pico's serial interface

While USB Serial terminal, such as the Arduino Serial Monitor can also be used, significant care needs to be taken to avoid ground loops. (See the safety warning at the beginning of this document).
It is highly recommended that an *isolated* USB serial connection be used to avoid damage to the computer, instrument or device under test.

SCPI Command Format

Commands consist of non-case-sensitive keywords, separated by colons, and each keyword may have parameters associated with it, e.g. ":SINE:FREQ 300.5" or :sqr:duty 44

Commands ending in a question mark are queries (e.g. ":sine:AMP?"), and the instrument should return a value or set of values to any query.

Parameters may be integers, floating point numbers or strings, depending on the command.

Some SCPI rules for this instrument:

- Commands are not case sensitive. "ABCX" is equivalent to "aBCX"
- There are no abbreviated command forms in this implementation.
- There *must* be one or more spaces between a command and its argument.
- Including type specifiers such as 5.00V in command strings should be avoided.
- String arguments are not enclosed in quotes.
- No other spaces are permitted within or between commands. For instance, ":INST:NAME Fred" (no extra spaces) is legal and ": INST : NAME Fred" (extra spaces) is illegal.
- Colons must be inserted between each command element in a command line.
- Units are Volts, Hz, milliseconds.
- Leading zeros before fractional floating-point arguments are optional, as is a decimal point for values with no fractional part.
- Incorrectly formatted commands will be ignored, with no error message.
- Only one command may be issued on each command line.
- Floating point values are stored as single-precision. Thus, 7 significant figure accuracy is available, but not required.
  Value are generally returned with two decimal places, however accuracy may be limited to less decimal places. See the instrument Specifications table for value limits and accuracy.

In the detailed explanation of commands below

- Square brackets [ ] indicate the type of input required, e.g. [floating point] or [command]
- Angle brackets < > indicate the specific options available, e.g. <ON|OFF> or <CH1|CH2
- Units and limits are noted in parentheses, e.g. (1 - 10 V) or (mS). Ranges may be (1 – 10) or (1 .. 10).

SCPI Argument and Return Value Types

Data type	Description
Float	Floating point number string. A leading zero is not required for values < 1.0 The actual value set may be constrained by limits embedded in the instrument (noted in individual command descriptions).
Int	An integer value string in the 16-bit signed integer. Value ranges are noted in the individual command descriptions.
String	Upper and lower case alpha numeric, plus keyboard symbols, no spaces (ASCII 0x21 .. 0x7E). No quote marks. May be case sensitive.

SCPI Command Quick Reference

- Commands begin with colons and elements are separated by colons (e.g., :INST:SEL A) with the exception of *IDN and *TST.
- Frequencies are in Hz
- Amplitudes are in Volts
- Time is in Milliseconds except for Sweep duration (seconds)
- ? in the Argument column indicates a query command is available.
- Where the argument is <T | F> <1 | 0> may be substituted. Return values are as noted.

Command tree		Argument / Value	Function
*IDN?			Identify instrument
*TST?			Self-test (POST) results
:SOURCE	Change channel parameters.		
	:SELECT	<1|2> <A|B>?	Select the channel for subsequent commands. SWEEP and BURST commands always change or query Channel A.
	:START :STOP		Start or stop the selected channel
	:WAVE	<SINE | IMD | WHITE | SQUARE | TRI | PULSE |STEP > ?	Waveform for the selected channel. IMD on Channel A only.
:SINE	All channels. Bursts in cycles. V sweeps.		
	:FREQ	[n.n] ? (0.01 – 70,000 Hz)	Frequency
	:AMP	[n.n] ? (0 .. 11.5 V p-p)	Amplitude *Combination of Amplitude and DC Offset must be within range.*
	:DCOFF	[n.n] ? (-5.75 .. 5.75 V)	DC offset voltage. Sweep and burst idle values are DCOFF.
:IMD	Channel A only. Affects both channels. Bursts in mS. No sweeps.		
	:F1 F2	[n.n] ? (0.01 – 70,000 Hz)	Set IMD frequencies. (Hz)
	:A1, A2	[n.n] ? (0 .. 11.5 V p-p)	Amplitudes *Sum of amplitudes must be within range.* Burst idle value is 0V.

:WHITE	All channels. Bursts in mS. No sweeps.		
	:AMP	[n.n] ? (0 .. 11.5 V p-p)	Amplitude *Combination of Amplitude and DC Offset must be within range.*
	:DCOFF	[n.n] ? (-5.75 .. 5.75 V)	DC offset voltage Burst idle value is DCOFF
:SQR :TRI	All channels. Bursts in cycles. V, F & D sweeps.		
	:FREQ	[n.n] ? (0.01 – 20,000 Hz)	Set waveform frequency
	:V1 :V2	[n.n] ? (-5.75 .. 5.75 V)	Set low and high voltages
	:DUTY	[n.n] ? (0.0 – 99.99 %)	Set waveform duty cycle
:PULSE	All channels. Bursts in cycles. V sweeps.		
	:V1 :V2	[n.n] ? (-5.75 .. 5.75 V)	Set low and high voltages. Burst idle value is V1 (V Low)
	:TLOW	[n.n] ? (0.1 .. 99,999 mS)	Low time
	:TRISE	[n.n] ?	Rise time
	:THIGH	[n.n] ?	High time
	:TFALL	[n.n] ?	Fall time
:STEP	All channels. Bursts in mS. V sweeps.		
	:V1 :V2	[n.n] ? (-5.75 .. 5.75 V)	Set low and high voltages. Burst idle value is V1 (V Low)
	:SUP	[nnn] ? (1 – 10,000)	Rising steps
	:SDN	[nnn] ?	Falling steps
	:TUP	[n.n] ? (0.1 .. 99,999 mS)	Total time of rising staircase
	:TDN	[n.n] ?	Total time of falling staricase
	:REPEAT	<T|F> ?	Continuously repeat step waveform
:SWEEP	Channel A only Sine, square and triangle only		
	:ENABLE	<T|F> ?	Set to SWEEP mode (F → NORMAL)
	:START :STOP		Start or stop the sweep function Affects Channel A output
	:TYPE	<V|F|D> ?	Frequency, voltage or duty cycle sweep. (only <F|V> for Sine).
	:INITIAL	[n.n] ?	Initial value for sweep type value (other values are taken from underlying waveform settings) (V|Hz|%)
	:FINAL	[n.n] ?	Final value for sweep type value (V|Hz|%)
	:TIME	[n.n] ? (0 – 99,999 S)	Total time for the sweep (S)
	:STEPS	[nnn] ? (1 – 10,000)	Total number of steps for the sweep.

	:LOG	<T | F >?	Linear (F) or Log (T) sweep.
	:REPEAT	<T|F> ?	Restart sweep once completed.
:BURST	Channel A only Sine, square, triangle, step and pulse only.		
	:ENABLE	<T|F>	Enter or exit Burst mode. Affects Channel A (and Channel B– if BALTA is true) output
	:START :STOP		Start or stop burst generation.
	:CYCON	[n.n] ? (0 - 10,000)	Number of active cycles (mS for White Noise and IMD) per burst
	:CYCOFF	[n.n] ?	Number of idle cycles (mS for White Noise and IMD) per burst
	:BALTA	<T|F> ?	Channel B outputs channel A waveform: B active when A is idle. (Overrides :CONT:BCOUPLE)
	:REPEAT	<T|F> ?	Continuous bursts
:CONT	Channel coupling and external triggers. May affect both channels.		
	:COUPLE	<T|F> ?	B channel follows A
	:BPHASE	[n.n] ? (0.00 – 359.99º)	Sine, Sqr, Tri: A-B phase in degrees Pulse, Step: 0 = in phase, else inverted. Other: Ignored (Ignored for Burst mode when BALTA = T)
	:EXTtrig	<T|F> ?	Ext trigger enable
	:INPOL	<+|-> ?	Ext trigger pulse polarity
	:OUTPOL	<+|-> ?	Trigger out polarity
:SYSTEM-	:FACTORY_RESET		Reset EEPROM to factory defaults and restart
	:SSID	[text] (2-32 chars)	Set WiFi SSID *Should always be issued before a :SYSTEM:PASS command.*
	:PASS	[text] (8-63 chars)	Set WiFi password *:SYSTEM:SSID command should be issued first*
	:ERROR?	?	Get last SCPI error
	:IP?	?	Return IP address

SCPI Command Categories

***IDN?**

Command format	*IDN?
Description	Identify the instrument
Query returns	Text string Manufacturer, product type, instrument name, EEPROM (major), software (minor) and hardware versions
Typical return	Platypus,DDS,S2.1_H5

***TST?**

Command format	*TST?
Description	Show the results of the power on self test
Query returns	Text string
Example return	No EEPROM found

:SYSTEM

Command format	:SYSTEM:[command] [value]
Description	Set or query system variables such as hostname and WiFi credentials

:SYSTEM:ERROR?

Command format	:SYSTEM:ERROR?
Description	Get the most recent error message.
Typical return	Bad Sine Freq: '73250.0'

:SYSTEM:SSID

Command format	:SYSTEM:SSID [string]
Description	Set the SSID of a preferred WiFi LAN The SSID must be 8 – 32 characters in length to conform with the 802.11 specification. The argument string is case sensitive and not enclosed in quotes. Restart or send a :WIFI F then :WIFI T sequence to change the web interface URL. There is no query form for this command.
Example	:SYSTEM:SSID MyWiFiSSID

:SYSTEM:PASS

Command format	:SYSTEM:PASS [string]
Description	Set the passphrase for the last entered SSID. If no previous :SSID command was sent, the passphrase to WiFi ID 1 will be changed. The argument string is case sensitive and not enclosed in quotes. The passphrase must be 8 – 32 characters in length to conform with the 802.11 specification. Restart or send a :WIFI F then :WIFI T sequence to change the web interface URL. There is no query form for this command.
Example	:SYSTEM:PASS mYpaSssWord123

:SYSTEM:IP?

Command format	:SYSTEM:IP?
Description	Get the current IP address string for the unit.
Typical return	192.168.1.33

:SYSTEM:FACTORY_RESET

Command format	:SYSTEM:FACTORY_RESET
Description	Reset the unit to its default settings. Clears WiFi, calibration, waveform and control settings. There is no query form for this command.

RESTart

Command format	:SYSTEM:RESTart
Description	Restart the web interface. Used after changing HOSTname, SSID or PASSphrase
Example	:SYST:REST

:CONT

Set or query a Control settings.

:CONT:BCOUPLE

Command format	:CONT:BCOUPLE < T | F > :CONT:BCOUPLE?
Description	Set or clear channel A-B coupling.
Query returns	Singe character
Example return	T

:CONT:PHASE

Command format	:CONT: PHASE [float] :CONT: PHASE?
Description	Set the phase relationship, in degrees, between channels A-B when coupled. [0..359.99] B lags A.
Query returns	Floating point number
Example return	35.000

:CONT:EXT

Command format	:CONT: EXT < T | F > :CONT: EXT?
Description	Set or disable external triggering.
Query returns	Single character
Example return	F

:CONT:INPOL

Command format	:CONT: INPOL < + | – > :CONT: INPOL?
Description	Set the polarity of the external trigger input, when enabled. + triggers on a high level – triggers on a low level Re-triggering is disabled until the trigger *output* resets.
Query returns	Single character
Example return	+

:CONT:OUTPOL

Command format	:CONT: OUTPOL < + | – > :CONT: OUTPOL?
Description	Set the polarity of the external trigger output. +: High level at the start of the waveform or sequence. -: Low level at the start of the waveform or sequence. See Table 1.
Query returns	Single character
Example return	+

:SWEEP

Set or query a Sweep mode setting.

:SWEEP:ENABLE

Command format	:SWEEP:ENABLE <T|F> :SWEEP:ENABLE?
Description	Enter or exit Sweep mode. Sweep uses channel A values other than indicated by the Sweep Type (see :SWEEP:INITIAL and :SWEEP:FINAL).V Query returns whether in Sweep mode.

Example	:SWEEP:ENABLE T
Query returns	Single character: T (Sweep mode) or F (not sweep mode)
Typical return	T

:SWEEP:START|STOP

Command format	:SWEEP:<START|STOP>
Description	Start or stop the sweep function. See also :SWEEP:REPEAT
Example	:SWEEP:START

:SWEEP:TYPE

Command format	:SWEEP:TYPE <V|F|D> :SWEEP:TYPE?
Description	Set or return the type of sweep V = voltage: V High for square, triangle and pulse; amplitude for sine F = frequency (triangle, square, sine) D = duty (square and triangle only)
Example	:SWEEP:TYPE V
Query returns	Single character: Type
Typical return	V

:SWEEP:INITIAL

:SWEEP:FINAL

Command format	:SWEEP:INITIAL<value> :SWEEP:INITIAL? :SWEEP:FINAL<value> :SWEEP:FINAL?
Description	Set or return the sweep start or end value (voltage, frequency or duty cycle, depending on the Sweep Type). Value limits are as for the underlying waveform. Channel B Coupling is allowed.
Example	If sweep type is V, set the sweep start value to 2.5V :SWEEP:INITIAL 2.5
Query returns	Floating point: Set value
Typical return	2.5

:SWEEP:TIME

Command format	:SWEEP:TIME <n.nn> :SWEEP:TIME?
Description	Set or return the total time of the sweep in seconds [0 – 99,999 S]
Example	Set the sweep time to 2.5 seconds :SWEEP:TIME 2.5
Query returns	Floating point, seconds.

Typical return	2.50

:SWEEP:STEPS

Command format	:SWEEP:STEPS <n> :SWEEP:STEPS?
Description	Set or return the number of steps in the sweep
Example	:SWEEP:STEPS 5
Query returns	Floating point: sweep steps
Typical return	5.00

:SWEEP:LOG

Command format	:SWEEP:LOG <T|F> :SWEEP:LOG?
Description	Set or return whether the sweep is logarithmic or linear
Example	Set a logarithmic sweep :SWEEP:LOG T
Query returns	Single character: T or F
Typical return	T

:SWEEP:REPEAT

Command format	:SWEEP:REPEAT <T|F> :SWEEP:REPEAT?
Description	Set or return whether the sweep repeats continuously on completion
Example	:SWEEP:REPEAT <T

:BURST

Set or query a Burst mode setting. Burst usee the settings of channel A. Affects channel B operation if BaltA is set.

:BURST:ENABLE

Command format	:INST: BURST:ENABLE < T | F > :INST: BURST:ENABLE?
Description	Enter or exit Burst mode. Affects channel B operation if BaltA is set. Query returns whether in Burst mode.
Example	:INST:BURST:ENABLE T
Query returns	Single character: T (Burst mode) or F (not Burst mode)
Typical return	T

:BURST:START and :BURST:STOP

See also :BURST:REPEAT

Command format	:BURST:START :BURST:STOP
Description	Start or stop burst generation. Seer also :BURST:REPEAT There are no query versions of these commands.

:BURST:CYCSON and :BURST:CYCSOFF

Command format	:BURST:CYCSON <integer or float> :BURST:CYCSOFF <integer or float> :BURST:CYCSON? :BURST:CYCSOFF?
Description	Set or read the number of on or off cycles (mS for IMD and White Noise) of the burst.
Example	:BURST:CYCSON 12
Query returns	Floating point number
Typical return	12.00

:BURST:BALTA

Command format	:BURST:BALTA < T | F > :BURST:BALTA?
Description	Set or read whether channel B will output alternate bursts to channel A. Channel A settings are used for Channel B when BaltA is set.
Example	:BURST: BALTA T
Query returns	Single character
Typical return	T

:BURST:REPEAT

Command format	:BURST: REPEAT < T | F > :BURST: REPEAT?
Description	Set or read whether a single or continuous burst cycles will be generated.
Example	:BURST: REPEAT T
Query returns	Single character
Typical return	T

:SOURCE

All waveform generation is controlled by :SOURCE commands.

For instance :SINE:FREQ 1000 will set the frequency of the previous :SOURCE:SELECT command channel but WILL NOT change the waveform currently being generated.

It is necessary to issue a :SOURCE:WAVE SINE command to change the waveform to be generated for the last selected channel.

:SOURCE:SELECT

Command format	:SOURCE:SELECT <1 | A | 2 | B> :SOURCE:SELECT?
Description	Set or query the channel for following waveform settings
Example	:SOURCE:SELECT A

Query returns	A = 1 B = 2
Typical return	1

:SOURCE:START and :SOURCE:STOP

Command format	:SOURCE:START :SOURCE:STOP
Description	Start or stop waveform generation for the last selected channel. There is no query form of this command.
Example	:SOURCE:START

:SOURCE:WAVE

Command format	:SOURCE:WAVE <SINE | IMD | WHITE | SQUARE | TRI | PULSE |STEP> :SOURCE:WAVE?
Description	Set or query the waveform being generated by the last selected channel. The waveform argument it not case-sensitive. There is no query form of this command. Channel B does not support WHITE or IMD waveforms.
Example	:SOURCE:WAVE SINE
Query returns	Capitalised string
Typical return	Sine

:SINE

Sine wave settings affect channel A or B, depending on the last :SOURCE:SELECT command.

If the result of the Amplitude and DC Offset settings exceeds the maximum (11.5V) voltage range, the command will be rejected and an error generated (see :SYSTEM:ERROR?).

Sweep and burst idle values are 0V.

V & F sweeps are permitted.

:SINE:FREQ

Command format	:SINE:FREQ <float> :SINE:FREQ?
Description	Set or query the Sine frequency [0.01 – 70,000] in Hz.
Example	:SINE:FREQ 1234.56
Query returns	Float
Typical return	1234.56

:SINE:AMP

Command format	:SINE:AMP <float> :SINE:AMP?
Description	Set or query the Sine peak-to-peak amplitude [0 .. 11.5] in Volts. If the result of the Amplitude and DC Offset exceeds the maximum range, the command will be rejected and an error generated.
Example	:SINE:AMP 5.0
Query returns	Float

Typical return	5.000

:SINE:DCOFF

Command format	:SINE:DCOFF <float> :SINE:DCOFF?
Description	Set or query the Sine 'zero' crossing point DC offset [-5.75 .. 5.75] in Volts. If the result of the Amplitude and DC Offset exceeds the maximum range, the command will be rejected and an error generated.
Example	:SINE:DCOFF 1.0
Query returns	Float
Typical return	1.000

:IMD

IMD waveform settings always affect channel A.

If the sum of the two amplitude settings settings exceeds the maximum (11.5V) voltage range, the command will be rejected and an error generated (see :SYSTEM:ERROR?).

Sweep and burst idle values are 0V.

V sweeps are permitted.

:IMD:FREQx

Command format	:IMD:FREQ1 <float> :IMD:FREQ2 <float> :IMD:FREQ1? :IMD:FREQ2?
Description	Set or query the IMD frequencies [0.01 – 70,000] in Hz.
Example	:IMD:FREQ1 1234.56
Query returns	Float
Typical return	1234.56

:IMD:AMPx

Command format	:IMD:AMP1 <float> :IMD:AMP2 <float> :IMD:AMP1? :IMD:AMP2?
Description	Set or query the Sine peak-to-peak amplitude [0 .. 11.5] in Volts. If the sum of the two Amplitudes exceeds the maximum range, the command will be rejected and an error generated.
Example	:IMD:AMP1 5.0
Query returns	Float
Typical return	5.000

:WHITE

White noise settings affect channel A or B, depending on the last :SOURCE:SELECT command.

If the result of the Amplitude and DC Offset settings exceeds the maximum (11.5V) voltage range, the command will be rejected and an error generated (see :SYSTEM:ERROR?).

Burst idle value is DCOFF. No sweeps are permitted.

:WHITE:AMP

Command format	:WHITE:AMP <float> :WHITE:AMP?
Description	Set or query the White noise peak-to-peak amplitude [0 .. 11.5] in Volts. If the result of the Amplitude and DC Offset exceeds the maximum range, the command will be rejected and an error generated.
Example	:WHITE:AMP 5.0
Query returns	Float
Typical return	5.000

:WHITE:DCOFF

Command format	:WHITE:DCOFF <float> :WHITE:DCOFF?
Description	Set or query the White noise ‘zero’ crossing point DC offset [-5.75 .. 5.75] in Volts. If the result of the Amplitude and DC Offset exceeds the maximum range, the command will be rejected and an error generated.
Example	:WHITE:DCOFF 1.0
Query returns	Float
Typical return	1.000

:SQR

Square wave settings affect channel A or B, depending on the last :SOURCE:SELECT command.

Sweep and burst idle values are V1 (V Low).

V, F & D sweeps are permitted.

:SQR:FREQ

Command format	:SQR:FREQ <float> :SQR:FREQ?
Description	Set or query the Square wave frequency [0.01 – 20,000] in Hz.
Example	:SQR:FREQ 1234.56
Query returns	Float
Typical return	1234.56

:SQR:V1 or :SQR:V2

Command format	:SQR:V1 <float> :SQR:V2 <float> :SQR:V1? :SQR:V2?
Description	Set or query the square wave’s V1 (V Low) or V2 (V High) voltage [-5.75 .. 5.75] in Volts.
Example	:SQR:V1 5.0
Query returns	Float
Typical return	5.000

:SQR:DUTY

Command format	:SQR: DUTY <float> :SQR: DUTY?
Description	Set or query the Square wave duty cycle [0 .. 99.99] in percent.
Example	:SQR: DUTY 45.0
Query returns	Float
Typical return	45.000

:TRI

Triangle waveform settings are the same as for Square waves.

:PULSE

Pulse wave settings affect channel A or B, depending on the last :SOURCE:SELECT command.

V sweeps are permitted.

:PULSE:V1 or :PULSE:V2

Command format	:PULSE:V1 <float> :PULSE:V2 <float> :PULSE:V1? :PULSE:V2?
Description	Set or query the Pulse V1 (V Low) or V2 (V High) voltages [-5.75 .. 5.75].
Example	:PULSE:V1 4.56
Query returns	Float
Typical return	4.56

PULSE:TLOW or :PULSE:THIGH or PULSE:TRISE or PULSE:TFALL

Command format	:PULSE:TLOW :PULSE:THIGH :PULSE:TRISE :PULSE:TFALL :PULSE:TLOW? :PULSE:THIGH? :PULSE:TRISE? :PULSE:TFALL?
Description	Set or query the pulse waveform’s four cycle time settings [0 .. 99,999] in mS.
Example	:PULSE:THIGH 15.0
Query returns	Float
Typical return	5.000

:STEP

Step wave settings affect channel A or B, depending on the last :SOURCE:SELECT command.

V2 sweeps are permitted (V High).

:STEP:V1 or :STEP:V2

Command format	:STEP:V1 <float> :STEP:V2 <float> :STEP:V1? :STEP:V2?
Description	Set or query the Step V1 (V Low) or V2 (V High) voltage [-5.75 .. 5.75].
Example	:STEP:V1 4.56
Query returns	Float
Typical return	4.56

:STEP:SUP or :STEP:SDN

Command format	:STEP: SUP :STEP: SDN :STEP:SUP? :STEP: SDN?
Description	Set or query the STEP waveform's steps up or down [1 .. 10,000]
Example	:STEP:SUP 15
Query returns	Float
Typical return	15.000

:STEP:TUP or :STEP:TDN

Command format	:STEP: TUP :STEP: TDN :STEP:TUP? :STEP:TDN?
Description	Set or query the STEP waveform's total time for the up or down ramp [0.1 .. 99,999] mS
Example	:STEP:TUP 15
Query returns	Float
Typical return	15.000

Circuit Design Overview

The design and construction of this project is described in greater detail in the 2024 Silicon Chip article.

The RP2040 Pico W handles all communication and DDS calculation. The PCM5102 module, connected via I2S at 24-bit / 192kHz, creates the two signal channels which are then filtered and buffered by a 2-pole Salley-Key active filter implemented with an NE5532, with a corner frequency of 120kHz. The buffer has a gain of two, providing +/- 5V p-p outputs capable of driving 600 ohm loads.

The 12V input supply is reduced to 9V and then to 5V for the Pico W. The two stage regulation process shares heat dissipation between the two regulators.

The op-amp minus 9V supply is provided by a MAX1044, operating in boost mode to reduce in-band noise.

Software Overview

CPU0 handles all communications, the touch screen, files and EEPROM, leaving CPU1 solely to calculate DDS signals.

Even with integer-based sine calculations, it is necessary to overclock at 240 MHz to ensure stable generation of two simultaneous sine waves when WiFi-based functions are enabled.

Construction Overview

A Bill of Materials and construction details are included in the associated Silicon Chip article published in 2024.

Specifications

Item	Value	
DDS	Sample frequency:	192kHz
	SNR:	89dB
Analogue Output	Voltage:	+/- 5.25V > 600 Ohms, 3V p-p into 50 Ohms
	Current:	30mA max
	Resolution:	10mV steps, rounded down by software
	Linearity	< 0.5%
Sine	Frequency:	0.1 to 80,000 Hz
	Resolution	0.01 Hz, reducing to 1Hz @ 70kHz
	Accuracy	0.01 Hz below 10kHz, Amplitude: 0.01% to 20kHz -1% @ 70kHz
	Amplitude:	0.01 – 11.5V p-p (4.0 V RMS)
	DC Offset	+/- 5V max
	Distortion:	<0.005% 20Hz – 20kHz) < 0.007% (1Hz – 60kHz)
Square, Triangle, Pulse	Frequency:	0.1 to 20 kHz (min 50uS cycle) (distortion increases above 10 kHz)
	Rise/fall time	5 uS (up to 8V change)
	Time Resolution	0.01mS
	Accuracy	+/- 1 sample 0.25 Hz @ 100 Hz 2.5 Hz @ 1kHz, rising to 25Hz @ 10kHz
	Overshoot	<8% (square wave) 0% (triangle)
	Amplitude:	+/-5.75V max
Trigger Inputs	3.3V logic, 5V tolerant	
	3.3V logic current:	50nA
	5V logic current:	< 0.3mA active, 50nA idle
	Trigger delay:	8-13mS (waveform change lags trigger signal)
Trigger Output	3.3V logic	
	Maximum drive:	12mA
	High output:	> 2.6V
	Low output:	< 0.33V
	Waveform delay:	8-13mS (waveform change lags trigger signal)
DC input	12VDC 250mA or greater, double insulated Positive pin, 5.5mm coaxial plug.	

Dimensions	Case: PCB:	114x200x40mm 142mm X 83.5mm

Communication

Remote control connections	
WiFi	802.11 b/g/n/e/i Auto-connect to the SSID/passphrase combinations set in the profile.json file or by SCPI :SYSTEM: commands. WPS is not supported. IP addresses are exclusively gained from WiFi LAN DHCP other than within AP mode. The current IP address is displayed at startup on the Serial Monitor (115,600 baud) and is available via SCPI command or on the LCD screen Set>Com menu. DNS name is DDS.local (via an mDNS responder) unless the HOSTname has been changed via the SCPI command :SYST:HOSTname Note: Some devices (particularly Android) do not resolved xxx.local DNS addresses correctly. For these devices the IP address must be used. If none of the stored networks (SSIDs) are available, an Access Point is set up:
WiFi Access Point (AP) mode	SSID: PICOW Pass: PW123456
Telnet	Port: 5025 SCPI commands accepted and results returned. Functionality has been tested with the open source software TestController, and an instrument definition file for this software is included in the project's downloads. https://lygte-info.dk/project/TestControllerIntro%20UK.html
Web (HTTP)	A web interface allows most settings can be altered and most actions initiated. Calibration and Communication settings are not available via the web interface. Port: 80 http://DDS.local normal operation http://DDS.local/utility file manager functions. http://IPaddress http://IPaddress/utility **The web page is and not secured or encrypted.**
Isolated USB Serial	**Damage may occur if a non-isolated USB connection is used.** Baud rate: 115,200 SCPI commands accepted and results returned.

Indicators and Troubleshooting

WiFi Indicator LED

The WiFi indicator LED flashes while attempting to connect to saved WiFi parameters.

It is ON when connected, or OFF if connection fails.

The LED changes state for two seconds when an EEPROM save is occurring.

Command Checking and Messages

While the TFT and web control panels have basic limit checking enabled, preventing values being set outside established limits. However, there are cases where a combination of settings may produce erroneous operation.

SCPI commands, however, can contain any values the issuer sees fit to send. The SCPI command processor checks command values before committing them.

Generally, setting combinations that will cause the signal generator to exceed its limits are identified and refused. For instance, a sine wave with an amplitude of 10V p-p and a DC Offset of 5V will exceed the +5.75V maximum output voltage limit. When this occurs, a SCPI command is ignored.

For the browser and LCD interfaces, the following behaviour occurs:

- Sine wave and White Noise: Amplitude is reduced to accommodate the DC Offset setting.
- IMD: Amplitude 2 is reduced to accommodate the Amplitude 1 setting.

Generally, a warning message is displayed on the screen and browser interface.

Remediation for all error and warning messages is to issue a legitimate control request!

Message	**Type**	**Applies to**	**Possible cause**
No output		All waveforms	Zero value settings.
Value outside limits		All waveforms	A value has been entered by a SCPI command that is outside the allowed maximum and minimum values. The TFT and web control panels have inbuilt limit checking. (see above)
Amp + Offset too big		Sine and White noise	The sum of Amplitude and DC offset are beyond the allowed limits.
A1 + A2 too big		IMD	For IMD, A1 + A2 must be less than the maximum amplitude allowed for sine waves.
B settings disabled in BURST + BaltA		Burst mode	When BaltA is enabled in Burst mode, settings for Channel B are ignored.
B settings disabled in COUPLED mode		All waveforms	When B=A is enabled in the Control panel, settings for Channel B are ignored. Burst mode BaltA overrides this setting.

Other issues

Symptom	Likely cause	Remediation
Setting value changes on wrong channel.	Another channel has been selected on the screen or by another remote control interface (e.g. SCPI, Web)	Only use one method of controlling the unit at a time.
Voltage reading or output incorrect.	Calibration not completed.	See the *Calibration* sections.
Can't access instrument (Web page or Telnet) remotely.	Wifi not connected. AC not set in Set>Com menu. Network parameters incorrect.	See *Changing Communication Settings* and *Specifications – WiFi* sections.
Can't access web interface using hostname.	Duplicate hostname. On some WiFi LANs the hostname mode may not work due to router or operating system configurations.	Resolve duplicate hostname. Use the IP address found in the Set>Com menu.
Other		Serial monitor messages at start-up or during operation may provide insight.